The Application of Additive Manufacturing in the Field of Model Rocketry

or

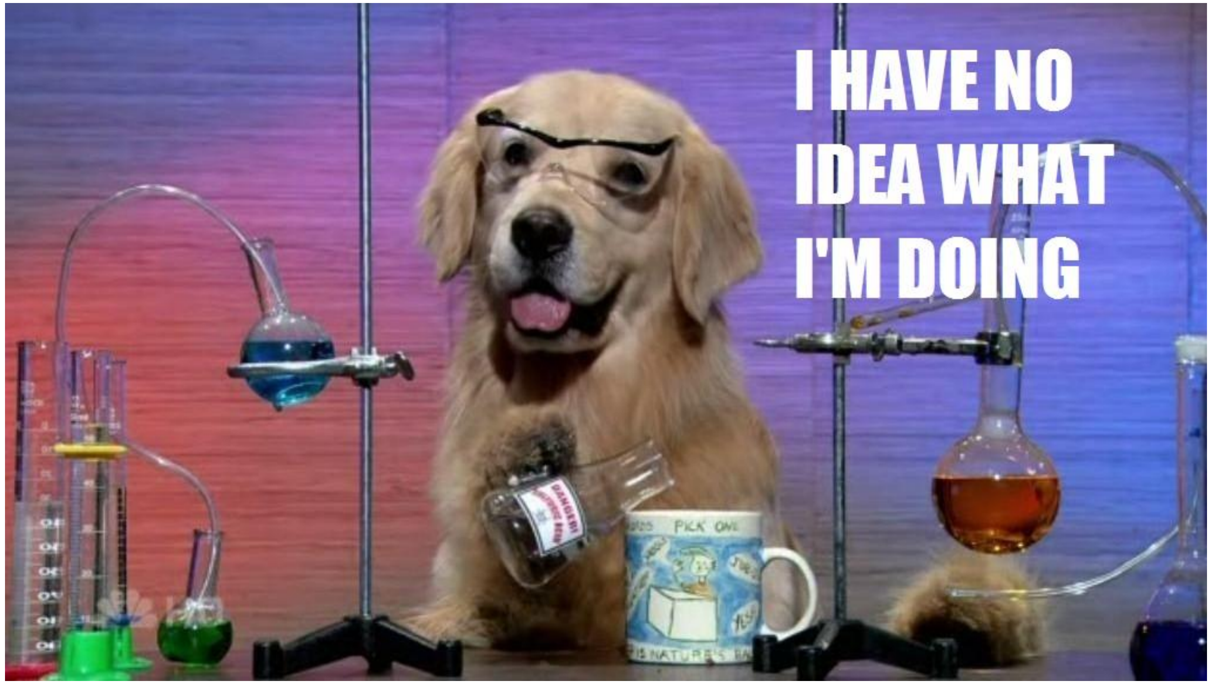
How I learned to build really heavy rockets with a fancy hot glue gun

In This Presentation…

- I have no idea what I’m doing
- Printer background
- General design considerations
- Rocket specific considerations (aka, why you are here)
- Example Rocket

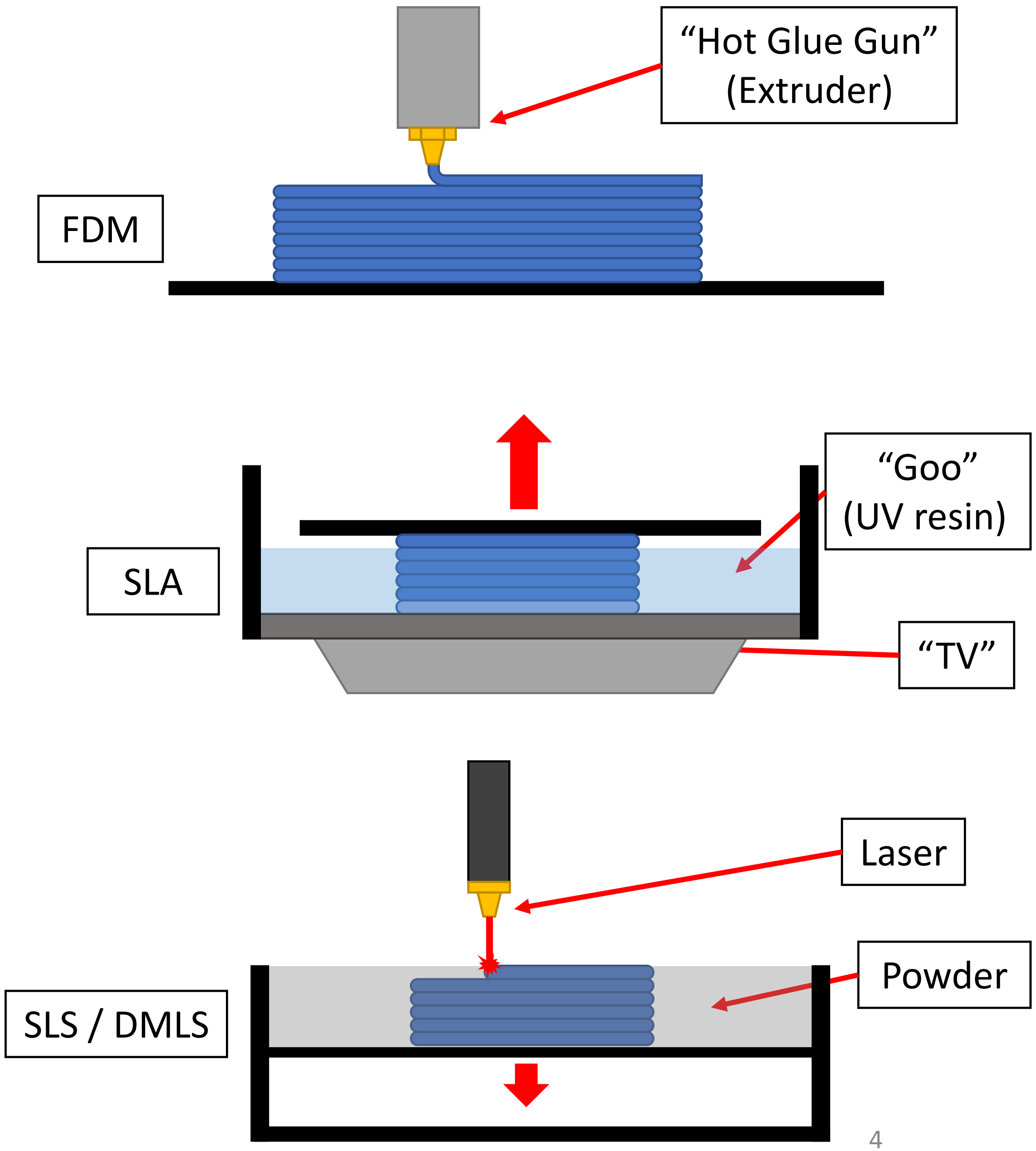
Disclaimer!

- I am not a 3D printer guy, just a guy who 3D prints
- I trial-and-errored my way to victory
  - The information here is not “the one true way”….
  - … but it is “a way”



How do work?

- All work using layers
  - 3D model is "sliced" into layers of a specific thickness
    - Usually 0.1mm to 0.2mm (4 to 8 thou in 'murrican)
  - Printer "draws" each layer on top of the previous layer
- Many different types
  - FDM – Fused Deposition Modeling (hot glue gun)
  - SLA – Stereolithography (TVs and fancy goo)
  - SLS – Selective Laser Sintering (shoot laser at ~~corn starch~~ powdered plastic)
  - DMLS – Direct Metal Laser Sintering (shoot laser at rocket fuel)
  - And many more…
- Most hobby printers are FDM, so I will focus on those

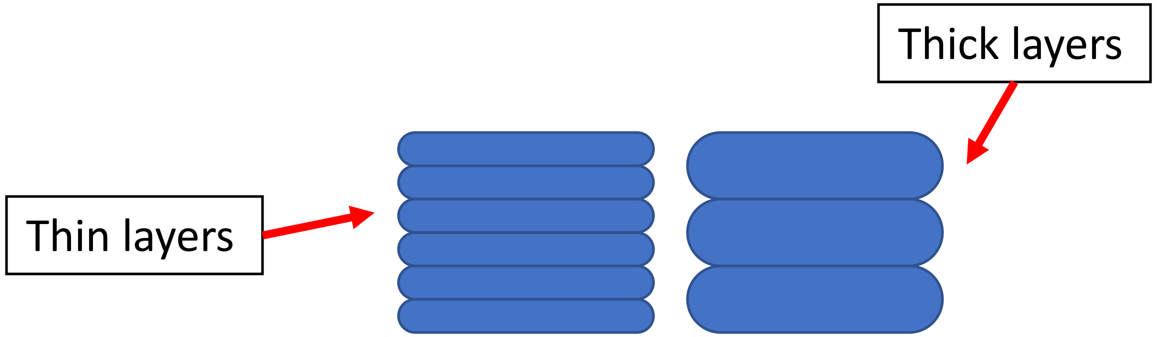


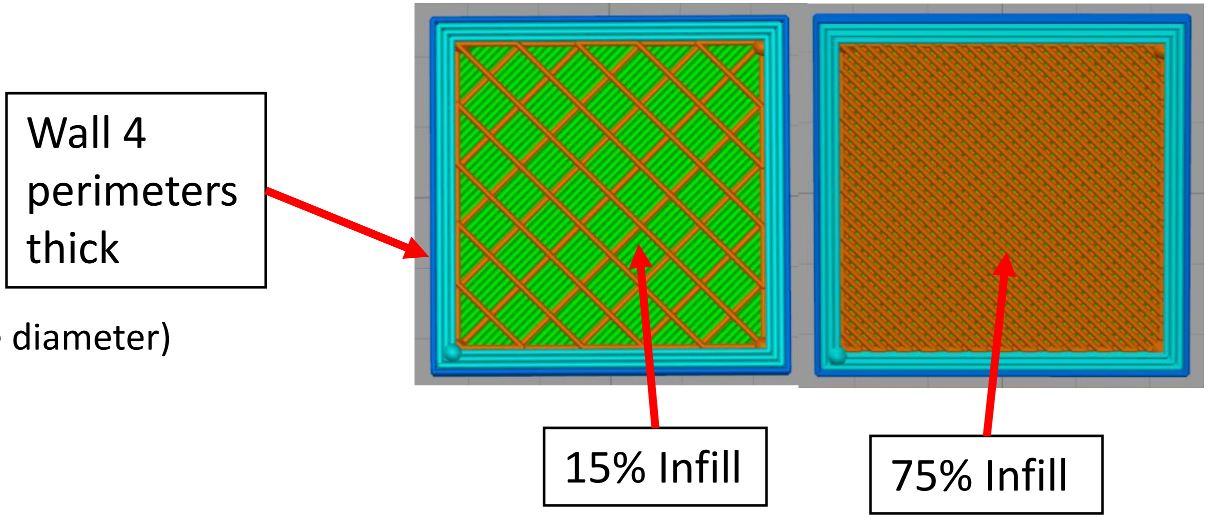
NOT MAGIC

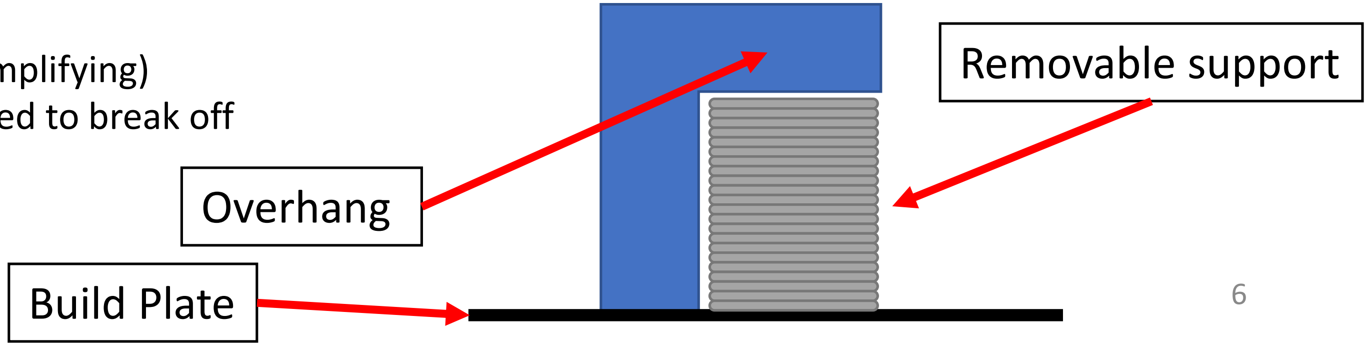
- Important to note that printers are not magic
- Just like every other form of manufacturing, they have their pros and cons
- Pros:
  - Can create geometries that are not possible by traditional machining
  - It’s almost like a replicator (that “almost” is important)
  - Low “hands on” time (you aren’t running it like a lathe, can leave it alone)
  - Don’t need to worry about getting a tool into tight places
- Cons:
  - Can’t create geometries that can be made by traditional machining
  - Still finicky to get working
  - Material properties (for hobby printers) are horrible
  - Surface finish is horrible
  - Slow printing speeds - “You are extruding your part through a 0.4mm nozzle; it’s going to take a long time”.

Design Considerations

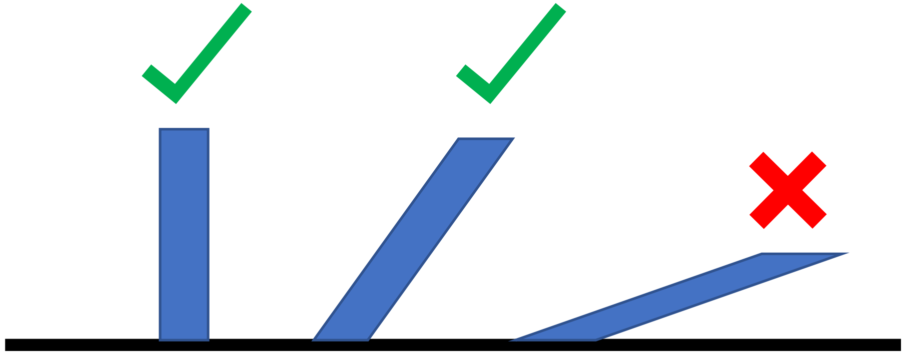
- Nozzle Diameter
  - Larger nozzle, faster print (more stuff coming out)
  - Also have poorer quality (pen vs marker)
- Layer height
  - Similar to nozzle diameter (speed vs quality)
  - Controlled by software instead of hardware
- Wall thickness
  - Usually set in “perimeters” or “shells” (multiples of nozzle diameter)
  - Design thin parts to be in multiples of nozzle diameter
- Infill
  - Part “density”
  - Different styles (grid, hex, triangle, “weird stuff”)
  - Strength not linear (50% infill stronger than 50% max strength)
- Support
  - Can’t print in thin air (well…., you can but I’m simplifying)
  - Structure that supports overhangs and is designed to break off
  - Has very bad surface finish



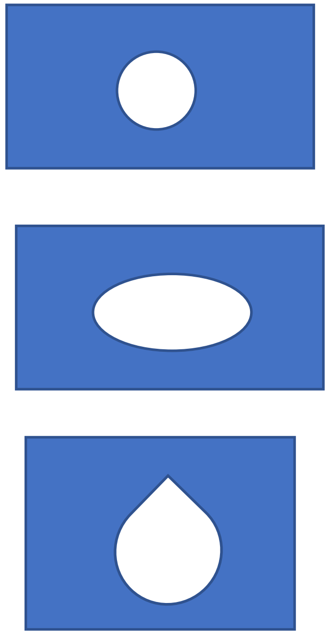




Geometry Tips

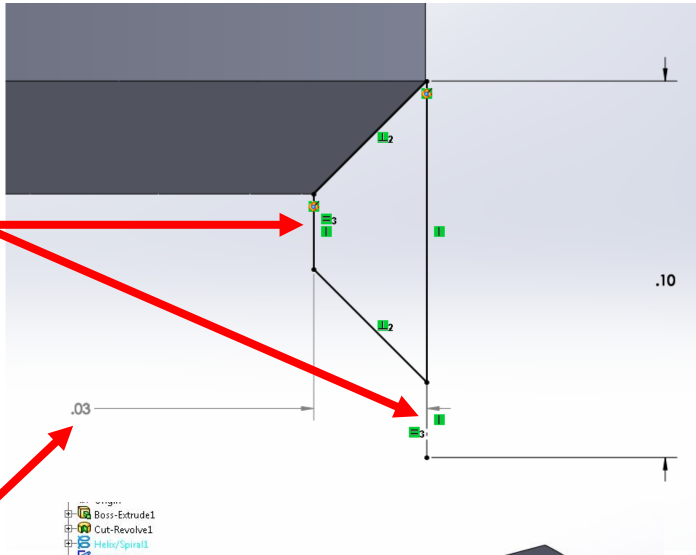


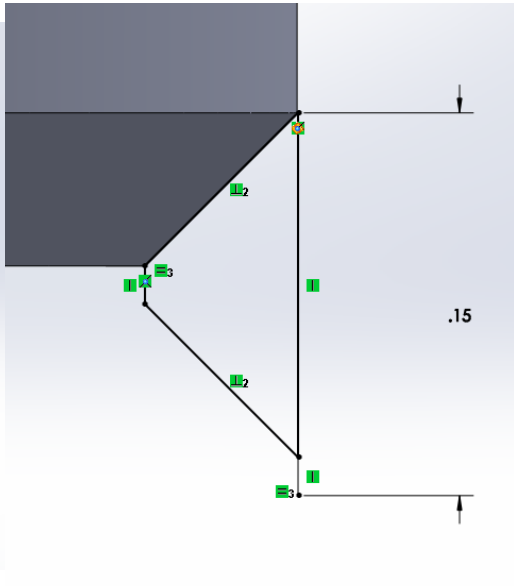
- Overhangs
  - Generally, there is a maximum overhang angle that can be printed (~45^0)
  - Use angles instead of full horizontal to avoid support material
    - Wasted material ($)
    - Wasted time
- Holes (the horizontal kind)
  - Small holes are generally fine (~1/4”)
  - Larger holes will have “sag”
  - Teardrop holes can help with this
    - Keeps overhangs within 45^o
    - Assumes you just need a “hole” (not round)
    - Can use support for circular holes



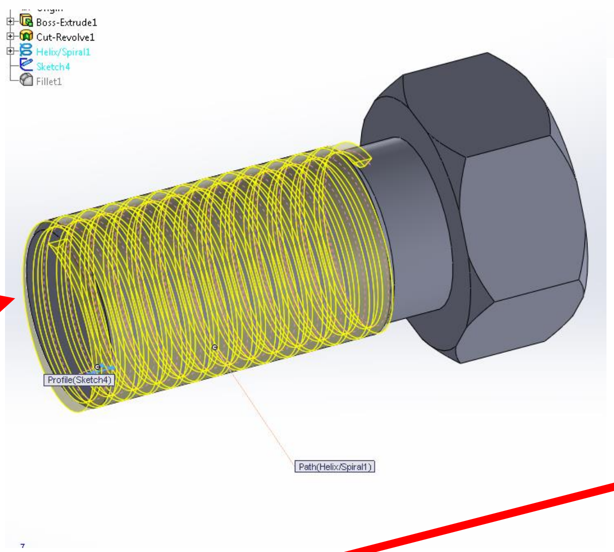
Threads

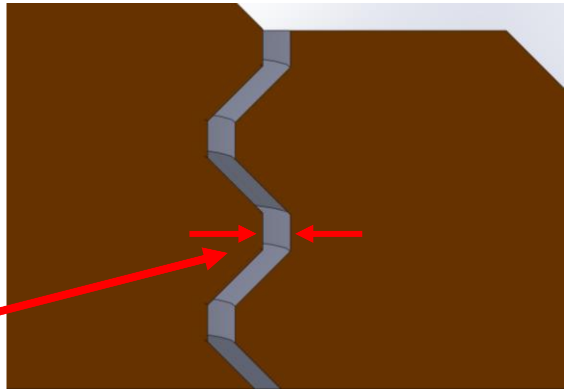
Equal length constraint

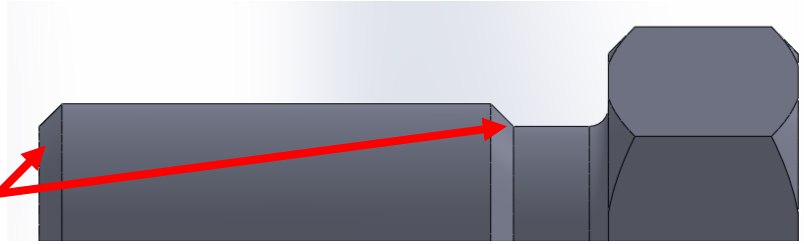




- Many standards, so I made my own (XKCD comic #927)
  - Revolved 90º trapezoid
  - Two flavors:
    - 0.1” thread pitch
    - 0.15” thread pitch
    - Any diameter you want
- Created by making a profile…
  - 0.1” pitch uses a 0.03” deep cut
  - 0.15” pitch uses a to 0.06” deep cut
- …then revolving it around a helix
- Diameter difference between internal and external threads varies with diameter and desired slop
  - Test prints are required to determine the correct gap
  - Usually in the 10 thou to 15 thou range



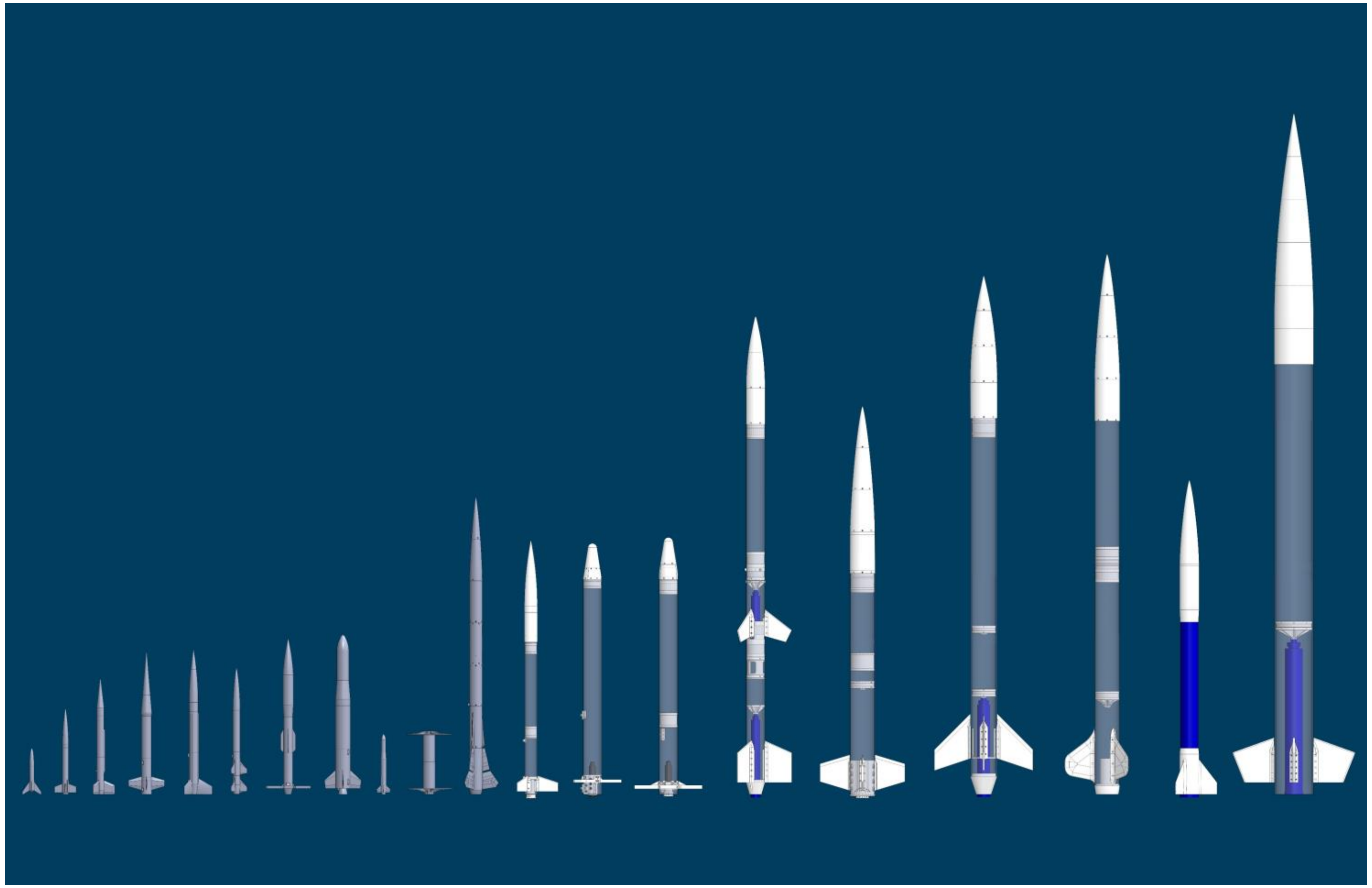




Chamfer start and end of threads

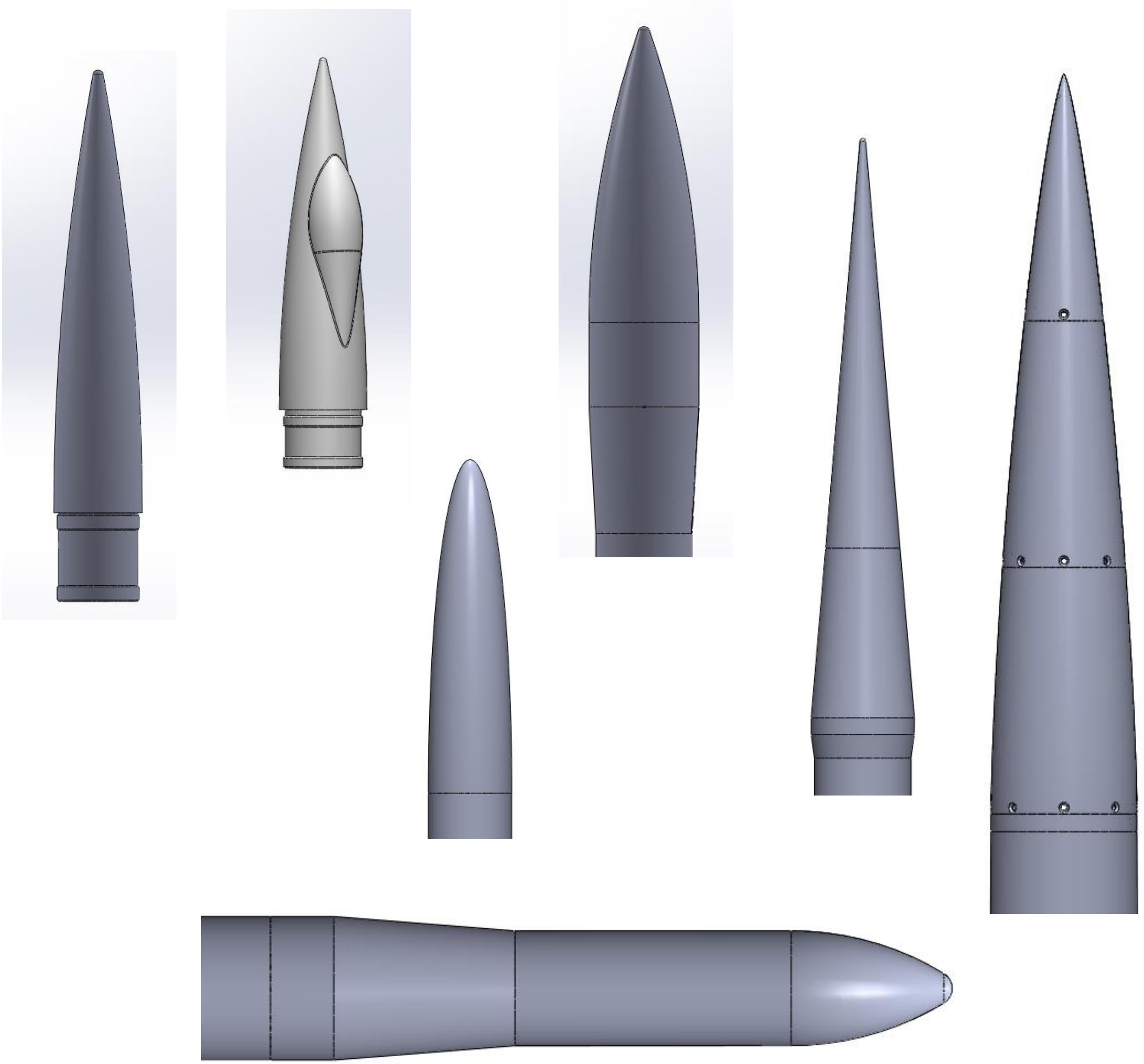
Rocket Stuff!!!!1 (finally)

- Nose cones
- Body Tubes
- Motor Mounts
- Fins
- Etc…..



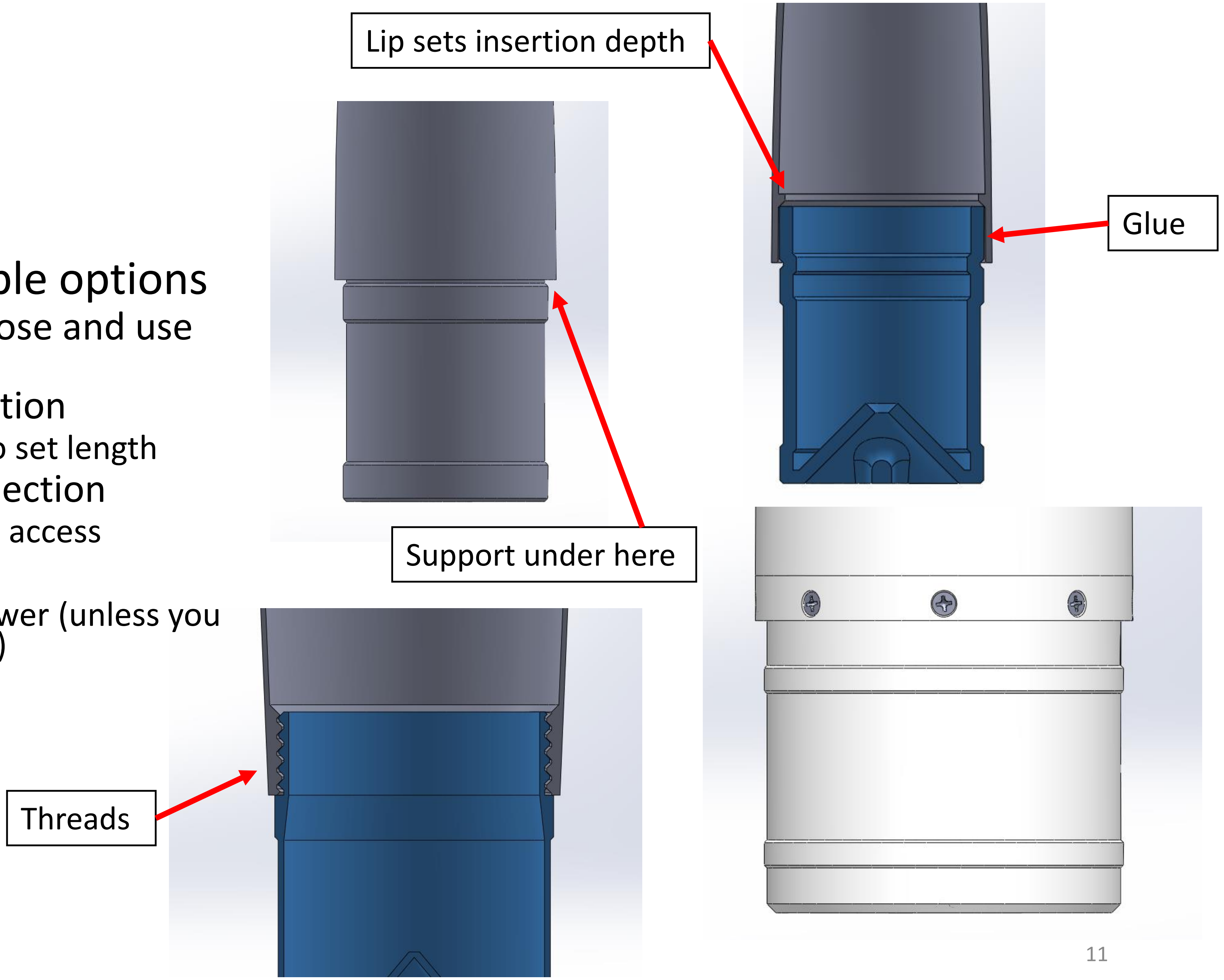
Nose Cones

- Shape only limited by your CAD skills…
  - Conical
  - Parabolic
  - Elliptical
  - Ogive
  - Von Karman (equation driven curves are your friend)
  - X-20 Dynasoar / hammerhead / pumpkin / snowman / potato / etc.

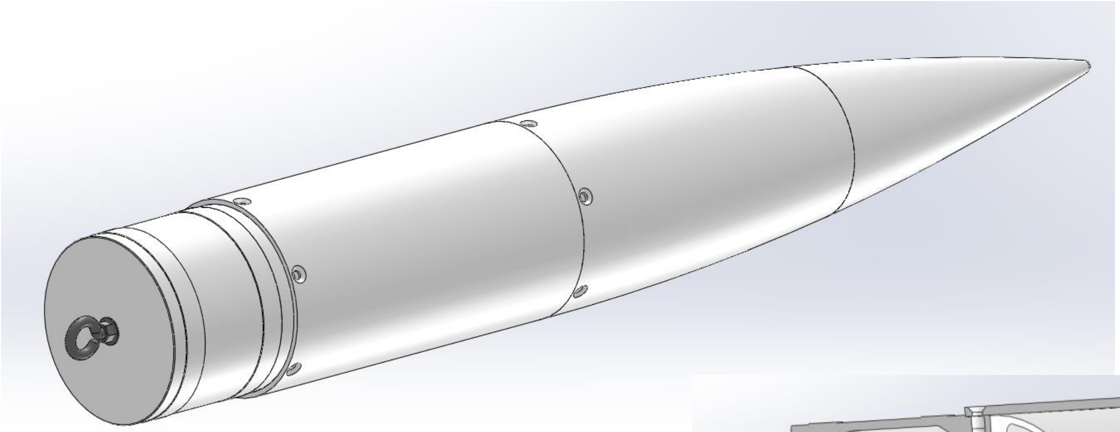


More Cones

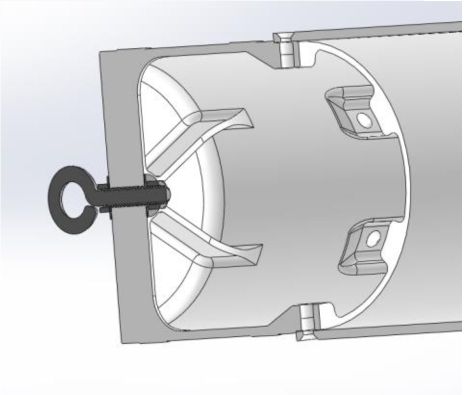
- Shoulder has multiple options
  - Print attached to nose and use support material
  - Glue in coupler section
    - Use internal lip to set length
  - Thread in coupler section
    - Good for payload access
  - Bolts!
    - Good for high power (unless you like #2-56 screws)

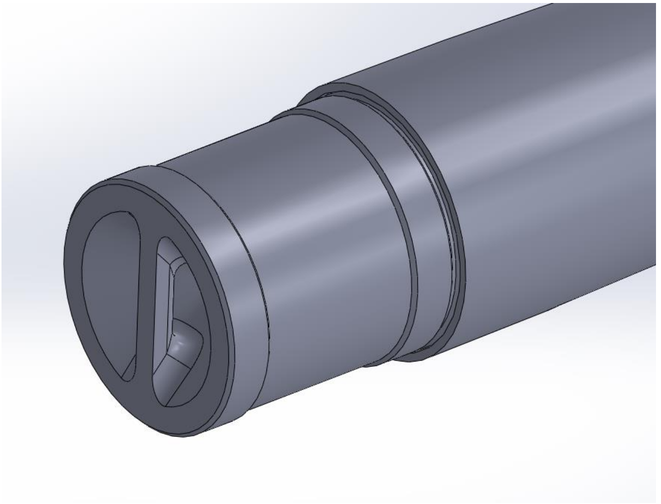


EVEN MORE CONES



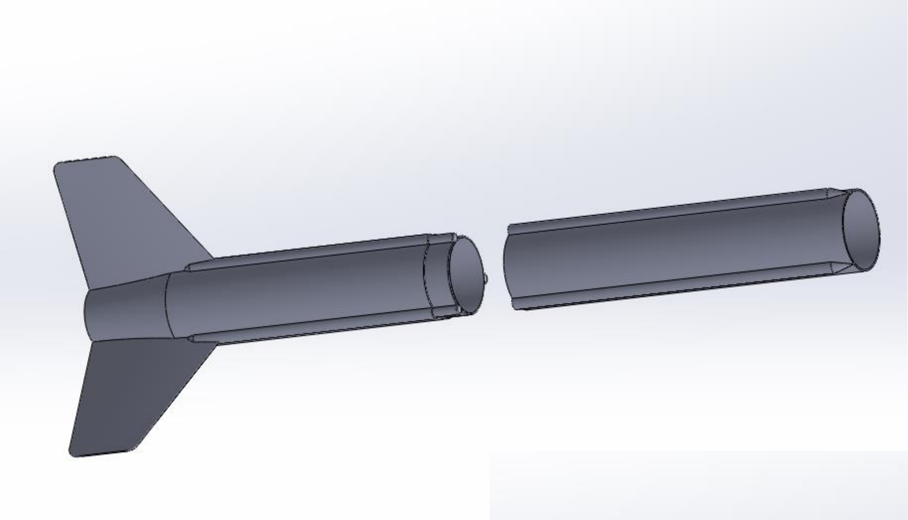
- Recovery attachment
  - Hole for eyebolt
    - Plastic not as strong
    - Add reinforcement structure
  - Printed hard point
- Can “print in” nose weight

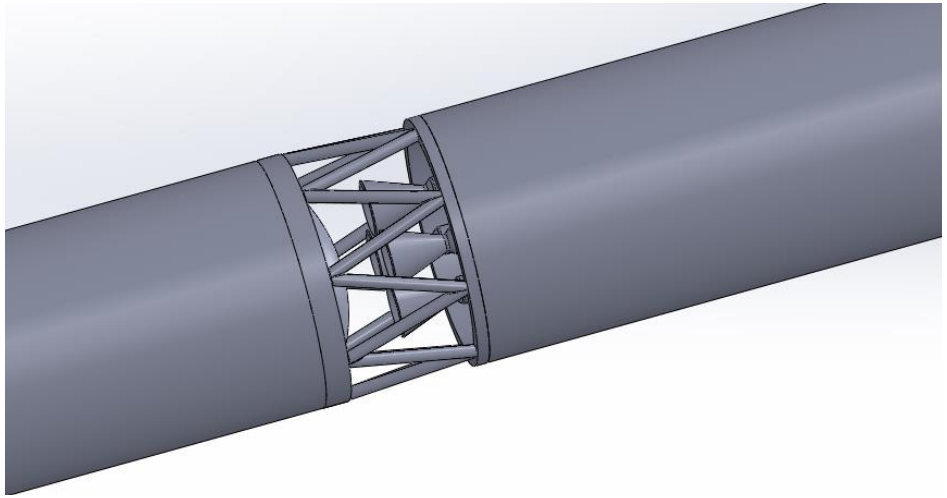


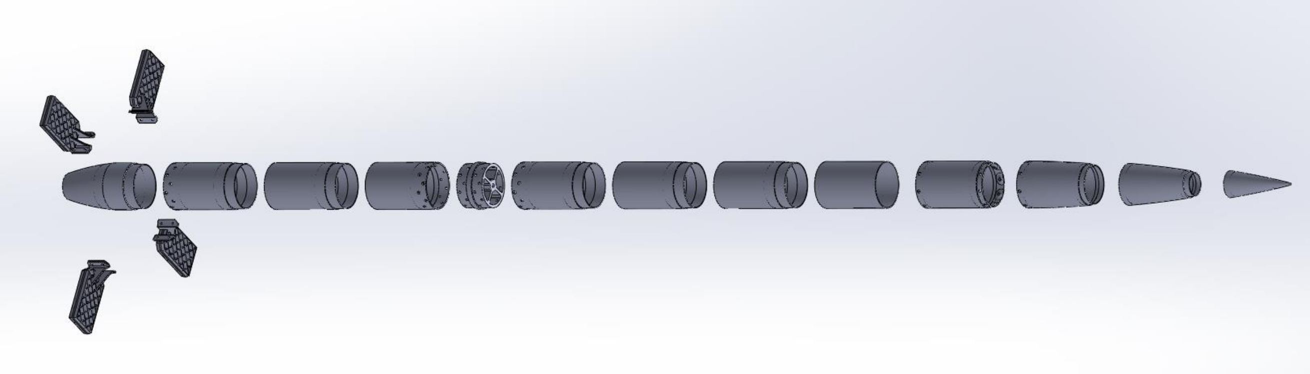


Body Tubes

- WHY!?!
  - Custom diameter
  - Custom thickness
    - ~30 thou for low power
    - ~60 thou for mid power
    - 60 thou or greater for high power
  - Not limited to circular cross sections
  - Could add reinforcement (ribs and stringers)
    - I haven’t, but it is theoretically possible
  - And most importantly: Because I can
- Single tube length is limited to printer height
  - Can join multiple sections
- Can do weird stuff
  - Strut interstages (Soyuz and Long March)
  - Fairings and cable tunnels
- Gets stupid at large sizes

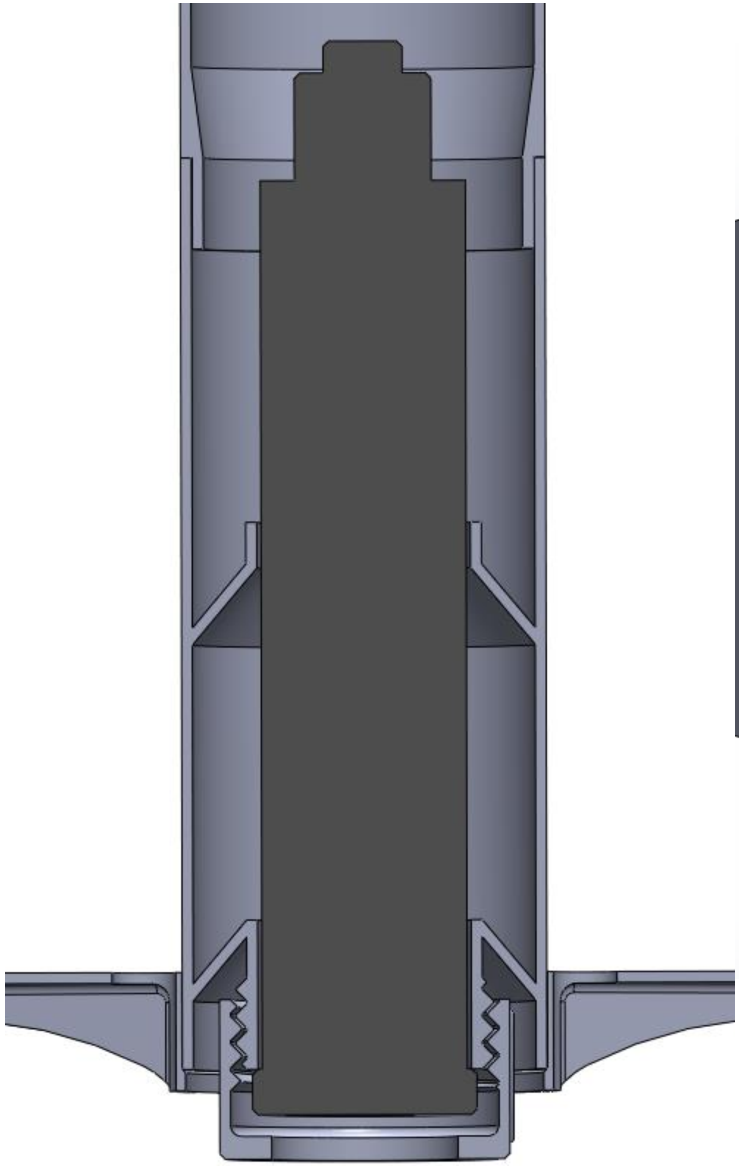


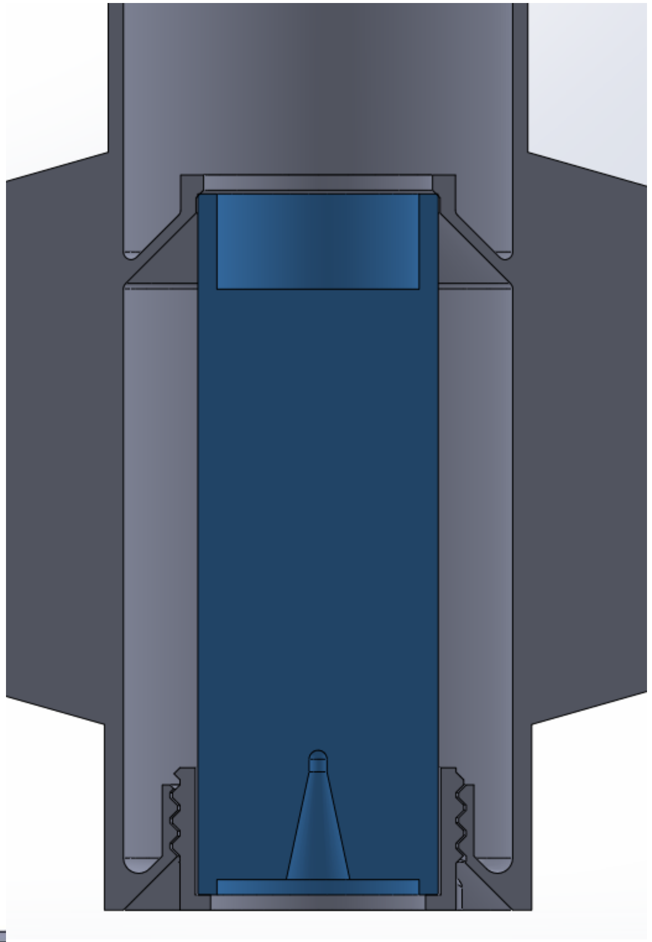




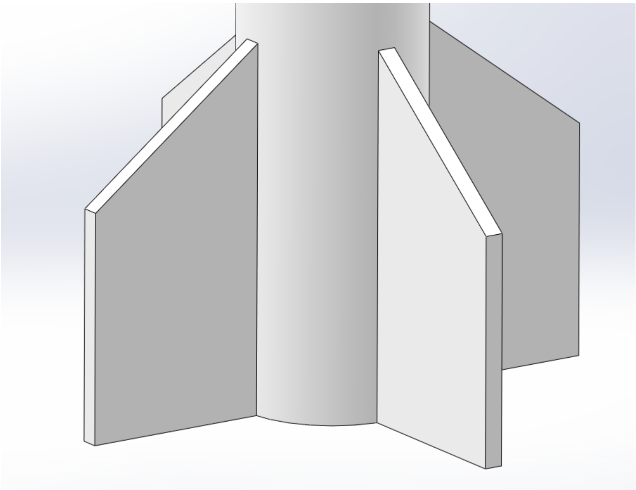
Motor Mounts

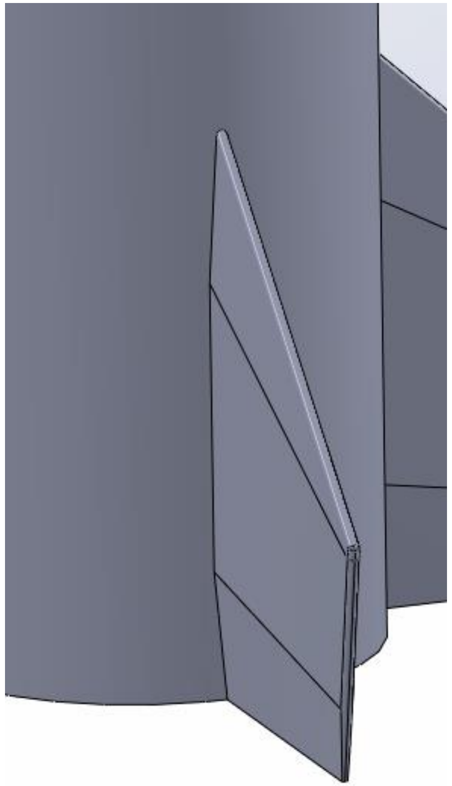
- You could print a tube and centering rings and glue them together….
- … buts that's ~~stupid~~ not optimal
- Use 45^{o} or greater to avoid supports
  - Centering "cones" instead of centering "rings"
- Traditional "tubes" are not needed, just enough material to:
  - Prevent radial motion
  - Prevent axial motion
- Threaded motor retainers are easy to add



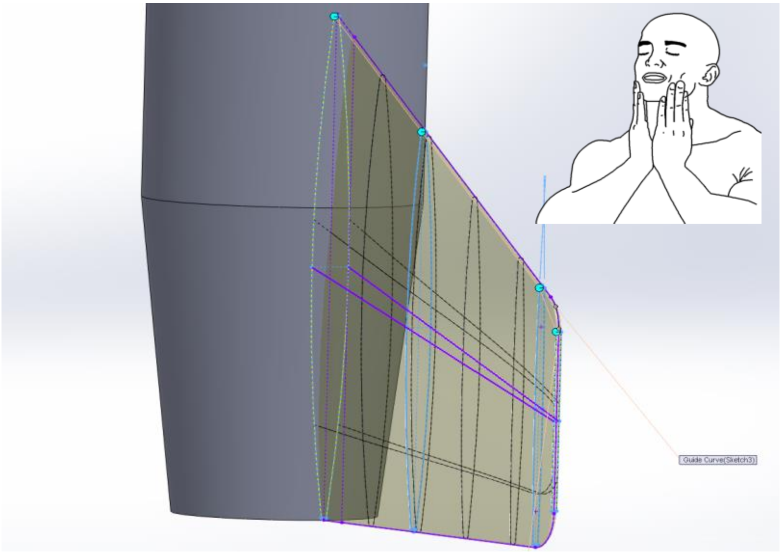


Fin Cross Sections



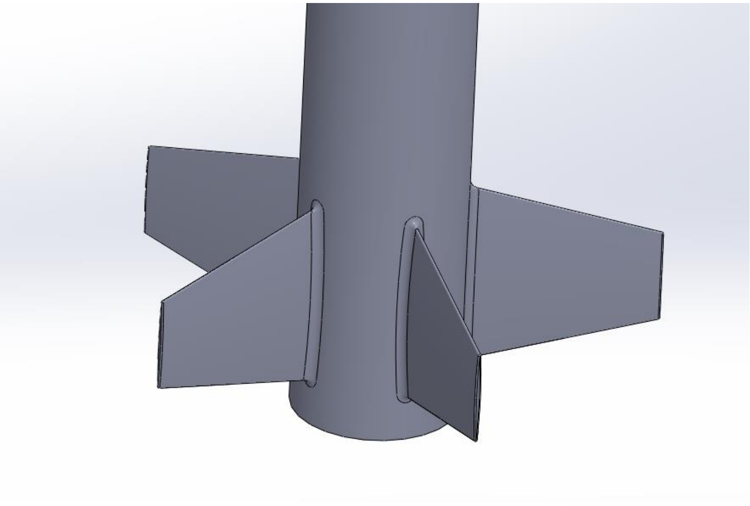


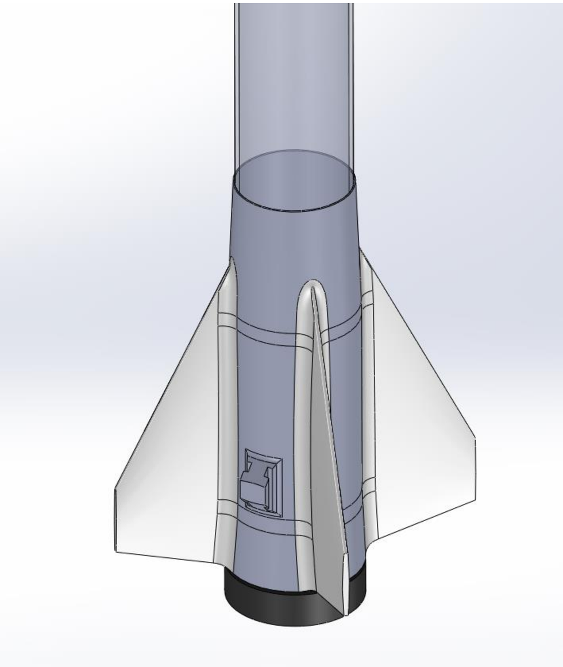
- Baby’s first fin
  - Rectangular extrusion
  - Simple
  - Lots of drag
- Look mom, I made an airfoil
  - Use chamfers to taper fin
  - Use fillets to round edges
- Biconvex
  - Scale profile (WAC Corporal, Aerobee, etc)
  - Loft tool can be “fun”
- Other types, but these are what I have used
- Note: Plastic not as strong
  - Make fins thicker to compensate
  - Airfoil can help reduce drag

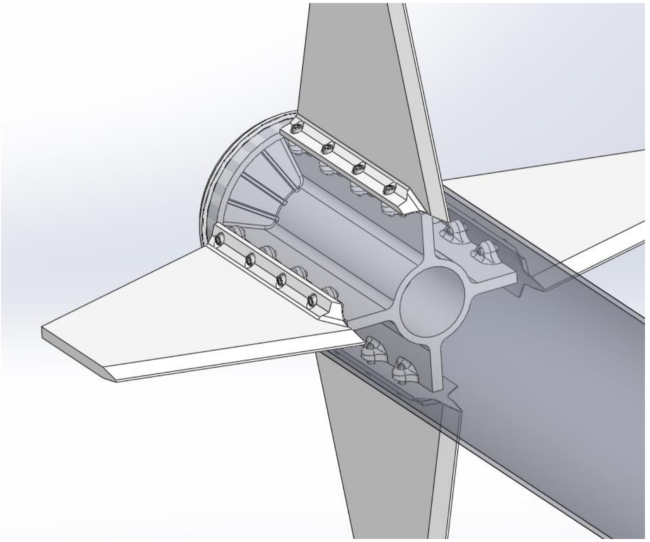


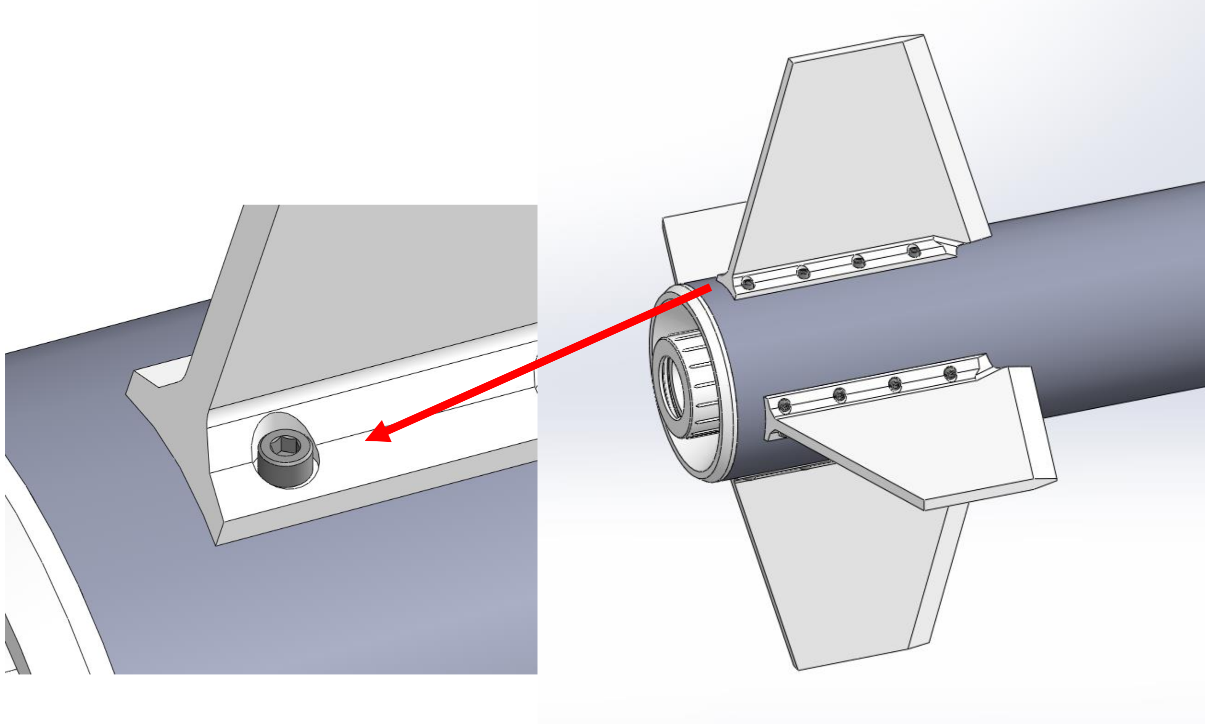
Fin Attachment

- Integrated
  - Best on small models
  - Fillets can be printed in
- Glue-on fin can
  - Fin span limited by printer bed size
- Bolt on
  - Can have much larger fin spans



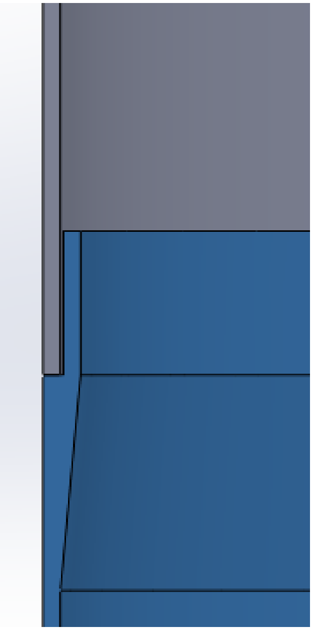




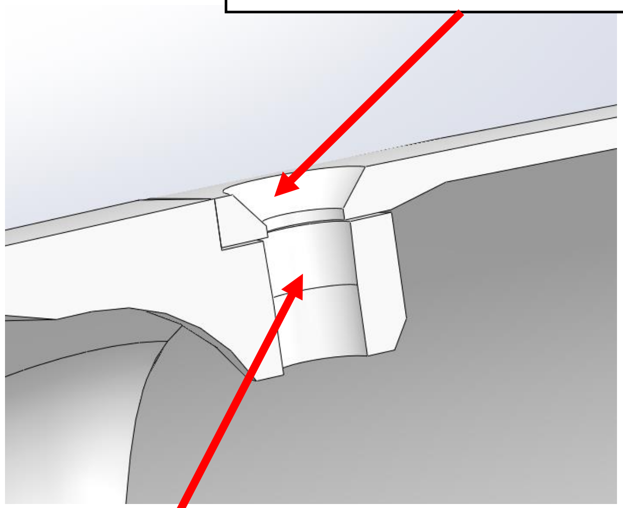


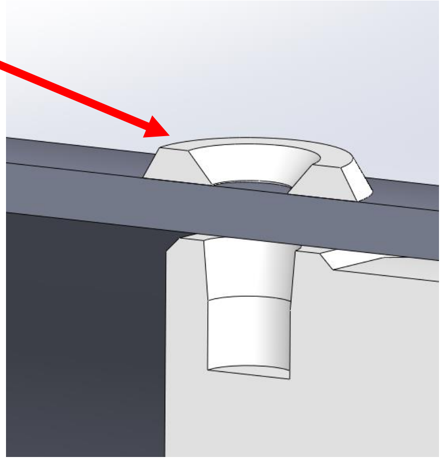
Joining Methods

- Glue
  - Use a “printed in” coupler
  - CA and epoxy work for PETG
- Fasteners
  - #4-40 for mid power
  - #6-32 for L1
  - Heat-Set Inserts
    - https://www.mcmaster.com/93365a132
  - “Fairings” for countersunk screws
- Threads
  - Nose cones
  - Body tubes
  - Motor retainers
- ~~Jank~~ Tape
  - Used when you want to:
    - *Eventually* use glue to hold it together
    - Also be able to take it apart
  - Great for temporary joints in development
  - I use aluminum tape from the hardware store
    - It looks cool
    - I had it already

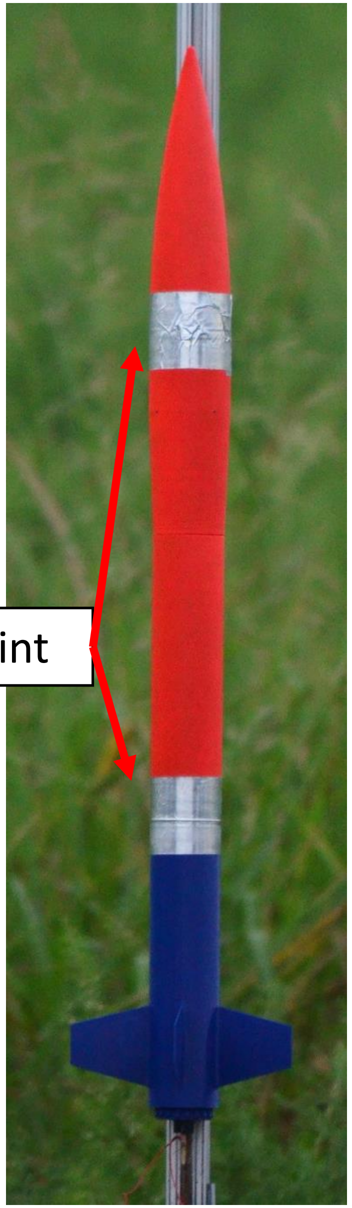


Countersink for screw



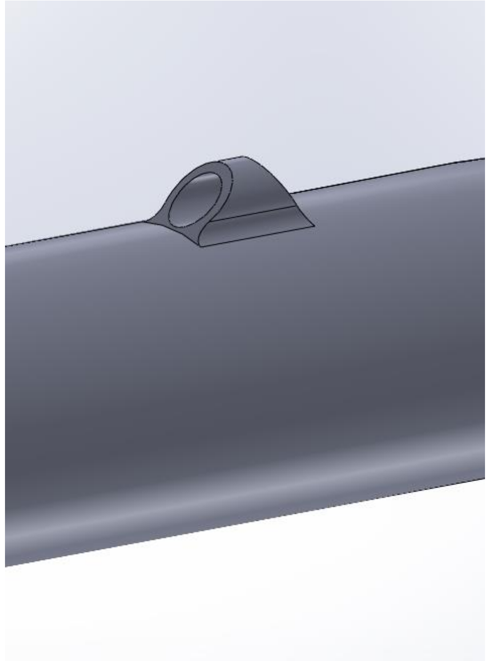


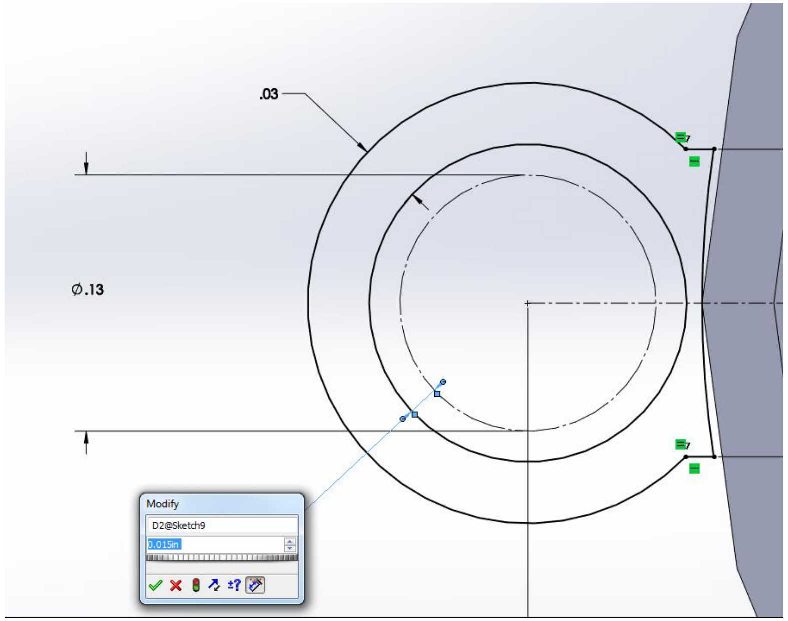
Temporary tape joint

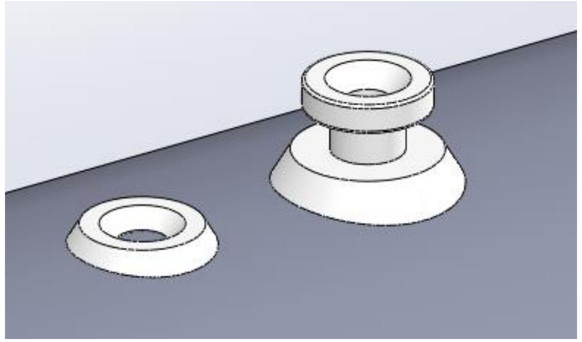


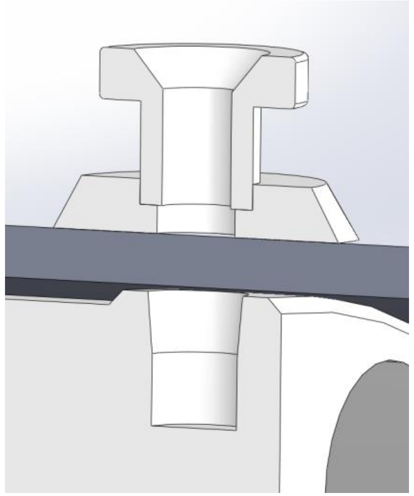
Launch

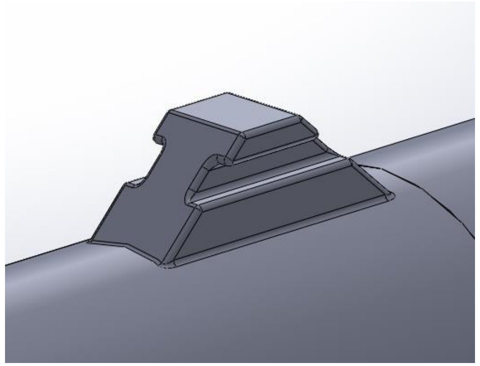
- Launch Lugs
  - Printed onto body tube
  - Could print separate glue/bolt on versions
  - Make ID larger than rod size
    - I use 15 thou for 1/8th inch rod
    - Your printer may vary
- Rail Buttons
  - I use two-piece to avoid support material
  - Can also print on like launch lug
  - Tolerance found by trial and error
  - Bolts to internal structure





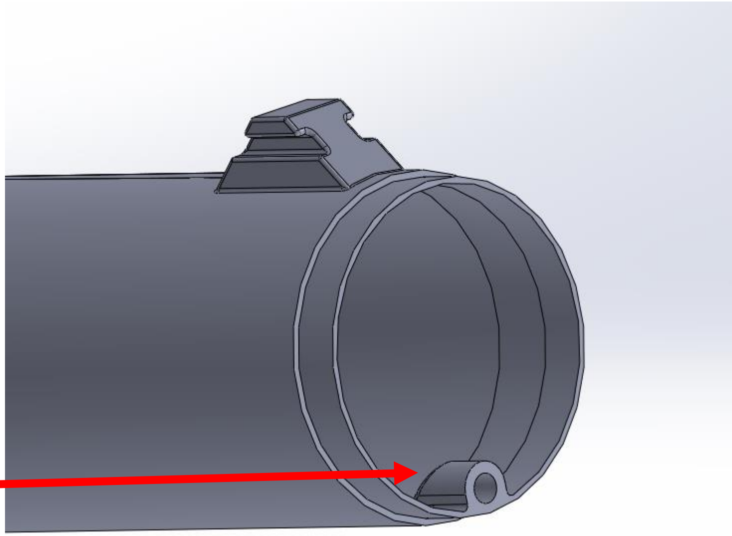


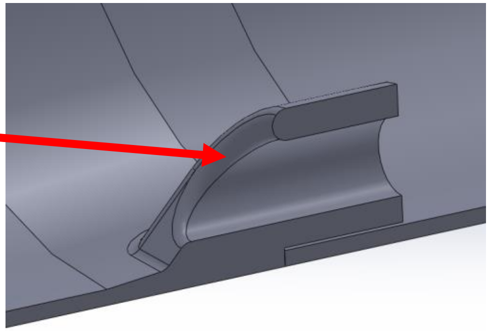


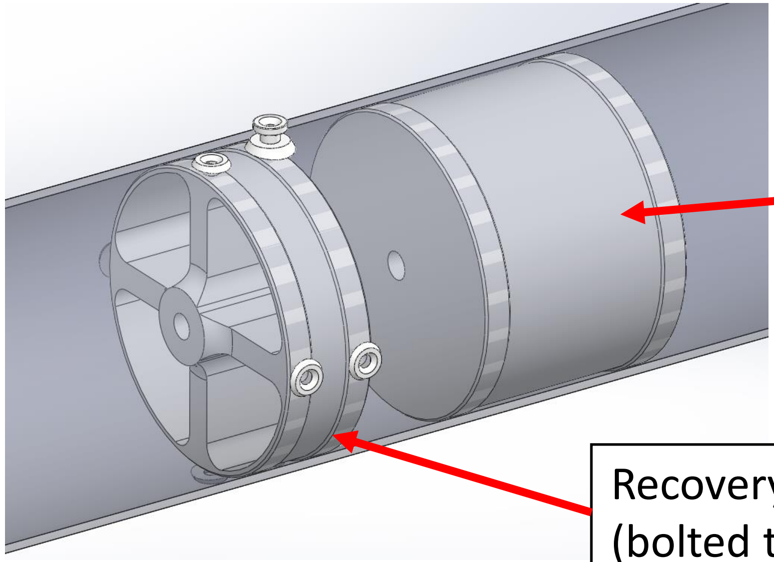


Recovery

- Small Rockets
  - Print a “launch lug” on the inside
  - Tie shock cord to it
  - Add fillets to avoid cutting
- Big Rockets
  - Add hard points to structure
    - Can be part of motor mount
    - Can be separate pieces
- Can also print PML style recovery pistons
  - No wadding required
  - Not recommended for small models





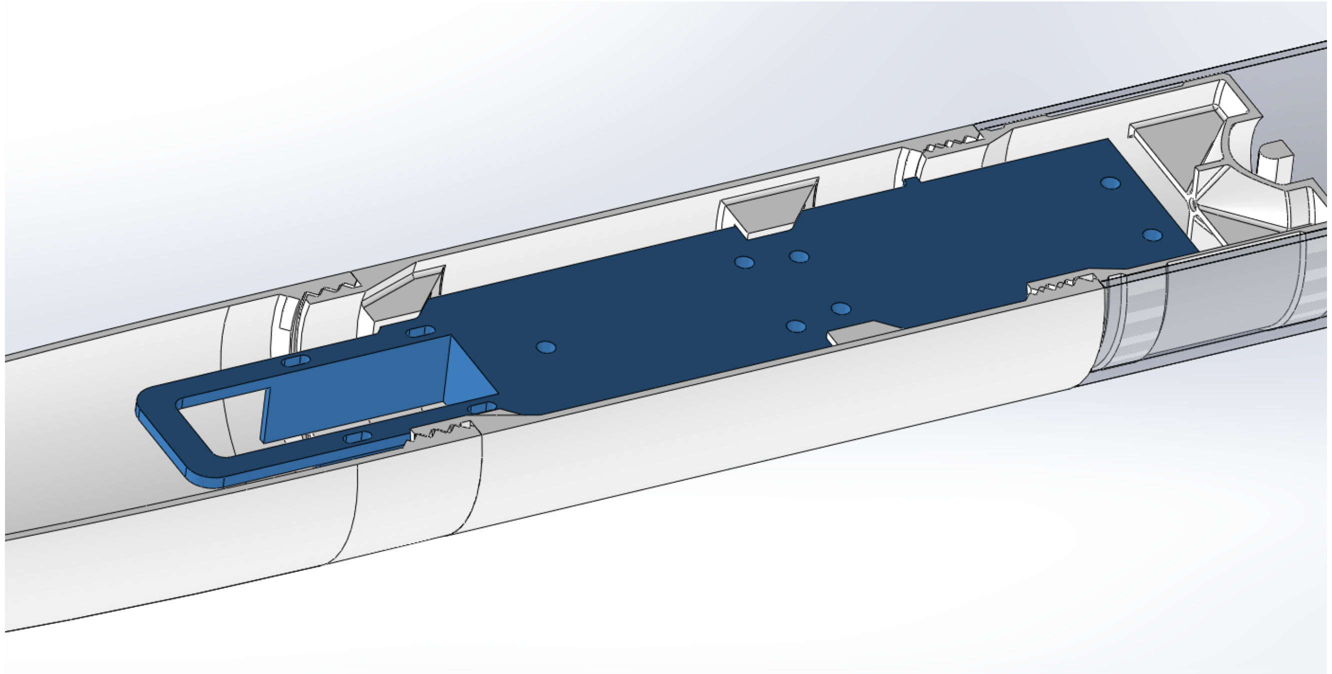


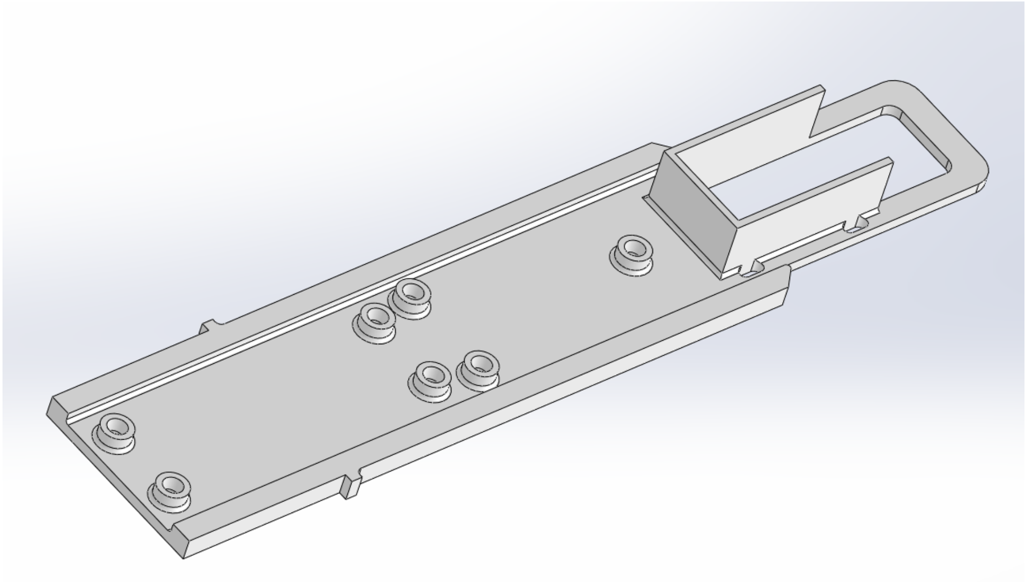
Piston

Recovery hardpoint (bolted to airframe)

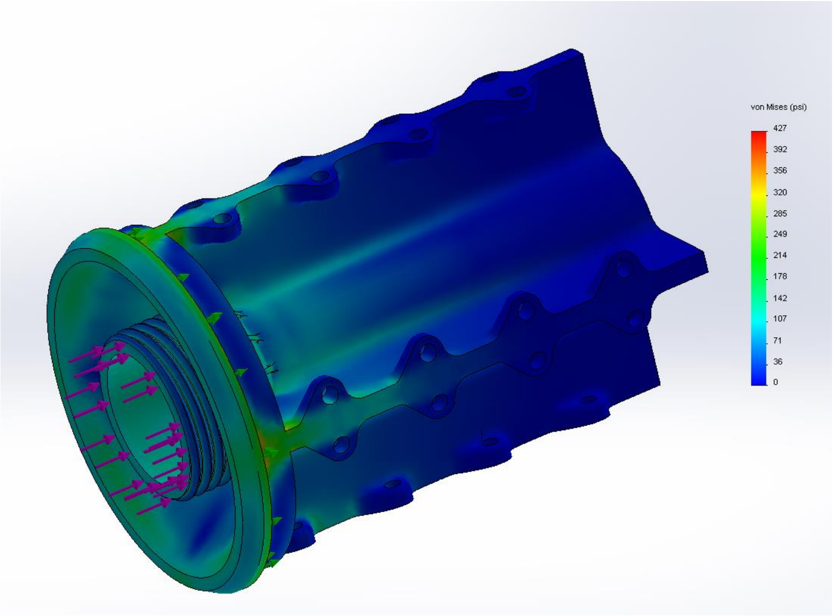
Misc

- Altimeter sleds
  - Can print custom mounting for your electronics and battery
    - Heat-Set inserts are handy here
  - Print guides into the side of the payload bay to hold sled
  - Many other methods
- Camera fairings
  - I haven't made one (electrical tape for the win)
  - Others have made them, lots of pictures online





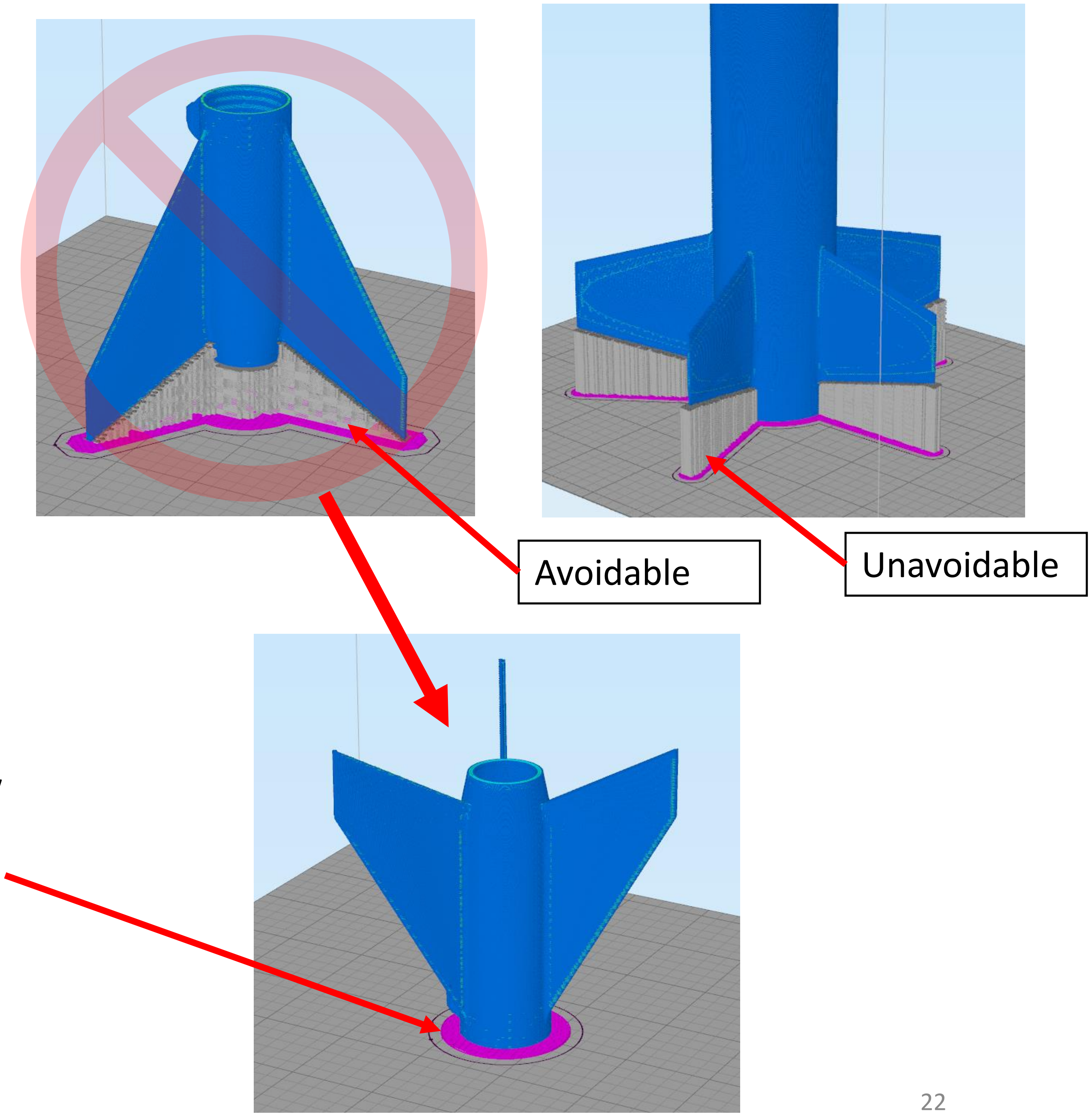
High Power Considerations



- Hand calcs and/or FEA is basically required
  - Forces and energies involved start to get real
  - Material is at 1 to 2 ksi after safety factors and printing factors are added
- Check flutter
  - https://www.apogeerockets.com/education/downloads/Newsletter291.pdf
  - Shear modulus is hard to find
  - Based on flight data, it is at least 23.4 ksi (for PETG, on my printer [450 mph flight])
- Some people have used motor mounts with no thermal liners (and they worked)
  - I've been adding a tube for thermal until I can do a static test to measure case temperature
  - Thick motor mounts add thermal mass (which helps with heating)
- Aero heating is unknown
  - Model Rocketeers: "you will melt over mach 1"
  - Aerodynamicists: "good luck finding references, nobody cares under mach 2"
  - Truth probably somewhere in the middle, need experiments to find the limits (carefully)

Printing

- Materials
  - Don't use PLA
  - PETG is great
- Direction
  - Some parts can be printed without support
  - Will be unavoidable on some parts
  - Treat the layers like wood grain
    - The layer bonds are usually weaker
    - Avoid having layers parallel to airflow
- Rafts
  - Use for parts with low-contact area
  - Can help tall parts from tipping over

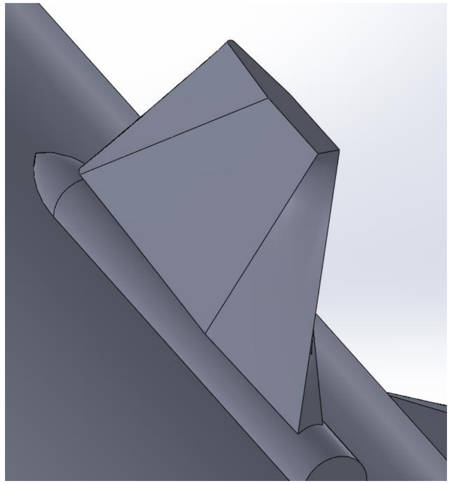


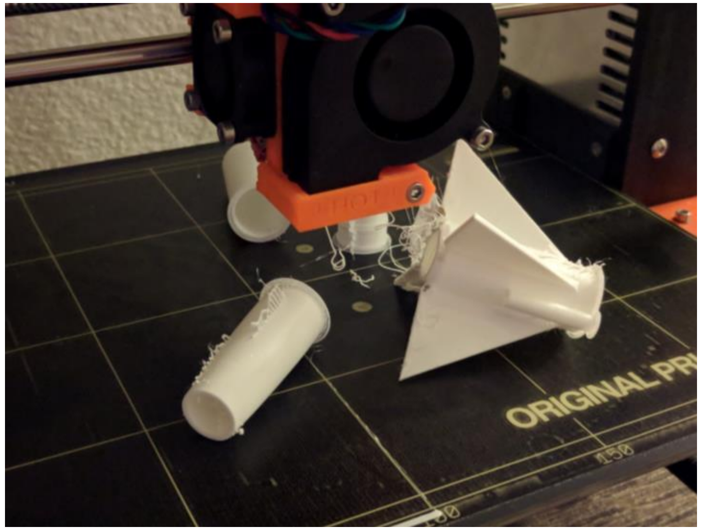
Flying and Finishing

- Avoid dark colors
  - They will absorb sunlight and heat the model
  - Mostly a PLA problem (PLA will slump in the sun)
- Paint (if you want)
  - I've had good luck with wet sanding and spray paint/primer for plastic
  - Multiple primer and wet sanding steps can help fill print imperfections
- ALL THE WADDING
  - I've noticed that I need to use more than normal amounts of wadding to stop printed tubes from melting

Conclusions

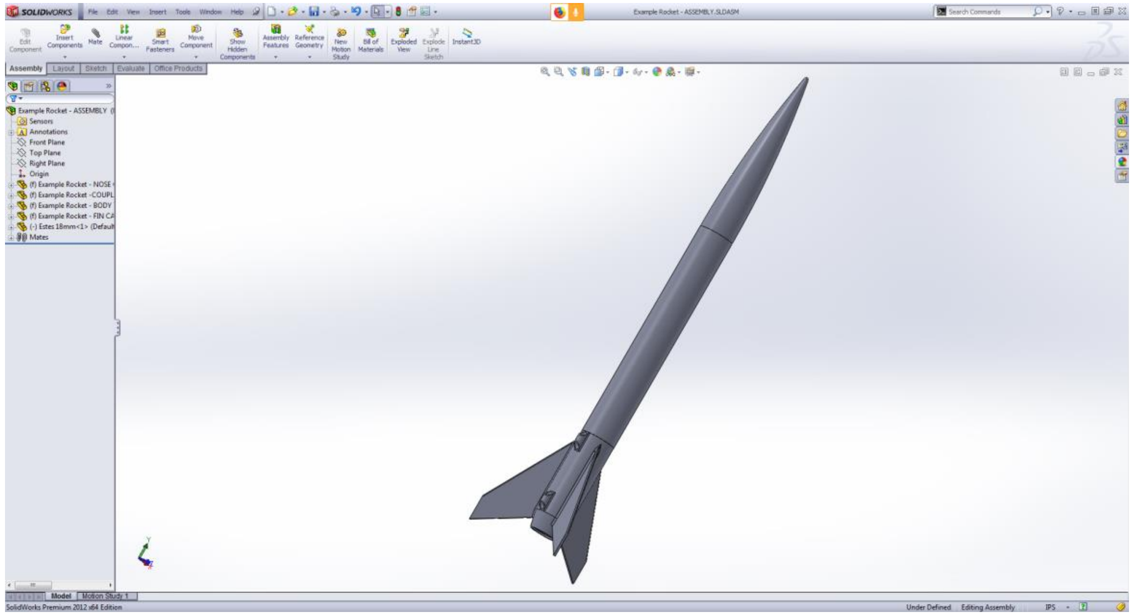
- Make test pieces
- Don't be afraid to experiment
- Don't print if you are optimizing for maximum performance
  - Not as strong
  - Not a light
  - But….
- RULE OF COOL
  - I optimize for combination of cost, lazy and stupid
  - Having fun is important (otherwise what is the point?)
  - Do what you enjoy (within reason, don't be *that guy*)

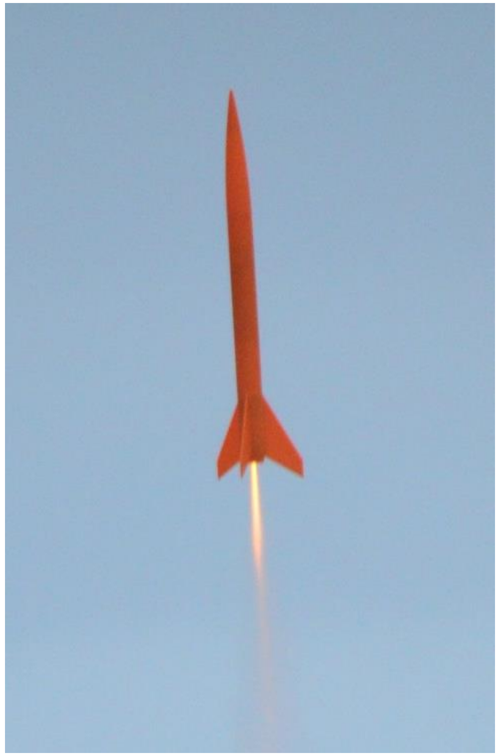


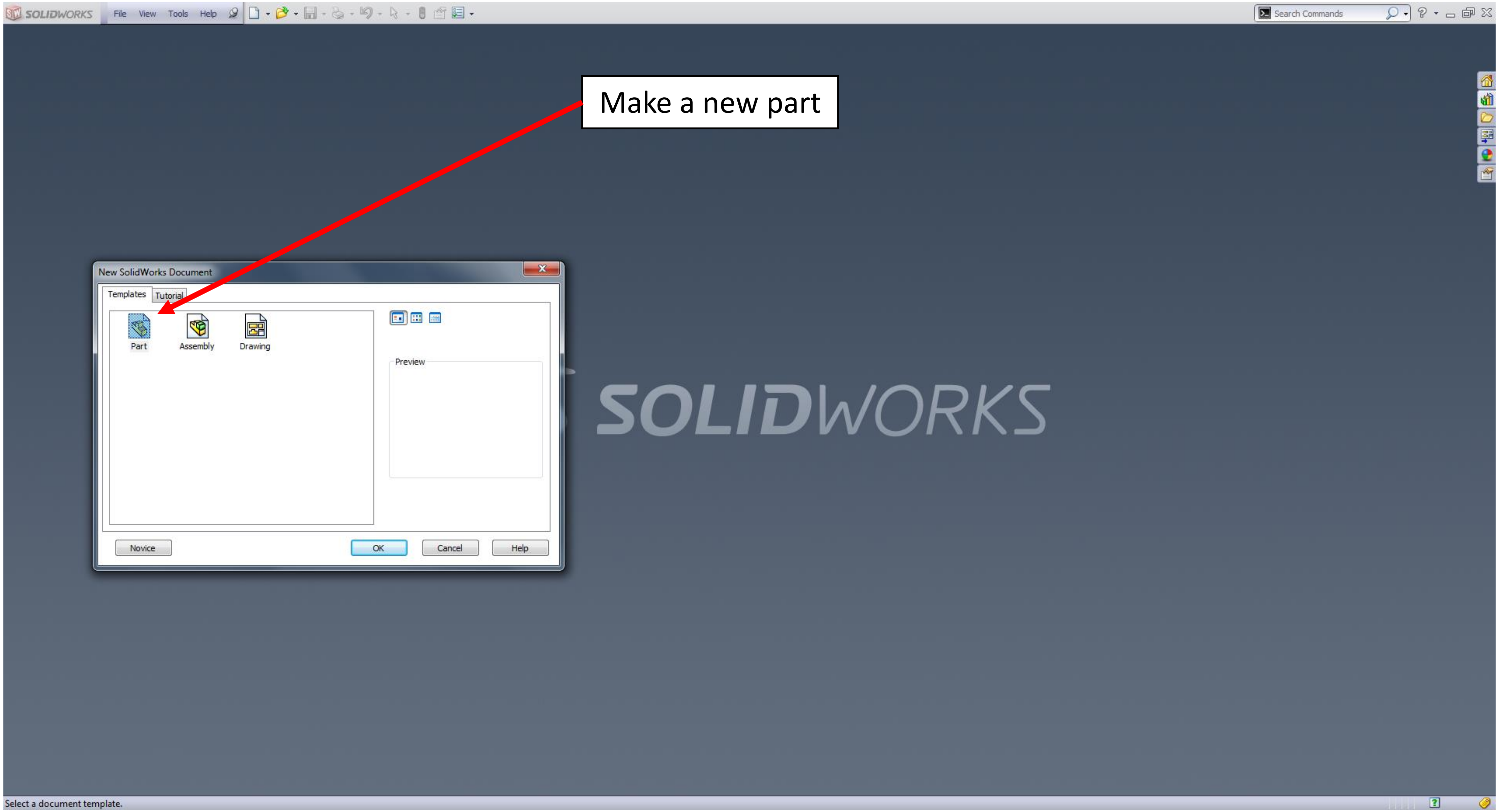


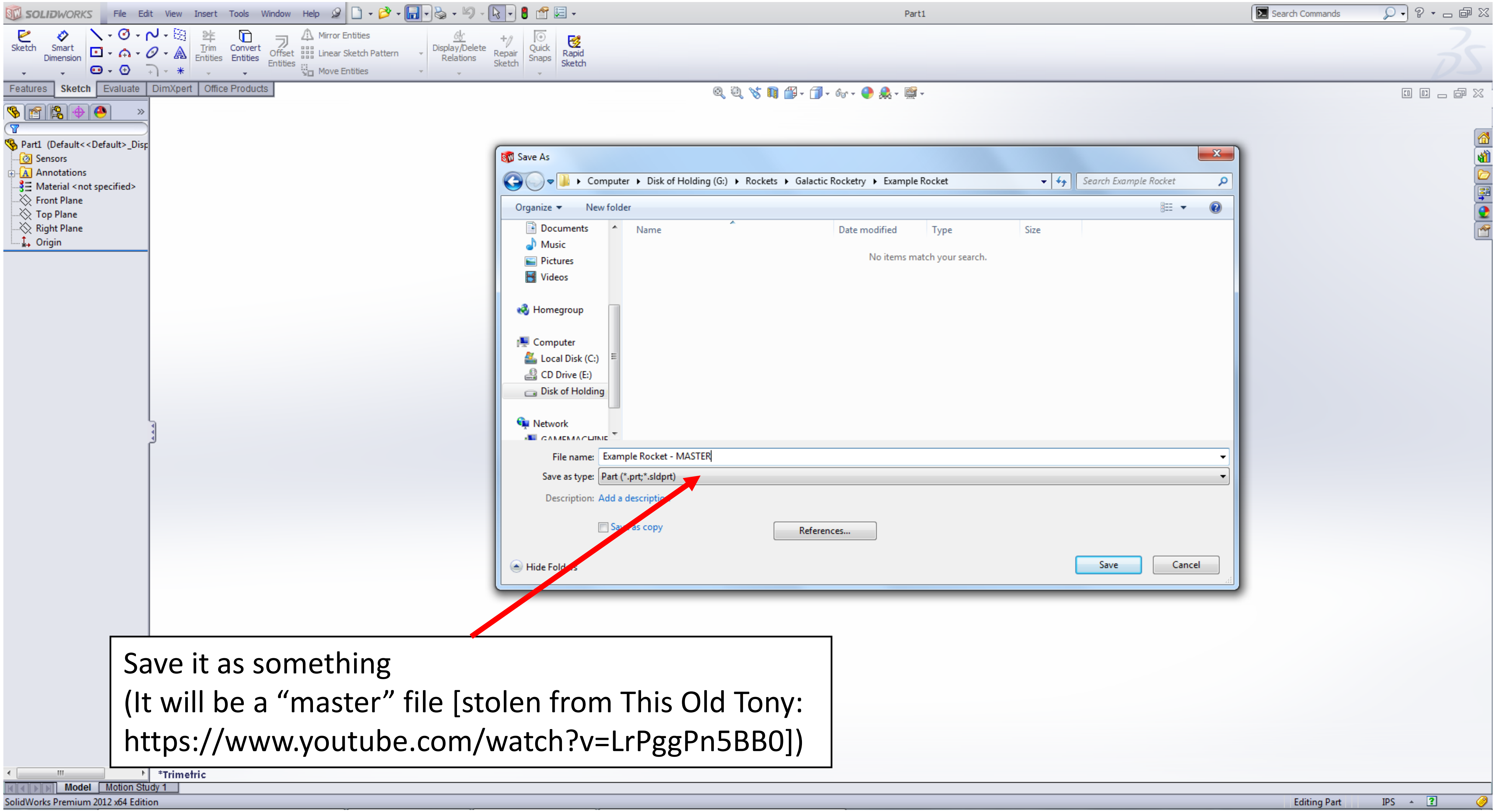
Example Rocket
(it’s over 120 slides, I’m not talking about it)

- Step-by-step unintelligible brain vomit of how I CAD
- 18mm Motors
- Estes Alpha-ish (have fun with those fins [use a raft])
- Threaded fin can stolen from Peanut (https://www.thingiverse.com/thing:2854353)

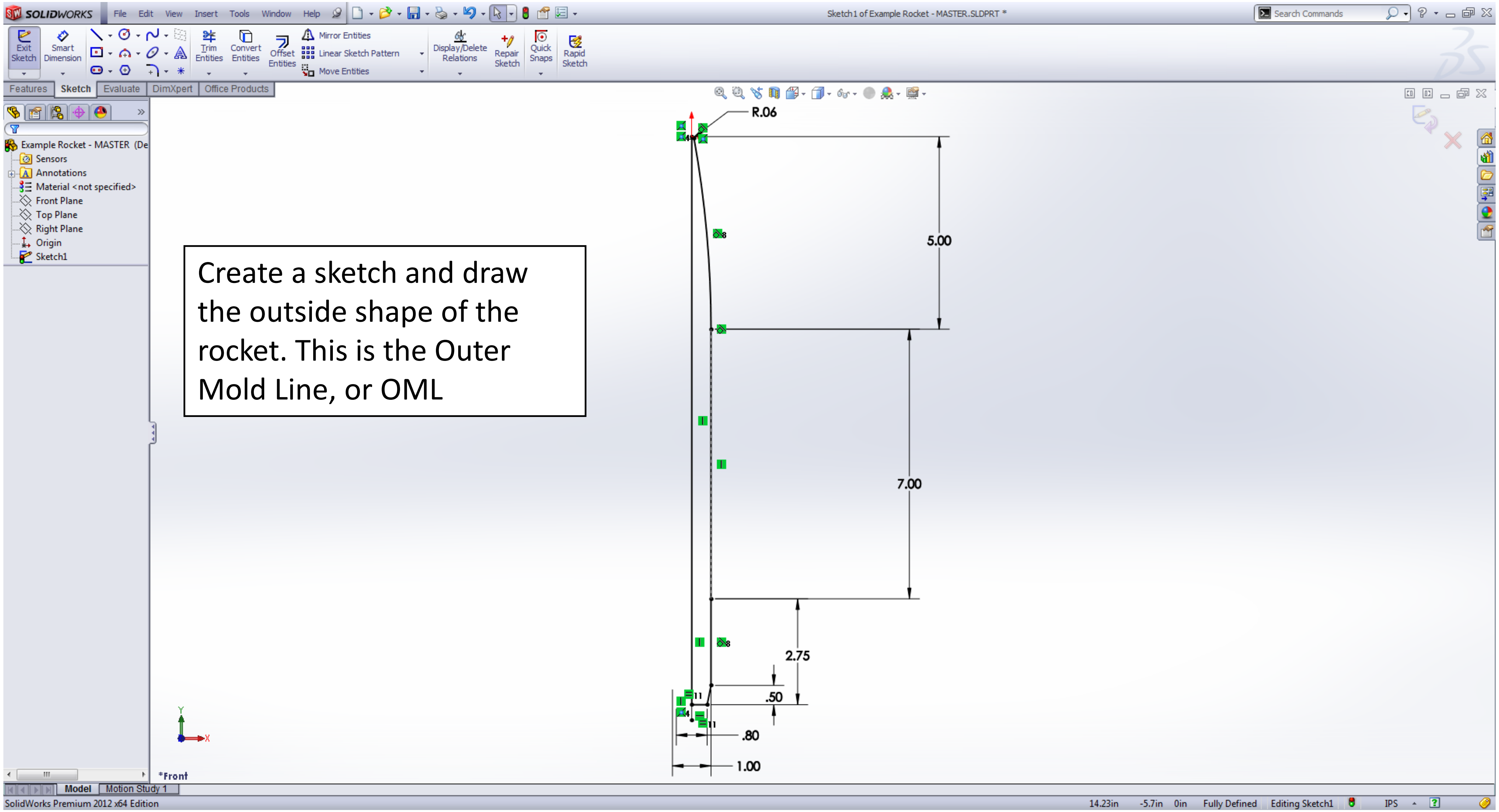





Make a new part
SOLIDWORKS
File View Tools Help
Search Commands
New SolidWorks Document
Templates
Tutorial
Part
Assembly
Drawing
Preview
Novice
OK
Cancel
Help
SOLIDWORKS
Select a document template.

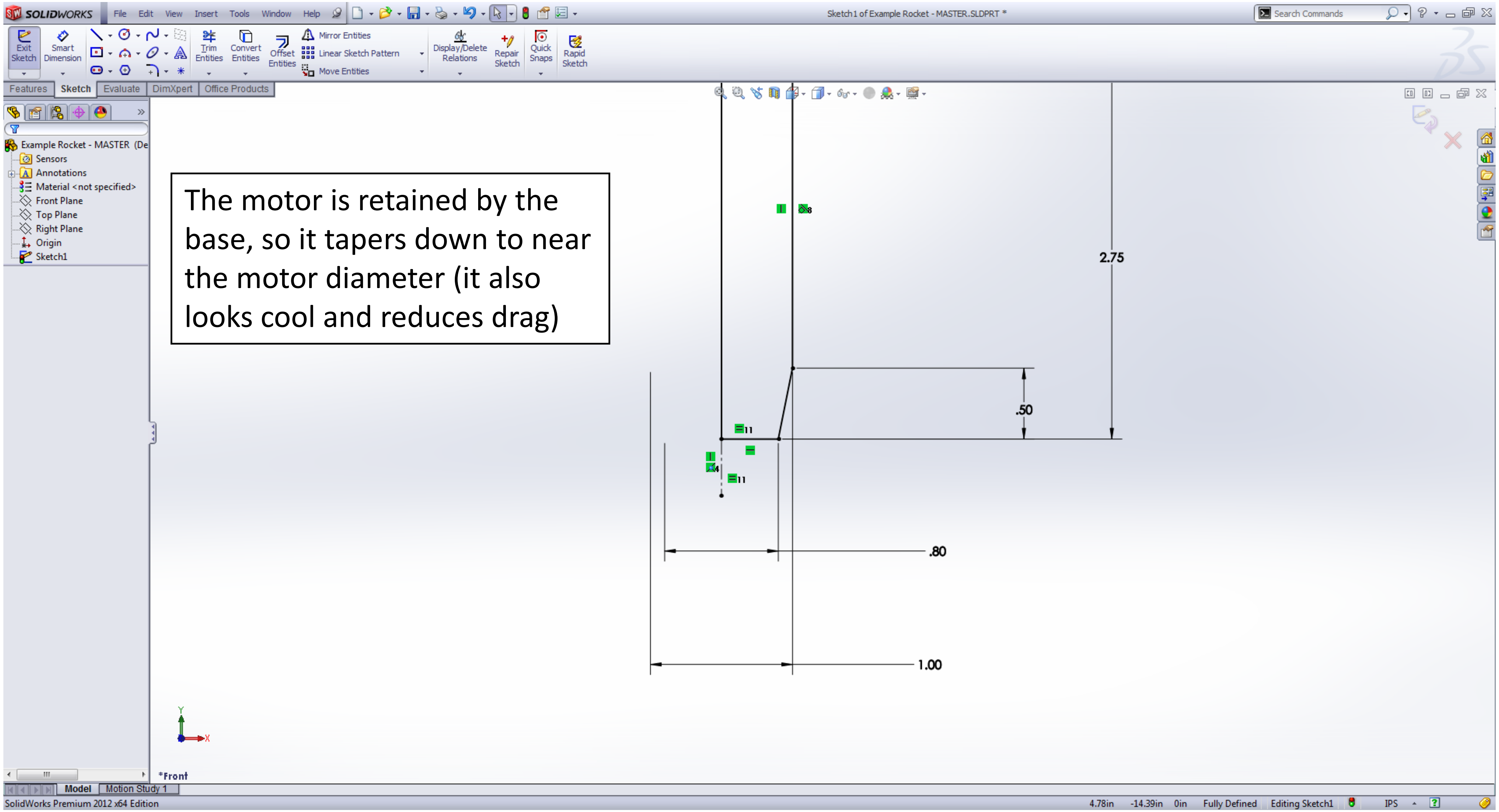


Save it as something
(It will be a “master” file [stolen from This Old Tony: https://www.youtube.com/watch?v=LrPggPn5BB0])

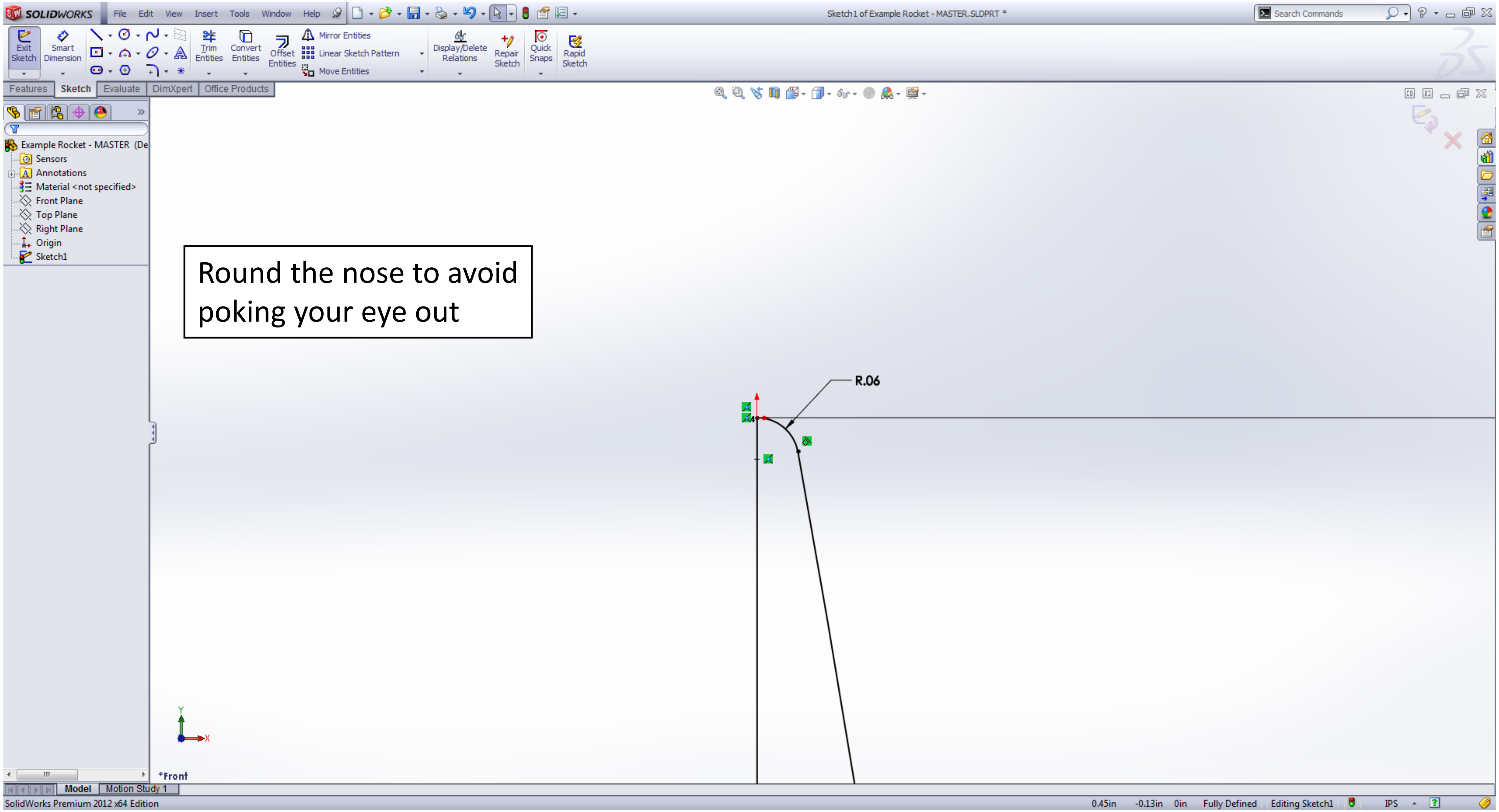


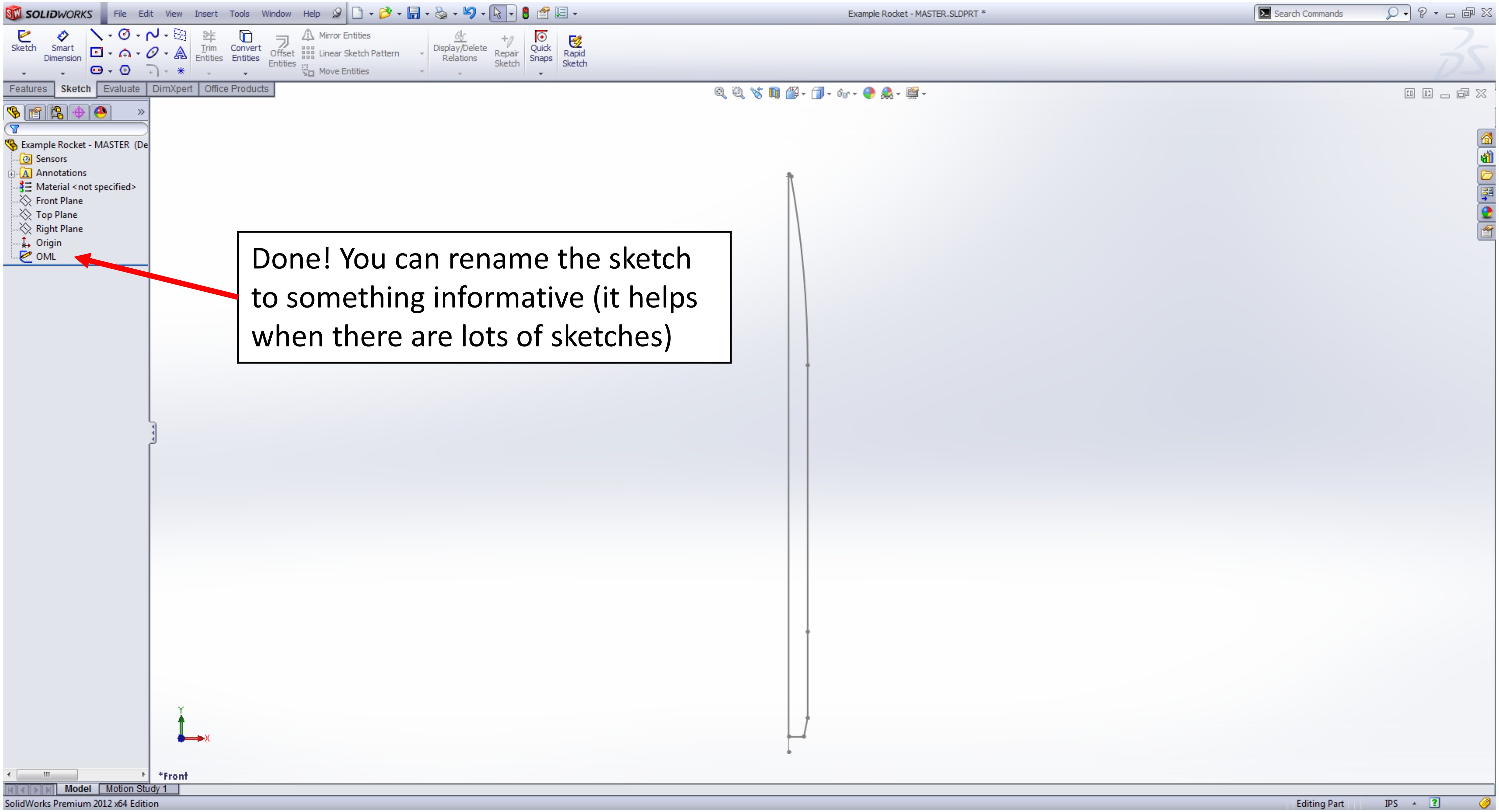
Create a sketch and draw the outside shape of the rocket. This is the Outer Mold Line, or OML

The motor is retained by the base, so it tapers down to near the motor diameter (it also looks cool and reduces drag)

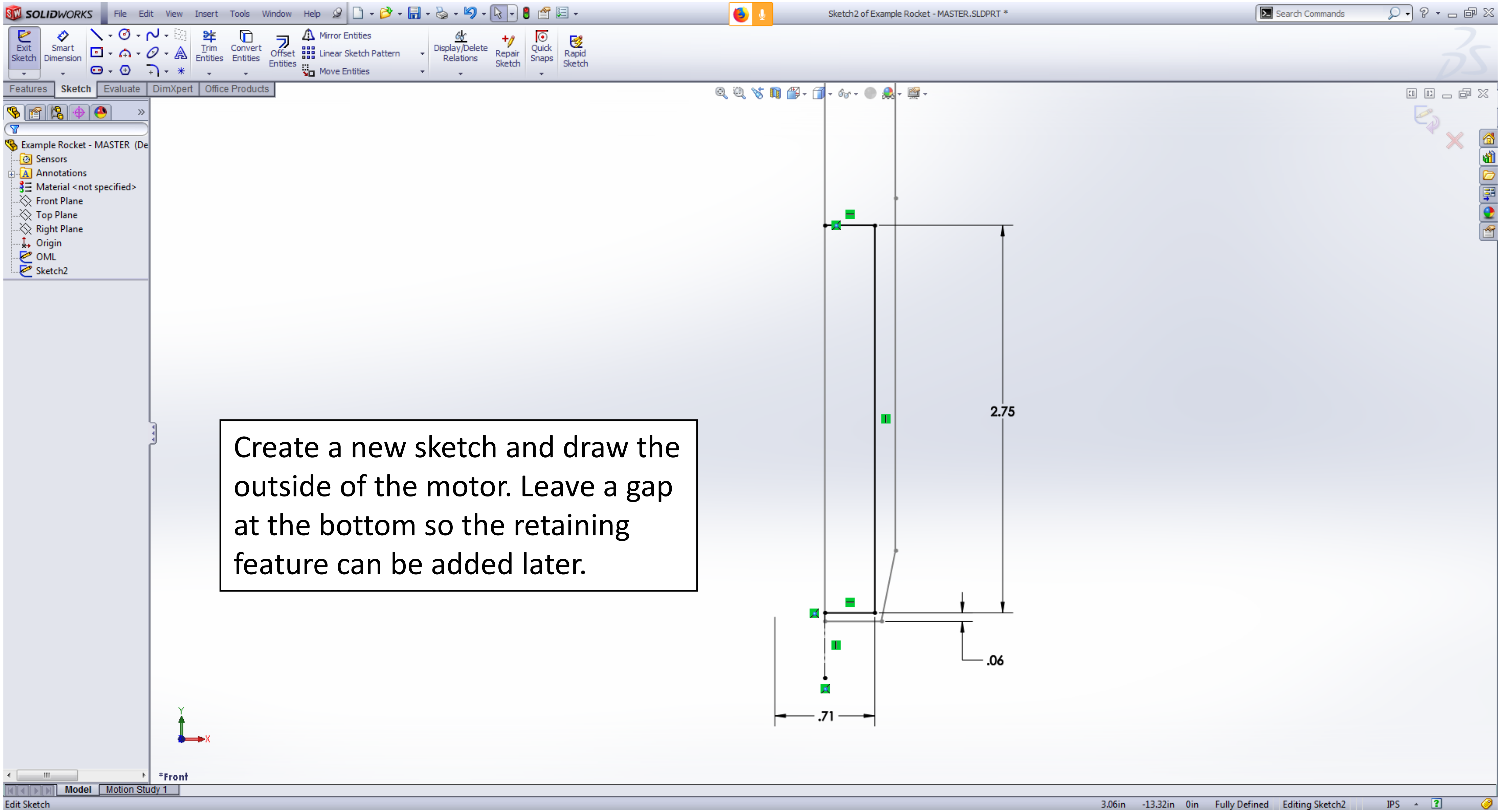


Round the nose to avoid poking your eye out

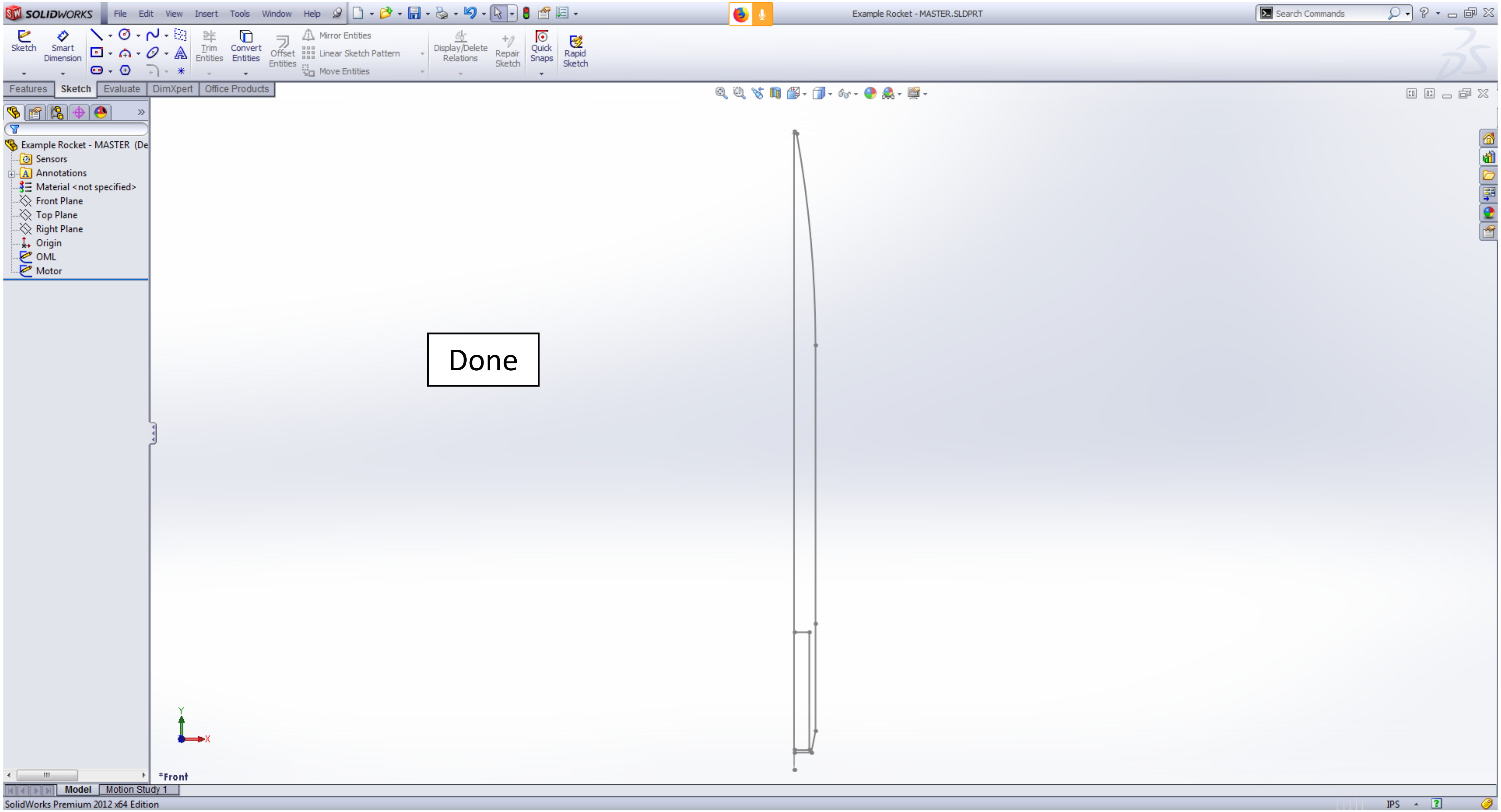




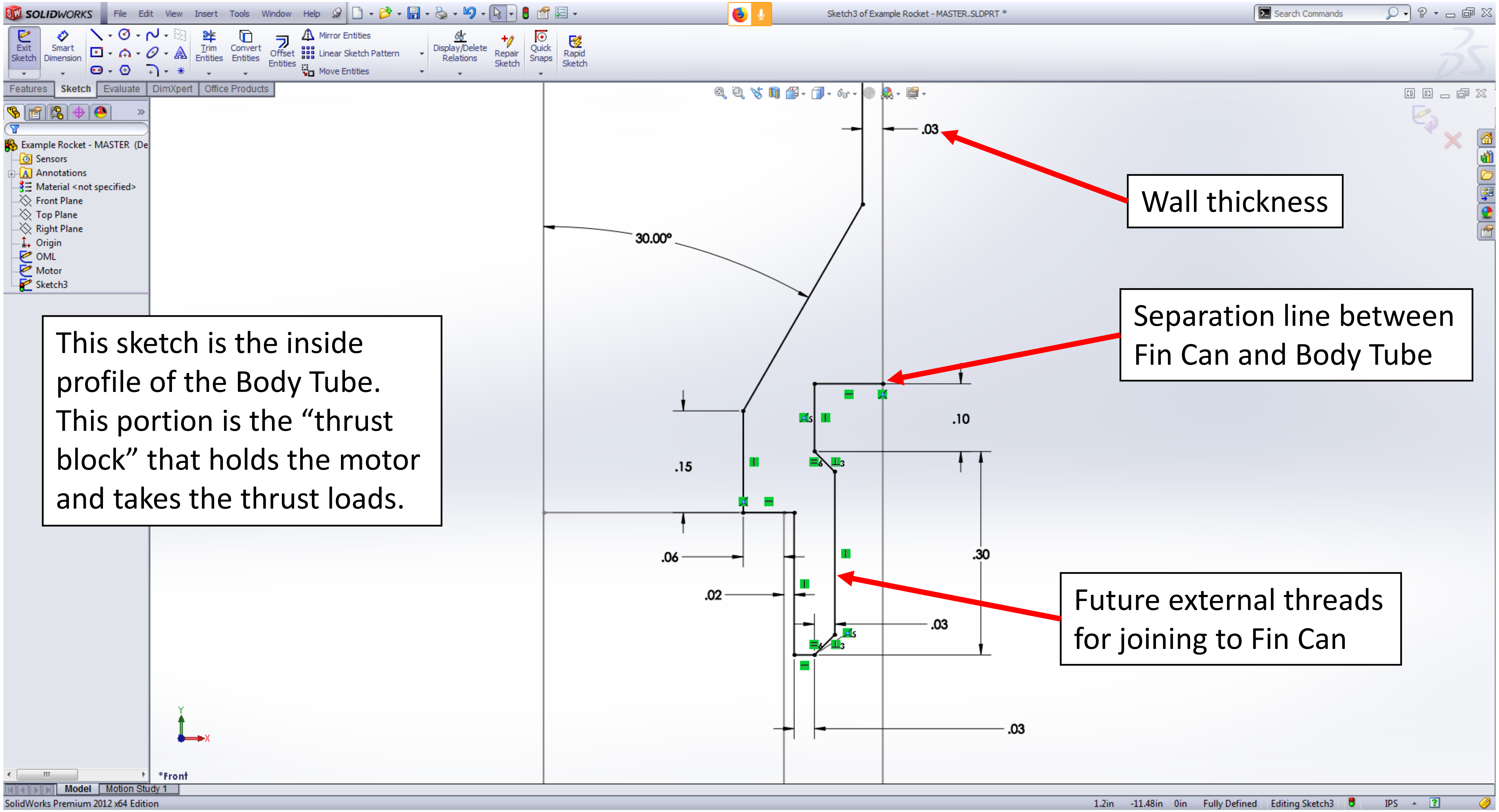
Done! You can rename the sketch to something informative (it helps when there are lots of sketches)

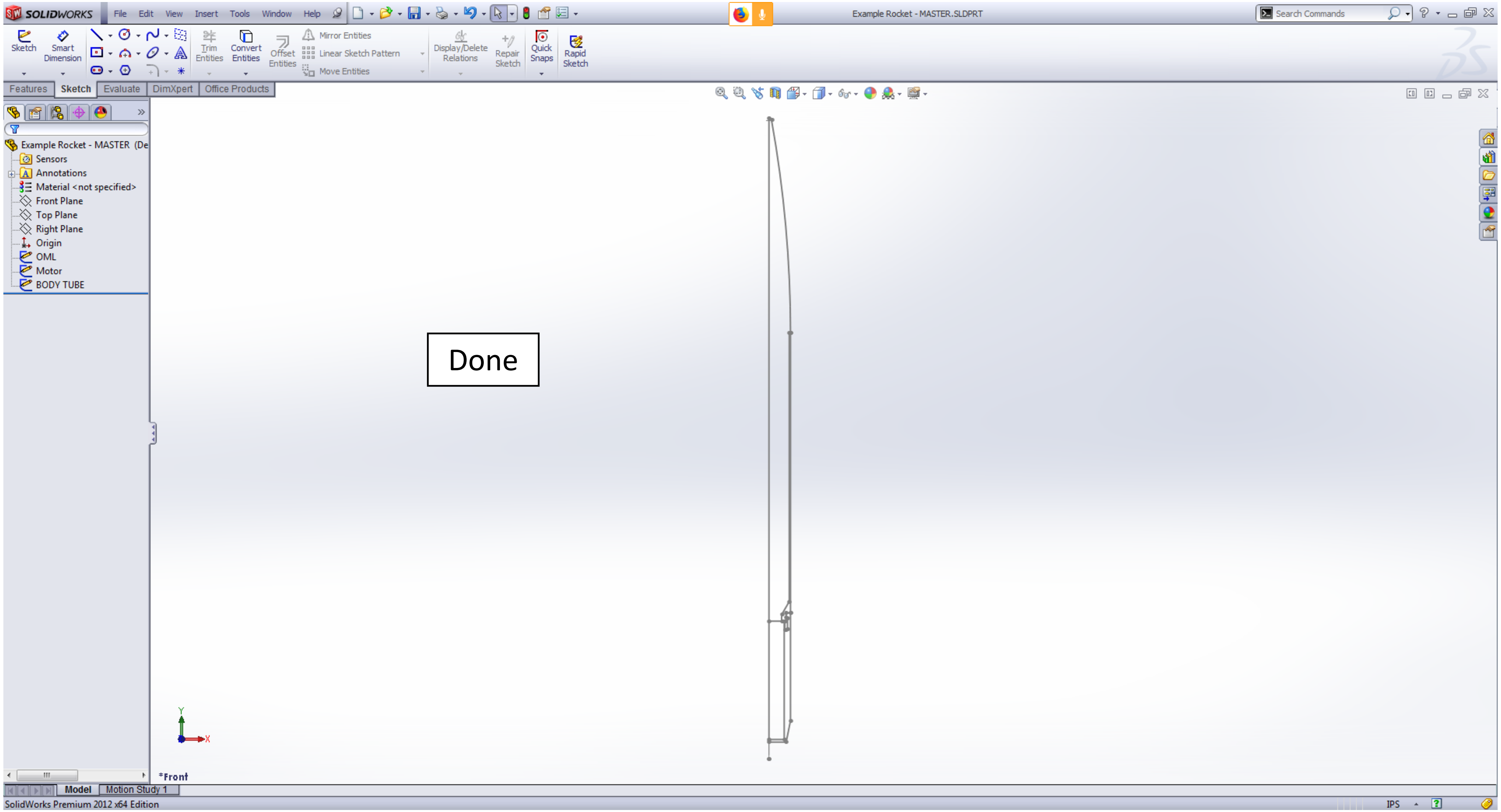


Create a new sketch and draw the outside of the motor. Leave a gap at the bottom so the retaining feature can be added later.

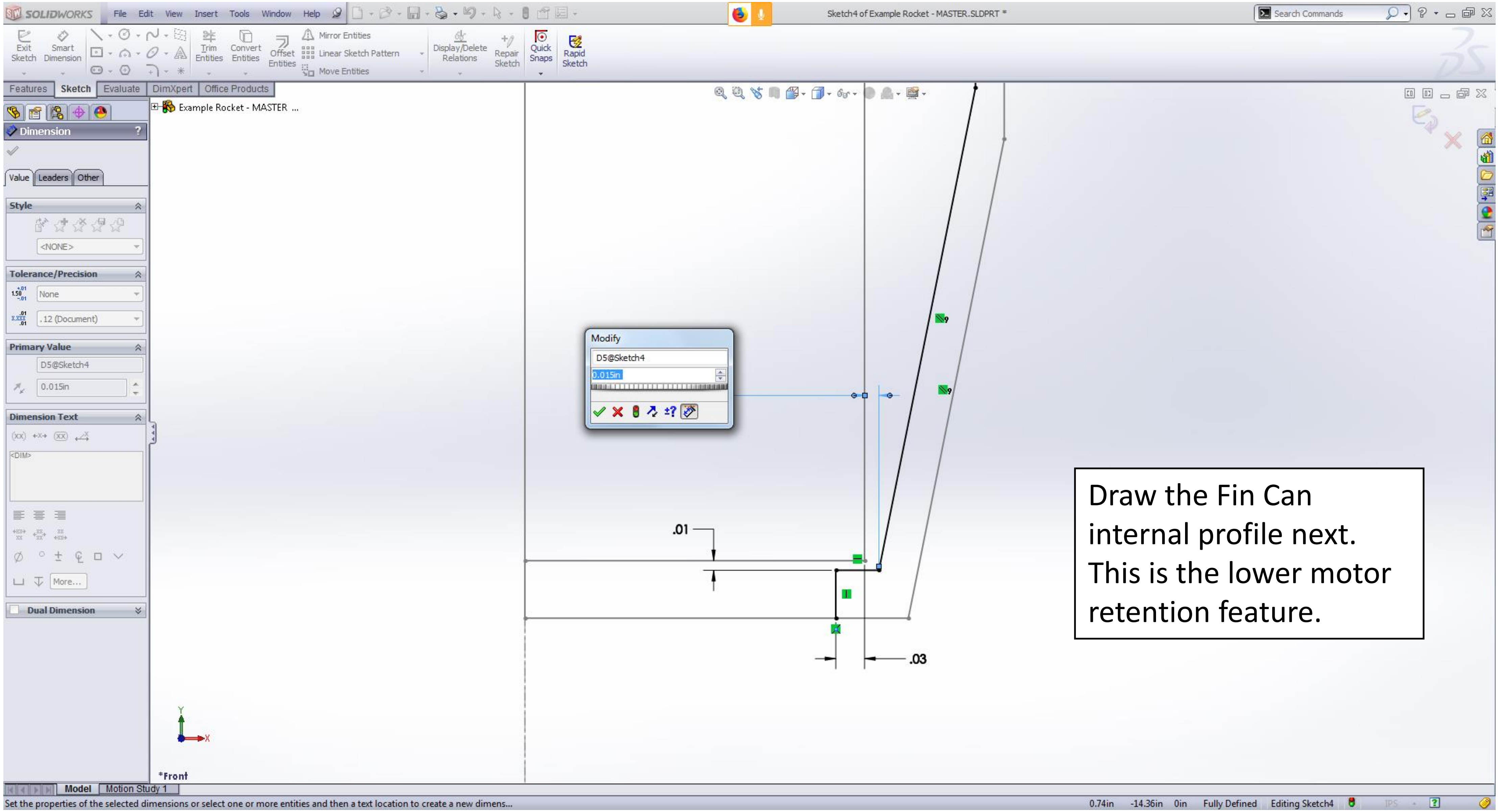


Done
Example Rocket - MASTER.SLDPRT
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - MASTER (De
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
OML
Motor
*Front
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition

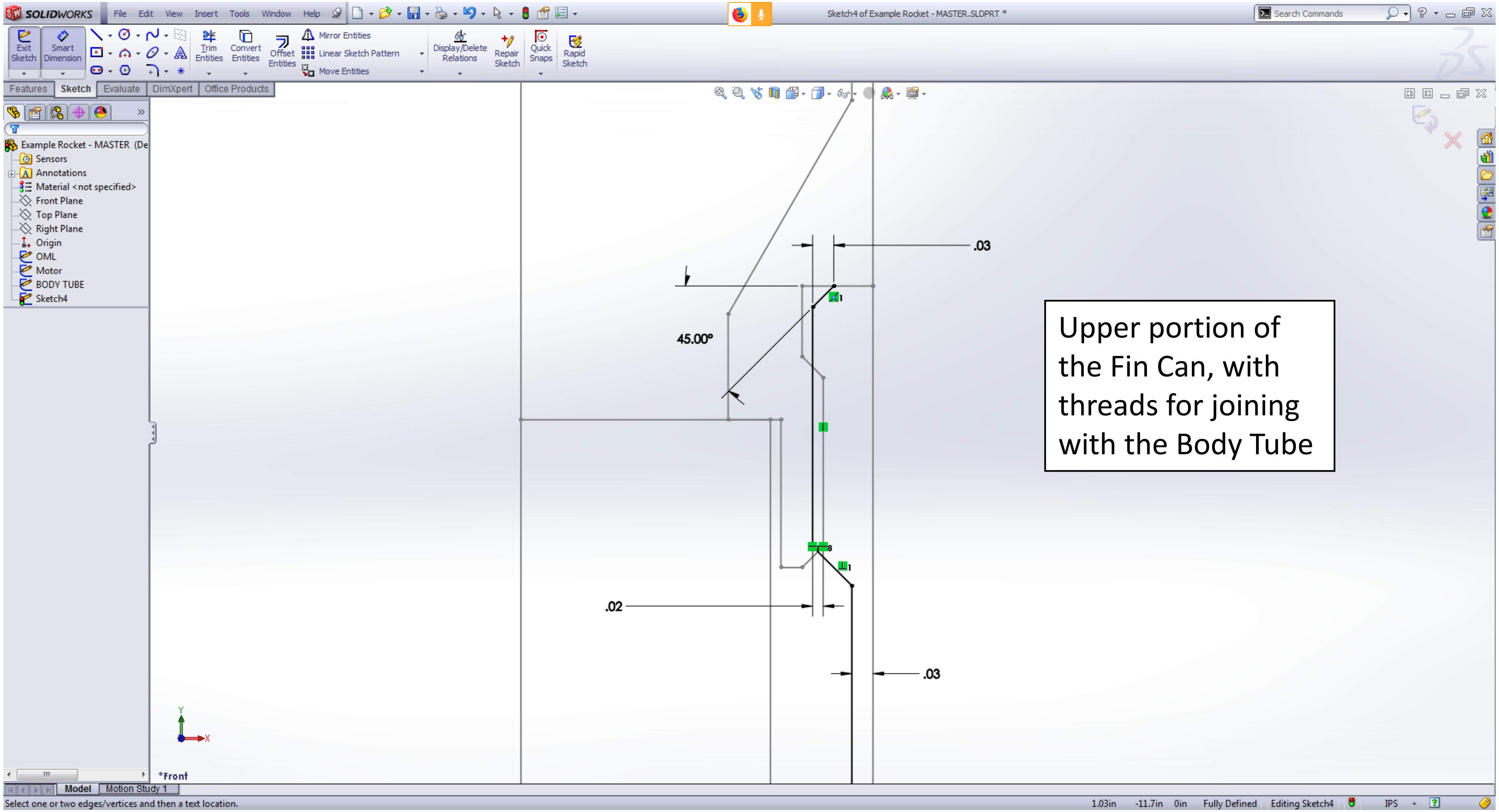

This sketch is the inside profile of the Body Tube. This portion is the "thrust block" that holds the motor and takes the thrust loads.
Wall thickness
Separation line between Fin Can and Body Tube
Future external threads for joining to Fin Can
.03
30.00°
.10
.15
.30
.06
.02
.03
.03
Sketch3 of Example Rocket - MASTER.SLDPRT *
Example Rocket - MASTER
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
OML
Motor
Sketch3
*Front
SolidWorks Premium 2012 x64 Edition
Fully Defined
Editing Sketch3


SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - MASTER.SLDPRT
Search Commands
Sketch
Smart Dimension
Trim Entities
Convert Entities
Offset Entities
Mirror Entities
Linear Sketch Pattern
Move Entities
Display/Delete Relations
Repair Sketch
Quick Snaps
Rapid Sketch
Features Sketch Evaluate DimXpert Office Products
Example Rocket - MASTER (De
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
OML
Motor
BODY TUBE
*Front
Model Motion Study 1
SolidWorks Premium 2012 x64 Edition
IPS

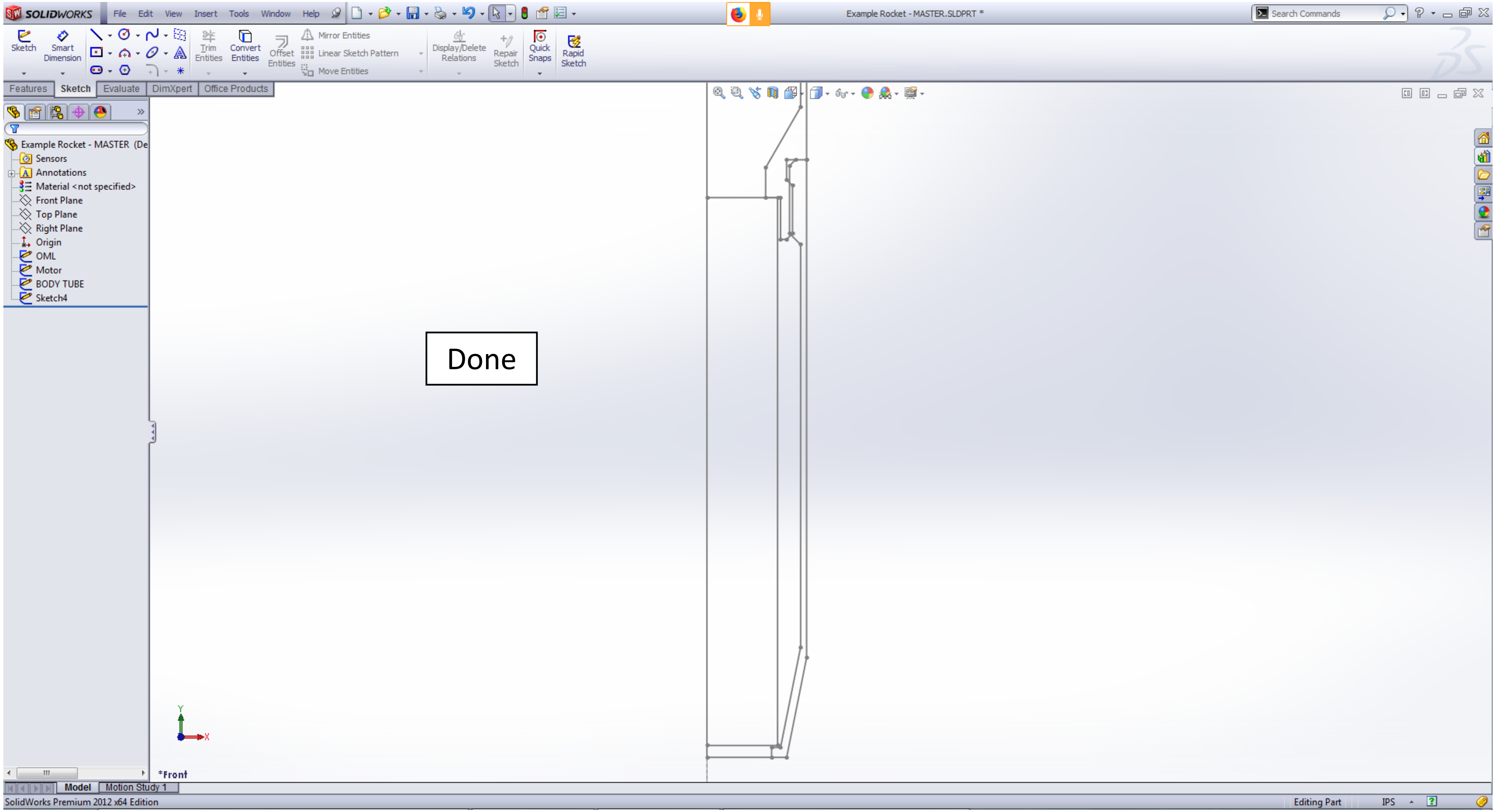
Done

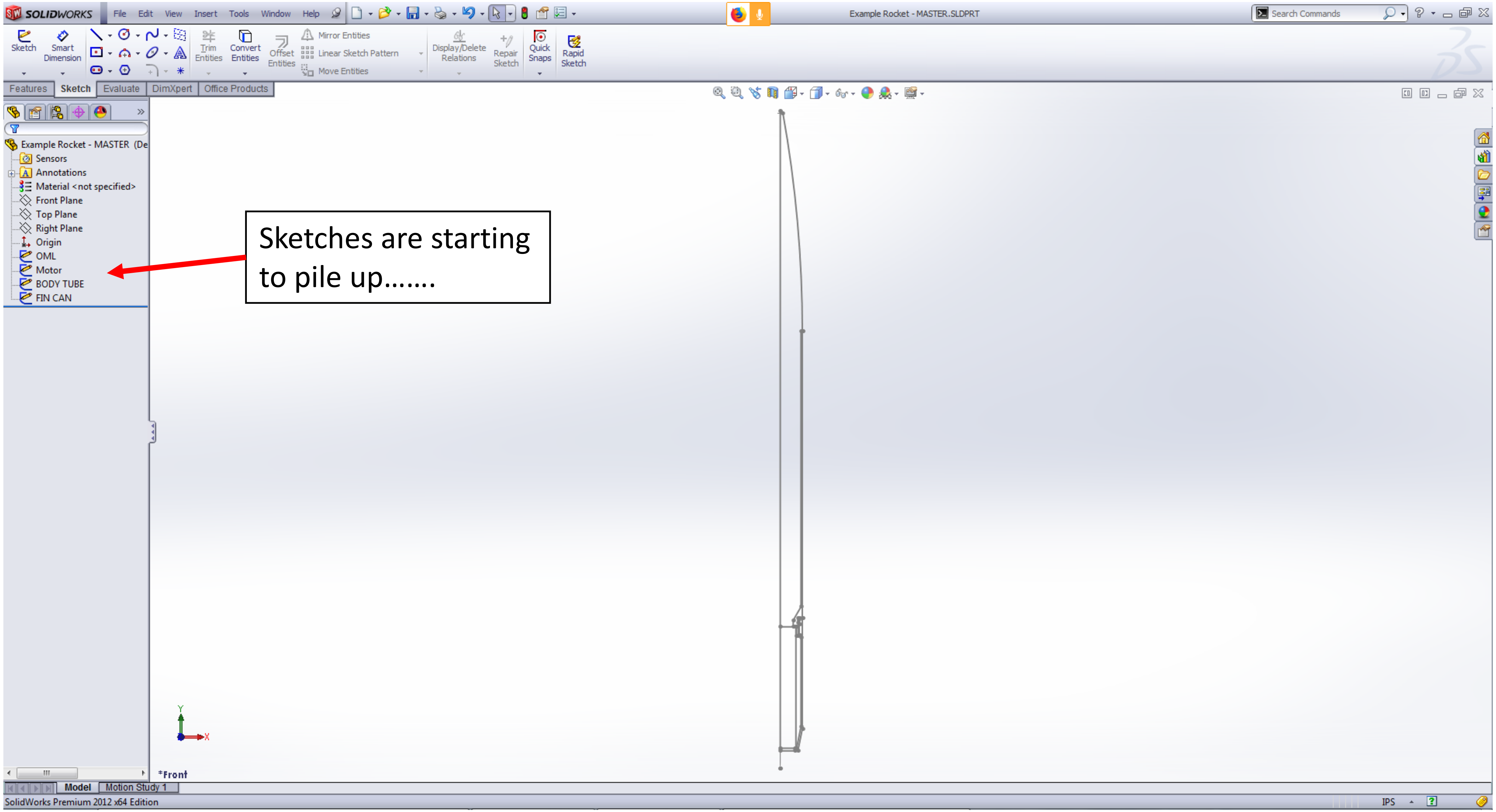


Draw the Fin Can internal profile next. This is the lower motor retention feature.

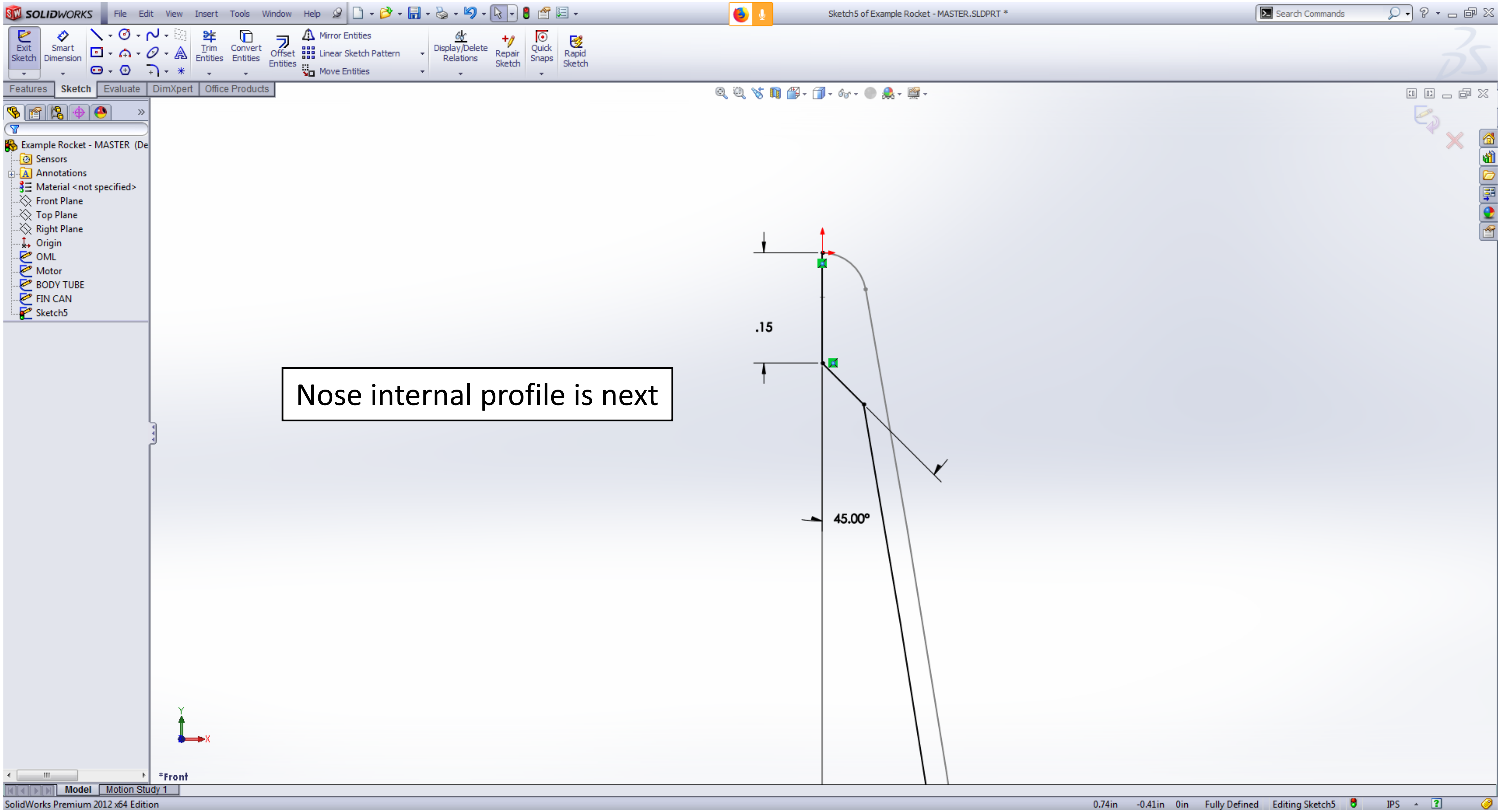


Upper portion of the Fin Can, with threads for joining with the Body Tube

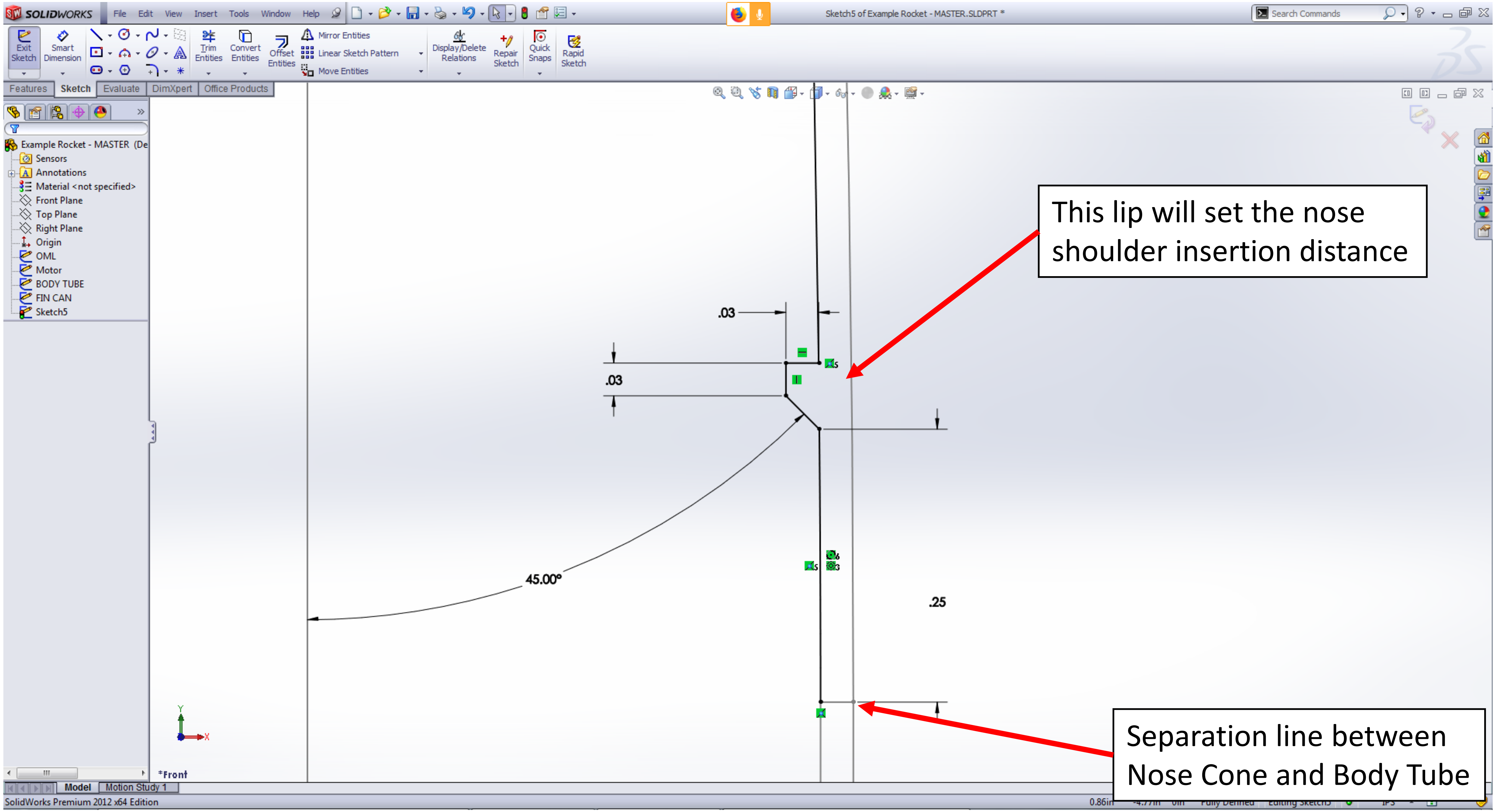

SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - MASTER.SLDPRT *
Search Commands
Sketch
Smart Dimension
Trim Entities
Convert Entities
Offset Entities
Mirror Entities
Linear Sketch Pattern
Move Entities
Display/Delete Relations
Repair Sketch
Quick Snaps
Rapid Sketch
Features Sketch Evaluate DimXpert Office Products
Example Rocket - MASTER (De
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
OML
Motor
BODY TUBE
Sketch4
Done
*Front
Model Motion Study 1
SolidWorks Premium 2012 x64 Edition
Editing Part
IPS



Sketches are starting to pile up.......

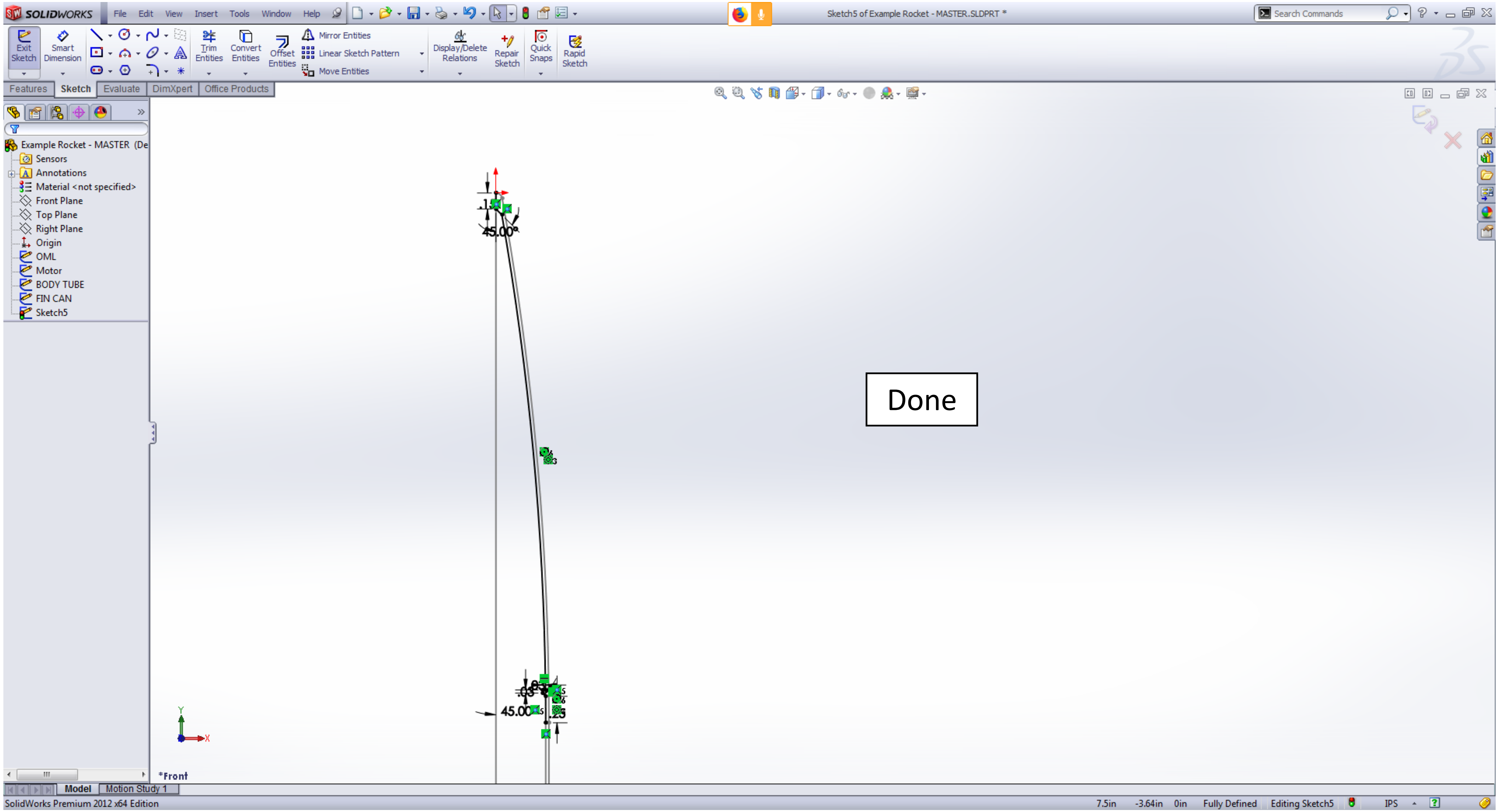


Nose internal profile is next

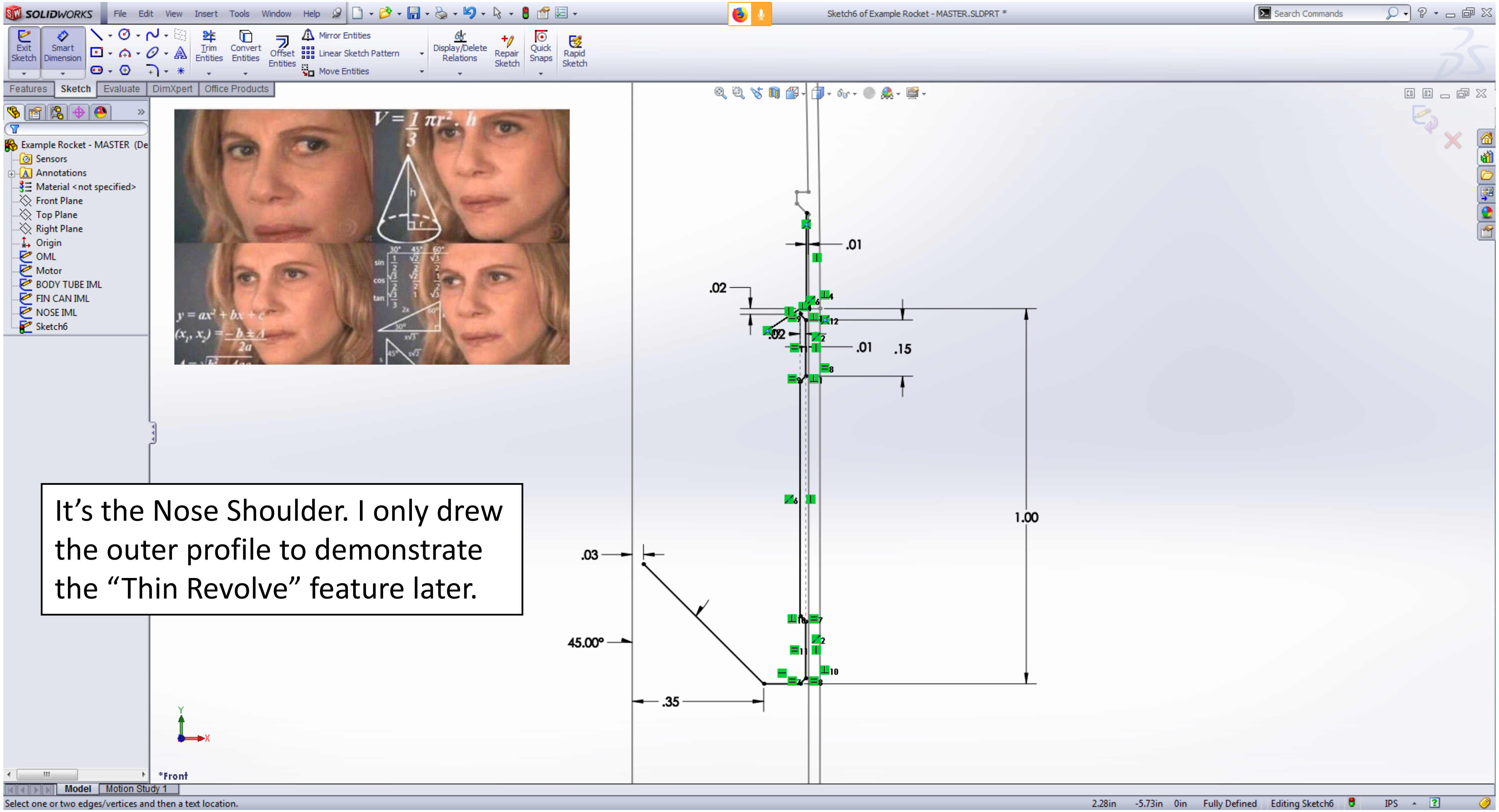


This lip will set the nose shoulder insertion distance

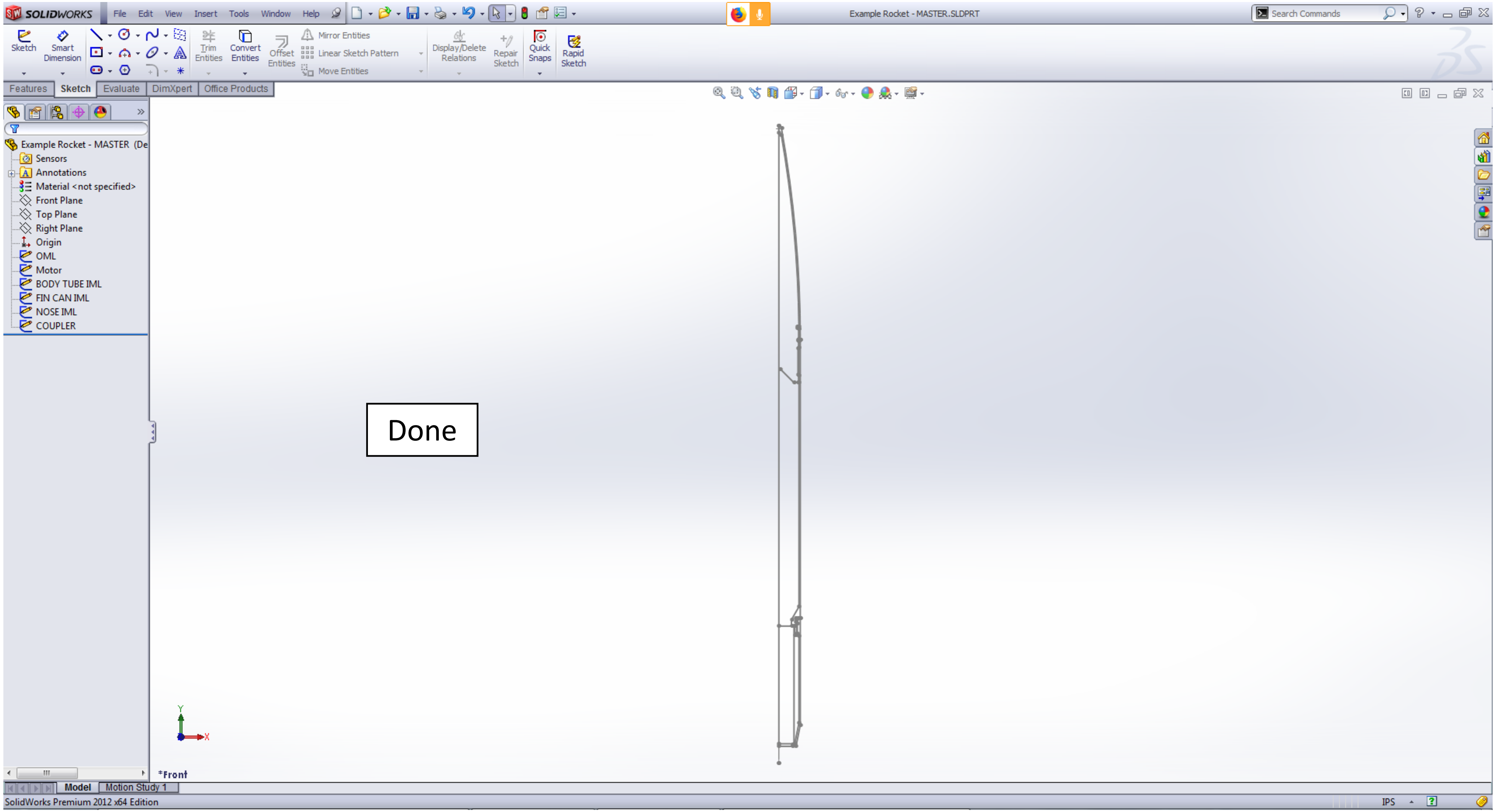
Separation line between Nose Cone and Body Tube

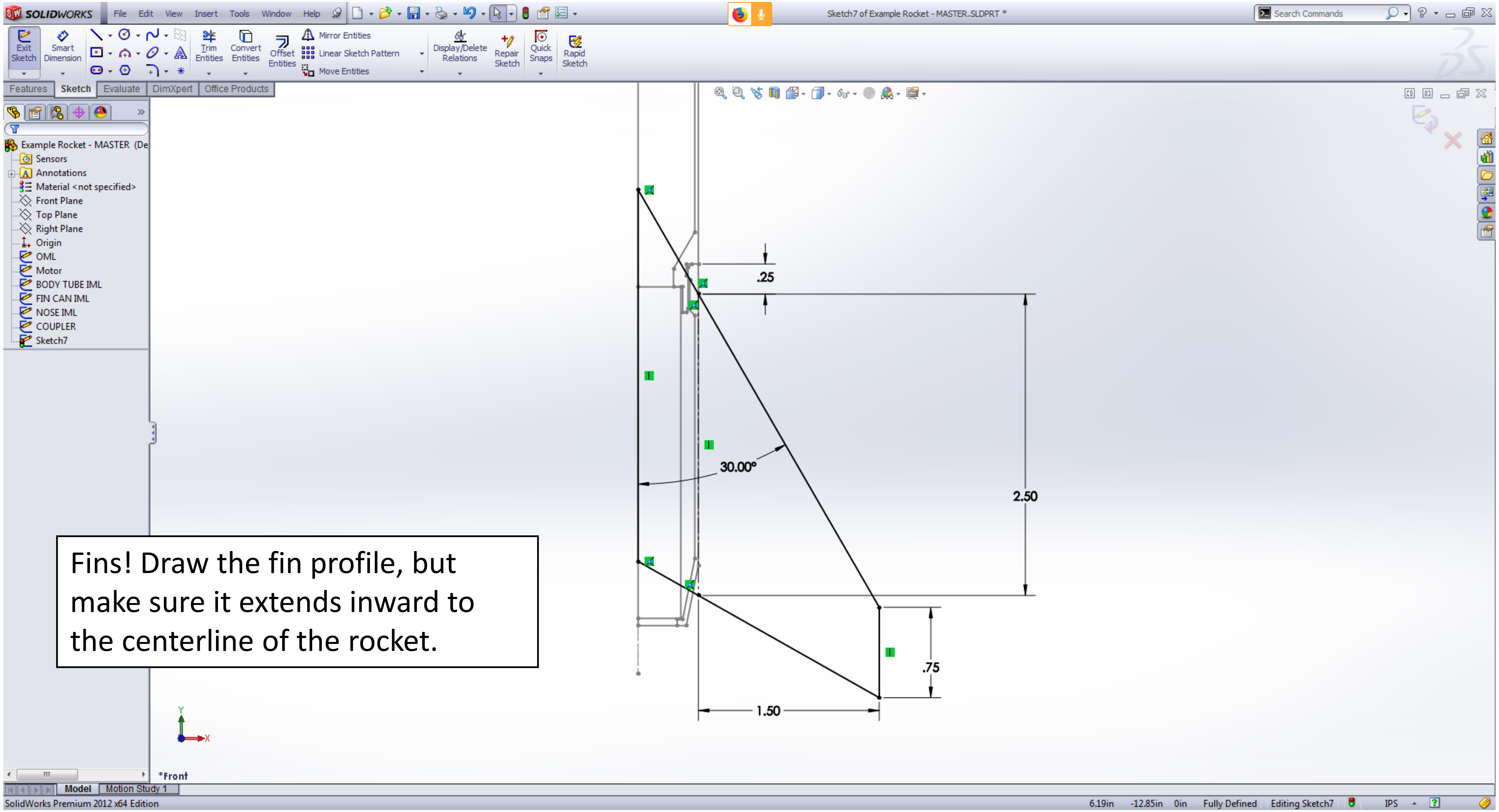

Sketch5 of Example Rocket - MASTER.SLDPRT *
Example Rocket - MASTER
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
OML
Motor
BODY TUBE
FIN CAN
Sketch5
45.00°
45.00
*Front
Fully Defined
Editing Sketch5
SolidWorks Premium 2012 x64 Edition

Done

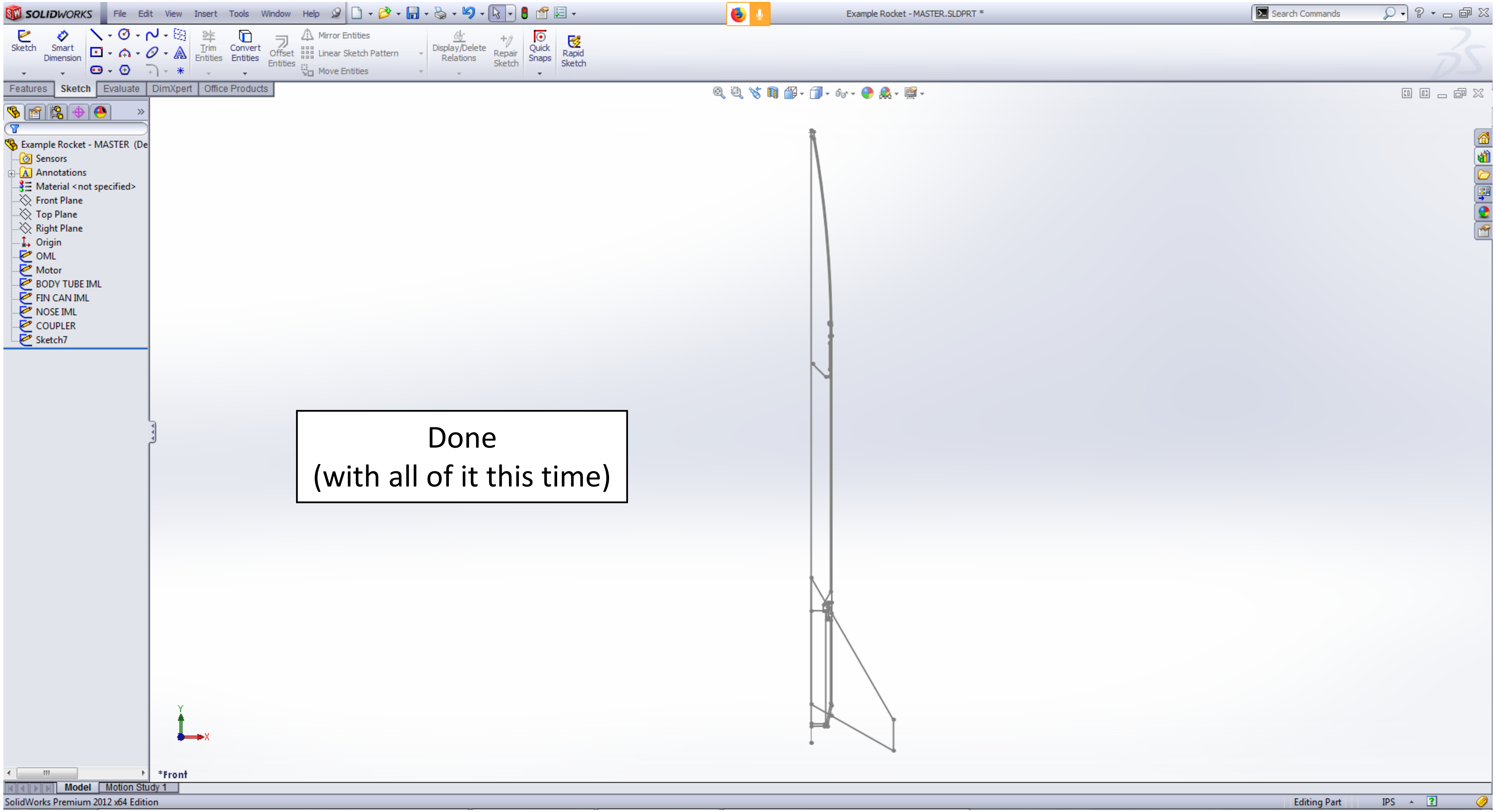


It’s the Nose Shoulder. I only drew the outer profile to demonstrate the “Thin Revolve” feature later.

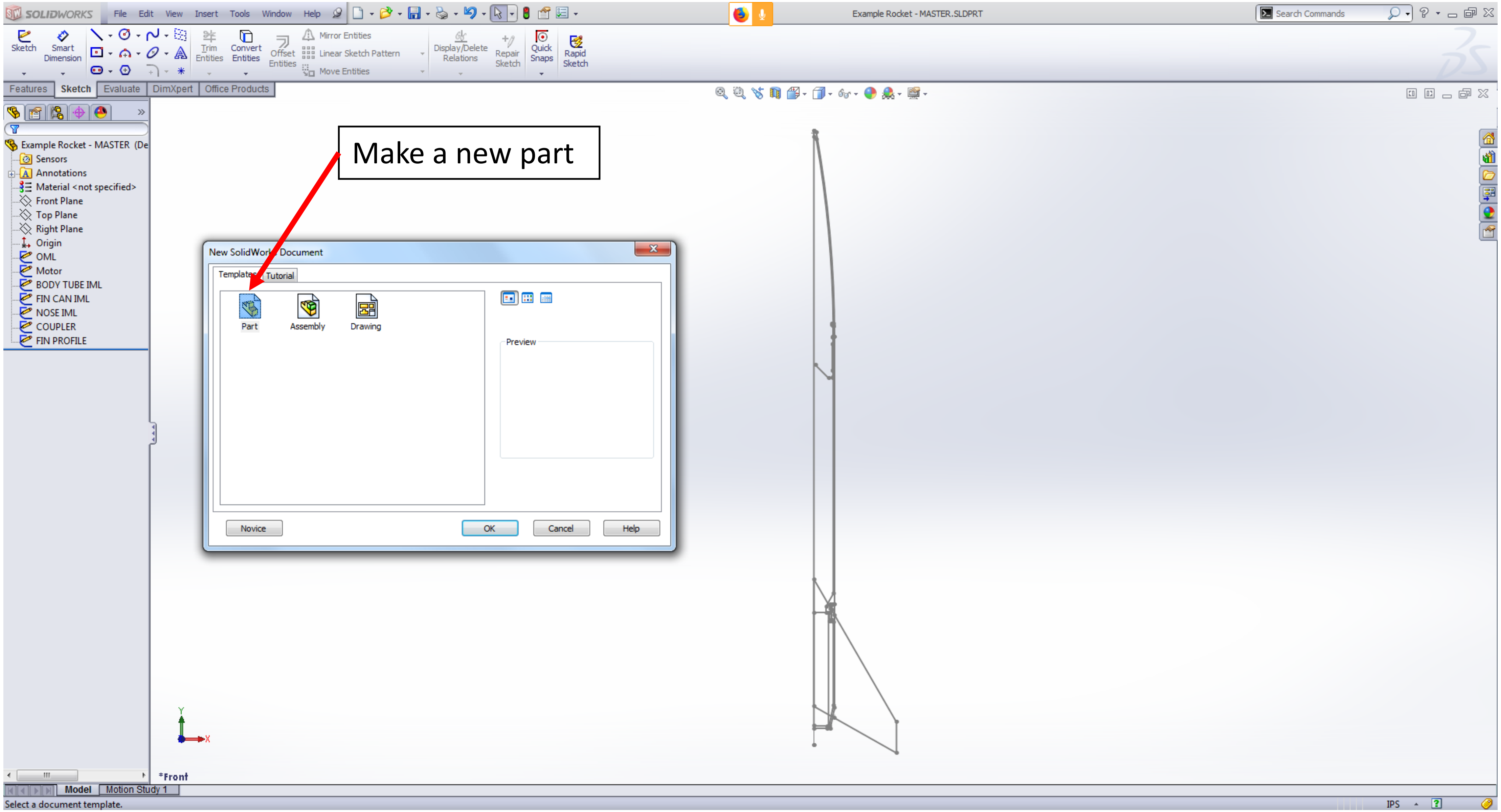

SOLIDWORKS
File
Edit
View
Insert
Tools
Window
Help
Example Rocket - MASTER.SLDPRT
Search Commands
Sketch
Smart Dimension
Trim Entities
Convert Entities
Offset Entities
Mirror Entities
Linear Sketch Pattern
Move Entities
Display/Delete Relations
Repair Sketch
Quick Snaps
Rapid Sketch
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - MASTER (De
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
OML
Motor
BODY TUBE IML
FIN CAN IML
NOSE IML
COUPLER
Done
*Front
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
IPS

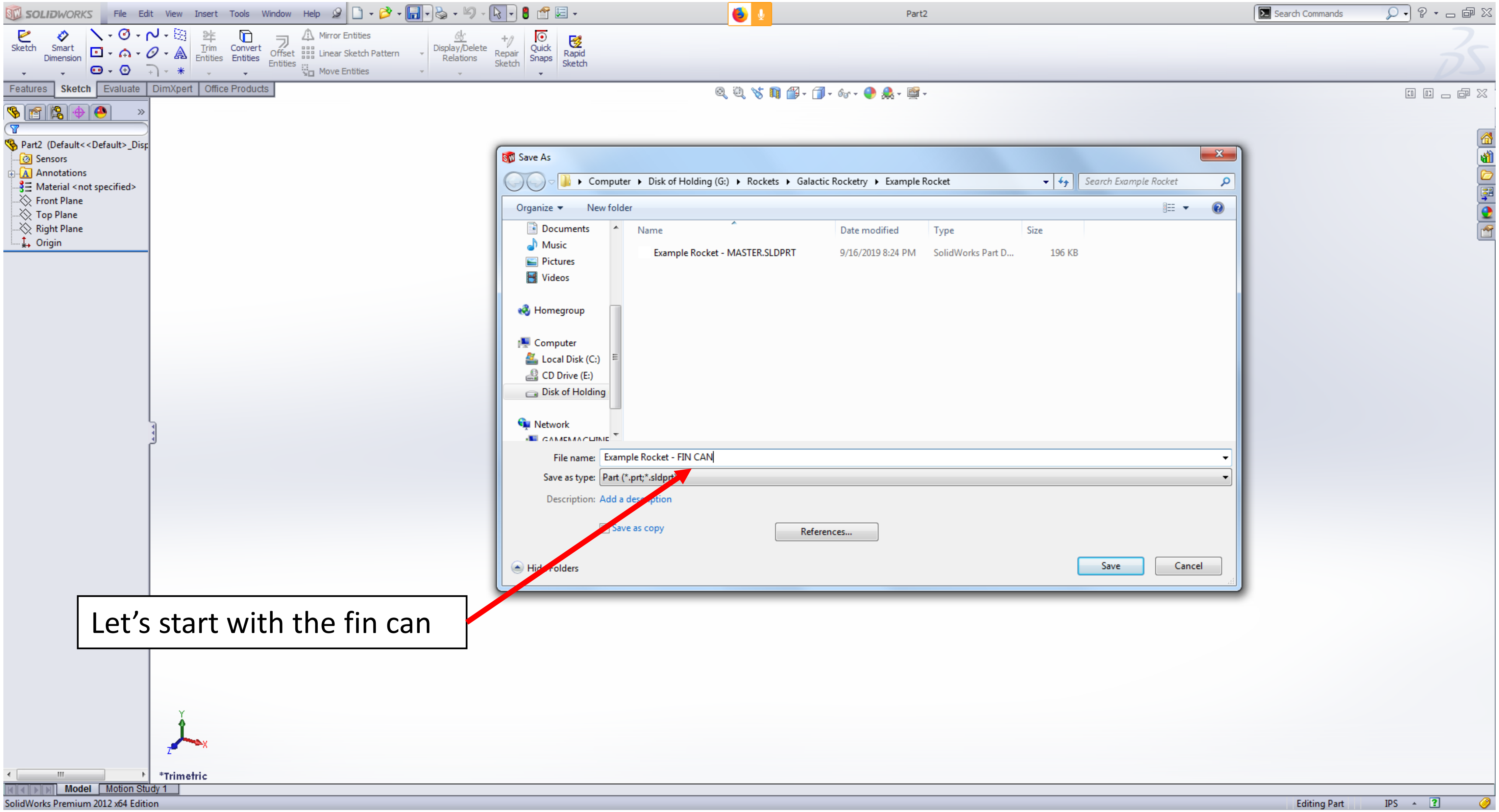


Fins! Draw the fin profile, but make sure it extends inward to the centerline of the rocket.

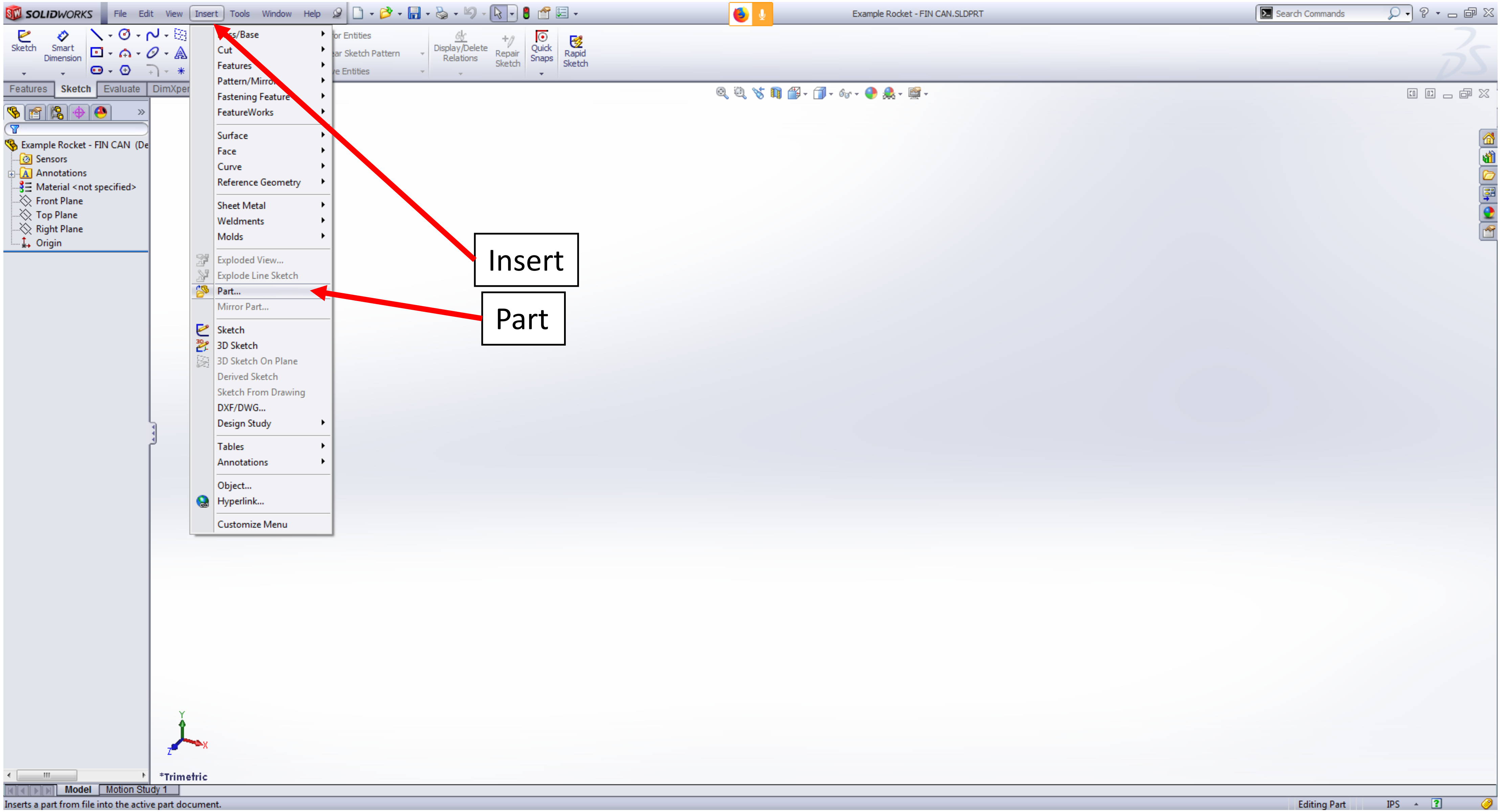


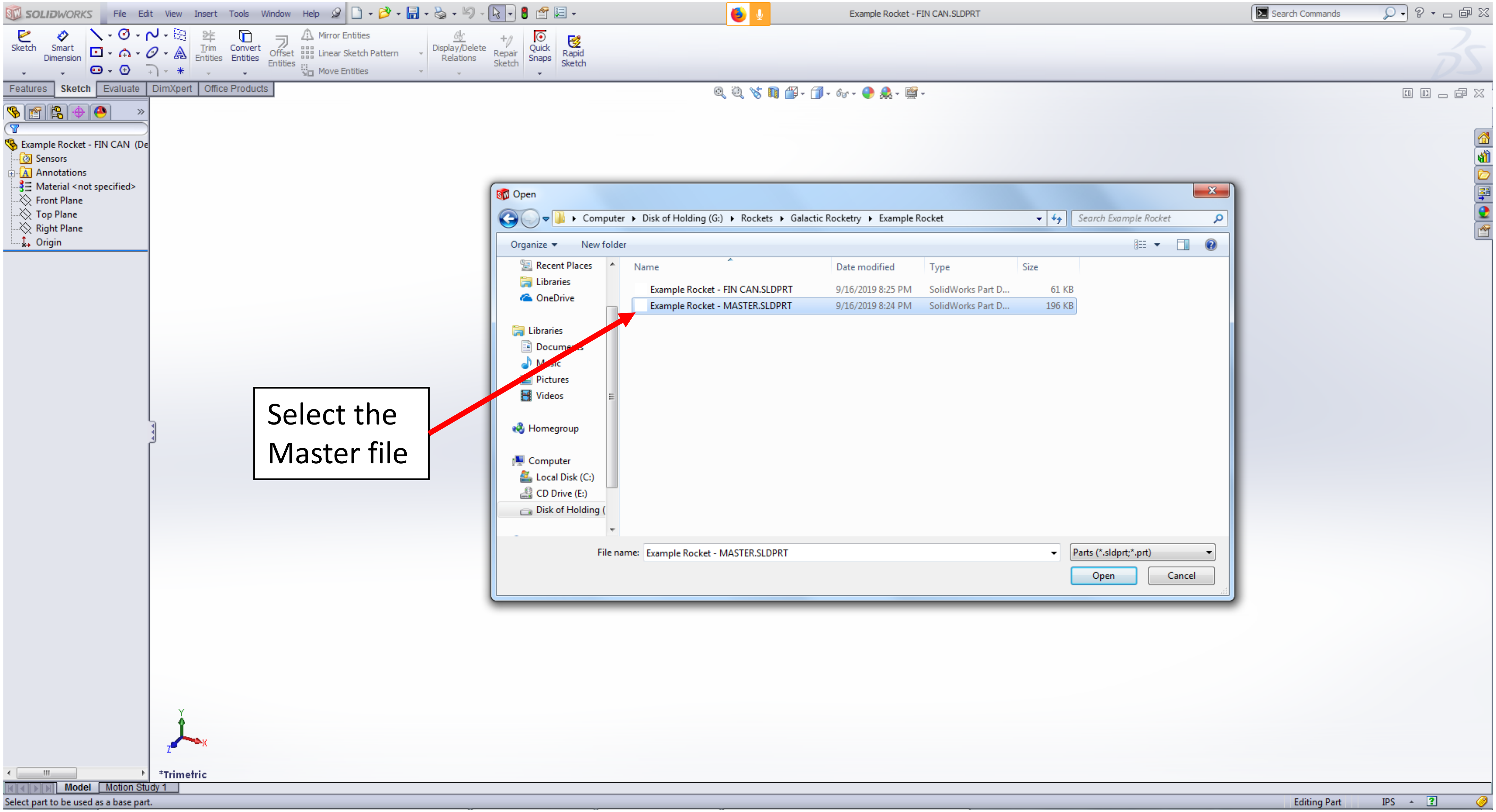
Done
(with all of it this time)

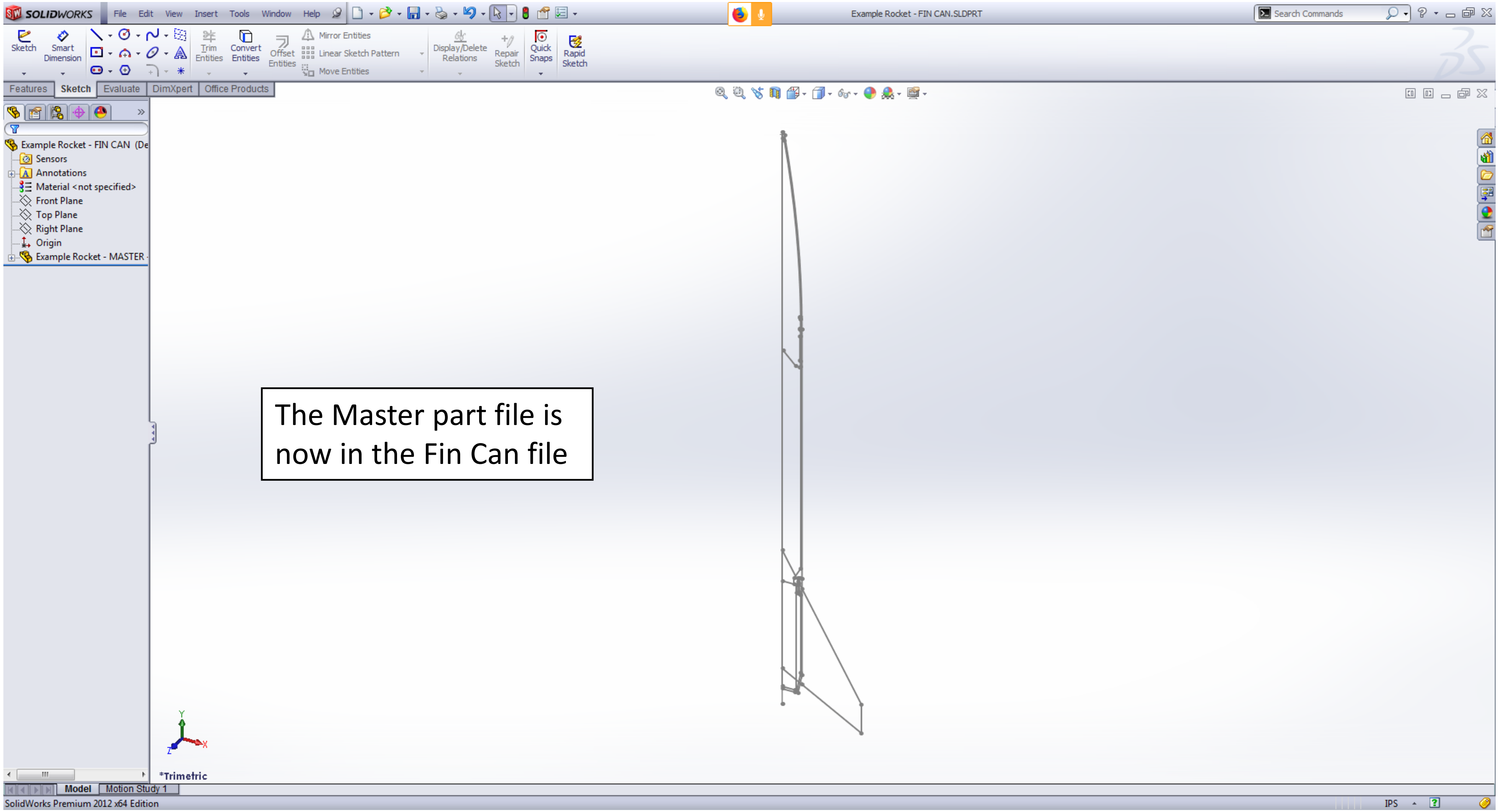

Make a new part
New SolidWorks Document
Templates
Tutorial
Part
Assembly
Drawing
Preview
Novice
OK
Cancel
Help
Example Rocket - MASTER.SLDPRT
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
OML
Motor
BODY TUBE IML
FIN CAN IML
NOSE IML
COUPLER
FIN PROFILE
Select a document template.



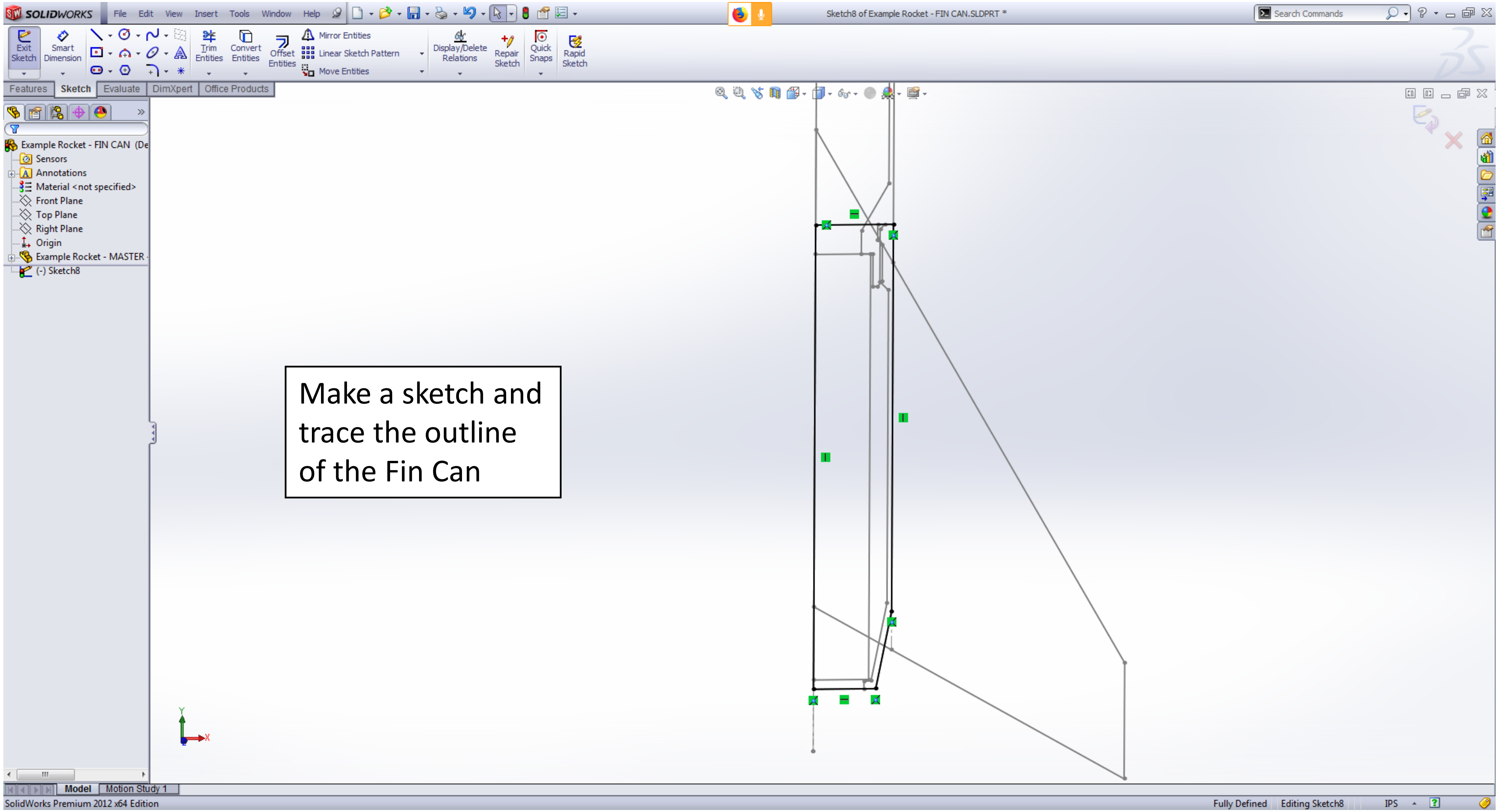
Let’s start with the fin can


Insert
Part
Example Rocket - FIN CAN.SLDPRT
File
Edit
View
Insert
Tools
Window
Help
Cut
Features
Pattern/Mirror
Fastening Feature
FeatureWorks
Surface
Face
Curve
Reference Geometry
Sheet Metal
Weldments
Molds
Exploded View...
Explode Line Sketch
Part...
Mirror Part...
Sketch
3D Sketch
3D Sketch On Plane
Derived Sketch
Sketch From Drawing
DXF/DWG...
Design Study
Tables
Annotations
Object...
Hyperlink...
Customize Menu
Example Rocket - FIN CAN
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
*Trimetric
Model
Motion Study 1
Inserts a part from file into the active part document.
Editing Part
IPS

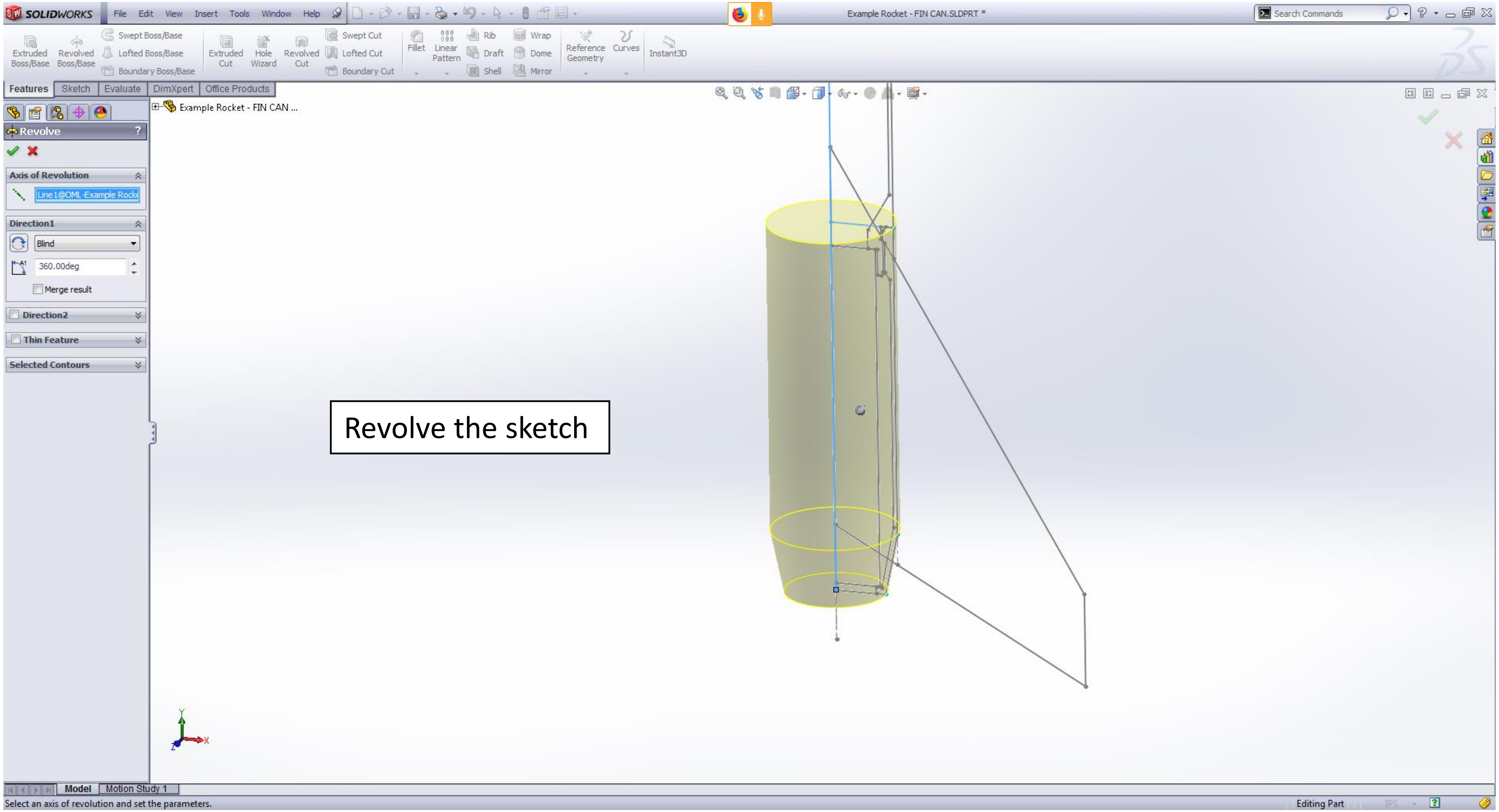

Select the Master file
Example Rocket - FIN CAN.SLDPRT
Open
Computer ▸ Disk of Holding (G:) ▸ Rockets ▸ Galactic Rocketry ▸ Example Rocket
Example Rocket - FIN CAN.SLDPRT 9/16/2019 8:25 PM SolidWorks Part D... 61 KB
Example Rocket - MASTER.SLDPRT 9/16/2019 8:24 PM SolidWorks Part D... 196 KB
File name: Example Rocket - MASTER.SLDPRT
Parts (*.sldprt;*.prt)
Open
Cancel
Select part to be used as a base part.



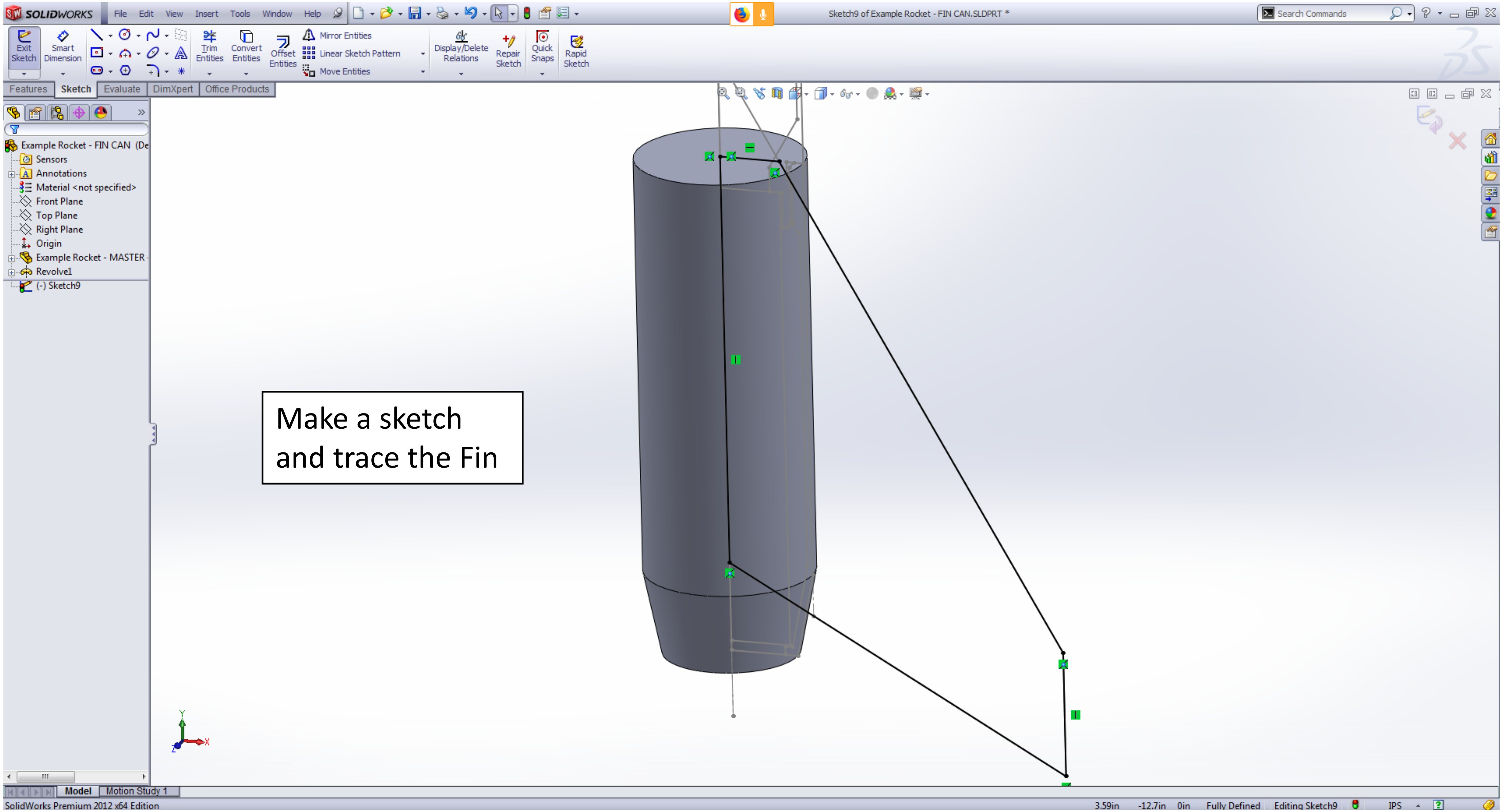
The Master part file is now in the Fin Can file



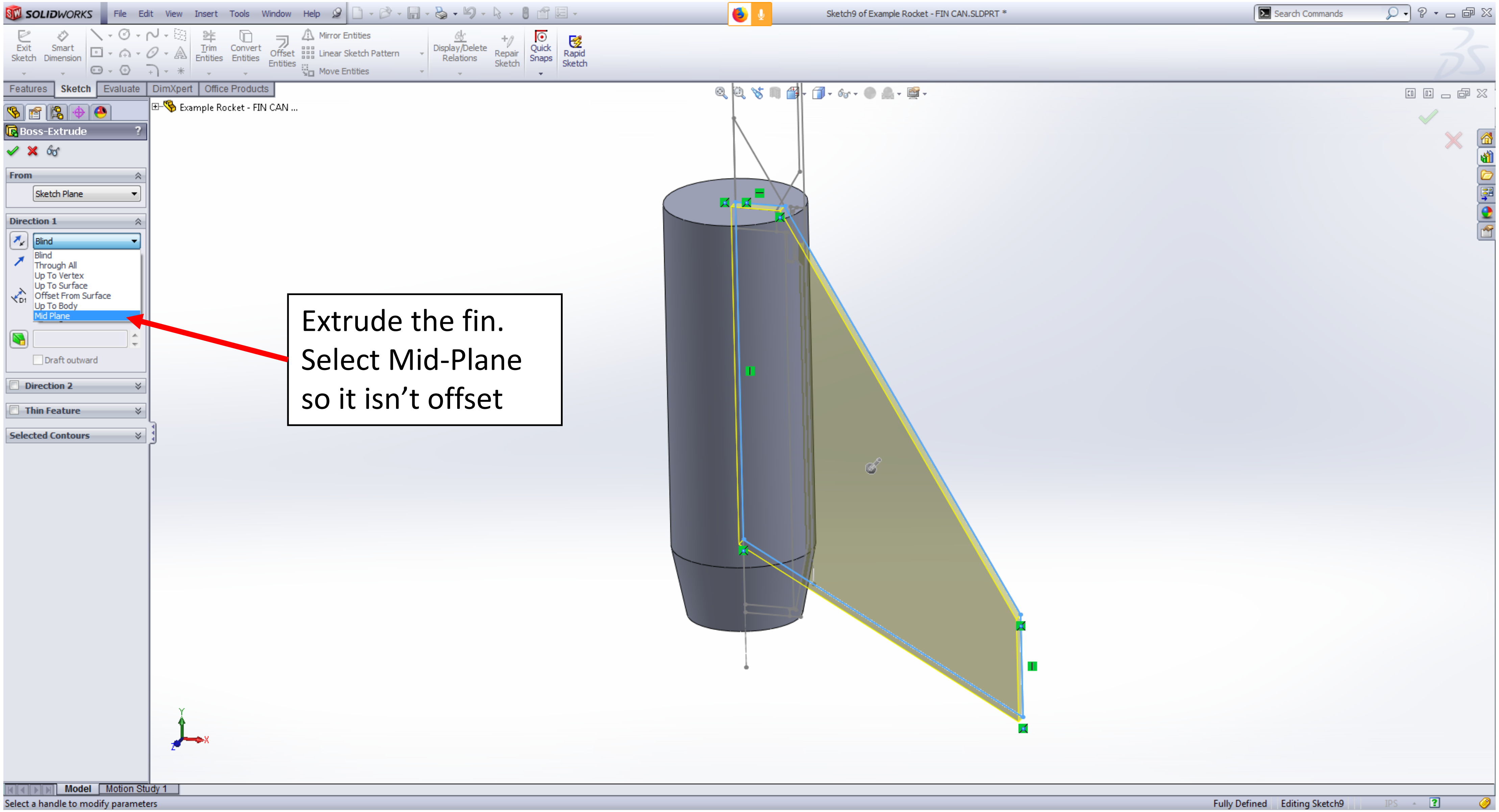
Make a sketch and trace the outline of the Fin Can



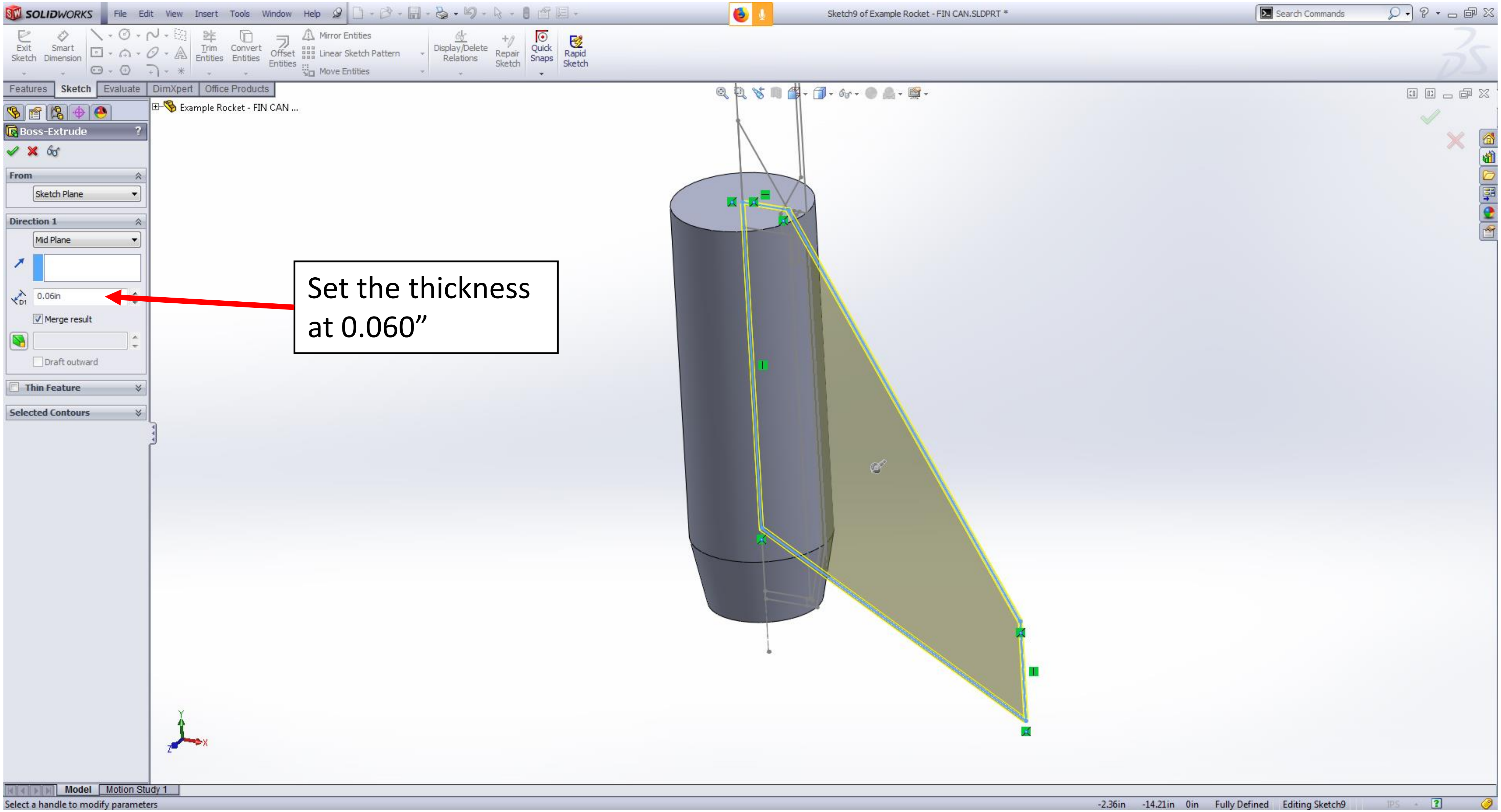
Revolve the sketch



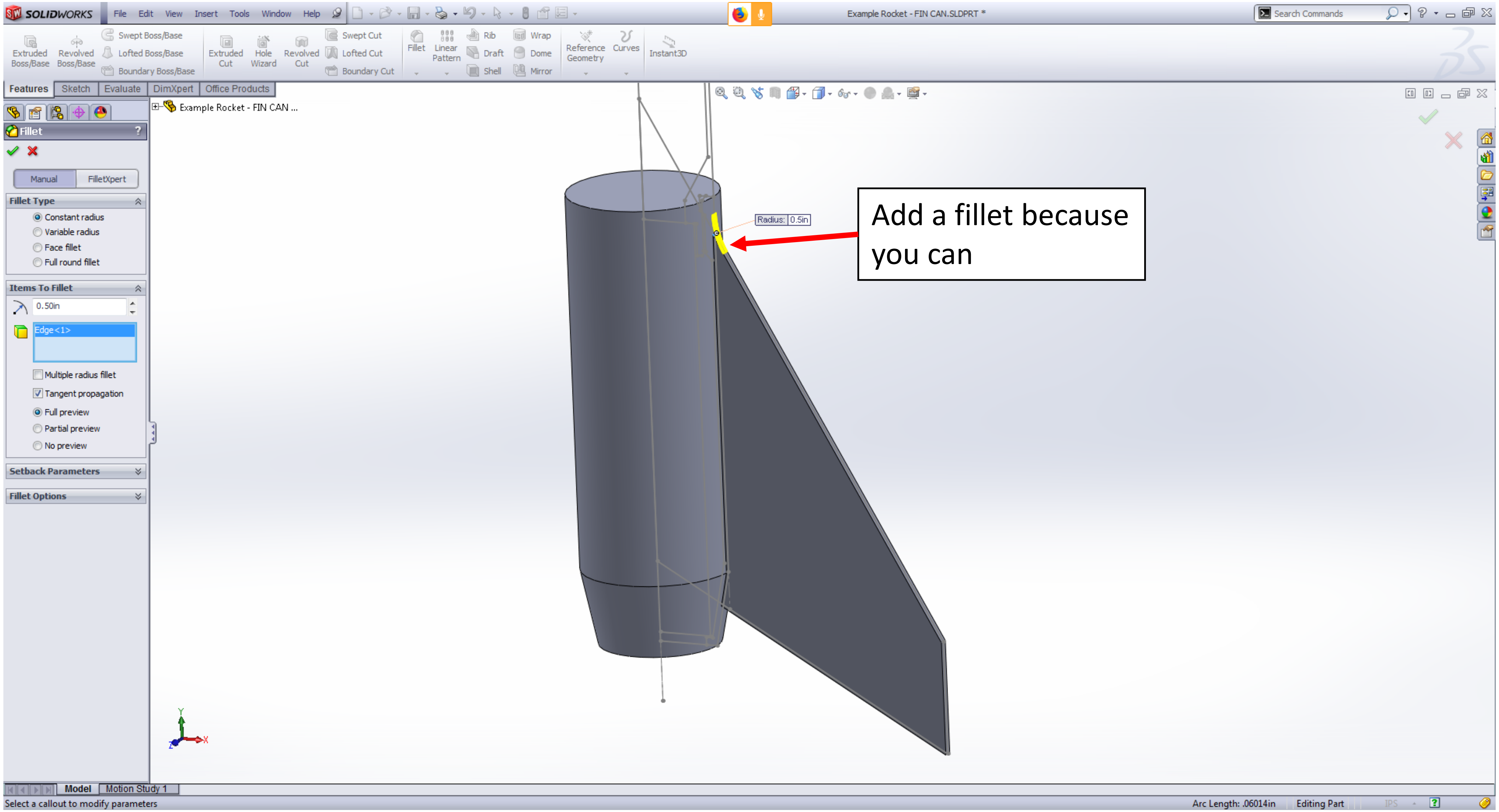
Make a sketch and trace the Fin



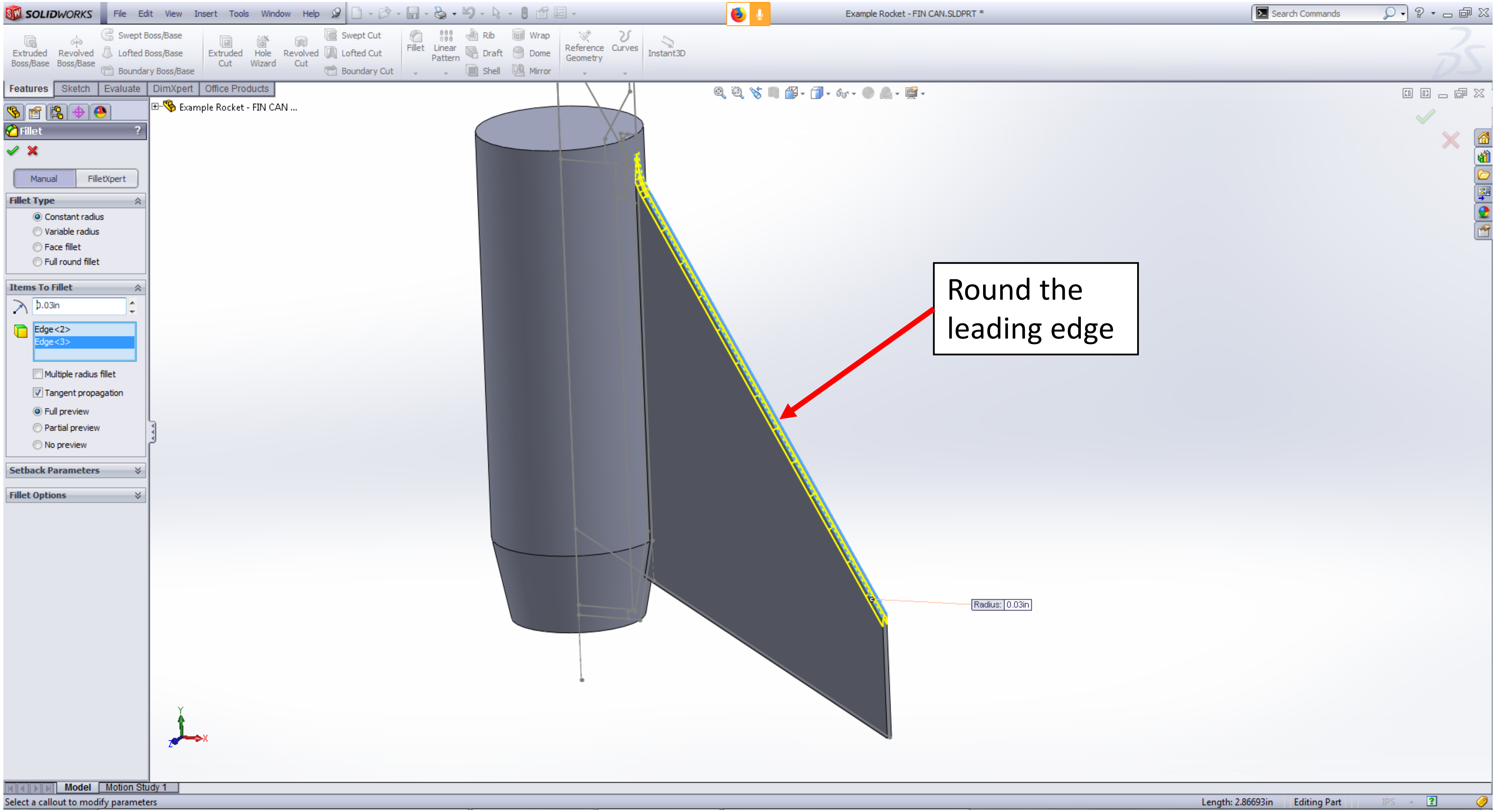
Extrude the fin.
Select Mid-Plane
so it isn’t offset



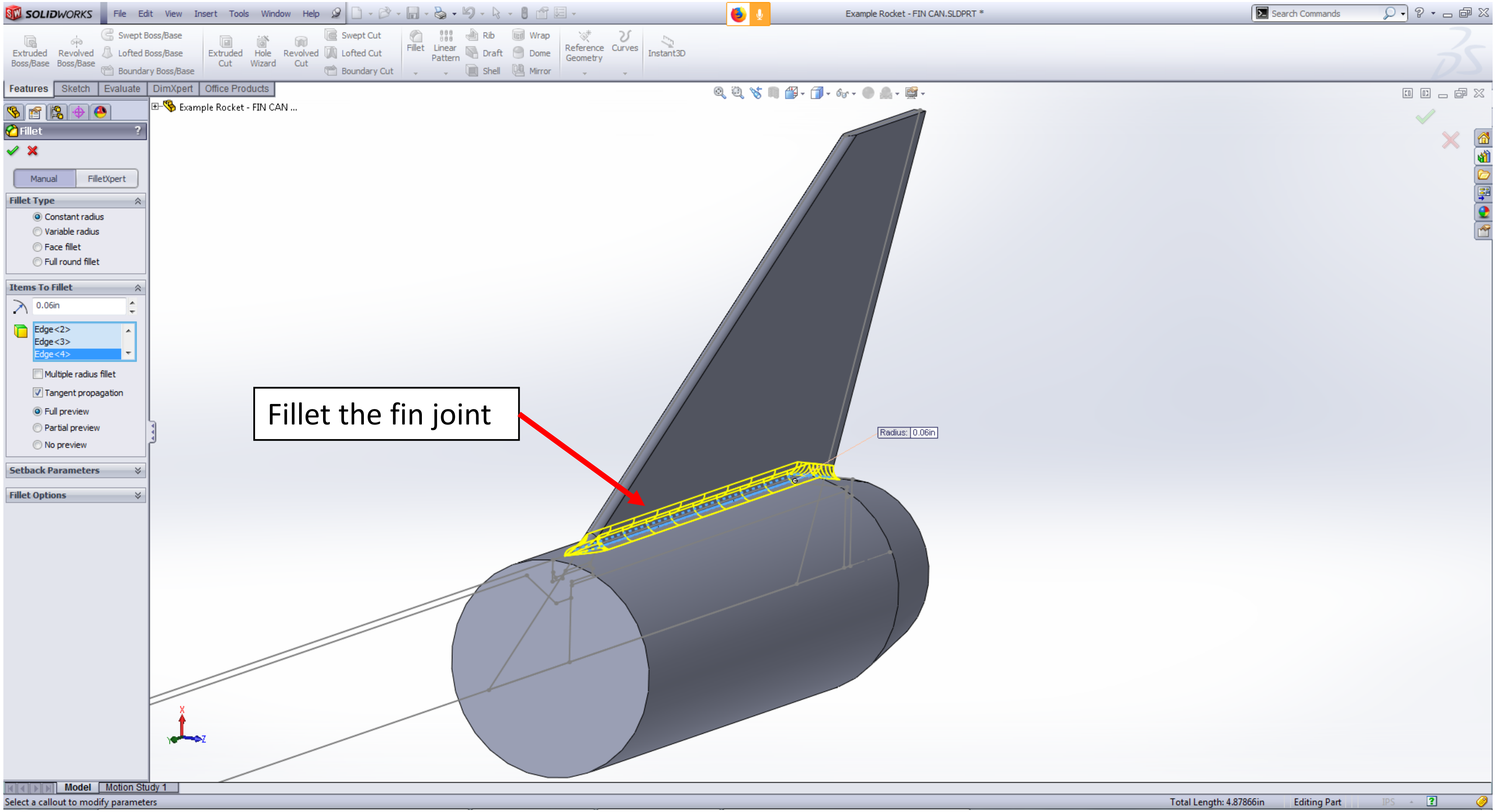
Set the thickness at 0.060”

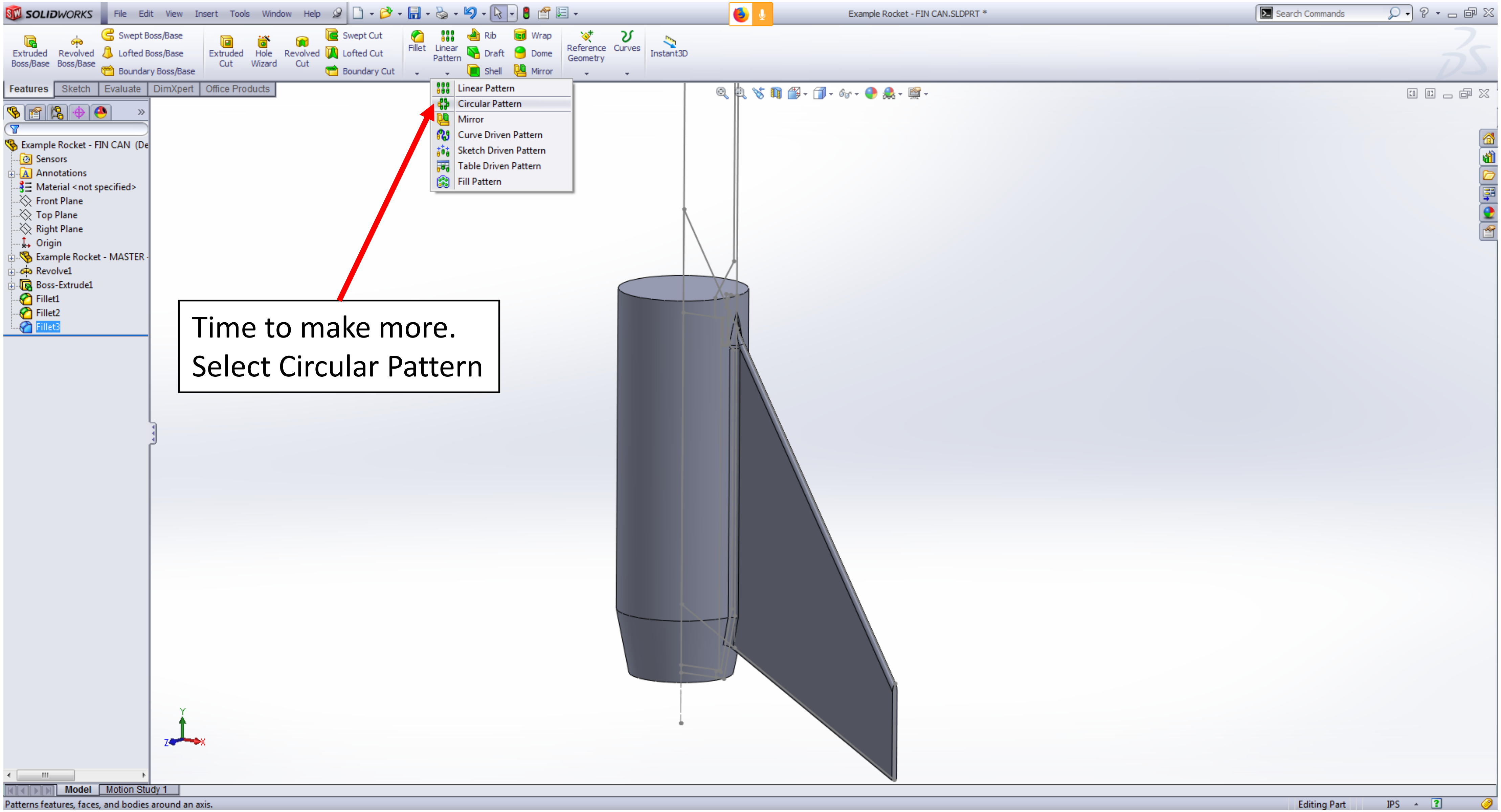


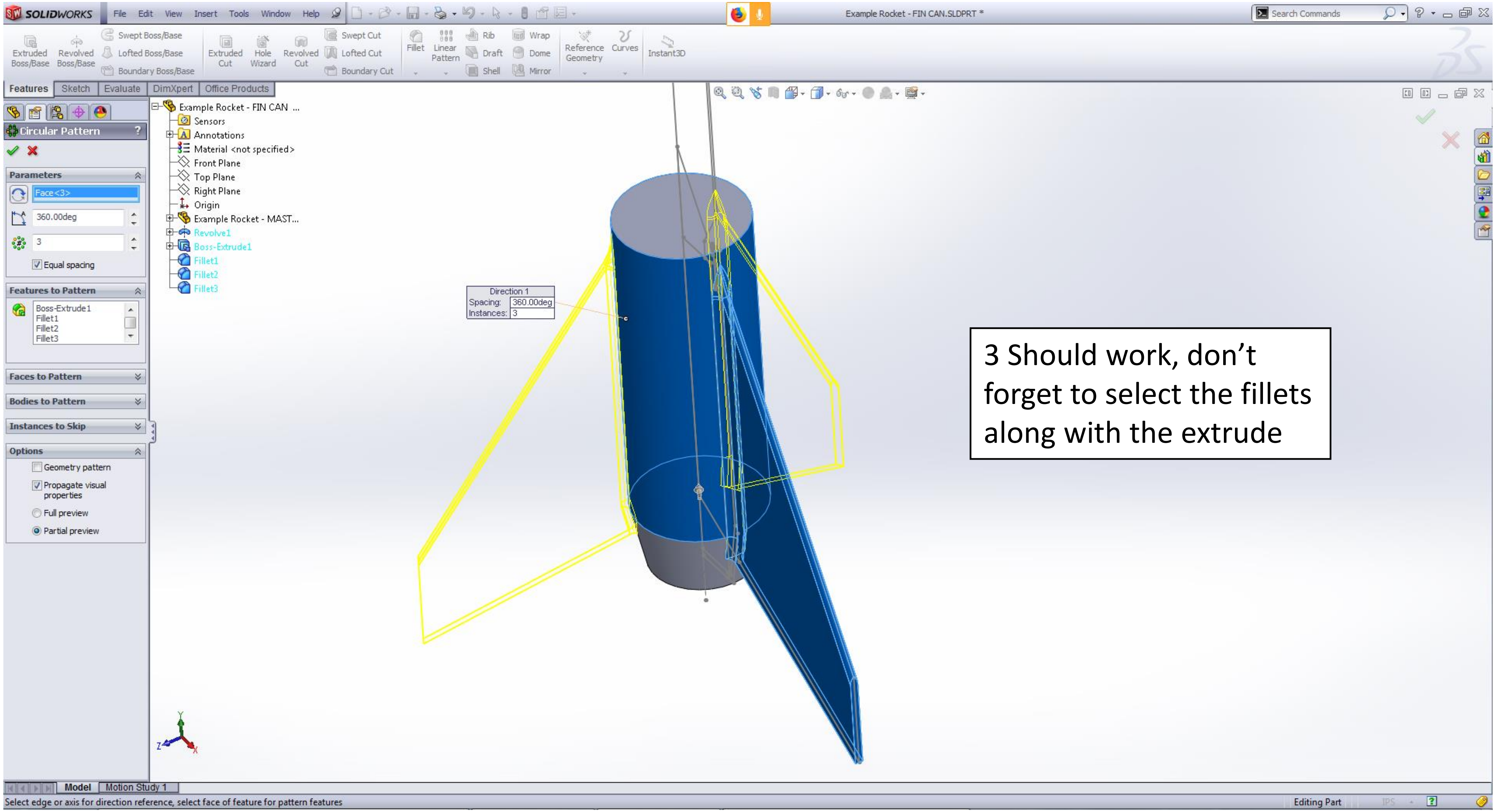
Add a fillet because you can



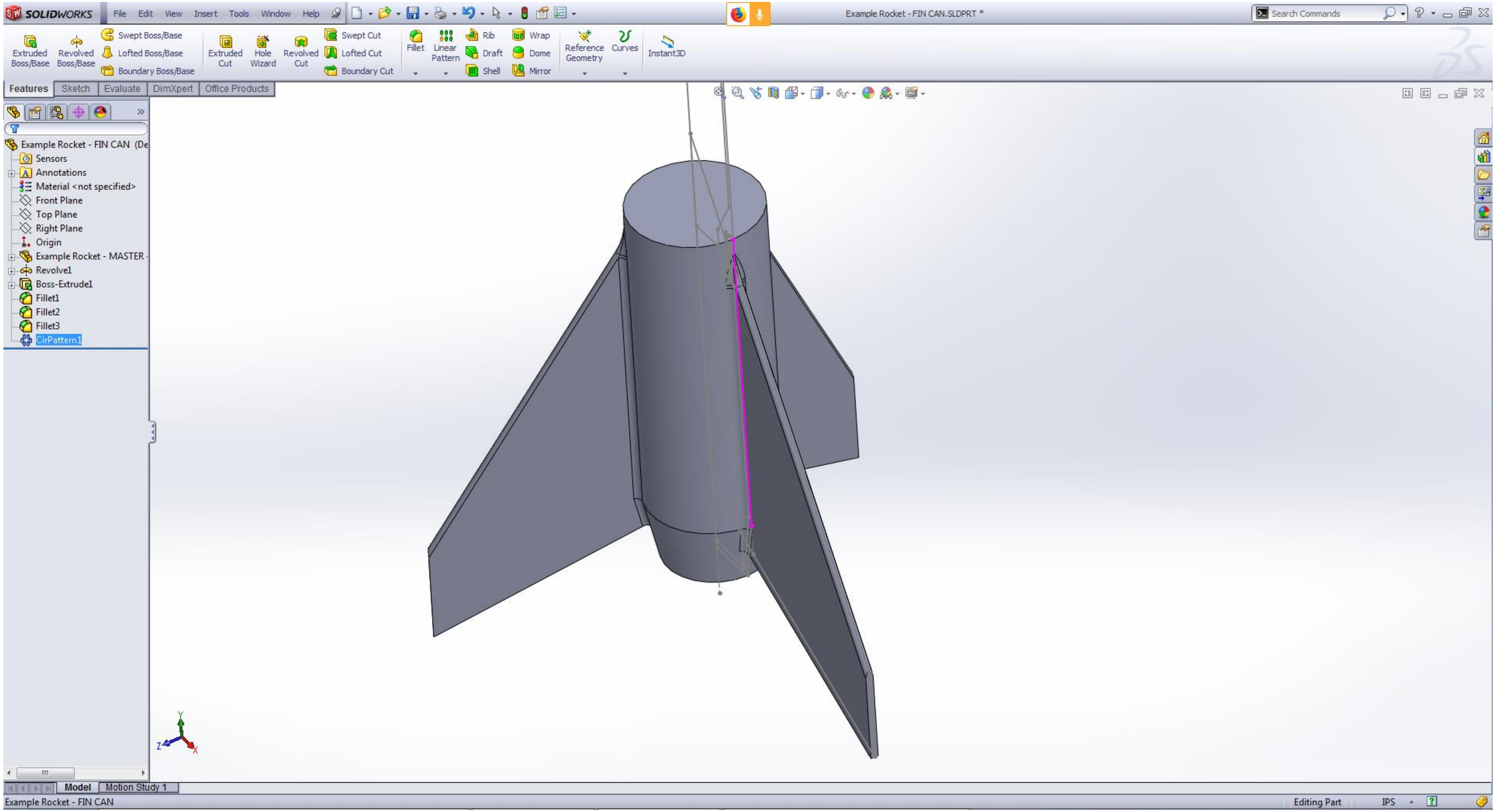
Round the leading edge

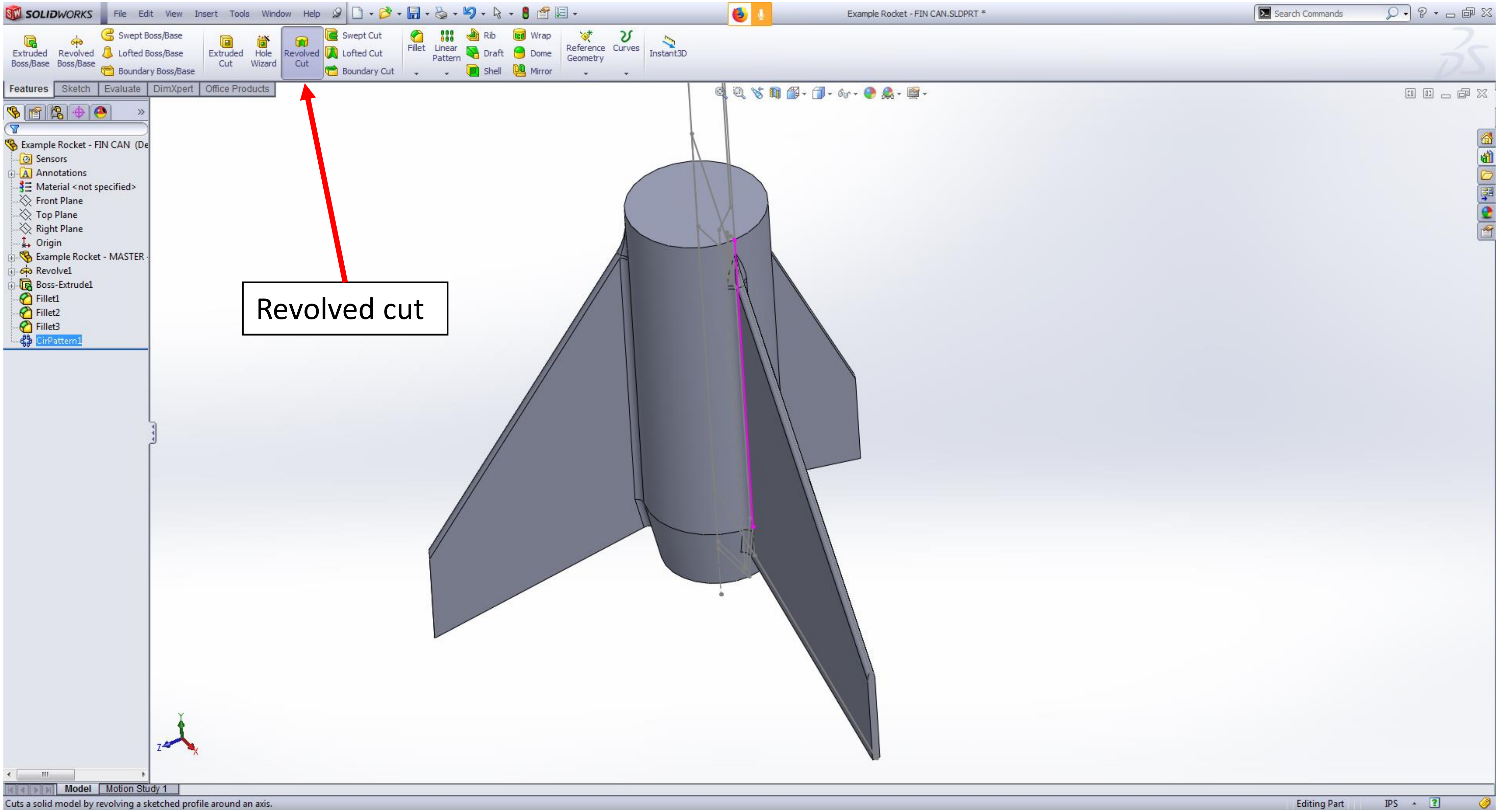

Fillet the fin joint
Radius: 0.06in
Fillet
Manual
FilletXpert
Fillet Type
Constant radius
Variable radius
Face fillet
Full round fillet
Items To Fillet
0.06in
Edge<2>
Edge<3>
Edge<4>
Multiple radius fillet
Tangent propagation
Full preview
Partial preview
No preview
Setback Parameters
Fillet Options
Example Rocket - FIN CAN.SLDPRT *
Select a callout to modify parameters
Total Length: 4.87866in
Editing Part

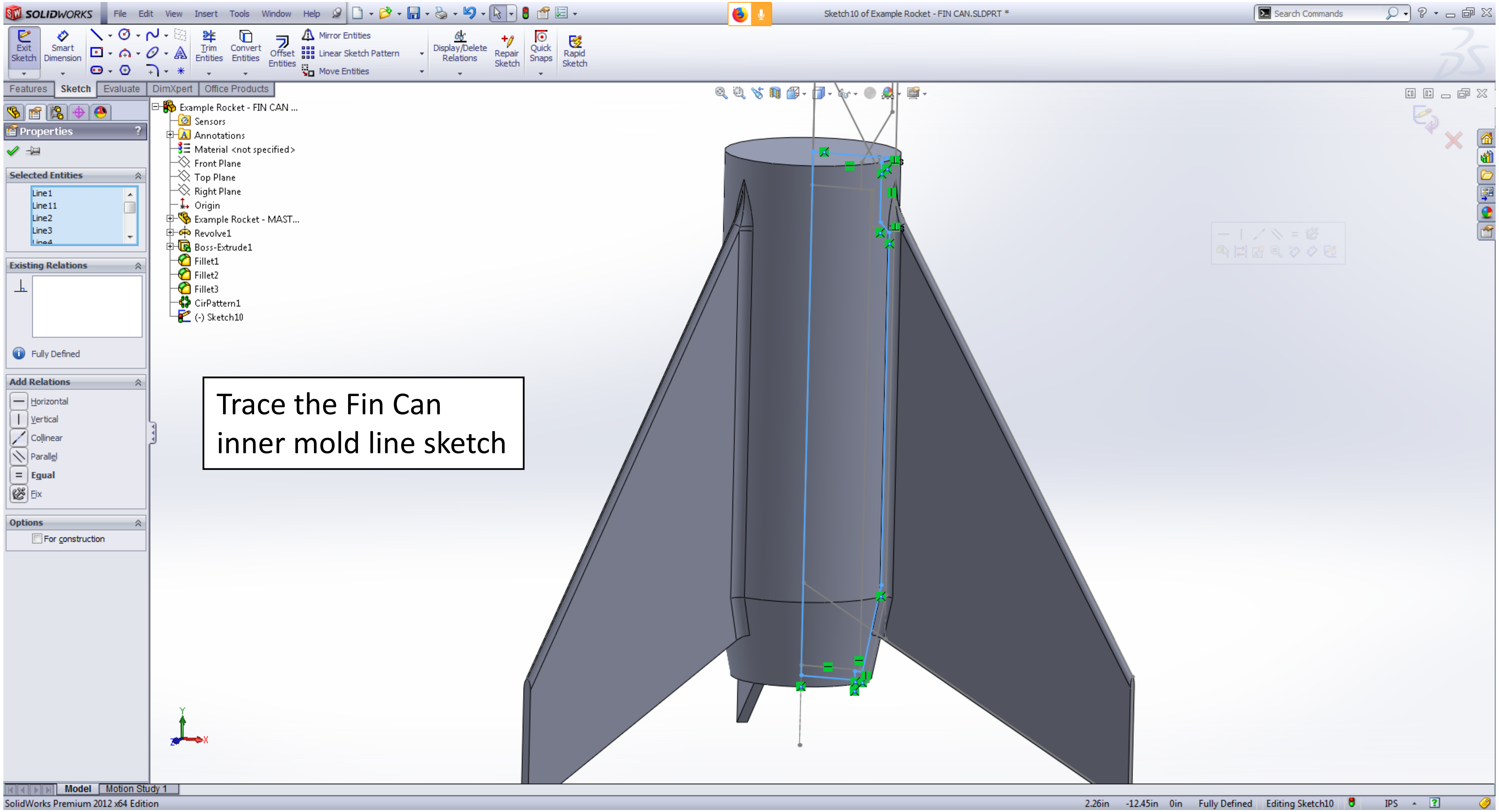

Time to make more.
Select Circular Pattern
Linear Pattern
Circular Pattern
Mirror
Curve Driven Pattern
Sketch Driven Pattern
Table Driven Pattern
Fill Pattern
Example Rocket - FIN CAN.SLDPRT *
Patterns features, faces, and bodies around an axis.



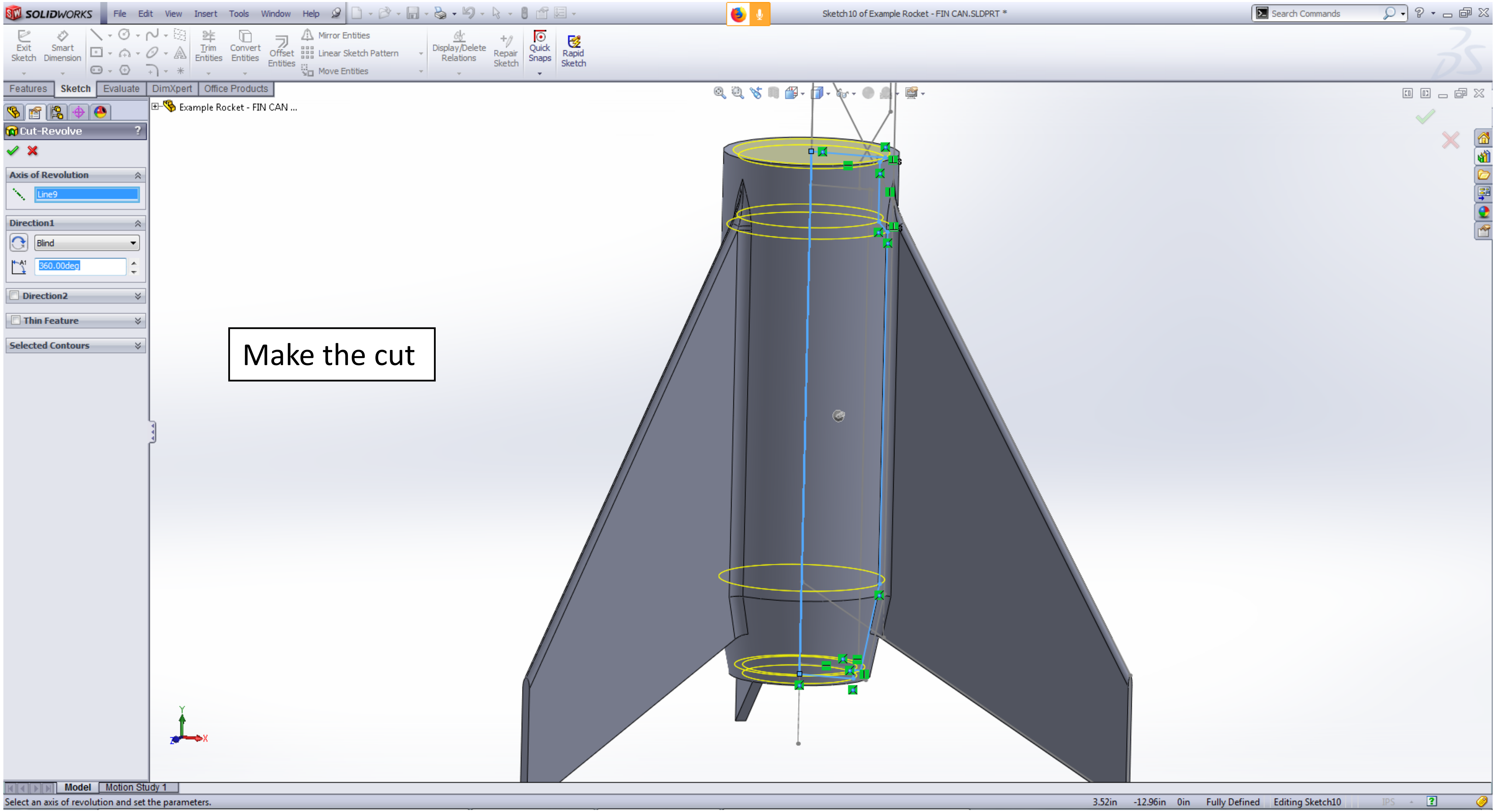
3 Should work, don't forget to select the fillets along with the extrude


SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - FIN CAN.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - FIN CAN (De
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER
Revolve1
Boss-Extrude1
Fillet1
Fillet2
Fillet3
CirPattern1
Model
Motion Study 1
Example Rocket - FIN CAN
Editing Part
IPS

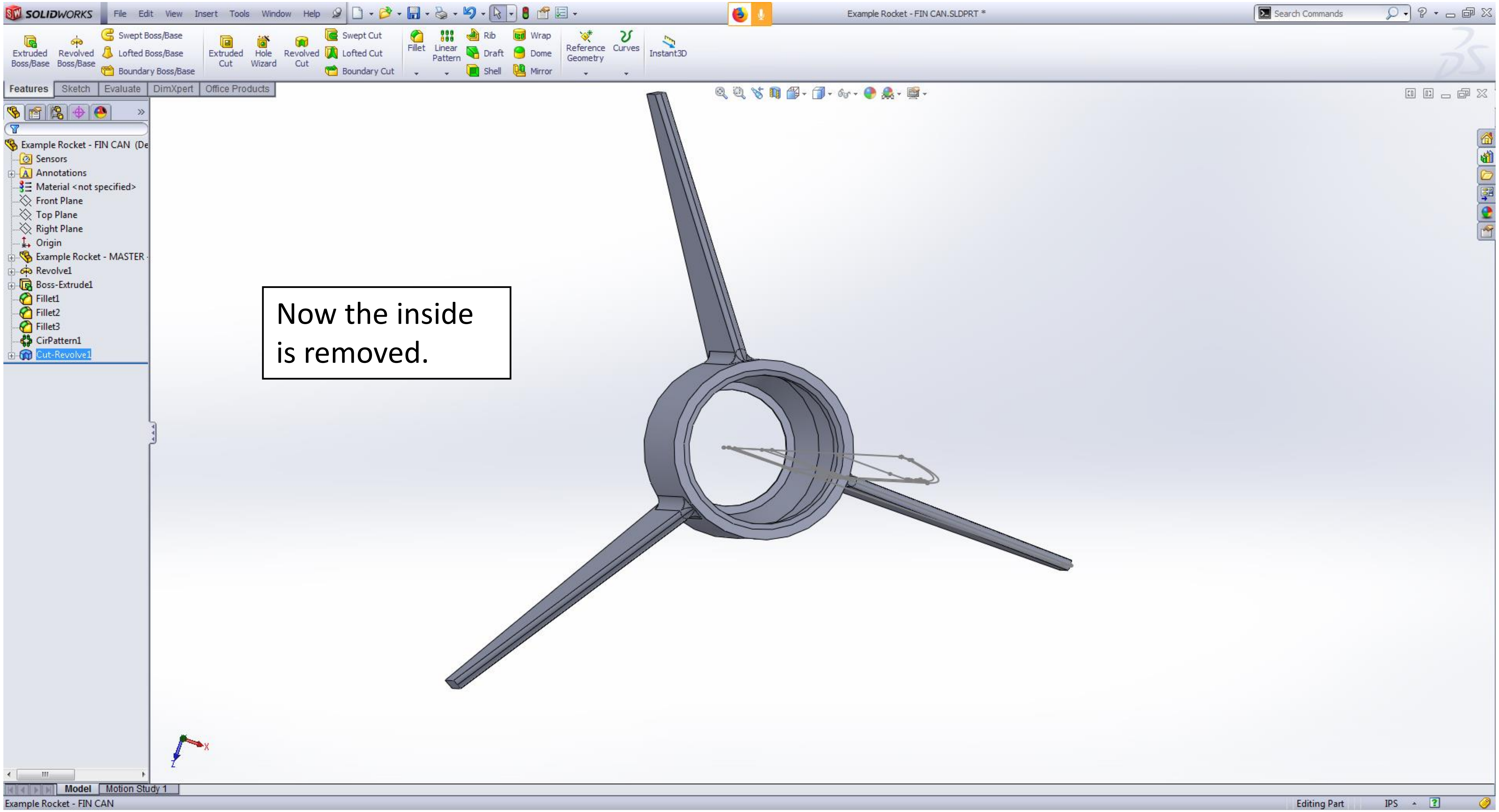

Revolved cut
SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - FIN CAN.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features Sketch Evaluate DimXpert Office Products
Example Rocket - FIN CAN (De
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER
Revolve1
Boss-Extrude1
Fillet1
Fillet2
Fillet3
CirPattern1
Model Motion Study 1
Cuts a solid model by revolving a sketched profile around an axis.
Editing Part
IPS



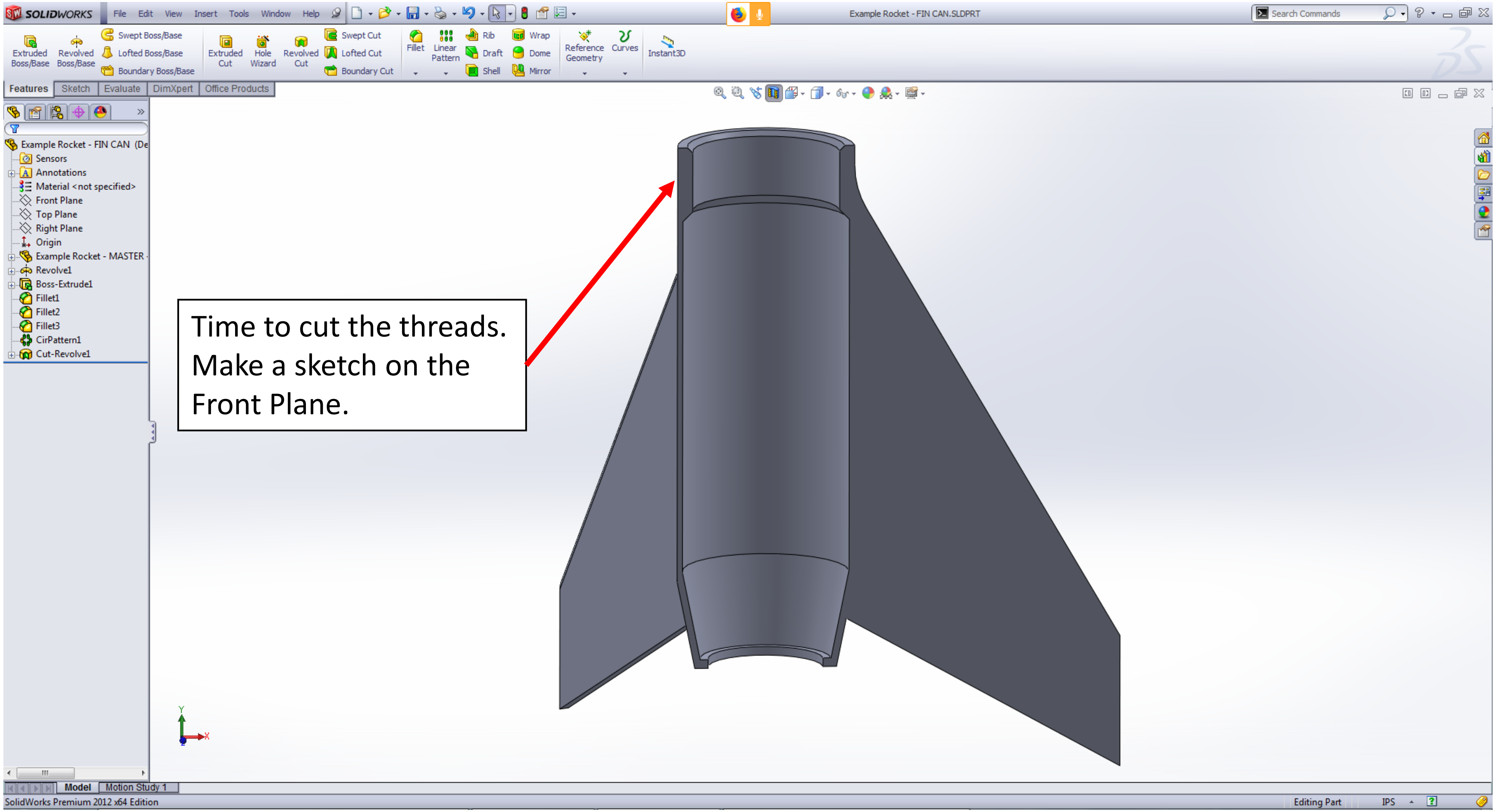
Trace the Fin Can inner mold line sketch

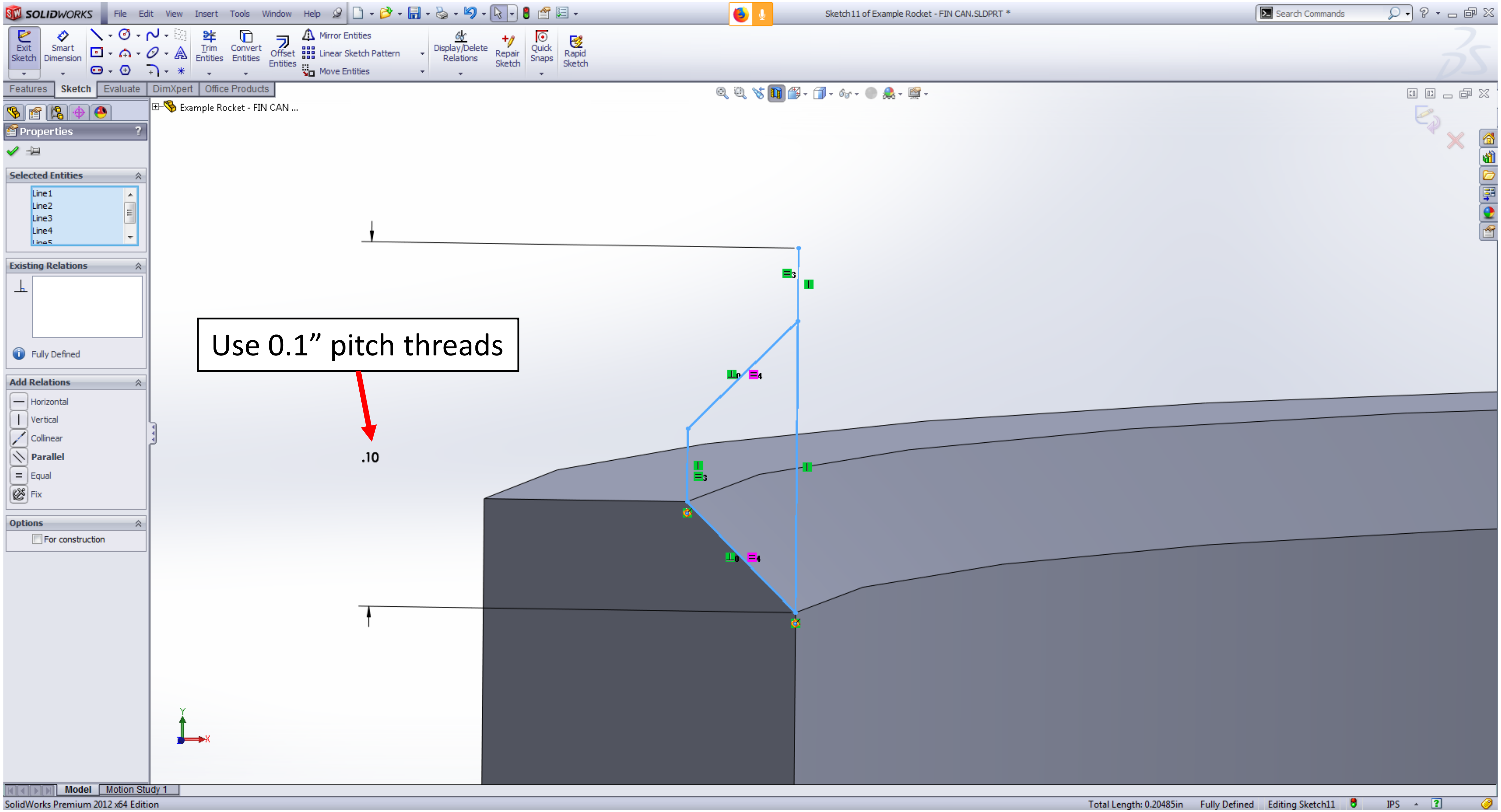

SOLIDWORKS
File Edit View Insert Tools Window Help
Sketch10 of Example Rocket - FIN CAN.SLDPRT *
Search Commands
Exit Sketch
Smart Dimension
Trim Entities
Convert Entities
Offset Entities
Mirror Entities
Linear Sketch Pattern
Move Entities
Display/Delete Relations
Repair Sketch
Quick Snaps
Rapid Sketch
Features Sketch Evaluate DimXpert Office Products
Example Rocket - FIN CAN ...
Cut-Revolve
Axis of Revolution
Line9
Direction1
Blind
360.00deg
Direction2
Thin Feature
Selected Contours
Model Motion Study 1
Select an axis of revolution and set the parameters.
3.52in -12.96in 0in Fully Defined Editing Sketch10

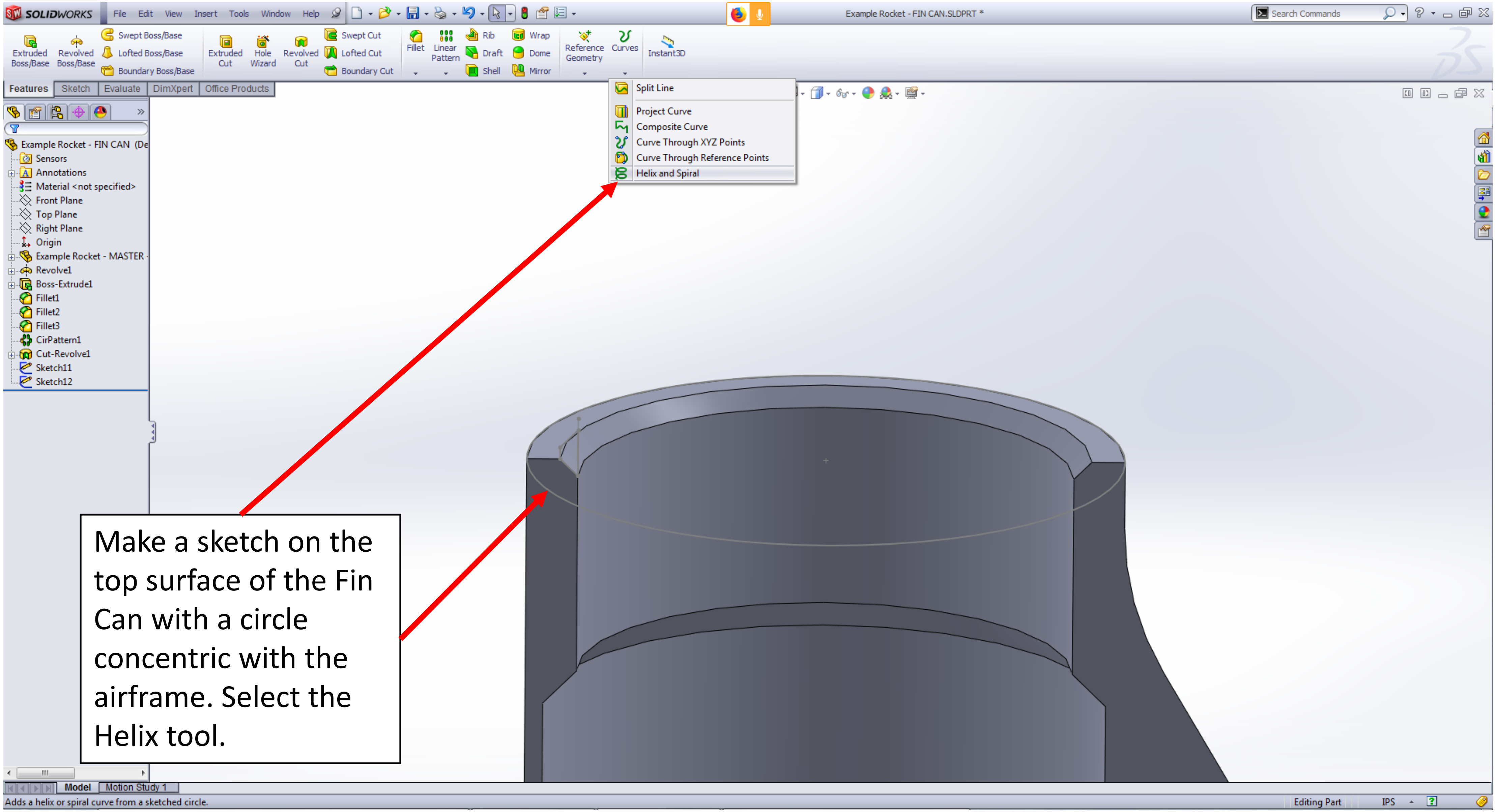
Make the cut



Now the inside is removed.

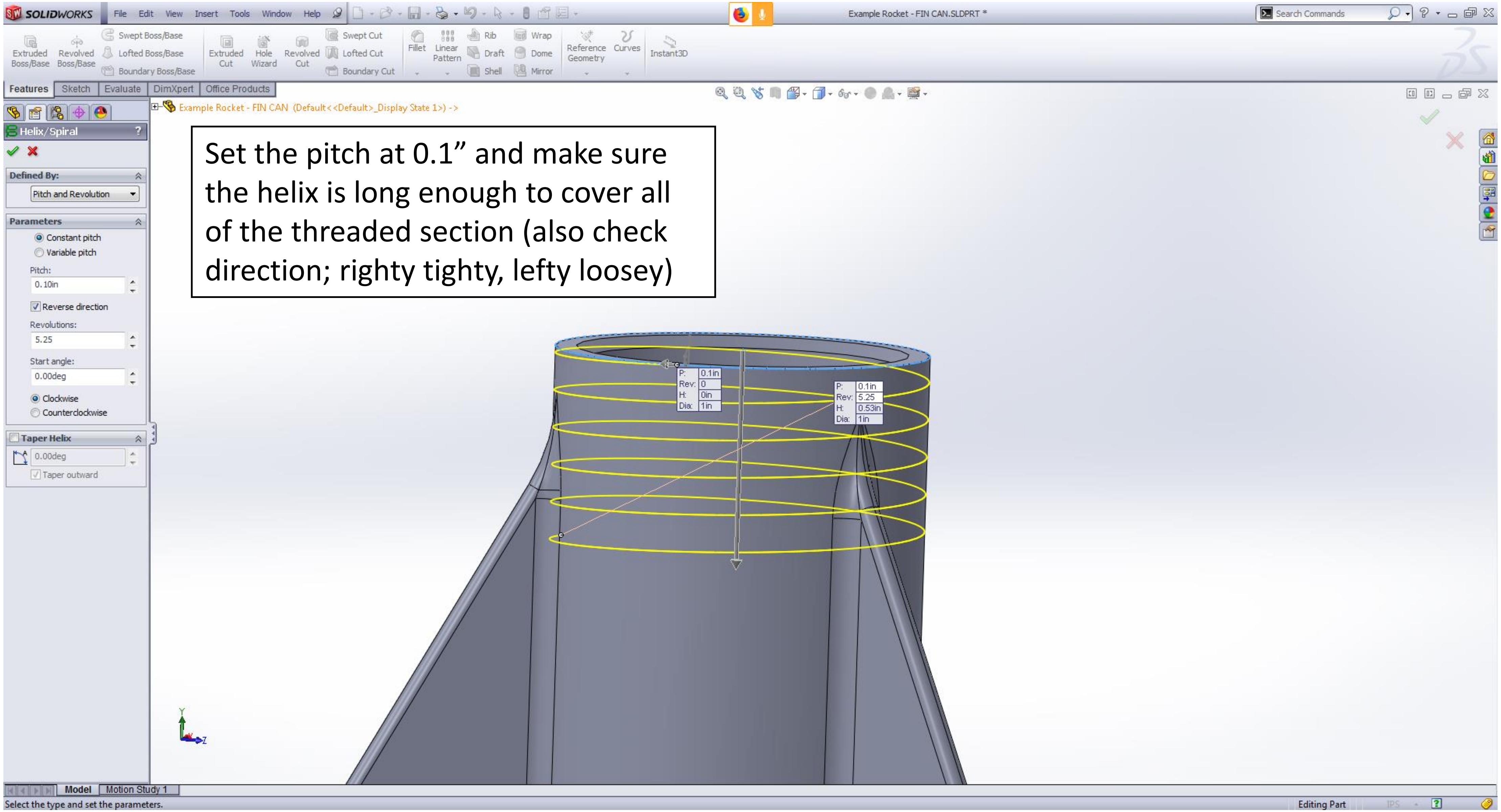

Time to cut the threads. Make a sketch on the Front Plane.
Example Rocket - FIN CAN.SLDPRT
Example Rocket - FIN CAN
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER
Revolve1
Boss-Extrude1
Fillet1
Fillet2
Fillet3
CirPattern1
Cut-Revolve1
SolidWorks Premium 2012 x64 Edition
Editing Part

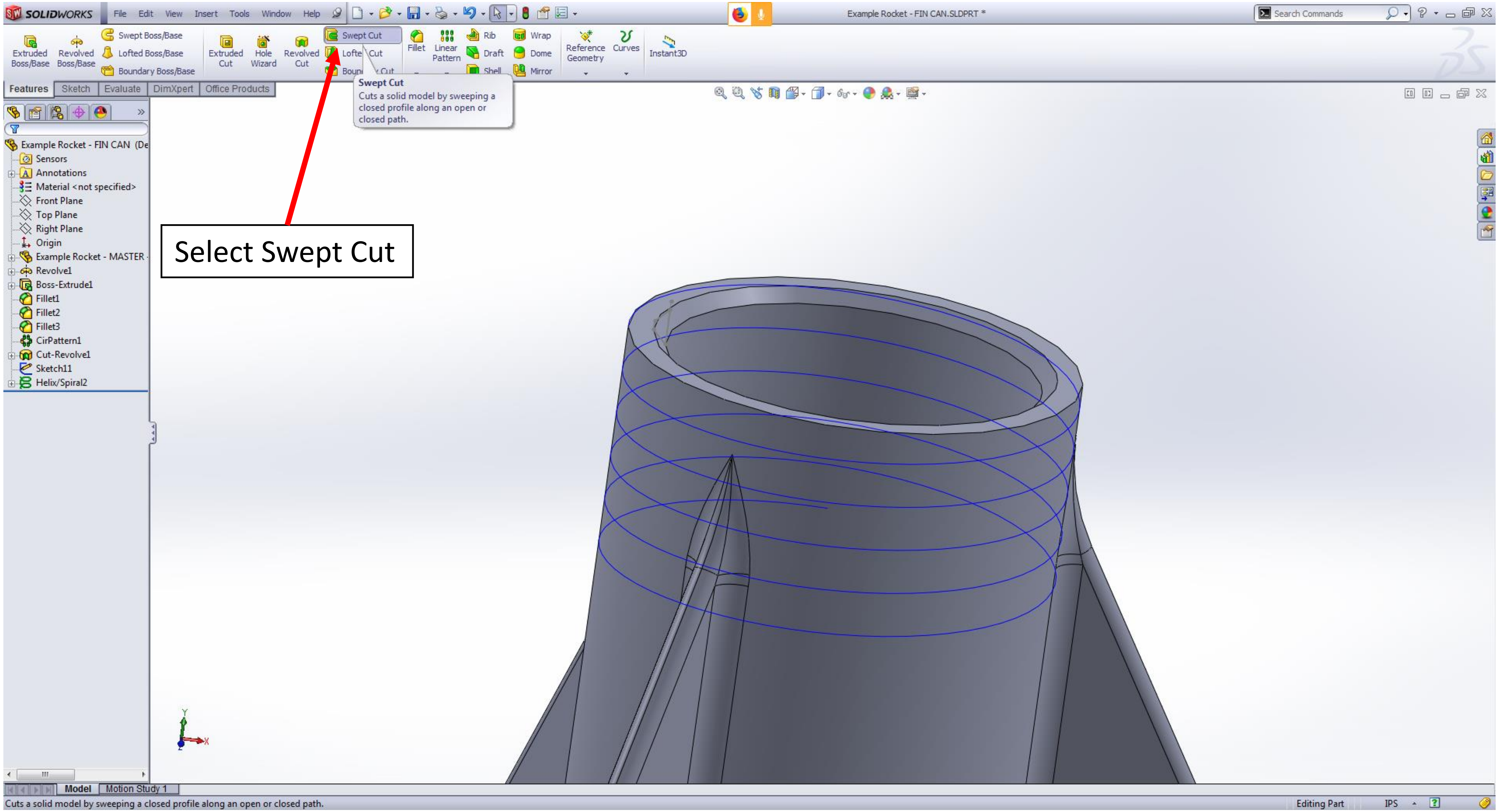

Use 0.1” pitch threads
.10
Sketch11 of Example Rocket - FIN CAN.SLDPRT *
Example Rocket - FIN CAN ...
Properties
Selected Entities
Line1
Line2
Line3
Line4
Existing Relations
Fully Defined
Add Relations
Horizontal
Vertical
Collinear
Parallel
Equal
Fix
Options
For construction
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Total Length: 0.20485in
Fully Defined
Editing Sketch11
IPS



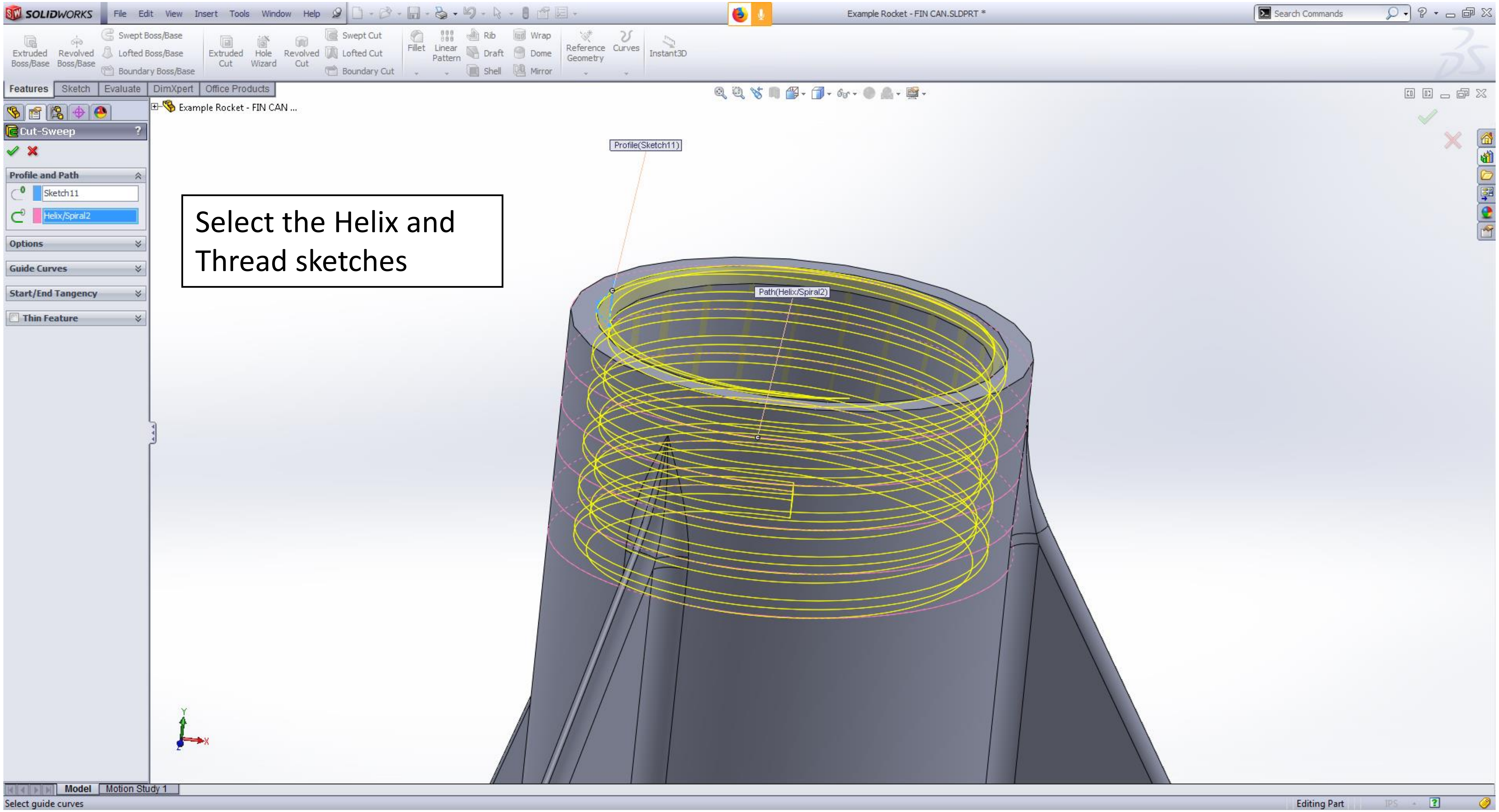
Make a sketch on the top surface of the Fin Can with a circle concentric with the airframe. Select the Helix tool.

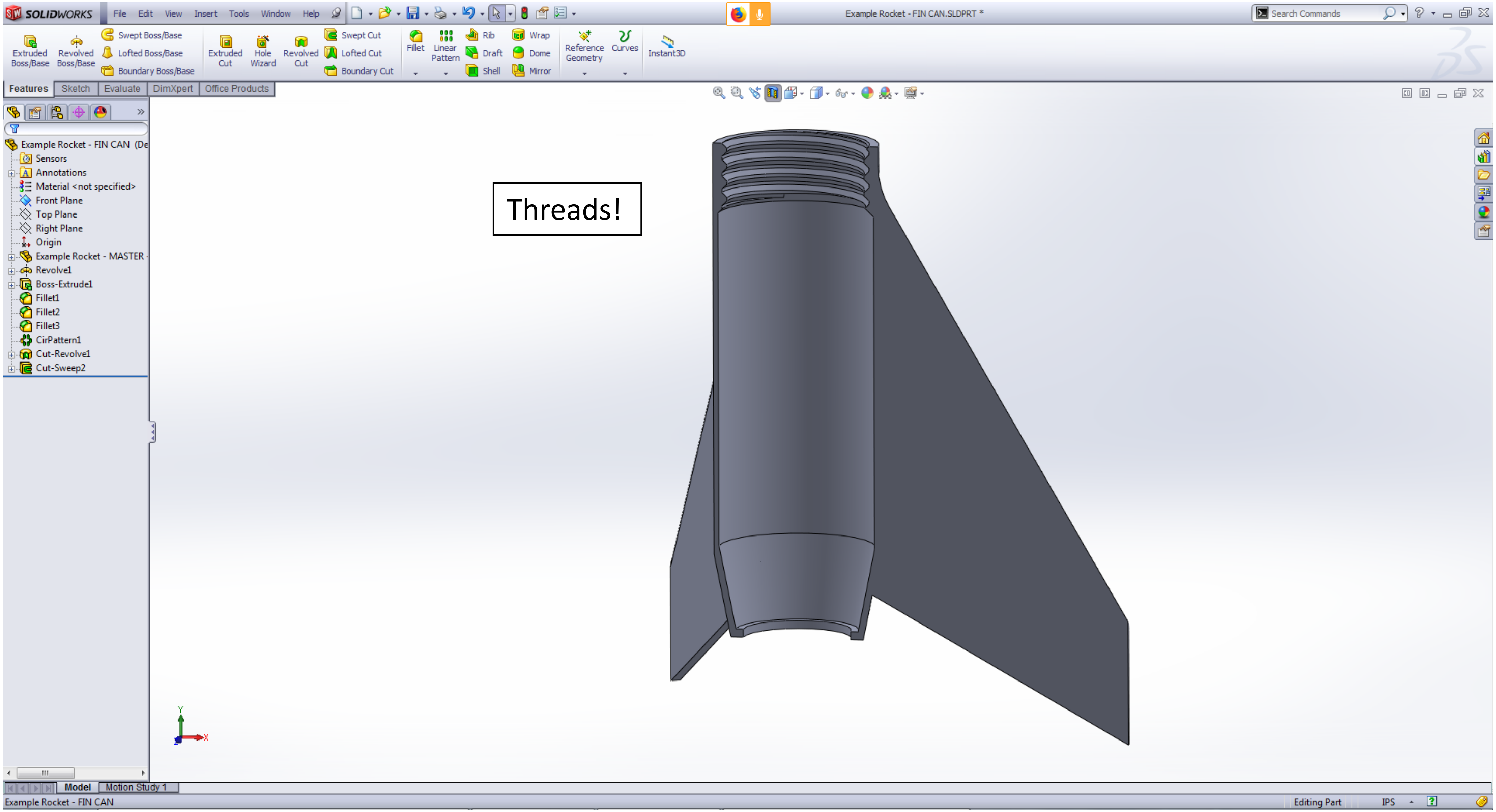
Set the pitch at 0.1” and make sure the helix is long enough to cover all of the threaded section (also check direction; righty tighty, lefty loosey)

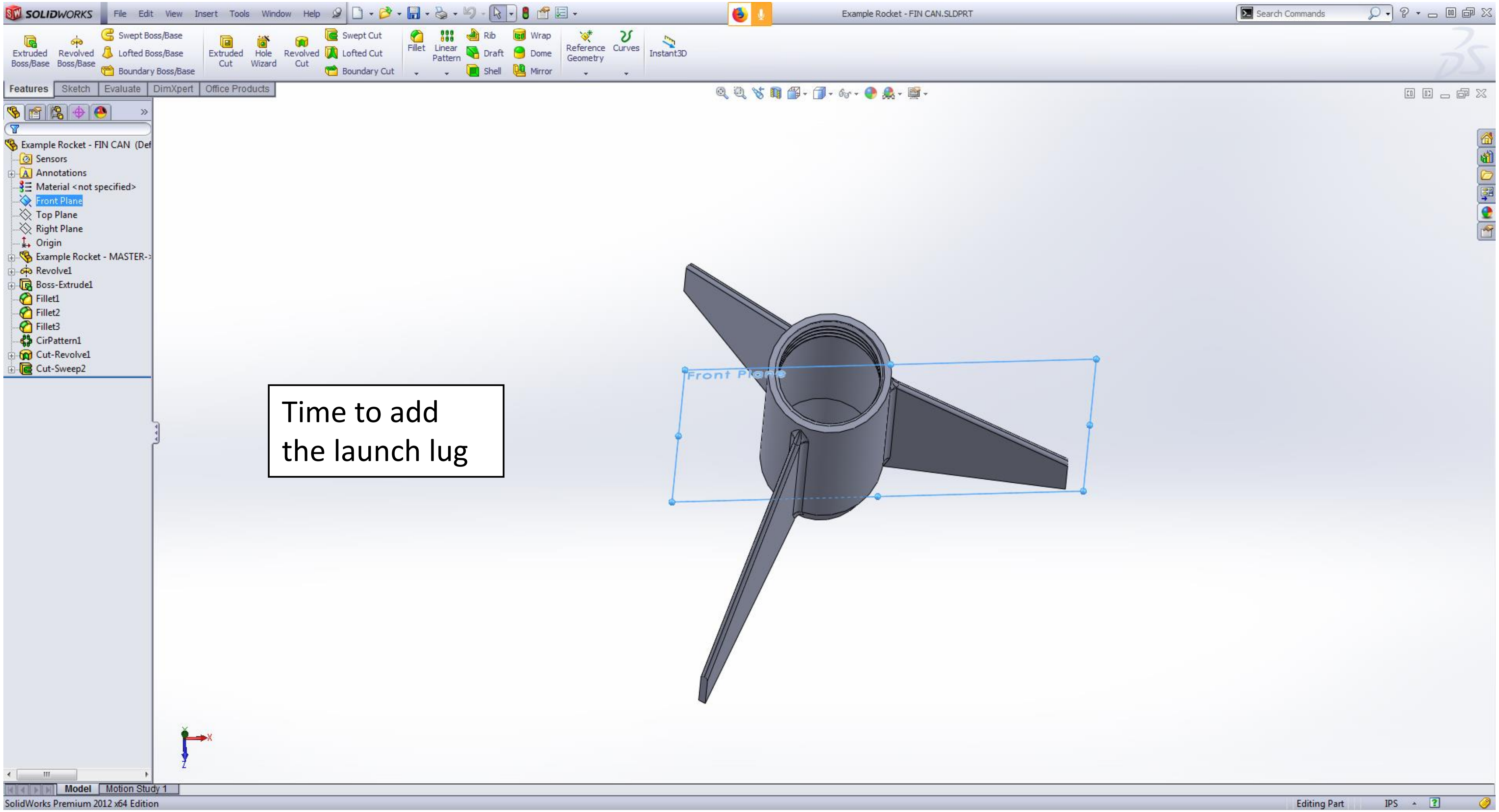



Select Swept Cut
Swept Cut
Cuts a solid model by sweeping a closed profile along an open or closed path.
Example Rocket - FIN CAN.SLDPRT *
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Boss/Base
Revolved Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - FIN CAN
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER
Revolve1
Boss-Extrude1
Fillet1
Fillet2
Fillet3
CirPattern1
Cut-Revolve1
Sketch11
Helix/Spiral2
Model
Motion Study 1
Cuts a solid model by sweeping a closed profile along an open or closed path.
Editing Part
IPS

Select the Helix and Thread sketches

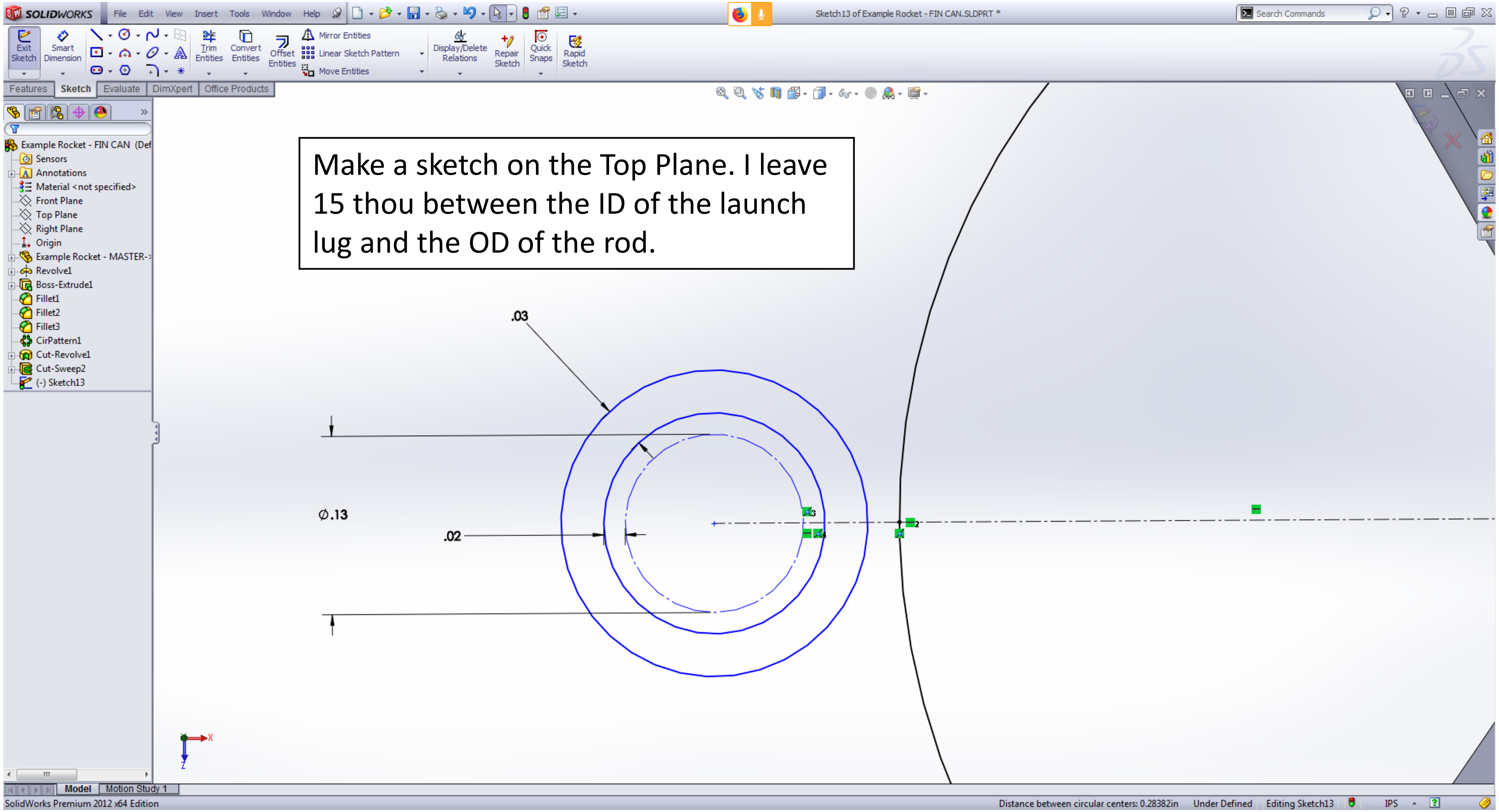



SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - FIN CAN.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - FIN CAN (De
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER
Revolve1
Boss-Extrude1
Fillet1
Fillet2
Fillet3
CirPattern1
Cut-Revolve1
Cut-Sweep2
Threads!
Y
X
Model
Motion Study 1
Example Rocket - FIN CAN
Editing Part
IPS

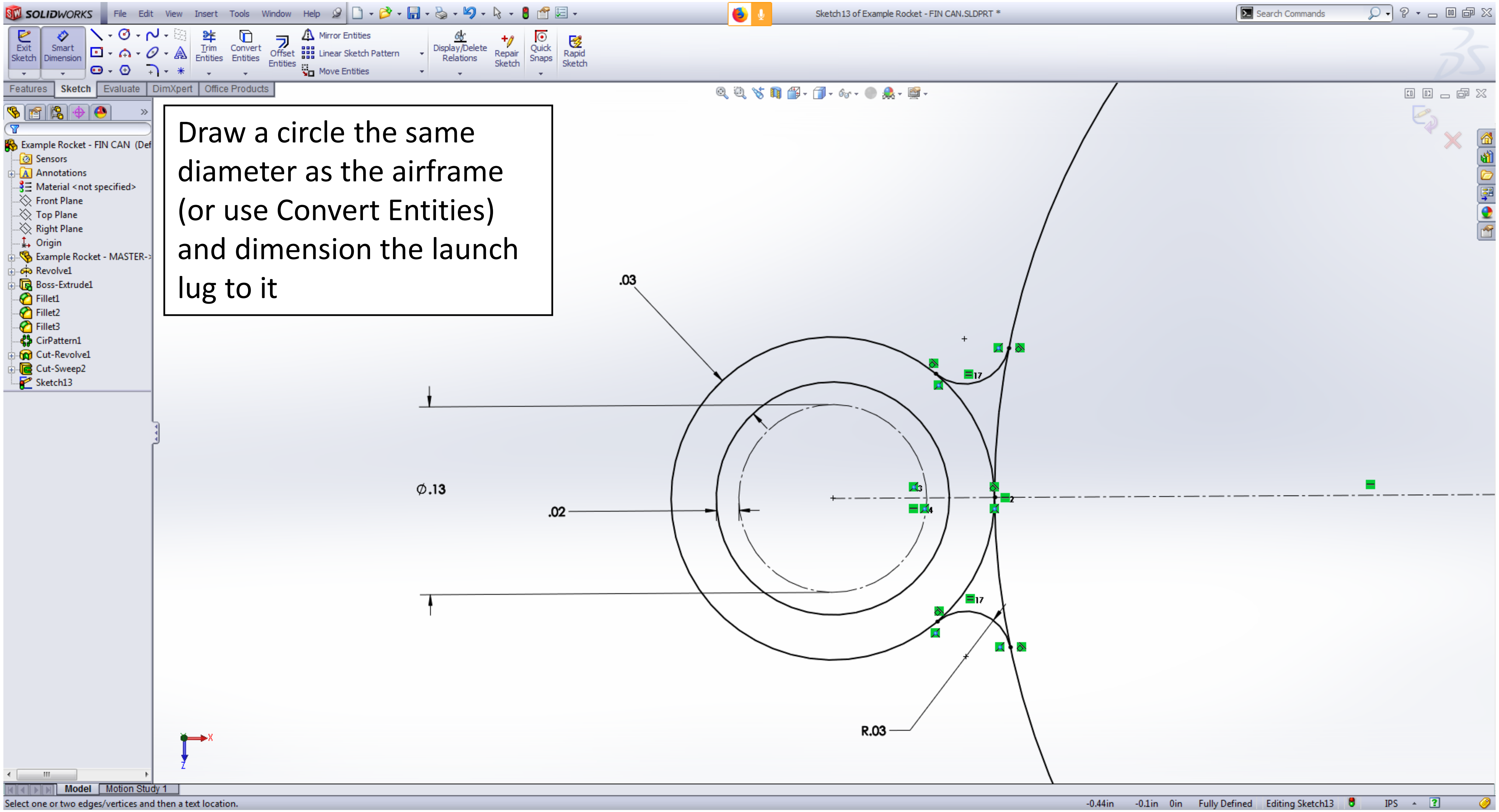


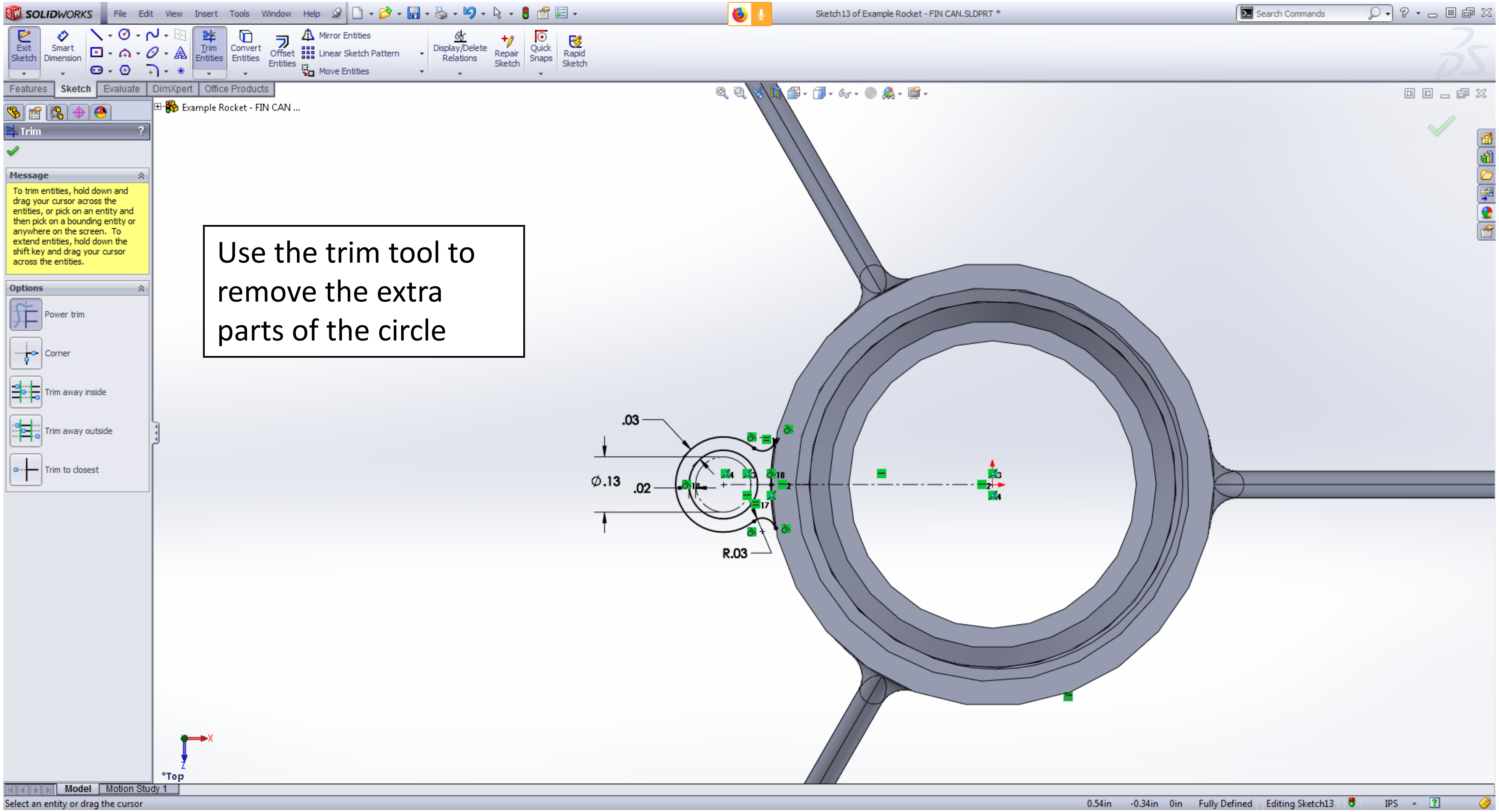
Time to add the launch lug

Make a sketch on the Top Plane. I leave 15 thou between the ID of the launch lug and the OD of the rod.

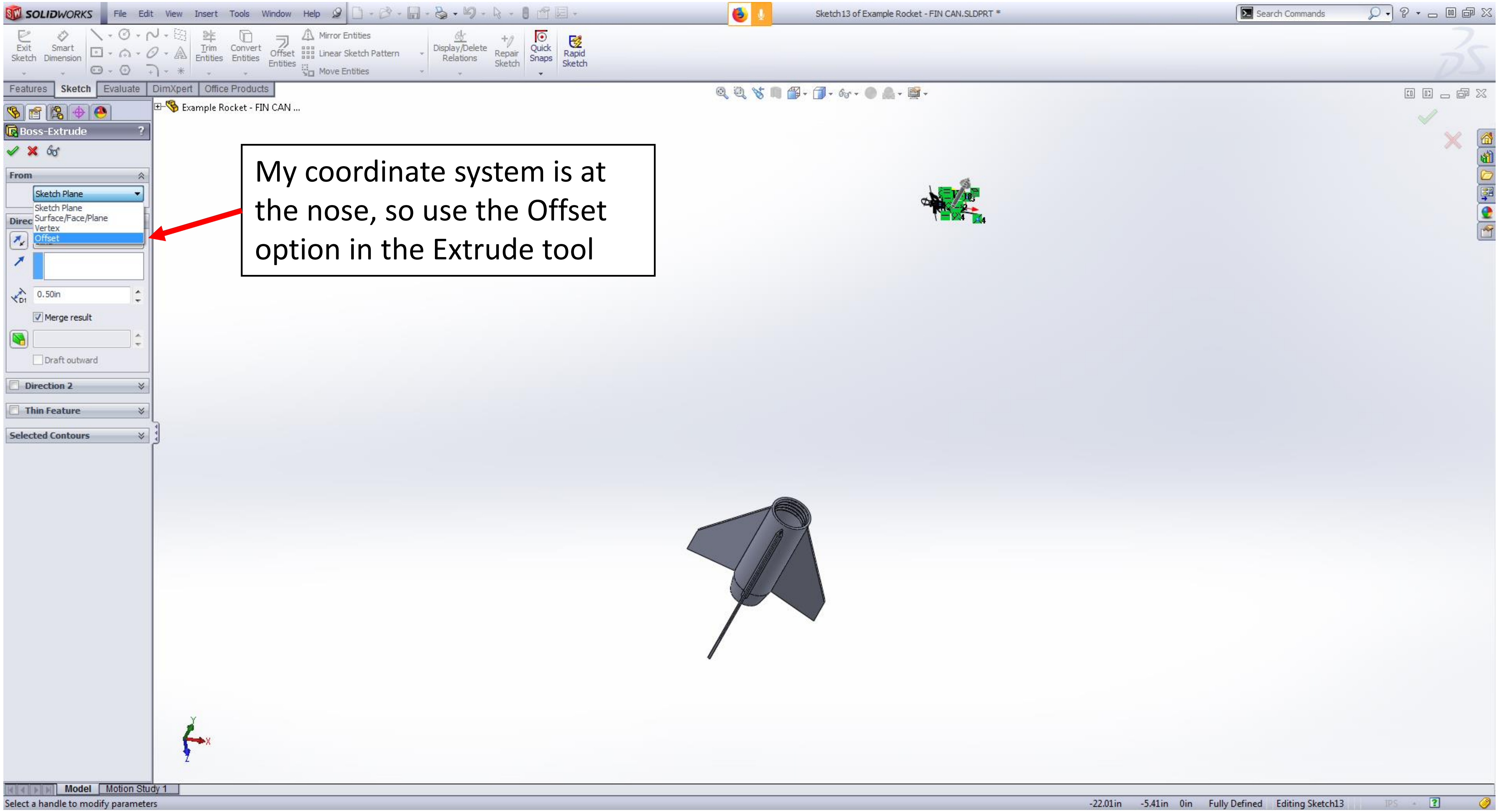


Draw a circle the same diameter as the airframe (or use Convert Entities) and dimension the launch lug to it

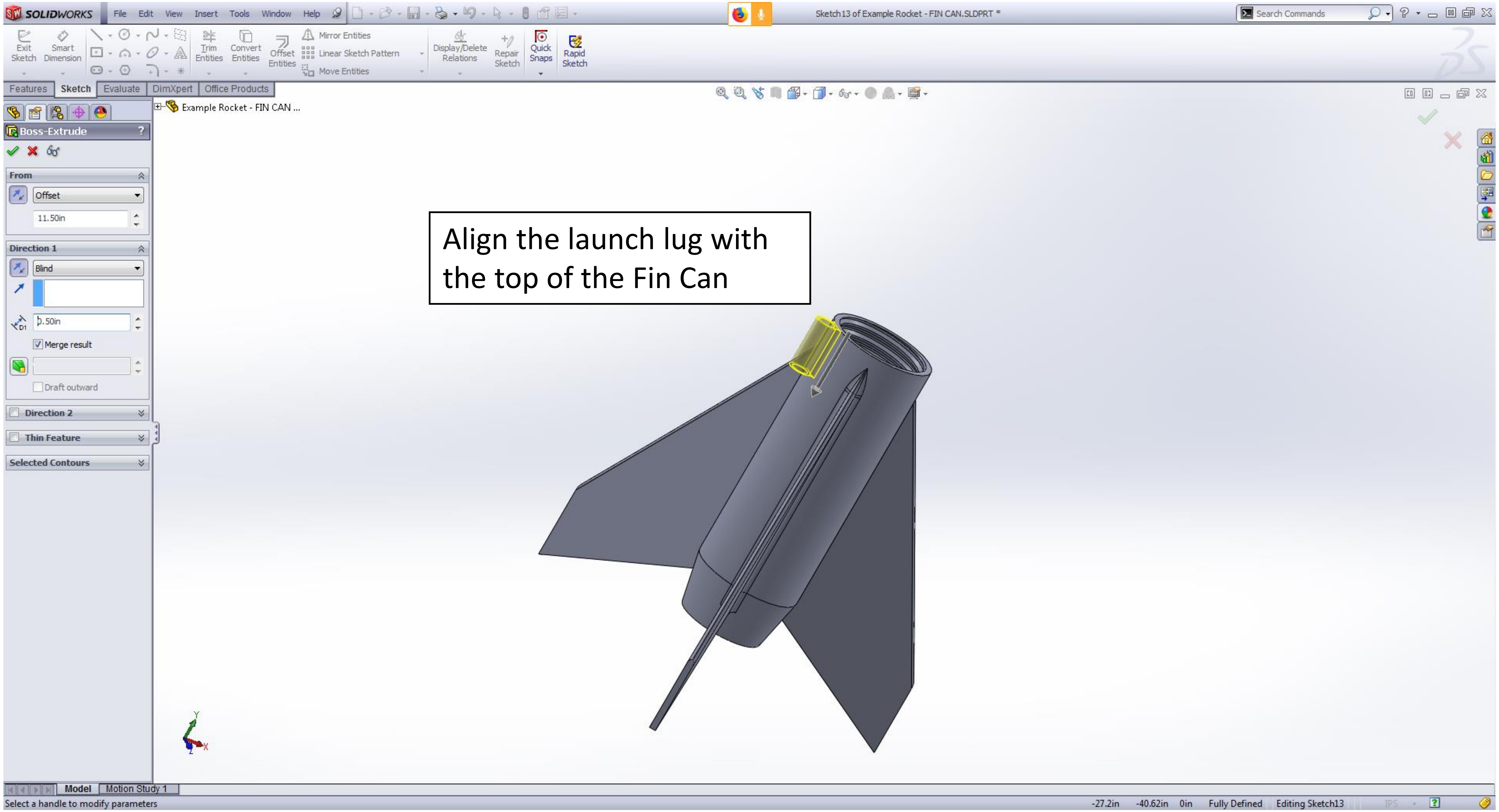




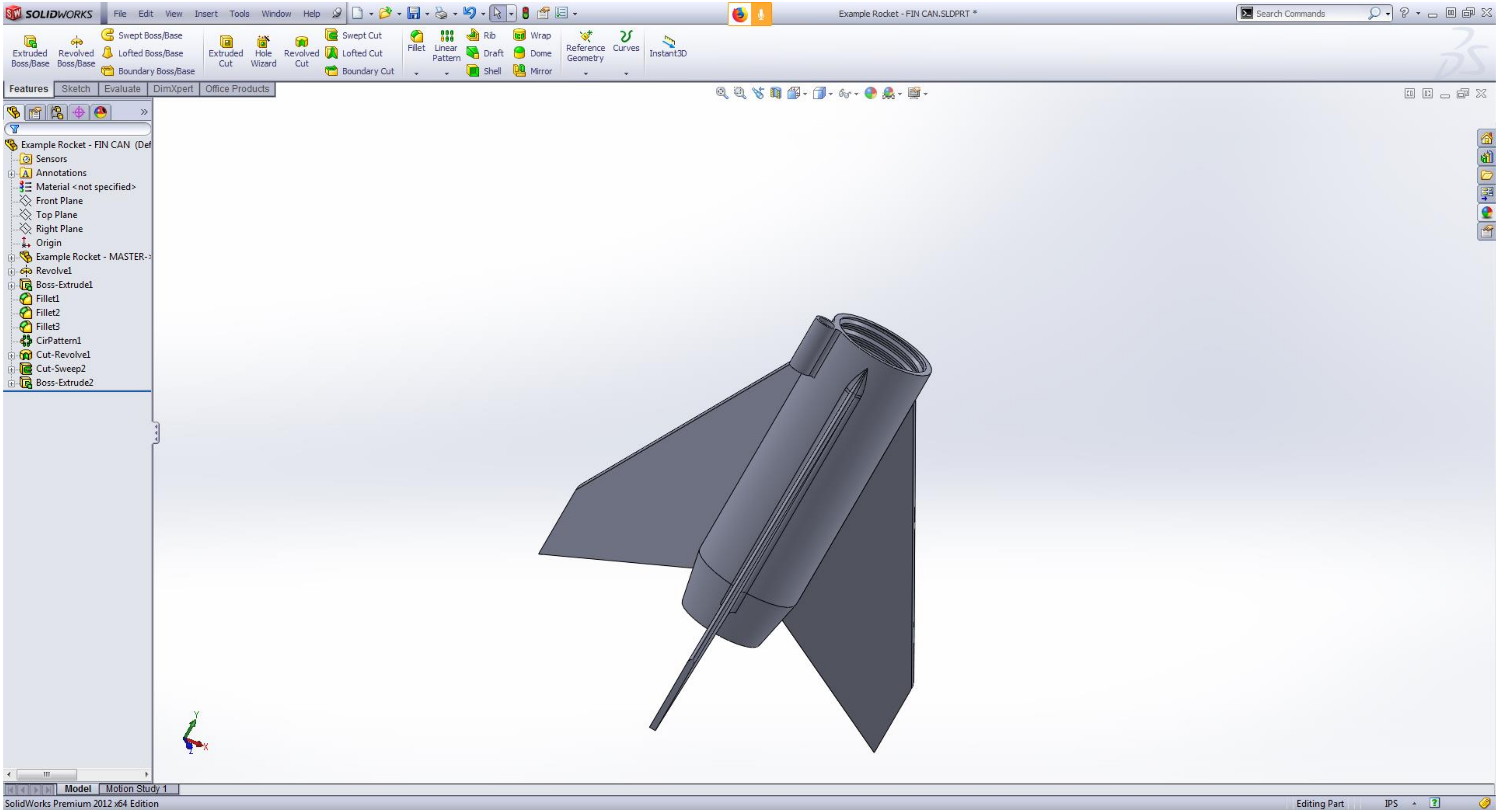
Use the trim tool to remove the extra parts of the circle

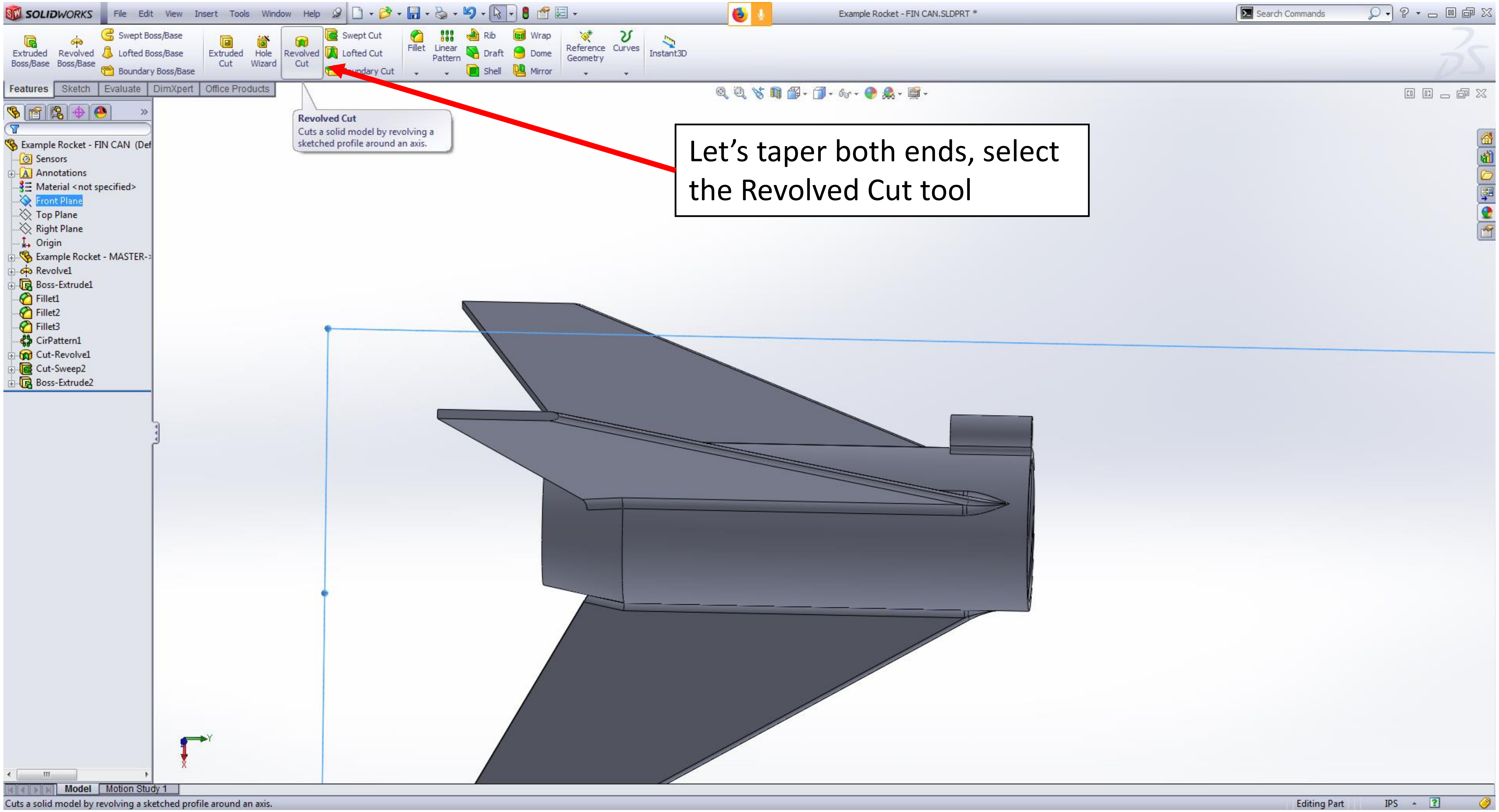


My coordinate system is at the nose, so use the Offset option in the Extrude tool

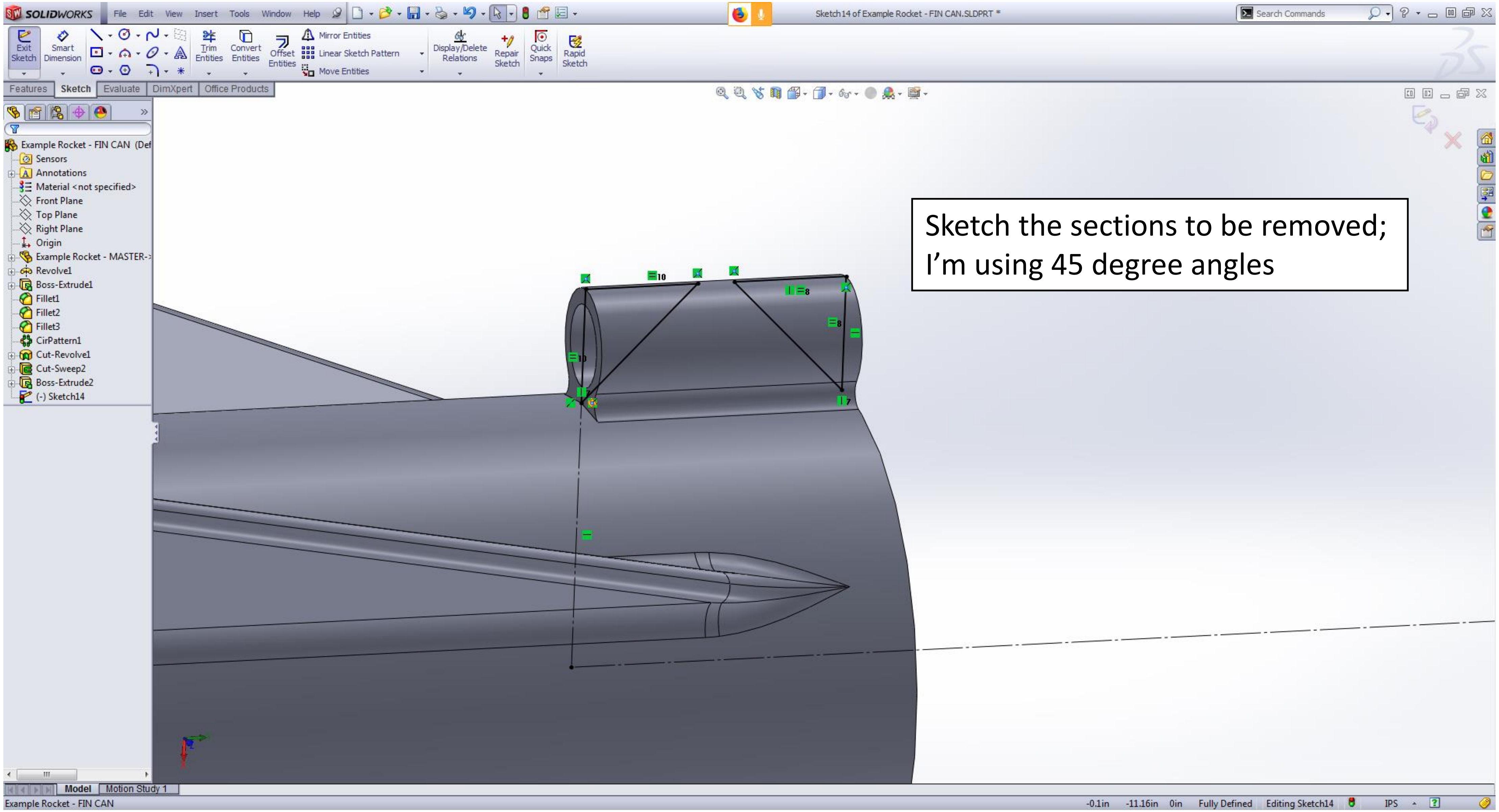


Align the launch lug with the top of the Fin Can

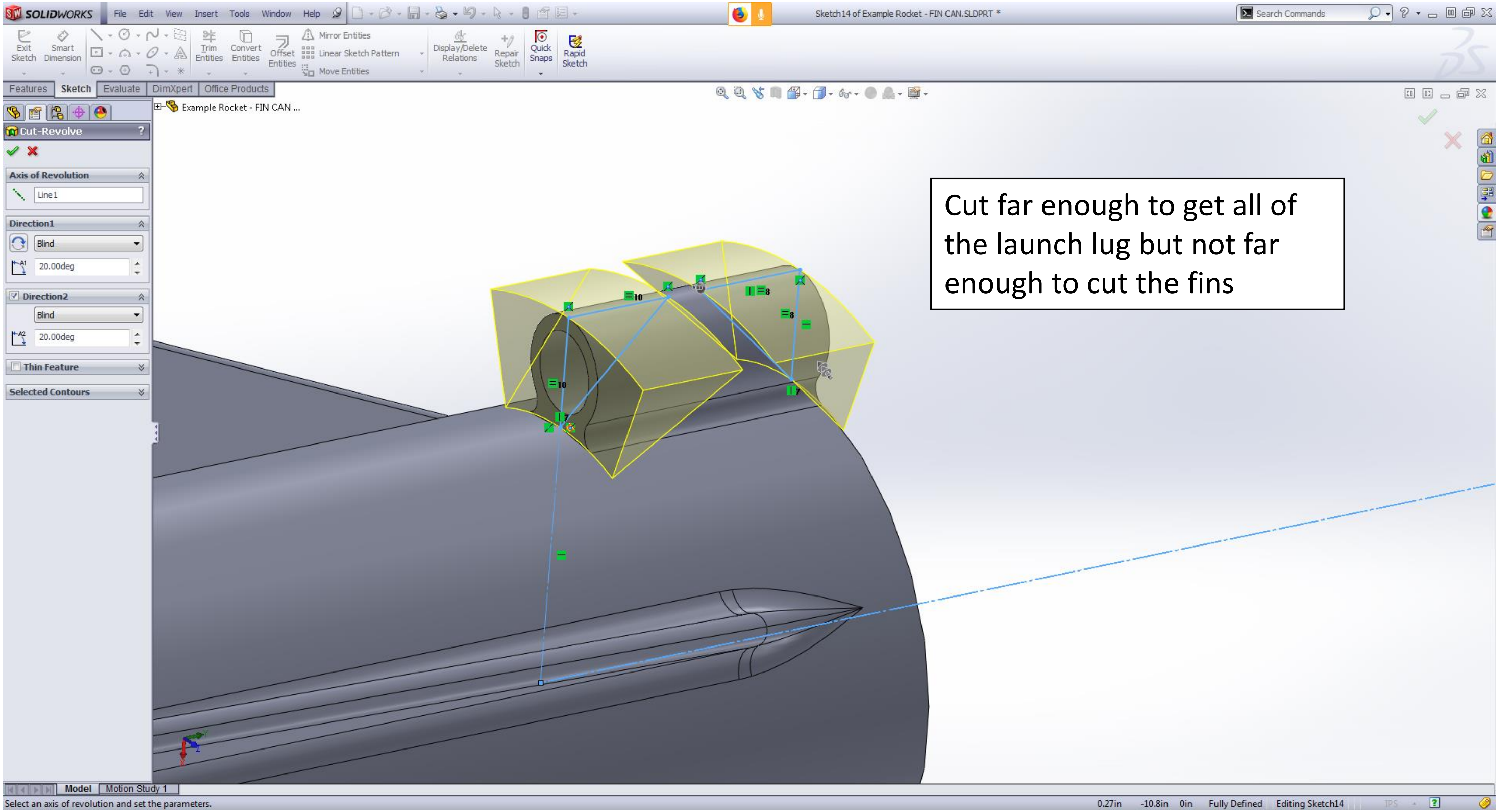

SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - FIN CAN.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - FIN CAN (Def
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER->
Revolve1
Boss-Extrude1
Fillet1
Fillet2
Fillet3
CirPattern1
Cut-Revolve1
Cut-Sweep2
Boss-Extrude2
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Editing Part
IPS



Let’s taper both ends, select the Revolved Cut tool

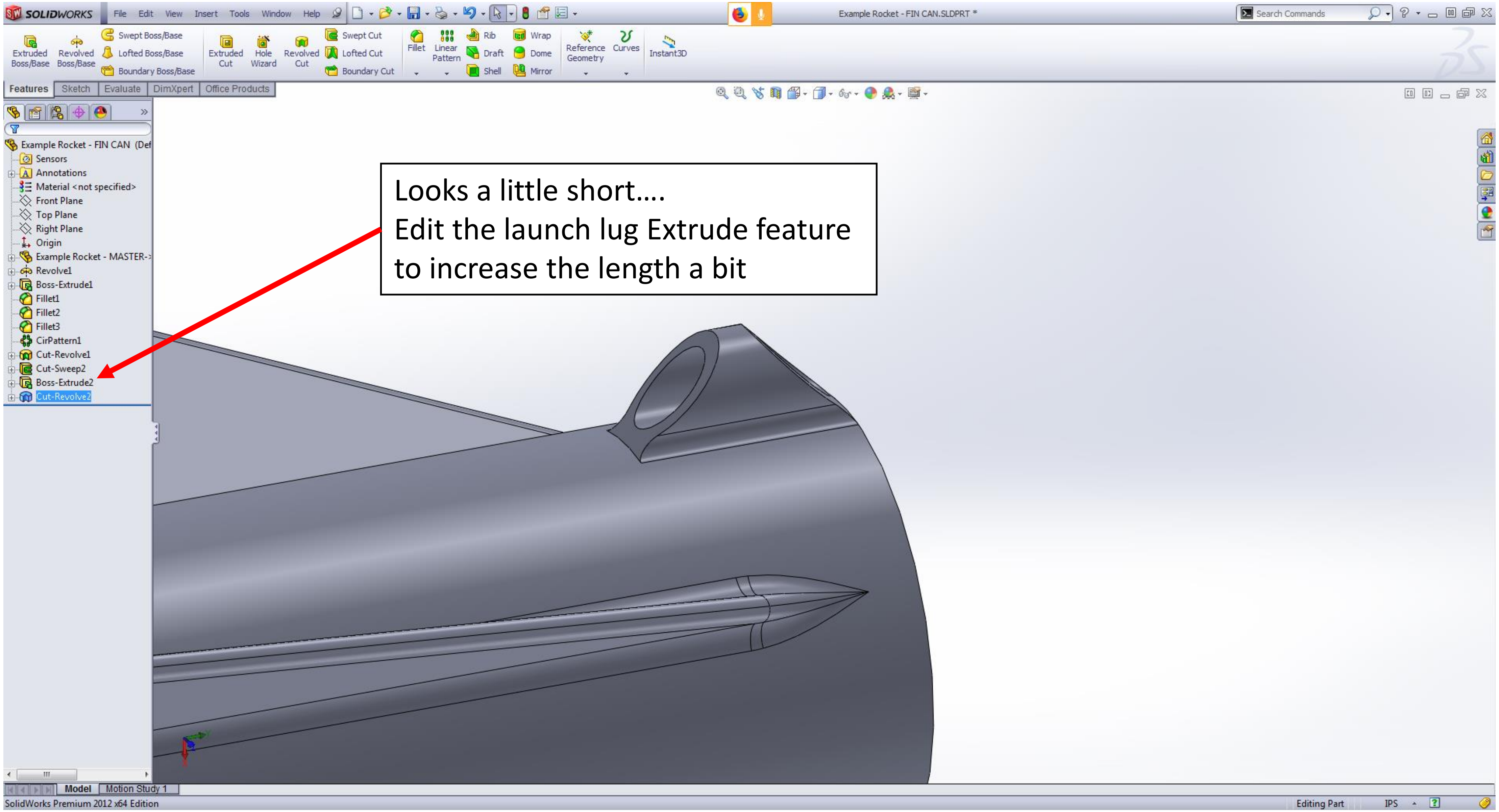


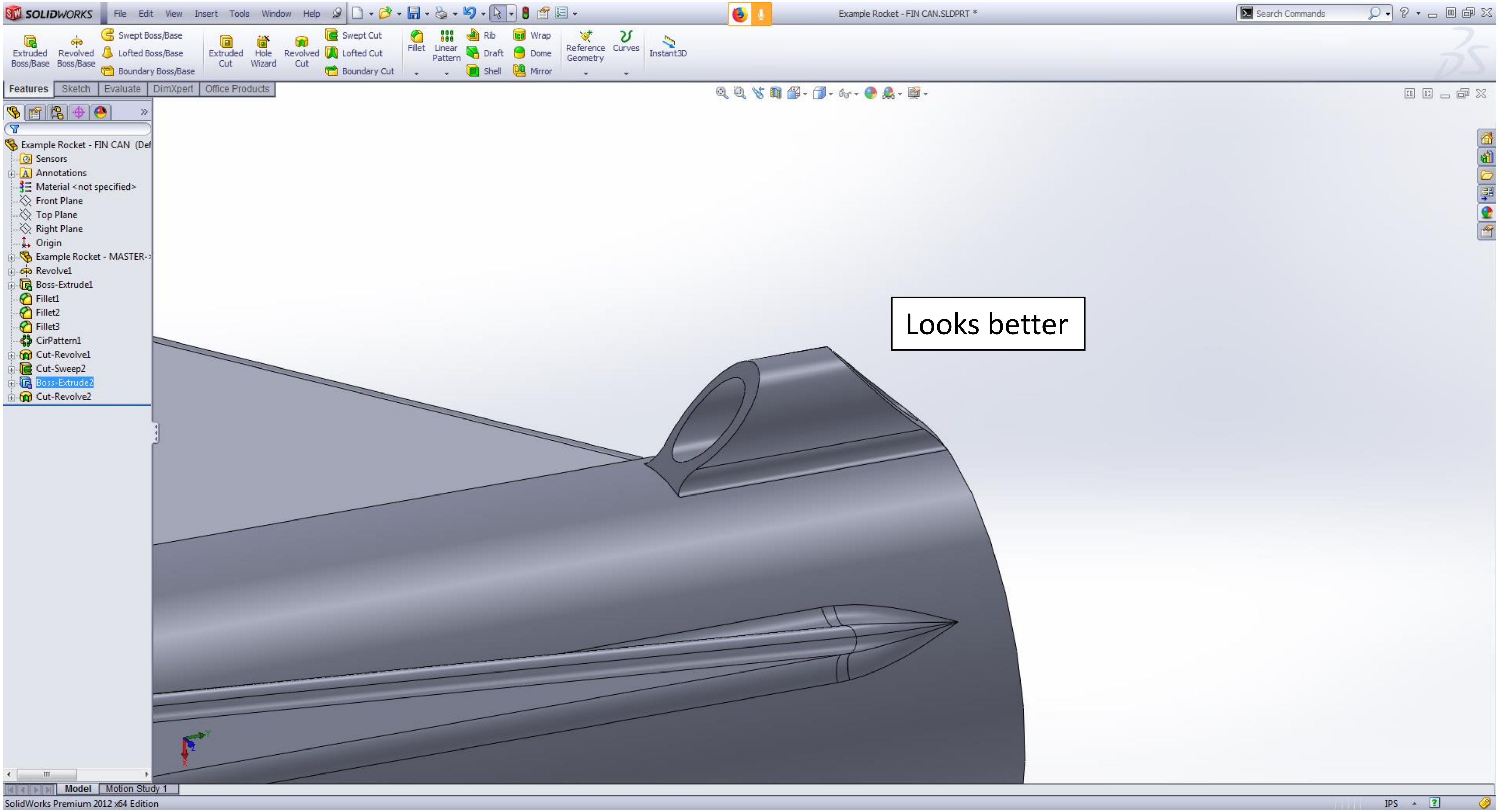
Sketch the sections to be removed; I'm using 45 degree angles



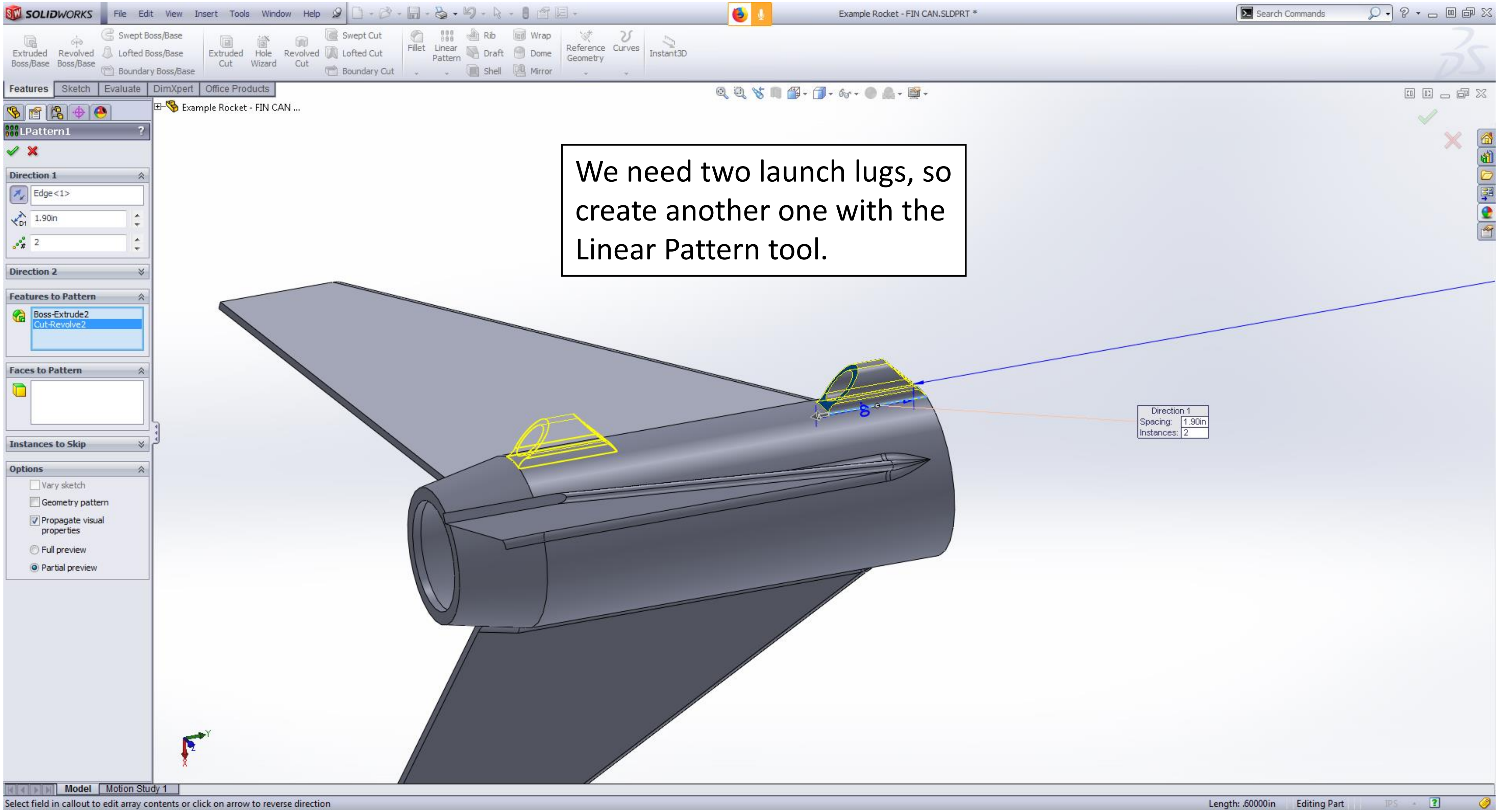
Cut far enough to get all of the launch lug but not far enough to cut the fins

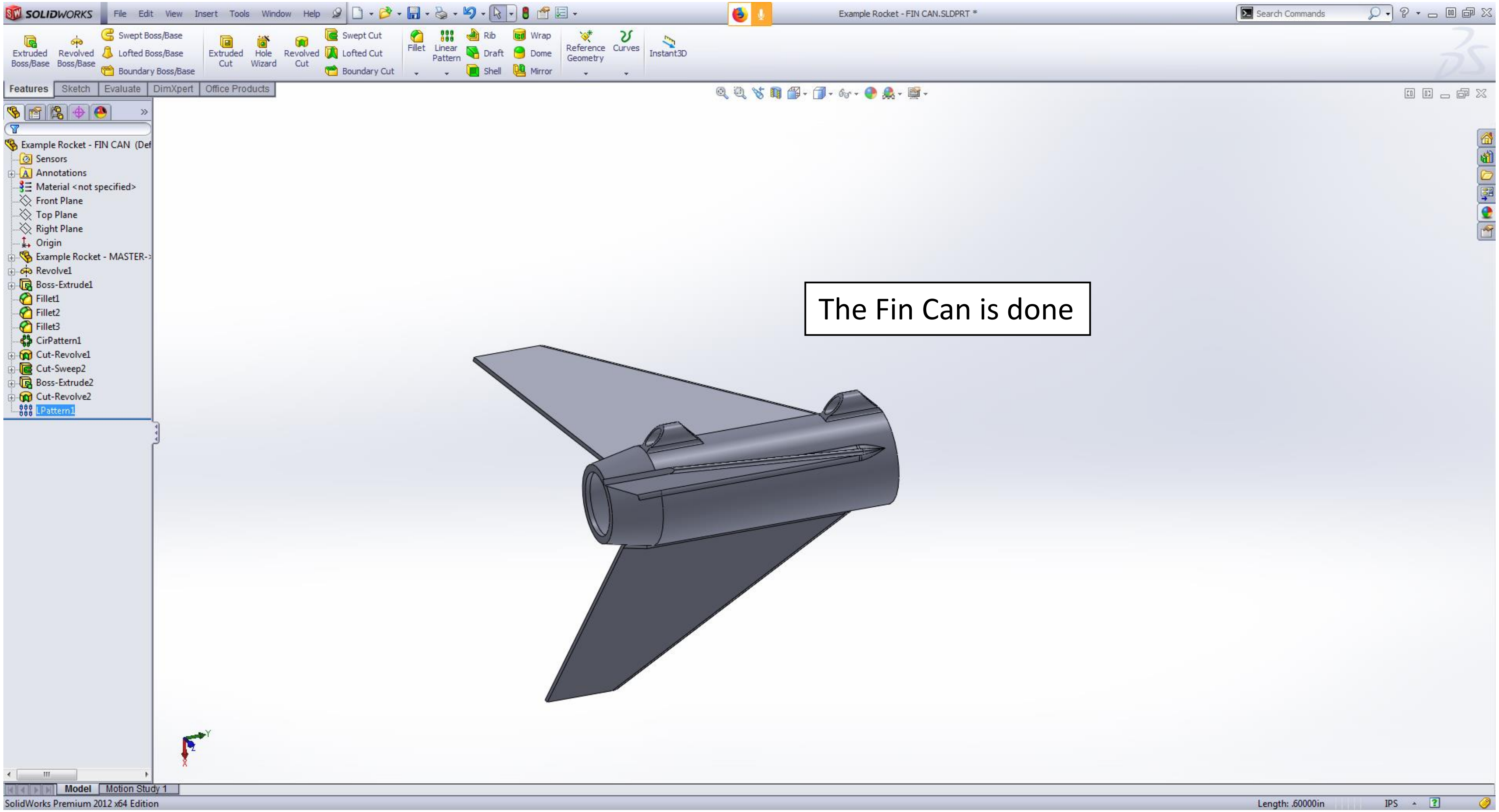
Looks a little short….
Edit the launch lug Extrude feature to increase the length a bit

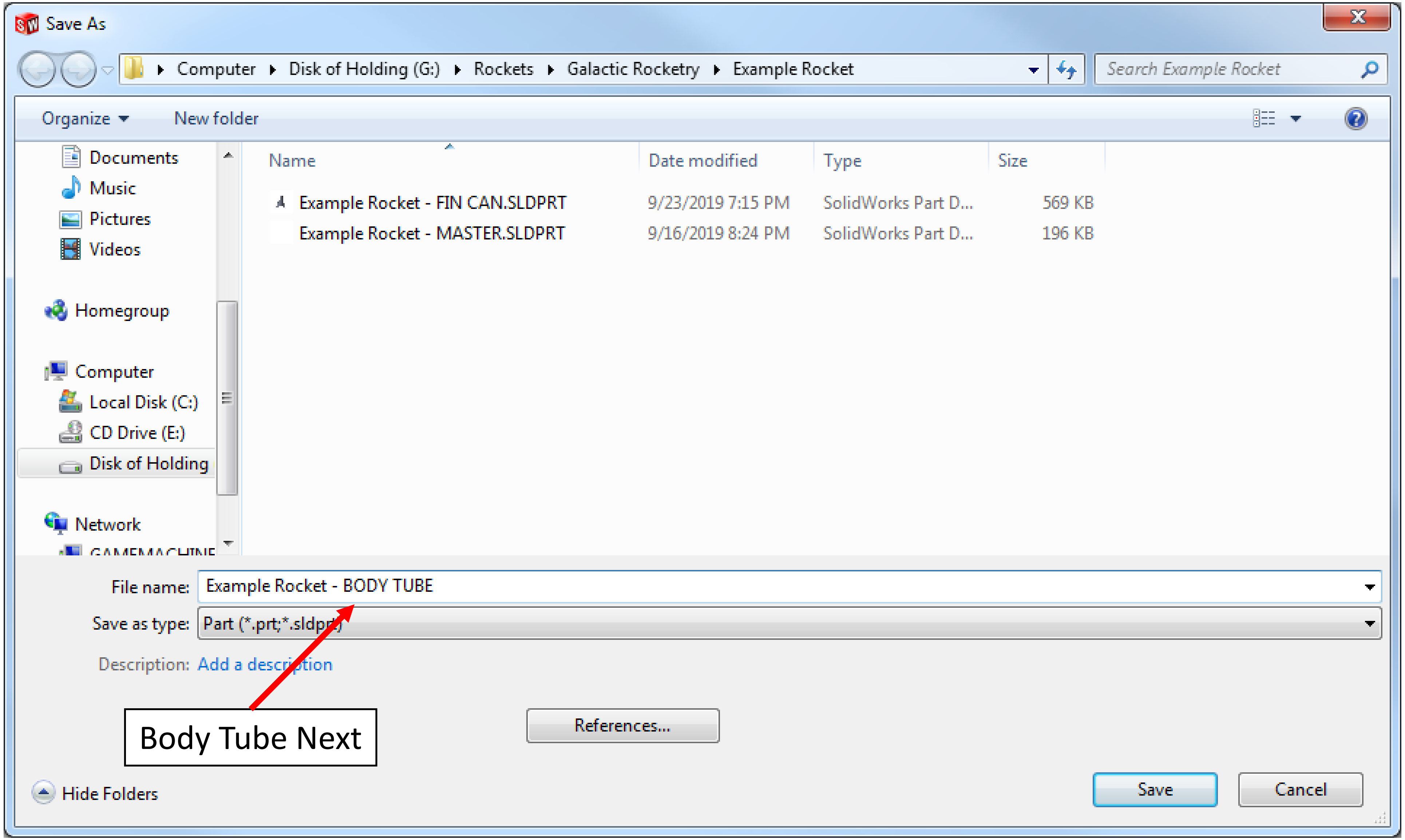


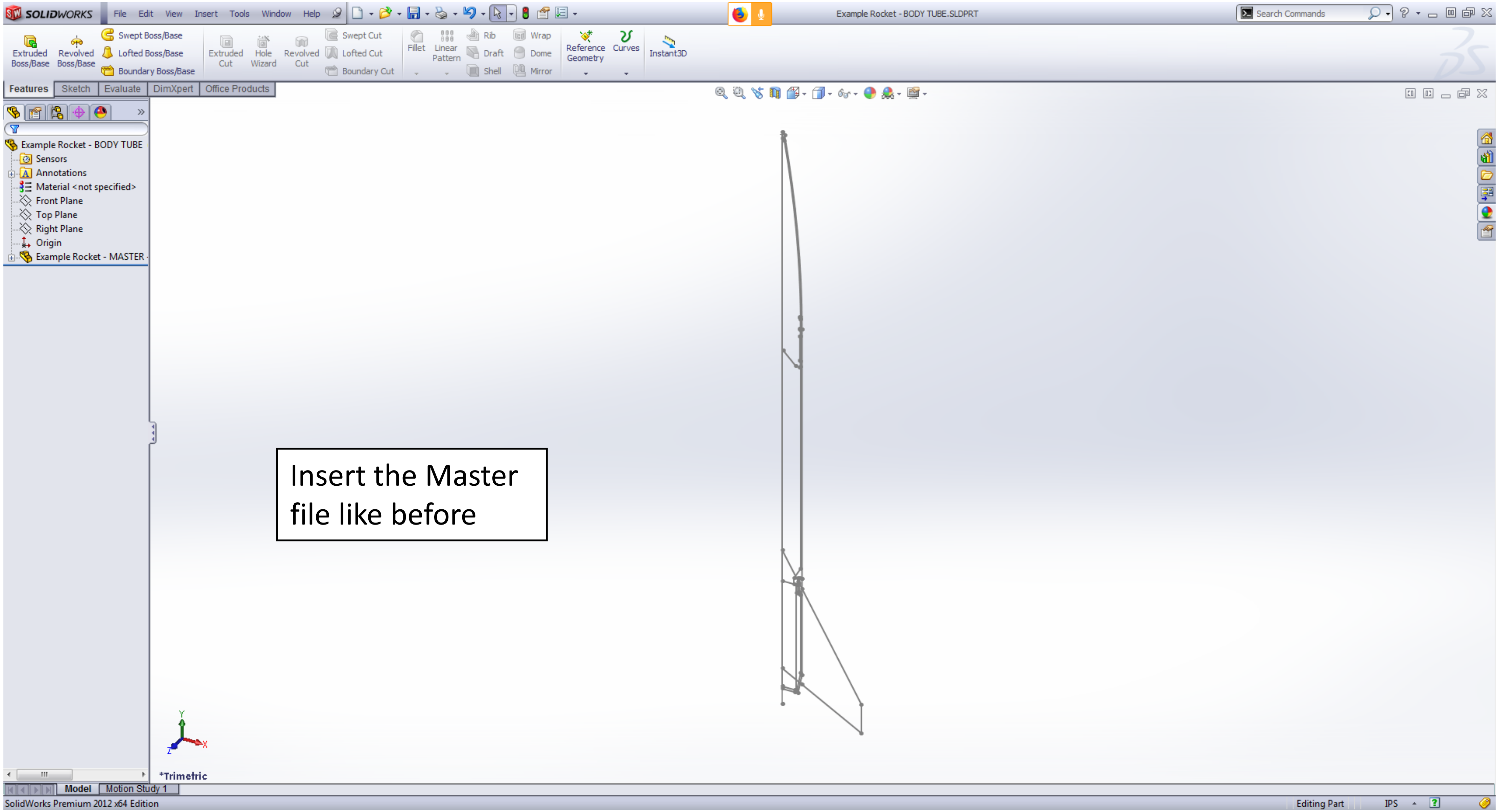

Looks better

We need two launch lugs, so create another one with the Linear Pattern tool.

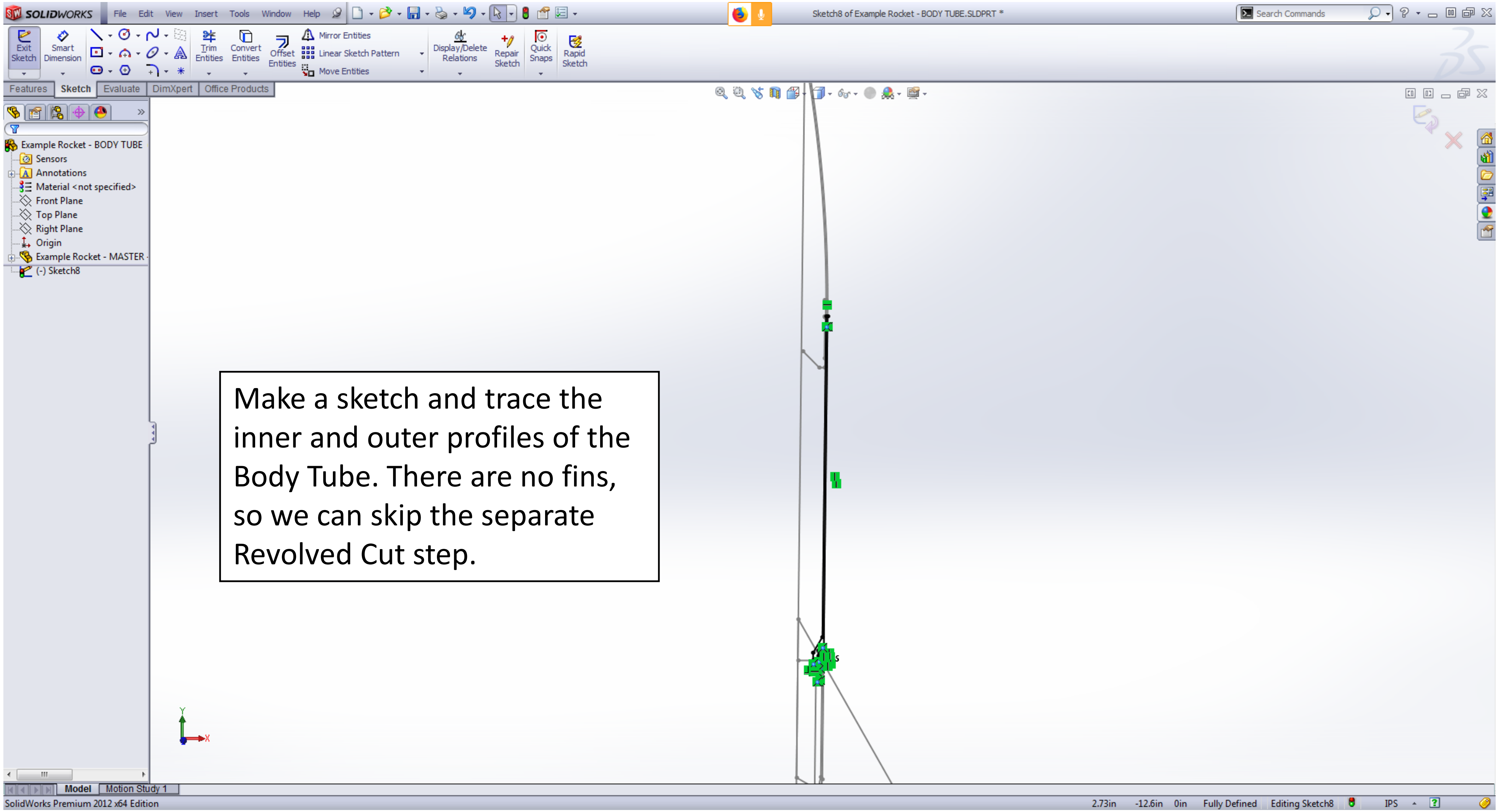



The Fin Can is done
SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - FIN CAN.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features Sketch Evaluate DimXpert Office Products
Example Rocket - FIN CAN (Def
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER->
Revolve1
Boss-Extrude1
Fillet1
Fillet2
Fillet3
CirPattern1
Cut-Revolve1
Cut-Sweep2
Boss-Extrude2
Cut-Revolve2
LPattern1
Model Motion Study 1
SolidWorks Premium 2012 x64 Edition
Length: .60000in
IPS

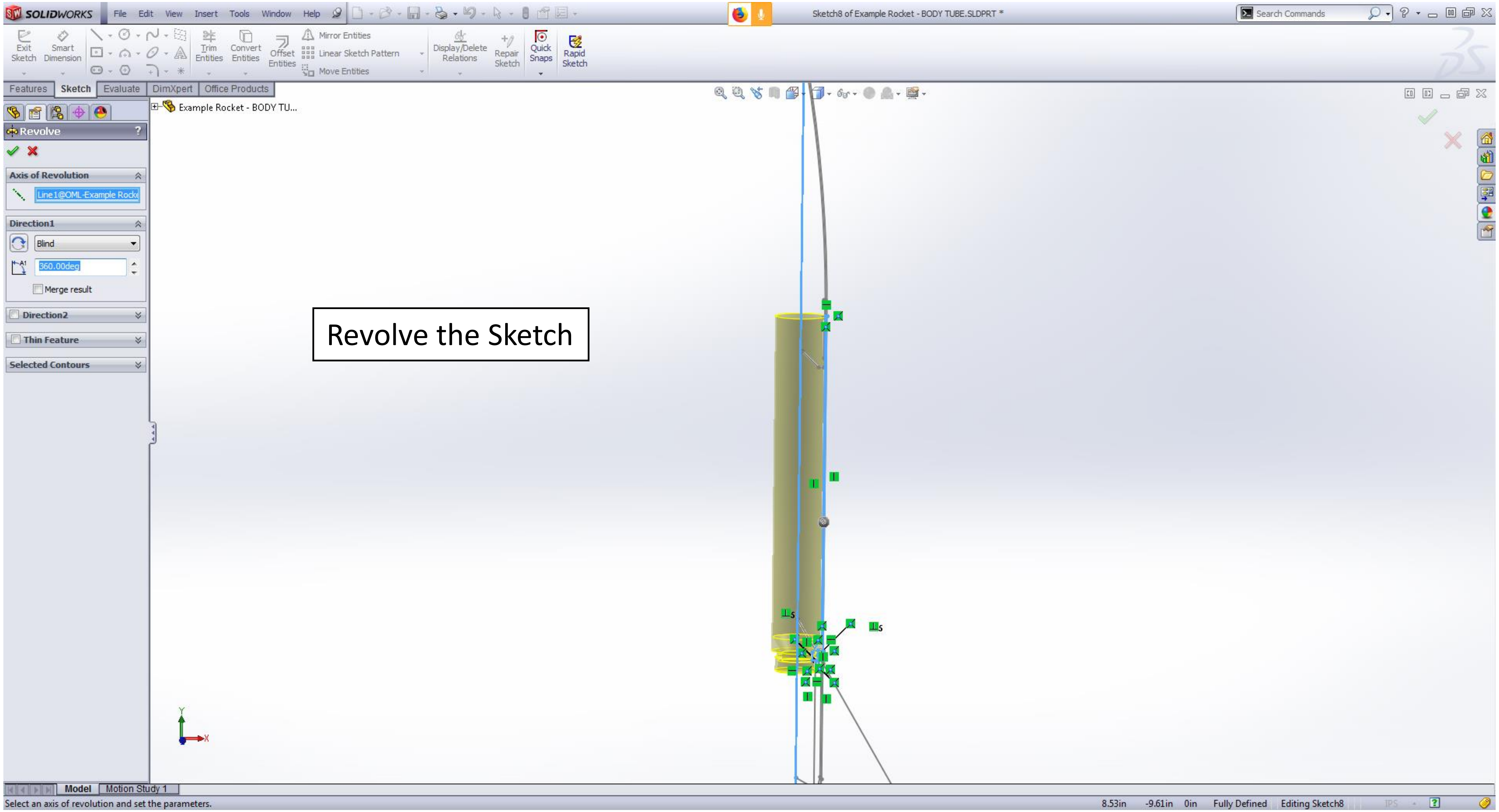

Save As
Computer ▸ Disk of Holding (G:) ▸ Rockets ▸ Galactic Rocketry ▸ Example Rocket
Search Example Rocket
Organize
New folder
Documents
Music
Pictures
Videos
Homegroup
Computer
Local Disk (C:)
CD Drive (E:)
Disk of Holding
Network
Name
Date modified
Type
Size
Example Rocket - FIN CAN.SLDPRT 9/23/2019 7:15 PM SolidWorks Part D... 569 KB
Example Rocket - MASTER.SLDPRT 9/16/2019 8:24 PM SolidWorks Part D... 196 KB
File name: Example Rocket - BODY TUBE
Save as type: Part (*.prt;*.sldprt)
Description: Add a description
Body Tube Next
References...
Hide Folders
Save
Cancel

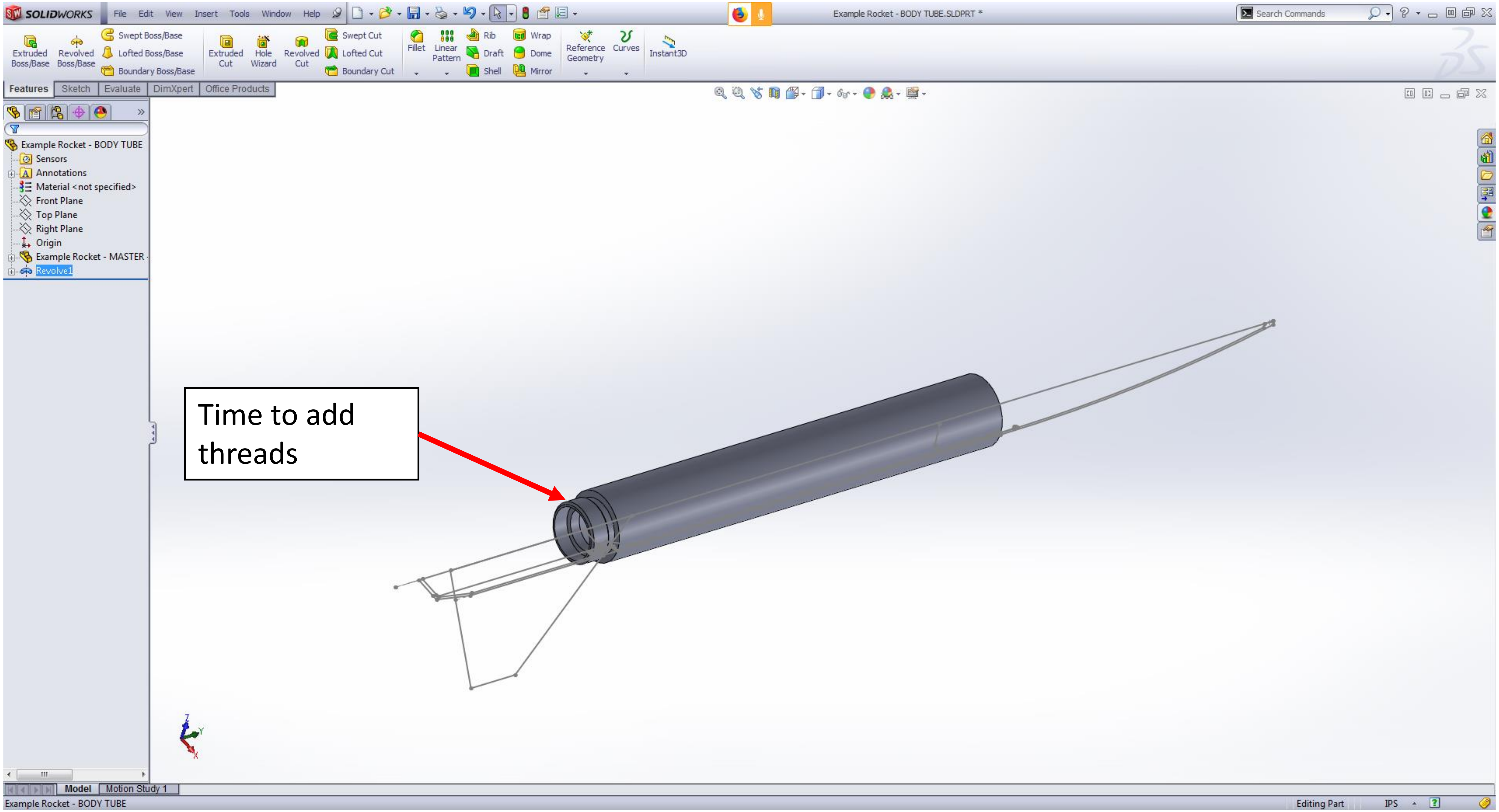


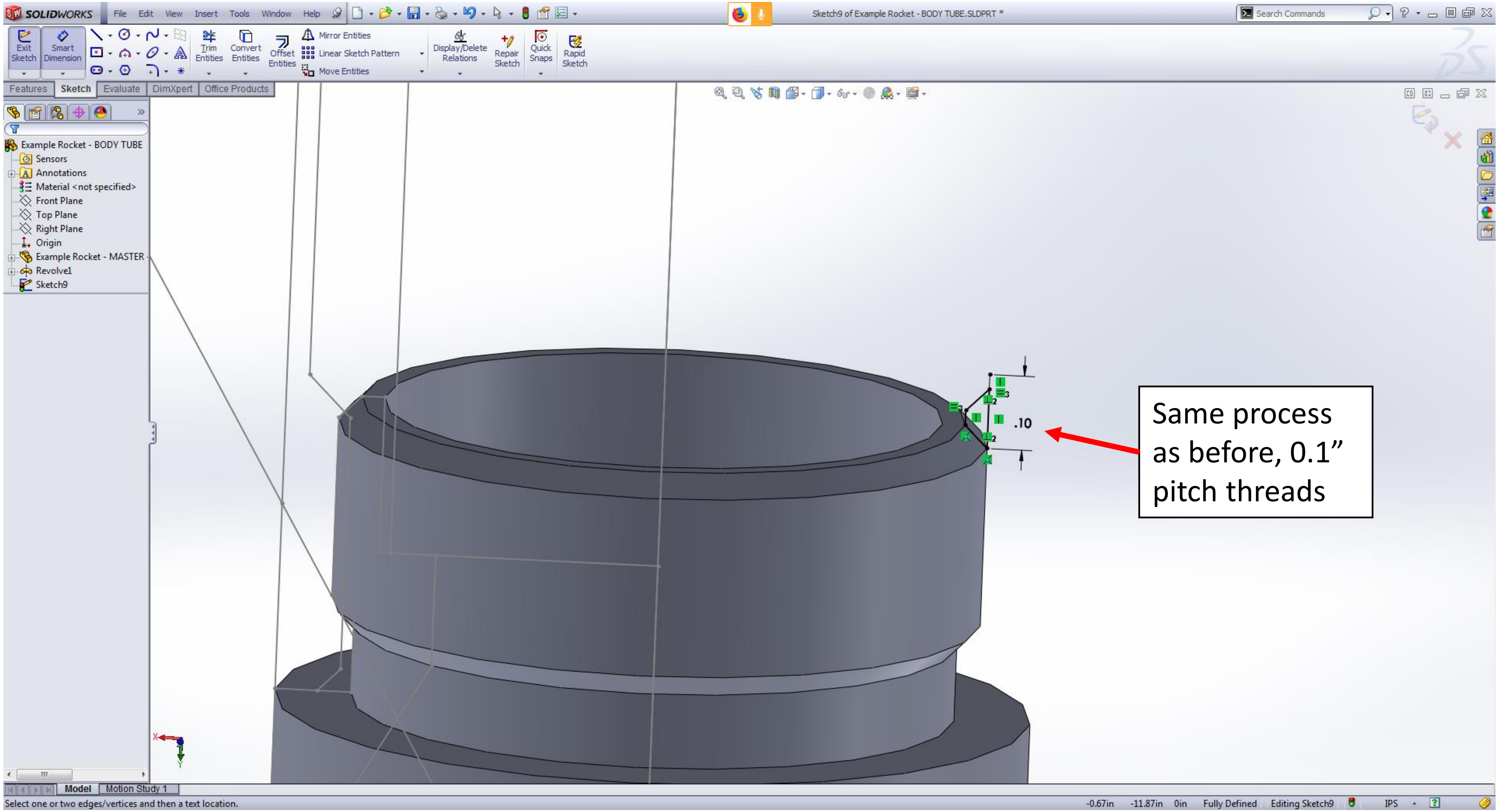
Insert the Master file like before



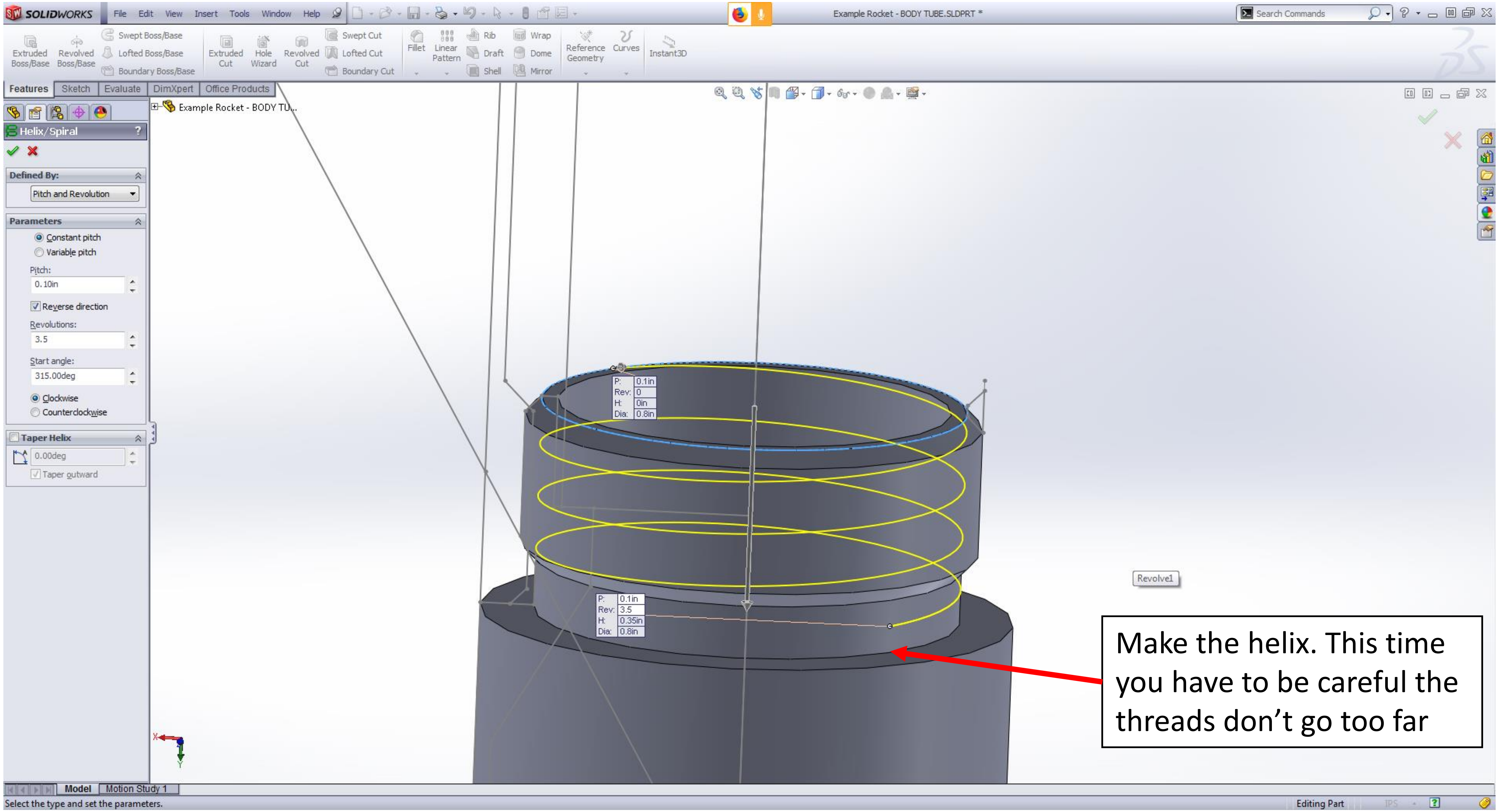
Make a sketch and trace the inner and outer profiles of the Body Tube. There are no fins, so we can skip the separate Revolved Cut step.


SOLIDWORKS
File Edit View Insert Tools Window Help
Sketch8 of Example Rocket - BODY TUBE.SLDPRT *
Search Commands
Exit Sketch
Smart Dimension
Trim Entities
Convert Entities
Offset Entities
Mirror Entities
Linear Sketch Pattern
Move Entities
Display/Delete Relations
Repair Sketch
Quick Snaps
Rapid Sketch
Features Sketch Evaluate DimXpert Office Products
Example Rocket - BODY TU...
Revolve
Axis of Revolution
Line1@OML-Example Rocke
Direction1
Blind
360.00deg
Merge result
Direction2
Thin Feature
Selected Contours
Revolve the Sketch
Model Motion Study 1
Select an axis of revolution and set the parameters.
8.53in -9.61in 0in Fully Defined Editing Sketch8

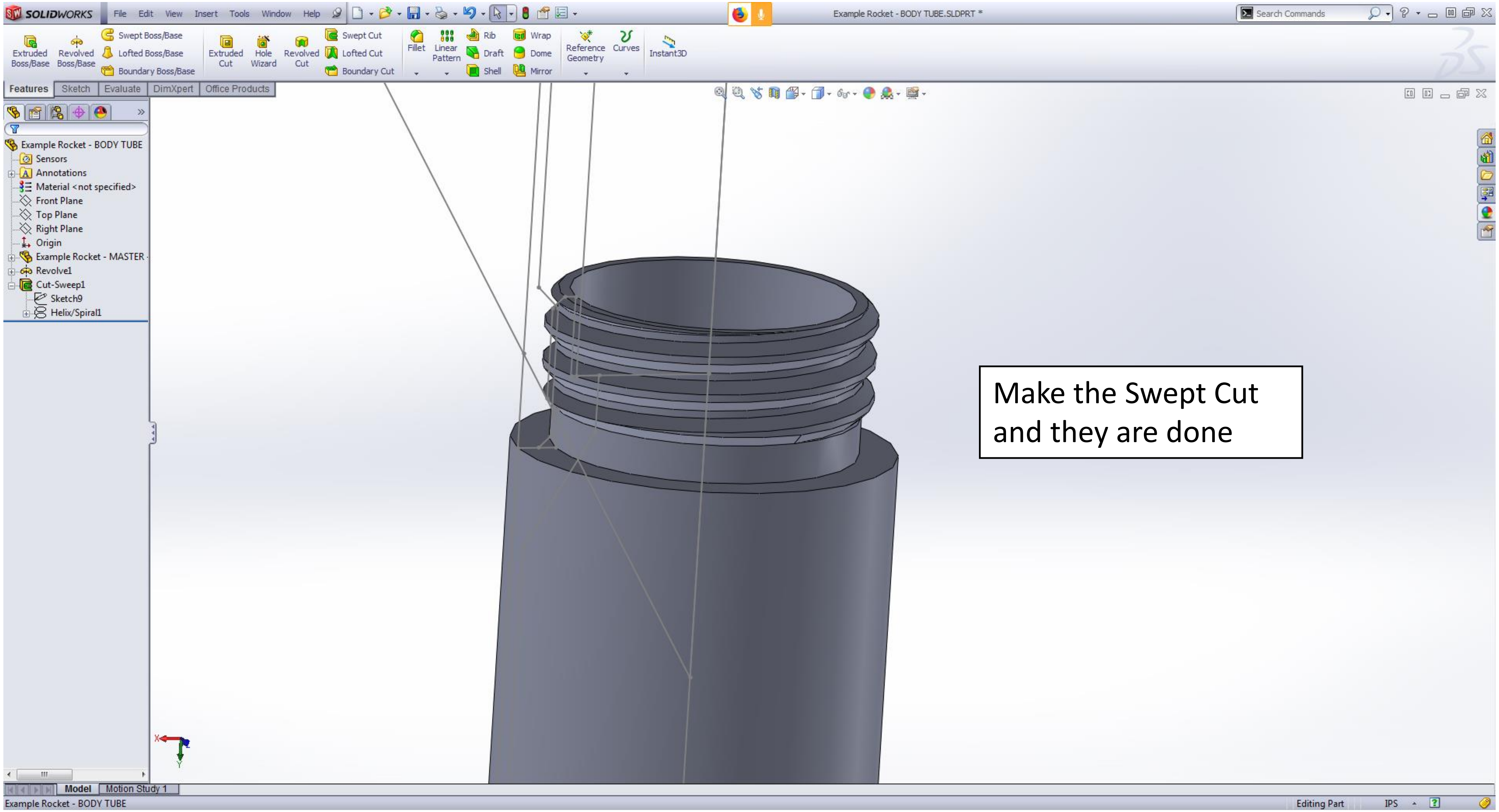

SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - BODY TUBE.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - BODY TUBE
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER
Revolve1
Time to add threads
Model
Motion Study 1
Example Rocket - BODY TUBE
Editing Part
IPS

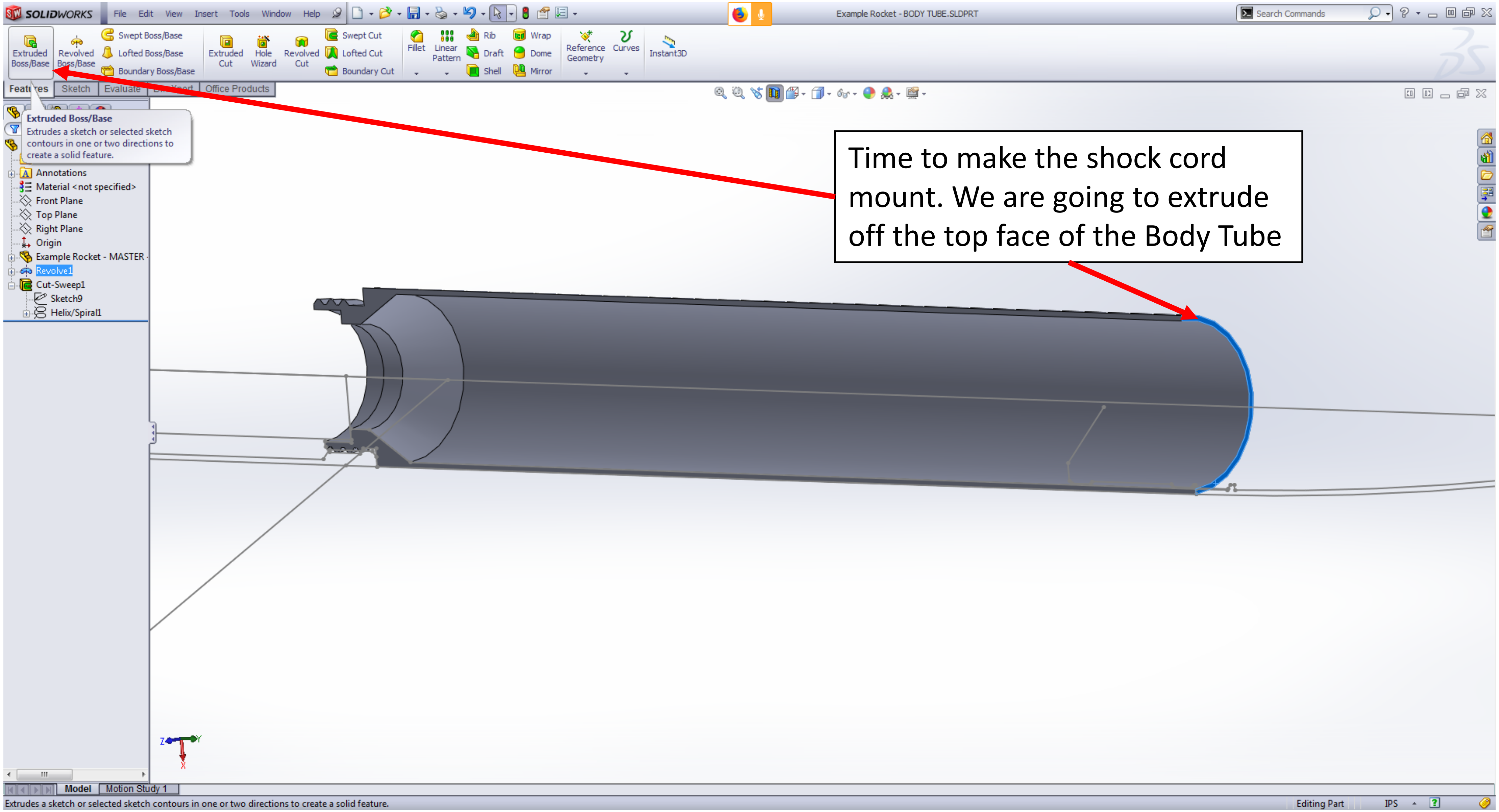


Same process as before, 0.1" pitch threads

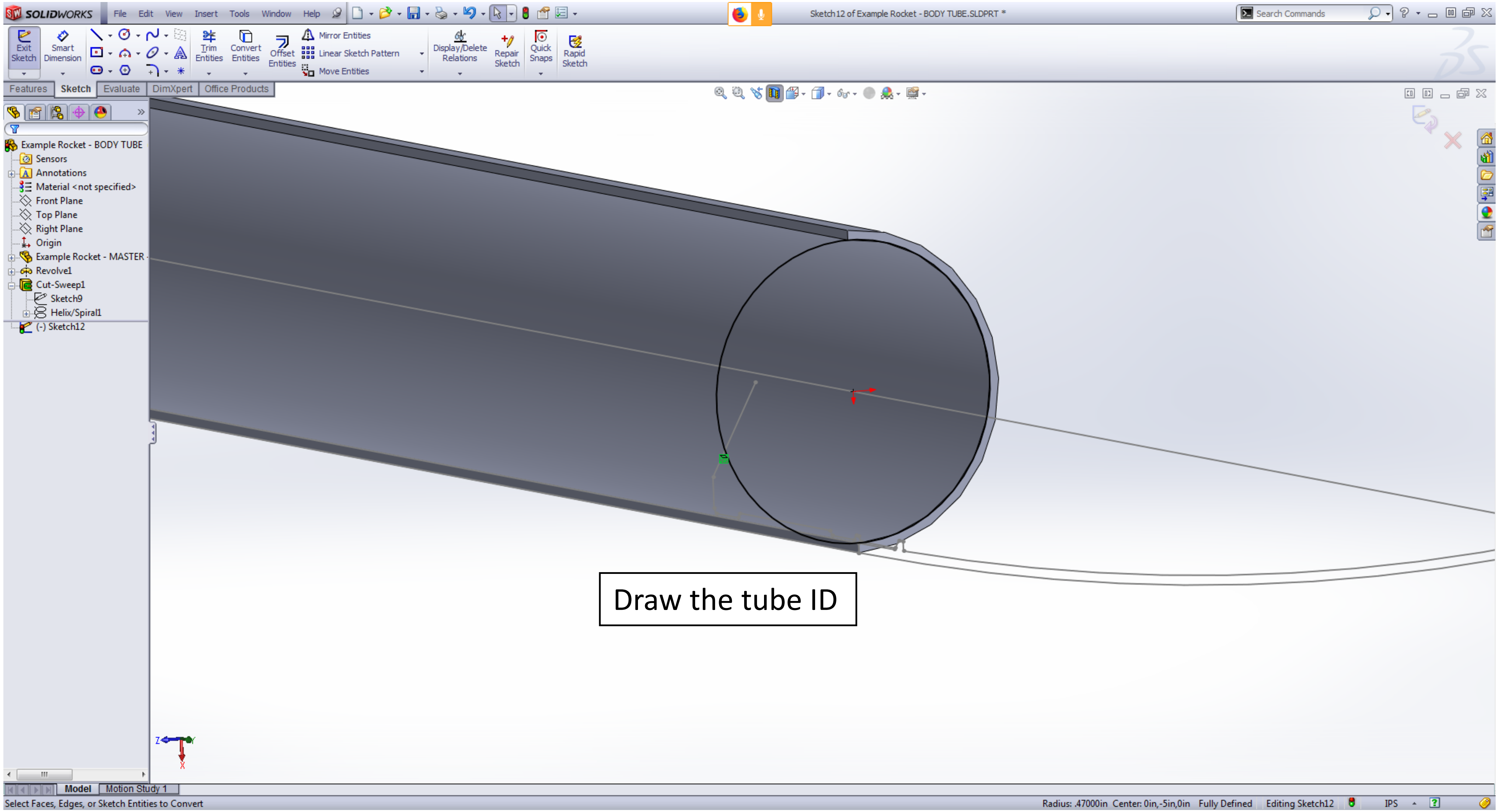


Make the helix. This time you have to be careful the threads don't go too far

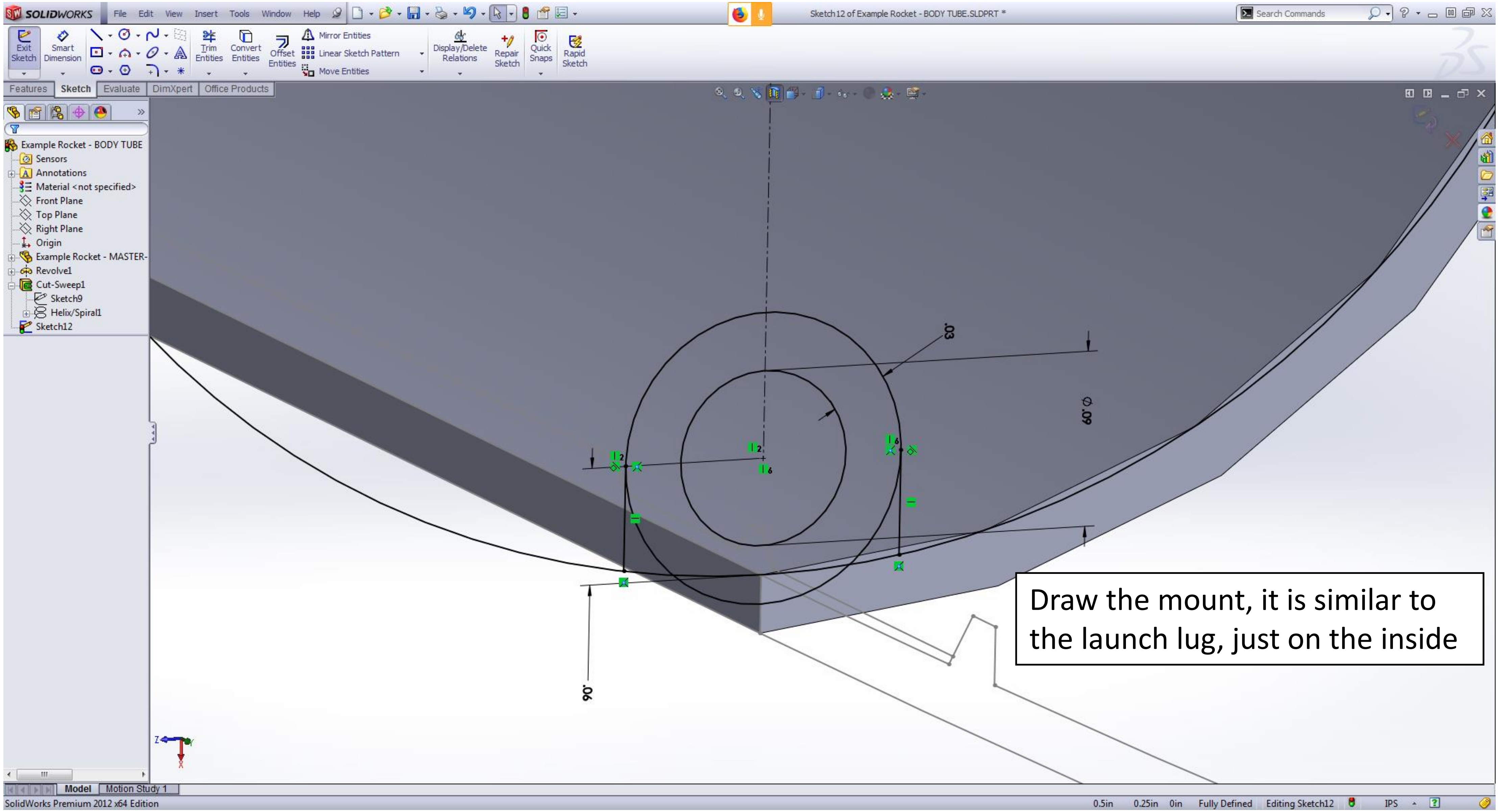

SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - BODY TUBE.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features Sketch Evaluate DimXpert Office Products
Example Rocket - BODY TUBE
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER
Revolve1
Cut-Sweep1
Sketch9
Helix/Spiral1
Model
Motion Study 1
Example Rocket - BODY TUBE
Editing Part
IPS
Make the Swept Cut
and they are done



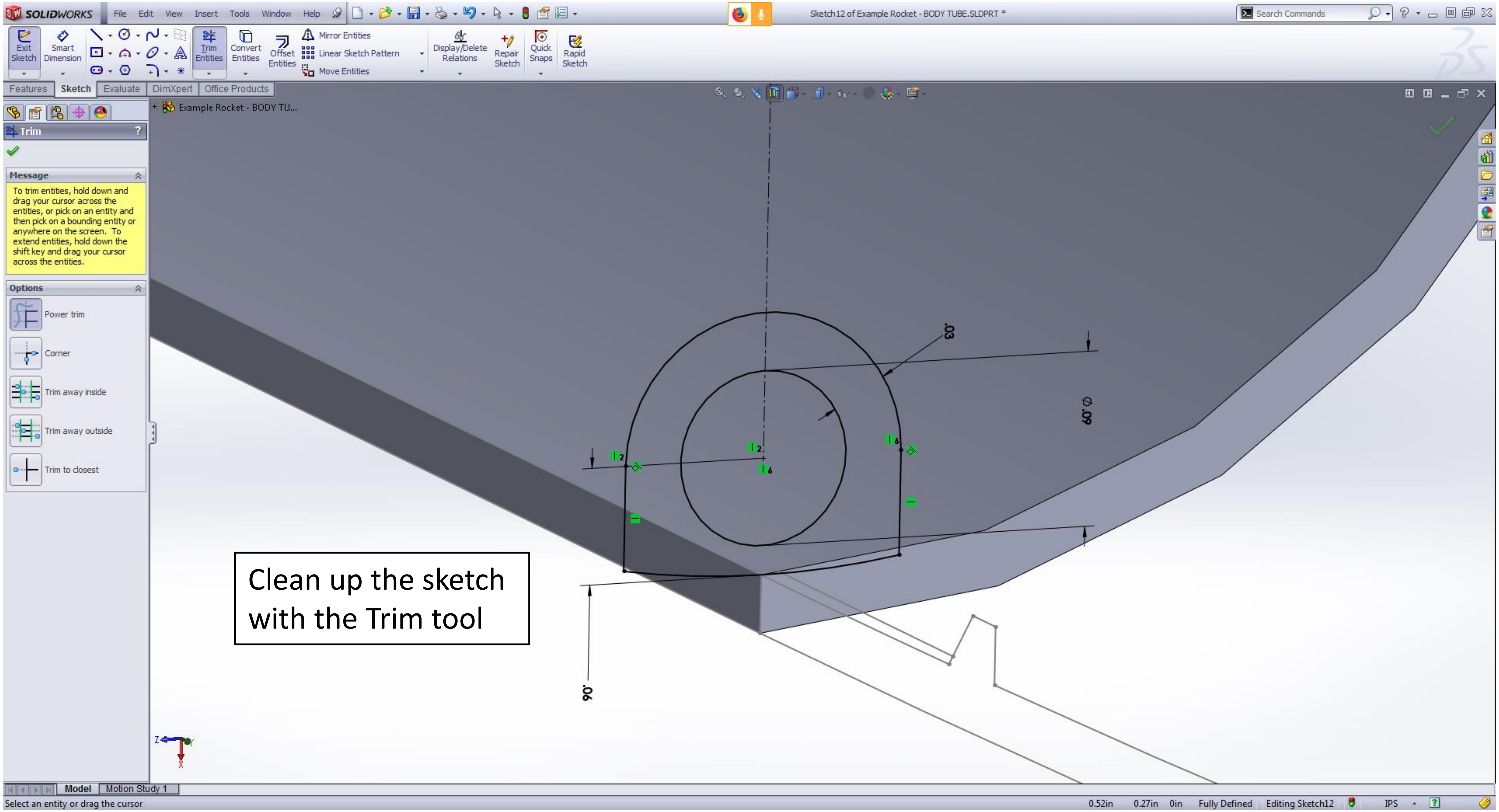
Time to make the shock cord mount. We are going to extrude off the top face of the Body Tube



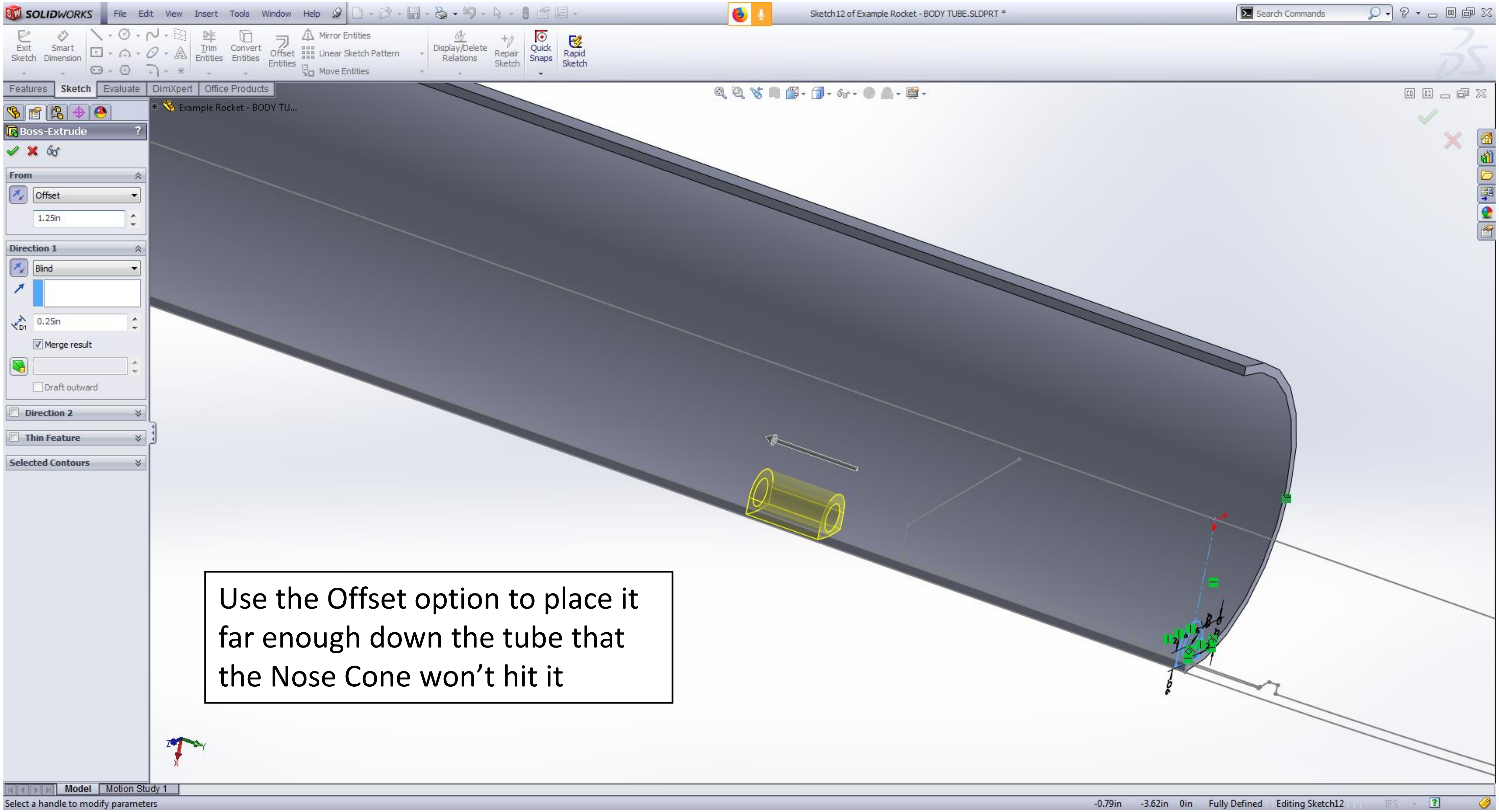
Draw the tube ID



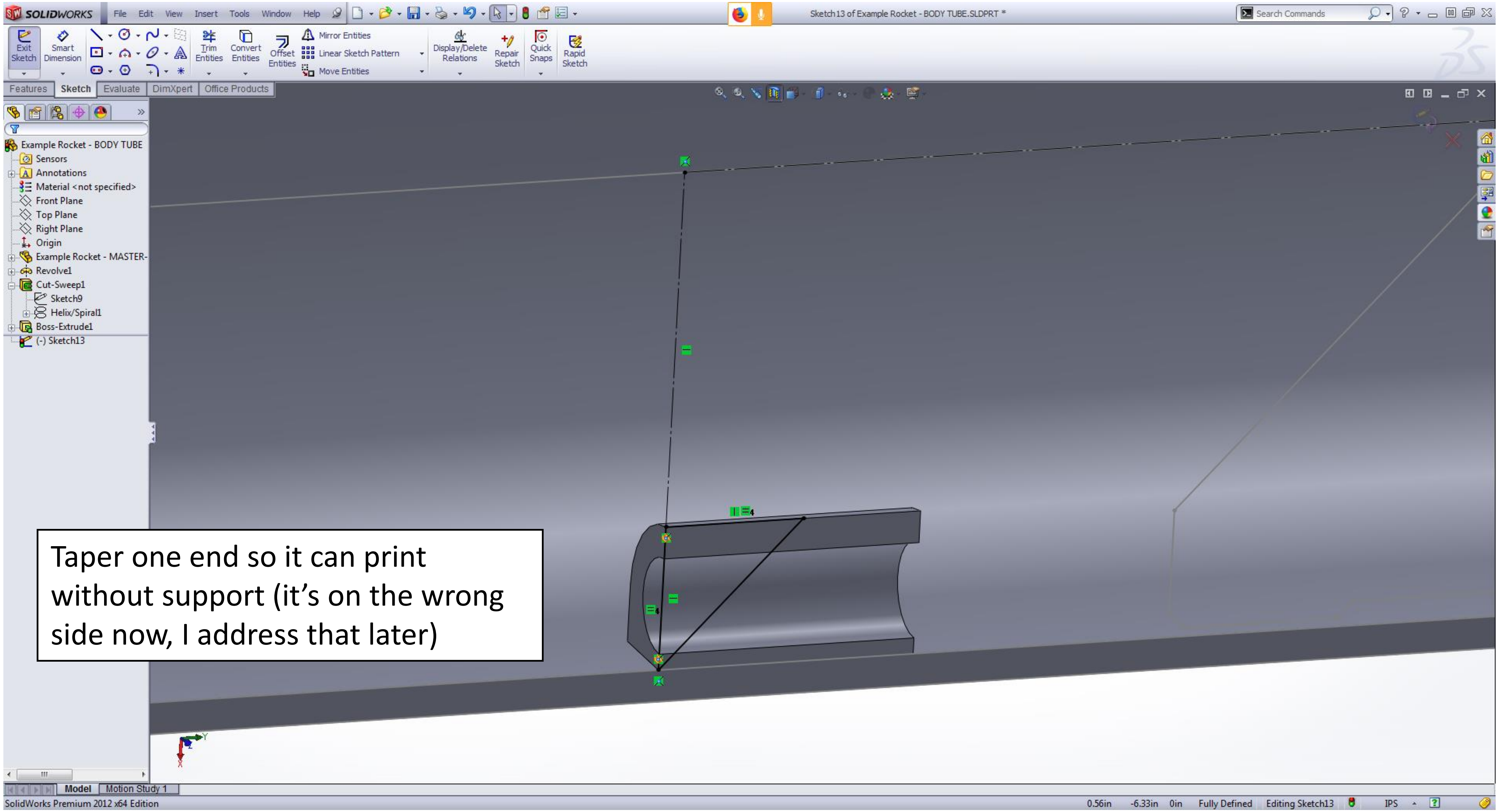
Draw the mount, it is similar to the launch lug, just on the inside



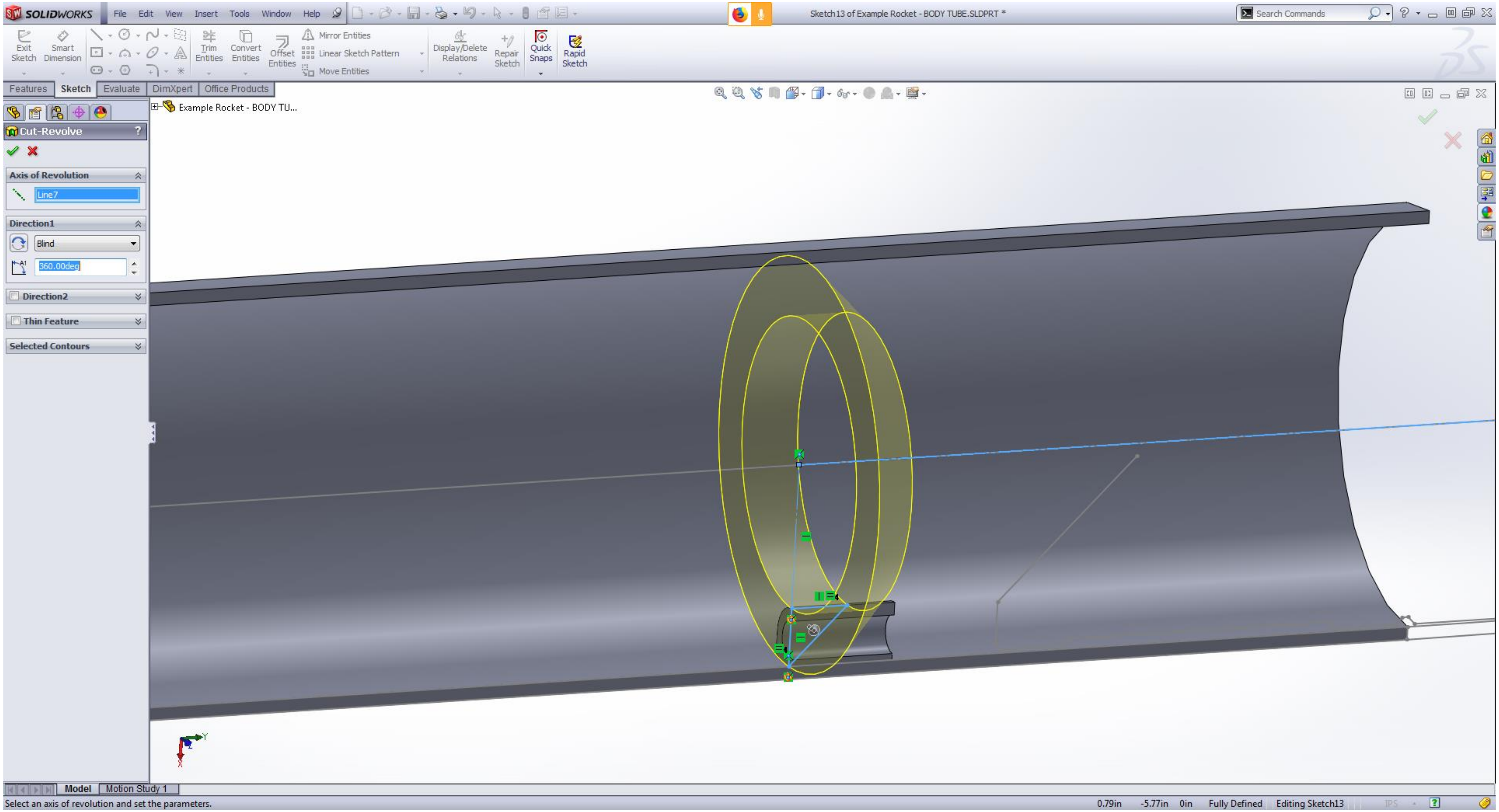
Clean up the sketch with the Trim tool

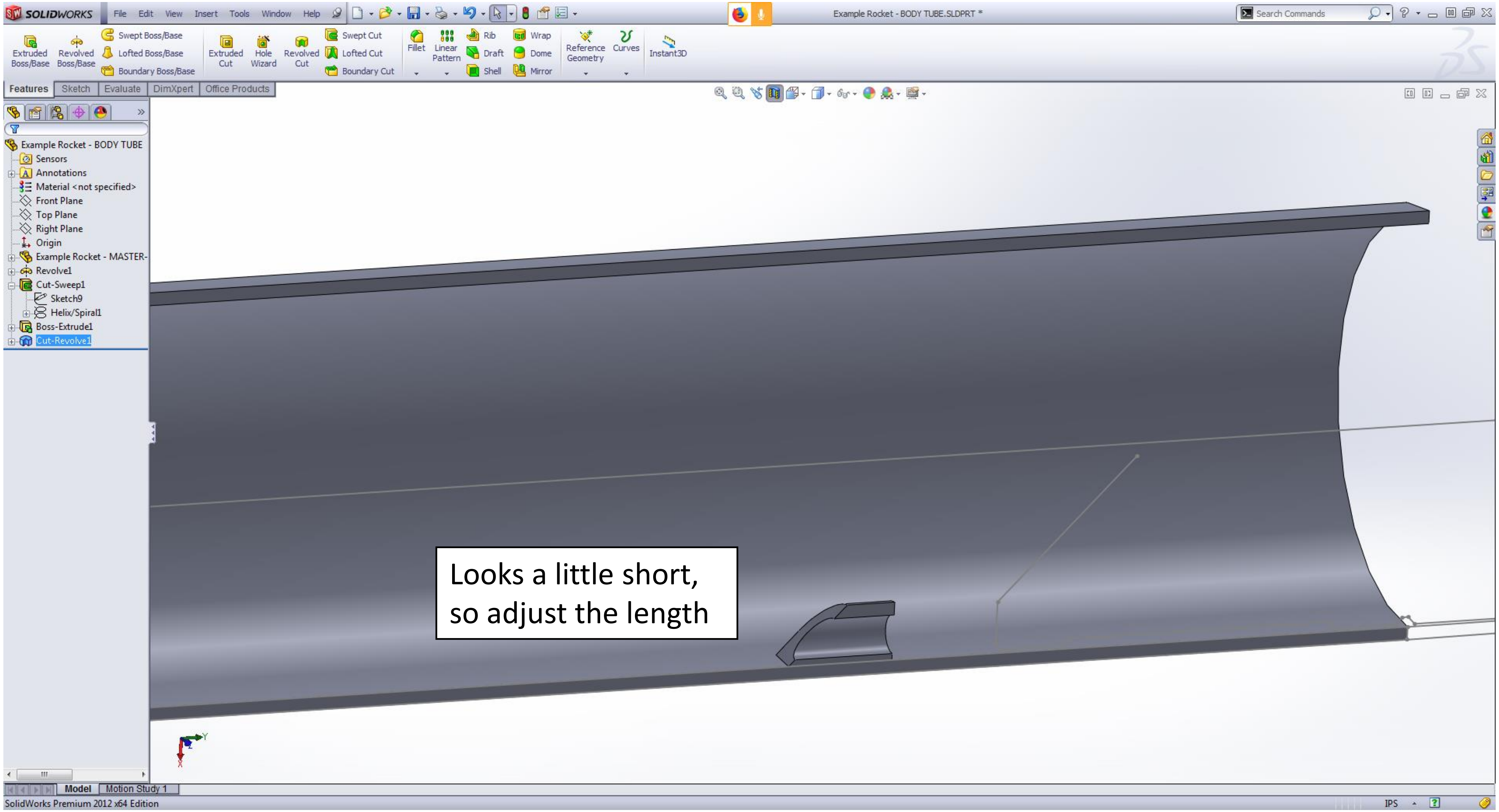


Use the Offset option to place it far enough down the tube that the Nose Cone won't hit it

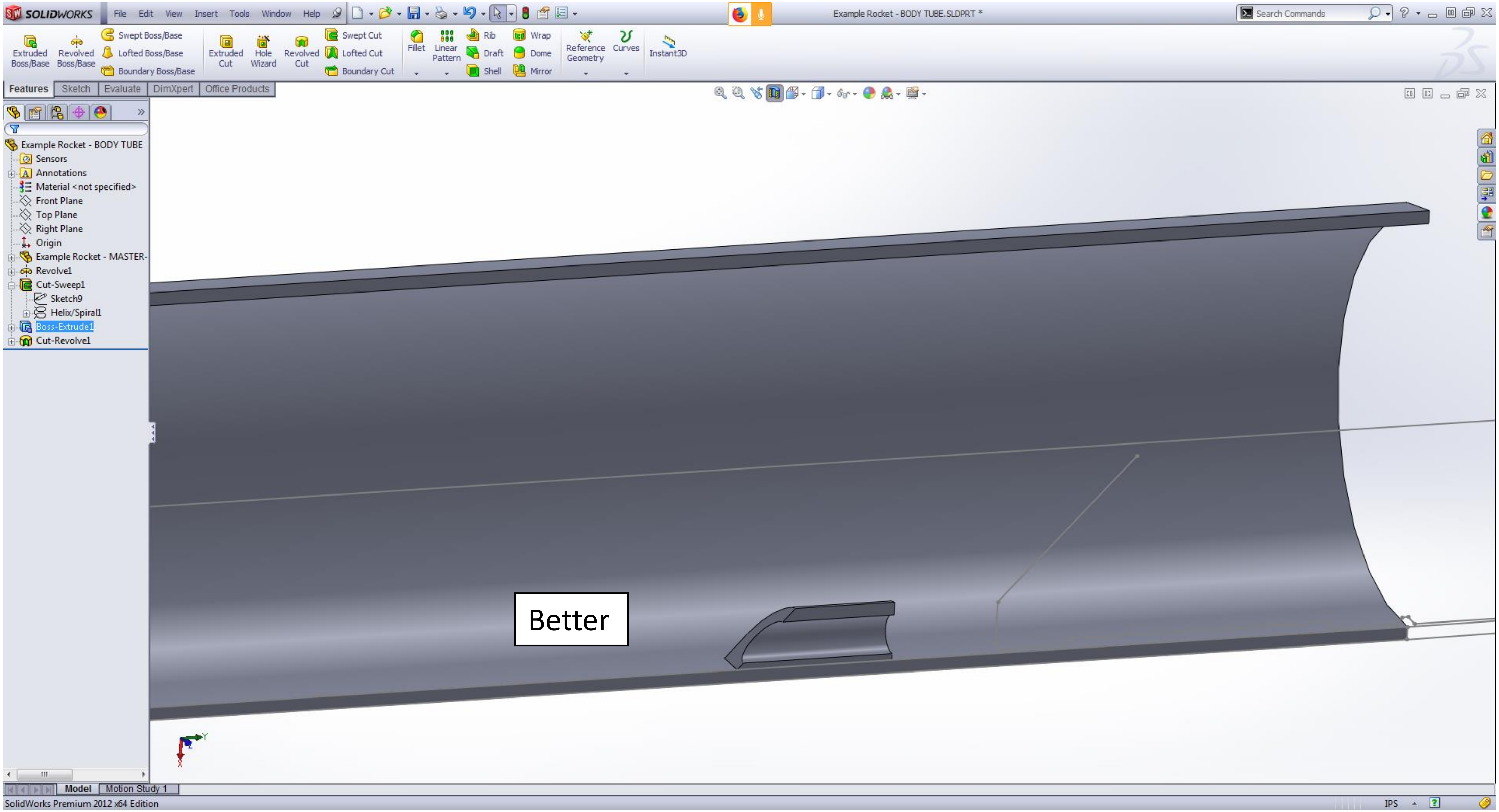


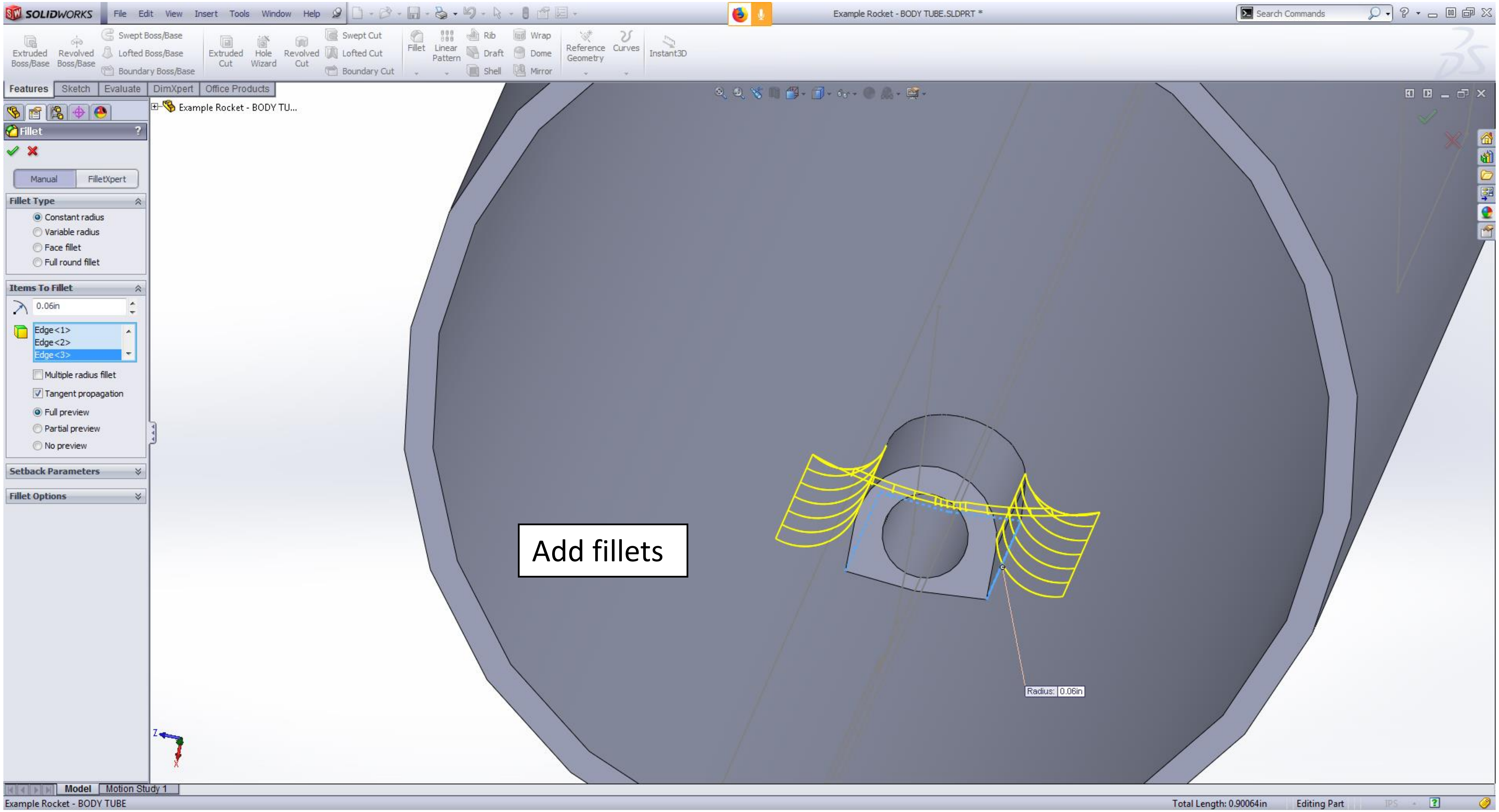
Taper one end so it can print without support (it’s on the wrong side now, I address that later)

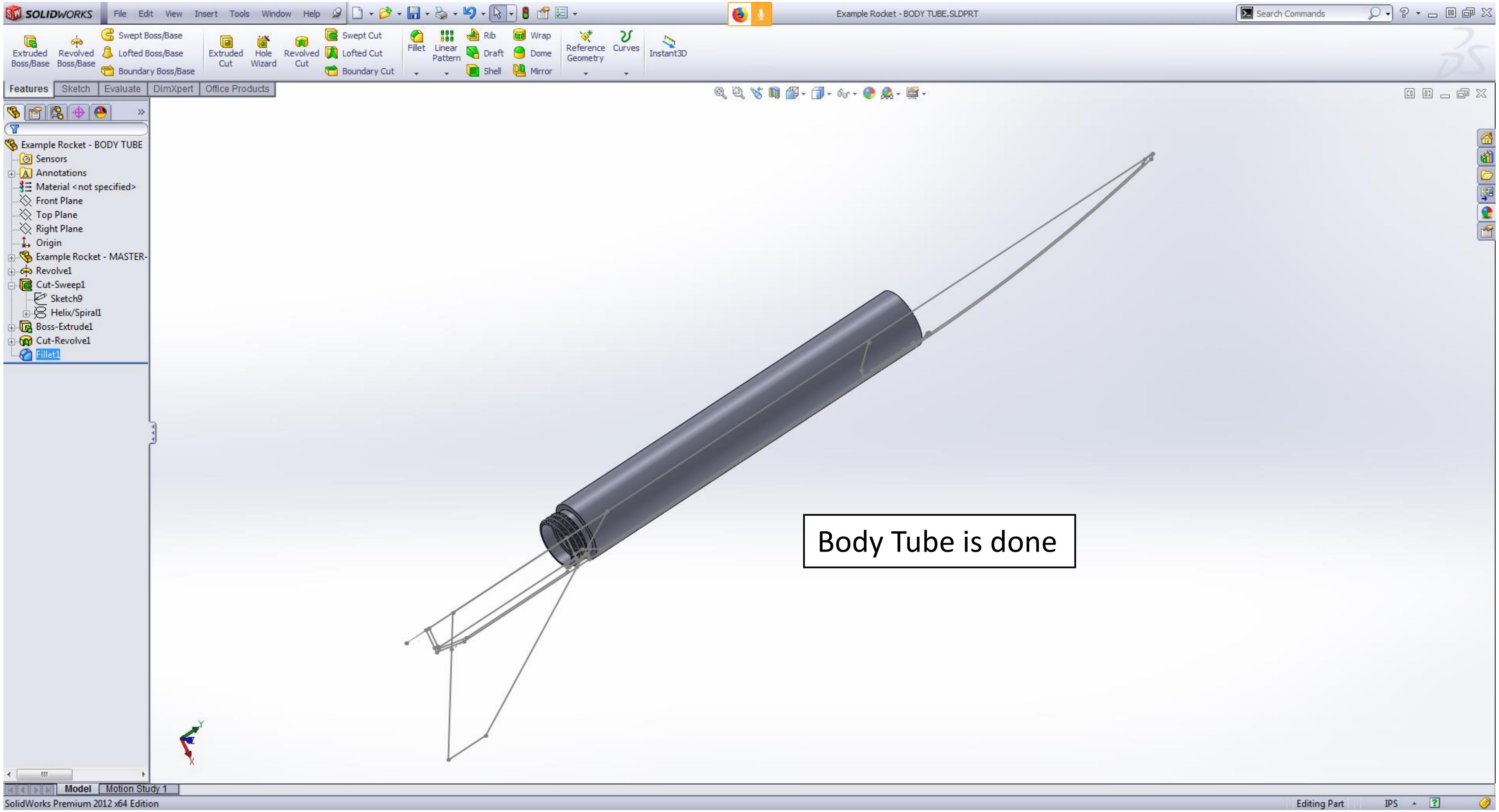

SOLIDWORKS
File Edit View Insert Tools Window Help
Sketch13 of Example Rocket - BODY TUBE.SLDPRT *
Search Commands
Exit Sketch
Smart Dimension
Trim Entities
Convert Entities
Offset Entities
Mirror Entities
Linear Sketch Pattern
Move Entities
Display/Delete Relations
Repair Sketch
Quick Snaps
Rapid Sketch
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - BODY TU...
Cut-Revolve
Axis of Revolution
Line7
Direction1
Blind
360.00deg
Direction2
Thin Feature
Selected Contours
Model
Motion Study 1
Select an axis of revolution and set the parameters.
0.79in -5.77in 0in Fully Defined Editing Sketch13

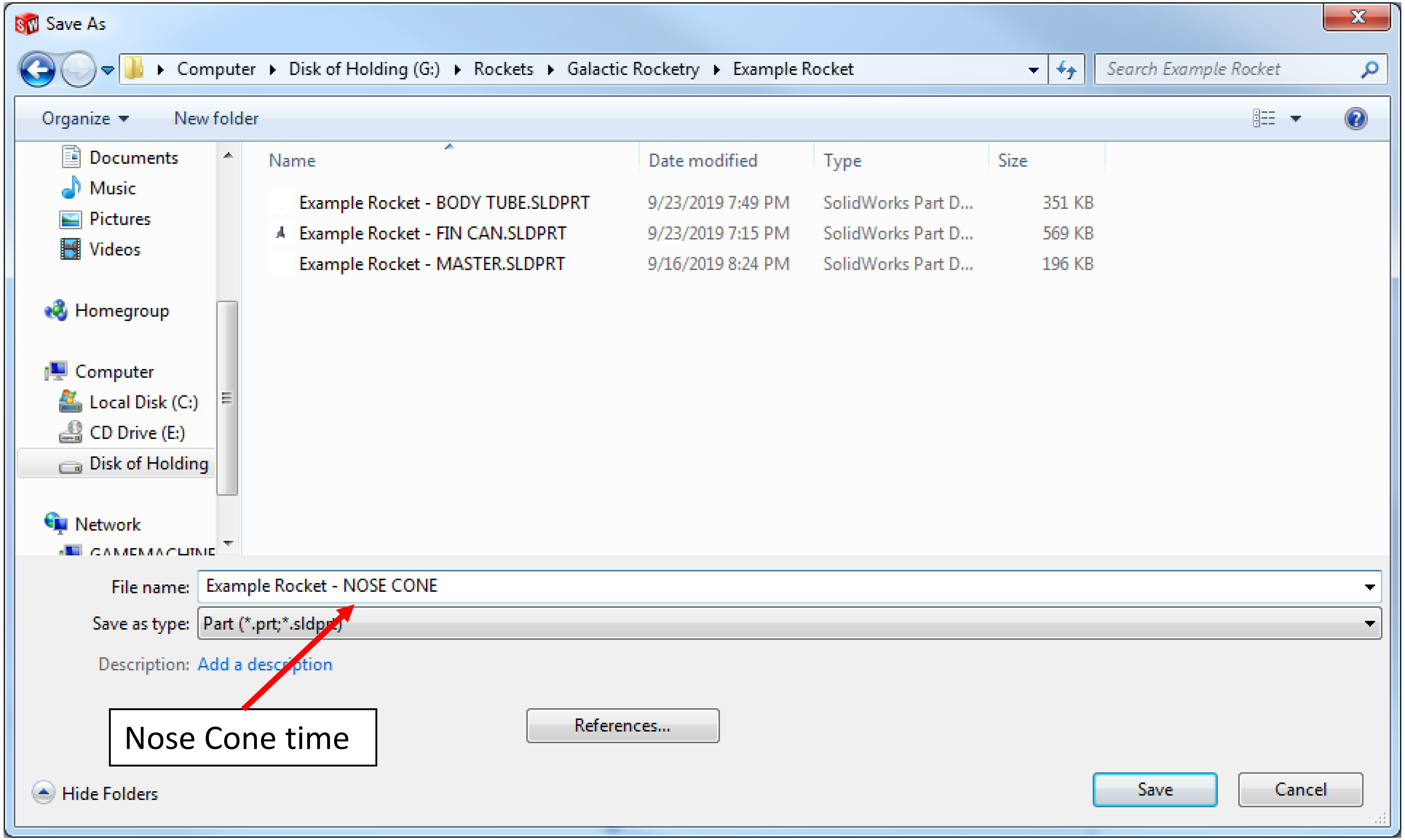


Looks a little short, so adjust the length

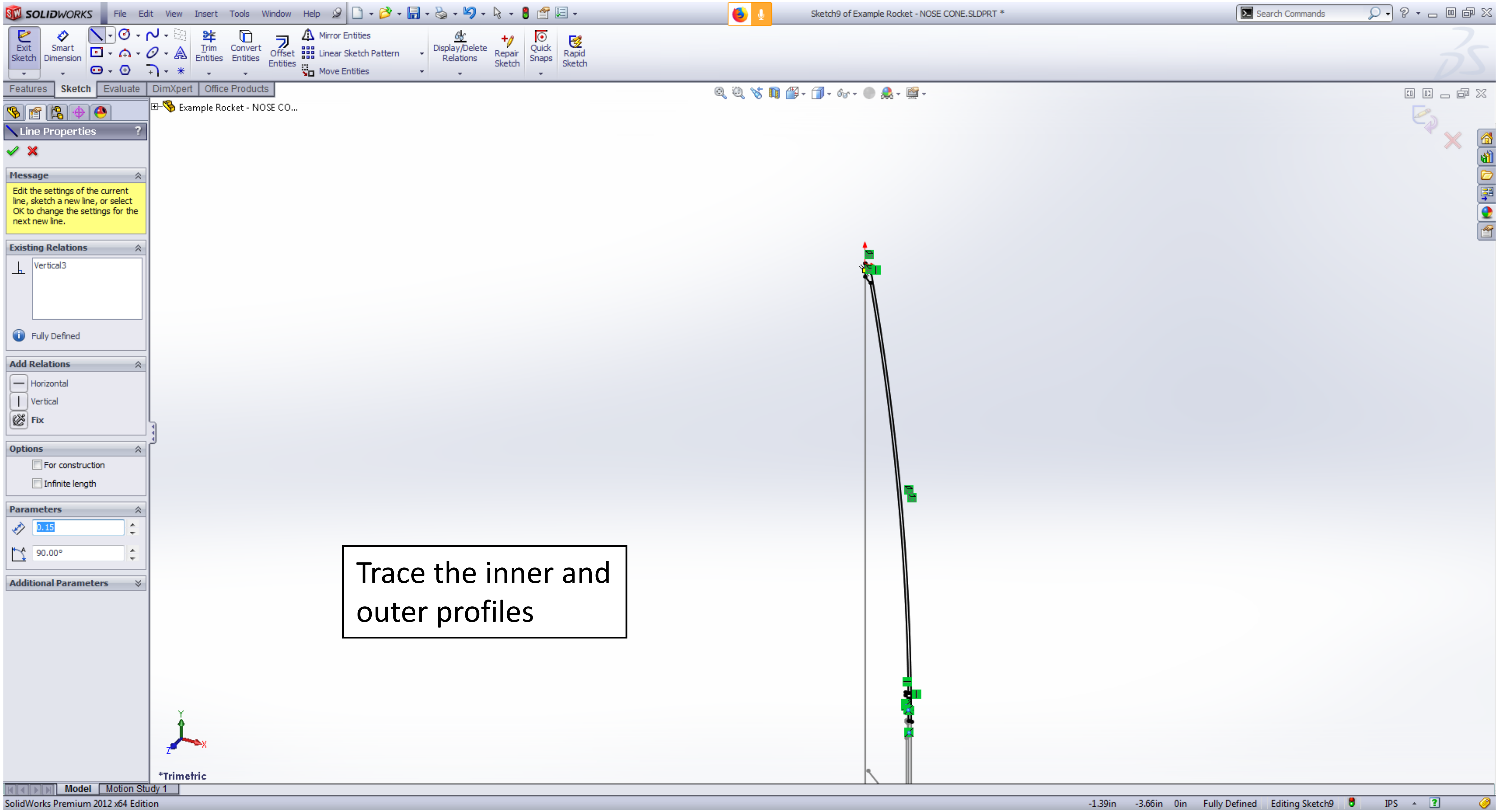

SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - BODY TUBE.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features Sketch Evaluate DimXpert Office Products
Example Rocket - BODY TUBE
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER-
Revolve1
Cut-Sweep1
Sketch9
Helix/Spiral1
Boss-Extrude1
Cut-Revolve1
Better
Model Motion Study 1
SolidWorks Premium 2012 x64 Edition
IPS


SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - BODY TUBE.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features Sketch Evaluate DimXpert Office Products
Example Rocket - BODY TU...
Fillet
Manual FilletXpert
Fillet Type
Constant radius
Variable radius
Face fillet
Full round fillet
Items To Fillet
0.06in
Edge<1>
Edge<2>
Edge<3>
Multiple radius fillet
Tangent propagation
Full preview
Partial preview
No preview
Setback Parameters
Fillet Options
Add fillets
Radius: 0.06in
Model Motion Study 1
Example Rocket - BODY TUBE
Total Length: 0.90064in
Editing Part

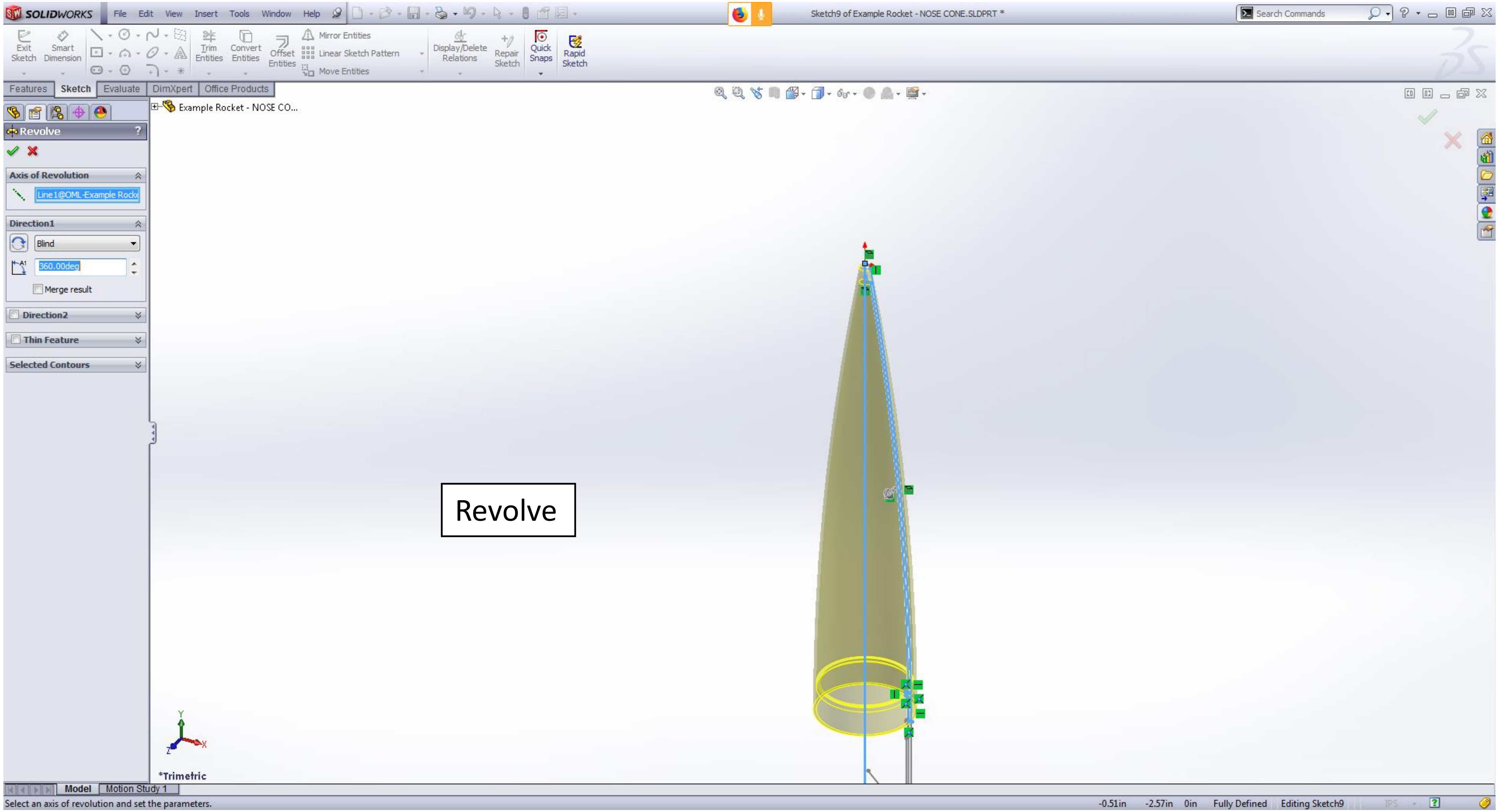

SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - BODY TUBE.SLDPRT
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - BODY TUBE
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER-
Revolve1
Cut-Sweep1
Sketch9
Helix/Spiral1
Boss-Extrude1
Cut-Revolve1
Fillet1
Body Tube is done
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Editing Part
IPS

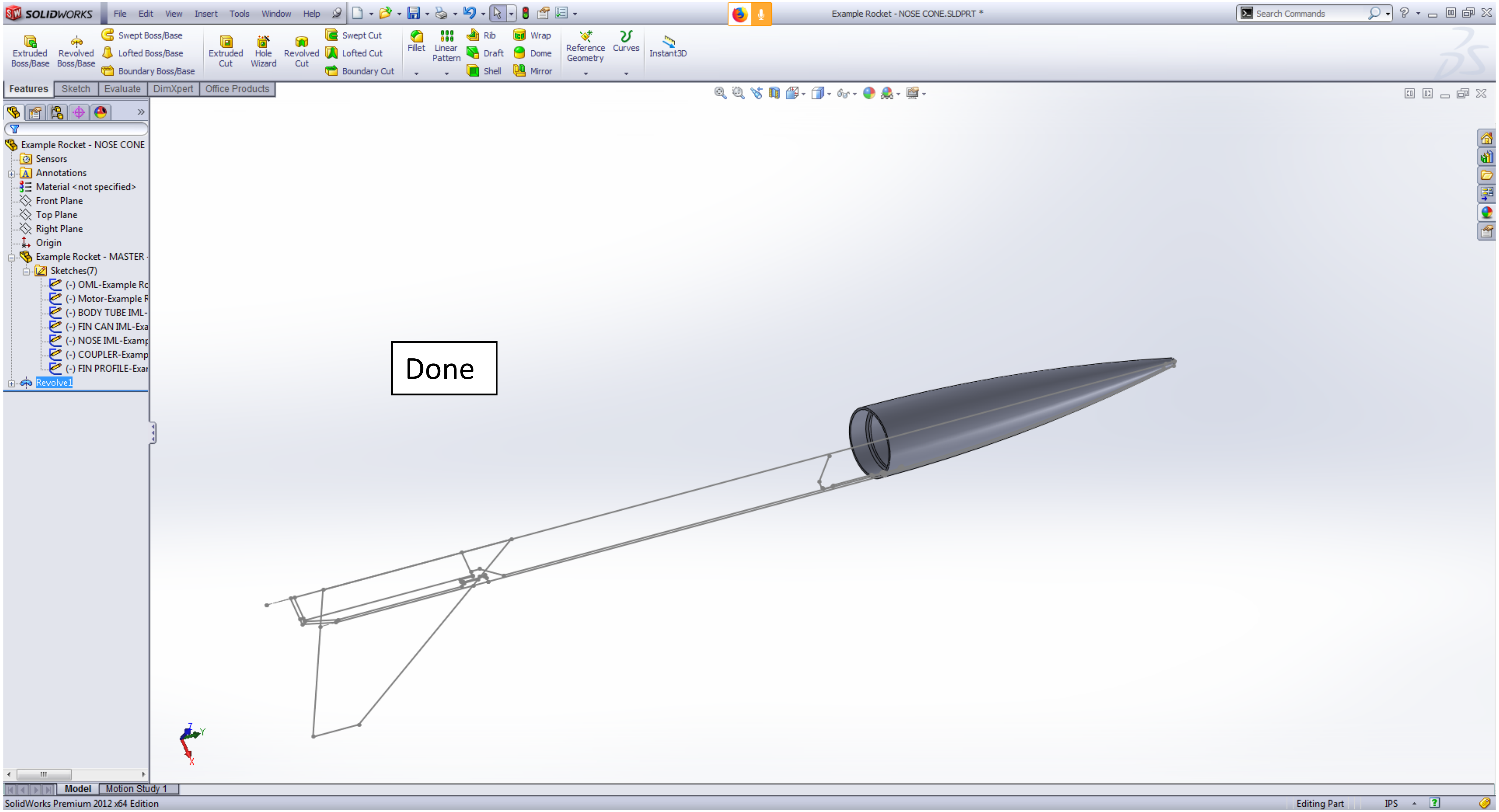


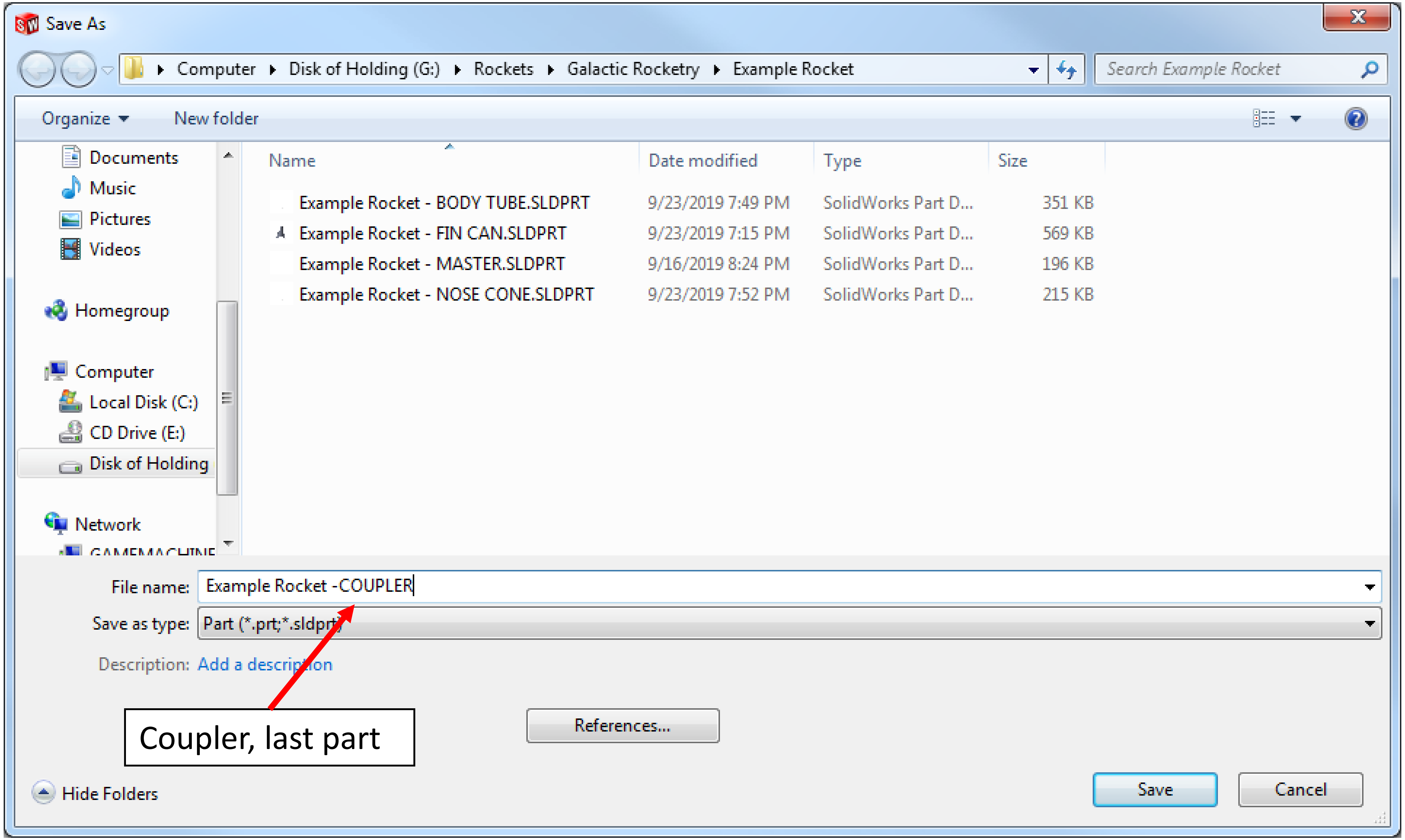
Nose Cone time

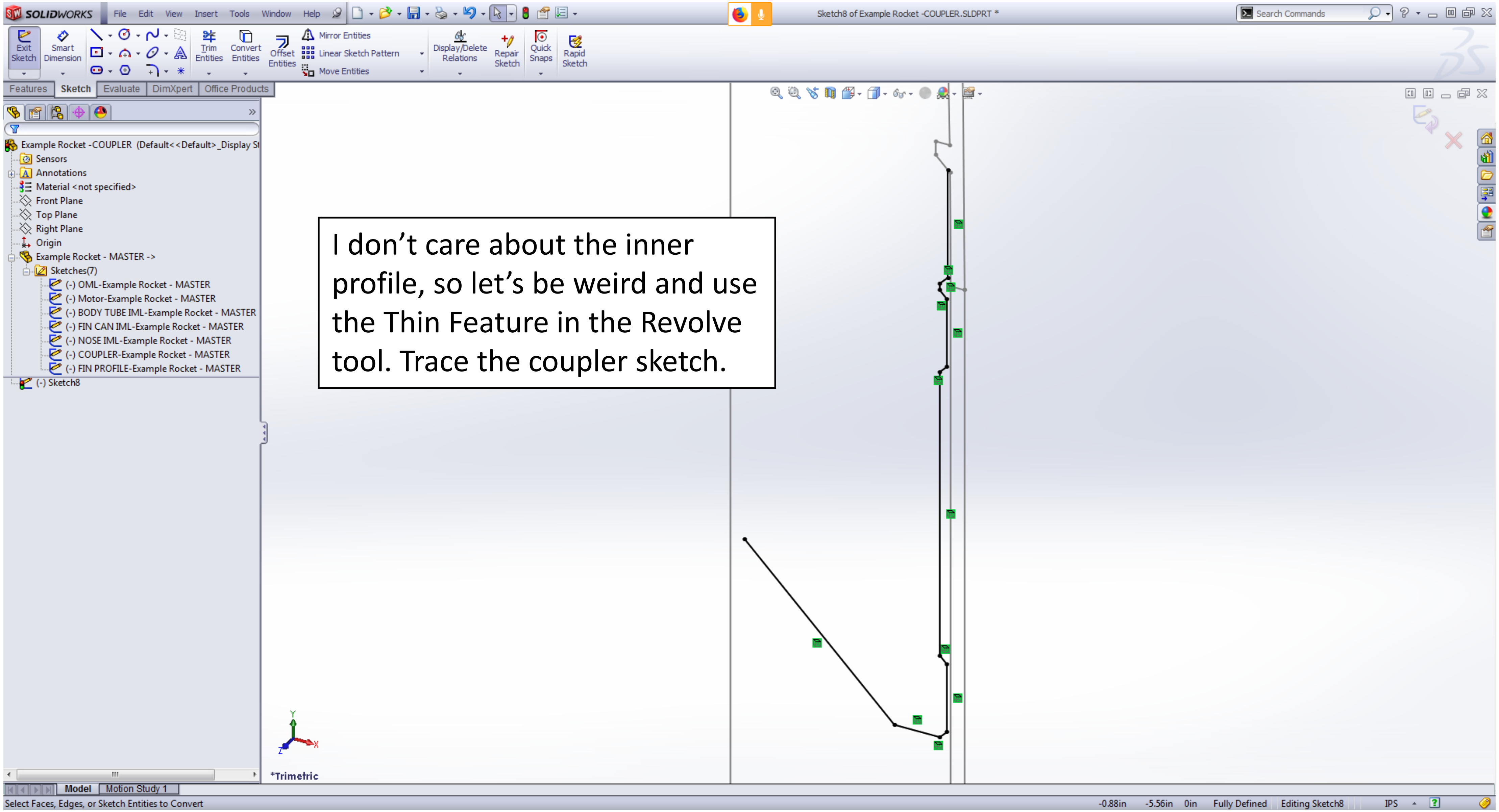


Trace the inner and outer profiles

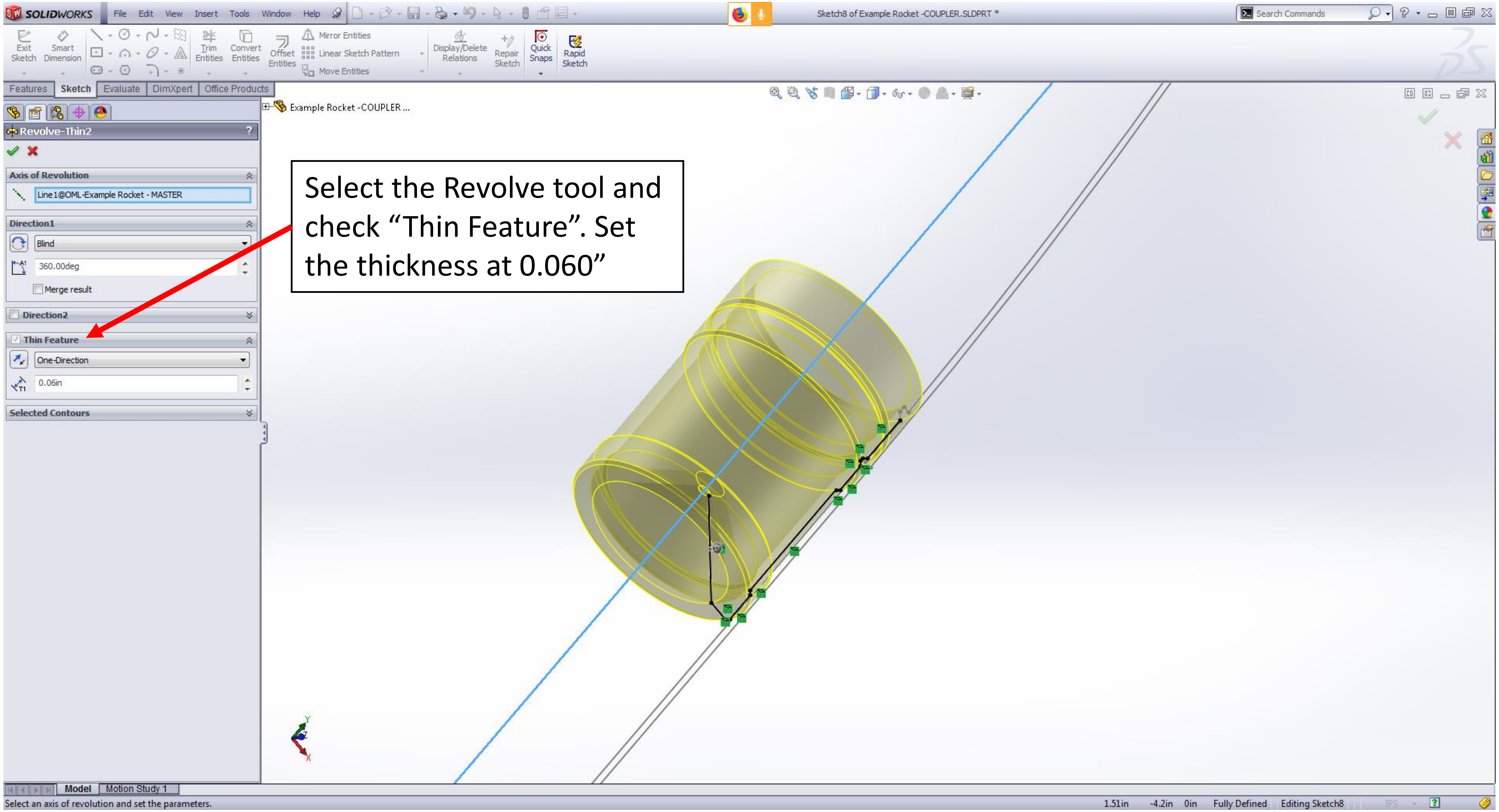

Sketch9 of Example Rocket - NOSE CONE.SLDPRT *
Revolve
Axis of Revolution
Line1@OML-Example Rocke
Direction1
Blind
360.00deg
Merge result
Direction2
Thin Feature
Selected Contours
Example Rocket - NOSE CO...
*Trimetric
Model
Motion Study 1
Select an axis of revolution and set the parameters.
-0.51in
-2.57in
0in
Fully Defined
Editing Sketch9
Revolve


SOLIDWORKS
File
Edit
View
Insert
Tools
Window
Help
Example Rocket - NOSE CONE.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - NOSE CONE
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER
Sketches(7)
(-) OML-Example Rc
(-) Motor-Example F
(-) BODY TUBE IML-
(-) FIN CAN IML-Exa
(-) NOSE IML-Examp
(-) COUPLER-Examp
(-) FIN PROFILE-Exar
Revolve1
Done
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Editing Part
IPS

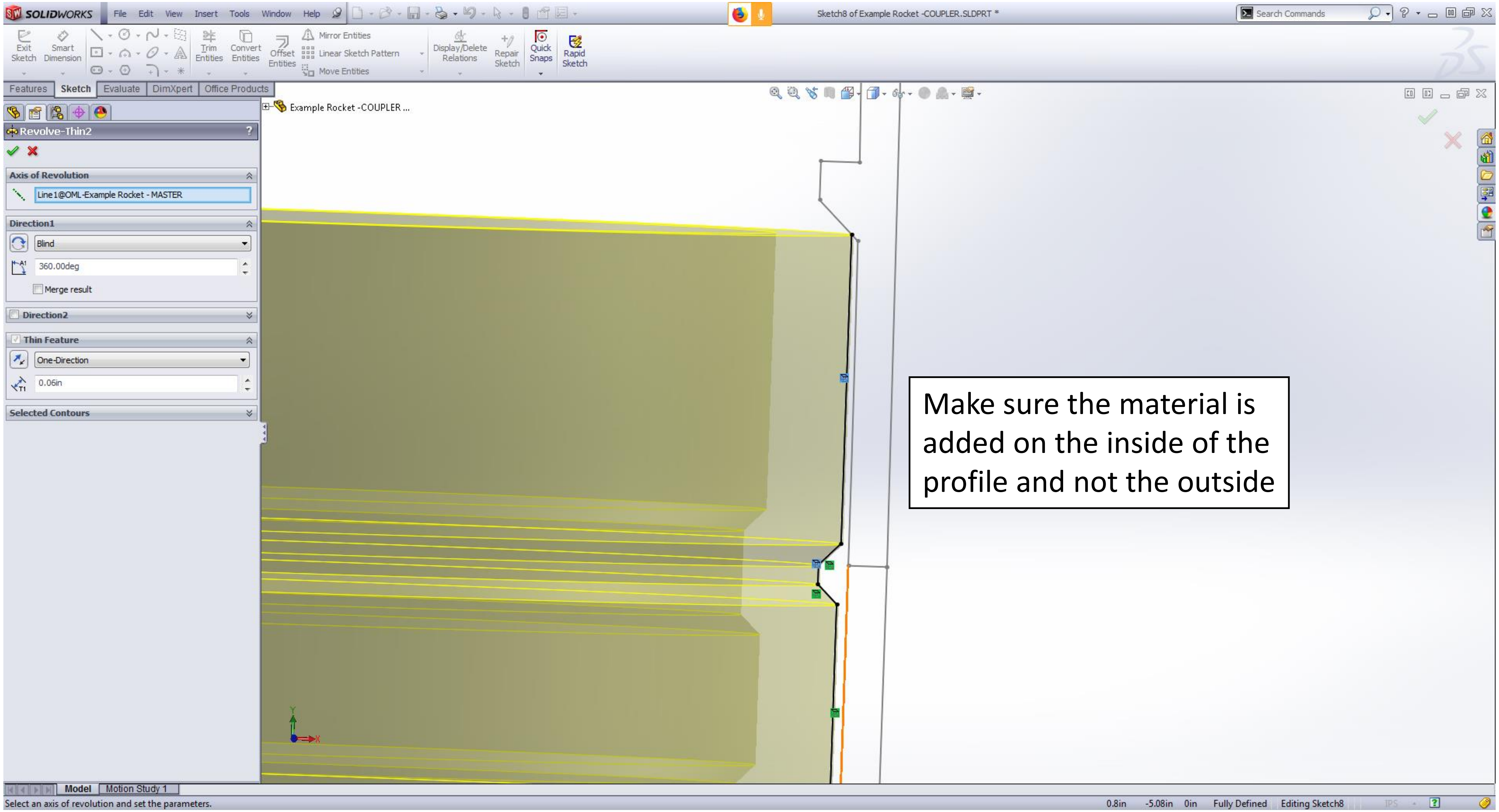

Save As
Computer ▸ Disk of Holding (G:) ▸ Rockets ▸ Galactic Rocketry ▸ Example Rocket
Search Example Rocket
Organize
New folder
Documents
Music
Pictures
Videos
Homegroup
Computer
Local Disk (C:)
CD Drive (E:)
Disk of Holding
Network
Name
Date modified
Type
Size
Example Rocket - BODY TUBE.SLDPRT
9/23/2019 7:49 PM
SolidWorks Part D...
351 KB
Example Rocket - FIN CAN.SLDPRT
9/23/2019 7:15 PM
SolidWorks Part D...
569 KB
Example Rocket - MASTER.SLDPRT
9/16/2019 8:24 PM
SolidWorks Part D...
196 KB
Example Rocket - NOSE CONE.SLDPRT
9/23/2019 7:52 PM
SolidWorks Part D...
215 KB
File name:
Example Rocket -COUPLER
Save as type:
Part (*.prt;*.sldprt)
Description:
Add a description
Coupler, last part
References...
Hide Folders
Save
Cancel



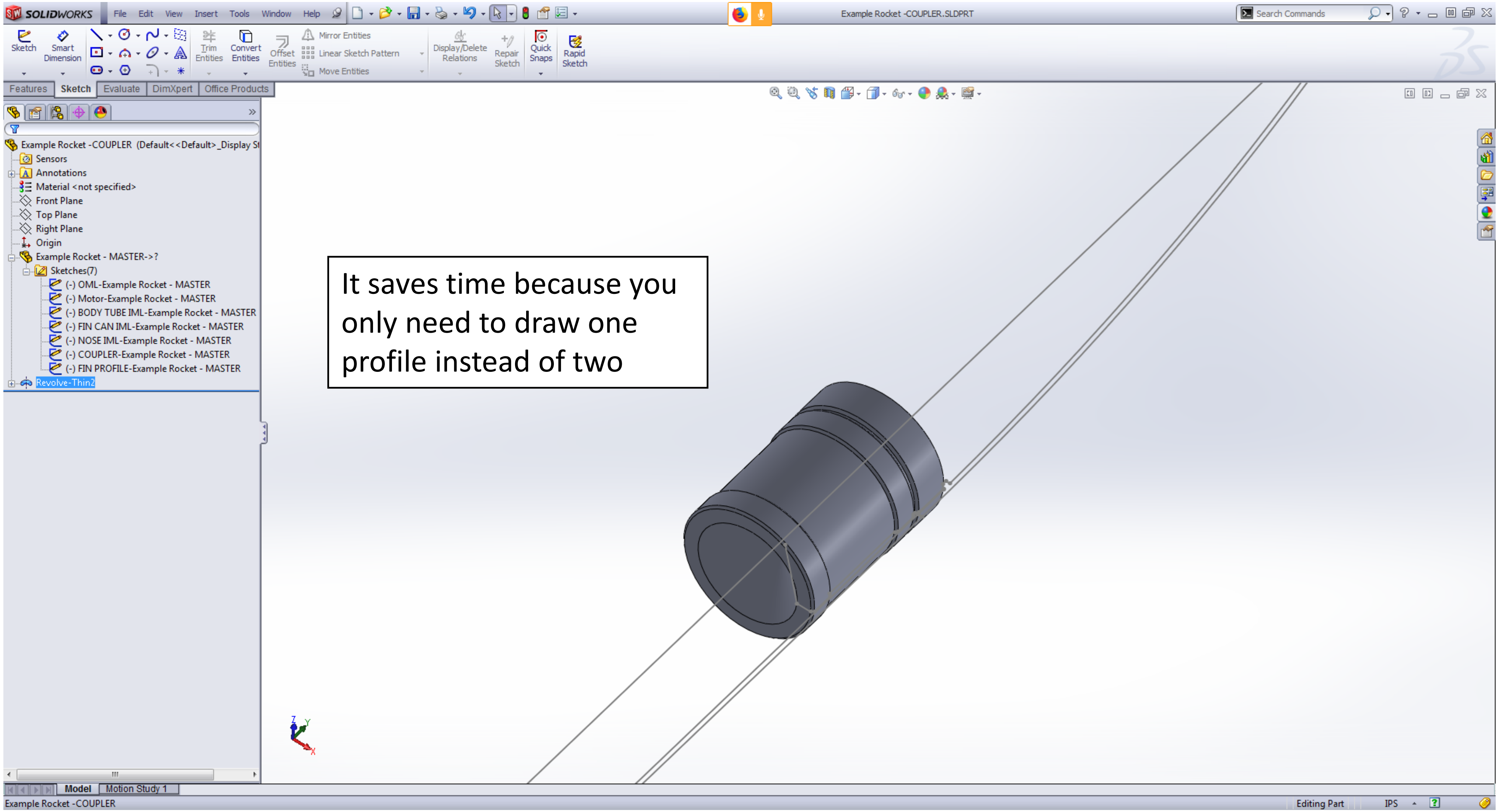
I don’t care about the inner profile, so let’s be weird and use the Thin Feature in the Revolve tool. Trace the coupler sketch.



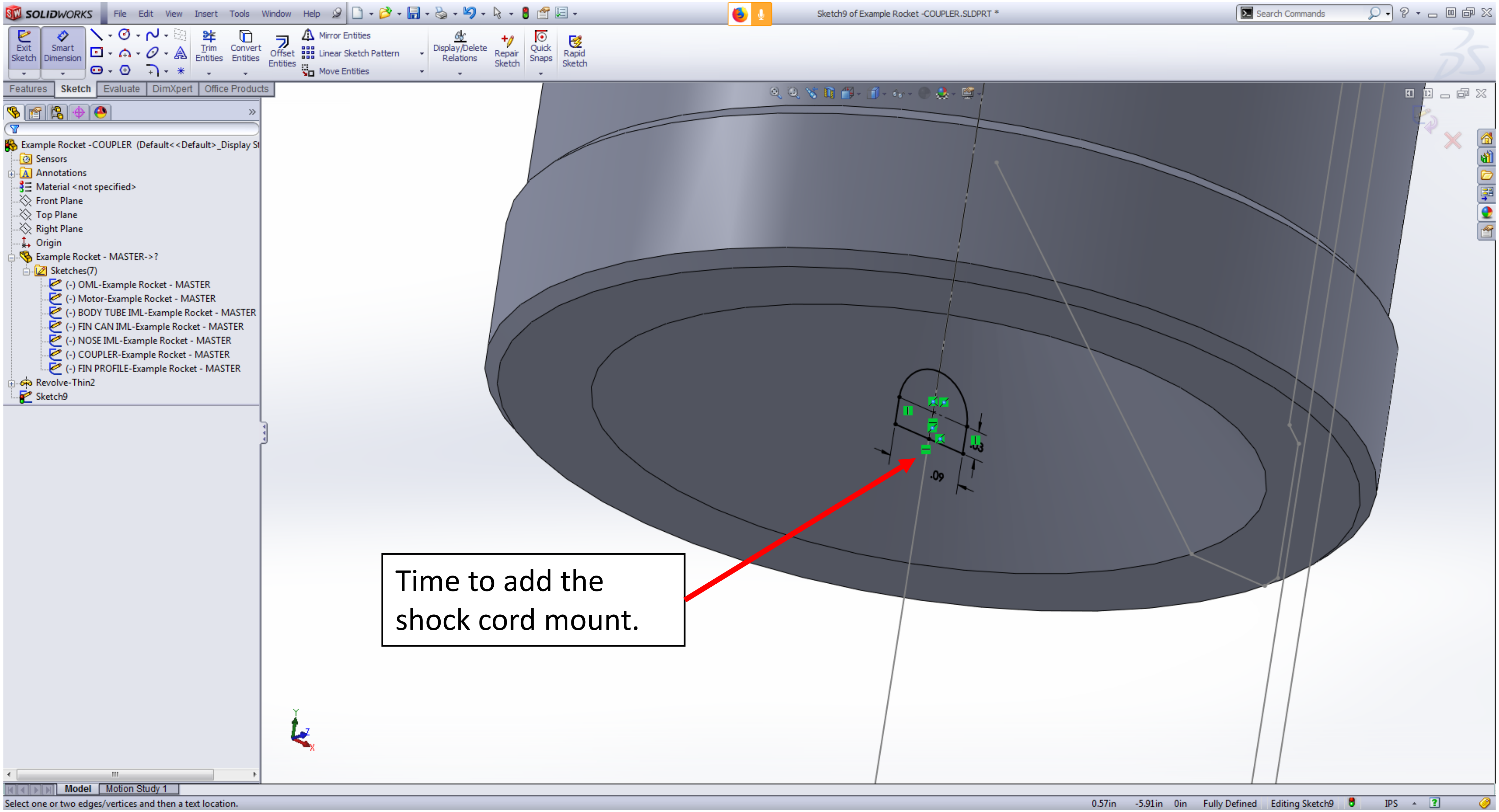
Select the Revolve tool and check “Thin Feature”. Set the thickness at 0.060”



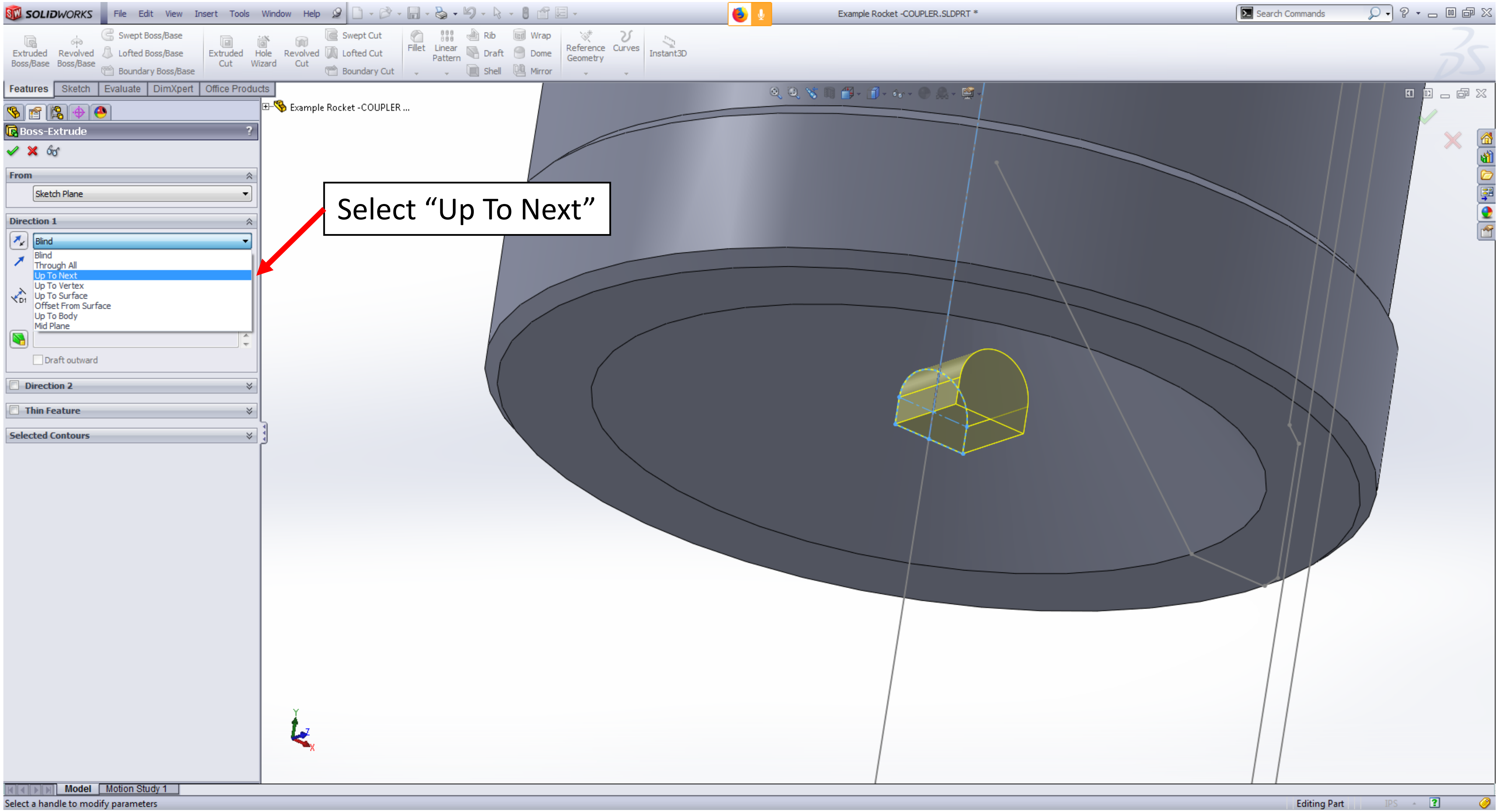
Make sure the material is added on the inside of the profile and not the outside

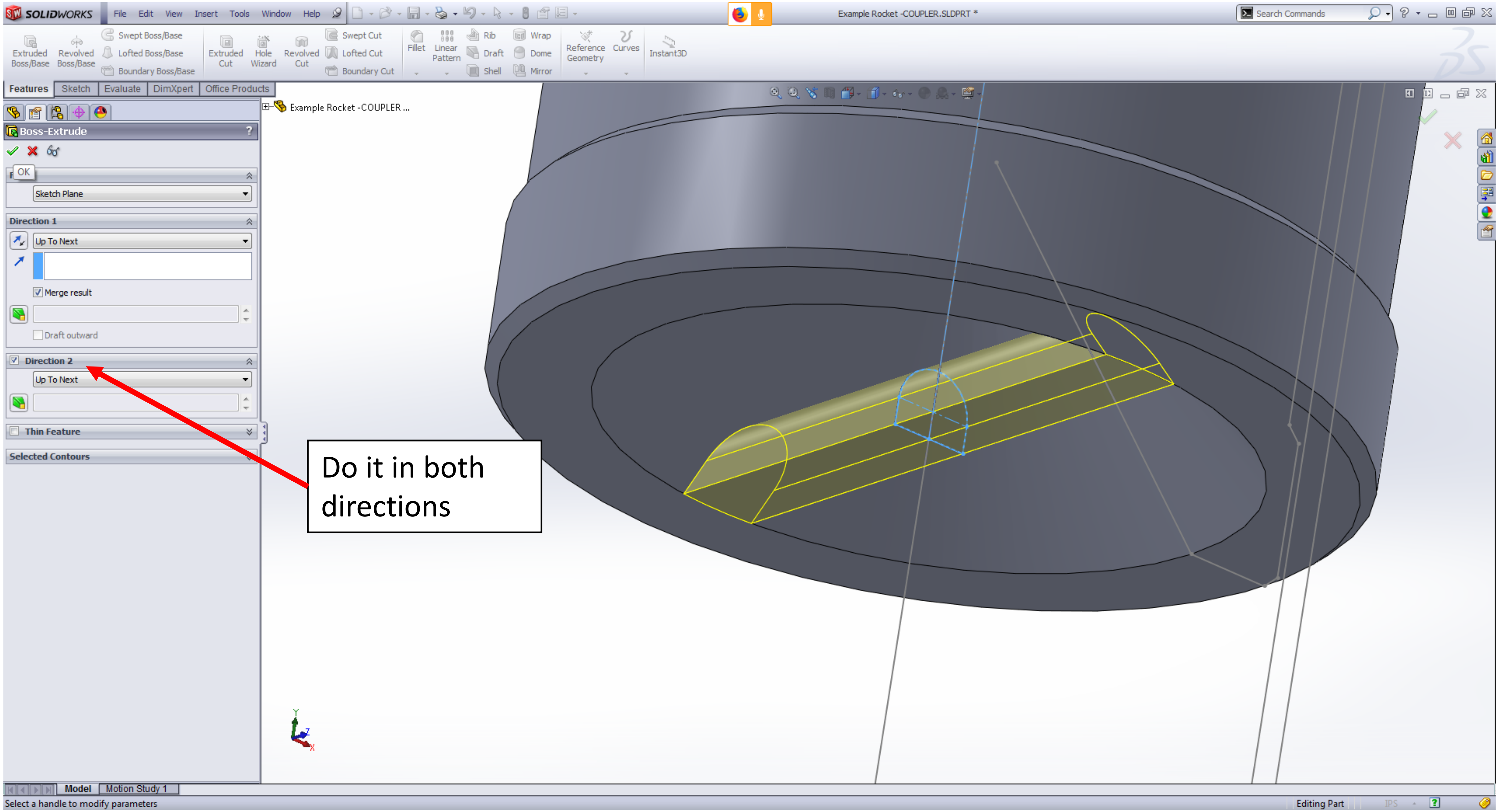


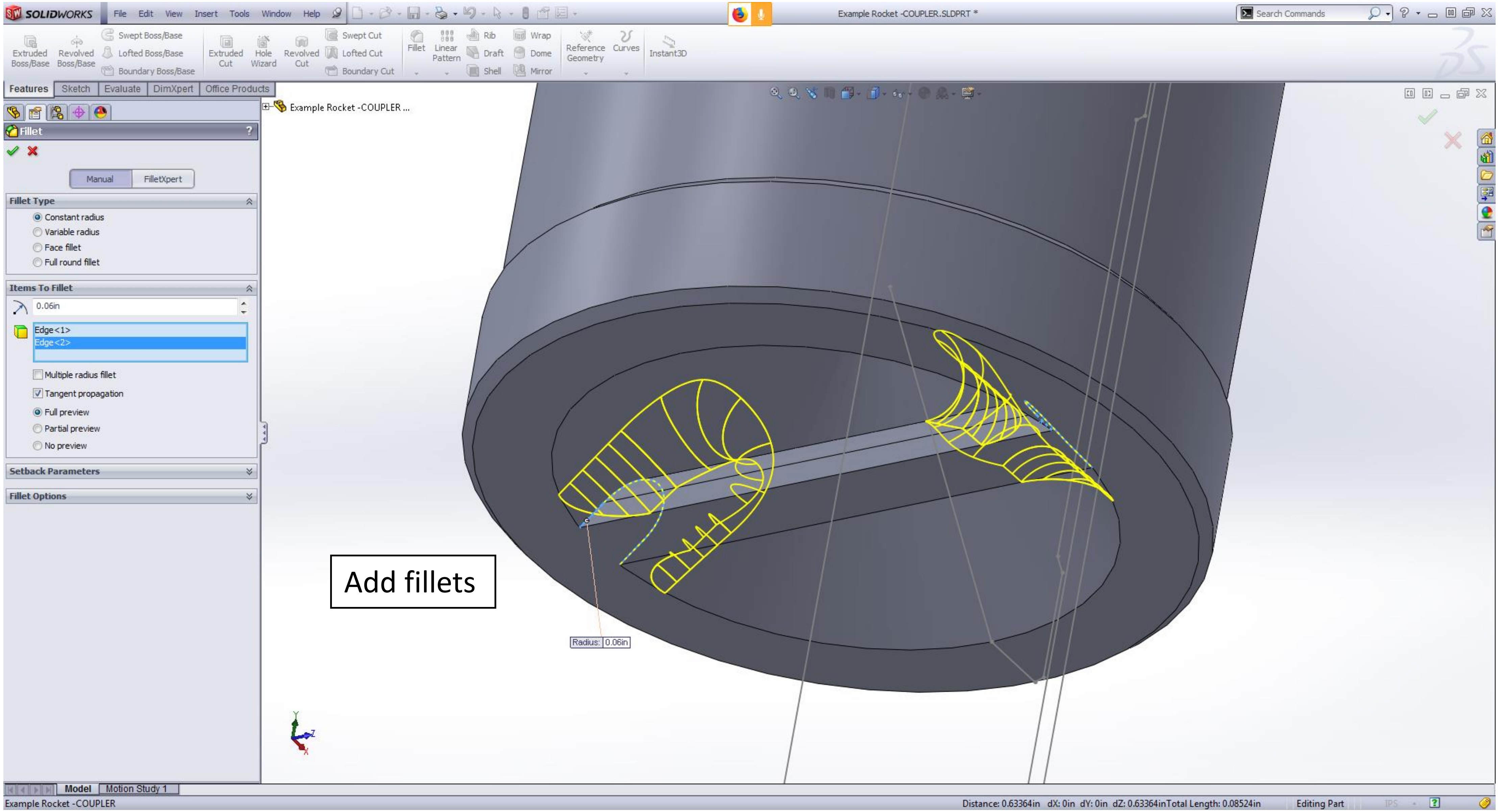
It saves time because you only need to draw one profile instead of two



Time to add the shock cord mount.

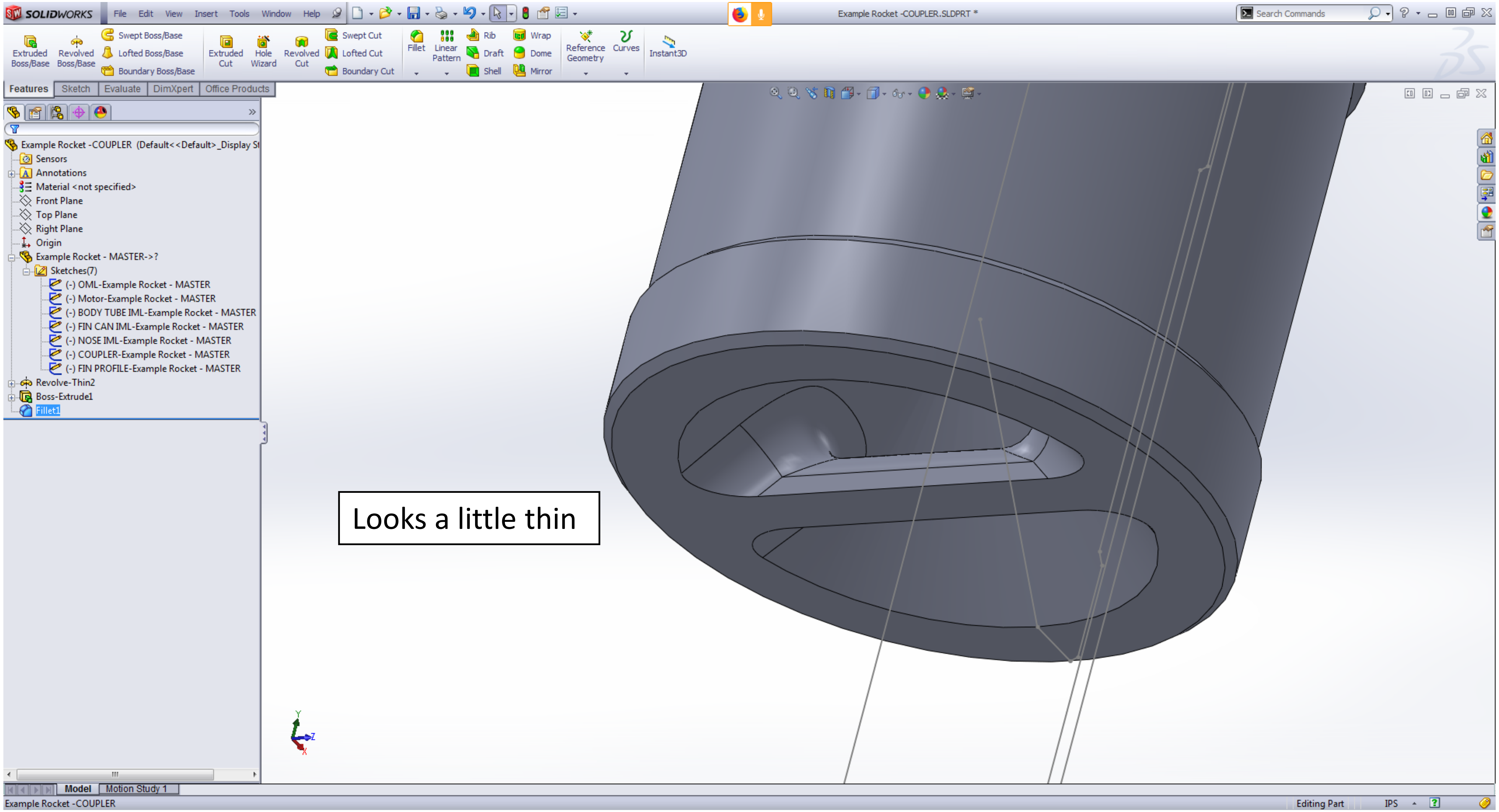

Select "Up To Next"
Boss-Extrude
From
Sketch Plane
Direction 1
Blind
Through All
Up To Next
Up To Vertex
Up To Surface
Offset From Surface
Up To Body
Mid Plane
Draft outward
Direction 2
Thin Feature
Selected Contours
Example Rocket -COUPLER.SLDPRT *
Select a handle to modify parameters
Editing Part

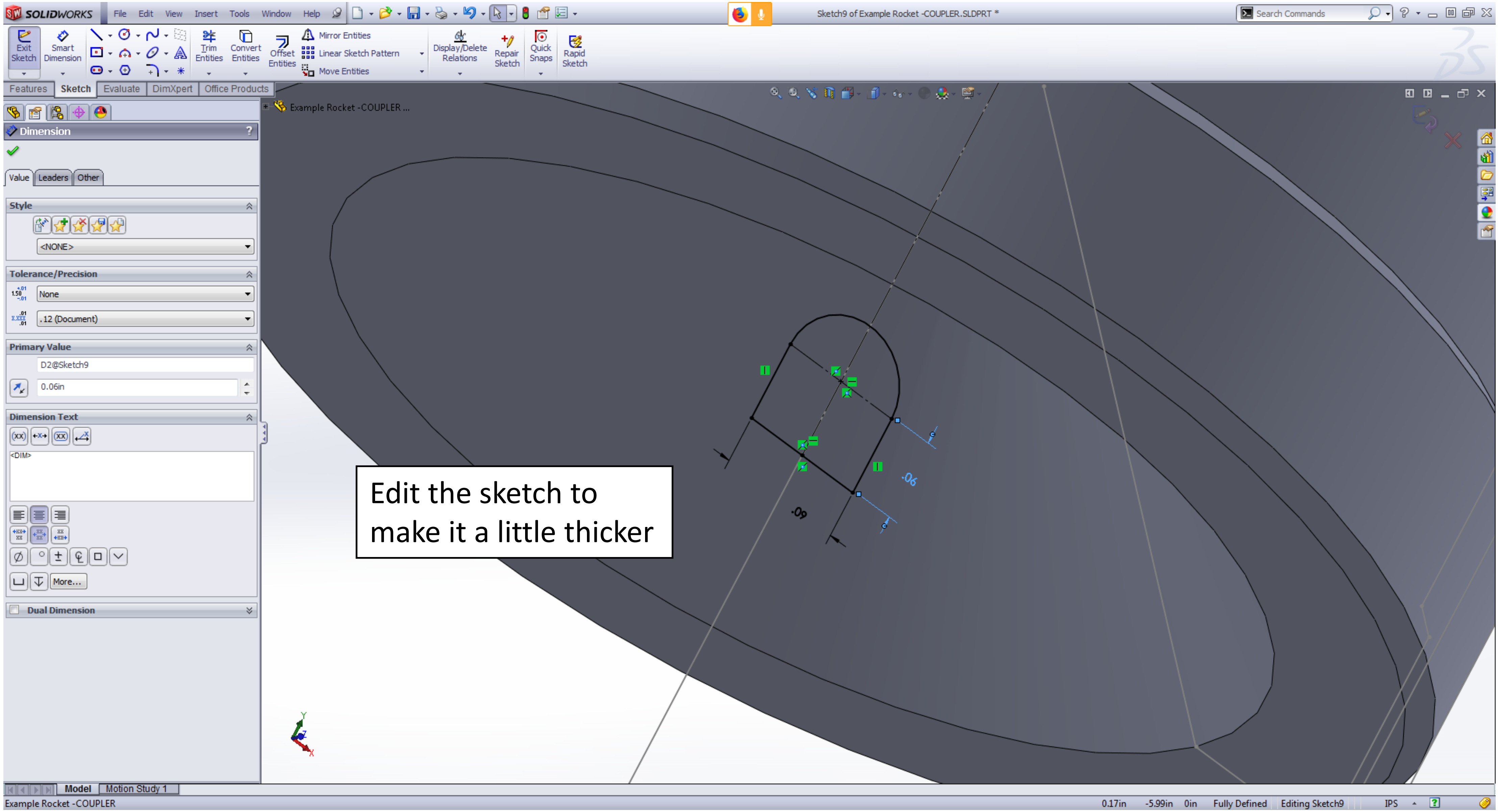

Do it in both directions
SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket -COUPLER.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket -COUPLER ...
Boss-Extrude
OK
Sketch Plane
Direction 1
Up To Next
Merge result
Draft outward
Direction 2
Up To Next
Thin Feature
Selected Contours
Model
Motion Study 1
Select a handle to modify parameters
Editing Part



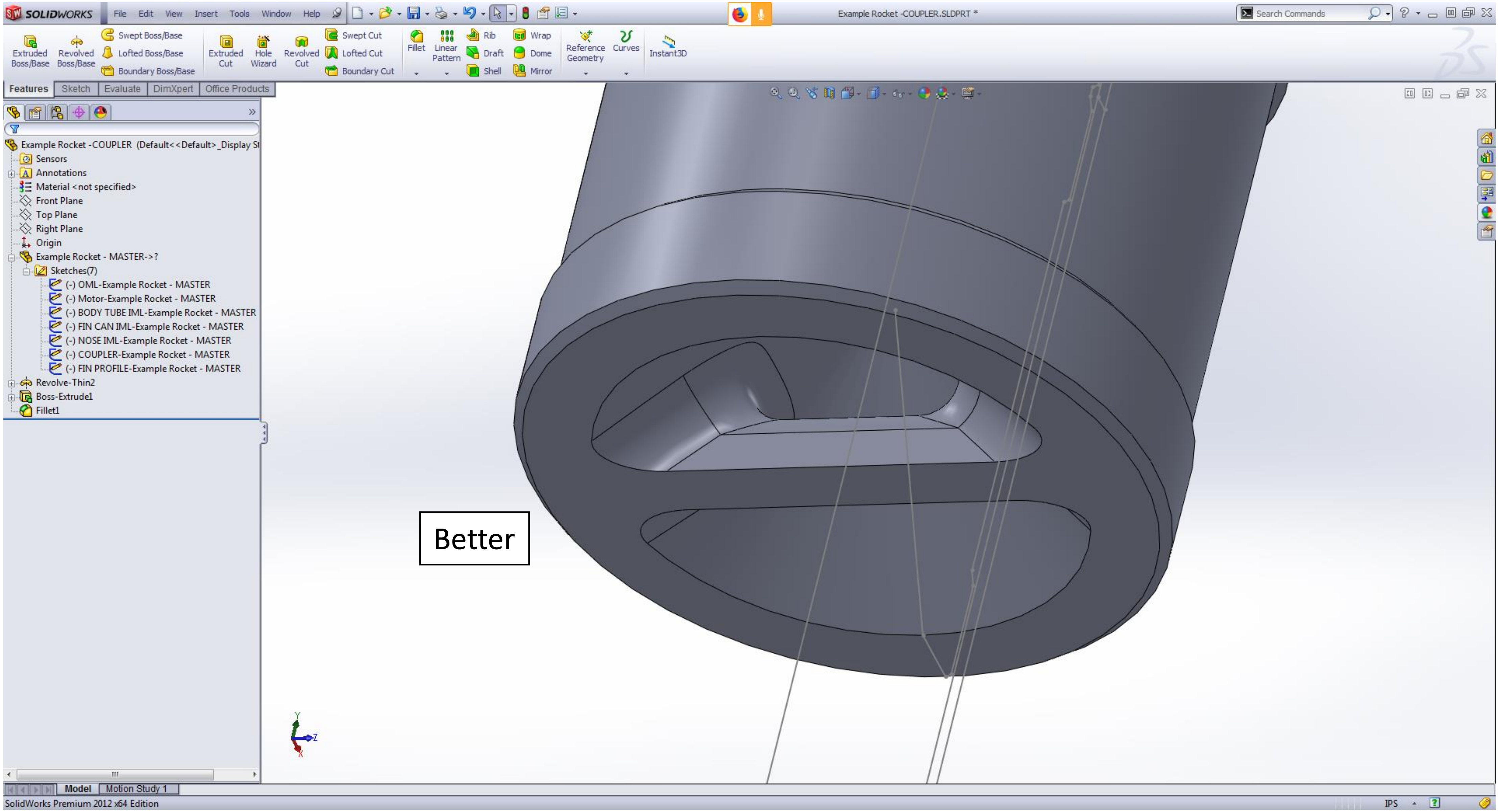
SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket -COUPLER.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features Sketch Evaluate DimXpert Office Products
Example Rocket -COUPLER ...
Fillet
Manual
FilletXpert
Fillet Type
Constant radius
Variable radius
Face fillet
Full round fillet
Items To Fillet
0.06in
Edge<1>
Edge<2>
Multiple radius fillet
Tangent propagation
Full preview
Partial preview
No preview
Setback Parameters
Fillet Options
Radius: 0.06in
Model
Motion Study 1
Example Rocket -COUPLER
Distance: 0.63364in dX: 0in dY: 0in dZ: 0.63364inTotal Length: 0.08524in
Editing Part

Add fillets


SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket -COUPLER.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket -COUPLER (Default<<Default>_Display St
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER->?
Sketches(7)
(-) OML-Example Rocket - MASTER
(-) Motor-Example Rocket - MASTER
(-) BODY TUBE IML-Example Rocket - MASTER
(-) FIN CAN IML-Example Rocket - MASTER
(-) NOSE IML-Example Rocket - MASTER
(-) COUPLER-Example Rocket - MASTER
(-) FIN PROFILE-Example Rocket - MASTER
Revolve-Thin2
Boss-Extrude1
Fillet1
Looks a little thin
Model
Motion Study 1
Example Rocket -COUPLER
Editing Part
IPS

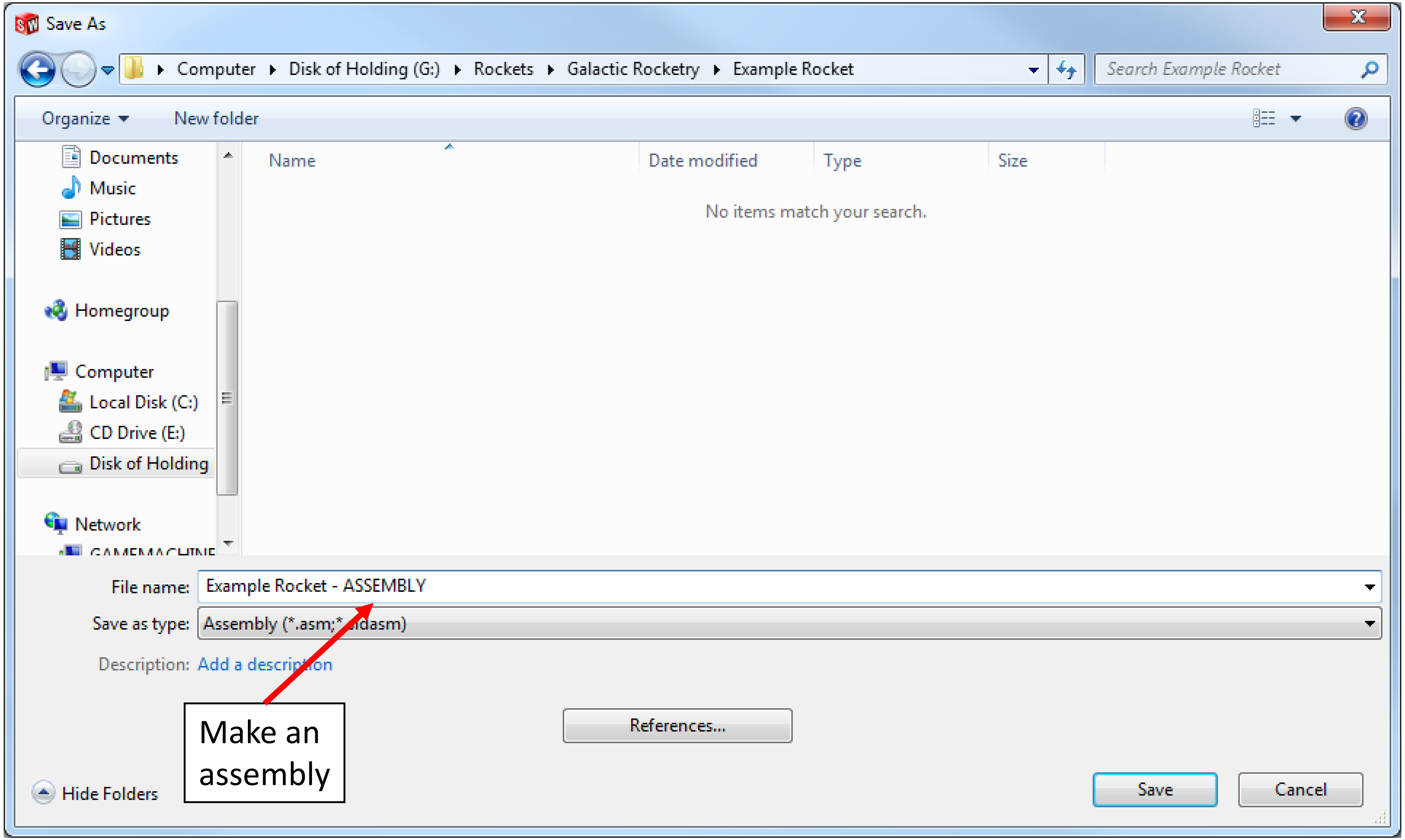


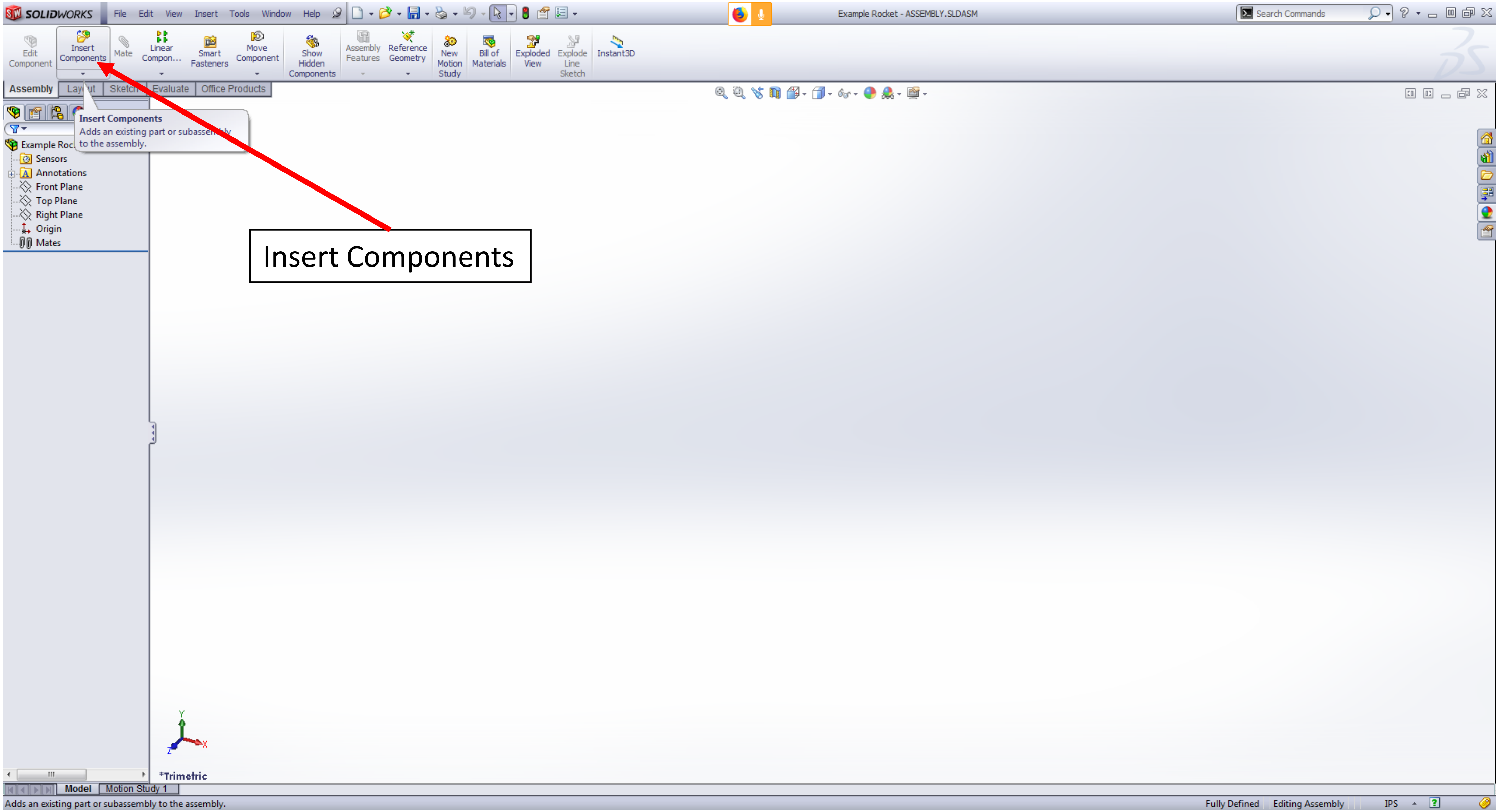
Edit the sketch to make it a little thicker

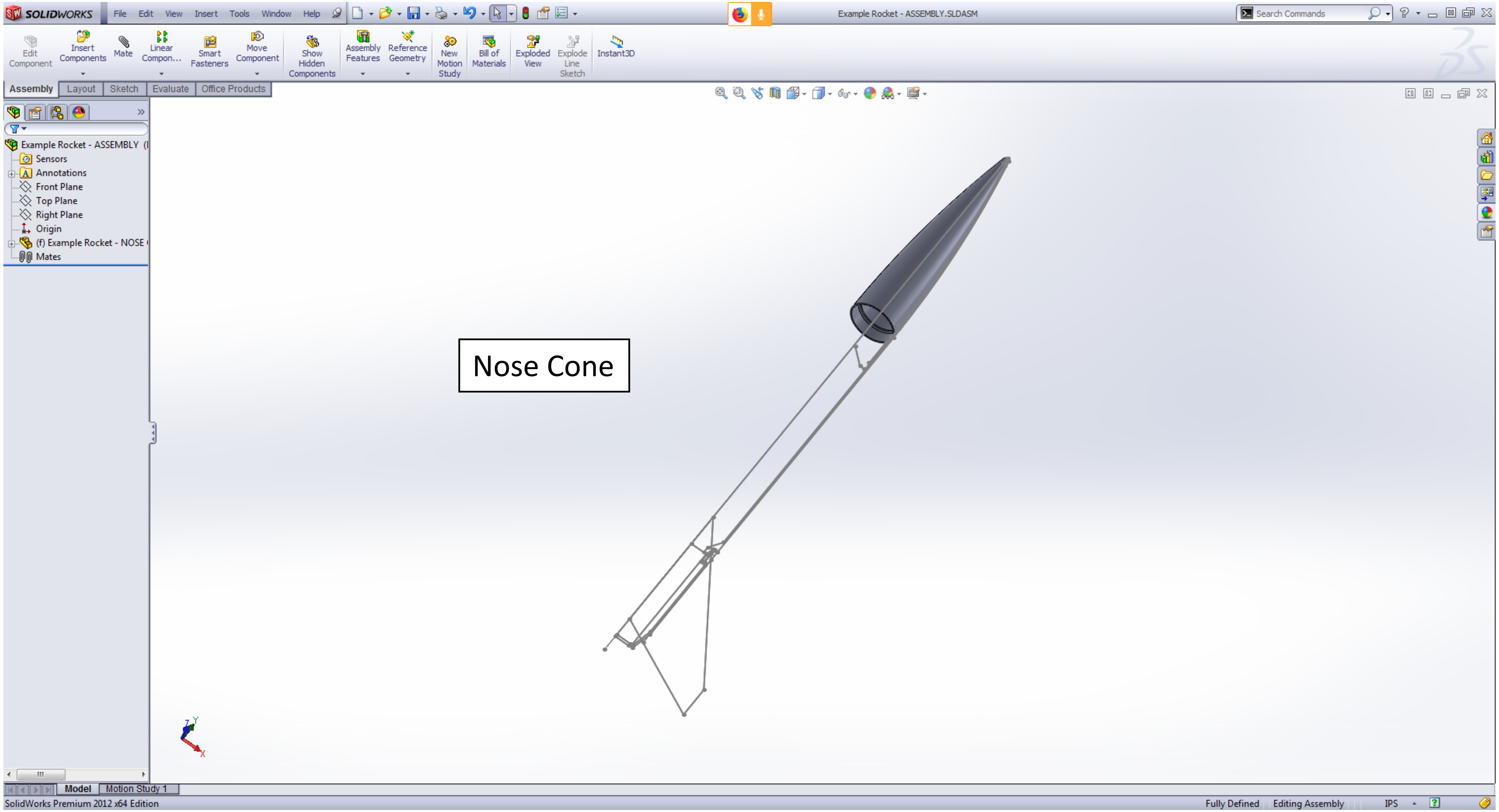


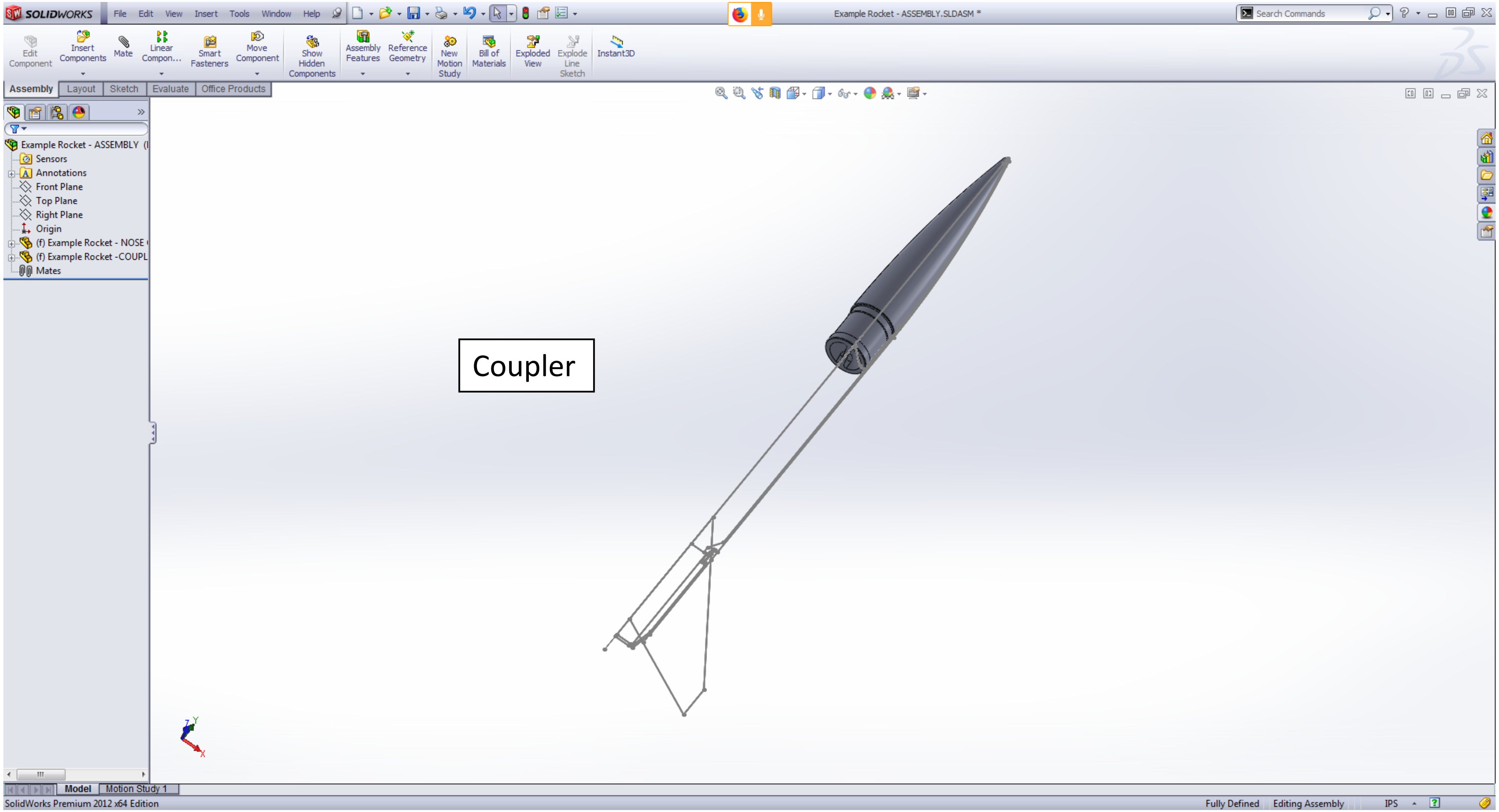
SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket -COUPLER.SLDPRT *
Search Commands
Extruded Boss/Base
Revolved Boss/Base
Swept Boss/Base
Lofted Boss/Base
Boundary Boss/Base
Extruded Cut
Hole Wizard
Revolved Cut
Swept Cut
Lofted Cut
Boundary Cut
Fillet
Linear Pattern
Rib
Draft
Shell
Wrap
Dome
Mirror
Reference Geometry
Curves
Instant3D
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket -COUPLER (Default<<Default>_Display St
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER->?
Sketches(7)
(-) OML-Example Rocket - MASTER
(-) Motor-Example Rocket - MASTER
(-) BODY TUBE IML-Example Rocket - MASTER
(-) FIN CAN IML-Example Rocket - MASTER
(-) NOSE IML-Example Rocket - MASTER
(-) COUPLER-Example Rocket - MASTER
(-) FIN PROFILE-Example Rocket - MASTER
Revolve-Thin2
Boss-Extrude1
Fillet1
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
IPS

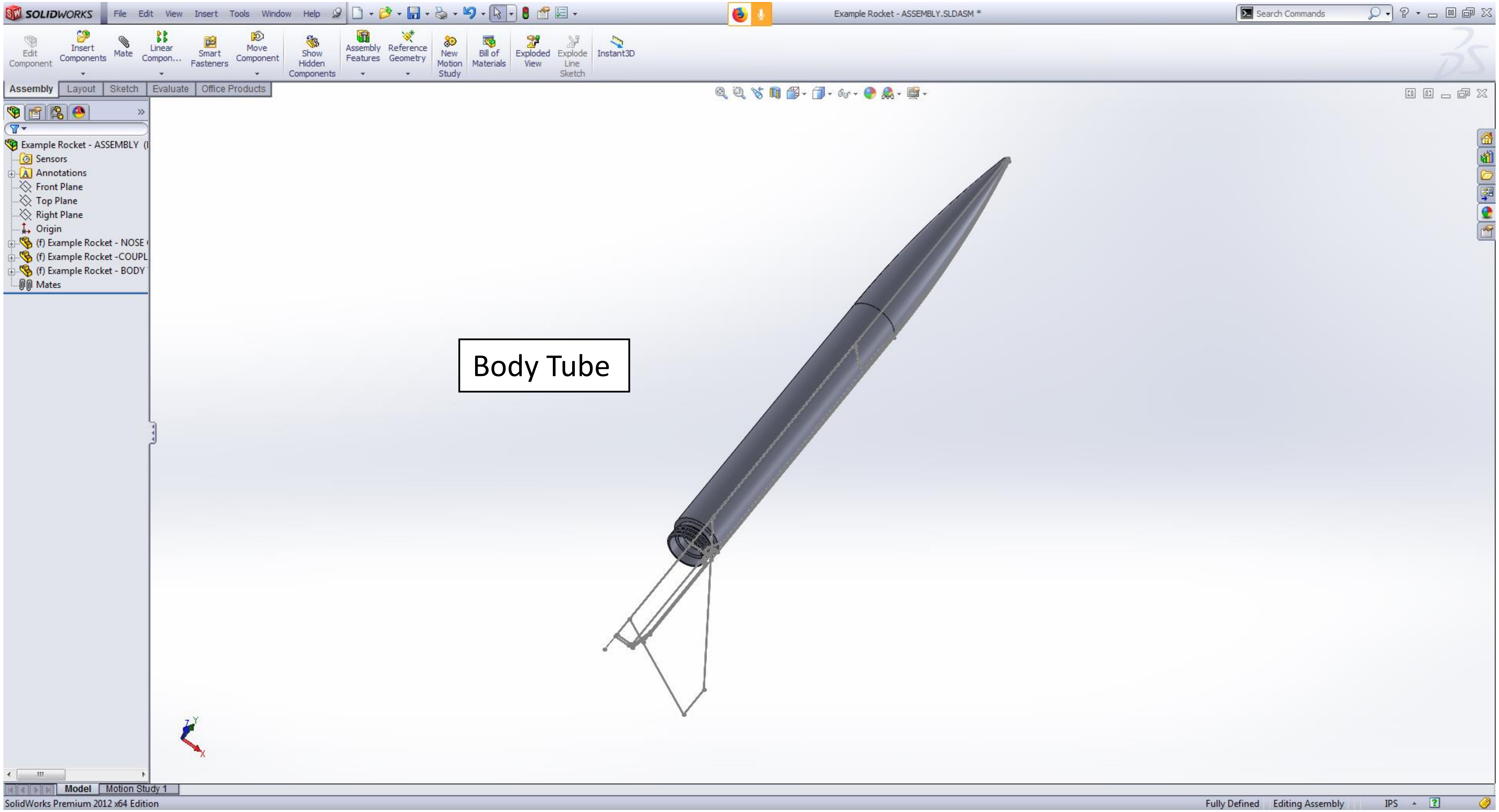
Better

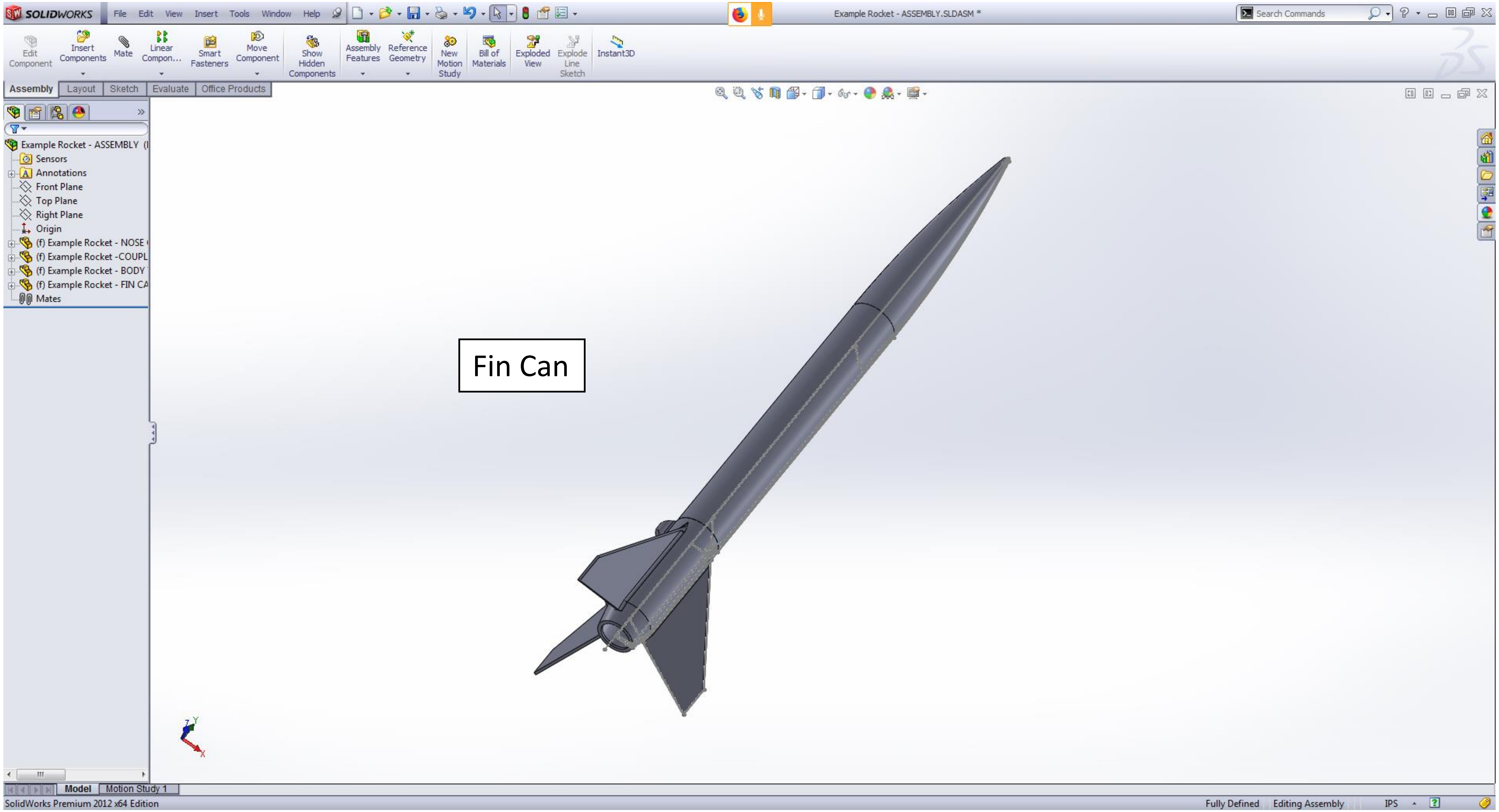

Save As
Computer
Disk of Holding (G:)
Rockets
Galactic Rocketry
Example Rocket
Search Example Rocket
Organize
New folder
Documents
Music
Pictures
Videos
Homegroup
Computer
Local Disk (C:)
CD Drive (E:)
Disk of Holding
Network
Name
Date modified
Type
Size
No items match your search.
File name:
Example Rocket - ASSEMBLY
Save as type:
Description:
Add a description
References...
Hide Folders
Save
Cancel
Make an assembly

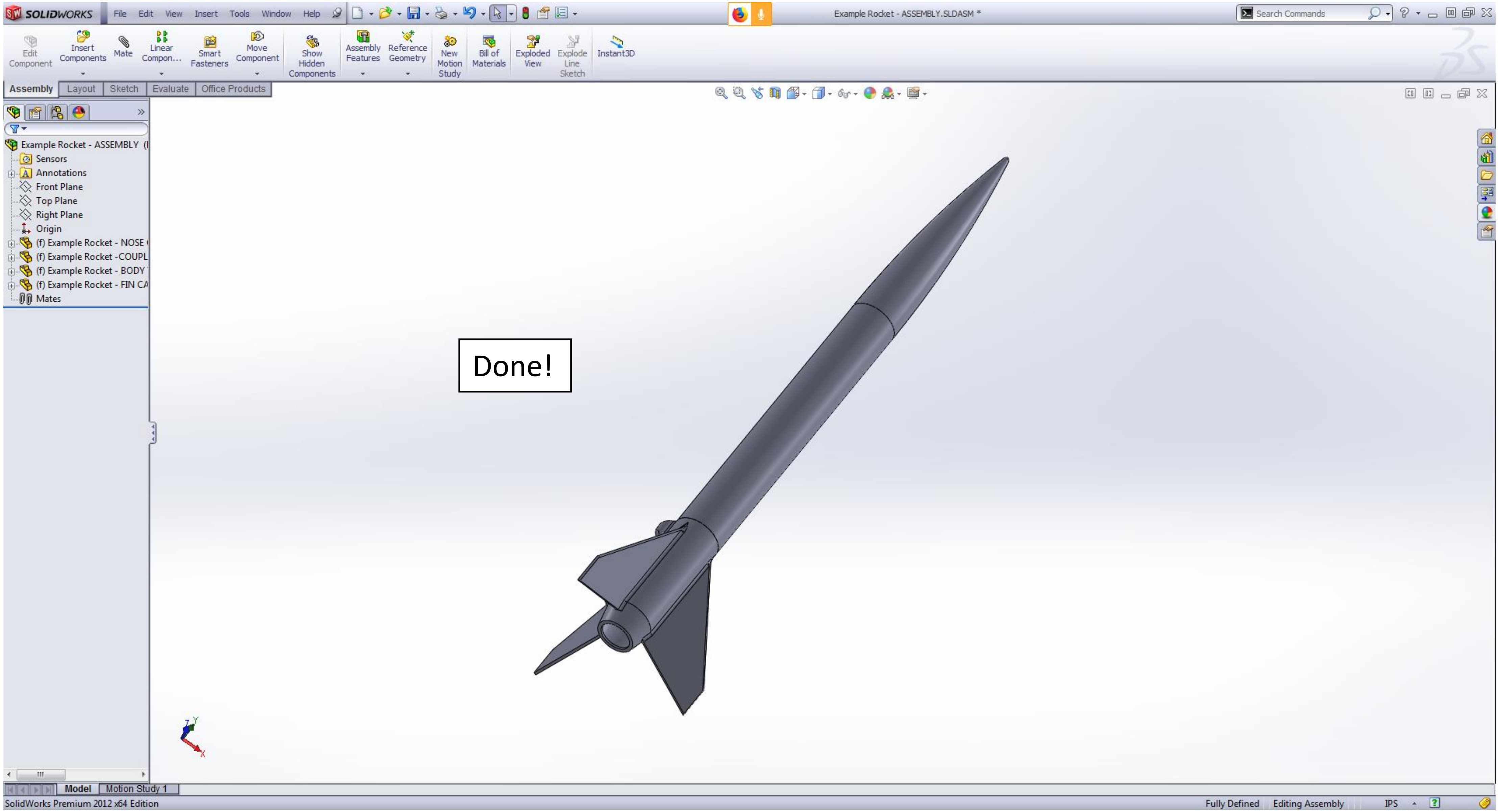

Insert Components
Insert Components
Adds an existing part or subassembly to the assembly.
Example Rocket - ASSEMBLY.SLDASM


SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - ASSEMBLY.SLDASM
Search Commands
Edit Component
Insert Components
Mate
Linear Compon...
Smart Fasteners
Move Component
Show Hidden Components
Assembly Features
Reference Geometry
New Motion Study
Bill of Materials
Exploded View
Explode Line Sketch
Instant3D
Assembly
Layout
Sketch
Evaluate
Office Products
Example Rocket - ASSEMBLY
Sensors
Annotations
Front Plane
Top Plane
Right Plane
Origin
(f) Example Rocket - NOSE
Mates
Nose Cone
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Fully Defined
Editing Assembly
IPS

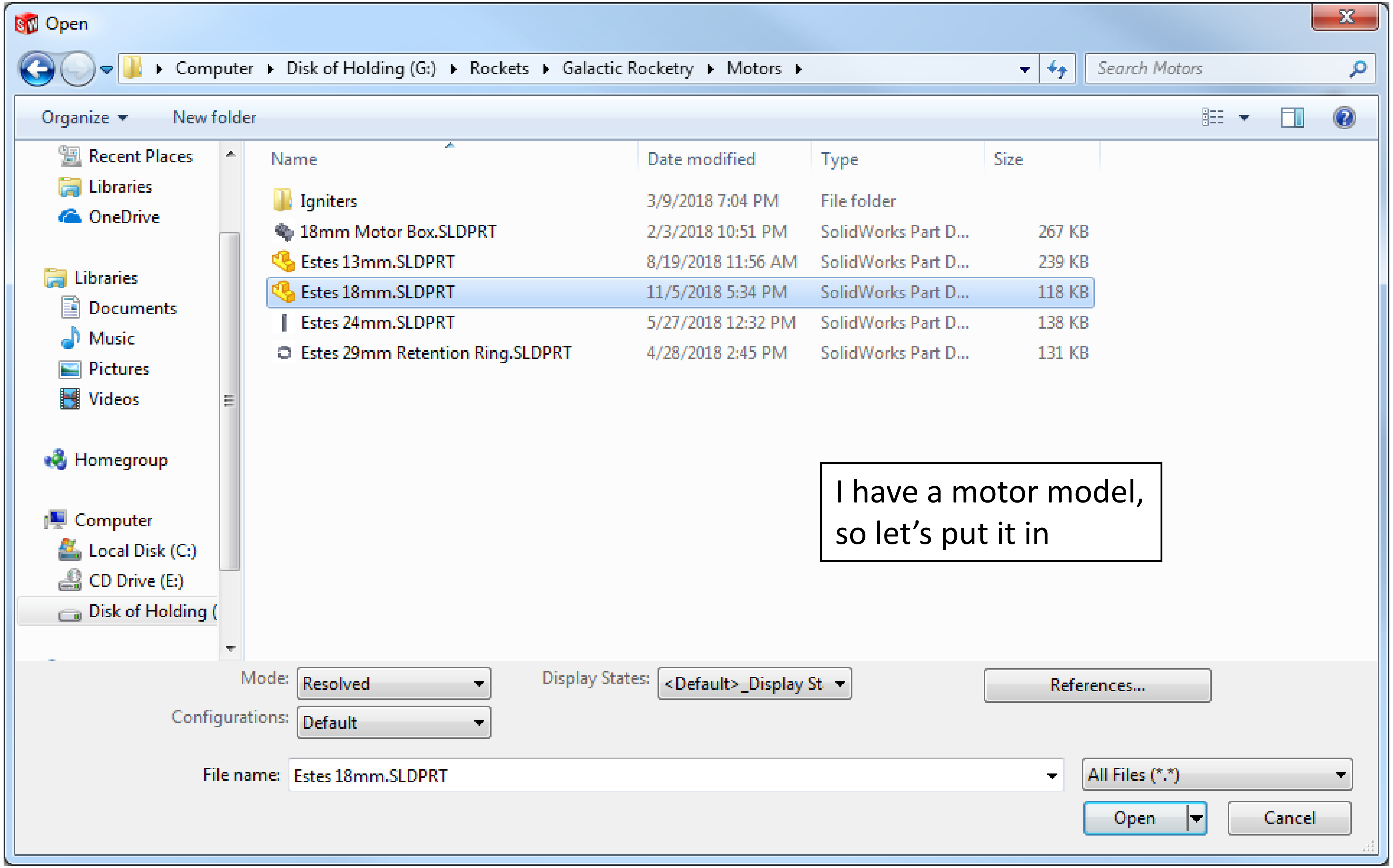

SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - ASSEMBLY.SLDASM *
Search Commands
Edit Component
Insert Components
Mate
Linear Compon...
Smart Fasteners
Move Component
Show Hidden Components
Assembly Features
Reference Geometry
New Motion Study
Bill of Materials
Exploded View
Explode Line Sketch
Instant3D
Assembly
Layout
Sketch
Evaluate
Office Products
Example Rocket - ASSEMBLY (
Sensors
Annotations
Front Plane
Top Plane
Right Plane
Origin
(f) Example Rocket - NOSE
(f) Example Rocket -COUPL
Mates
Coupler
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Fully Defined
Editing Assembly
IPS


SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - ASSEMBLY.SLDASM *
Search Commands
Edit Component
Insert Components
Mate
Linear Compon...
Smart Fasteners
Move Component
Show Hidden Components
Assembly Features
Reference Geometry
New Motion Study
Bill of Materials
Exploded View
Explode Line Sketch
Instant3D
Assembly Layout Sketch Evaluate Office Products
Example Rocket - ASSEMBLY
Sensors
Annotations
Front Plane
Top Plane
Right Plane
Origin
(f) Example Rocket - NOSE
(f) Example Rocket -COUPL
(f) Example Rocket - BODY
Mates
Body Tube
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Fully Defined
Editing Assembly
IPS

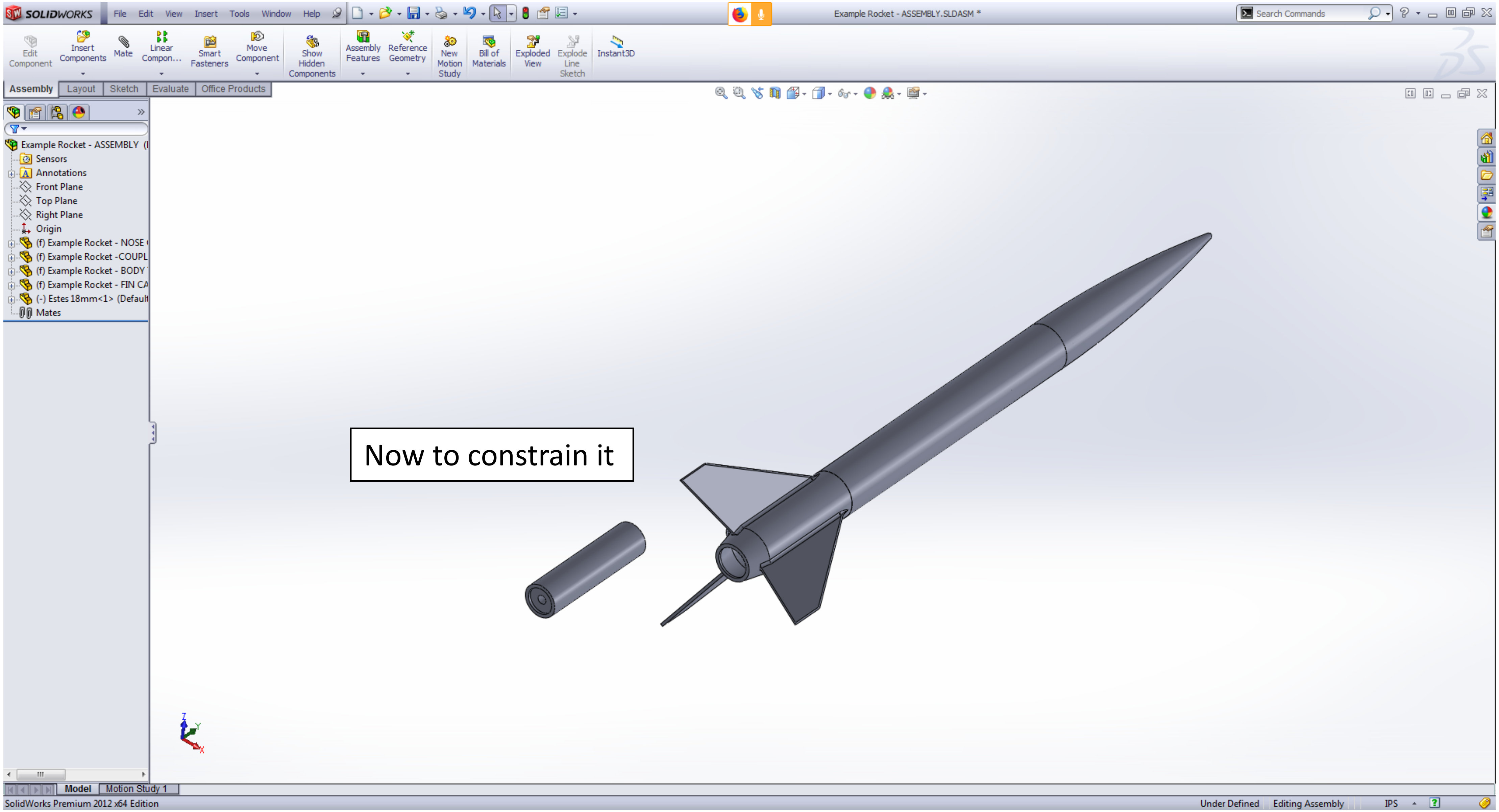

SOLIDWORKS
Example Rocket - ASSEMBLY.SLDASM *
Assembly
Layout
Sketch
Evaluate
Office Products
Example Rocket - ASSEMBLY
Sensors
Annotations
Front Plane
Top Plane
Right Plane
Origin
(f) Example Rocket - NOSE
(f) Example Rocket -COUPL
(f) Example Rocket - BODY
(f) Example Rocket - FIN CA
Mates
Fin Can
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Fully Defined
Editing Assembly
IPS


Example Rocket - ASSEMBLY.SLDASM *
Assembly
Layout
Sketch
Evaluate
Office Products
Example Rocket - ASSEMBLY
Sensors
Annotations
Front Plane
Top Plane
Right Plane
Origin
(f) Example Rocket - NOSE
(f) Example Rocket -COUPL
(f) Example Rocket - BODY
(f) Example Rocket - FIN CA
Mates
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Fully Defined
Editing Assembly
IPS

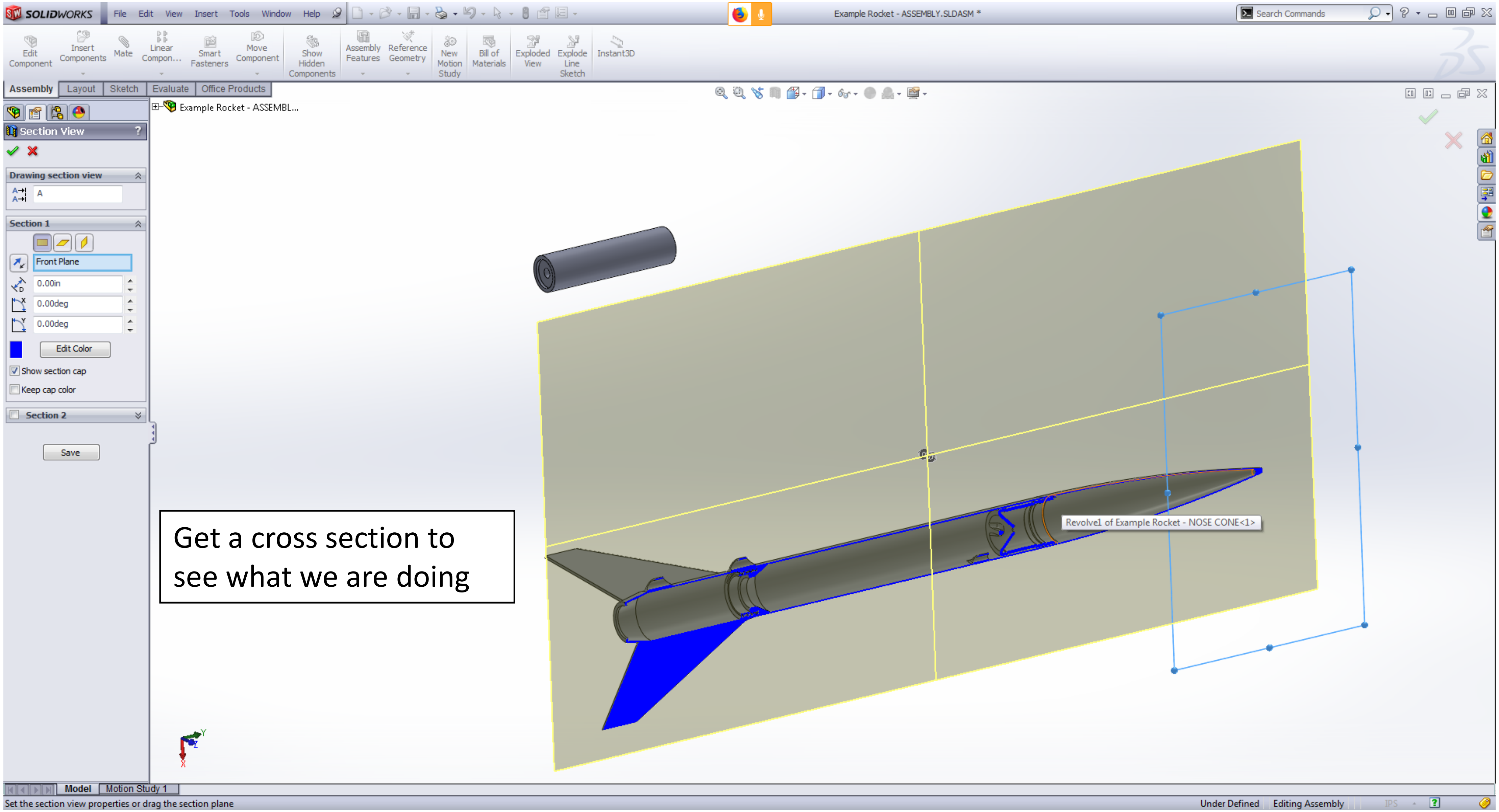
Done!



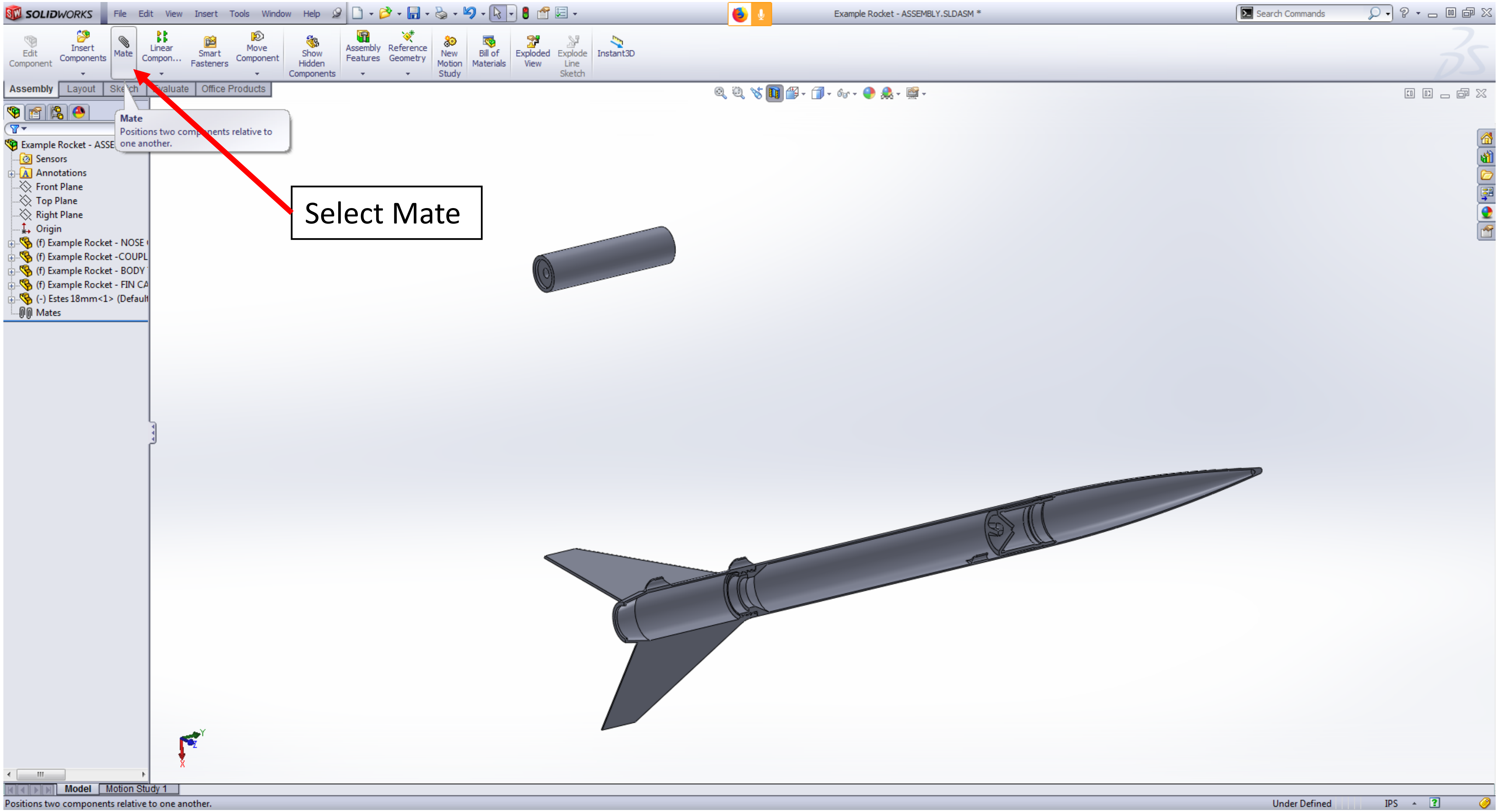
I have a motor model, so let’s put it in

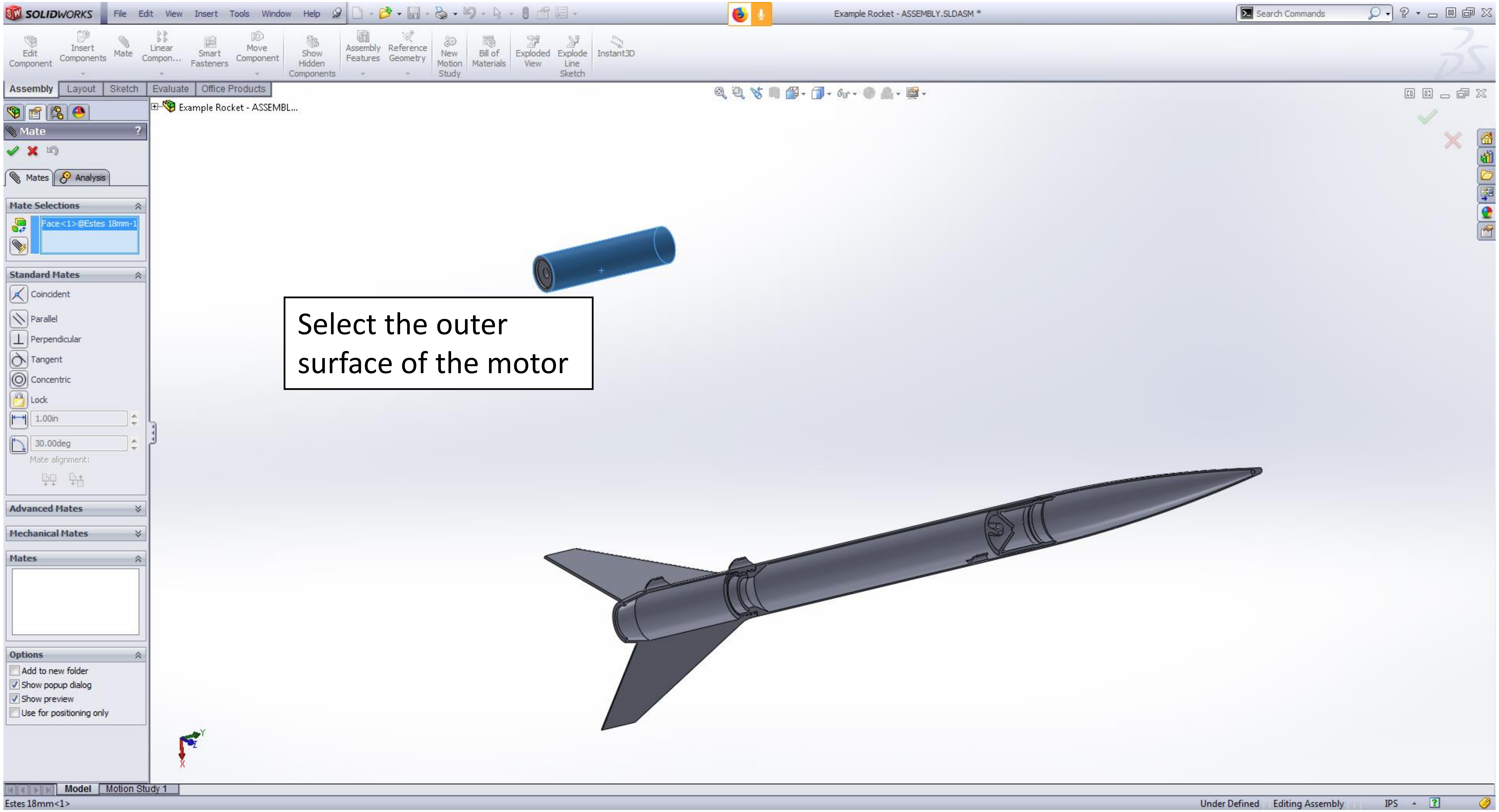


Now to constrain it

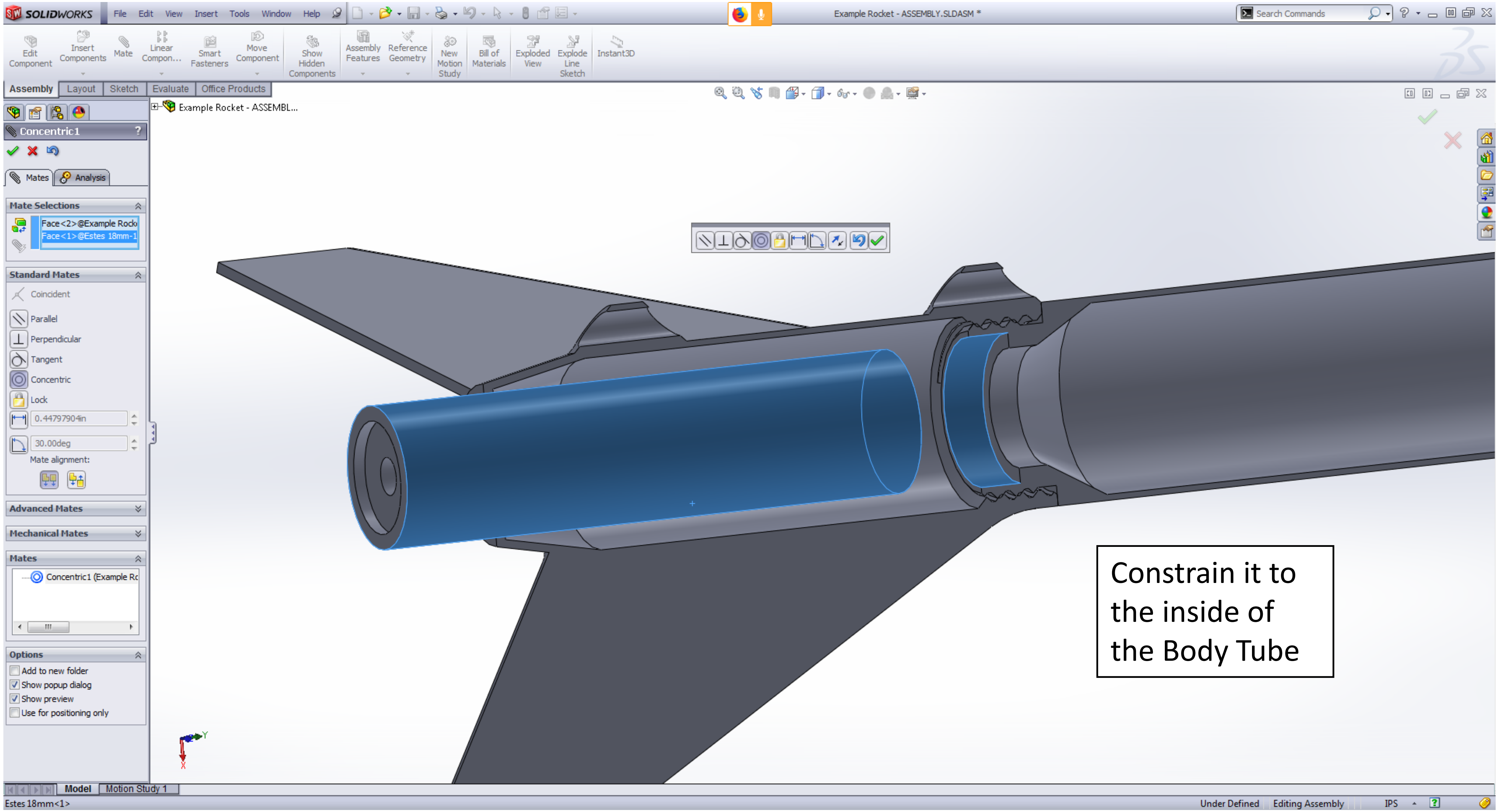


Get a cross section to see what we are doing

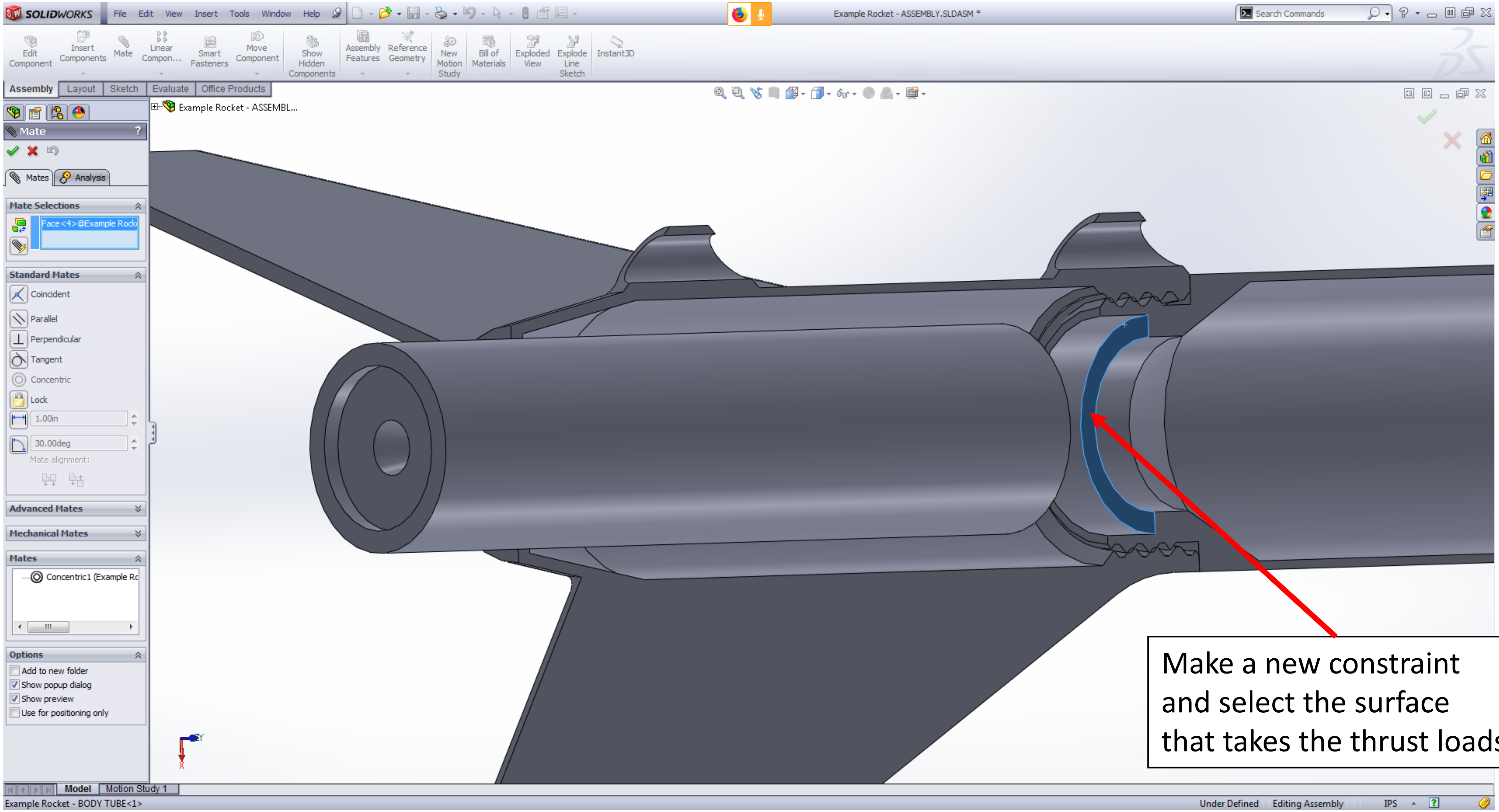

Select Mate
Mate
Positions two components relative to one another.
Example Rocket - ASSEMBLY.SLDASM *
Edit Component
Insert Components
Mate
Linear Compon...
Smart Fasteners
Move Component
Show Hidden Components
Assembly Features
Reference Geometry
New Motion Study
Bill of Materials
Exploded View
Explode Line Sketch
Instant3D
Assembly
Layout
Office Products
Sensors
Annotations
Front Plane
Top Plane
Right Plane
Origin
Mates
Model
Motion Study 1
Positions two components relative to one another.
Under Defined
IPS



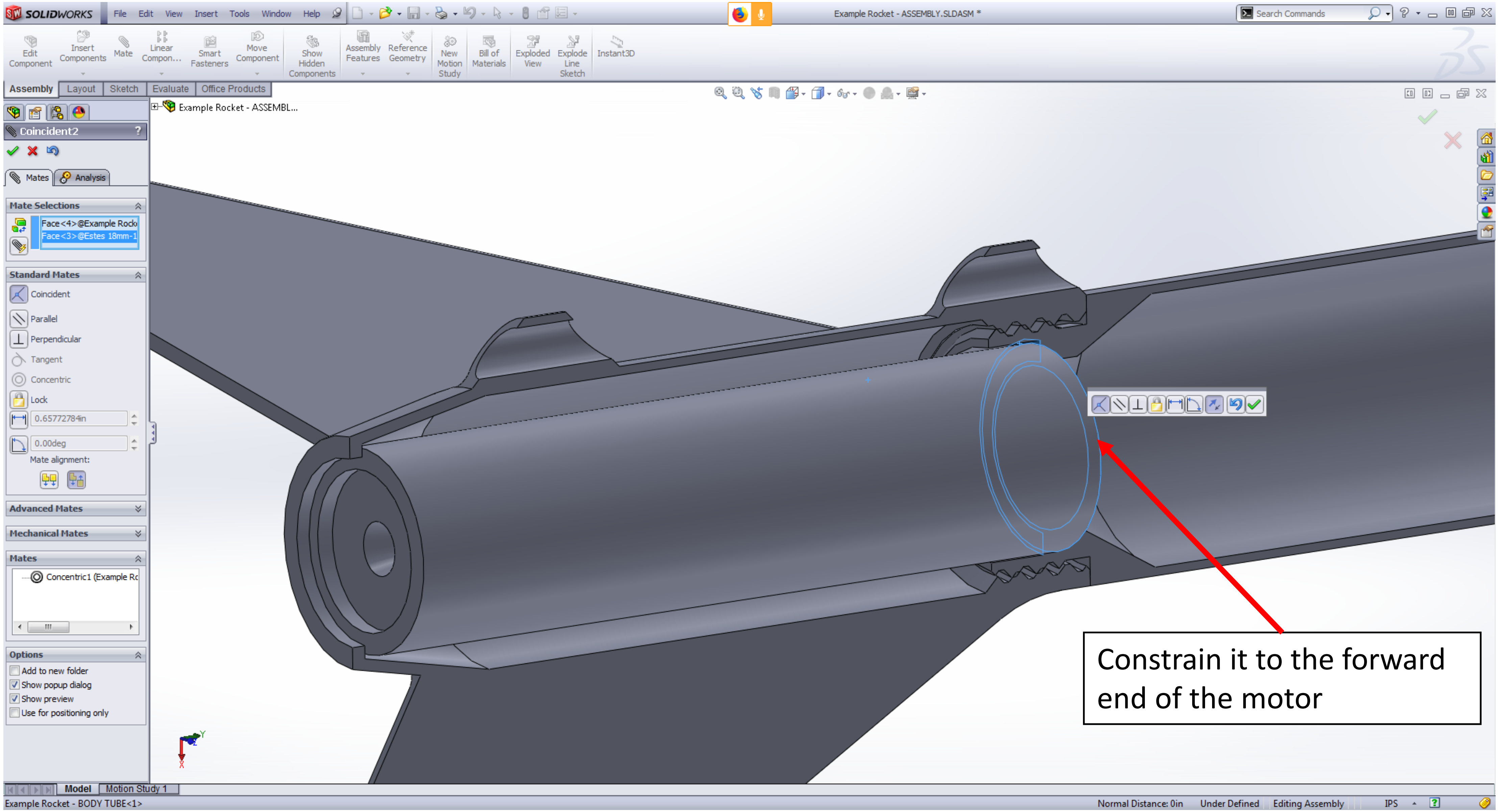
Select the outer surface of the motor



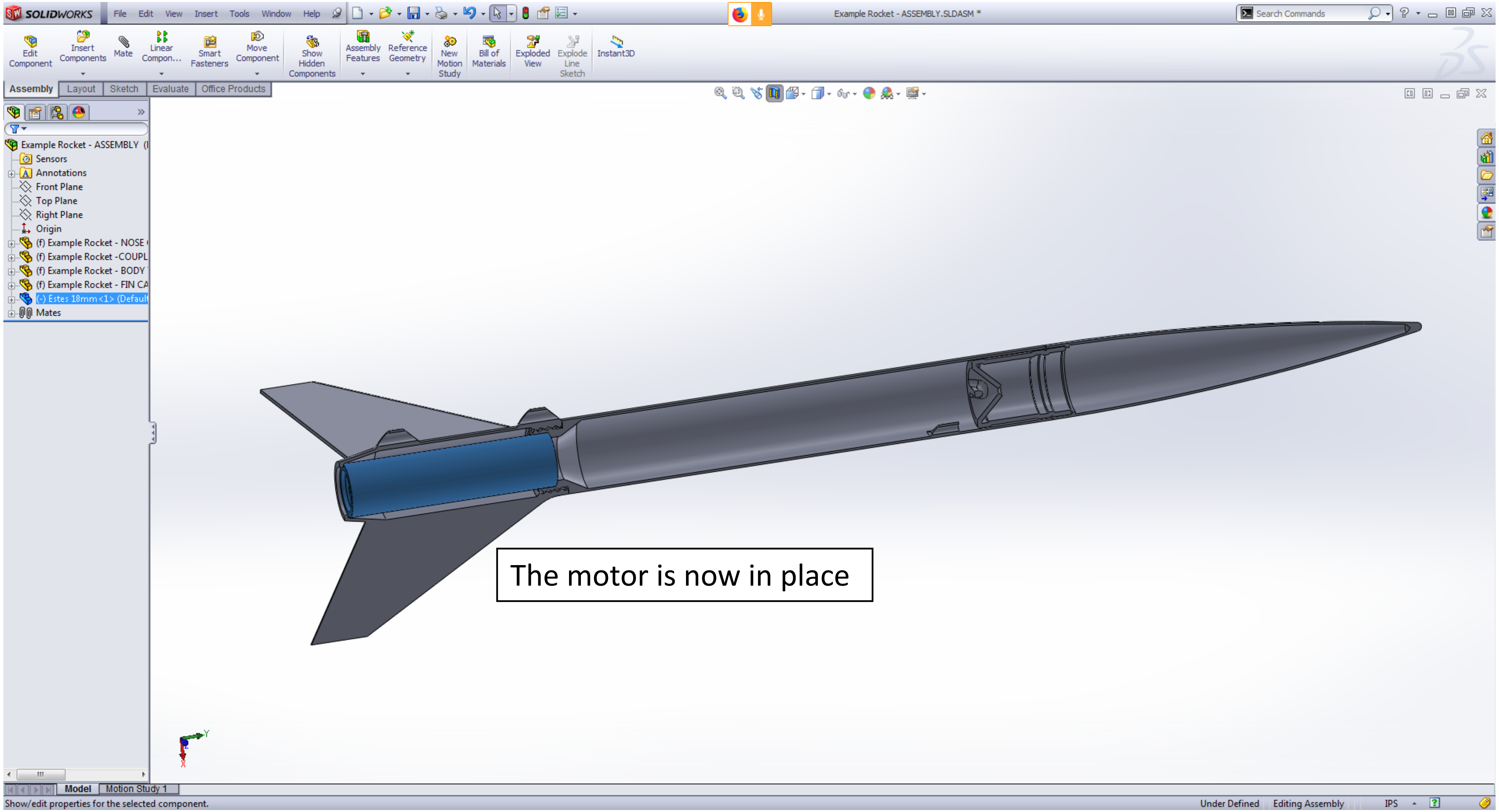
Constrain it to the inside of the Body Tube



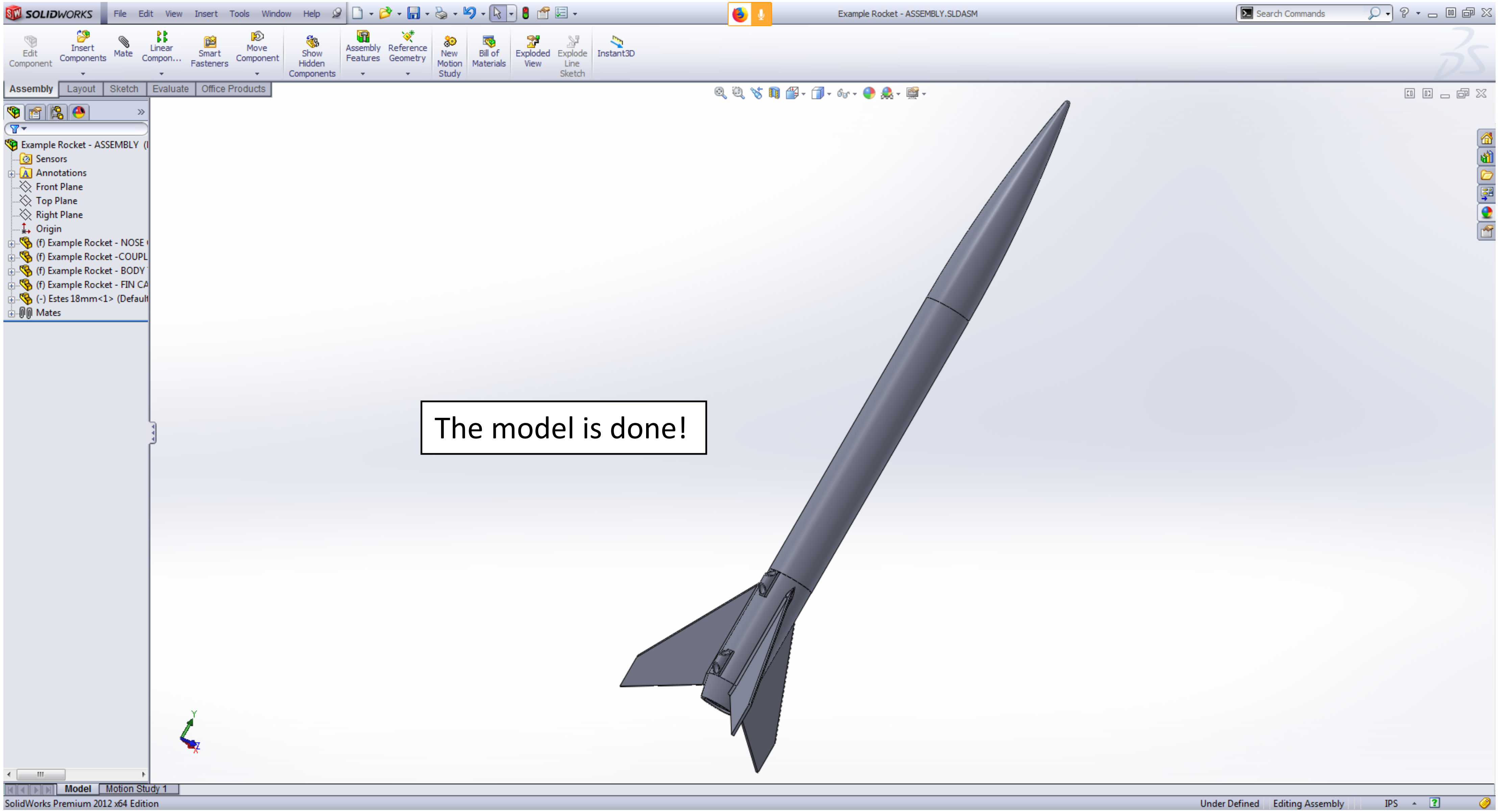
Make a new constraint and select the surface that takes the thrust loads

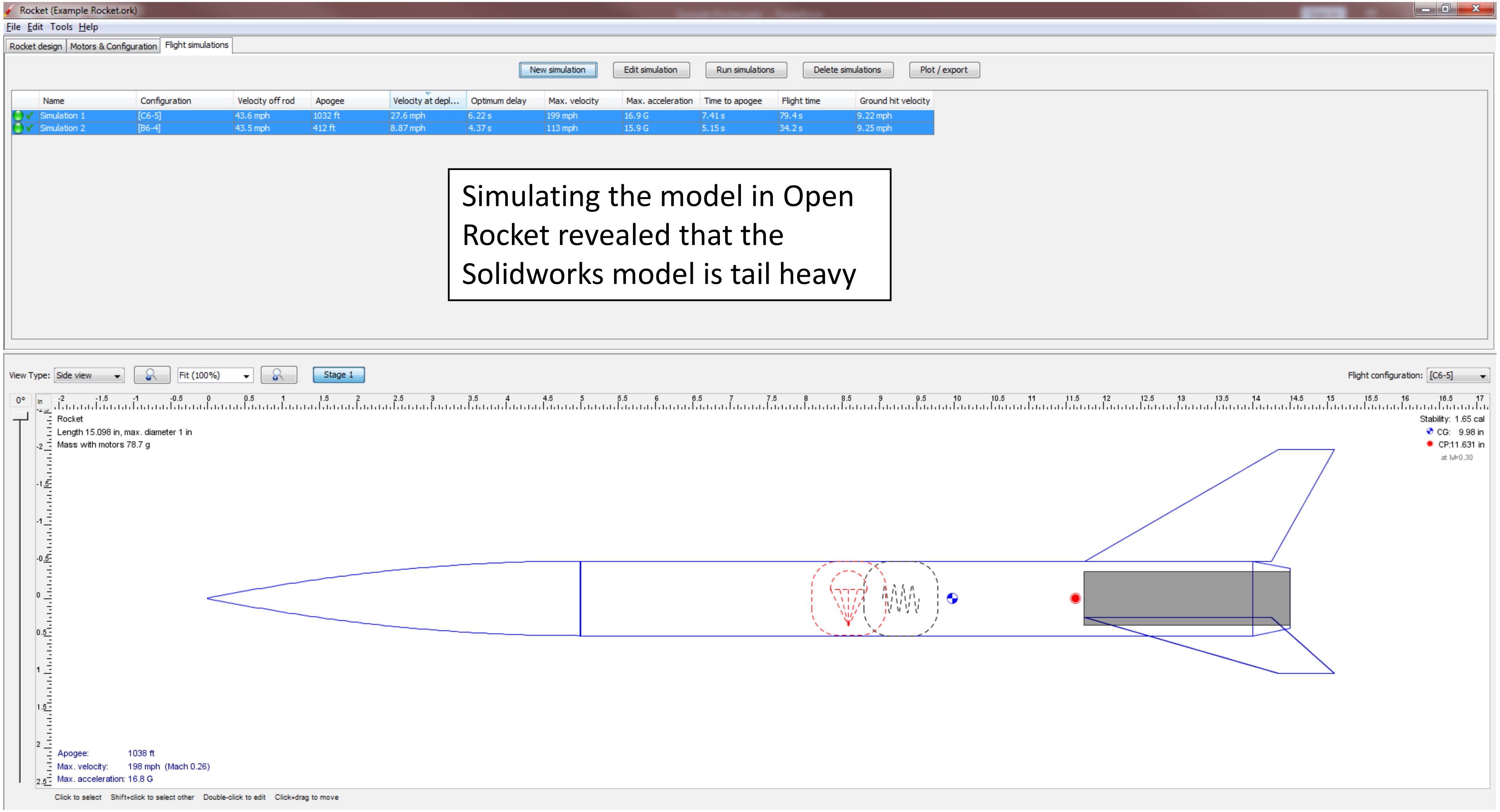


Constrain it to the forward end of the motor

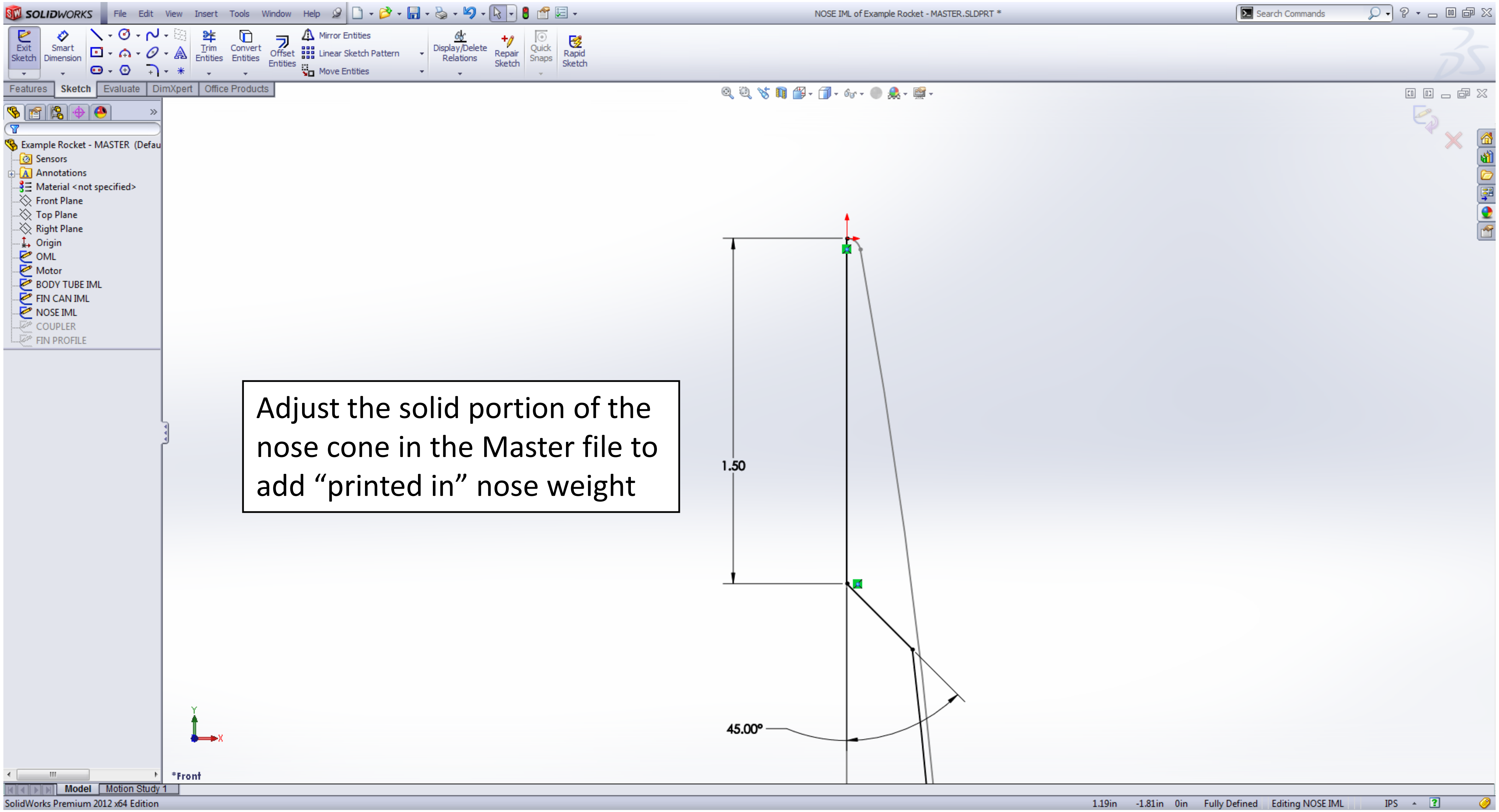


The motor is now in place

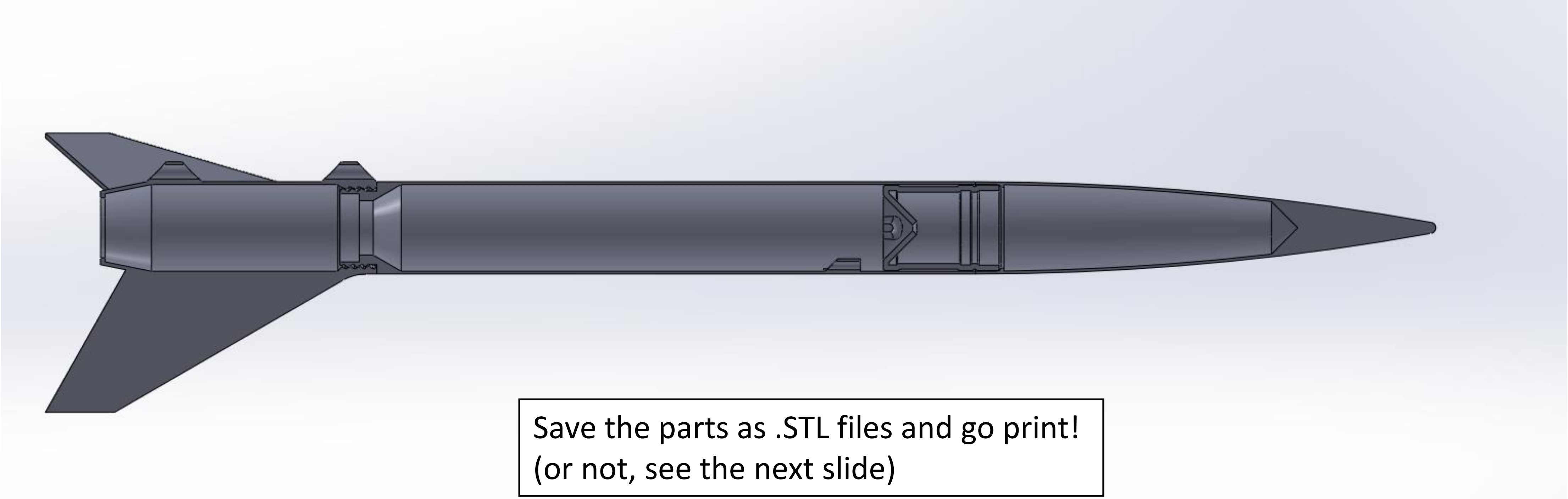

SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - ASSEMBLY.SLDASM
Search Commands
Edit Component
Insert Components
Mate
Linear Compon...
Smart Fasteners
Move Component
Show Hidden Components
Assembly Features
Reference Geometry
New Motion Study
Bill of Materials
Exploded View
Explode Line Sketch
Instant3D
Assembly
Layout
Sketch
Evaluate
Office Products
Example Rocket - ASSEMBLY
Sensors
Annotations
Front Plane
Top Plane
Right Plane
Origin
(f) Example Rocket - NOSE
(f) Example Rocket -COUPL
(f) Example Rocket - BODY
(f) Example Rocket - FIN CA
(-) Estes 18mm<1> (Default
Mates
The model is done!
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Under Defined
Editing Assembly
IPS



Simulating the model in Open Rocket revealed that the Solidworks model is tail heavy



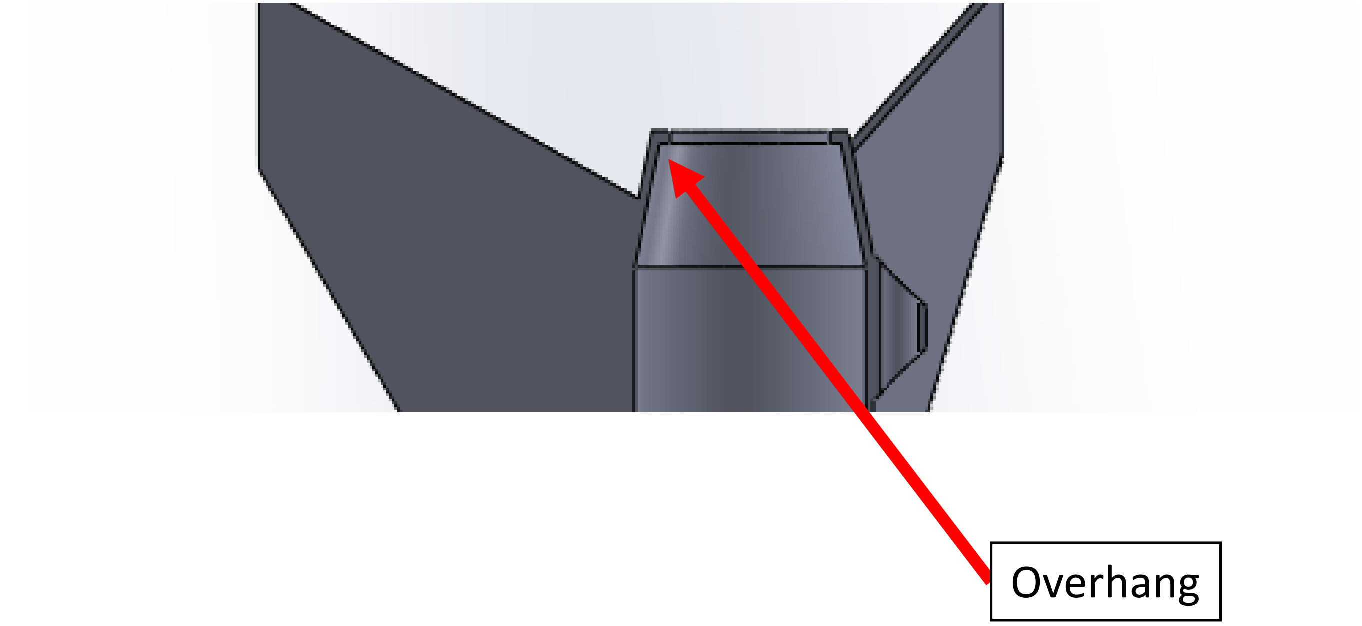
Adjust the solid portion of the nose cone in the Master file to add “printed in” nose weight

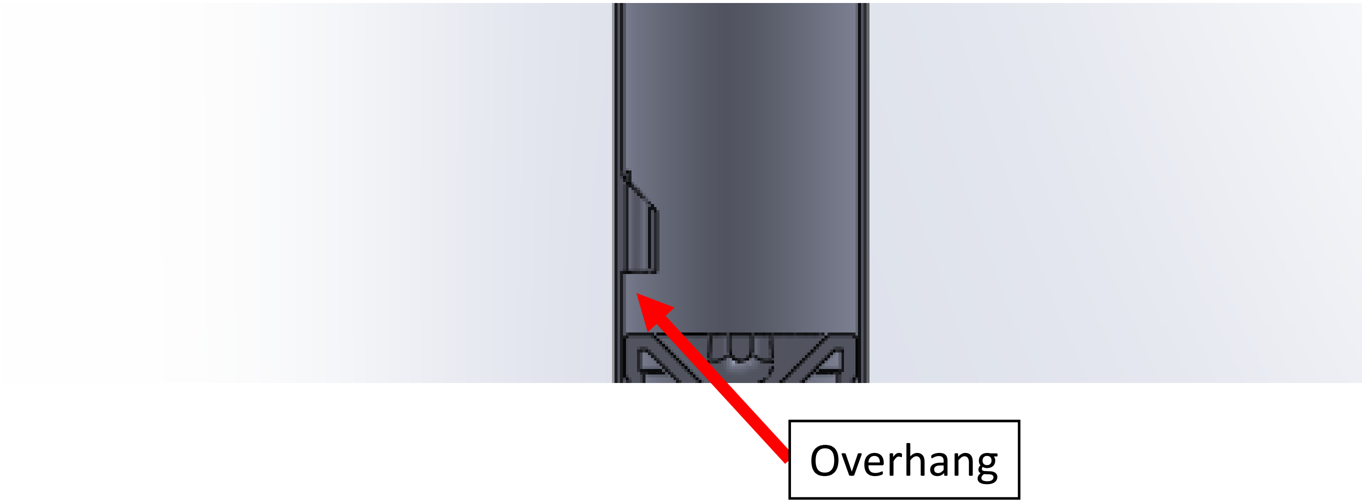


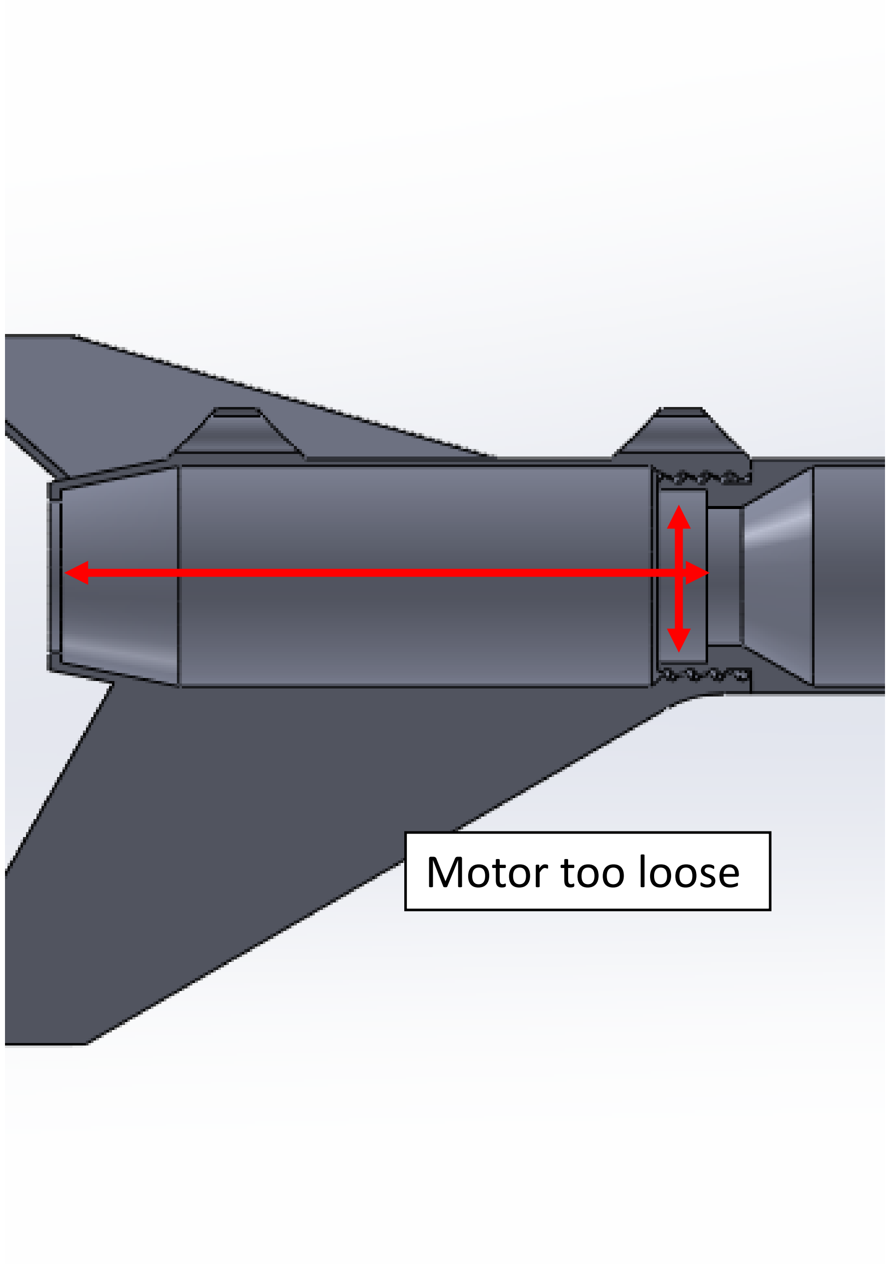
Save the parts as .STL files and go print!
(or not, see the next slide)

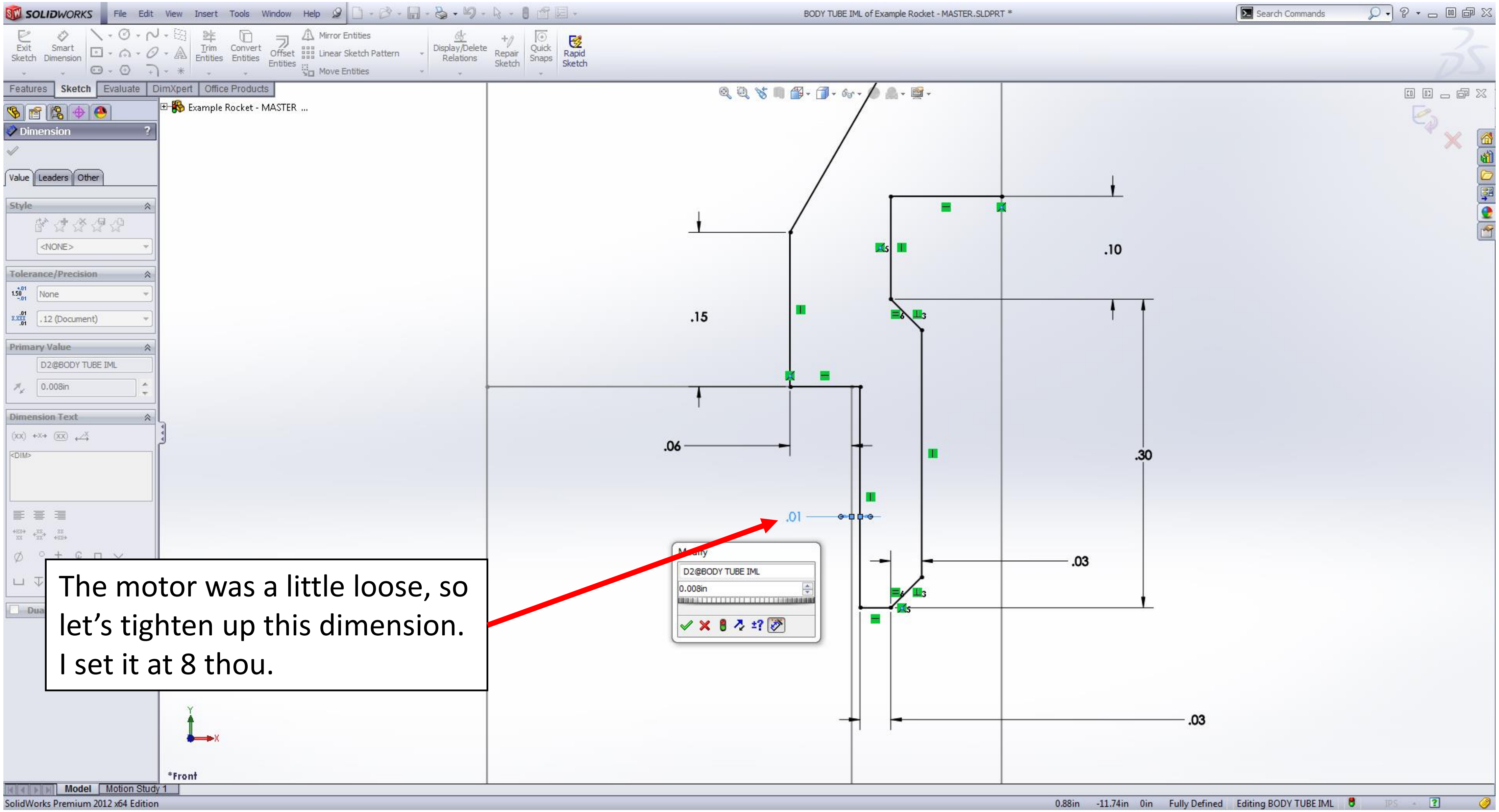
Problems

- Overhangs
  - Aft motor retention (found before printing)
  - Shock cord mount (found after printing)
- Tolerances (found after printing)
  - Fin can threads loose
  - Motor loose axially
  - Motor loose radially

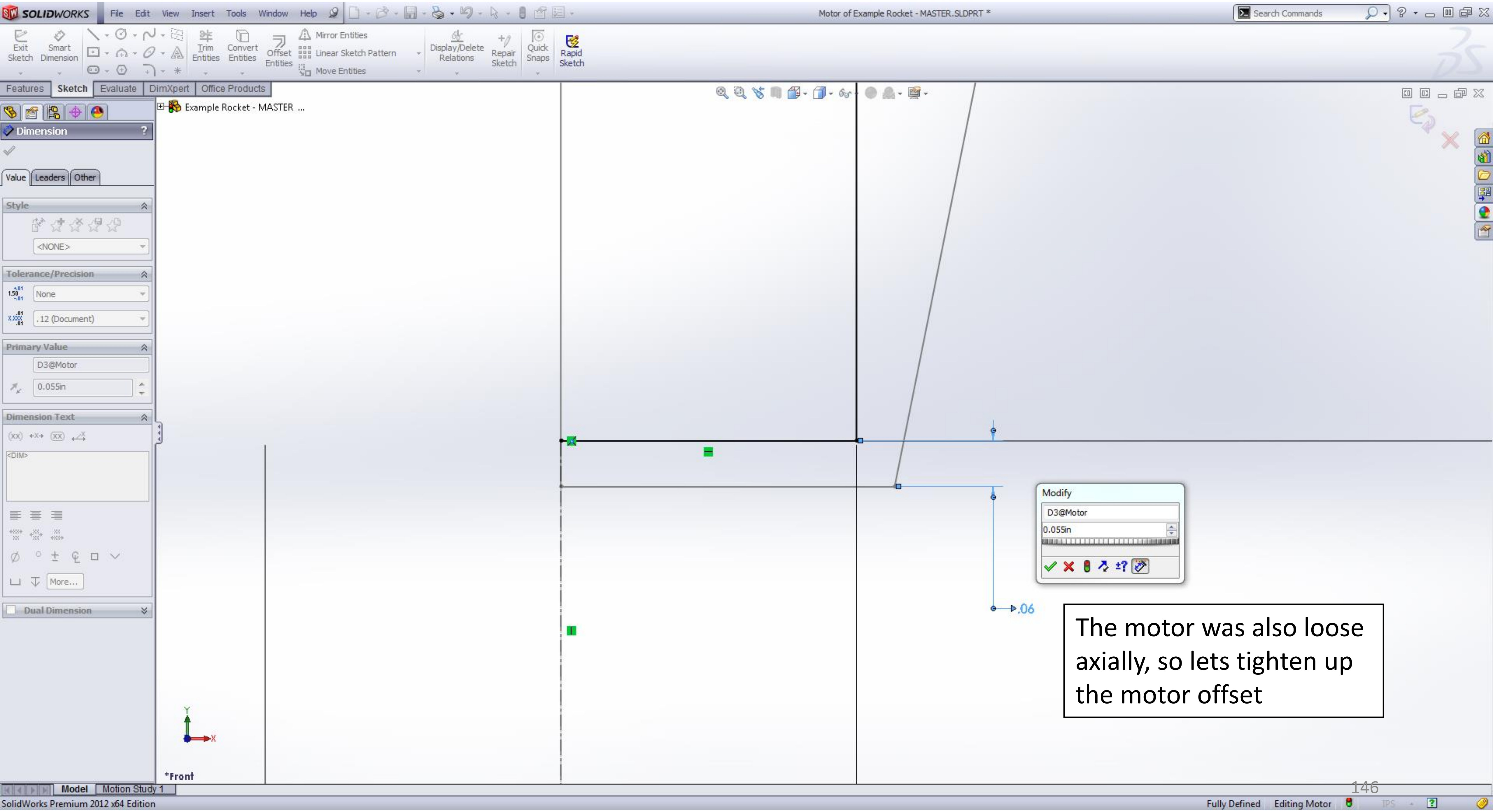

Overhang


Overhang

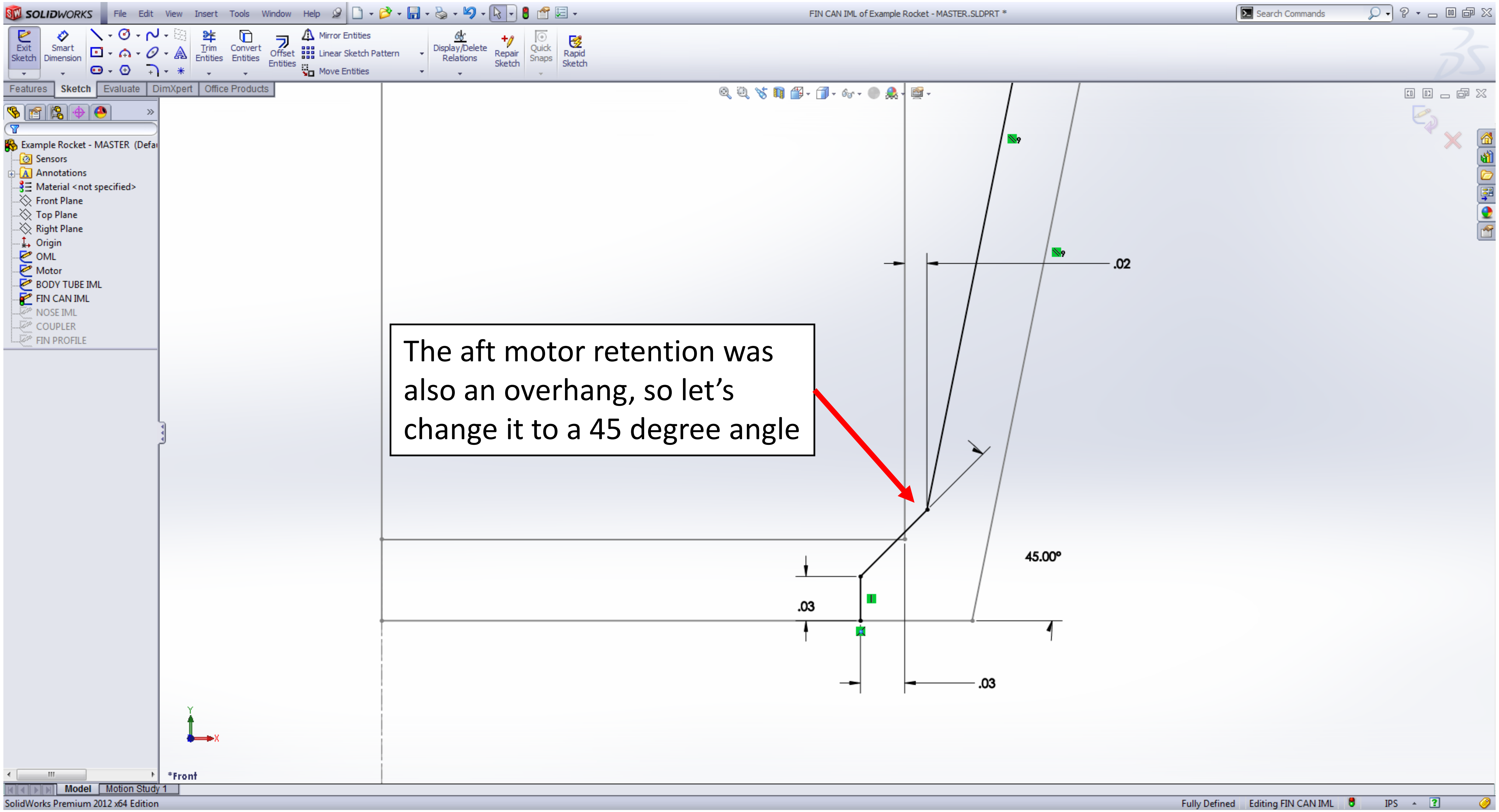

Motor too loose



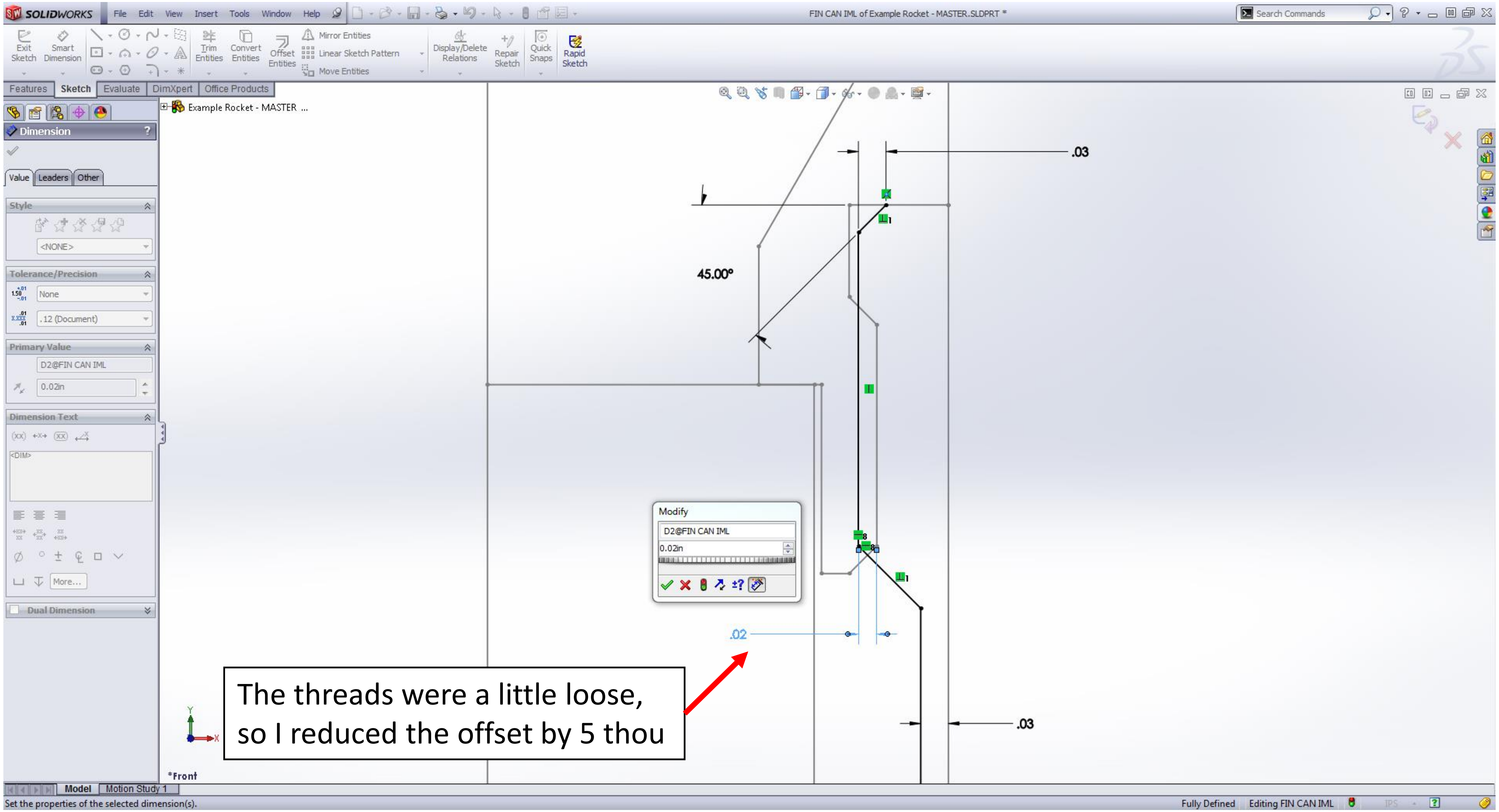
The motor was a little loose, so let’s tighten up this dimension. I set it at 8 thou.



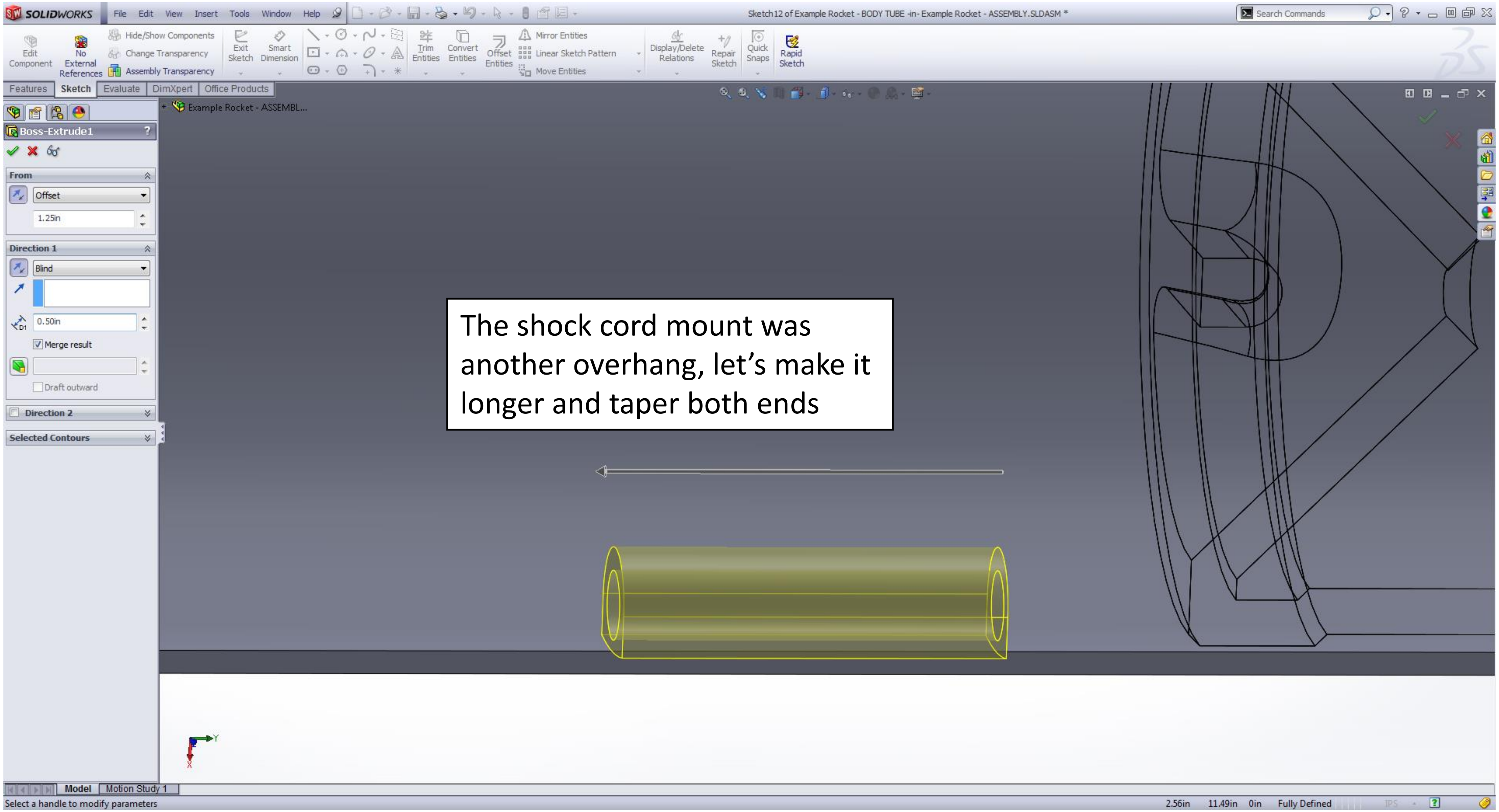
The motor was also loose axially, so lets tighten up the motor offset



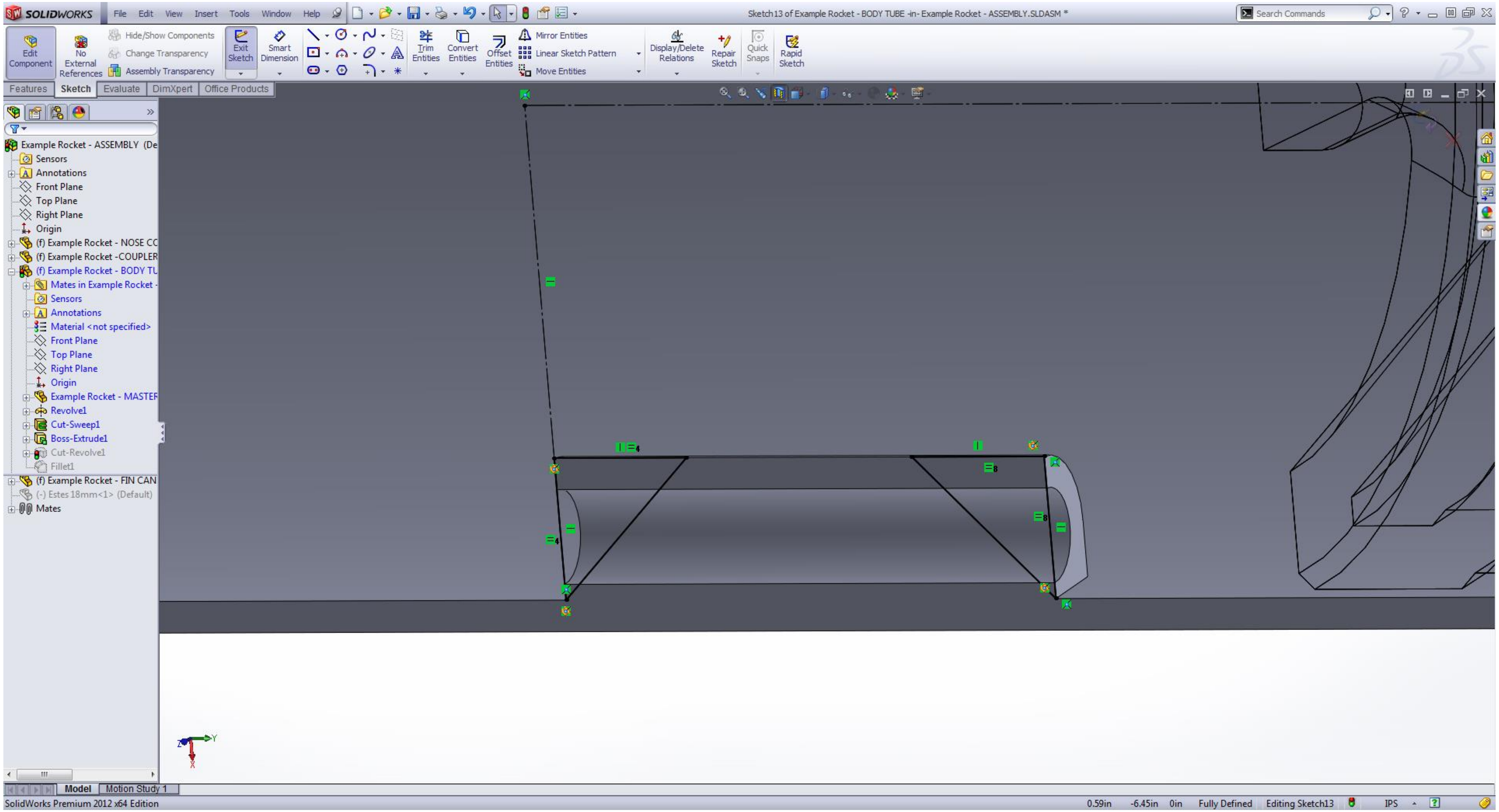
The aft motor retention was also an overhang, so let's change it to a 45 degree angle
FIN CAN IML of Example Rocket - MASTER.SLDPRT *
Example Rocket - MASTER
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
OML
Motor
BODY TUBE IML
FIN CAN IML
NOSE IML
COUPLER
FIN PROFILE
.02
45.00°
.03
.03
*Front
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
Fully Defined
Editing FIN CAN IML
IPS



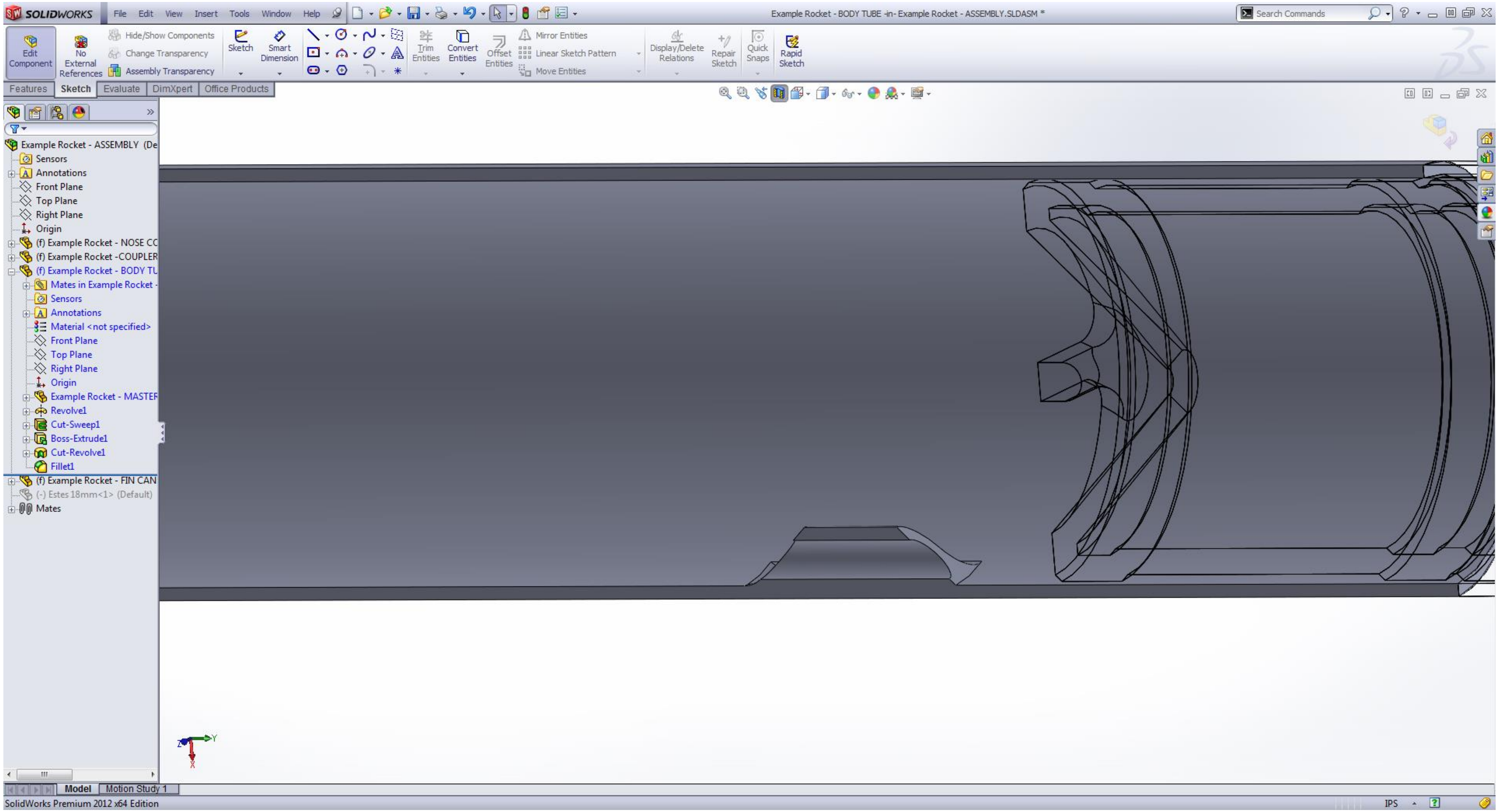
The threads were a little loose, so I reduced the offset by 5 thou



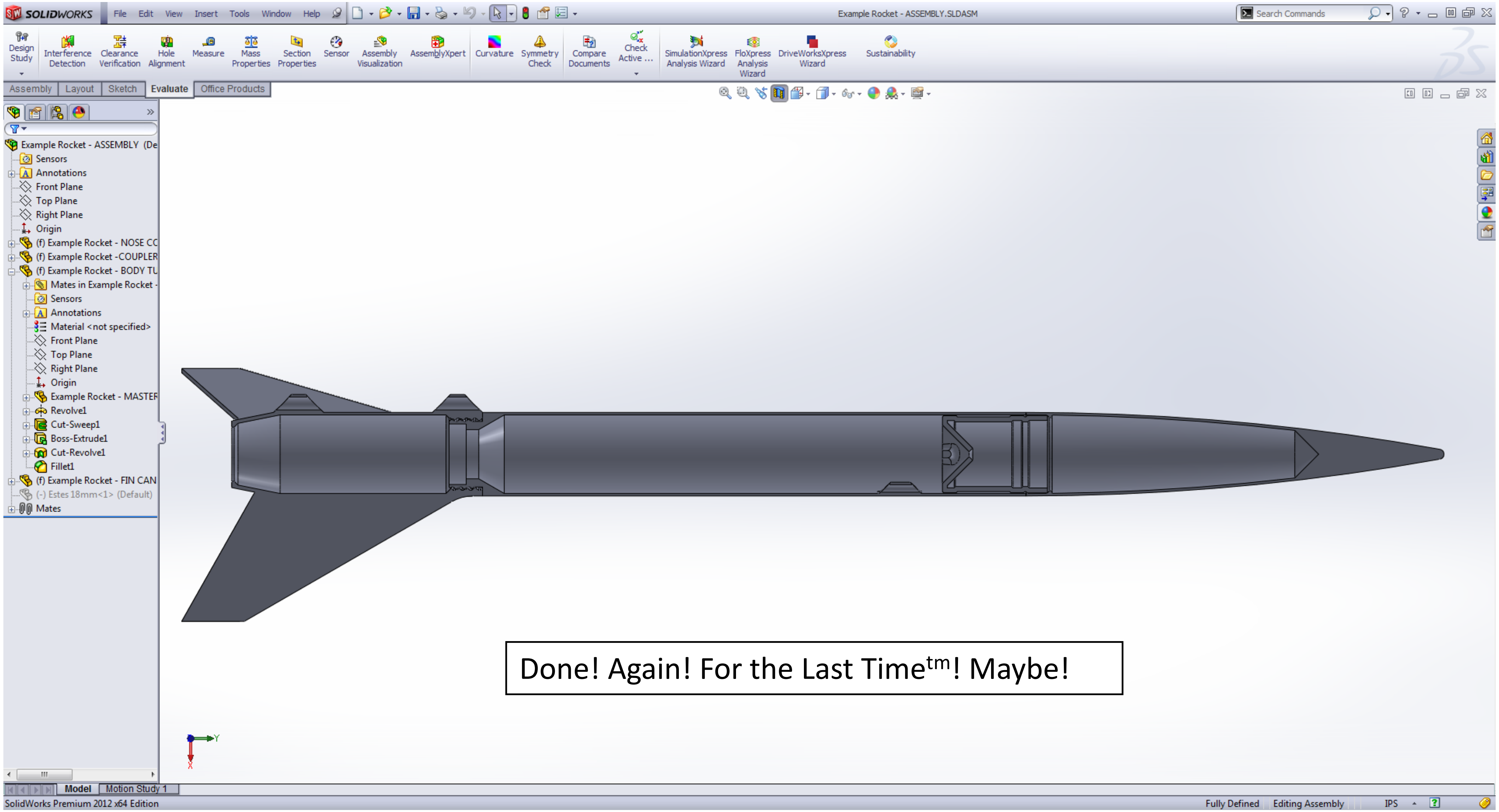
The shock cord mount was another overhang, let's make it longer and taper both ends



SOLIDWORKS
File Edit View Insert Tools Window Help
Sketch13 of Example Rocket - BODY TUBE -in- Example Rocket - ASSEMBLY.SLDASM *
Search Commands
Edit Component
No External References
Hide/Show Components
Change Transparency
Assembly Transparency
Exit Sketch
Smart Dimension
Trim Entities
Convert Entities
Offset Entities
Mirror Entities
Linear Sketch Pattern
Move Entities
Display/Delete Relations
Repair Sketch
Quick Snaps
Rapid Sketch
Features Sketch Evaluate DimXpert Office Products
Example Rocket - ASSEMBLY (De
Sensors
Annotations
Front Plane
Top Plane
Right Plane
Origin
(f) Example Rocket - NOSE CC
(f) Example Rocket -COUPLER
(f) Example Rocket - BODY TU
Mates in Example Rocket -
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTER
Revolve1
Cut-Sweep1
Boss-Extrude1
Cut-Revolve1
Fillet1
(f) Example Rocket - FIN CAN
(-) Estes 18mm<1> (Default)
Mates
Model Motion Study 1
SolidWorks Premium 2012 x64 Edition
0.59in -6.45in 0in Fully Defined Editing Sketch13 IPS



SOLIDWORKS
File Edit View Insert Tools Window Help
Example Rocket - BODY TUBE -in- Example Rocket - ASSEMBLY.SLDASM *
Search Commands
Edit Component
No External References
Hide/Show Components
Change Transparency
Assembly Transparency
Sketch
Smart Dimension
Trim Entities
Convert Entities
Offset Entities
Mirror Entities
Linear Sketch Pattern
Move Entities
Display/Delete Relations
Repair Sketch
Quick Snaps
Rapid Sketch
Features
Sketch
Evaluate
DimXpert
Office Products
Example Rocket - ASSEMBLY (De
Sensors
Annotations
Front Plane
Top Plane
Right Plane
Origin
(f) Example Rocket - NOSE CC
(f) Example Rocket -COUPLER
(f) Example Rocket - BODY TU
Mates in Example Rocket -
Sensors
Annotations
Material <not specified>
Front Plane
Top Plane
Right Plane
Origin
Example Rocket - MASTEF
Revolve1
Cut-Sweep1
Boss-Extrude1
Cut-Revolve1
Fillet1
(f) Example Rocket - FIN CAN
(-) Estes 18mm<1> (Default)
Mates
Model
Motion Study 1
SolidWorks Premium 2012 x64 Edition
IPS



Done! Again! For the Last Time™! Maybe!