

The background is a dark blue gradient with a technical drawing overlay. The drawing features several concentric circles and arcs, some with dashed lines and arrows indicating direction. A prominent circular scale is visible on the left side, with numerical markings ranging from 140 to 260 in increments of 10. The overall aesthetic is clean and professional, typical of a technical manual or engineering document.

A FANCY TOOL GRINDING JIG

BY NORM BERLS

WHY INVENT YET ANOTHER GRINDING JIG?

- Invention is an escape from boredom... enjoy design work
- Eyesight failing and grip not steady... resulting in multi-facets on tool faces that should be flat.
- Need help from a grinding jig to grind HSS

CUBIC BORON NITRIDE

- CBN is almost as hard as diamond
- Higher heat tolerance than diamond
- CBN will grind HSS easily
- **CBN cannot grind carbide**
- No need to true up CBN with a diamond point
- Electroplated best... avoid resinoid
- Numbers
 - \$120 each from Wood Turners Wonders
 - 80 grit wheel
 - 180 grit wheel
- Cutting face is 1" wide. Would be nice to get some 0.5" wide.
- Base of wheel is stainless steel
 - No disintegrations as with aluminum oxide wheels
 - Balanced: minimal vibration



PRINCIPLES OF OPERATION

- The jig is fundamentally a hand grinding tool that positions workpieces against an ordinary benchtop grinder.
- It's only an orientation aid.
- With additional electronic or mechanical aids, the jig can enable precise control of tool face and cutting edge angles... (**hopefully**)

COPING WITH COLD ROLLED STEEL

- CRS = Cold Rolled Steel
- CRS used extensively in jig
- CRS contains a lot of stress which often causes warpage after cutting
- Solution: Temper the CRS in an oven at 450 F and hold for 1 hour
- Slow cooling removes most of the stress and makes it ready for cutting
- CRS and tool steel joined with silver solder
- CRS joined to CRS with brazing... or maybe MIG welded
- CRS can be case hardened where extra durability desired

THREADS

- Fine threads (UNF) used wherever possible
 - 3/4 – 16 UNF
 - 7/16 – 20 UNF
 - #10 - 32 UNF
 - #4 - 40 UNF
- Discovered that when doing initial threads in CRS, must use a taper tap
- Plug tap will strip the threads out on an initial thread in CRS.

MATERIALS LEGEND



O1 Tool Steel



1018 Cold Rolled Steel



1018 Case Hardened



Stainless Steel



Mild Steel



Cubic Boron Nitride (Borazon)



Plywood



Hardwood

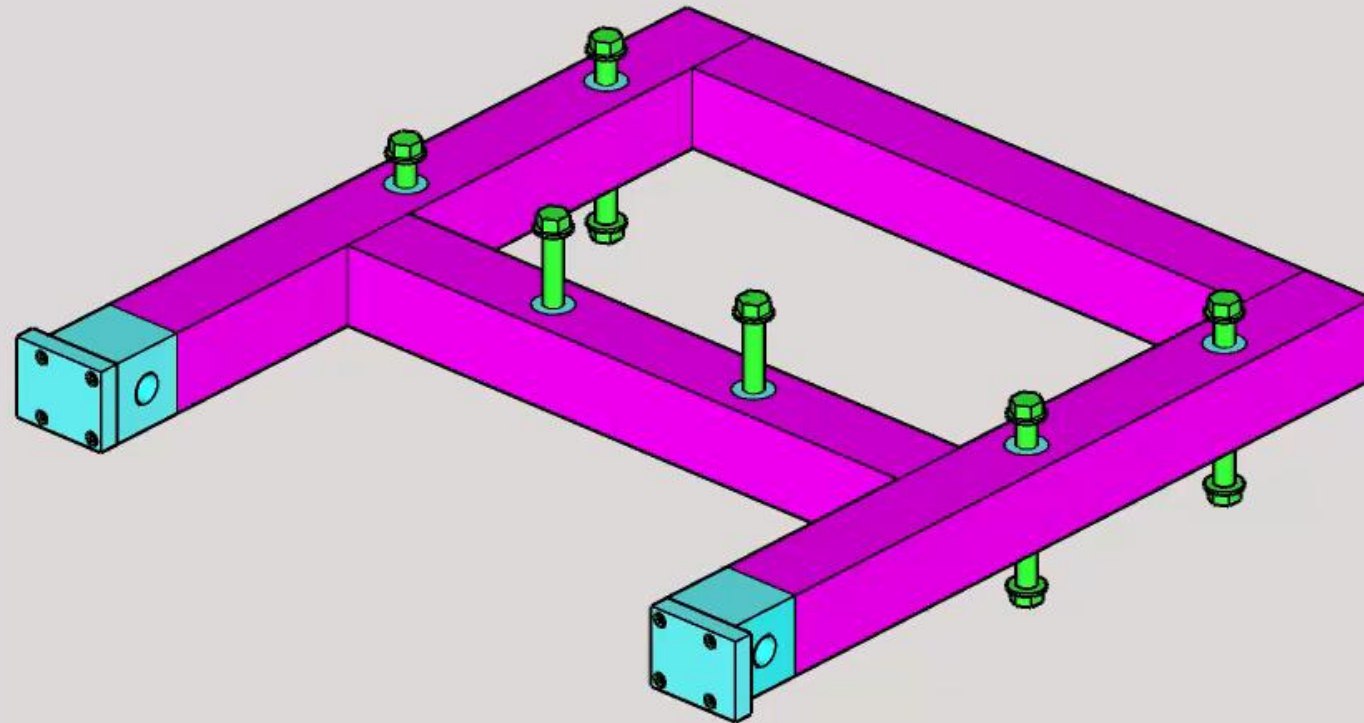
WORKMATE 425



MAYBE MODIFY THE WORKMATE FOR METAL WORK?

- Acme threaded rod goes into nylon fitting
- Acme rod and coupling available from McMaster-Carr... basis for a weldment
- Plastic riser blocks could be replaced with aluminum
- Wood work table leaves could be replaced with aluminum

THE JIG FRAME



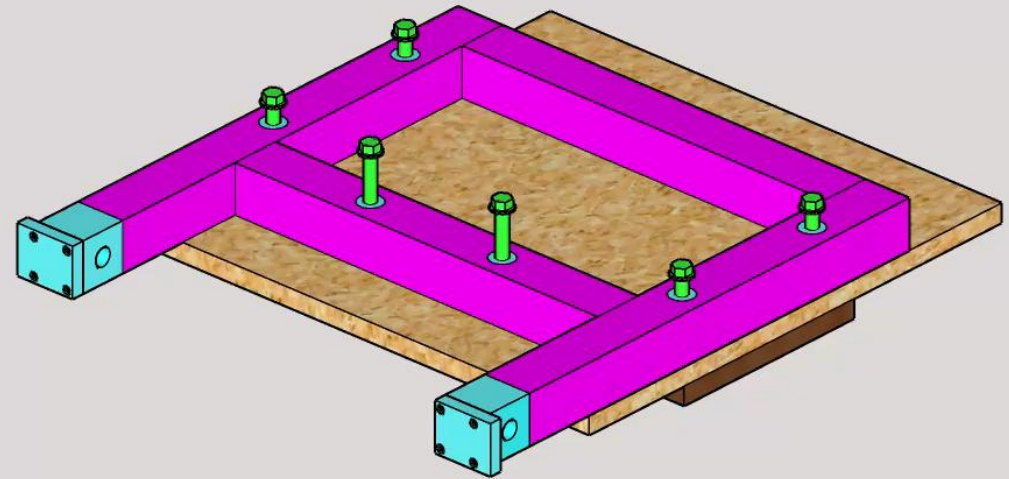
LOWER BASE AND FRAME

About the lower base

- Plywood and Hardwood for clamping in Workmate 425
- Plan is to use the Workmate as a stand for this and other tools and jigs

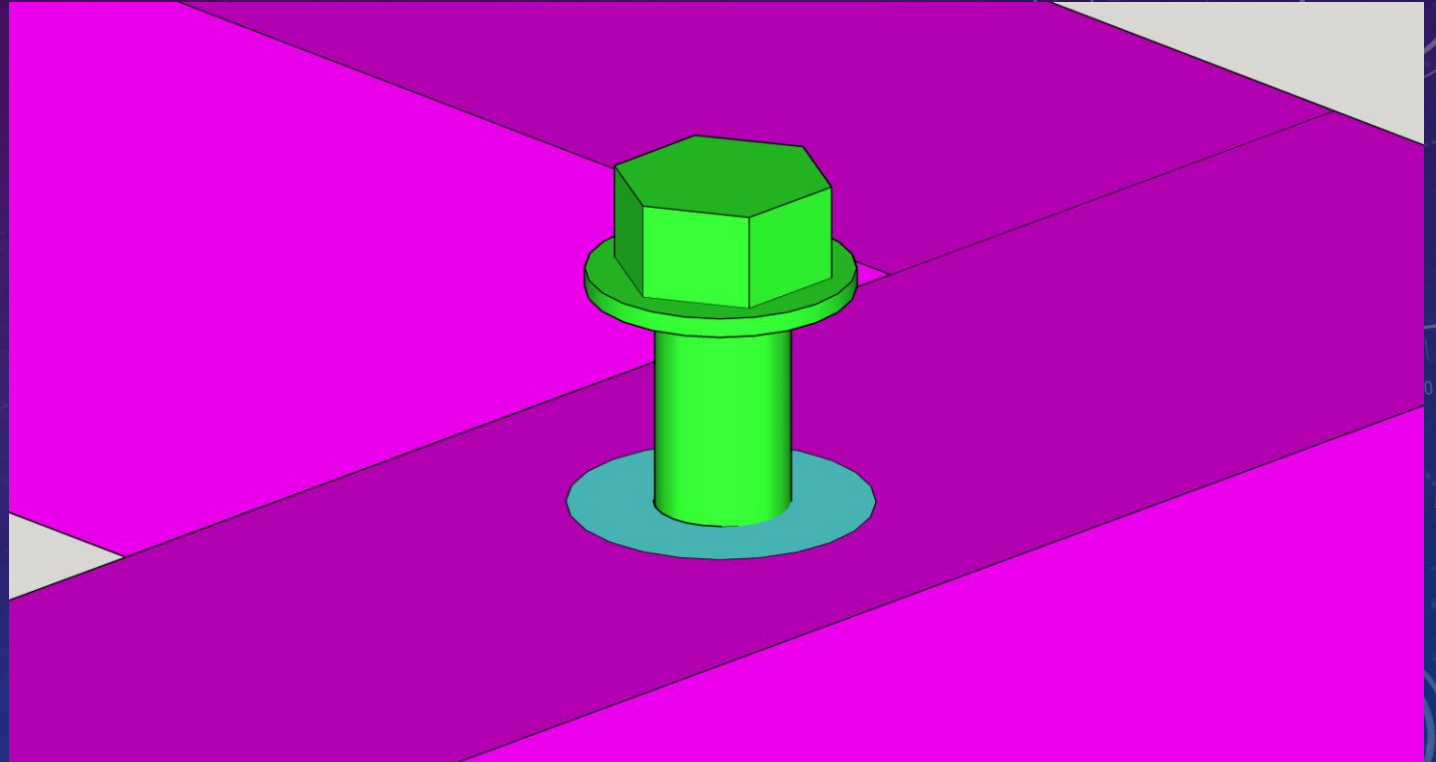
About the Frame

- Frame is the heart of the jig. Every other part bolts or screws to the Frame.
- 2 in. Square Steel Tube
- A weldment brazed together



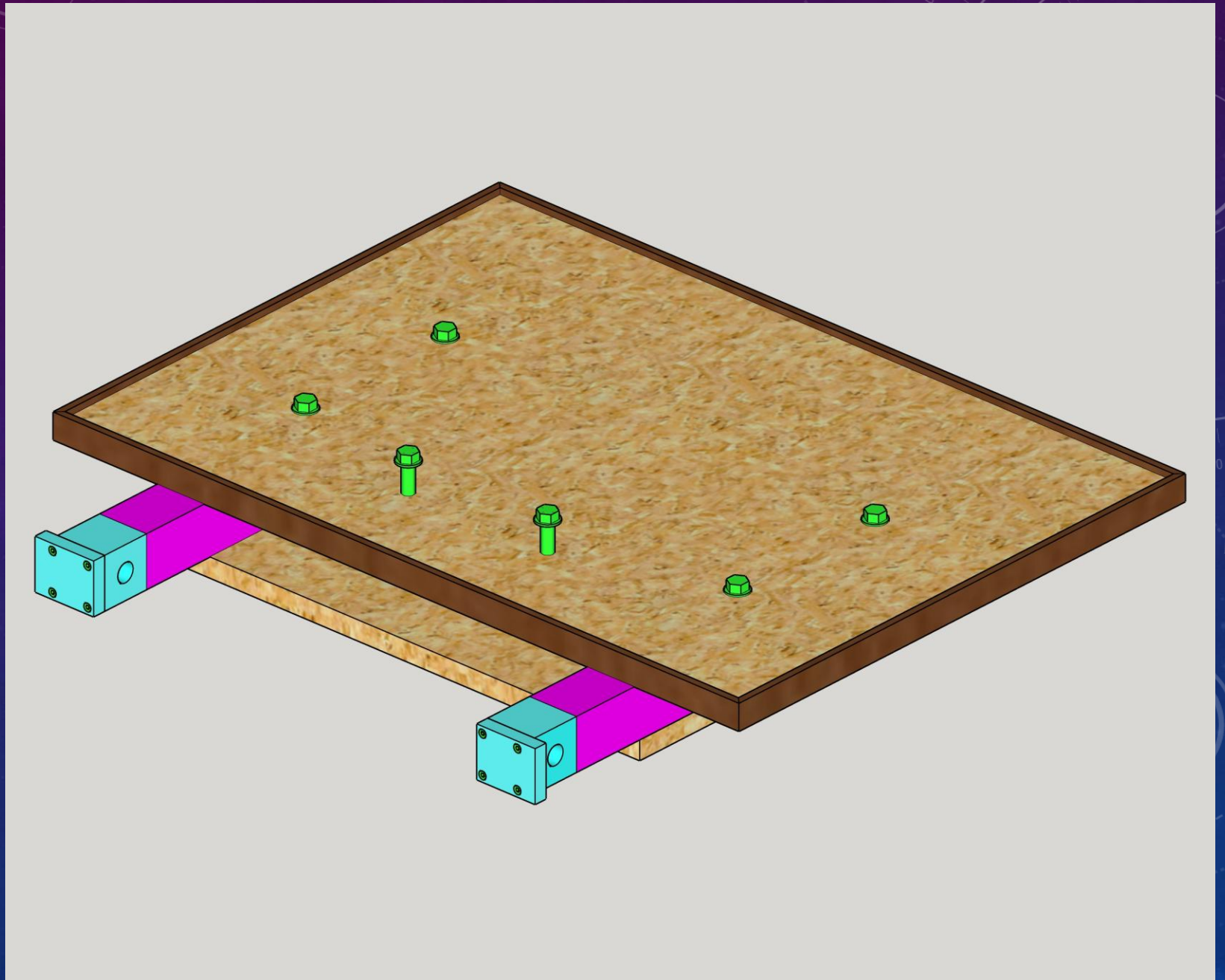
BOLT SLEEVE DETAIL

- Bolt sleeve is 1" CRS
- 2" long
- Drilled and tapped all the way through
- 2" square steel tube drilled through and sleeve brazed in place
- Bolts go in BOTH ends of sleeve



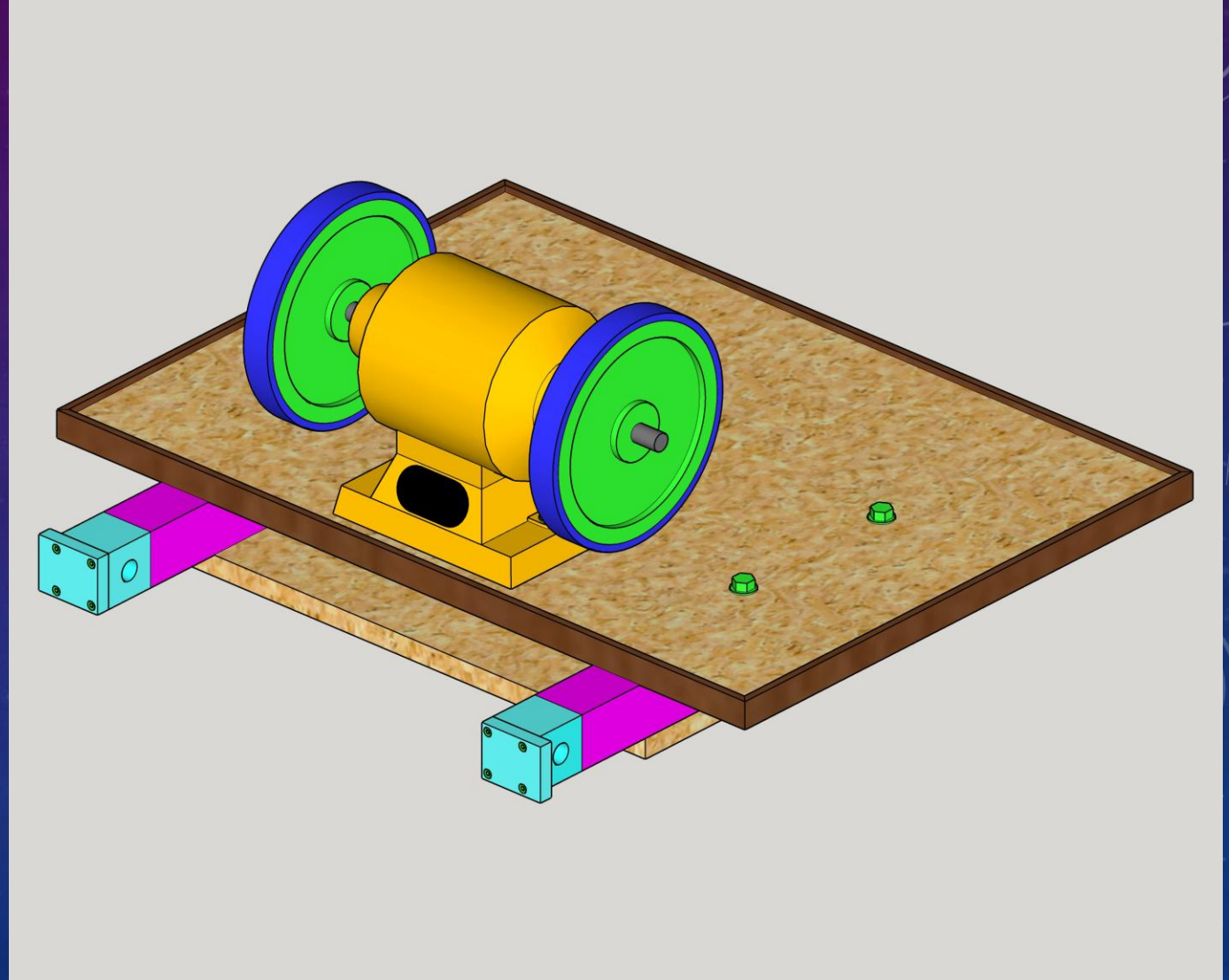
WORK TABLE

- Plywood with hardwood edge
- Primary work space for the jig
 - DeWalt Grinder
 - Workpieces
 - Alignment accessories
 - Bowl of water
 - Calibration tools
 - LED overhead lights
 - Shop Vac



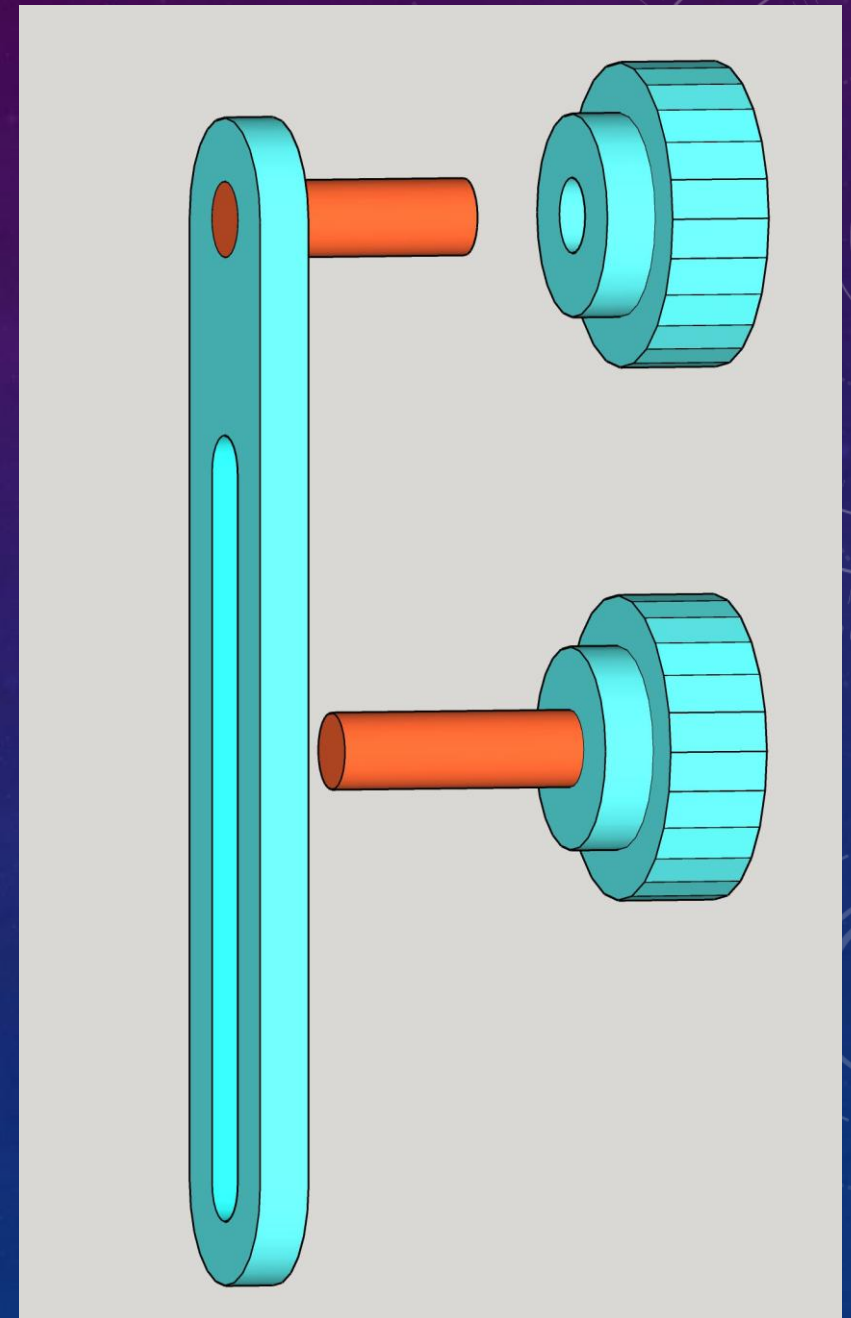
DEWALT BENCH GRINDER

- $\frac{3}{4}$ HP, 3600 RPM
- 8 inch
- Cast iron base
- \$169 at Home Depot



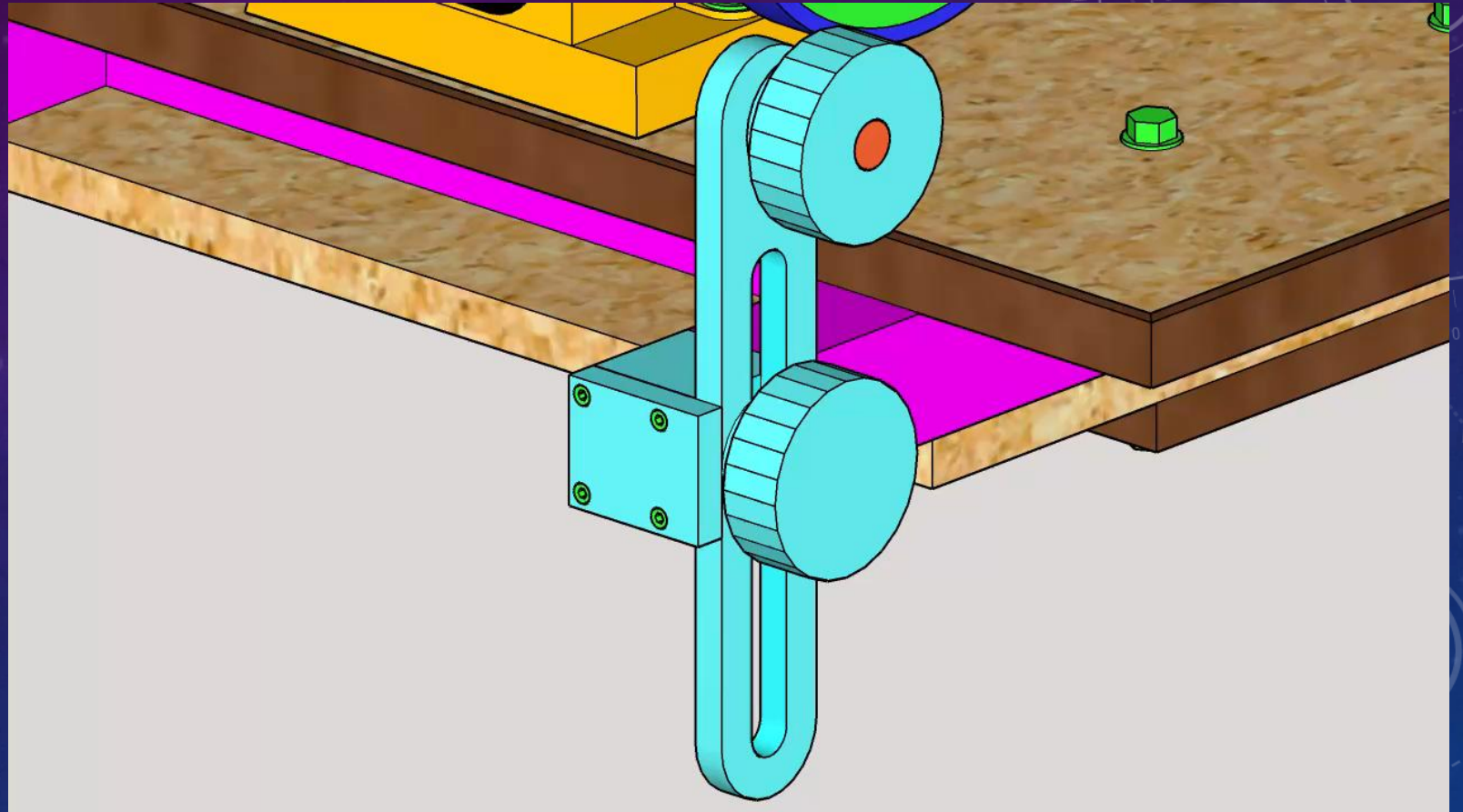
VERTICAL ARM EXPLODED

- Vertical arm is two pieces silver soldered together. Tool steel part is threaded.
- Lower knob is two pieces silver soldered together. Tool steel part is threaded.
- Upper knob screws onto vertical arm.
- Tool steel is $\frac{3}{4}$ " in diameter



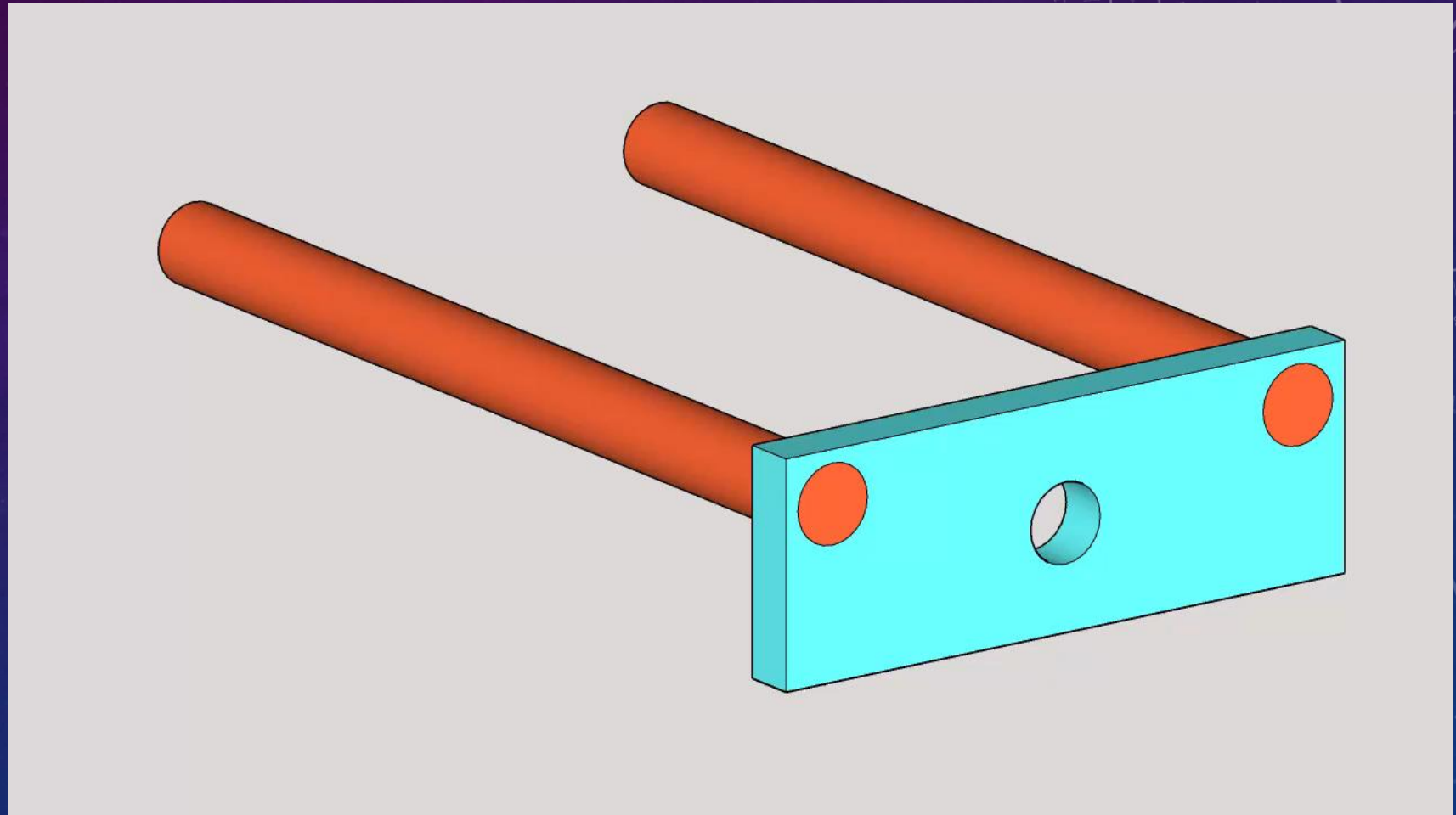
VERTICAL ARM

- Lower knob screws into the base and holds the vertical arm in place
- Upper knob screws onto Vertical Arm and holds a work table
- Up-Down adjustment only
- Block on front of Frame prevents rotation
- Knobs are 3" in diameter and are knurled



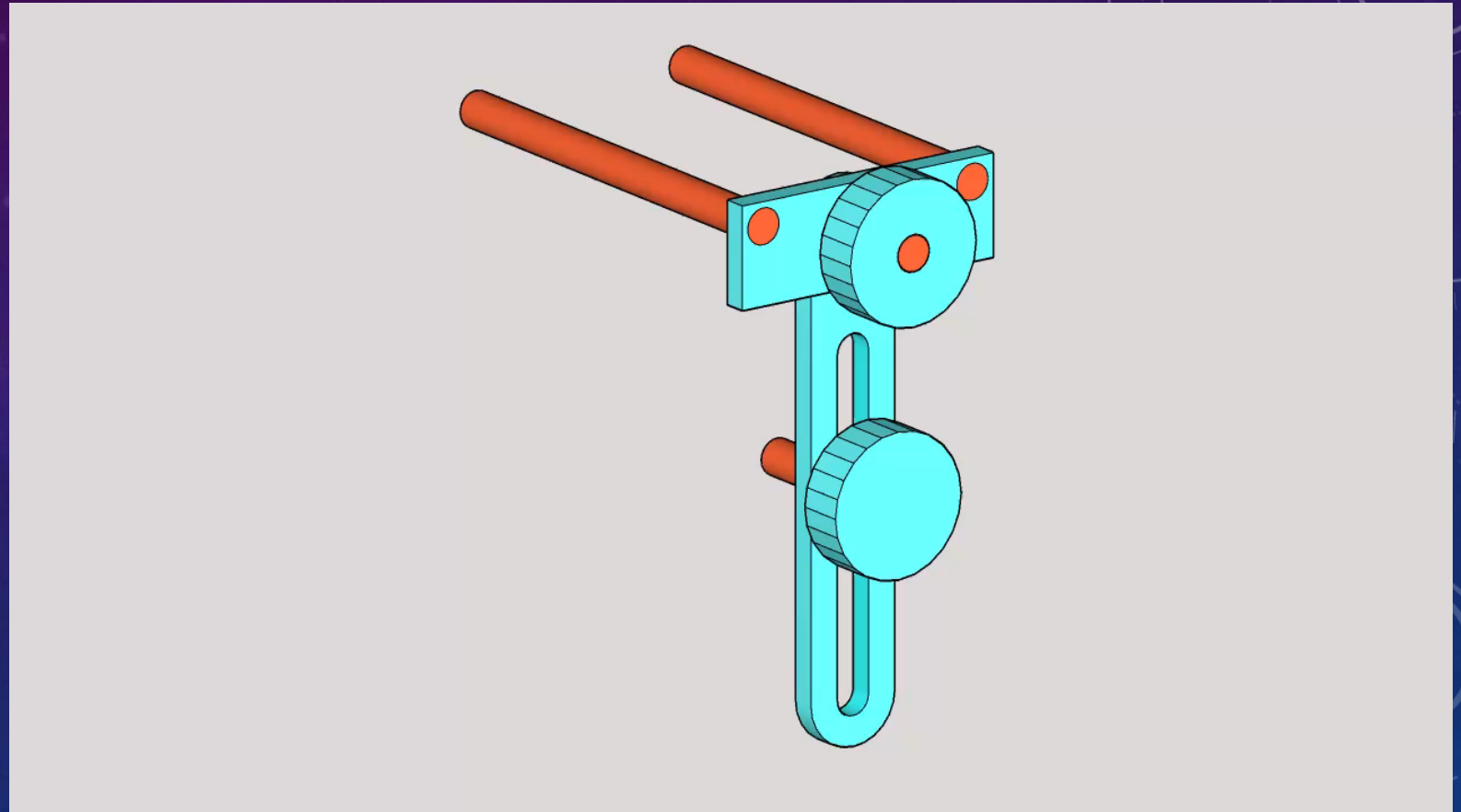
WORK TABLE BASE

- A weldment
- Tool steel and cold rolled steel
- Silver soldered
- Rods have flats for seating of thumb screws



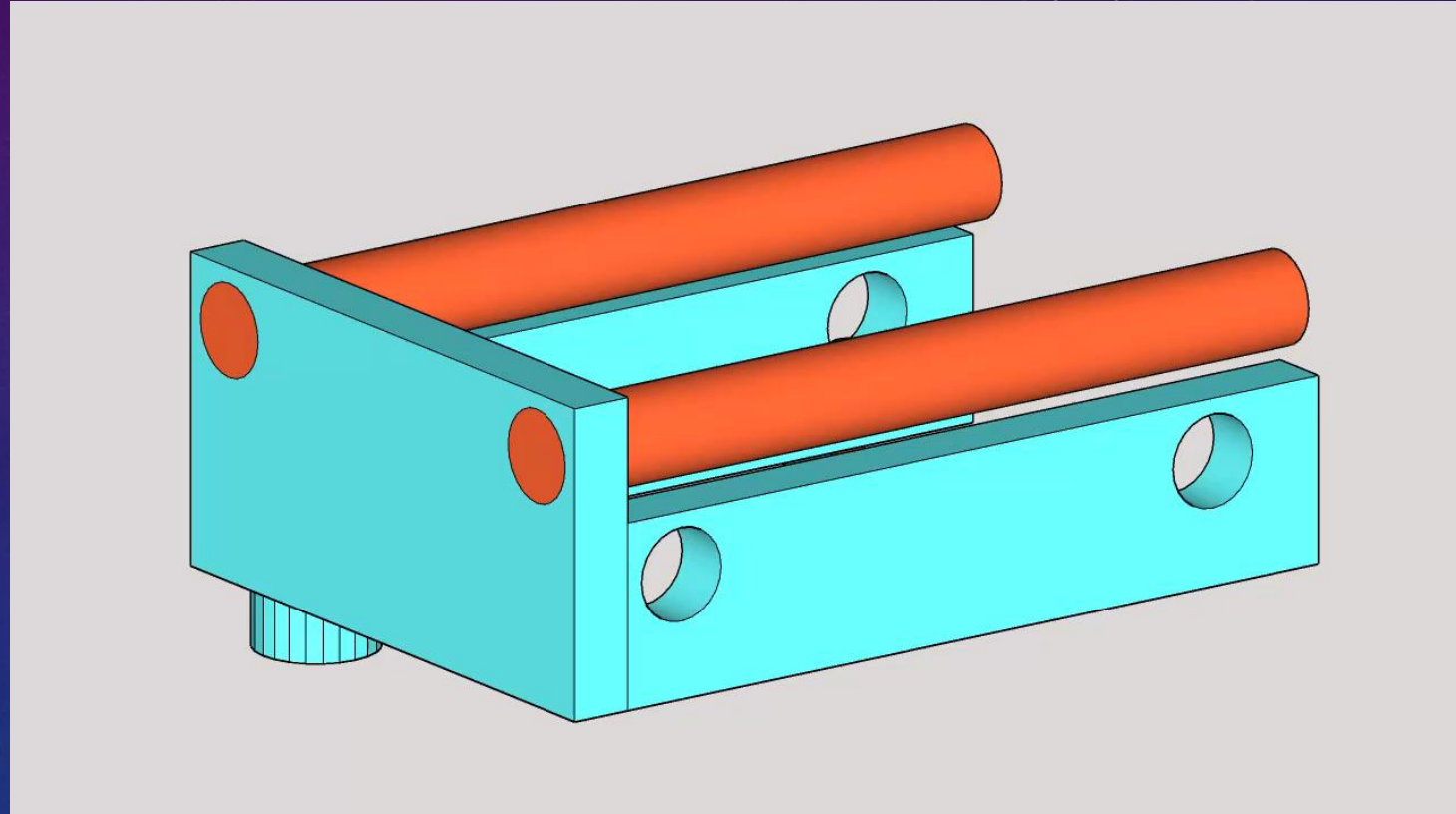
WORK TABLE BASE ASSEMBLED

- Work table base held in place by upper arm knob.
- Allows base (hence entire work table) to be tilted.
- Facilitates cutting of relief angles on tools.



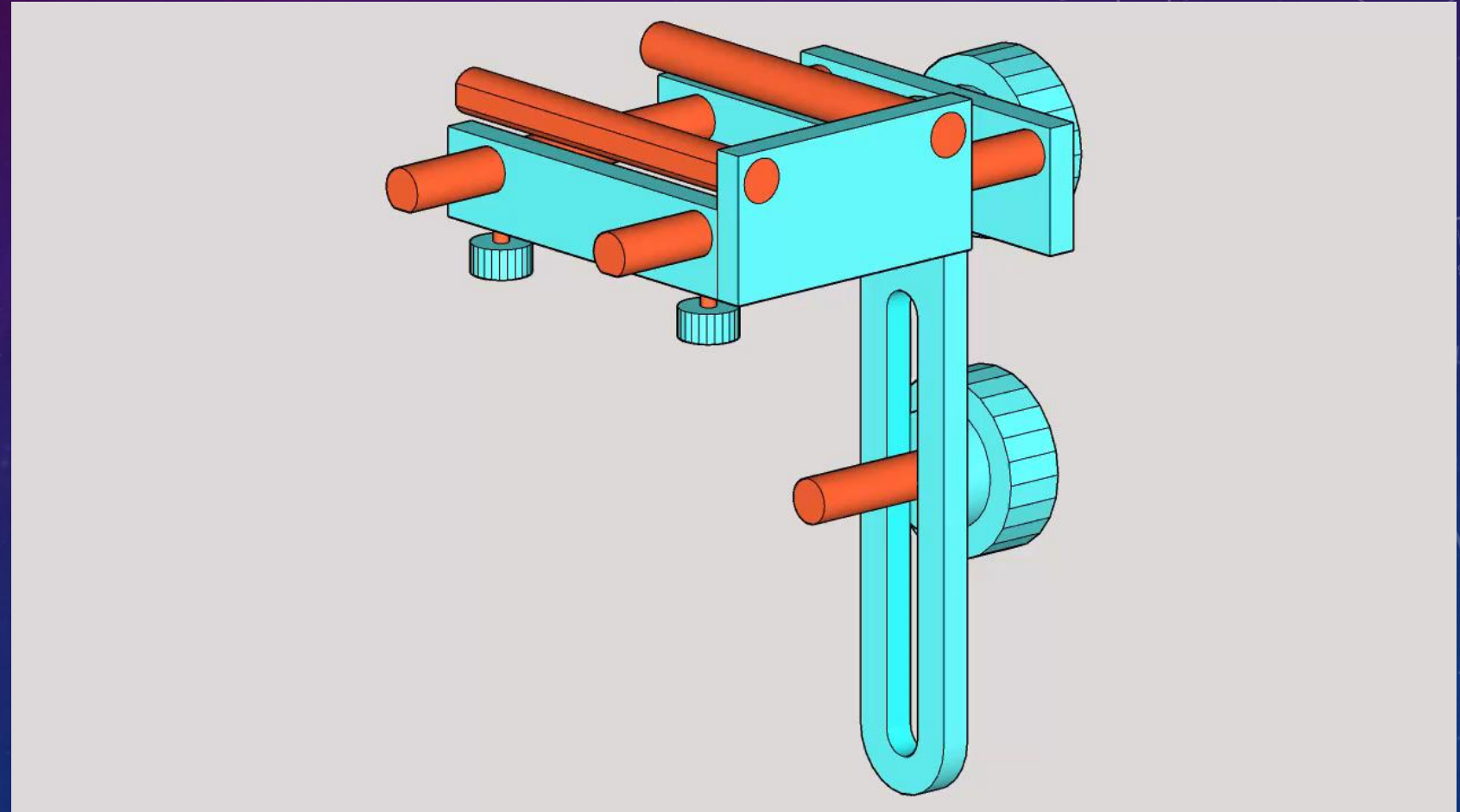
WORK TABLE CARRIAGE

- A weldment
- Tool steel and cold rolled steel
- Silver soldered and brazed
- Large tool steel rods are 0.750"
- Large holes reamed to 0.752"
- Is 0.002" enough clearance for a sliding fit?



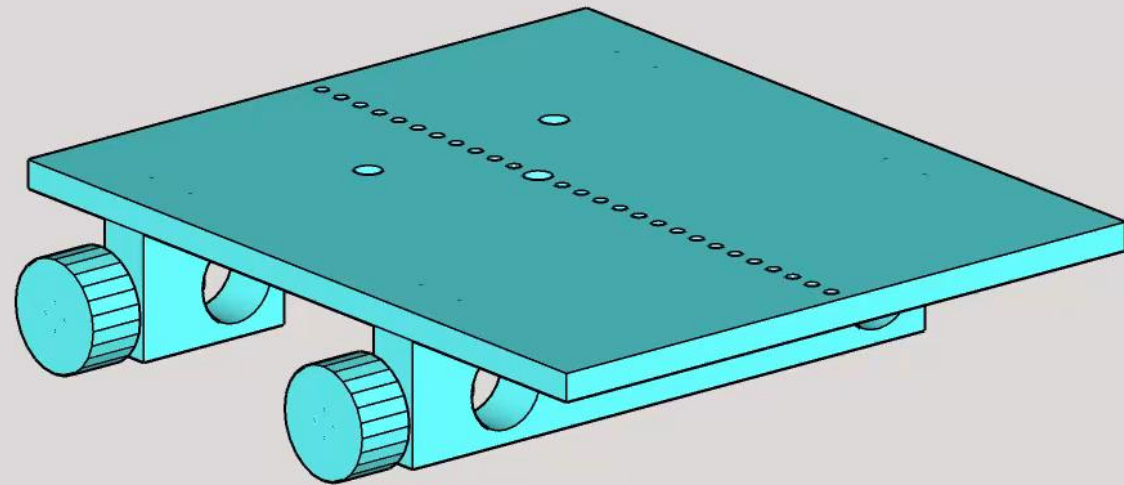
WORK TABLE CARRIAGE ASSEMBLED

- Carriage slides along forks of table base
- Facilitates left-right movement of workpiece across grinding wheel.
- Thumb screws can lock carriage to base



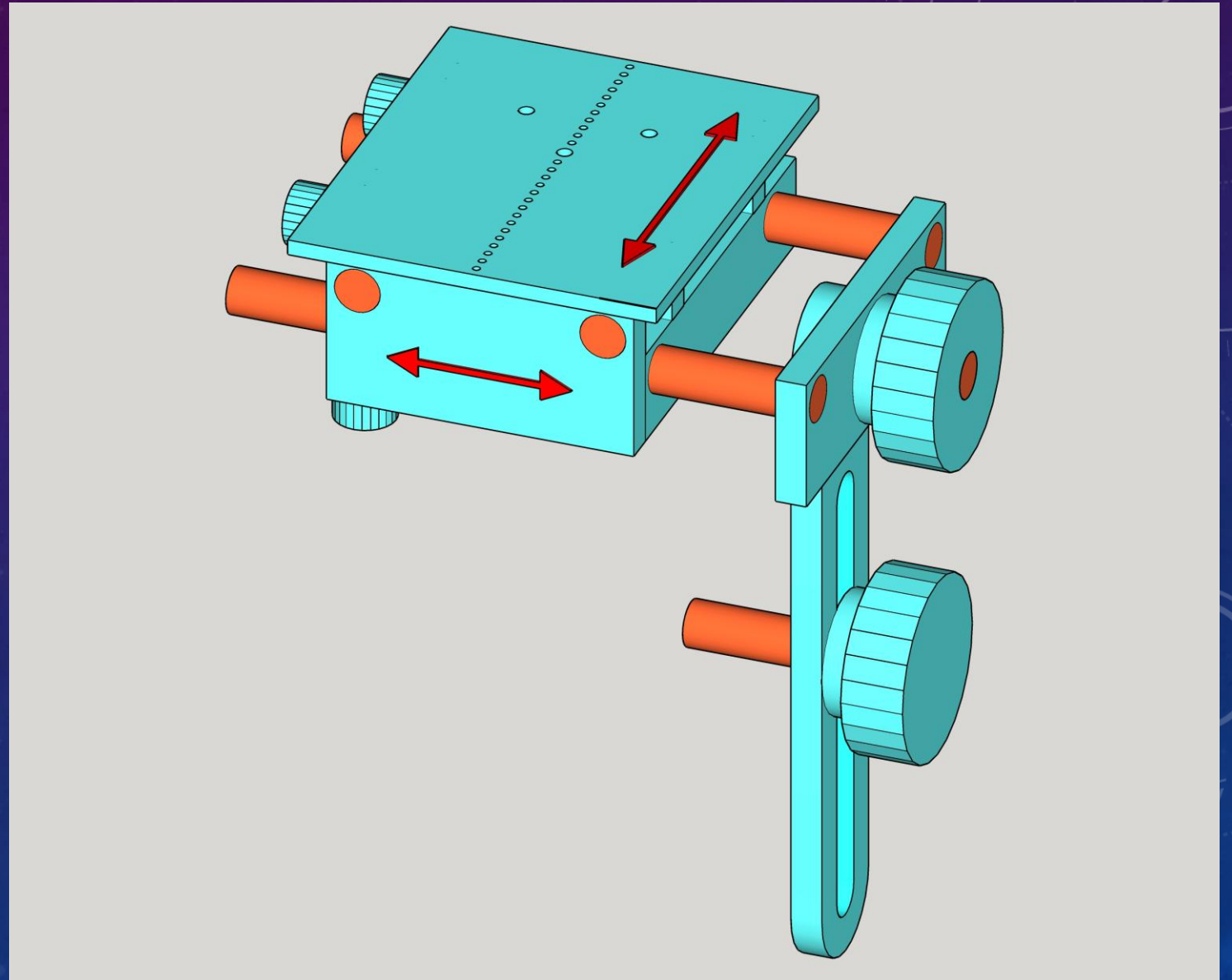
THE WORK TABLE

- A weldment
- Tool steel and cold rolled steel
- Silver soldered and brazed
- Holes in top of table serve to hold other accessories.
- Accessories serve to align workpieces WRT grinding wheel
- Large holes are 0.250"
- Small holes are about 0.125"



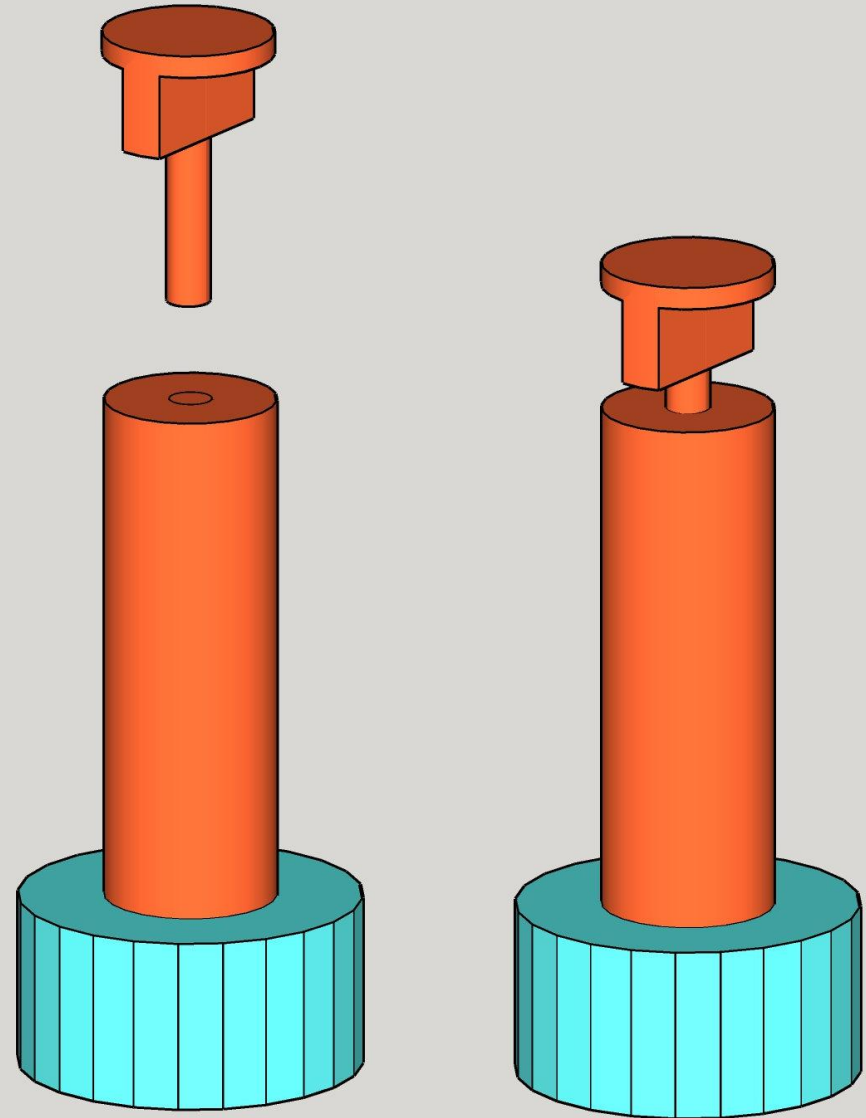
THE WORK TABLE ASSEMBLED

- Work table slides along forks of carriage
- Facilitates forward-backward movement of workpiece WRT grinding wheel.
- Thumb screws can lock work table to carriage

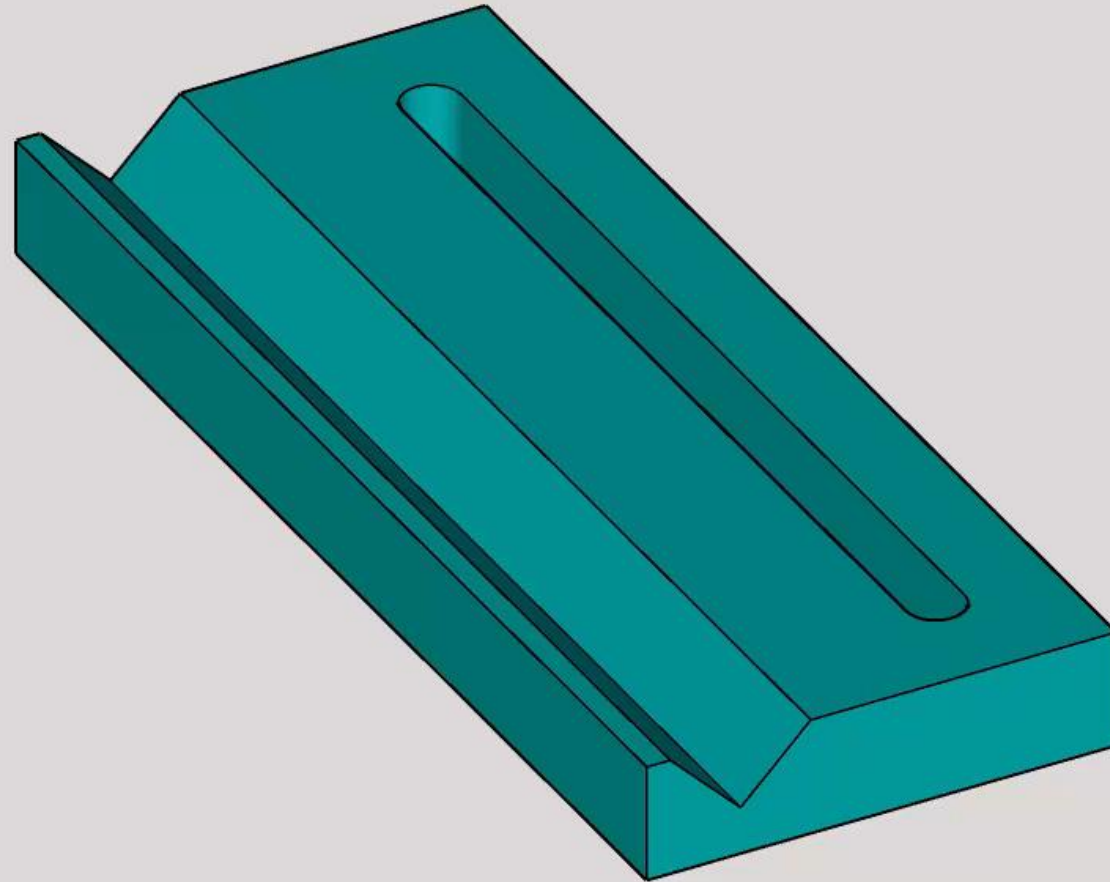


WING NUT + LONG KNOB

- Wing nut and long knob screw together to form a clamp **through** the work table
- They serve to hold alignment accessories in place on the work table.
- Wing nut fits through the 0.25" holes in the work table

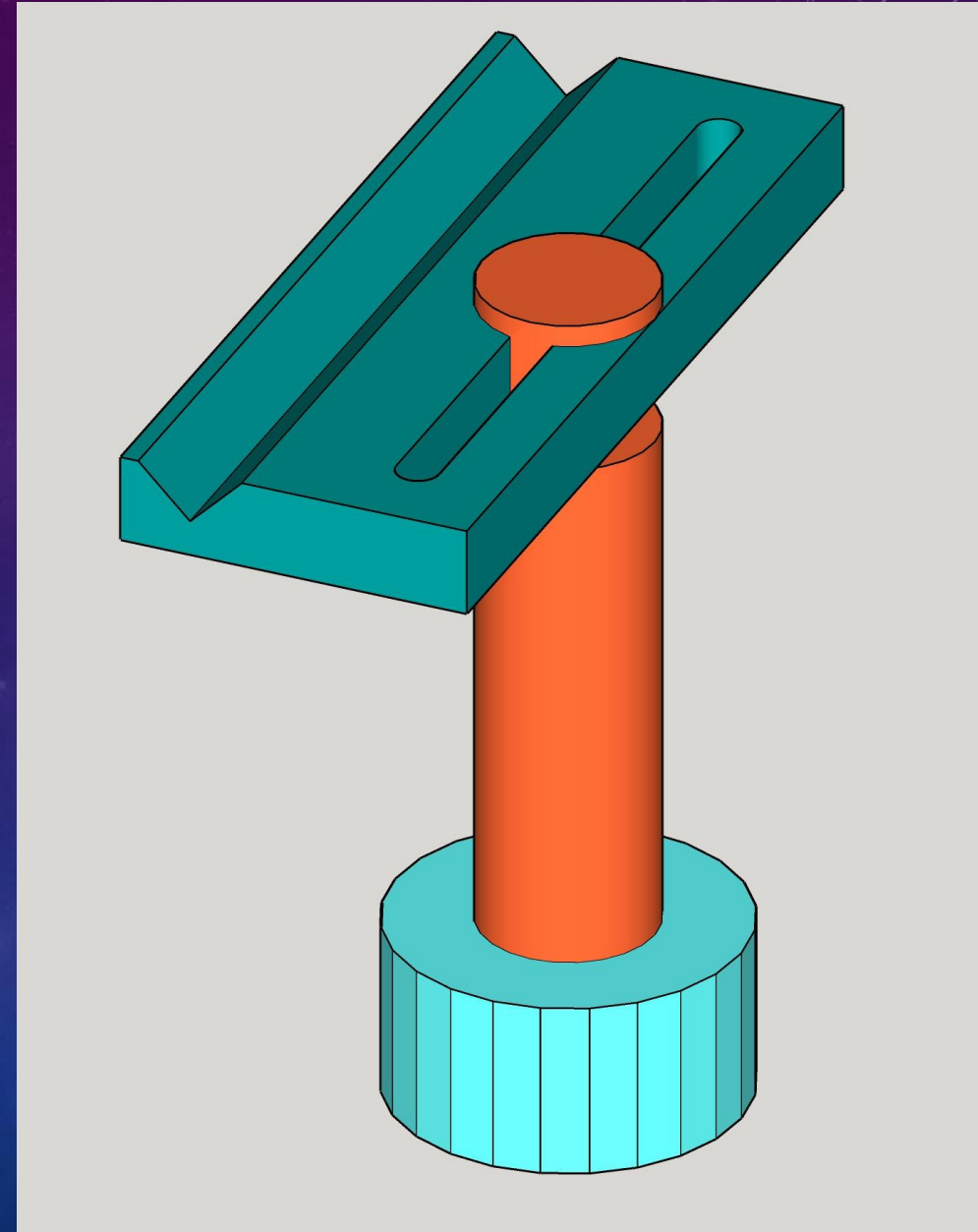


INTRODUCING THE PERPENDICULAR SLIDER



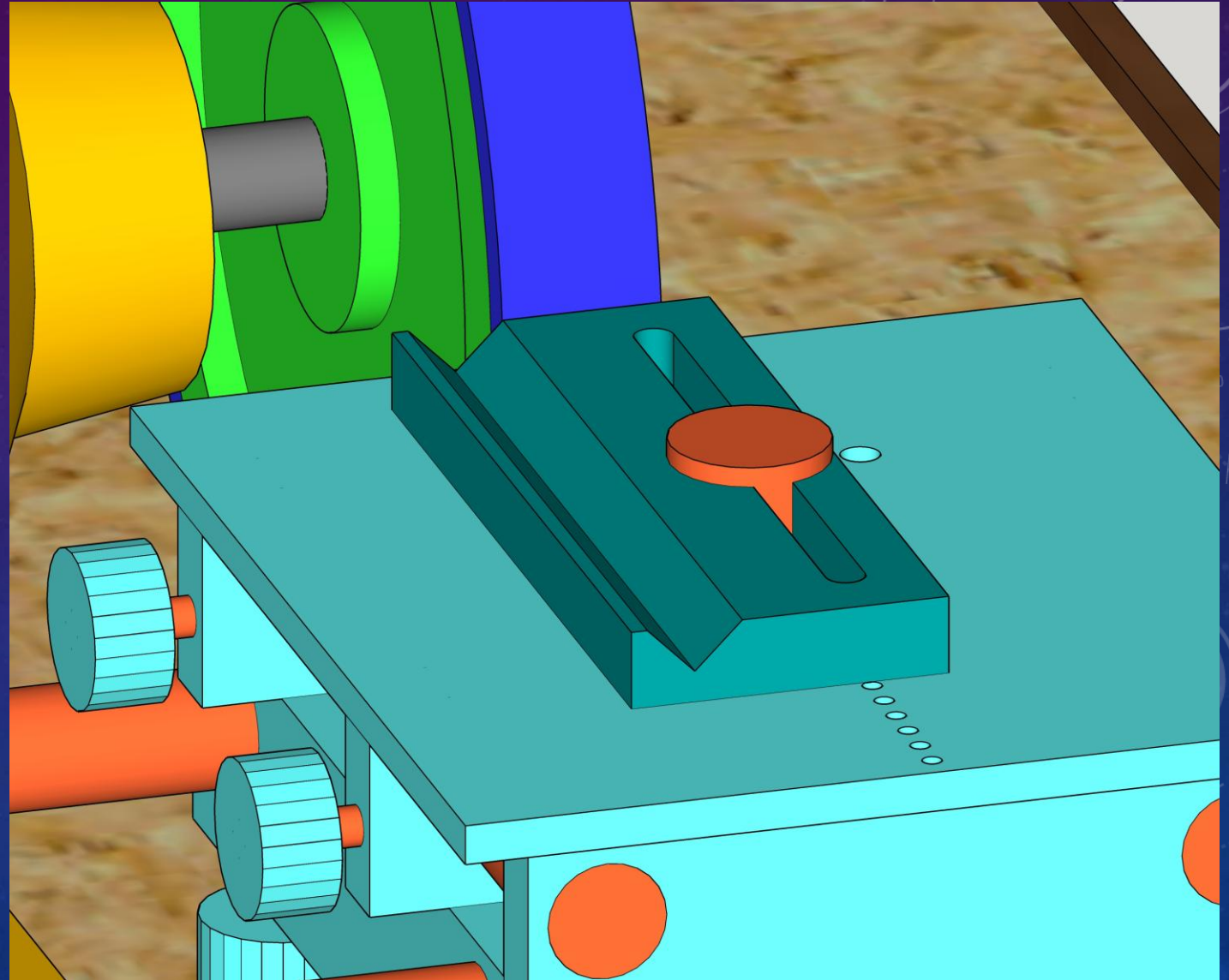
ASSEMBLED

- Wing nut and long knob clamp the perpendicular slider to the work table
- It's called "perpendicular" because it orients workpieces more-or-less perpendicular to the grinding wheel.
- It's called a "slider" because it can slide and/or rotate when the clamp is loose.
- It's called a "slider" because workpieces are held against it by hand and can be slid towards the grinding wheel



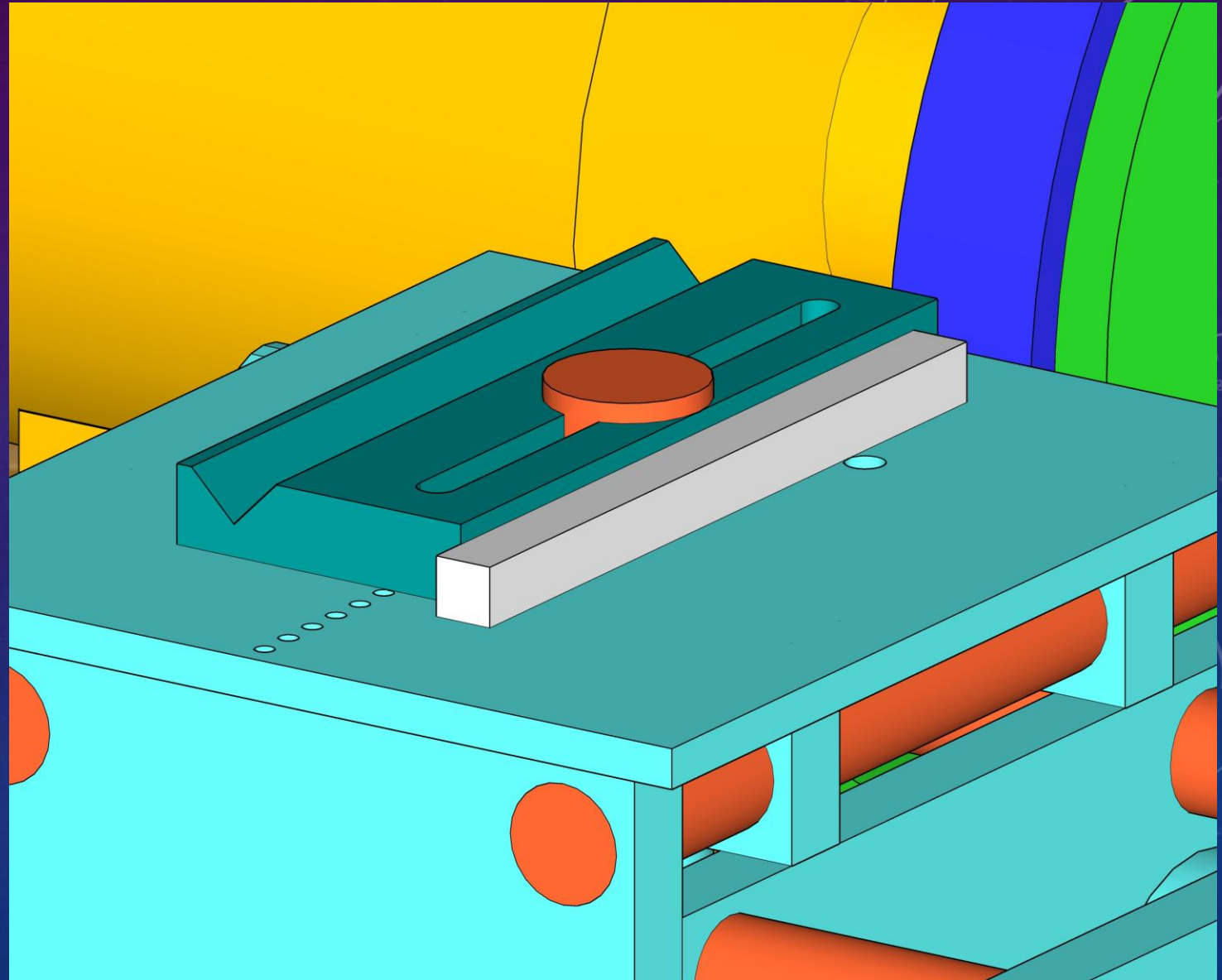
PERPENDICULAR SLIDER ASSEMBLED

- Perpendicular slider on work table and with grinder
- CRS case hardened



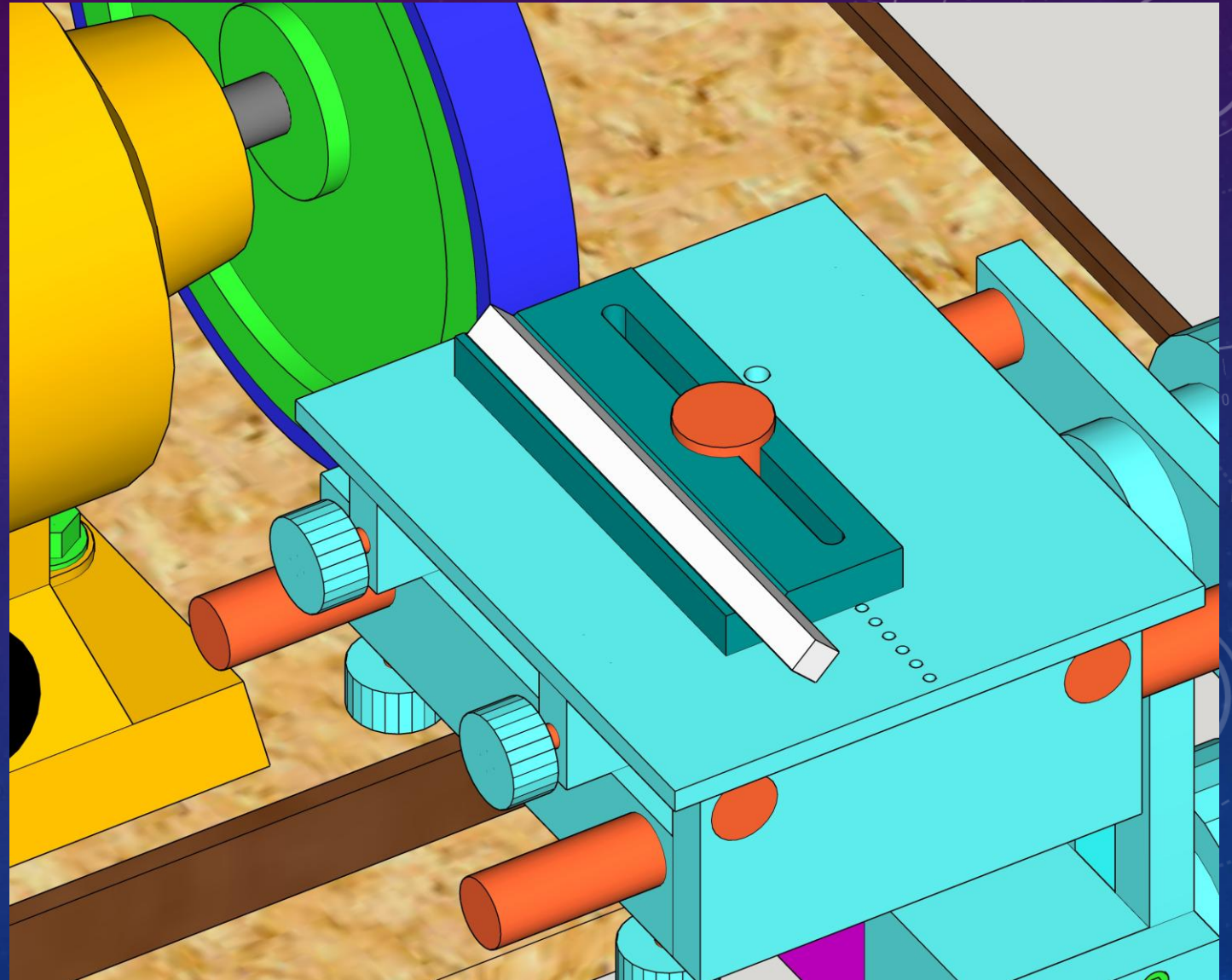
PERPENDICULAR SLIDER + WORKPIECE

- Perpendicular slider with workpiece

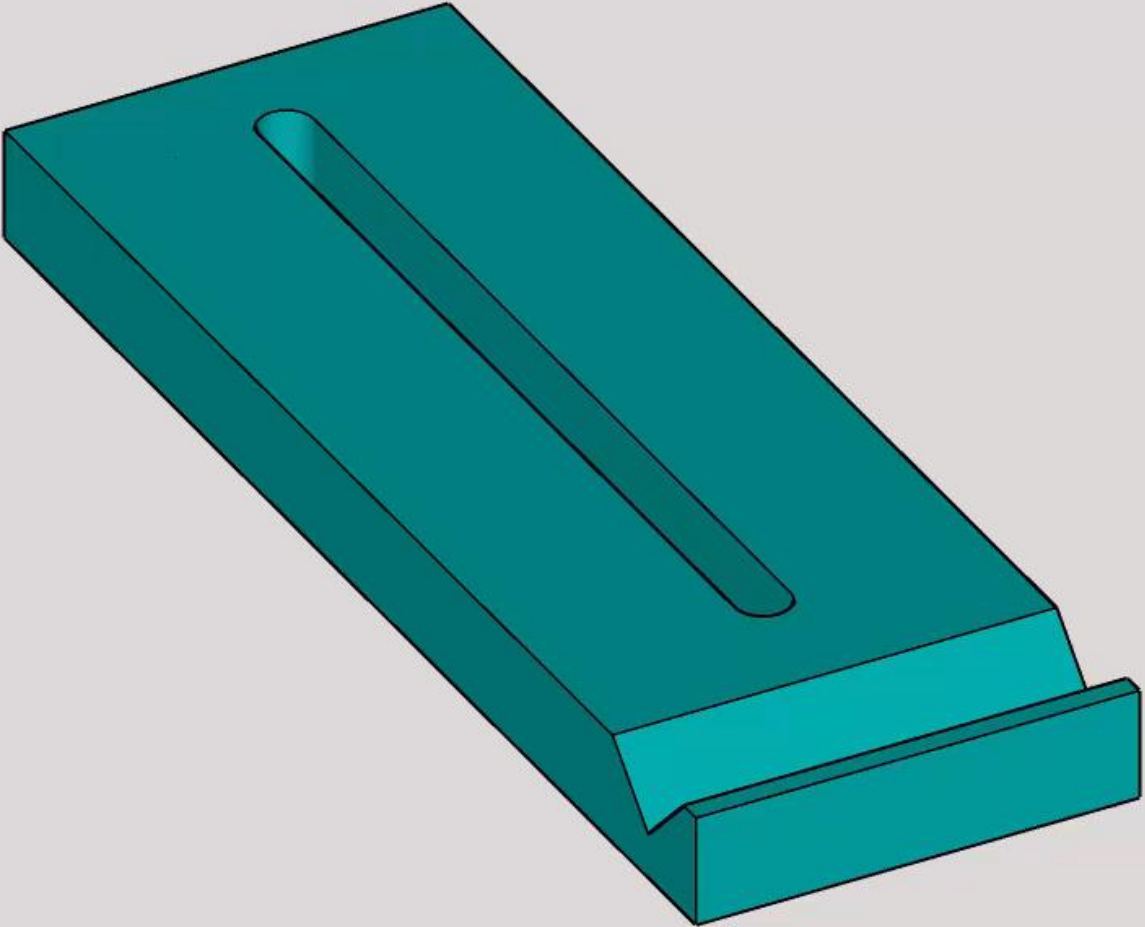


PERPENDICULAR SLIDER WITH WORKPIECE

- Perpendicular slider contains a V Block
- Workpiece can be held in canted position

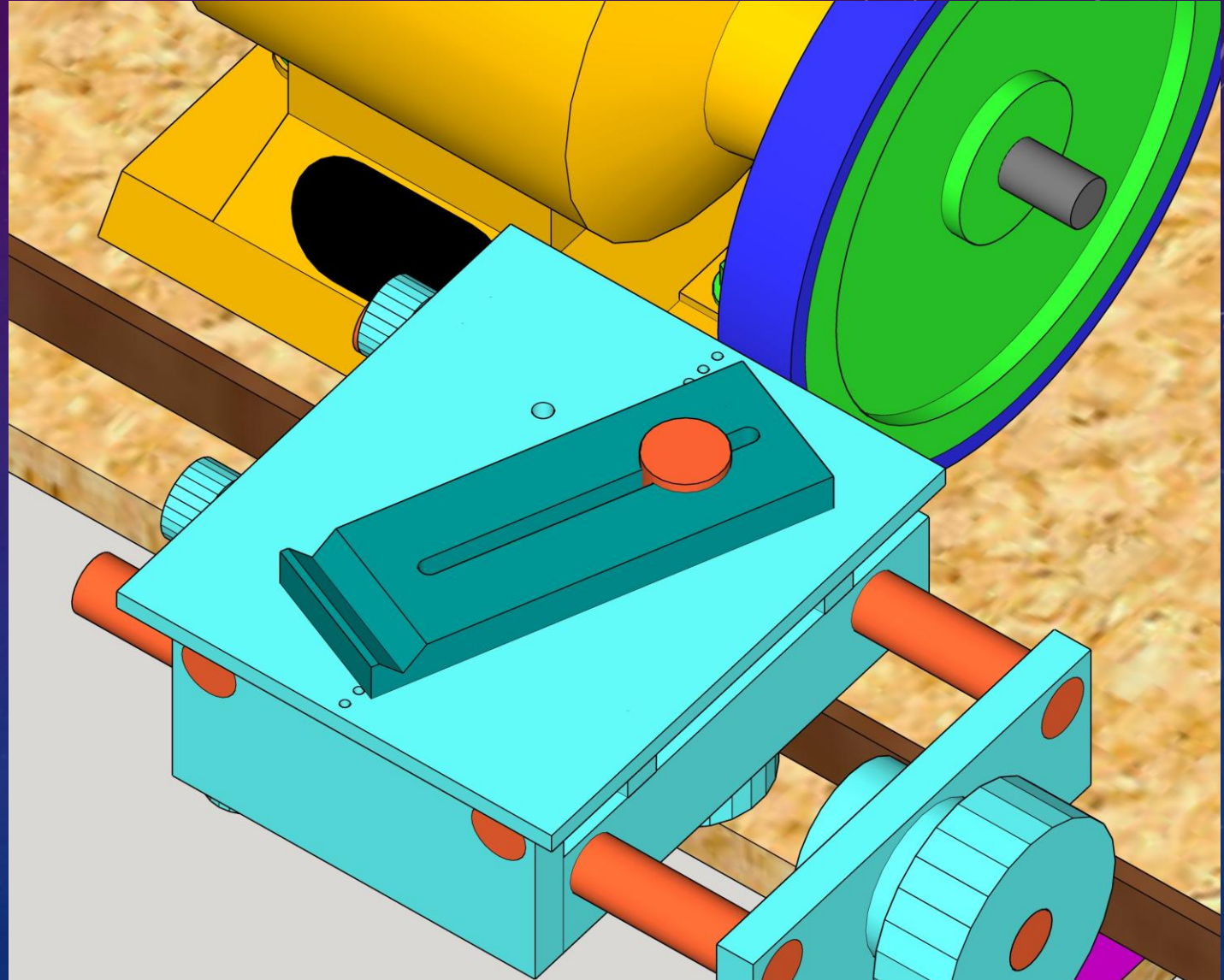


INTRODUCING THE PARALLEL SLIDER



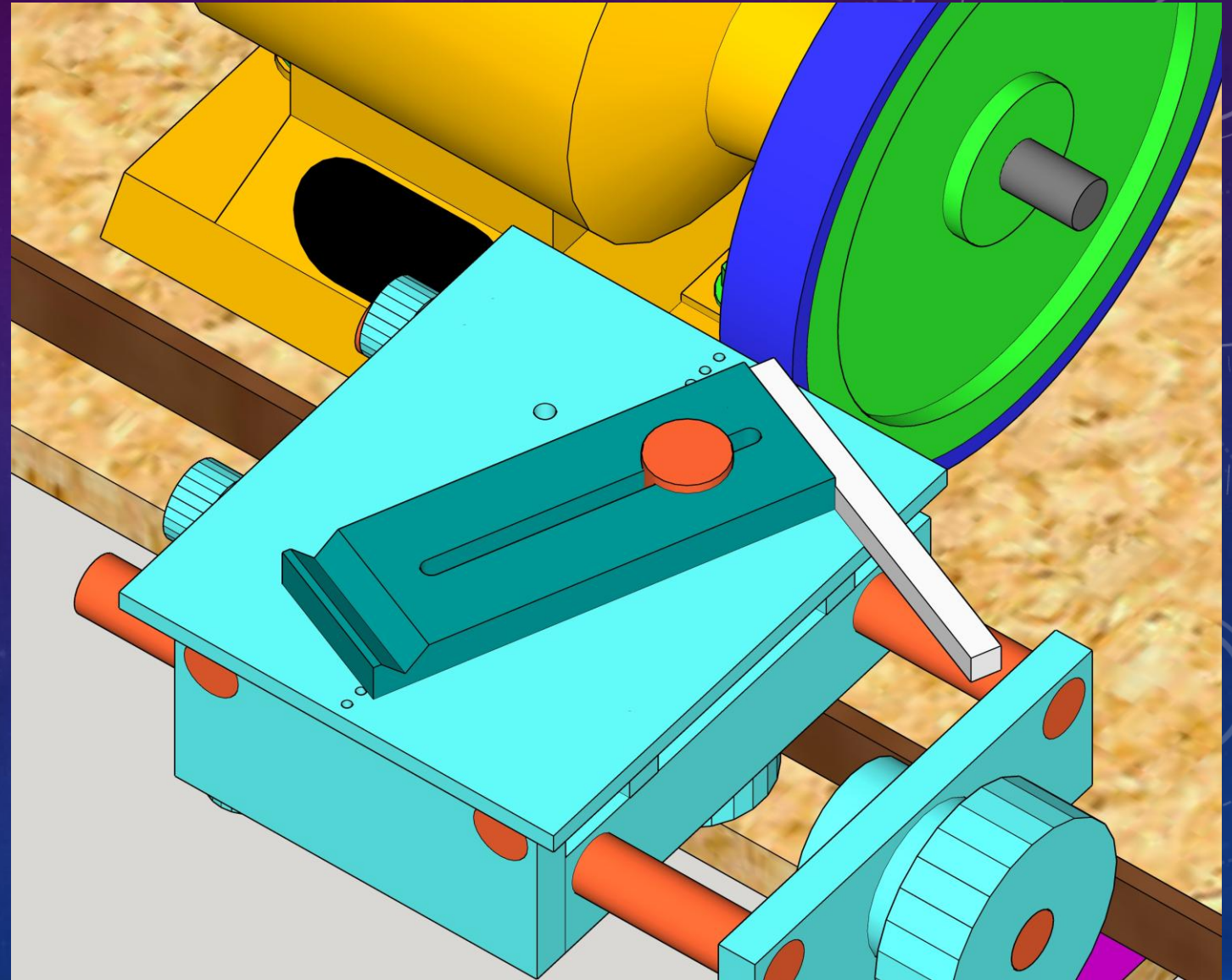
PARALLEL SLIDER ASSEMBLED

- Parallel Slider installed on work table.
- Parallel Slider can orient workpieces more-or-less parallel to the face of the grinder wheel
- Wing nut has been moved to another hole
- Slider has been rotated to a non-parallel angle
- CRS case hardened

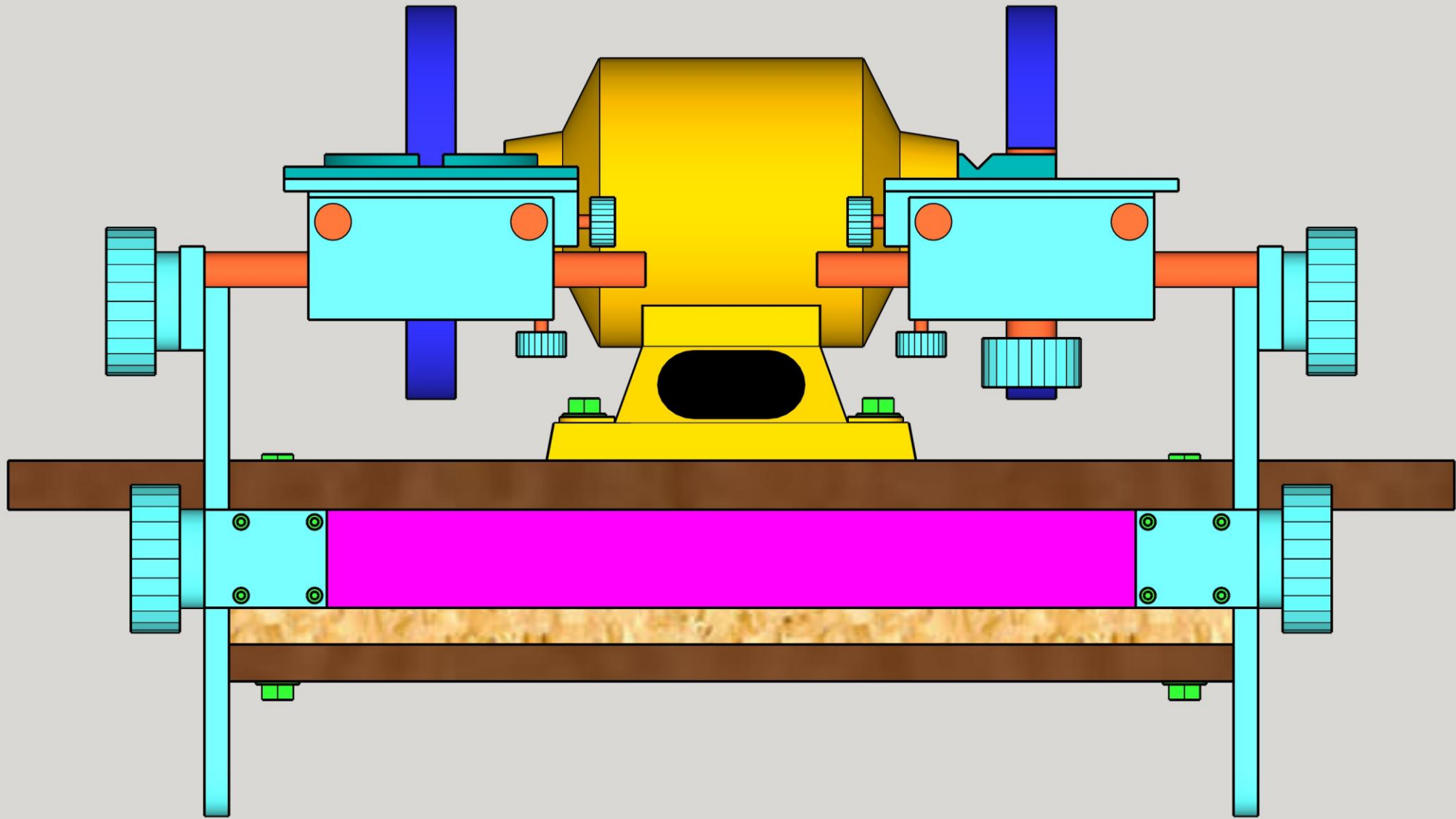


PARALLEL SLIDER WITH WORKPIECE

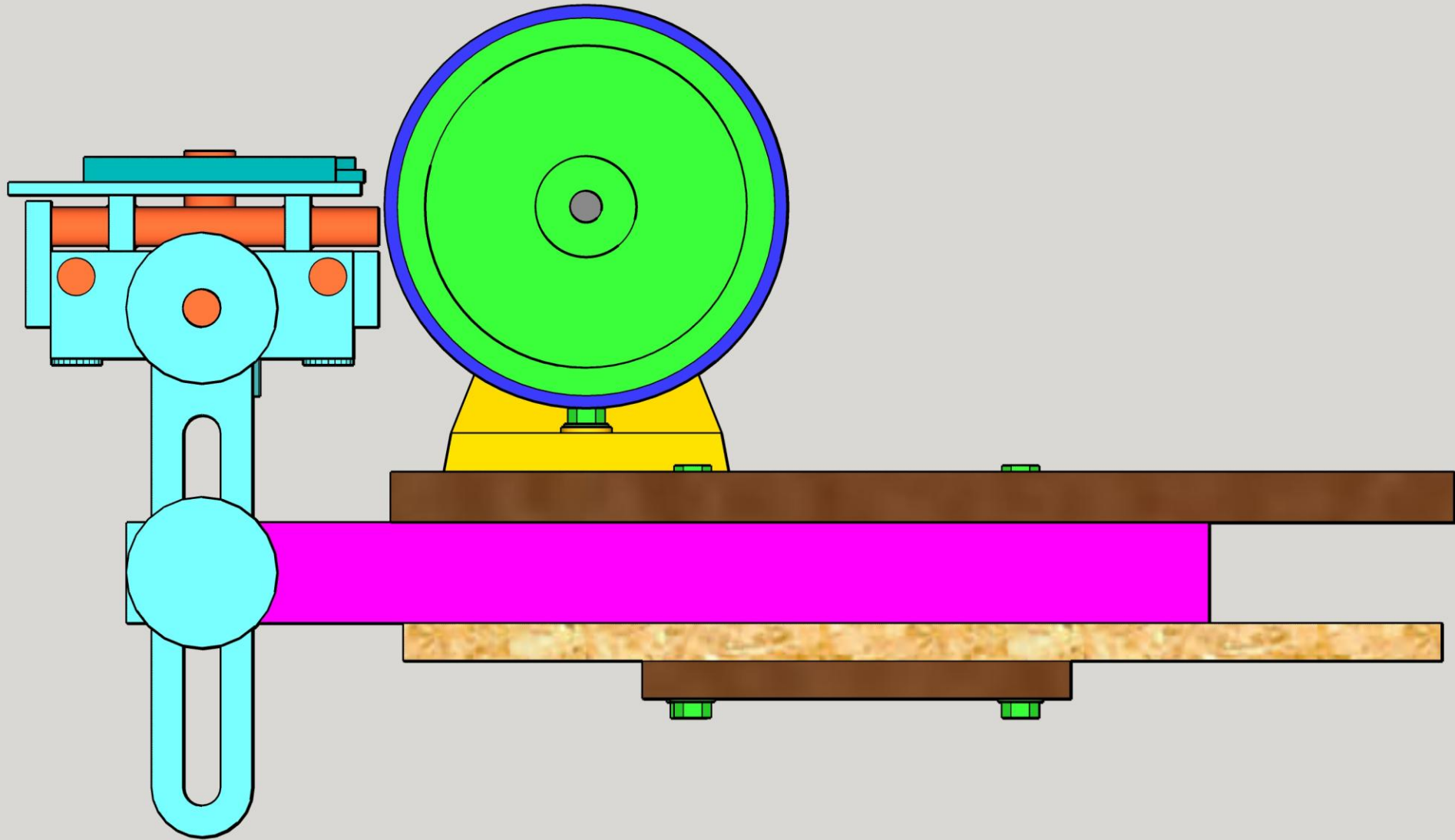
- Parallel Slider with workpiece
- Note V Block on other end of Parallel Slider
- Flip it end-for-end and a canted Workpiece can be cut



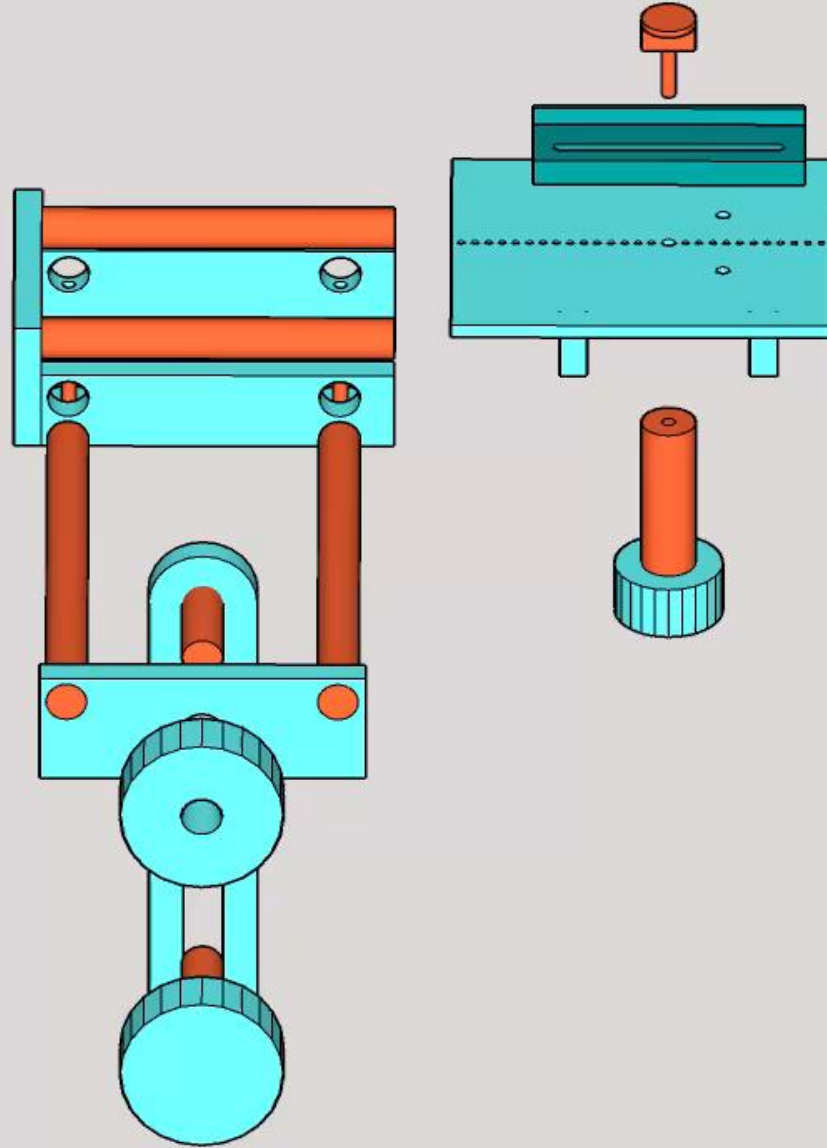
IN SUMMARY, ORTHOGRAPHIC FRONT VIEW



IN SUMMARY, ORTHOGRAPHIC RIGHT VIEW



IN SUMMARY, EXPLODED VIEW



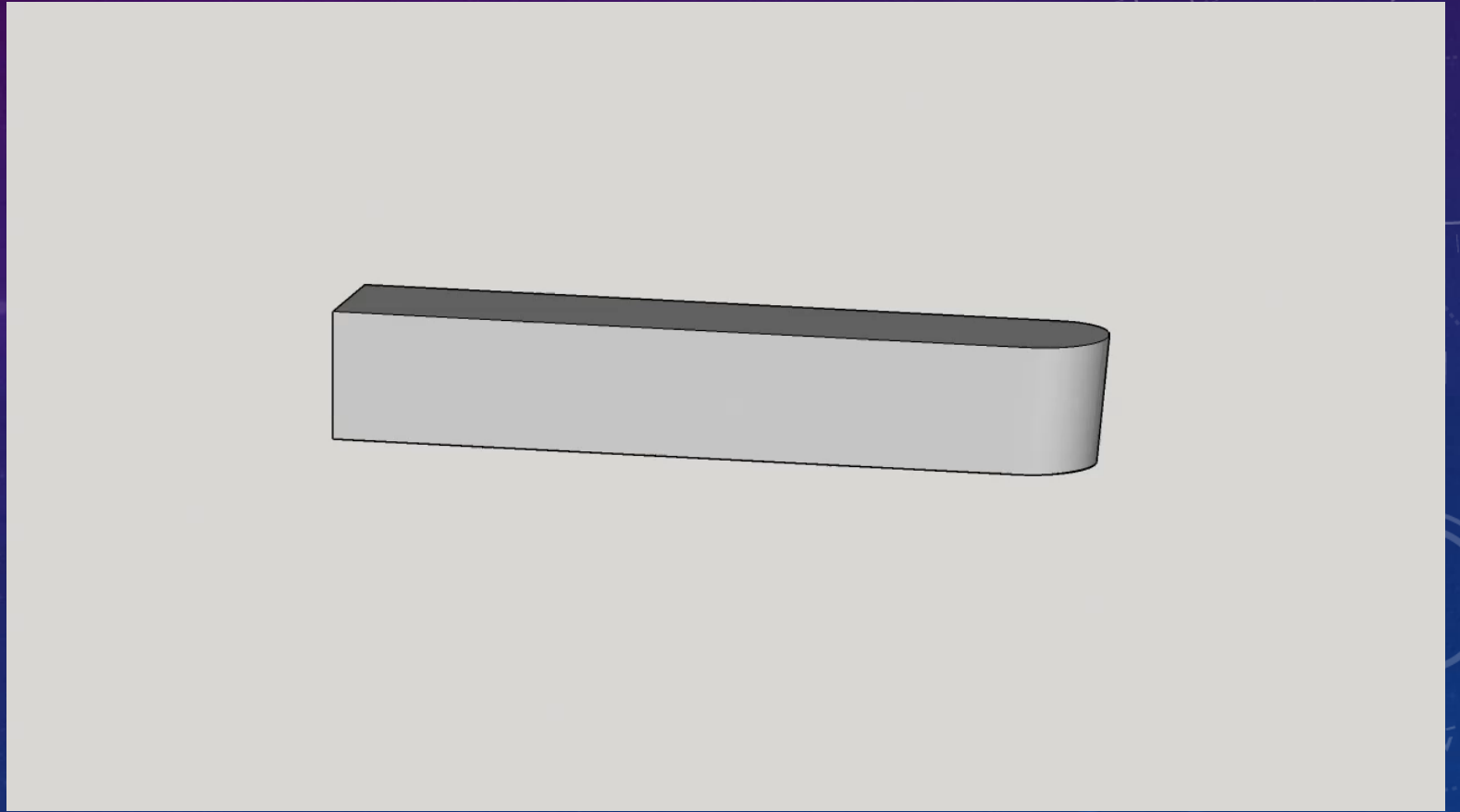
THUS FAR

- These Sliders only allow the cutting of flat faces
- Need something to aid radius cutting

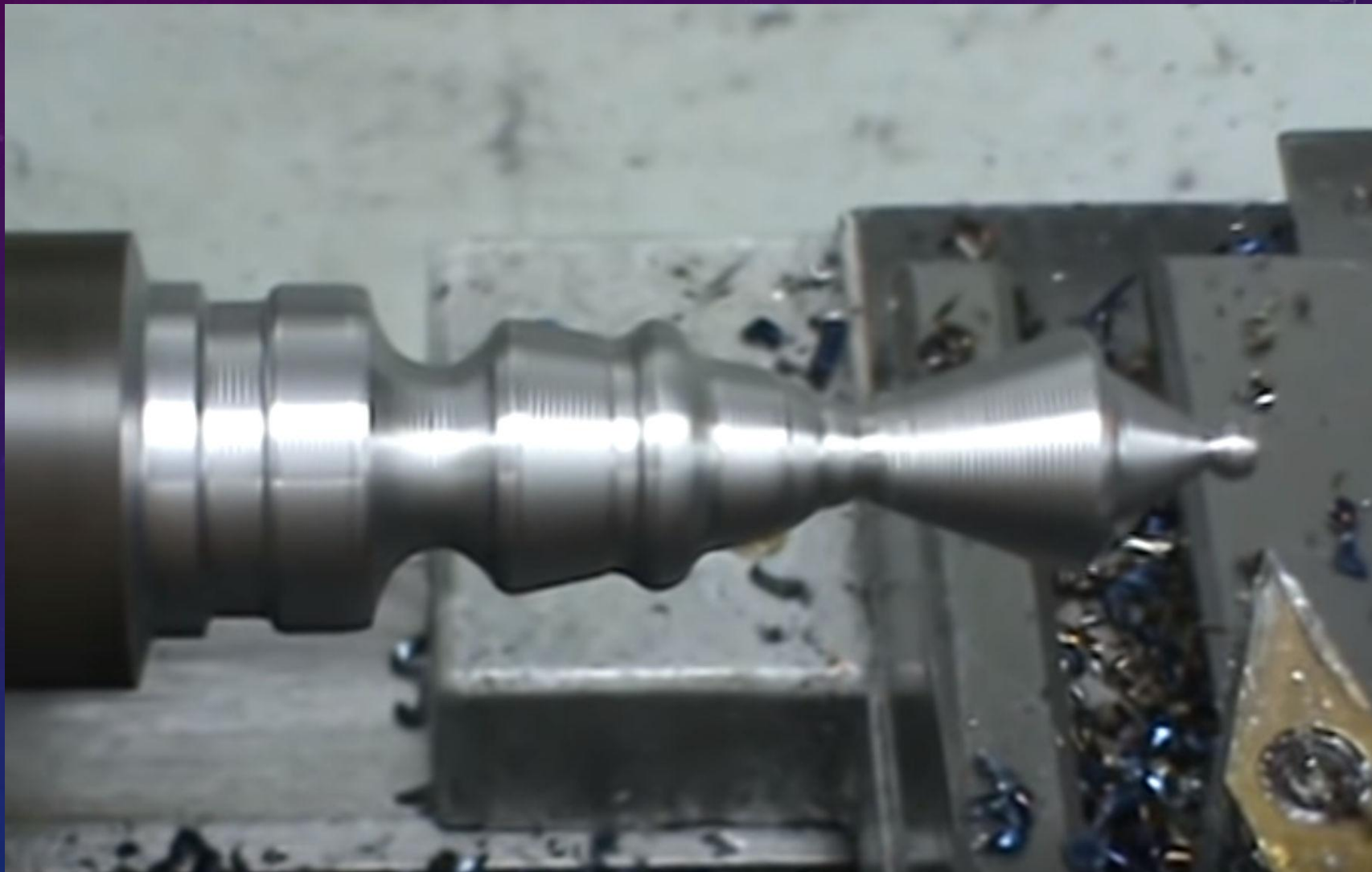


A SMALL RADIUS CUTTING TOOL

- Radius of the cutting edge is a semi-circle.
- A fillet cutting tool?
- A fly cutter?
- A form cutting tool?

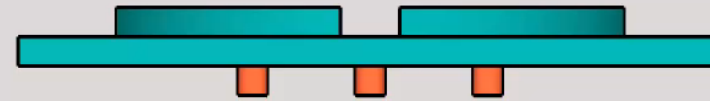


MAYBE MAKE A SET OF METAL CHESS PIECES



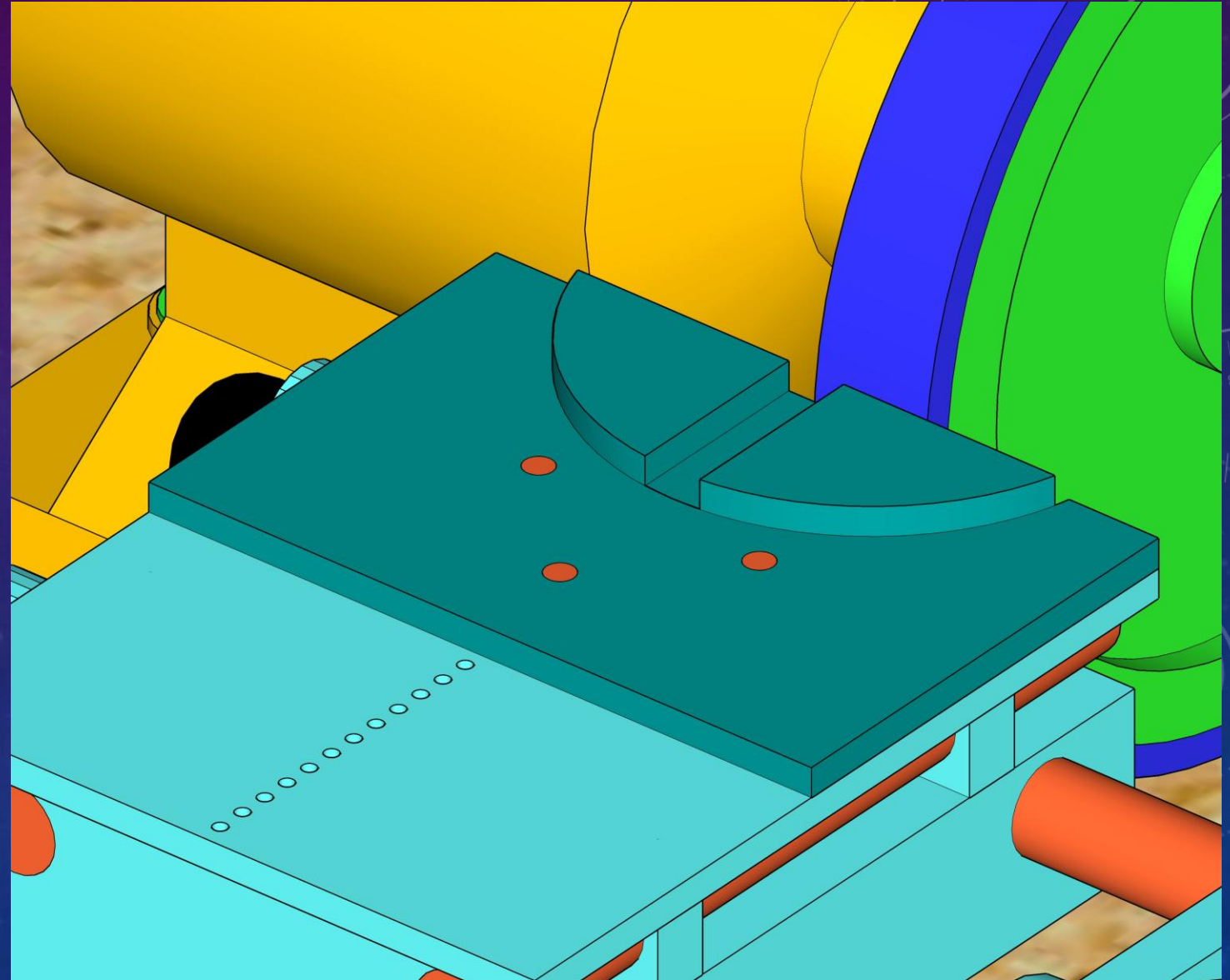
INTRODUCING TWO NEW PARTS

- Small radial tool holder and guide
- The three pins fit into the work table
- Goal is to cut a small radius on a tool
- CRS case hardened and some tool steel

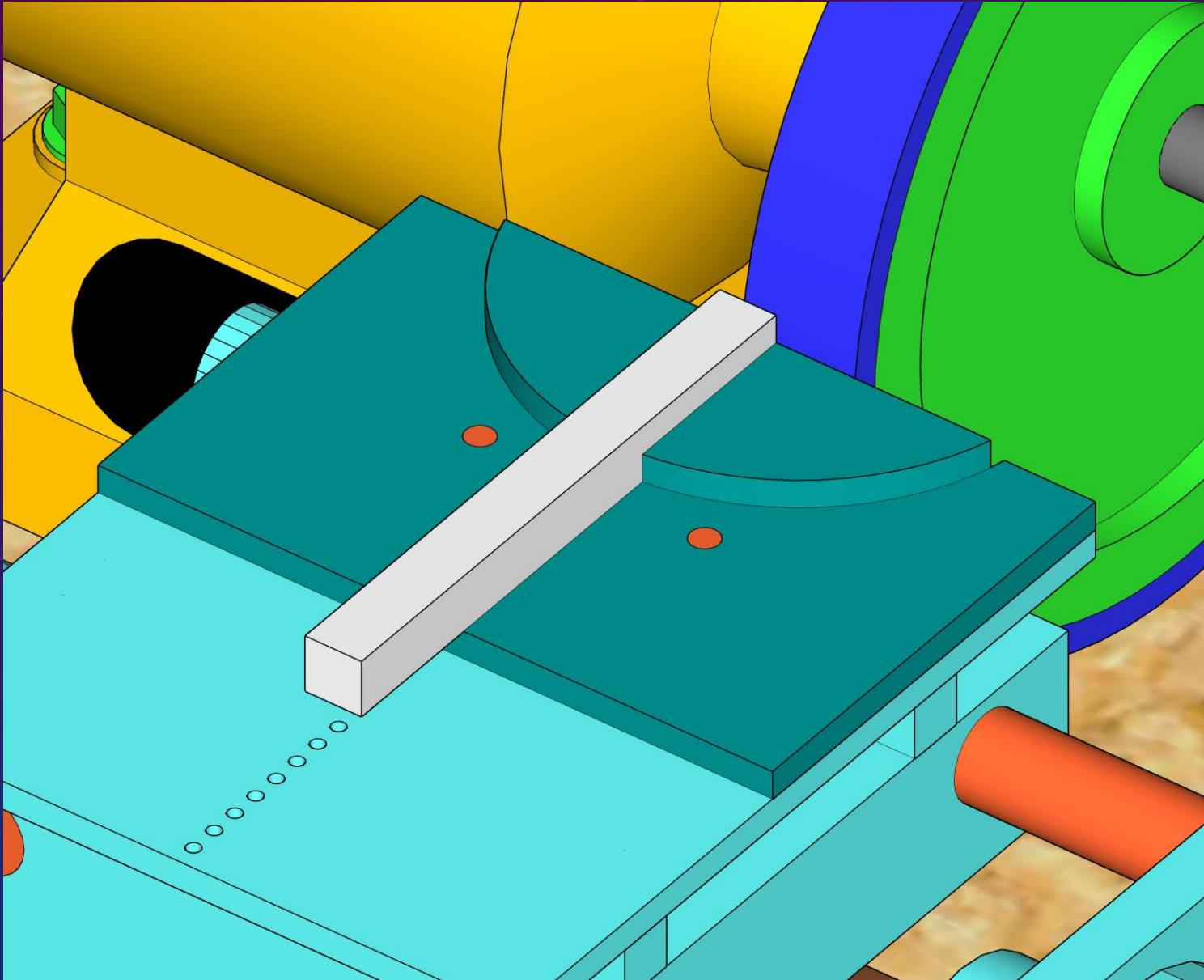


SMALL RADIAL TOOL HOLDER ASSEMBLED

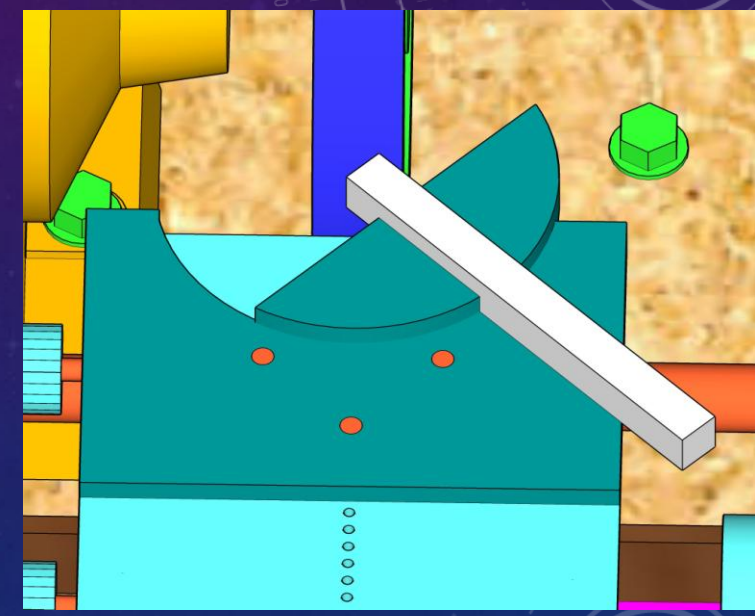
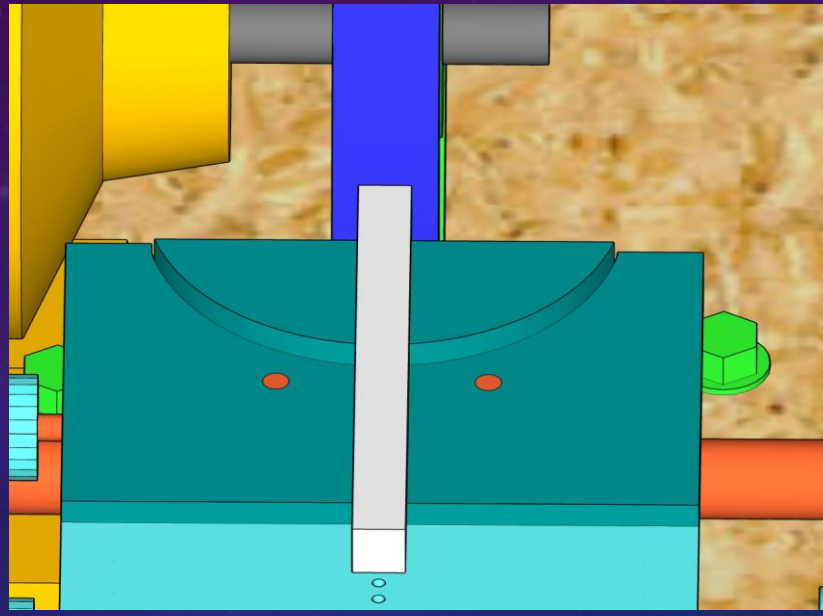
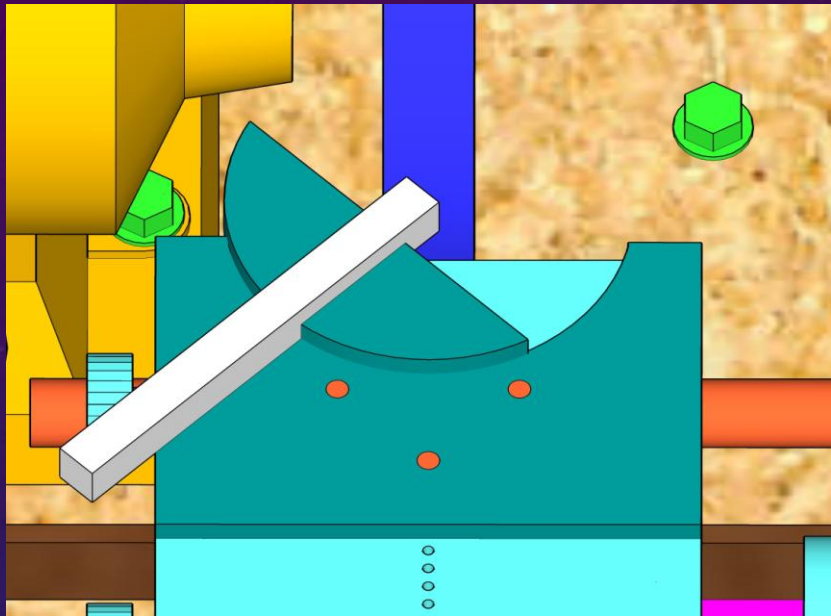
- Small radial tool holder and guide in place atop the work table



SMALL RADIAL TOOL HOLDER WITH WORKPIECE

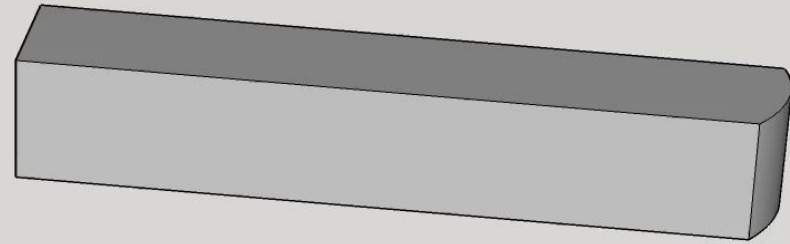


SMALL RADIUS CUTTING OPERATION



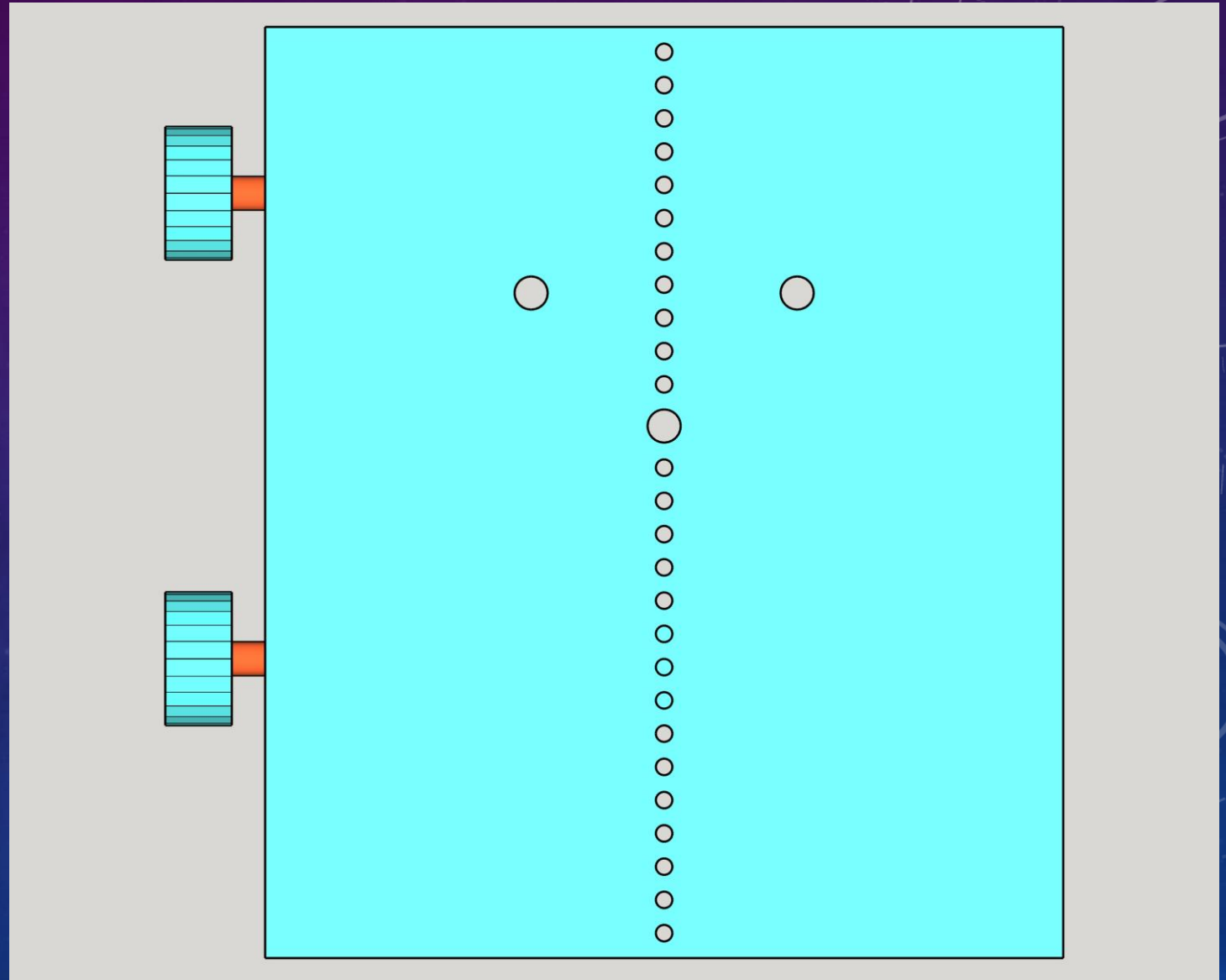
A LARGE RADIUS CUTTING TOOL

- End of the tool is not flat but, it is curved.
- Cutting edge is only a few degrees of a circular arc.
- Use to scrape in precision surfaces?
- A form cutting tool?

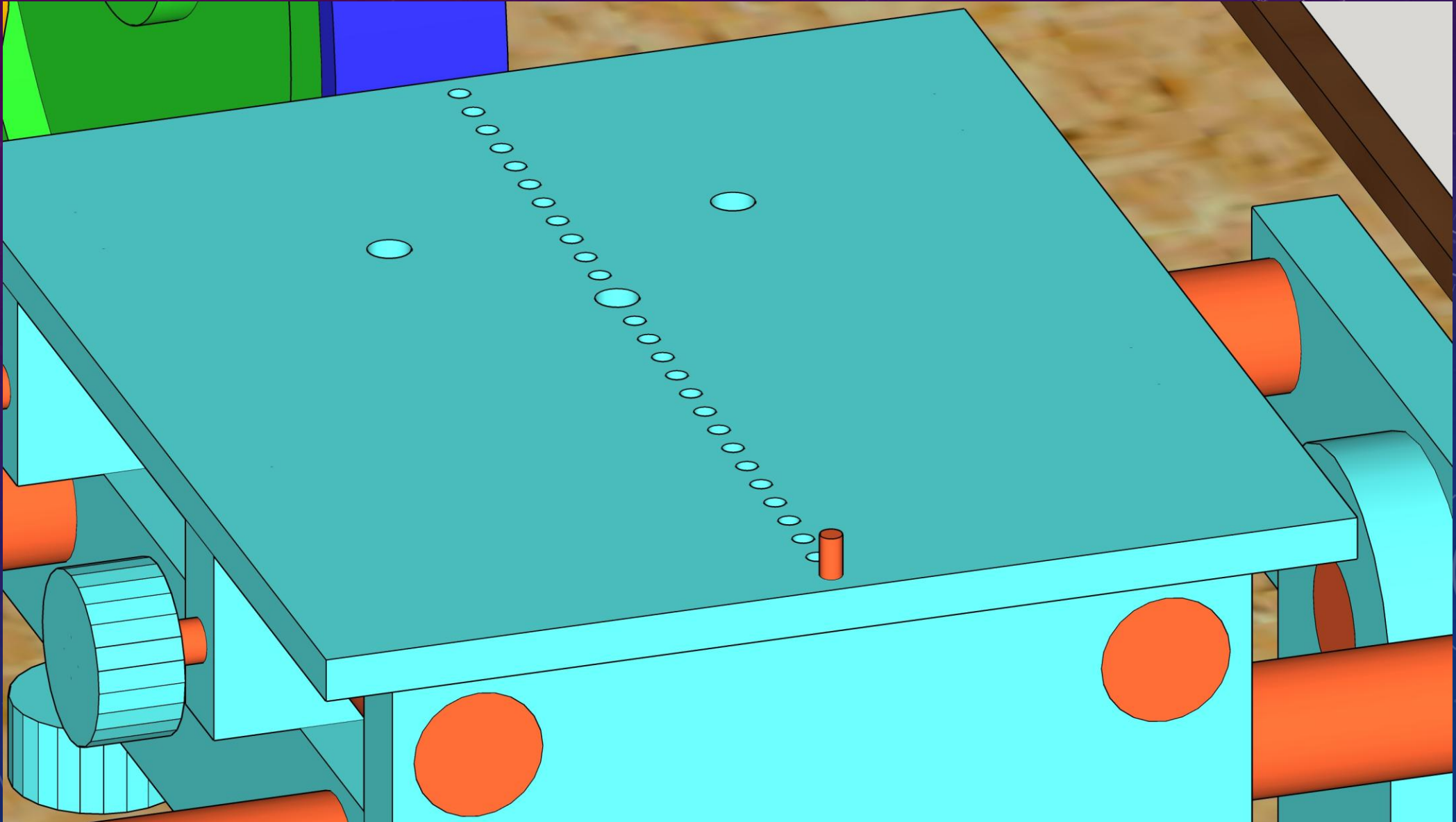


TOP VIEW OF WORK TABLE

- Small holes are drilled and tapped 4 - 40 UNF
- One small hole is selected to hold a 0.125" pin

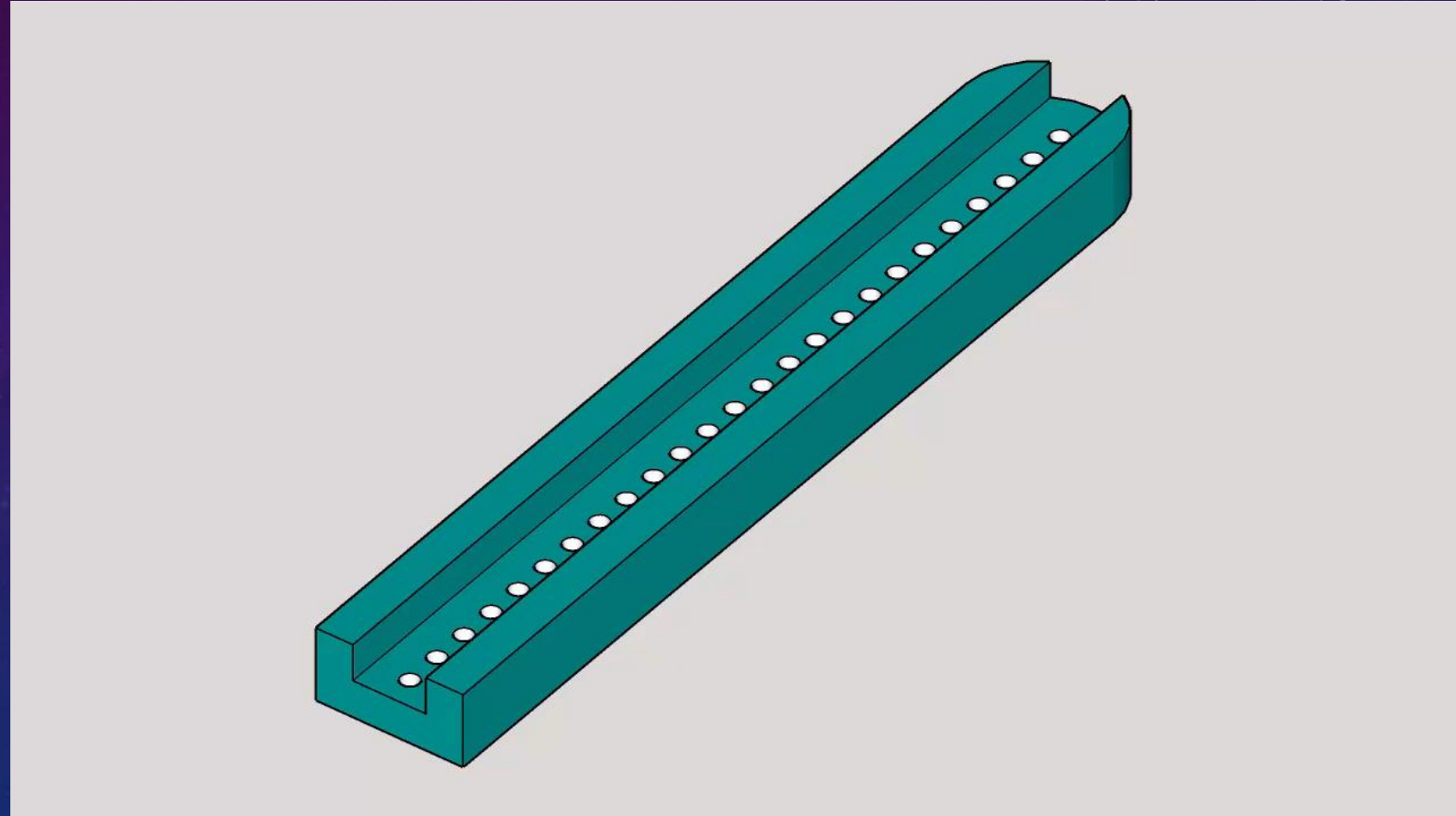


PIVOT PIN PLACED



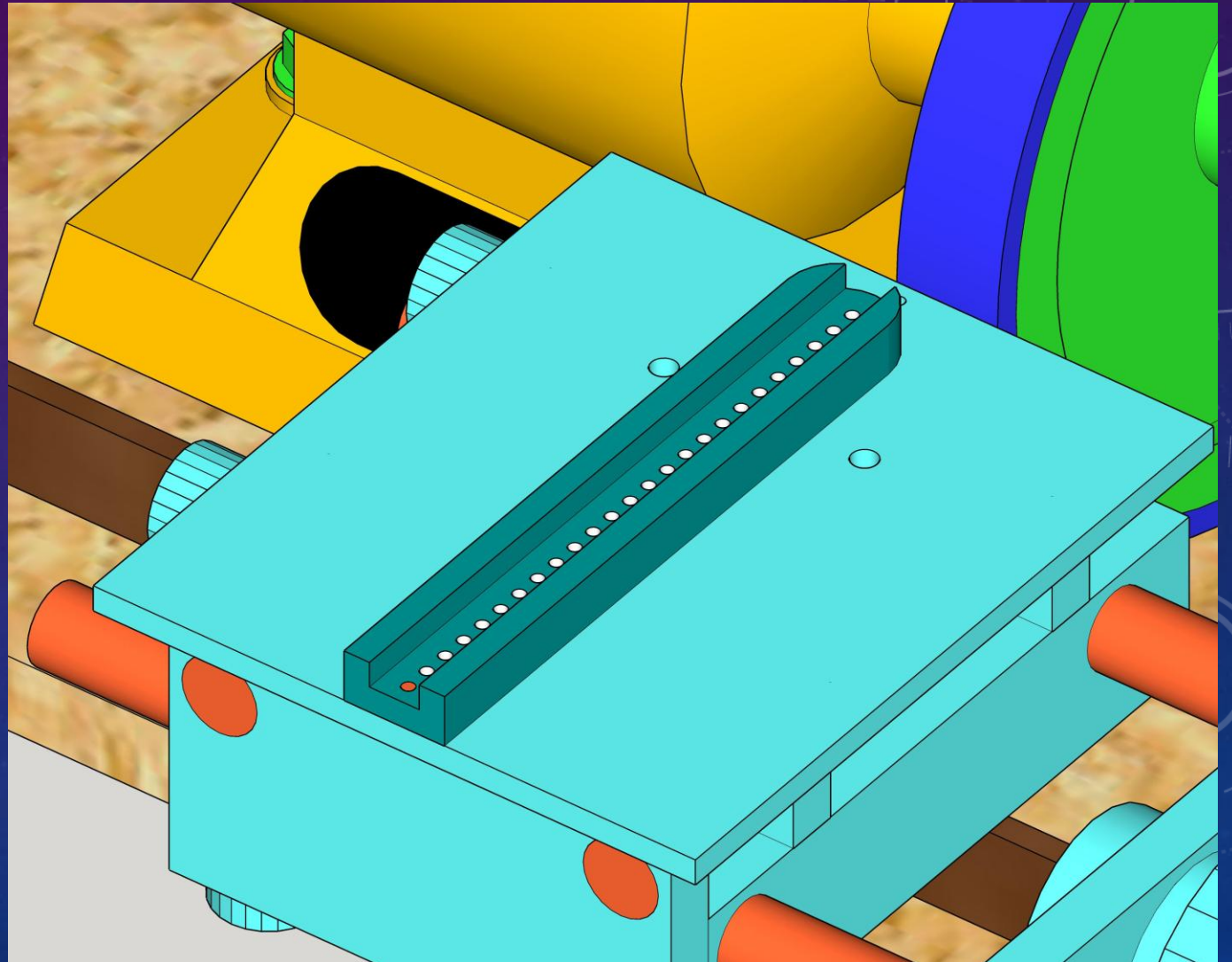
YET ANOTHER NEW PART

- Large radius tool holder
- CRS case hardened

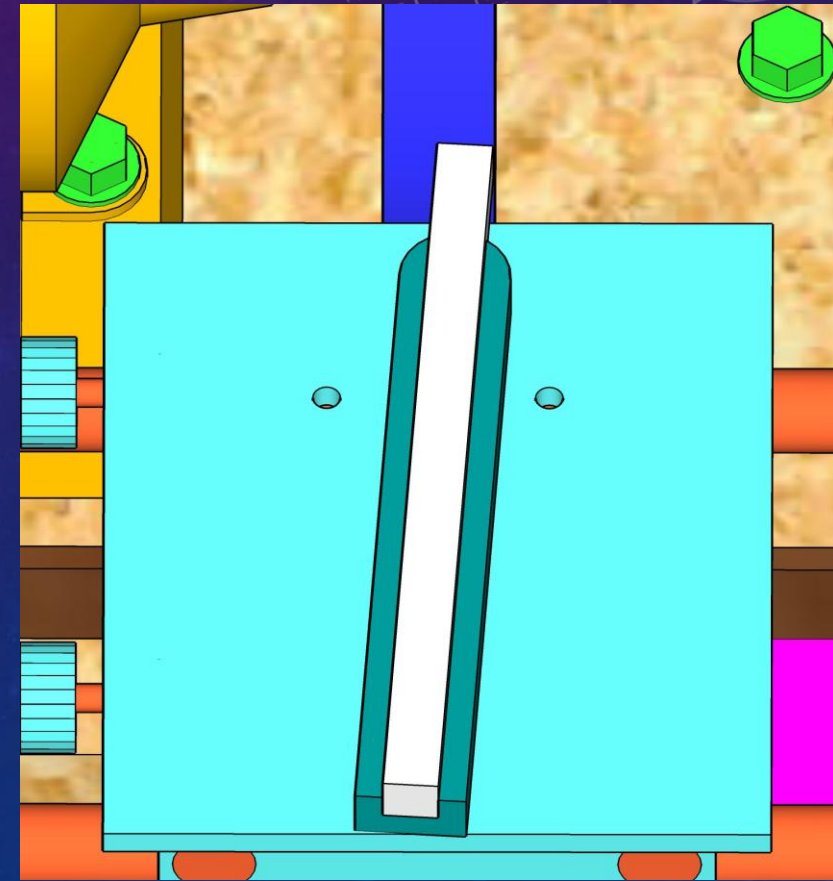
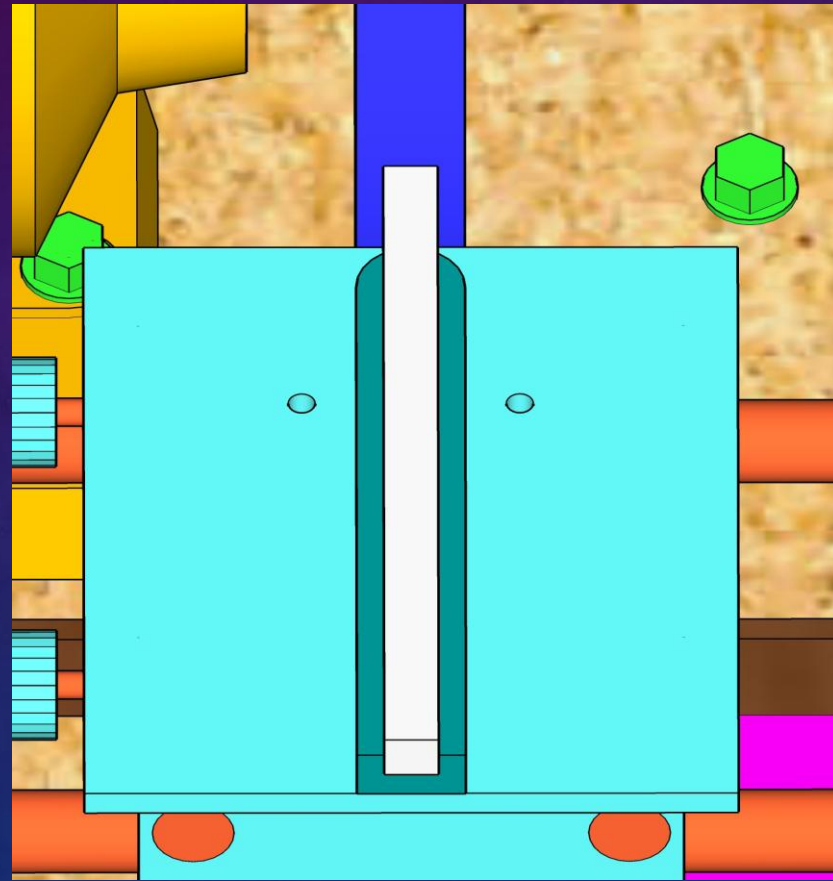
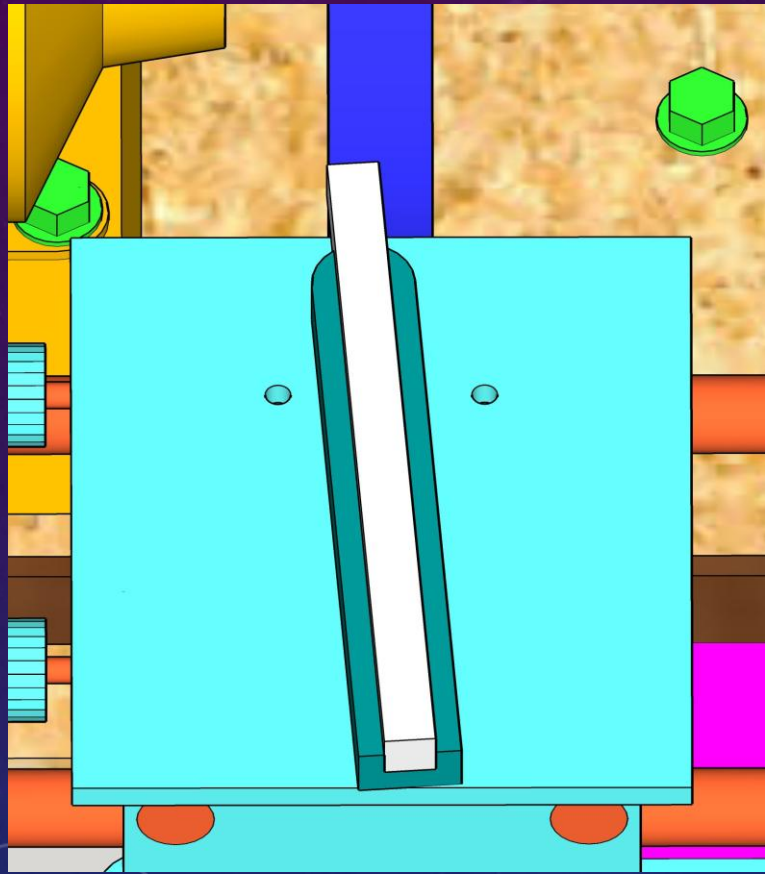


LARGE RADIUS TOOL HOLDER ASSEMBLED

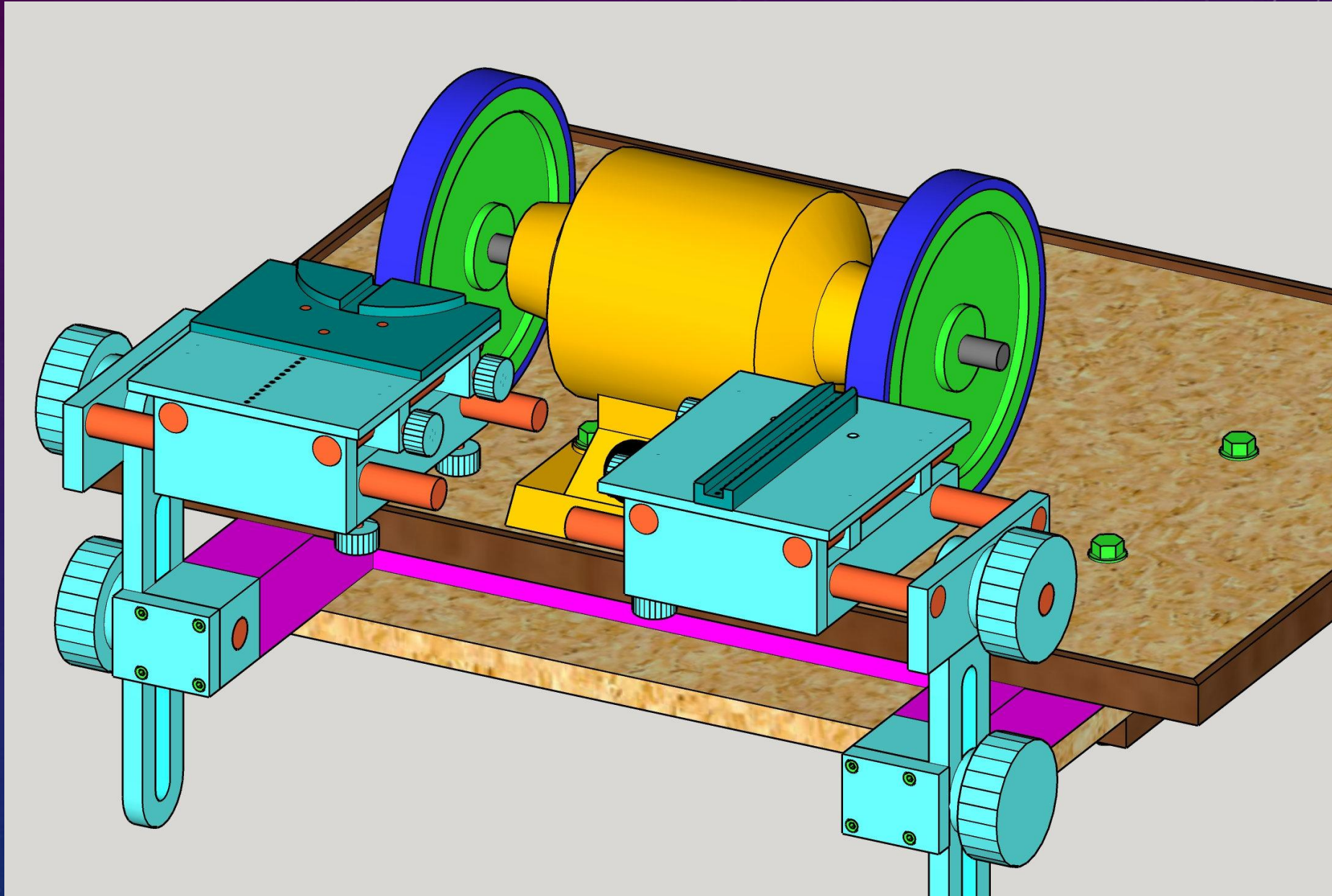
- Large radius tool holder in place atop work table
- Tool holder sits on top of the pivot pin
- Many pivot holes in tool holder
- Many pivot holes in work table
- Work table can slide toward/away from grinding wheel
- Vast number of different radii can be cut



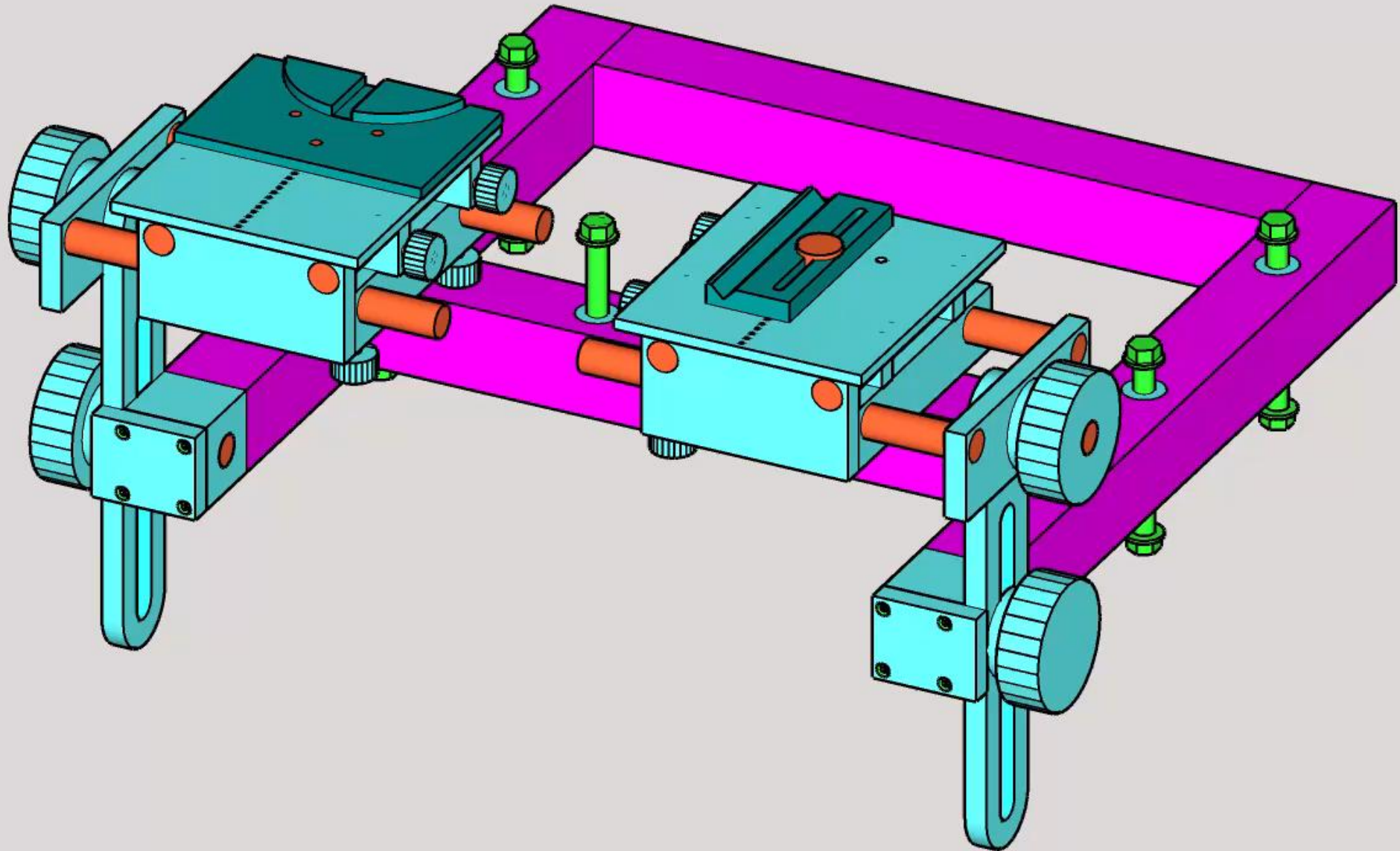
LARGE RADIUS CUTTING OPERATION



THE BIG PICTURE

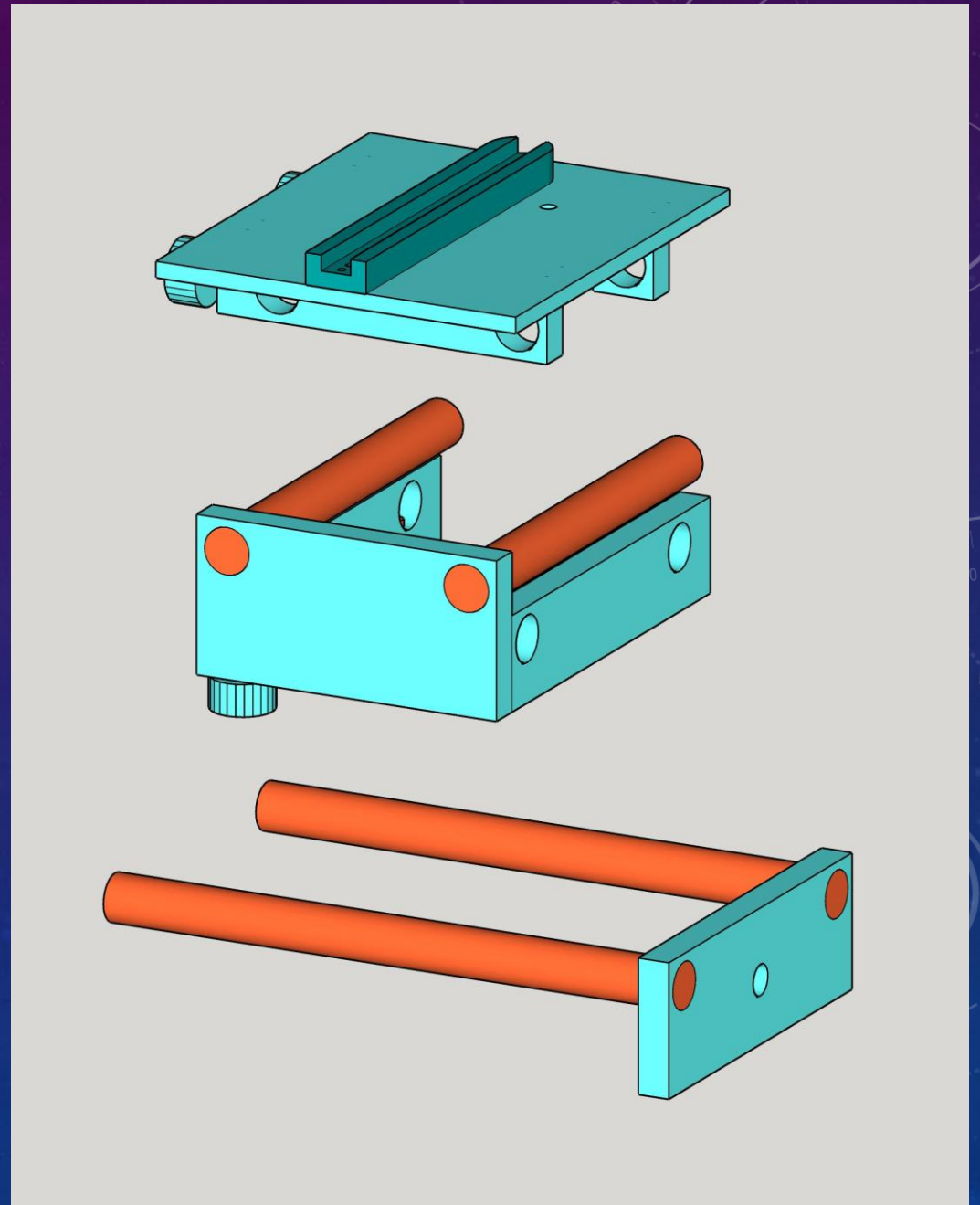


THE SKELETON



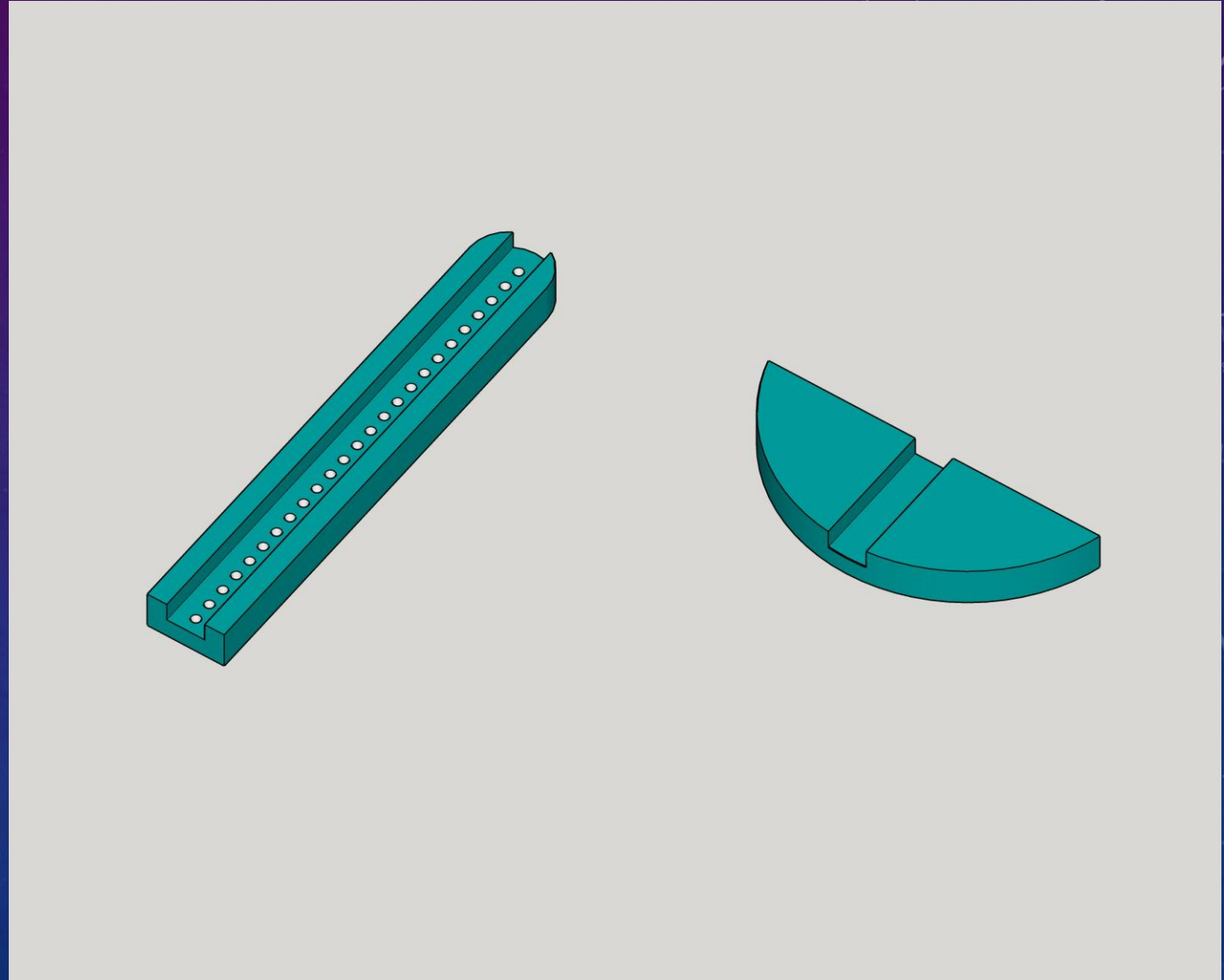
DEJA VU

- The fork arms of the tilt assembly are analogous to the ways of a metal lathe
- The carriage assembly is analogous to the carriage of a metal lathe
- The work table is analogous to the cross slide of a metal lathe
- The alignment guides are analogous to the compound slide of a metal lathe



EXTRA PARTS NEEDED

- Both radial tool holders are custom made to fit a specific size of stock
- Will need different sized tool holders for different sizes of stock
- For starters:
 - 0.500"
 - 0.375"
 - 0.250"
- For engraving tools:
 - 0.125
 - 0.094



PRECISION GRINDING

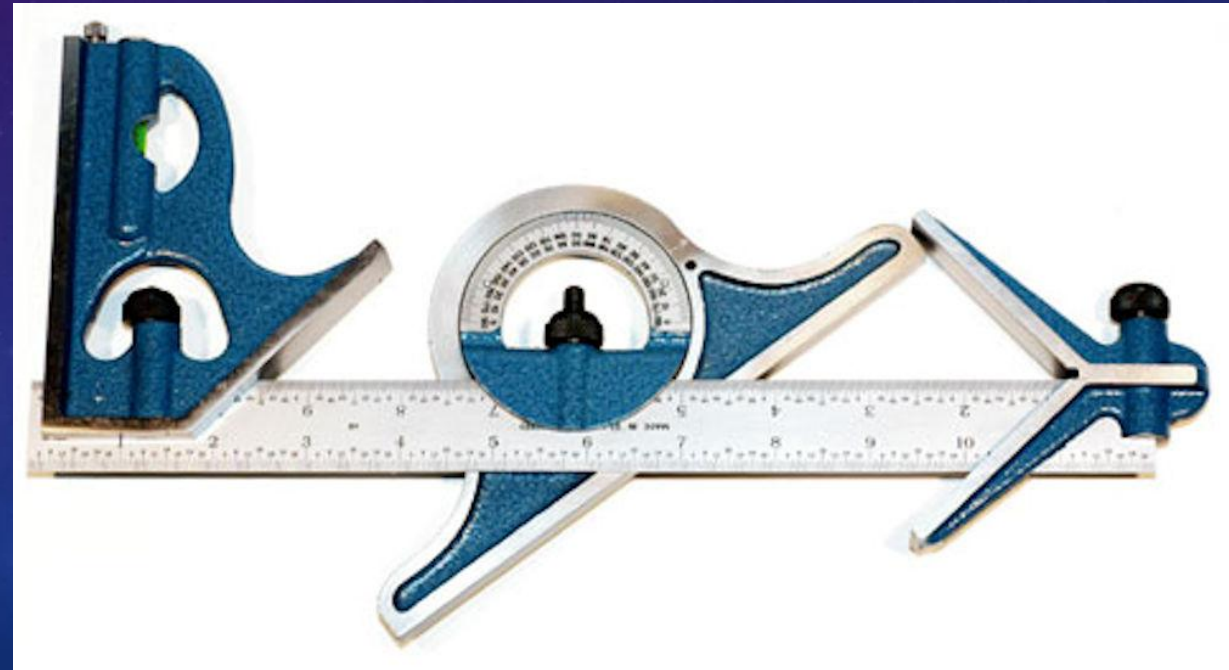
- Most tools used for lathe work, fly cutter work and scraping, do not require precision angles on the tool faces.
- Other things, like engraving tools and form-cutting tools, may need faces and cutting edges positioned at exact angles.
- This grinding jig allows substantial control of tool face angles and edges although probably not to the extent that a tool and die maker would want.

SETTING A SLIDER ANGLE

Digital Protractor

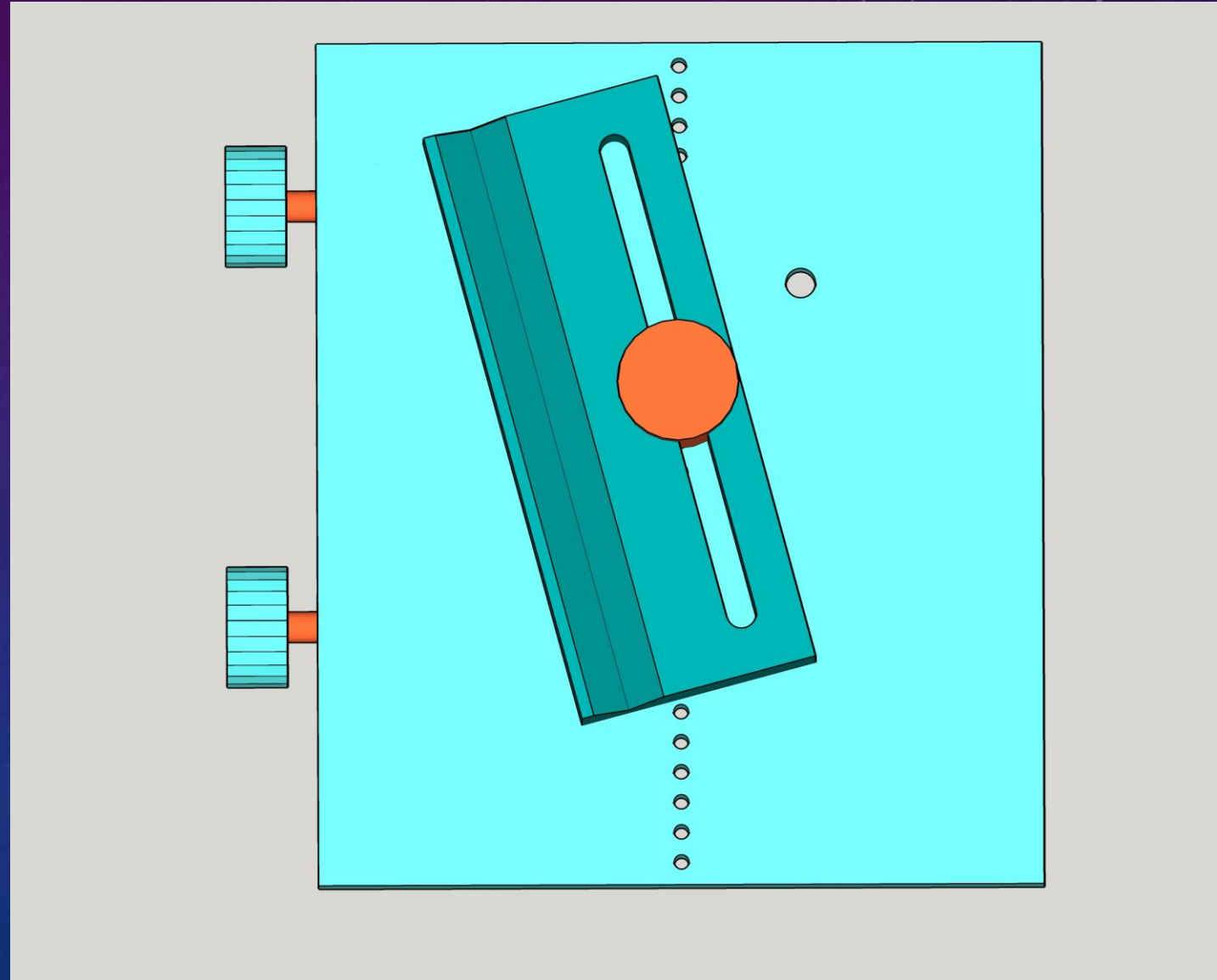


Combination Square



SLIDER SET AT AN ANGLE

- Goal: set cutting edge of workpiece at an exact angle
- Top view of work table
- Edges of the work table have been cut square and are square with the grinding wheel face
- Angle can be set with a machinists' square + a digital protractor or, with just a compound square
- Perpendicular Slider shown set at an angle



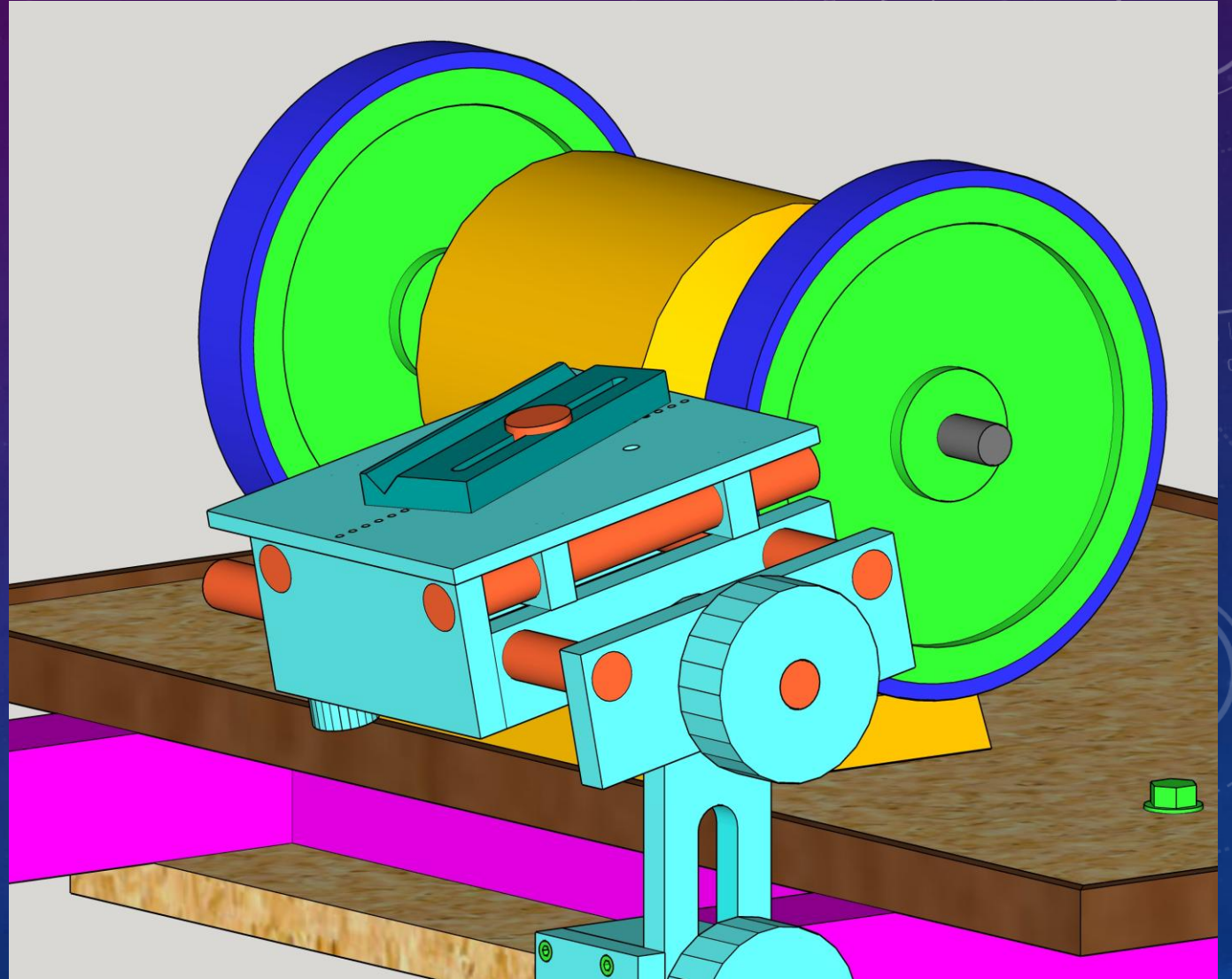
INCLINOMETERS

- The tilt of the work table must be controlled.
- Digital inclinometers measure vertical angles
- Objective is to exactly control relief angles
- Inclinometers typically come with a magnetic base... ideal for attachment to CRS
- Good quality inclinometers cost \$100+
- A cheaper version at Home Depot only cost \$27



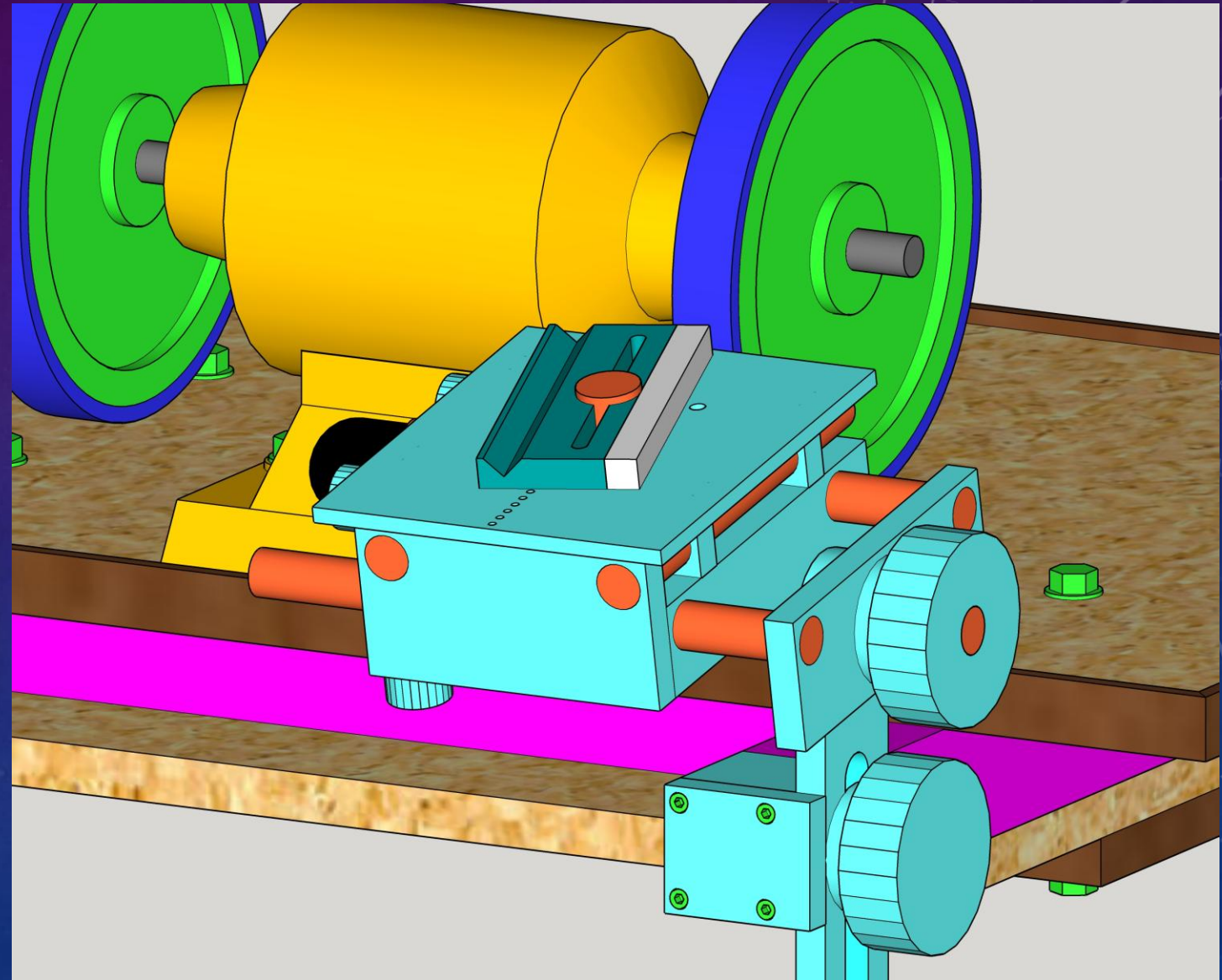
WORK TABLE TILTED

- Goal: Cut an exact relief angle
- Work table shown set at an angle



READY TO CUT COMPOUND ANGLE

- Slide rotated to cut proper face angle
- Work table tilted to cut proper relief angle
- Work table lowered to aim workpiece at CBN wheel
- Ready to cut a compound angle



WHY GRIND AT A COMPOUND ANGLE?

- Tangential lathe tools have cutting edges ground at a compound angle
- Point of the tool is at a corner
- Cutting takes place at the corner and along the two edges that form the corner
- The cutting edges slope down and away from the point... possibly at different angles
- Tangential tools are cool because you only have to remove a little metal from one face to resharpen them
- Resharpening not only cleans up the cutting edges but moves back the face at the same time



HOW CAN I CUT CHIP BREAKERS?

- Dremel tool?
- 8" disk out of an angle grinder in place of CBN wheel?
- Diamond files?
- Mounted stone or carbide burr and a vertical mill?

CLEAN UP THE MESS!

- CBN means no aluminum oxide grit to worry about
- Still have to deal with HSS swarf.
- 4.0 gallon shop vac **should** fit on shelf under the top of the Workmate 425
- \$70



BEHIND THE DEWALT GRINDER

- Grinder has exhaust ports formed from the safety shields surrounding the abrasive wheels
- Planning on a manifold that will connect the shop vac to the grinder exhaust ports
- Probably screw the manifold onto the work table.



I CAN'T SEE

- Every grinder needs light
- Maybe two lights will be enough
- Vendor wants \$136 for this light... more than a CBN wheel



THE END

