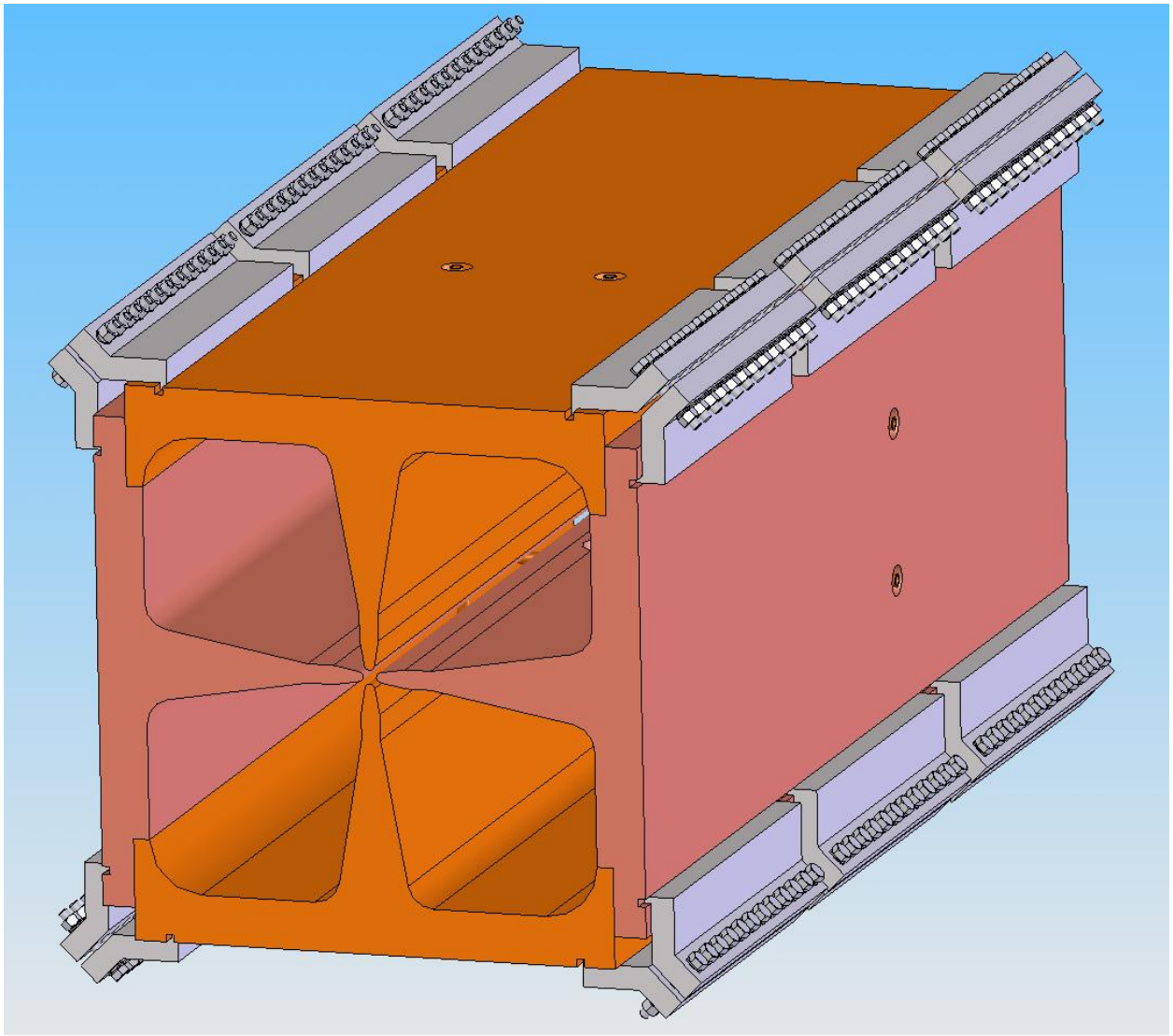
RFQ Construction Options

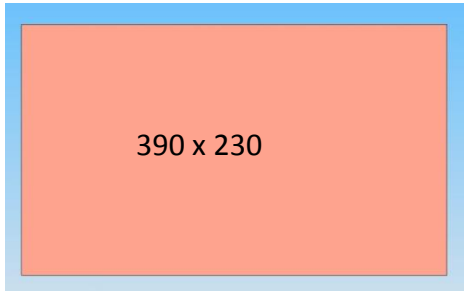


Matt Hoff LBNL May 19, 2011

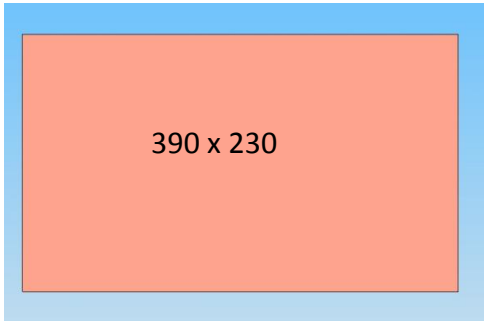
Raw Copper pieces required

Option 1

All Oven Braze



Major Vane

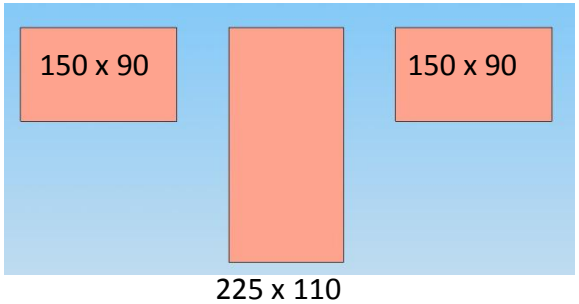


Minor Vane

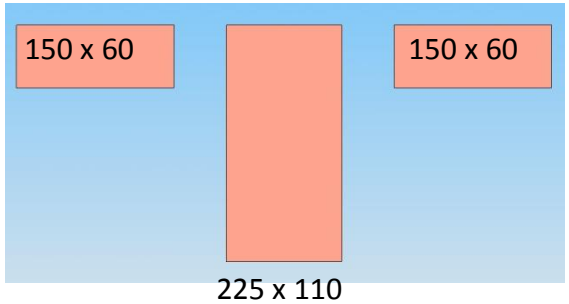
179,400 sq mm

Option 2

Part Ebeam weld
Part Oven Braze



Major Vane

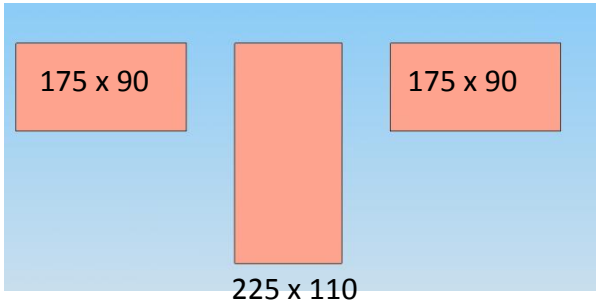


Minor Vane

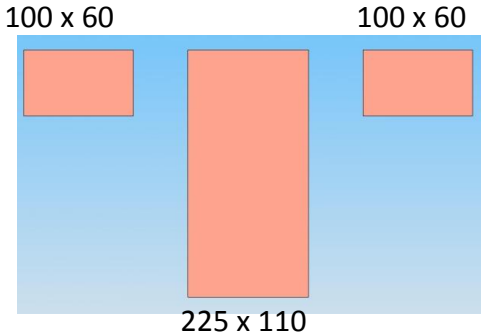
94,500 sq mm

Option 3

All Ebeam weld



Major Vane

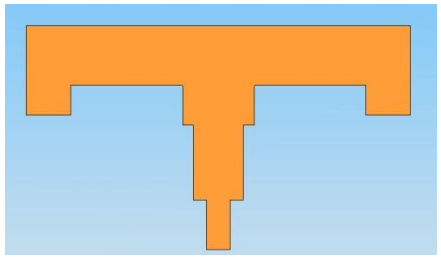


Minor Vane

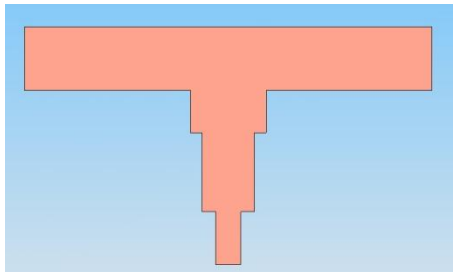
87,000 sq mm

Pre-machining step

Option 1

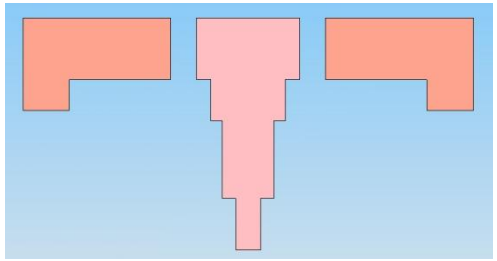


Major Vane

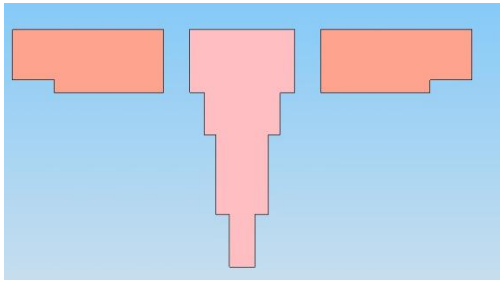


Minor Vane

Option 2

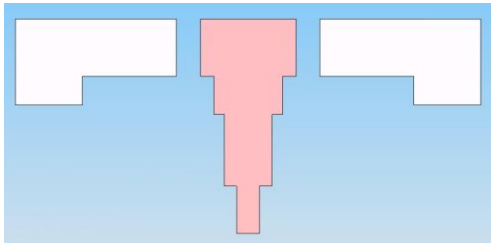


Major Vane

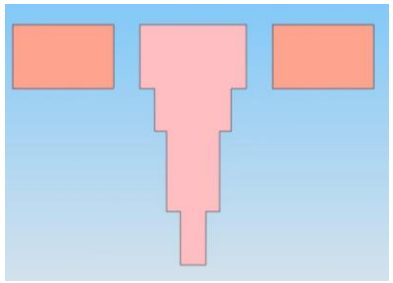


Minor Vane

Option 3



Major Vane



Minor Vane

Electron Beam Welding of vane pieces

Option 1

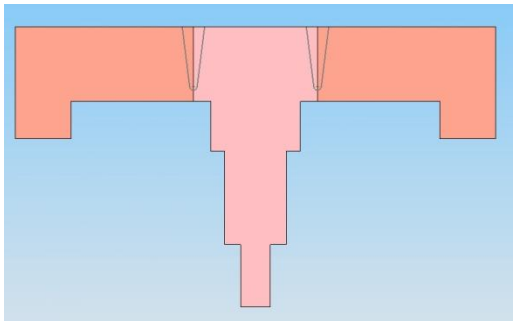
No weld

Major Vane

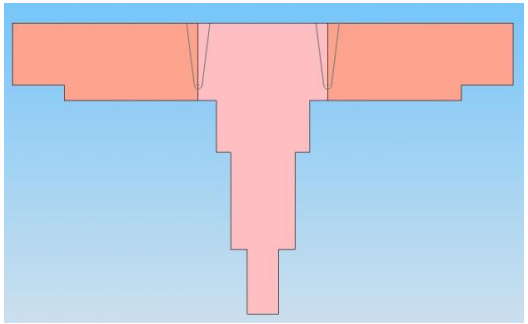
No weld

Minor Vane

Option 2

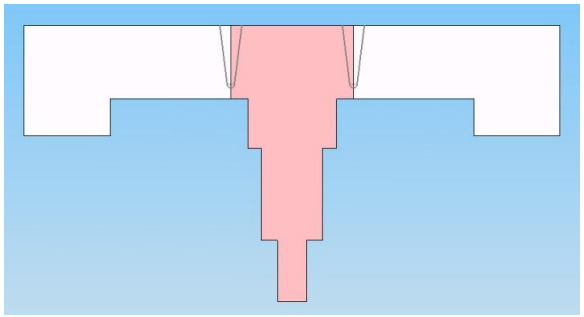


Major Vane

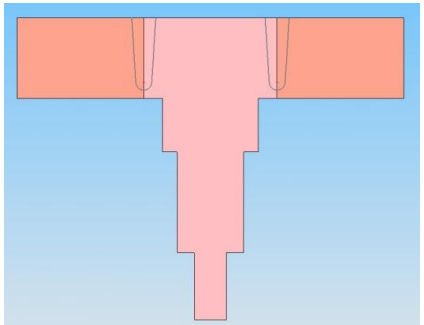


Minor Vane

Option 3



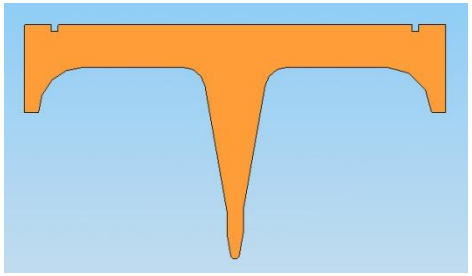
Major Vane



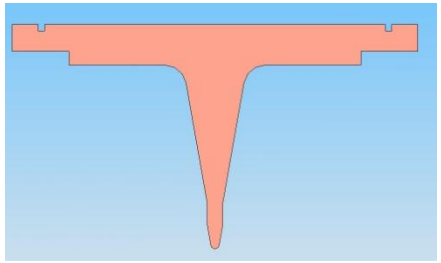
Minor Vane

Final Machining of Vanes

Option 1

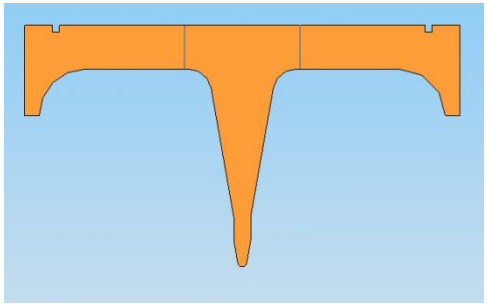


Major Vane

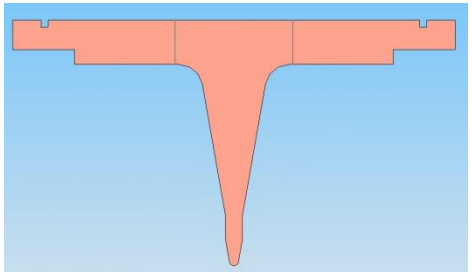


Minor Vane

Option 2

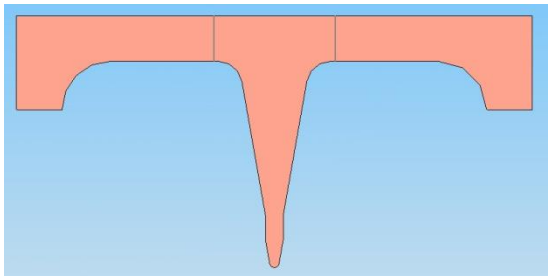


Major Vane

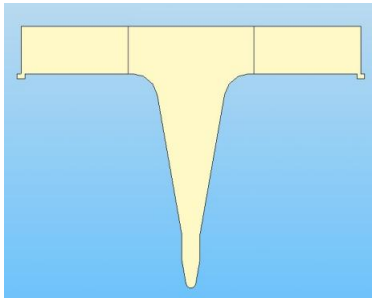


Minor Vane

Option 3



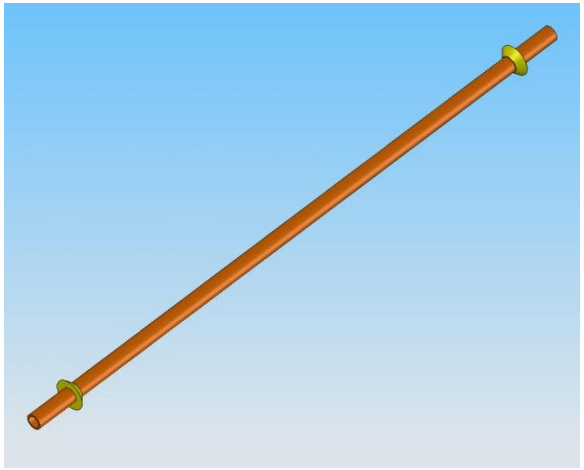
Major Vane



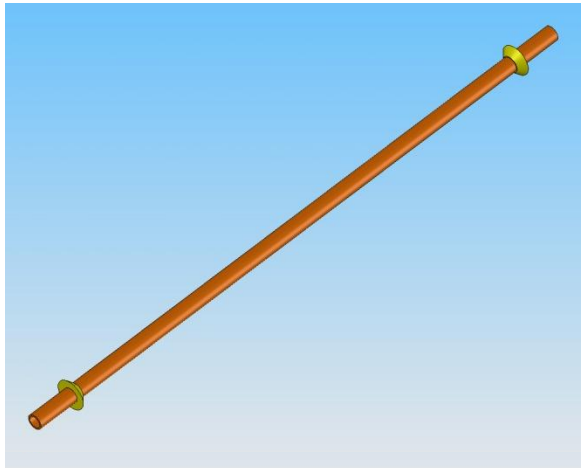
Minor Vane

Pi-mode Rods

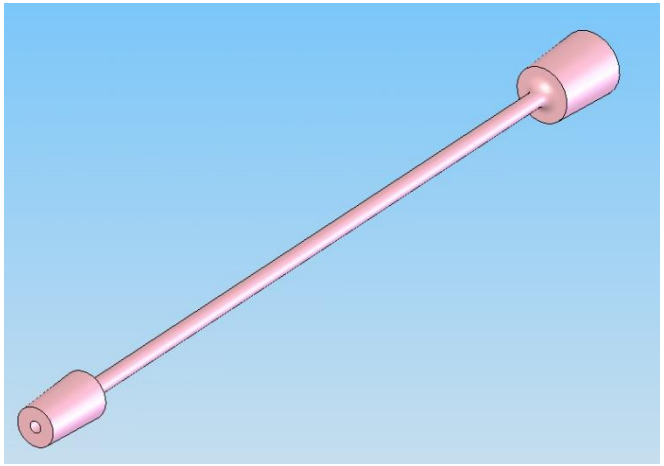
Option 1



Option 2

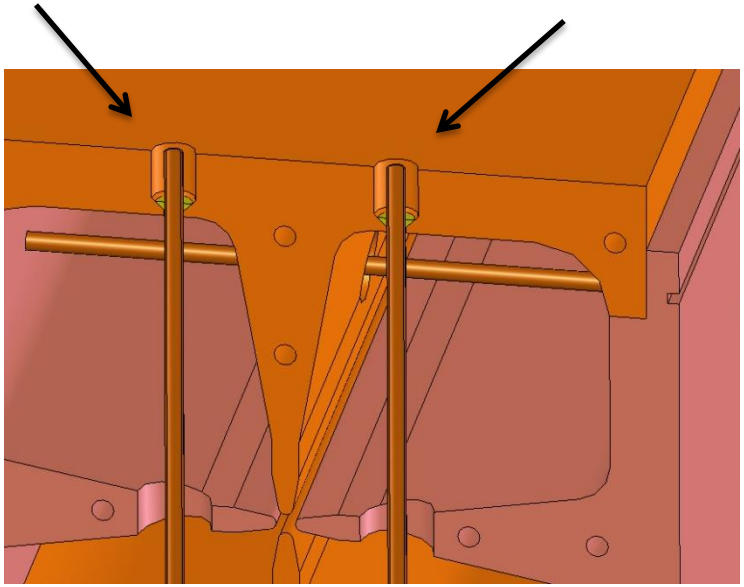


Option 3

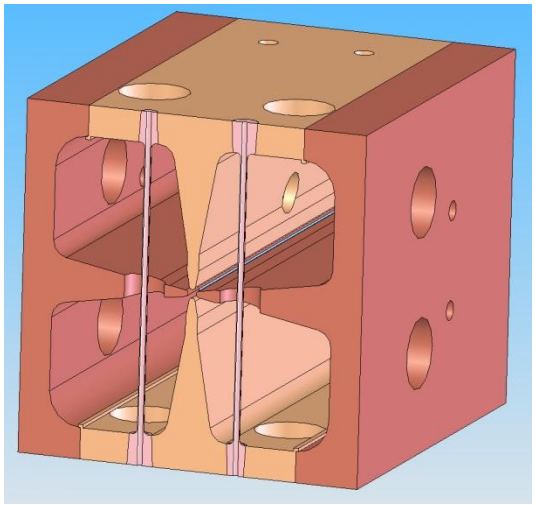


Oven Braze

Oven Braze

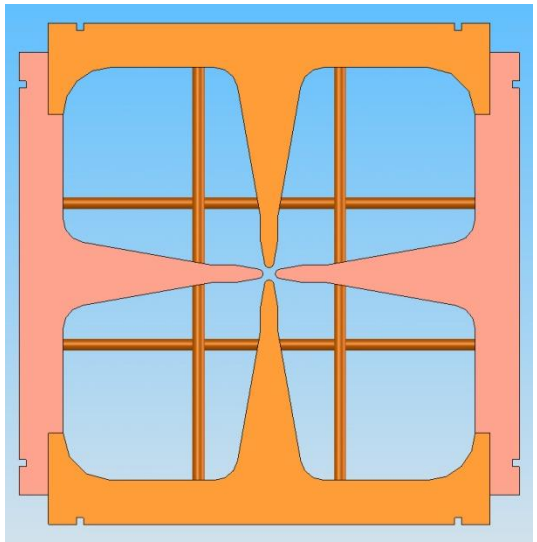


Electron Beam Weld

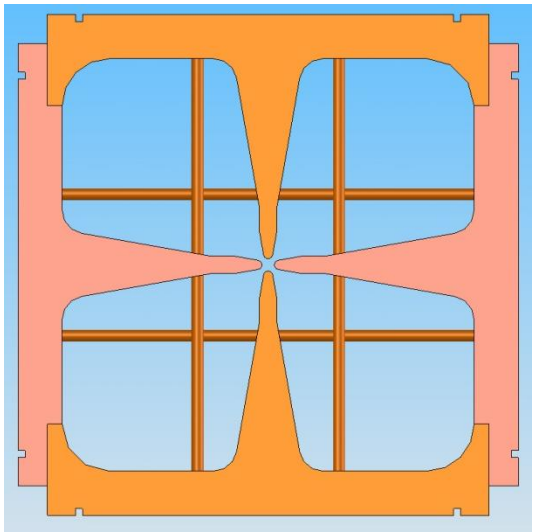


Module Dry Assembly

Option 1



Option 2



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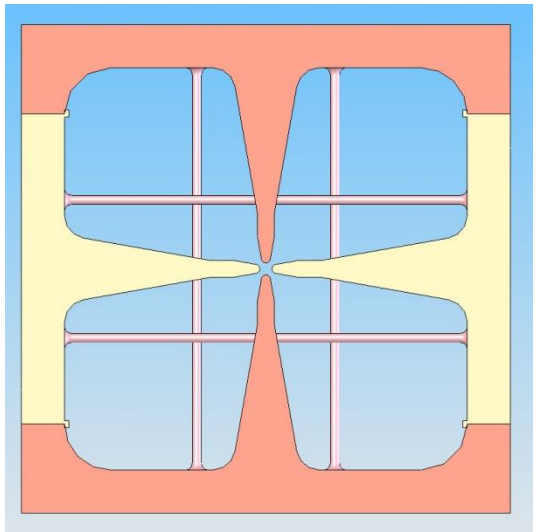
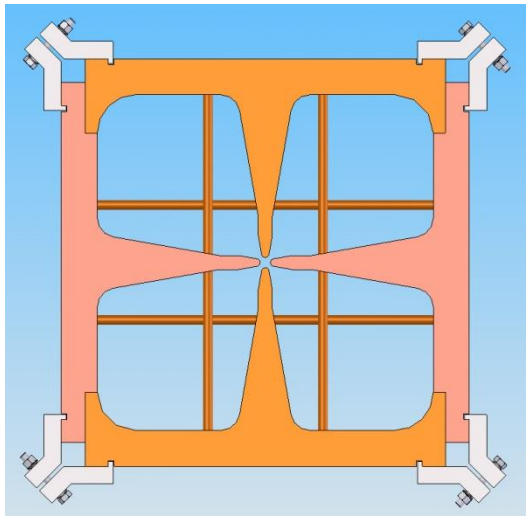
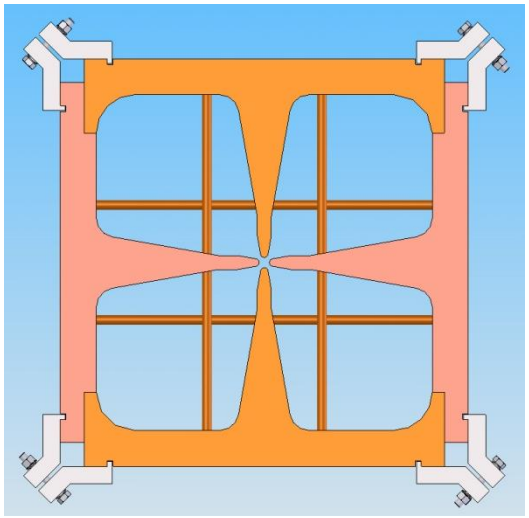


Oven Braze of Vanes and Pi-mode Rods

Option 1

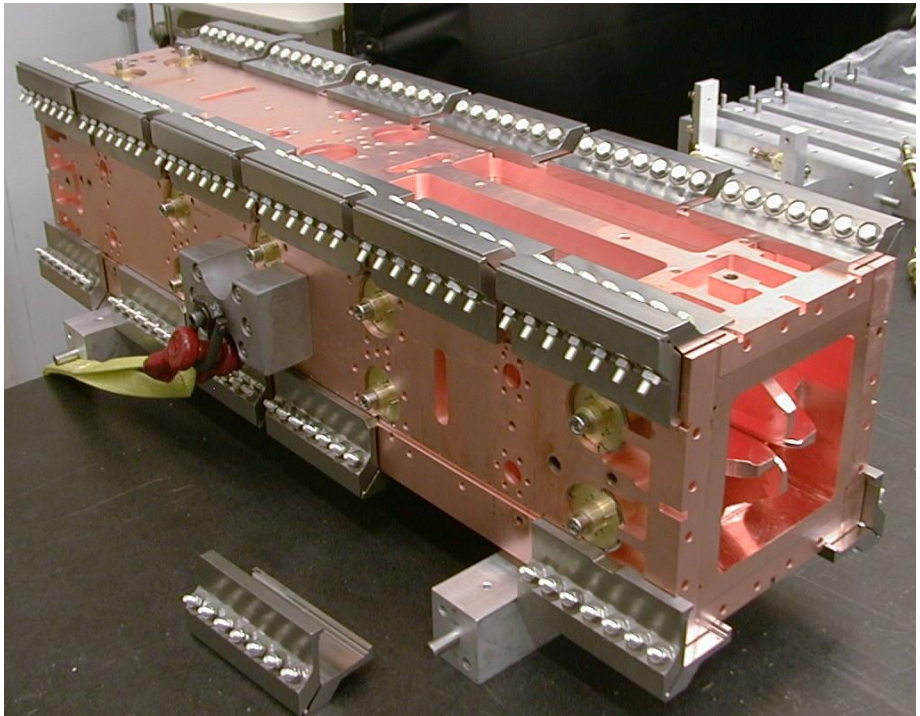


Option 2



Option 3

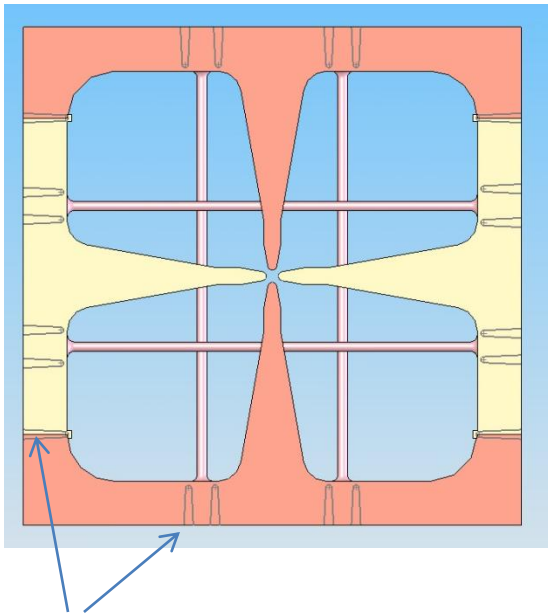
No Oven Braze



Electron Beam Weld Vanes and Pi-mode Rods Together

No electron beam weld

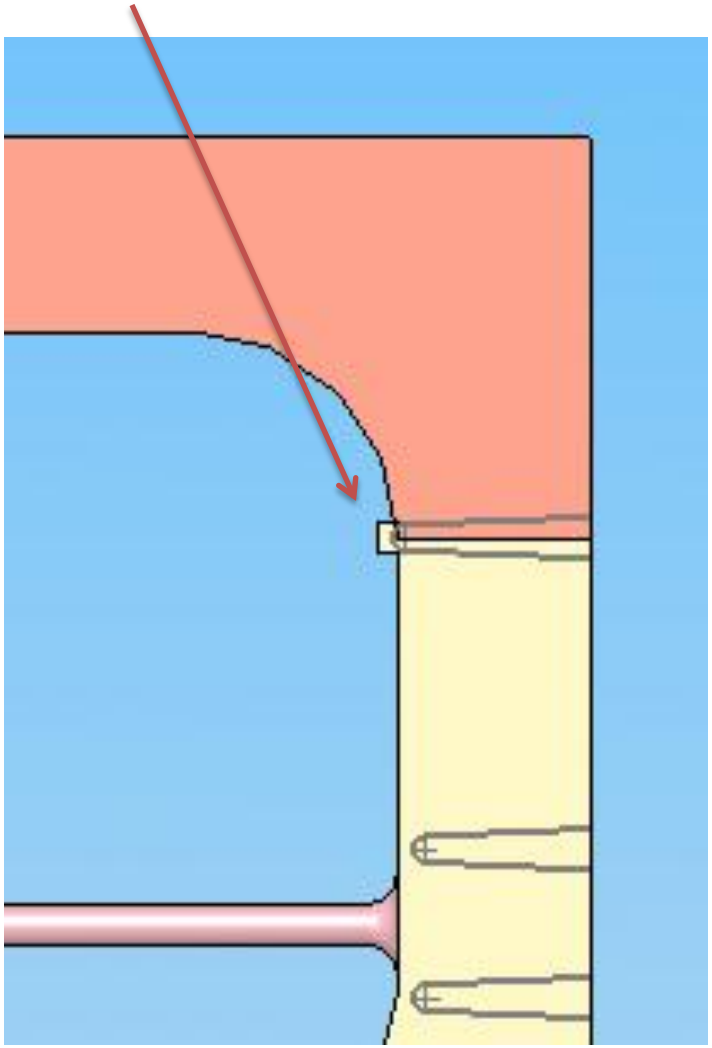
No electron beam weld



Grey lines show weld zones

Remove beam stop material from Option 3 module

This beam stop material must be removed in Option 3



Idea A

Remove the beam stop material with a long throat wire EDM machine. Etch area afterword to remove EDM scale.

Idea B

Find a mill or broach that will reach far enough to remove the beam stop material

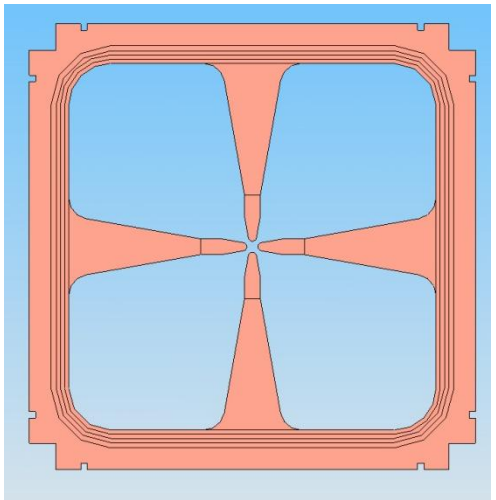
Idea C

Fabricate a self motorized tool that will travel through the cavity and machine off the beam stop material as the tool passes.

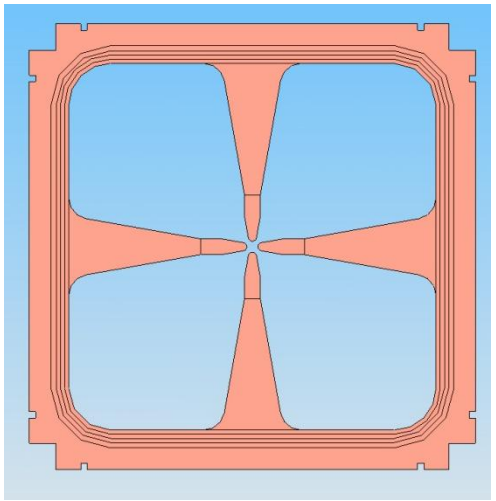
Machine Module Ends

Machine modules to finished lengths
Machine O-ring and canted spring grooves
Machine vane cut backs at entrance and exit modules

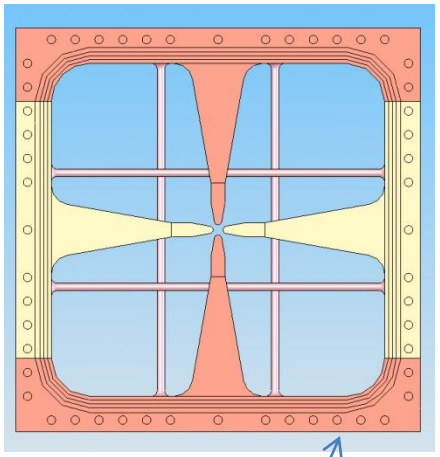
Option 1



Option 2



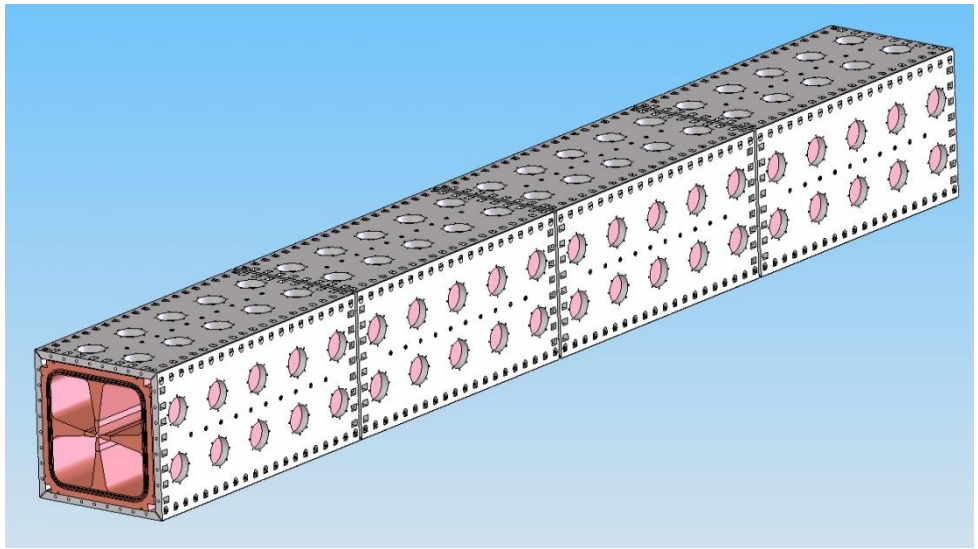
Option 3



Add coupling holes

Assemble Modules Together

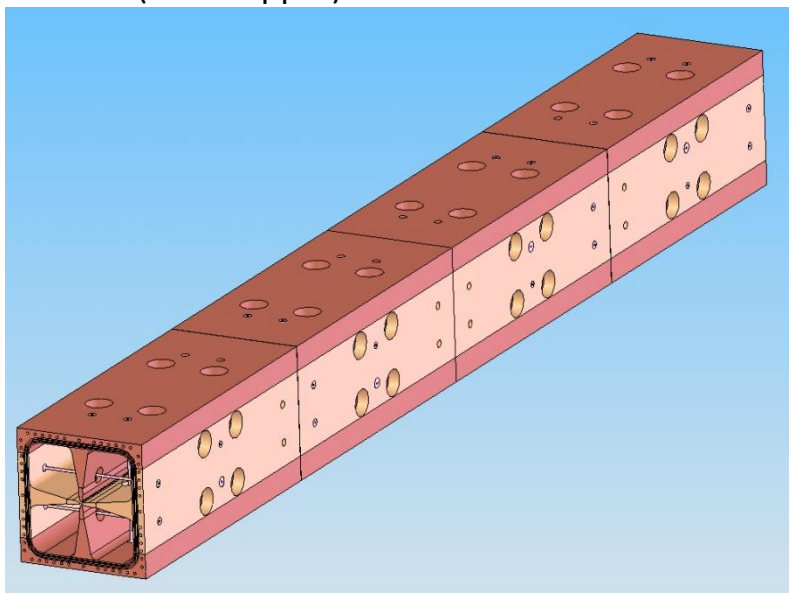
Option 1 and 2
(soft copper)



Stainless steel jacket

The jacket provides hard points for bolting modules together, lifting and attaching support equipment

Option 3
(hard copper)



No jacket

The copper remains strong enough so additional hard points are not required.

Summary

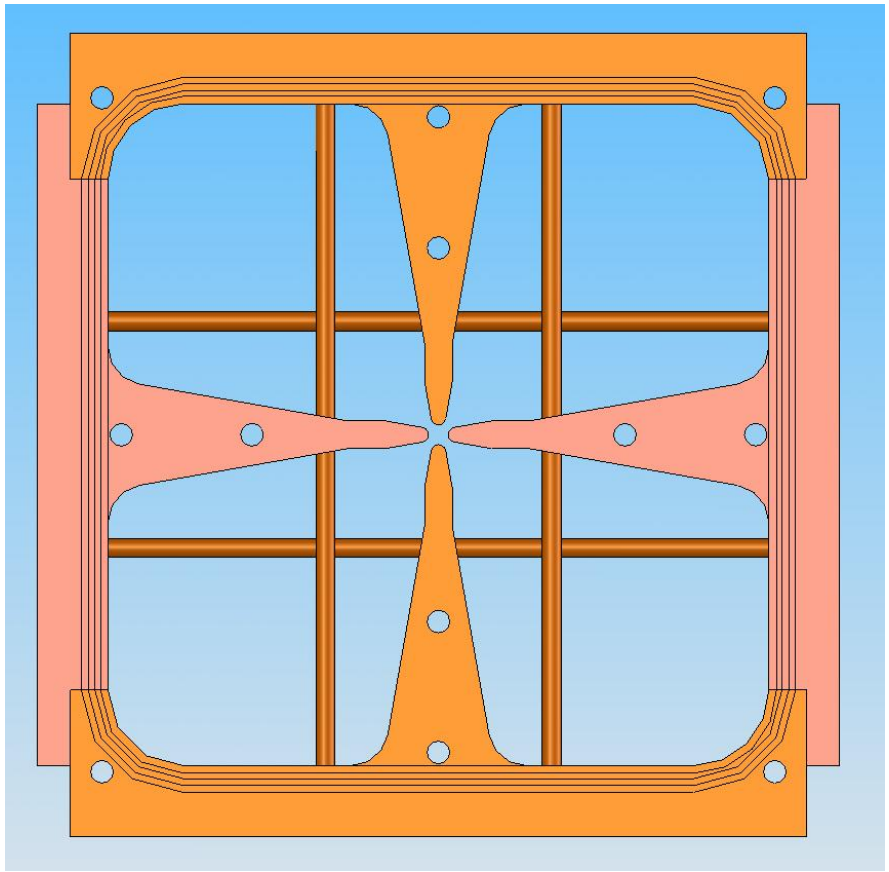
Option 1
Largest amount of copper required
A lot of machining
Support jacket required
Large hydrogen brazing oven required

Option 2
Smallest amount of copper required
Less machining
Support jacket required
Large hydrogen brazing oven required
Electron Beam welding required

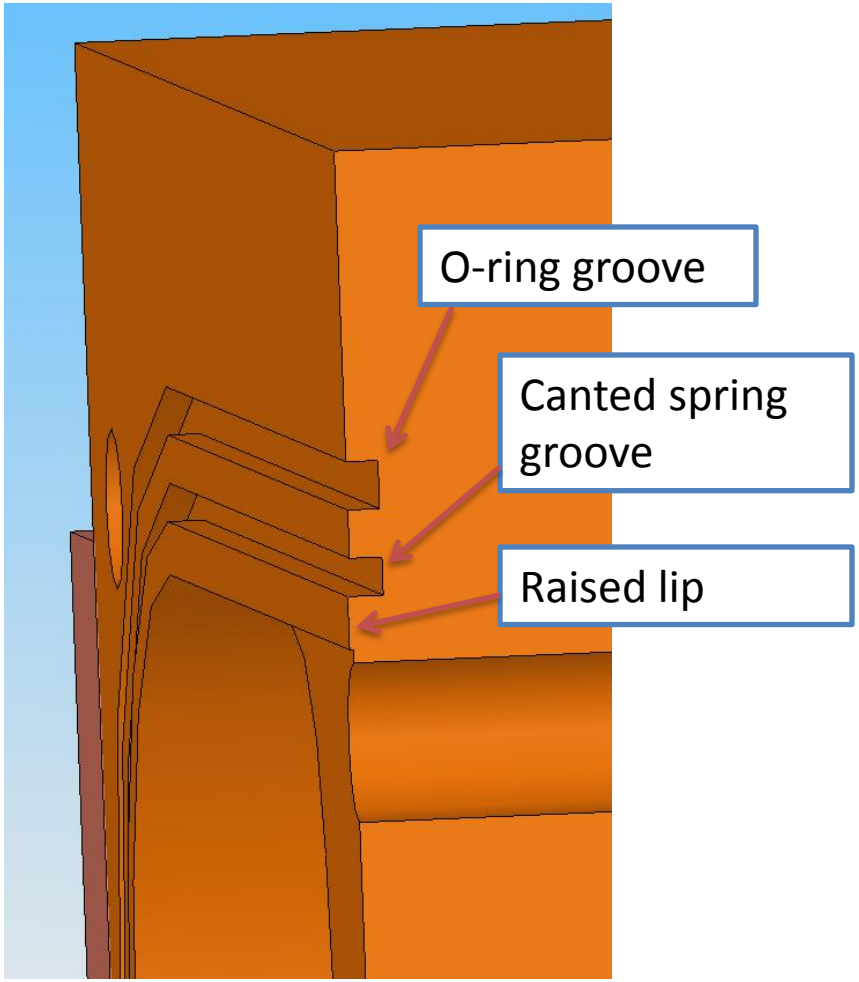
Option 3
Moderate amount of copper required
Less machining
No jacket required
A big Electron Beam welder required
Requires Electron Beam welding shrinkage tests

Design ideas common to all three options

12 cooling channels, 12mm in diameter



End Seal



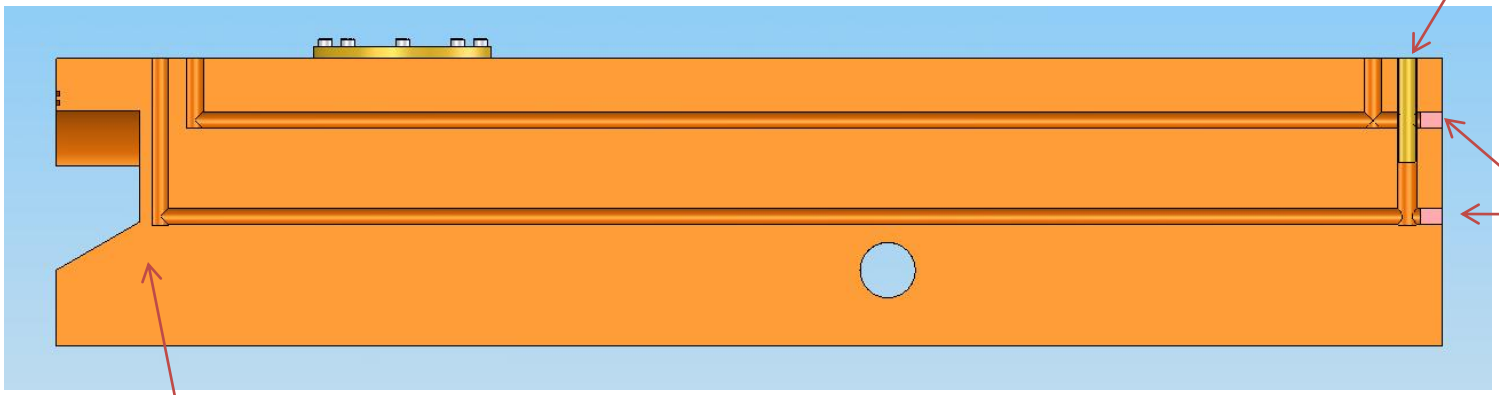
All modules bolt together. (not shown)

Options 1 and 2 (soft copper) bolt from jacket to jacket.

Option 3 (hard copper) bolts from copper to copper.

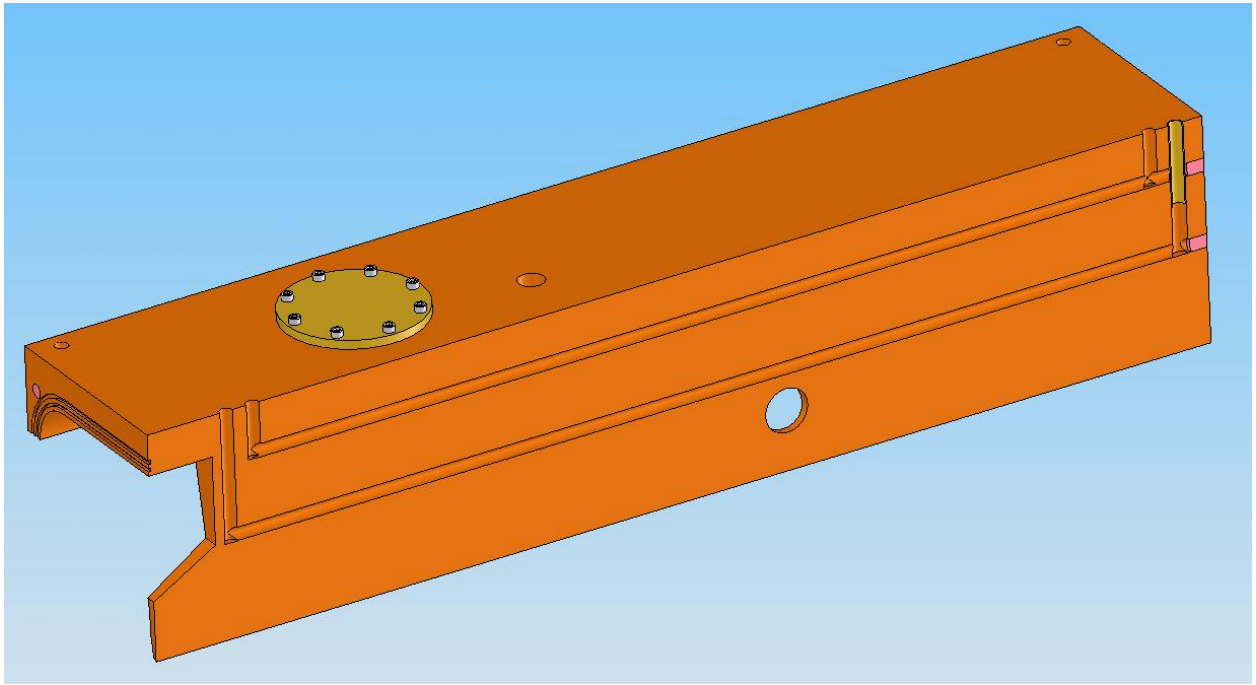
Section view of vane cooling passages. Gun drilled from one end.

Sleeve to direct flow

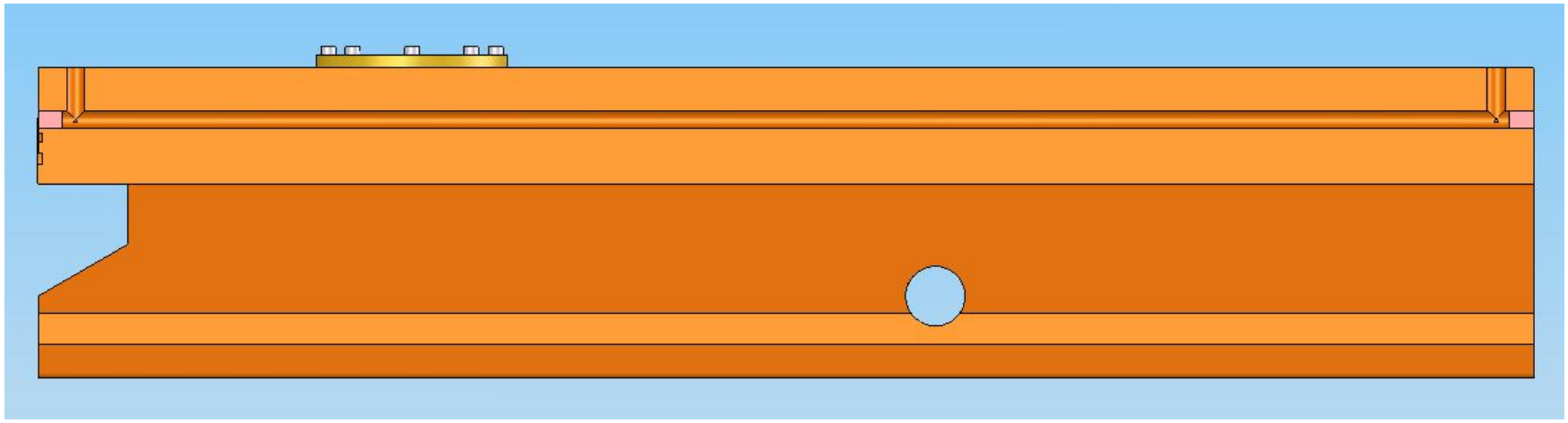


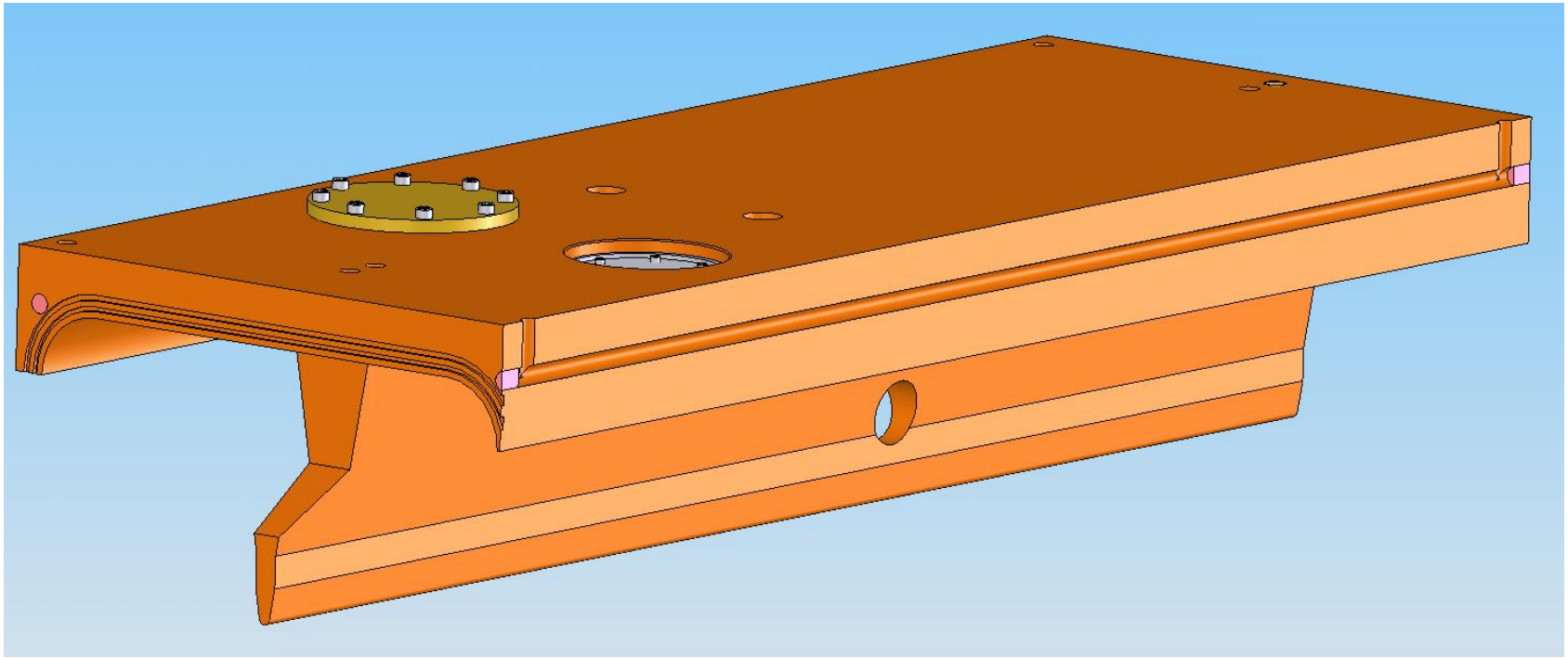
Plugs, Ebeam welded in place

Allows good cooling of cut back

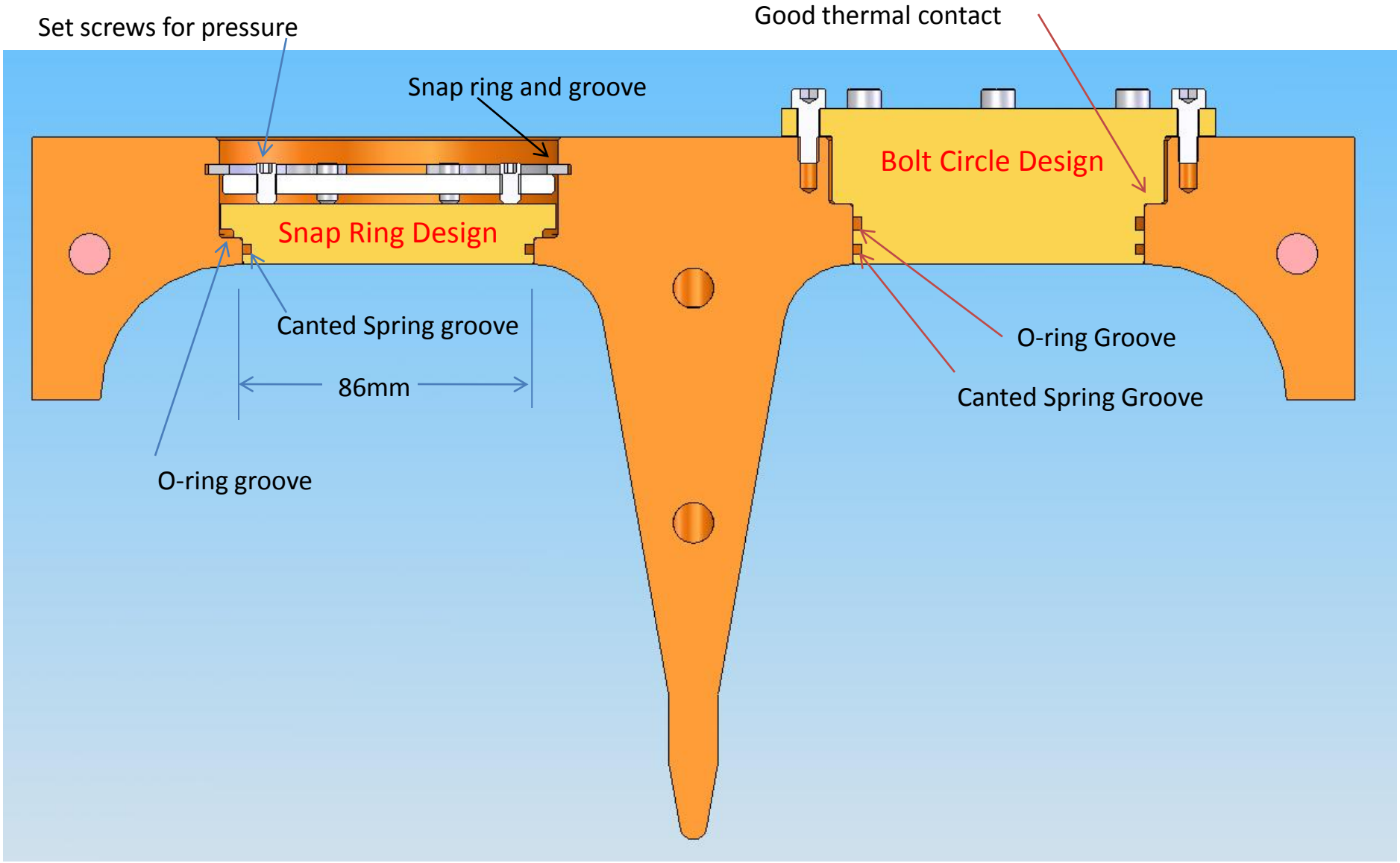
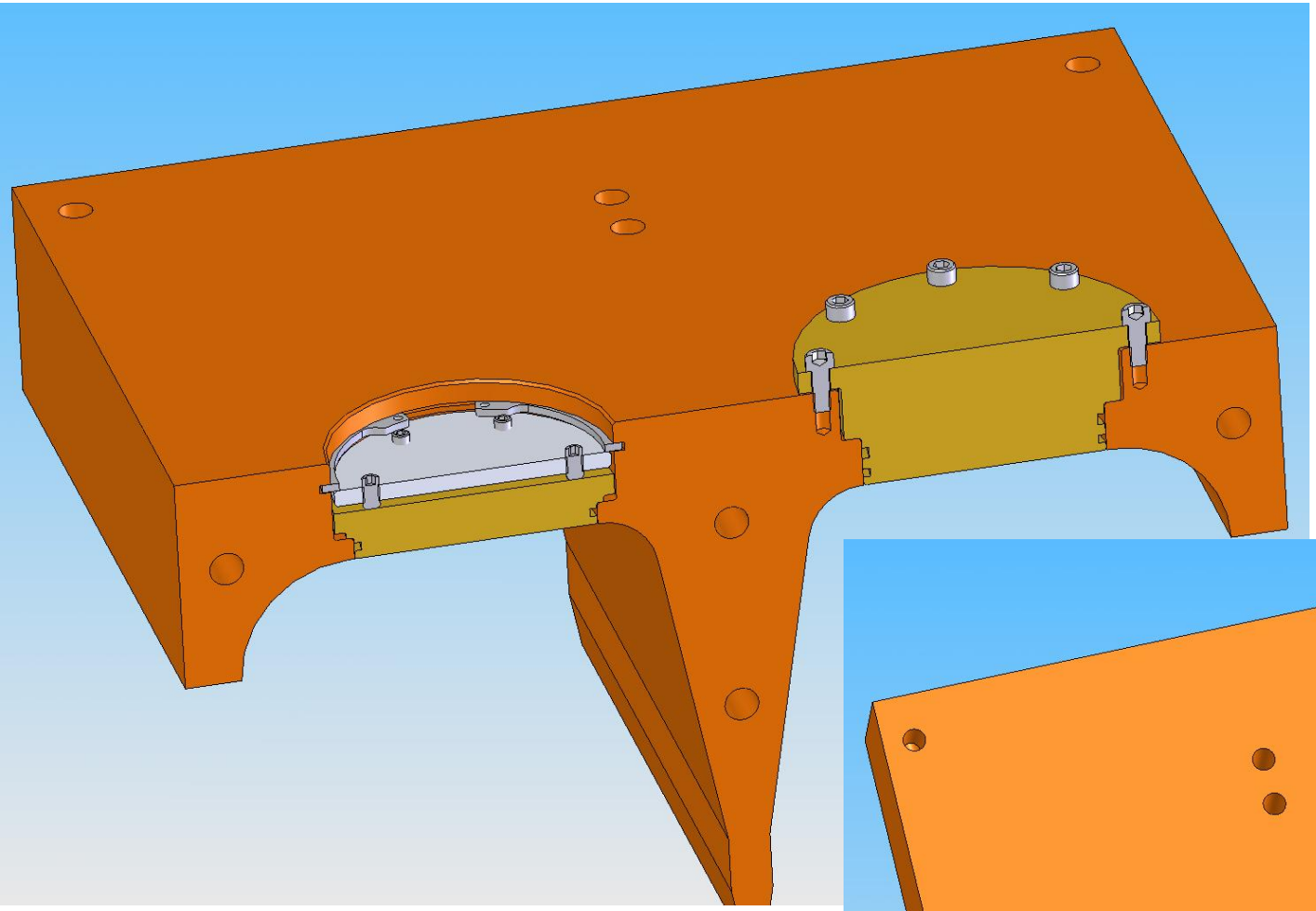
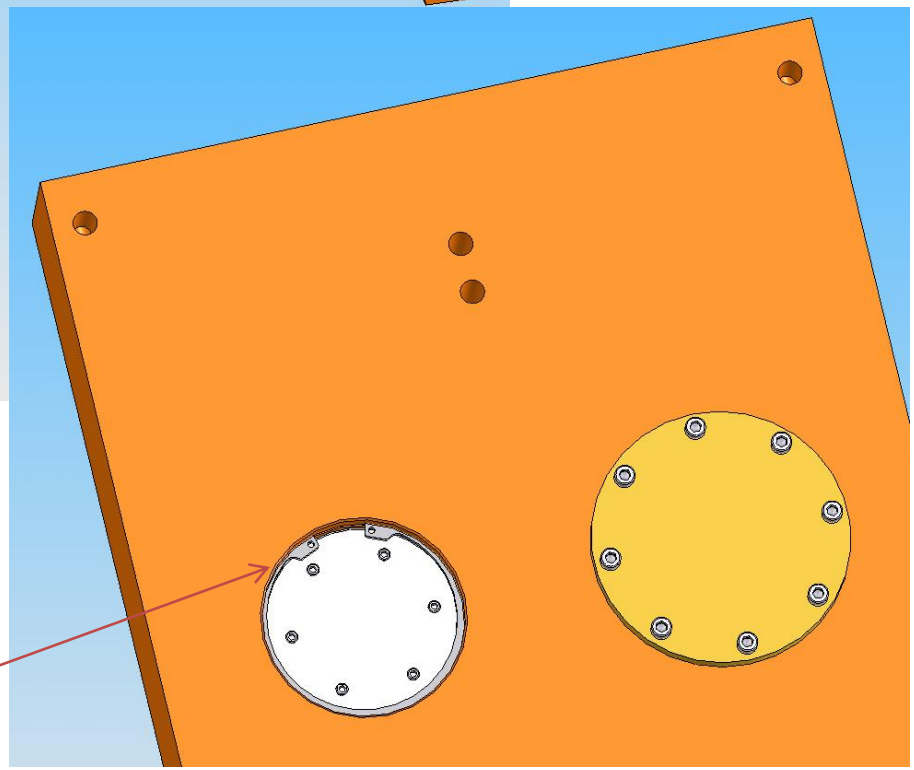


Section view of corner cooling passages. Gun drill through and plugged at each end.





Two tuner designs common to all options.



Two more tuner views