

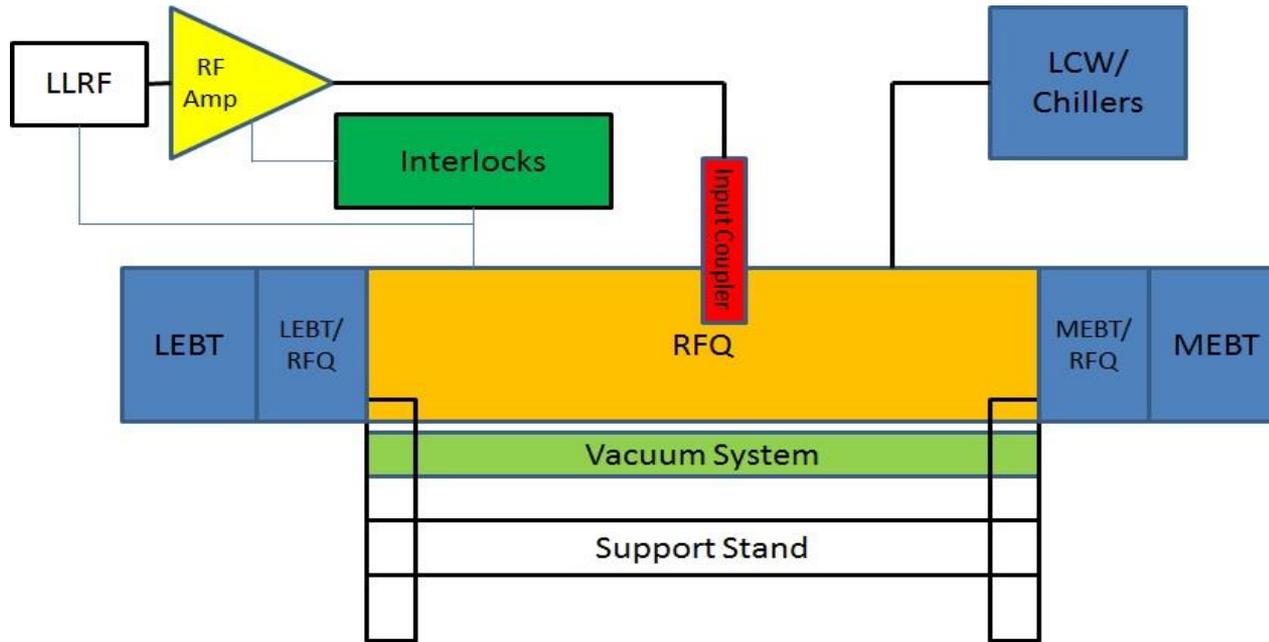


Managed by Fermi Research Alliance, LLC for the U.S. Department of Energy Office of Science

PXIE RFQ Production and Installation Plans

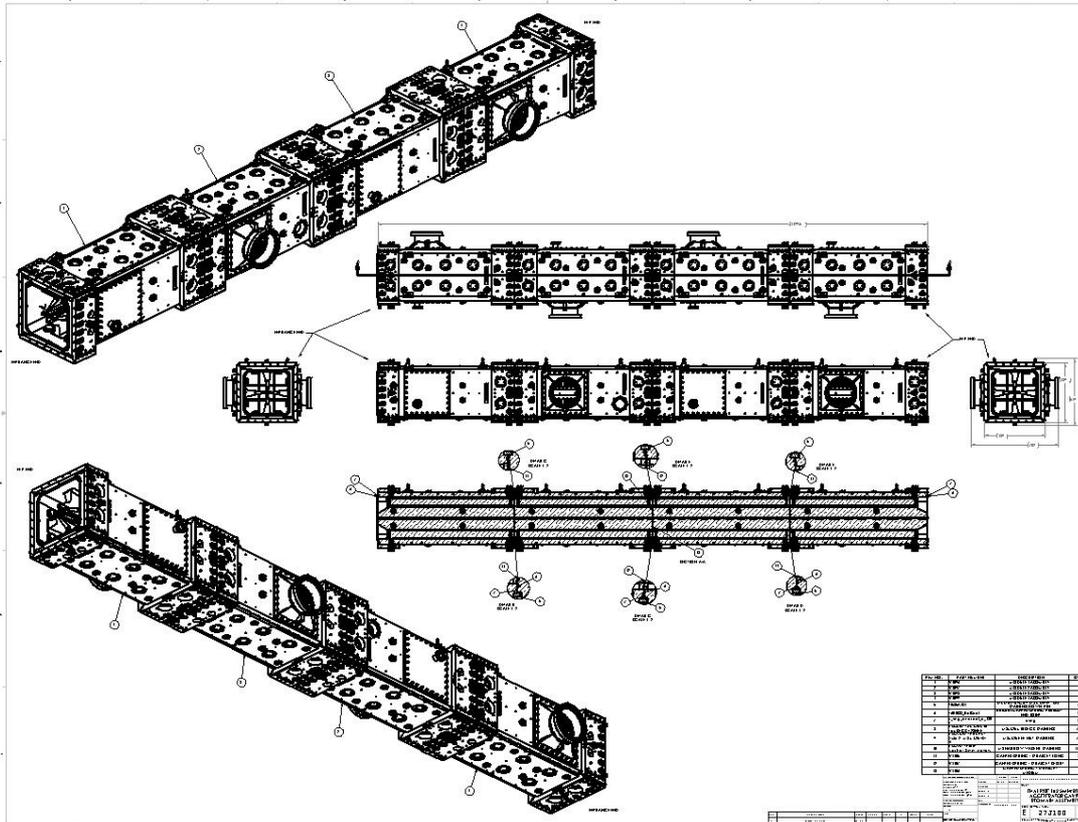
Jim Steimel
PIP-II Meeting
13 Jan 2015

PXIE RFQ System Block Diagram



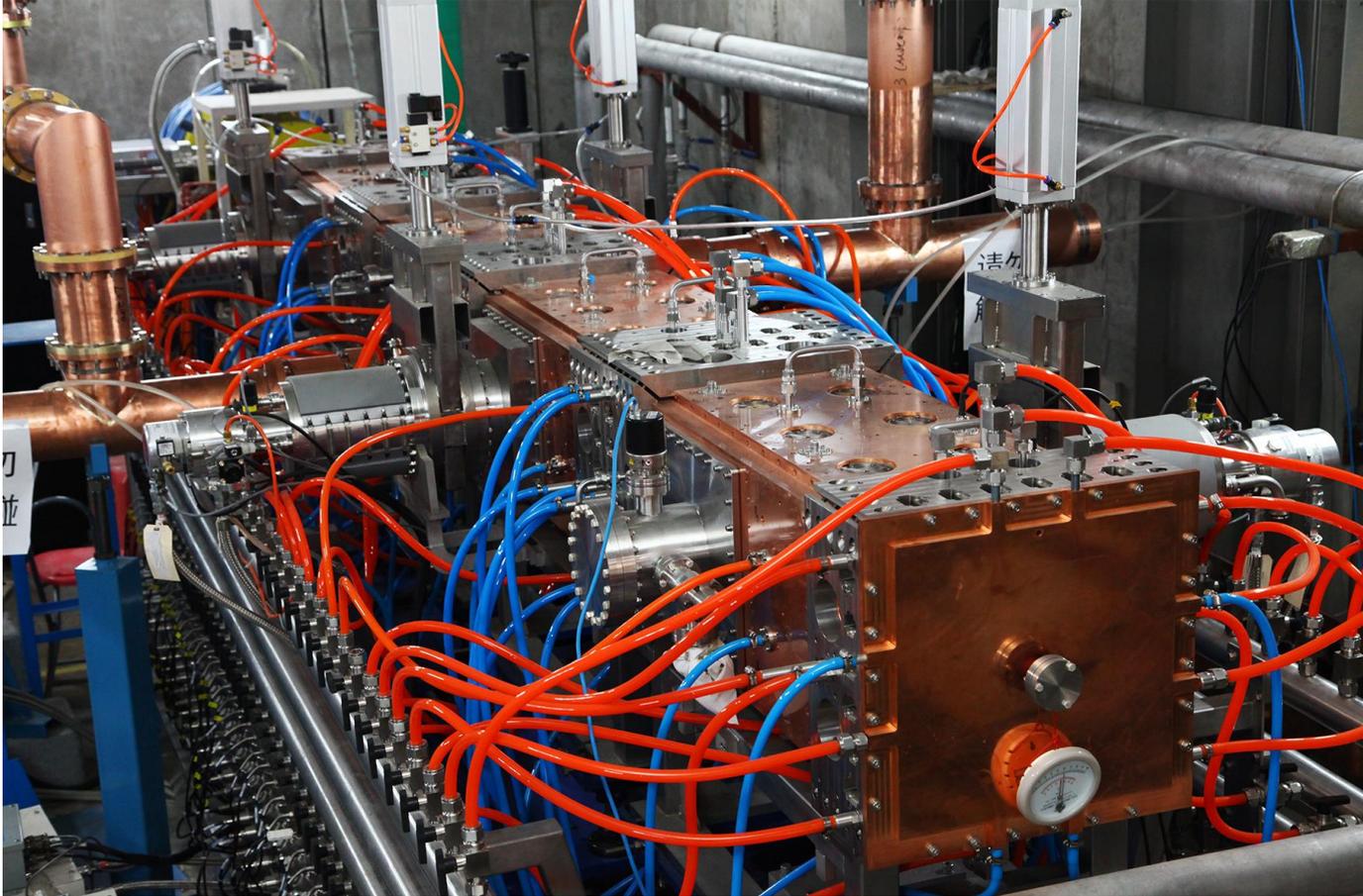
Block diagram showing the critical sub-systems of the RFQ accelerator section design. The rest of the talk will be broken down into sub-system status.

Main RFQ Body Design



- RFQ design has remained stable for last two years.
- Module construction nearly complete.
- Next need to concentrate on tuning and delivery.

Main RFQ Body Design – IMP Results



IMP has successfully commissioned nearly duplicate design with 10mA of CW beam.

Module 2 First Braze @ Bodycote



Pre-Braze



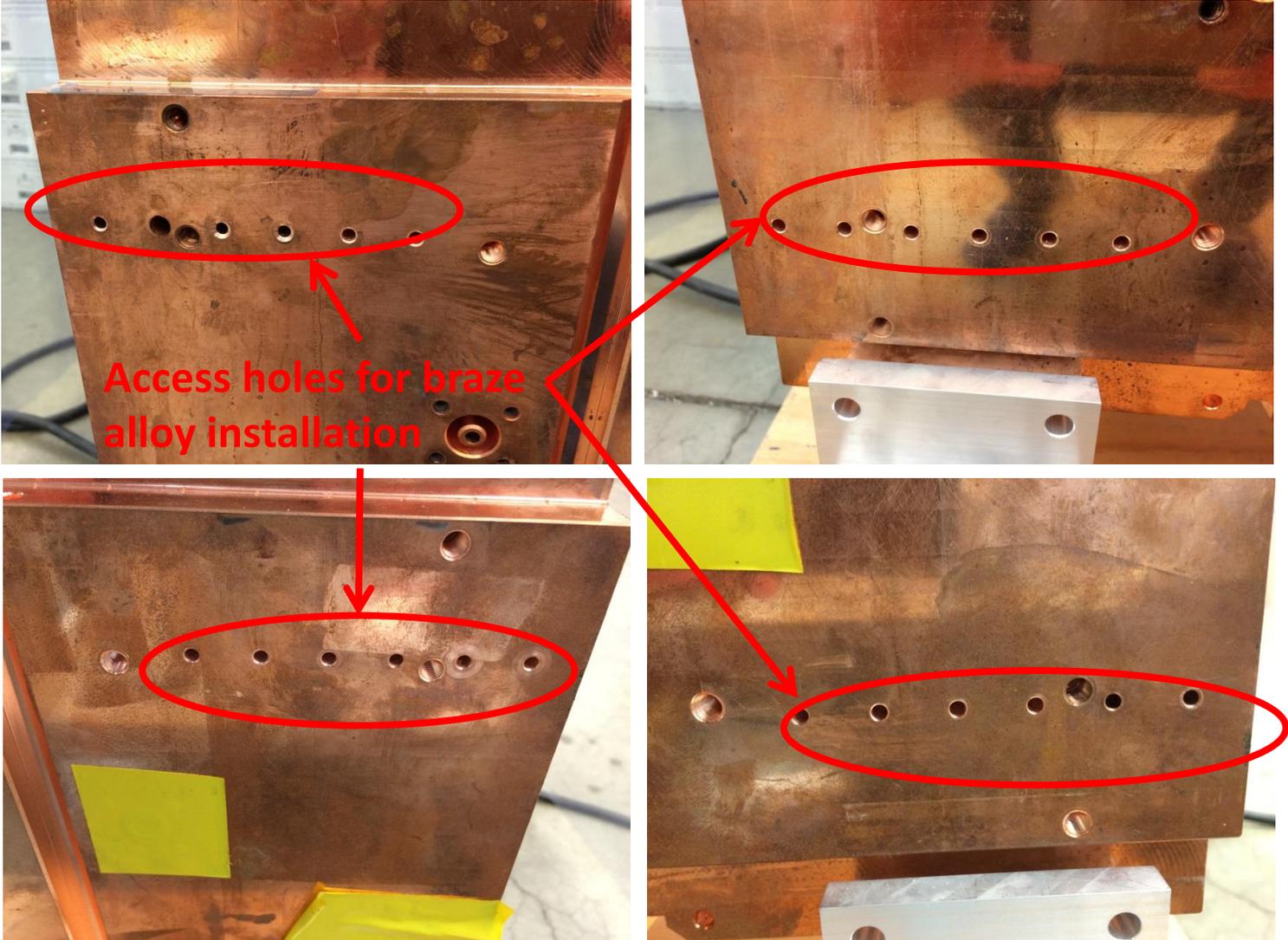
Post-Braze

Module 2 First Braze Vacuum Leak

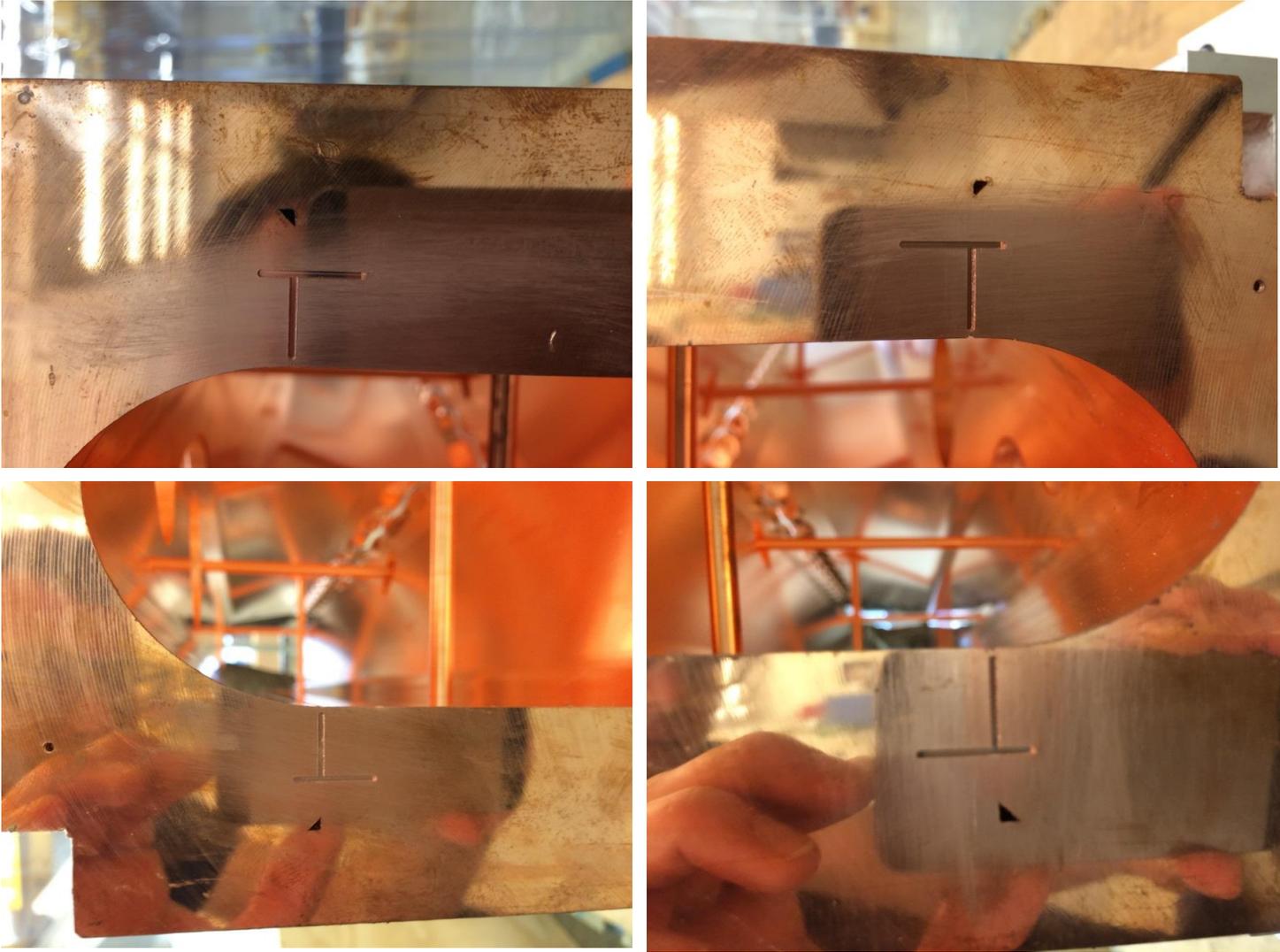
- Found a vacuum leak at the top portion of the RFQ near the ends
 - This is the “top” portion of the module in reference to its orientation in the braze furnace
 - Two large leaks at two corners, possible smaller leaks at other two corners
 - We will effect repair at each braze joint



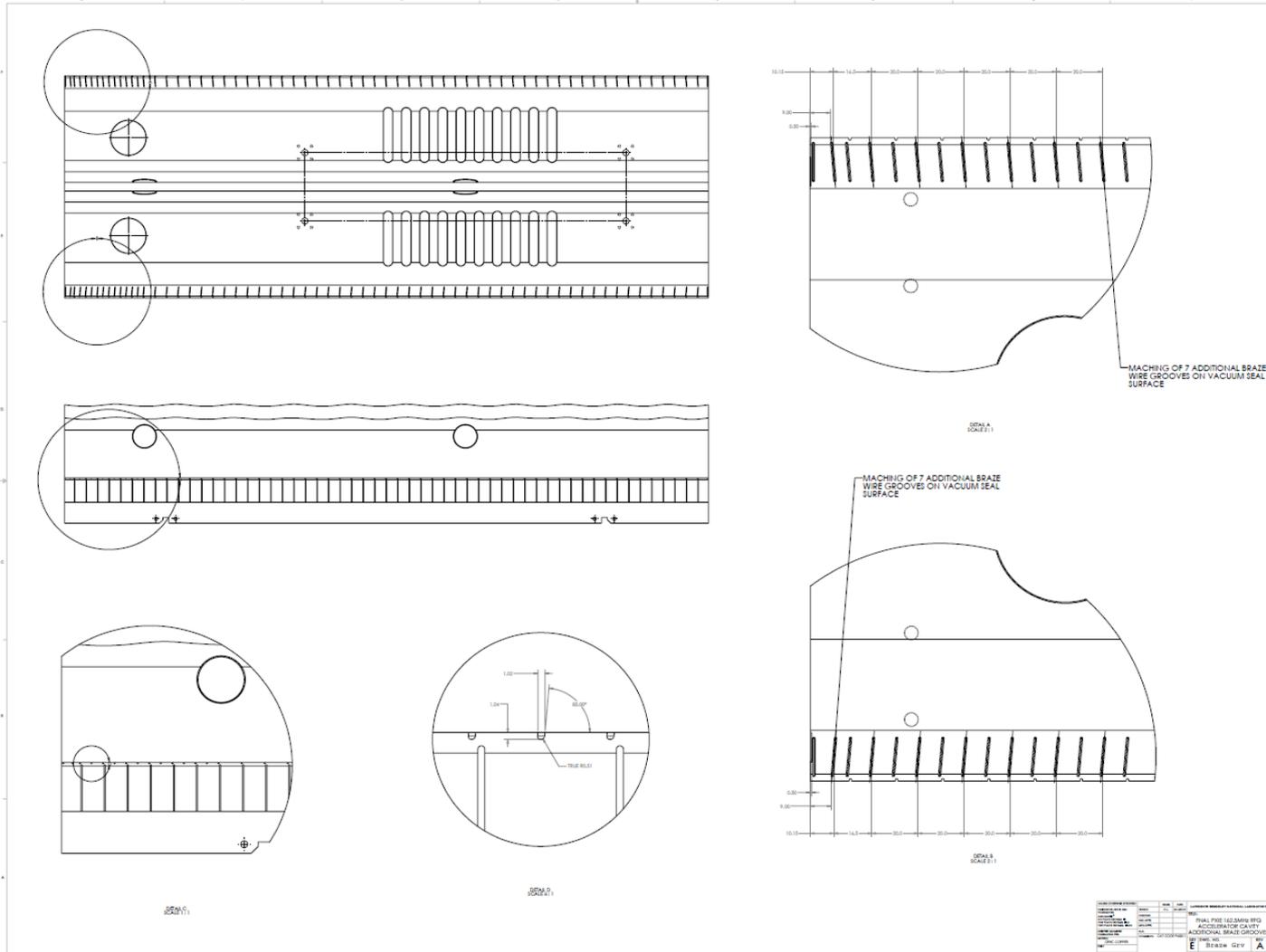
Module 2 Repair Machining



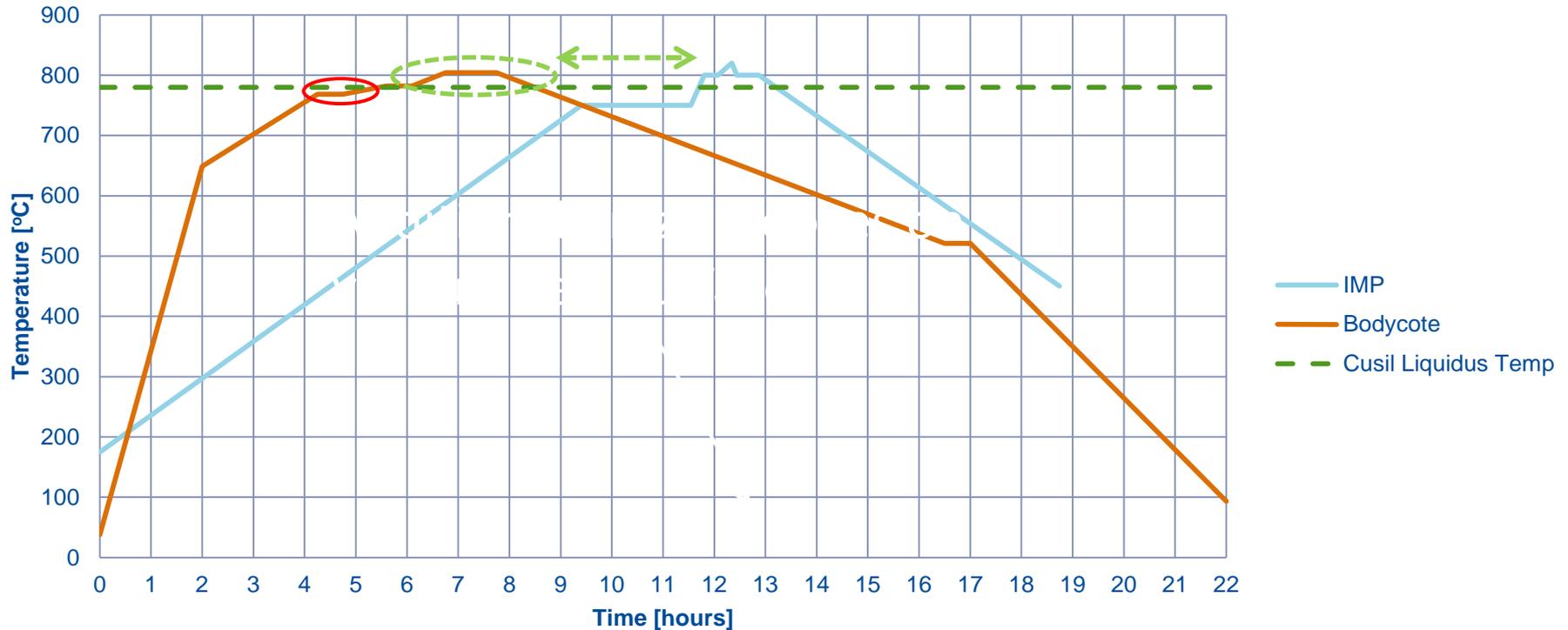
Module 2 Repair Machining Cont'd



Braze Process Modifications - Additional grooves & alloy



Braze Process Modifications – Braze Cycle

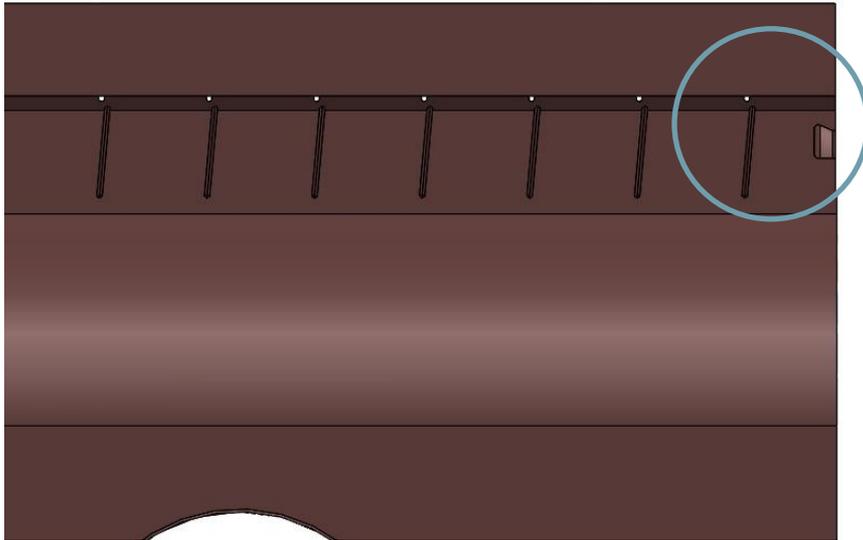


We would like to **increase** the soak time pre-liquidus temperature and **reduce** the time above liquidus.

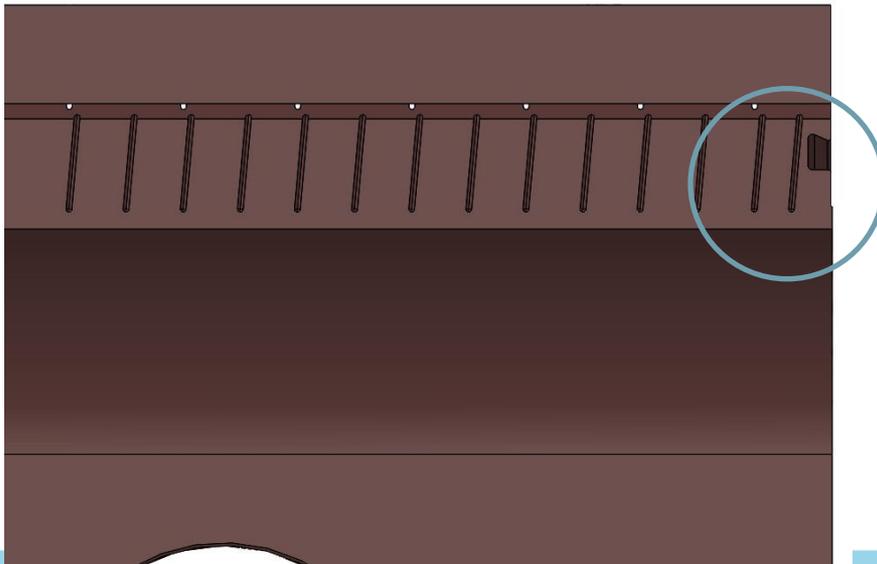
RFQ Module Braze Schedule

- Nov 17, 2014 – Module 3 successfully brazed and verified leak tight.
- Dec 12, 2015 – Module 1 braze complete.
- Jan 9, 2015 – Module 2 repair successfully completed and verified leak tight.
- Jan 12-16 – Start leak check on Module 1.
- Jan 20-23 – Send Module 4 to Bodycote for braze after verifying Module 1 is leak tight.
- Jan 30 – Plan to have all modules brazed and leak tight.

Final Machining Issues

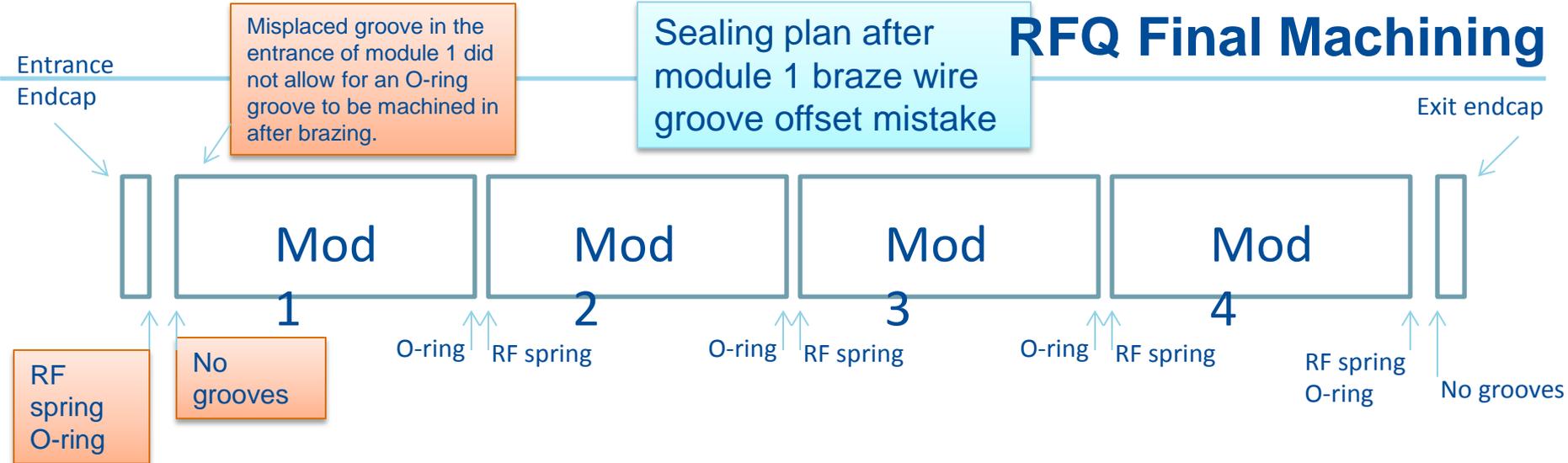


CAD model view of Module 2 exit end. **The original plan.** Lots of space between the O-ring groove and angled wire groove.

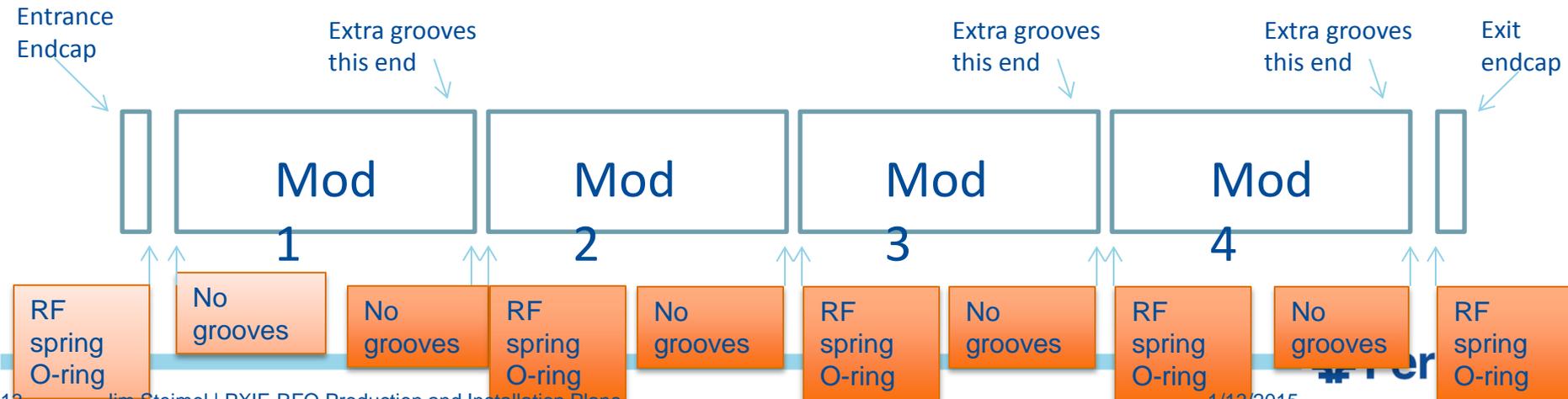


CAD model view of Module 3 exit end with the **7 extra wire grooves** added. Very little space between the O-ring groove and angled wire groove. If they touch or develop a leak between them, the entire module may leak.

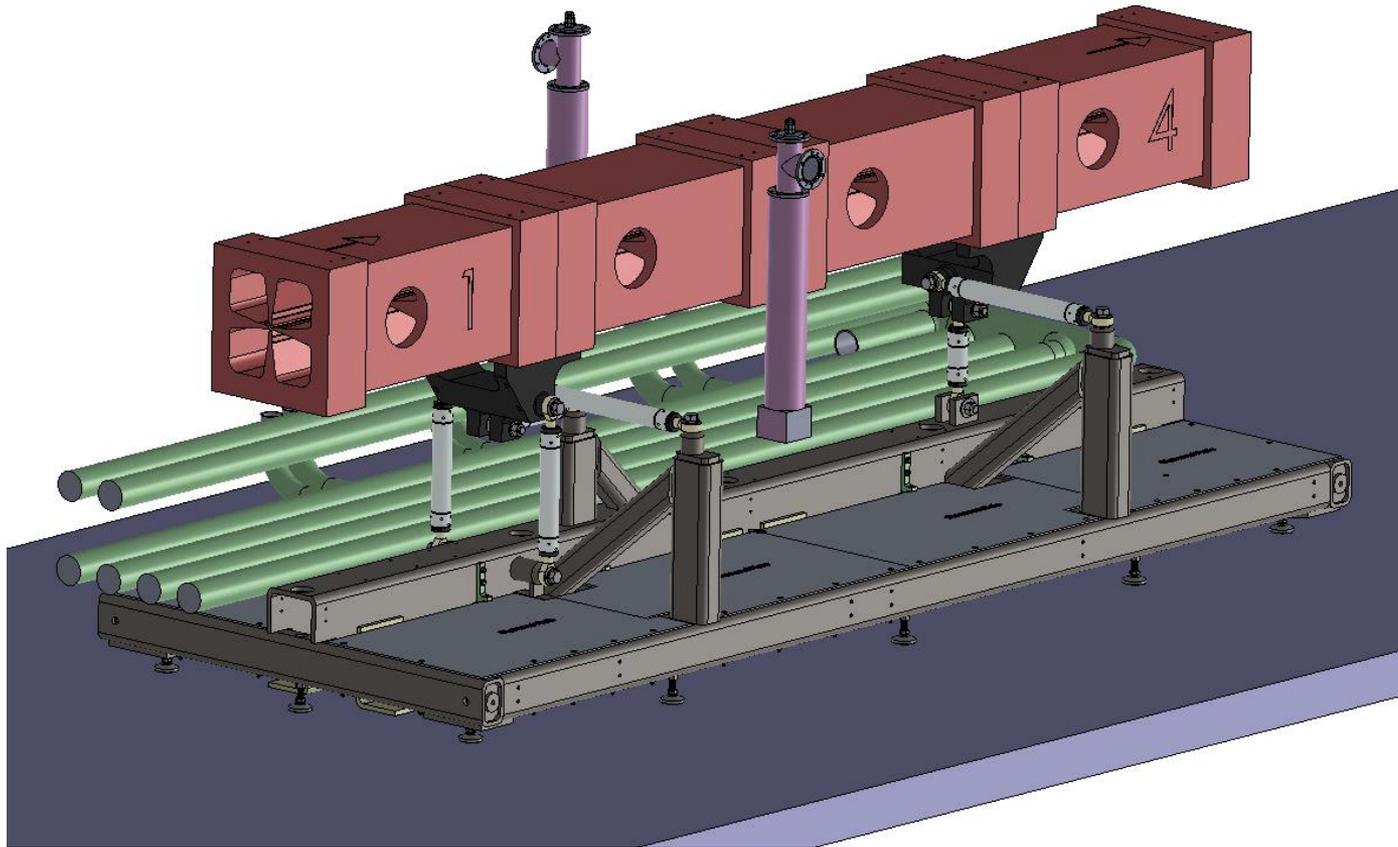
RFQ Final Machining



Proposed sealing plan



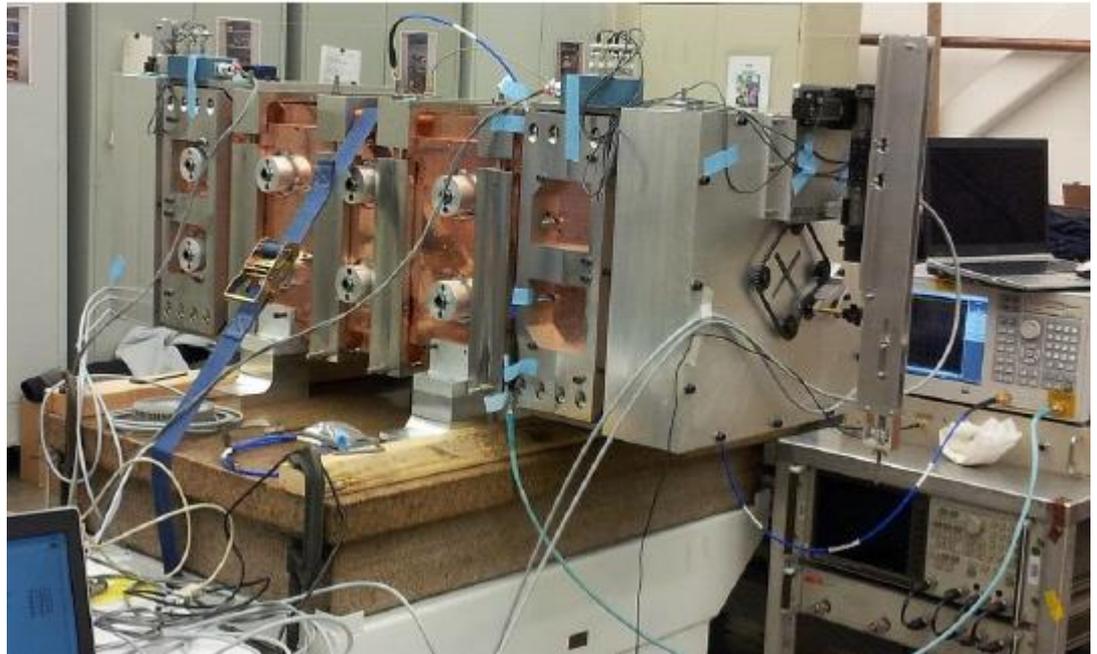
RFQ Support Stand Design



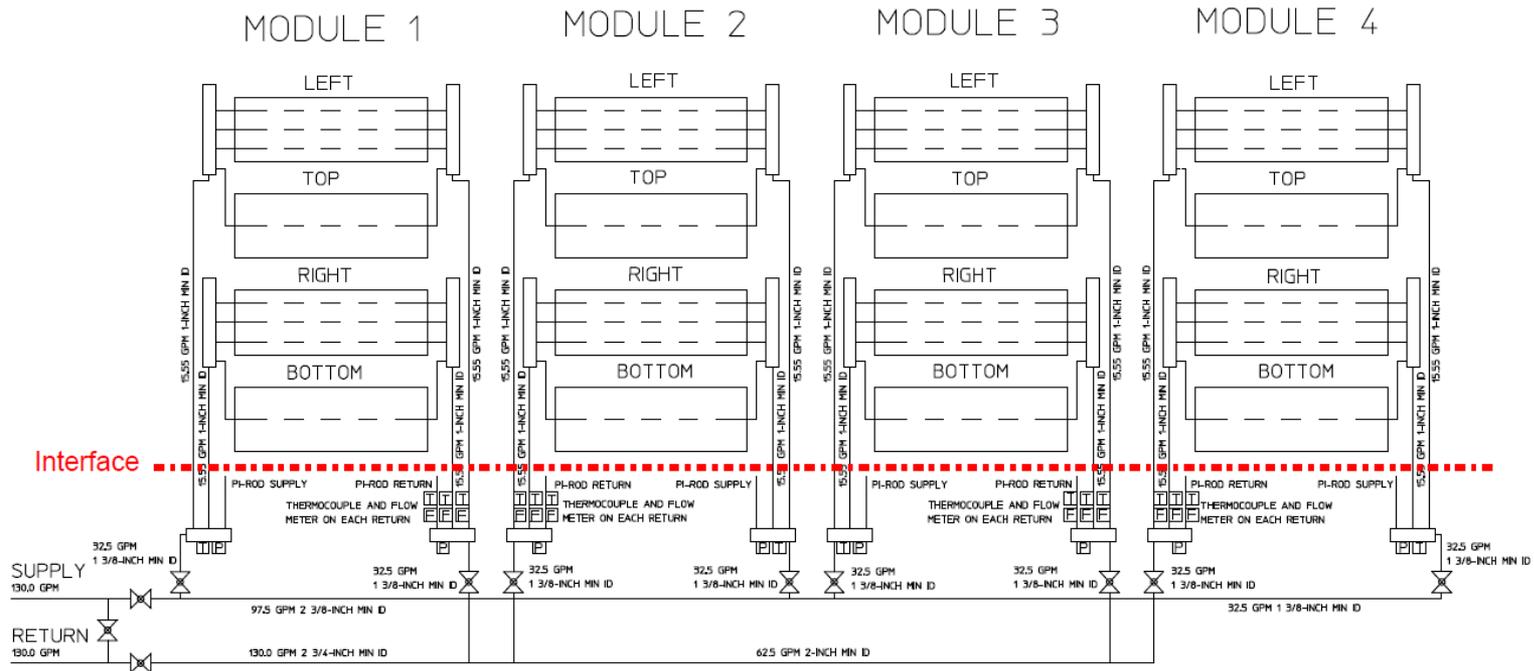
- Solid model of support stand complete and reviewed.
- Final mechanical drawings are underway.
- Anticipate final design review Feb 4-6 at LBNL.

Bead Pull and Tuning Preparation

- Need to procure final tuning components (variable tuner slugs and pick-up loops).
- Bead pull system tested successfully on Module 2. We anticipate few problems with length of full RFQ.
- Need to commit to final nominal water temperature before tuning.

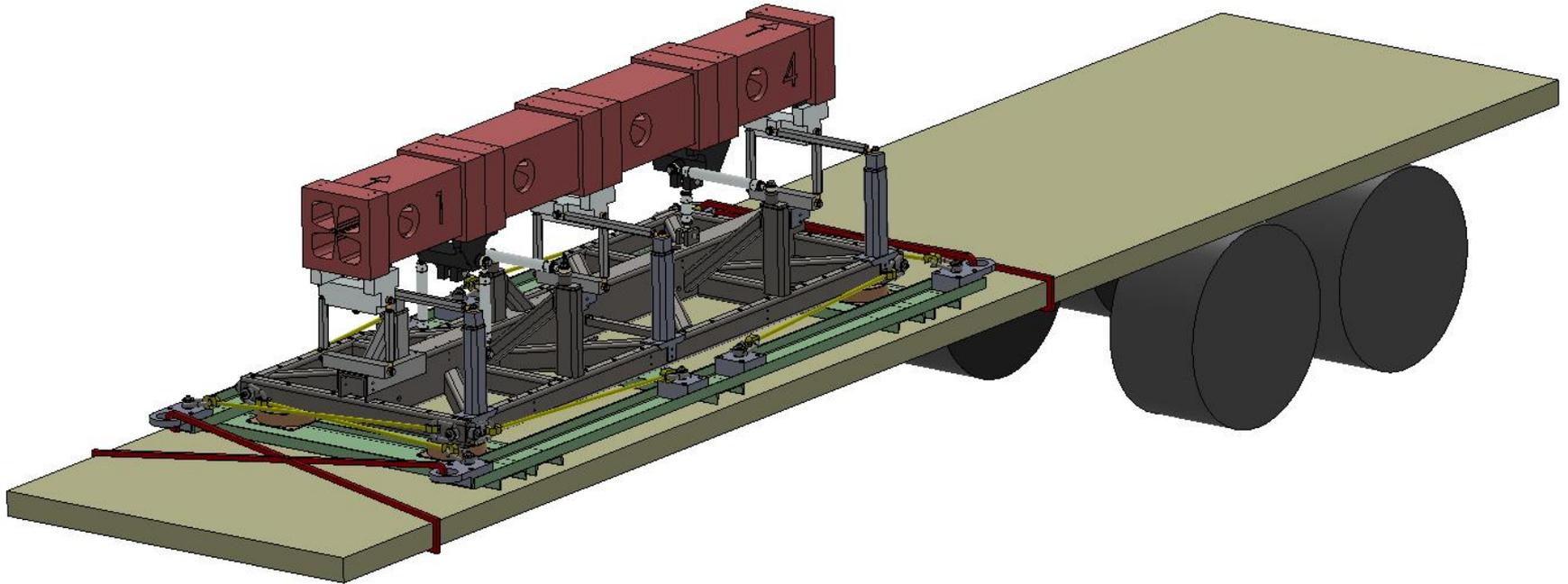


Local Water Manifolds



LBNL responsible for design and construction of module level water manifolds (items above red, dashed line).

Final Preparation Before Shipping



- Fixed tuners and endplates need to be machined after lengths are determined.
- Shipping support model complete, including extra struts for stabilization.

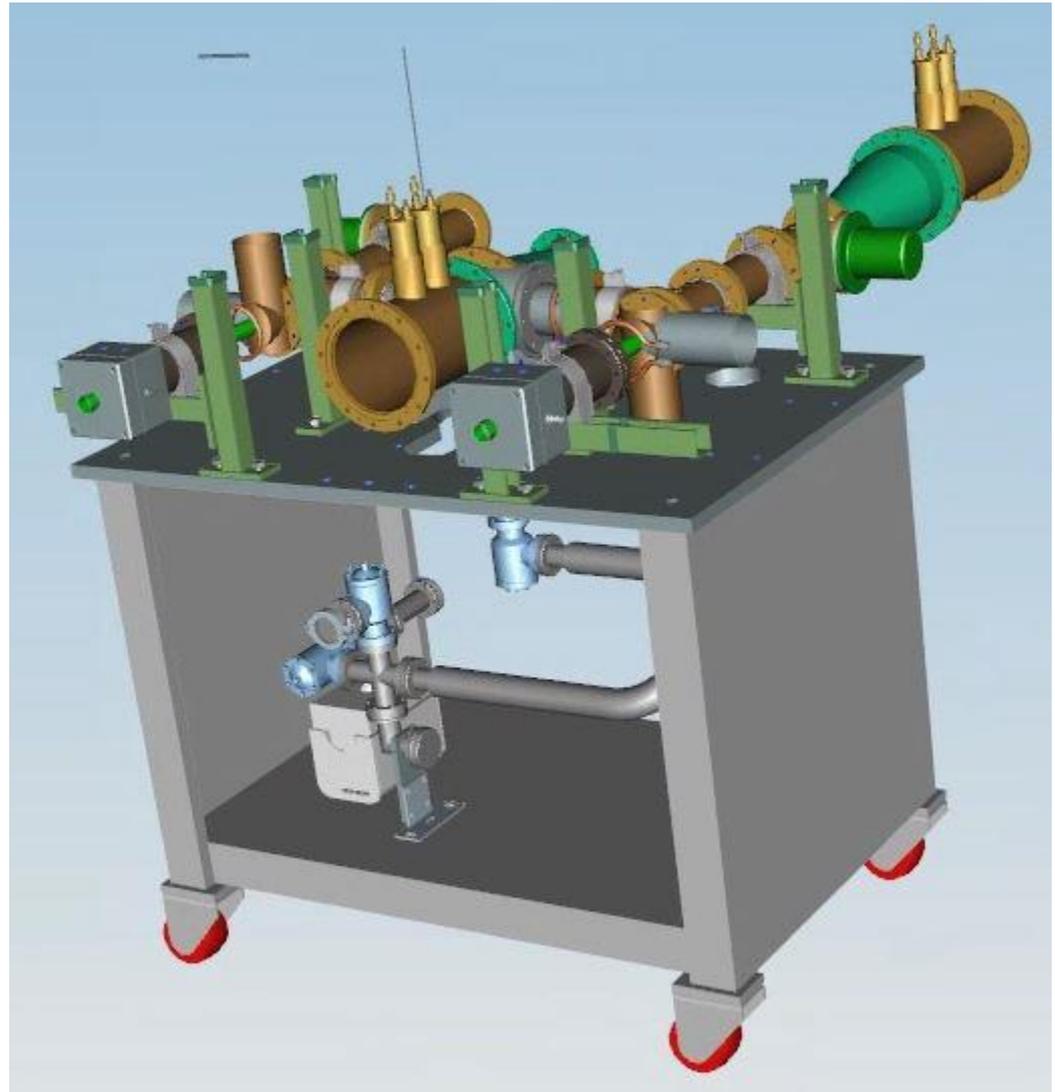
RF Distribution Status

- Both 75kW power amplifiers are commissioned to spec and operational.
- Circulators are not capable of CW operation into a short, but they will be good enough to protect amplifiers from RFQ filling time and sparks.
- Flex RF sections and directional couplers are on hand.
- The rest of 6" hard-line coax will be ordered.



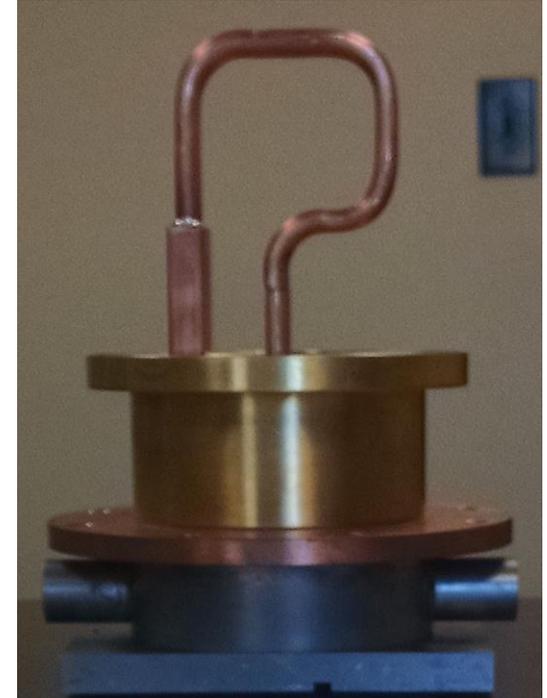
Input Coupler Design

- Input coupler design complete and being manufactured by vendor, Mega Inc.
- Test stand design complete, including coupling cavity.

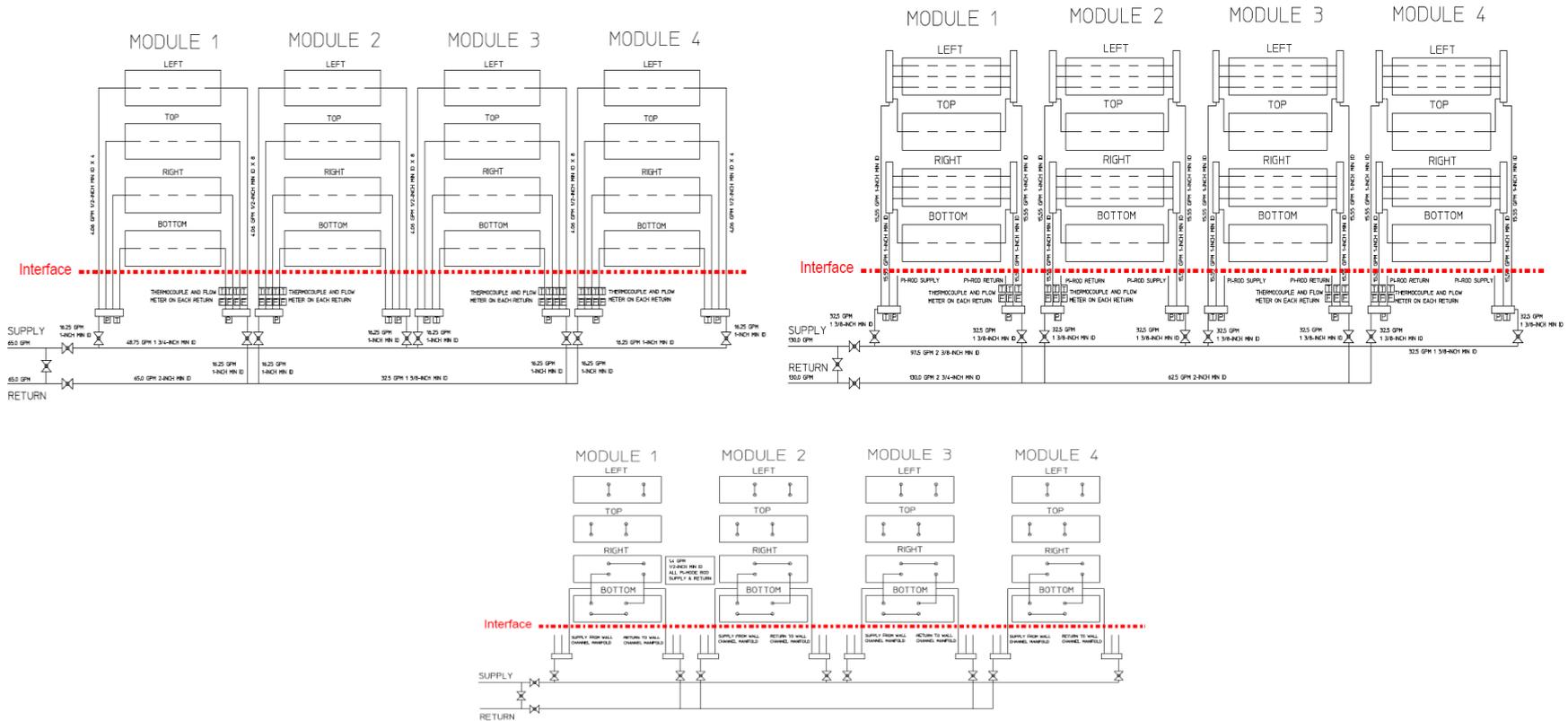


Input Coupler Test Status

- Circulator performance not good enough to allow test of couplers with full reflection.
- Only able to test couplers to full power into load.
- Test cavity has been constructed and tested (left picture).
- Vacuum window braze complete by Mega (right picture).
Estimate completion in March.



Cooling Design Status

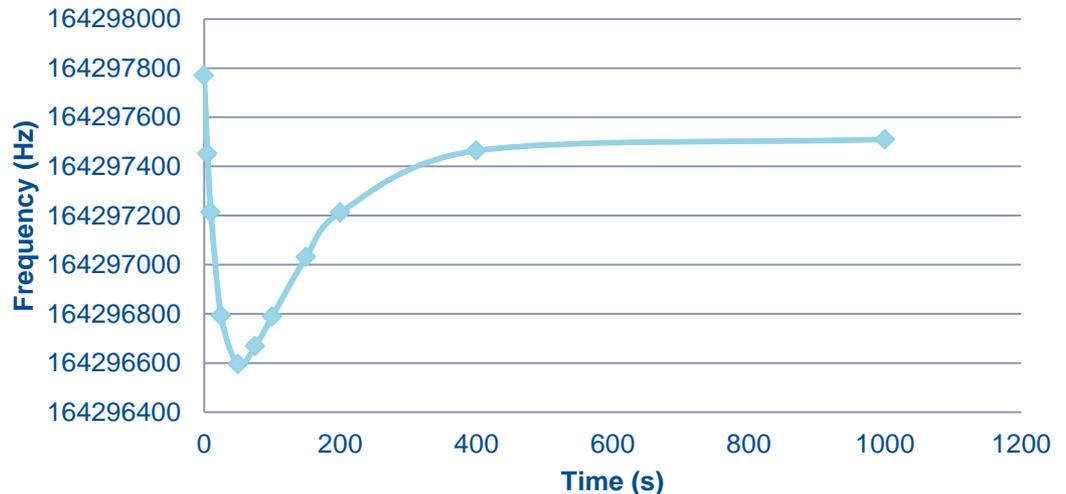


- Currently can't run both amplifiers, but chiller upgrade will give us required flow.
- Working on manifold design involving 80 water sensors (below red line).

Resonance Control Cooling System

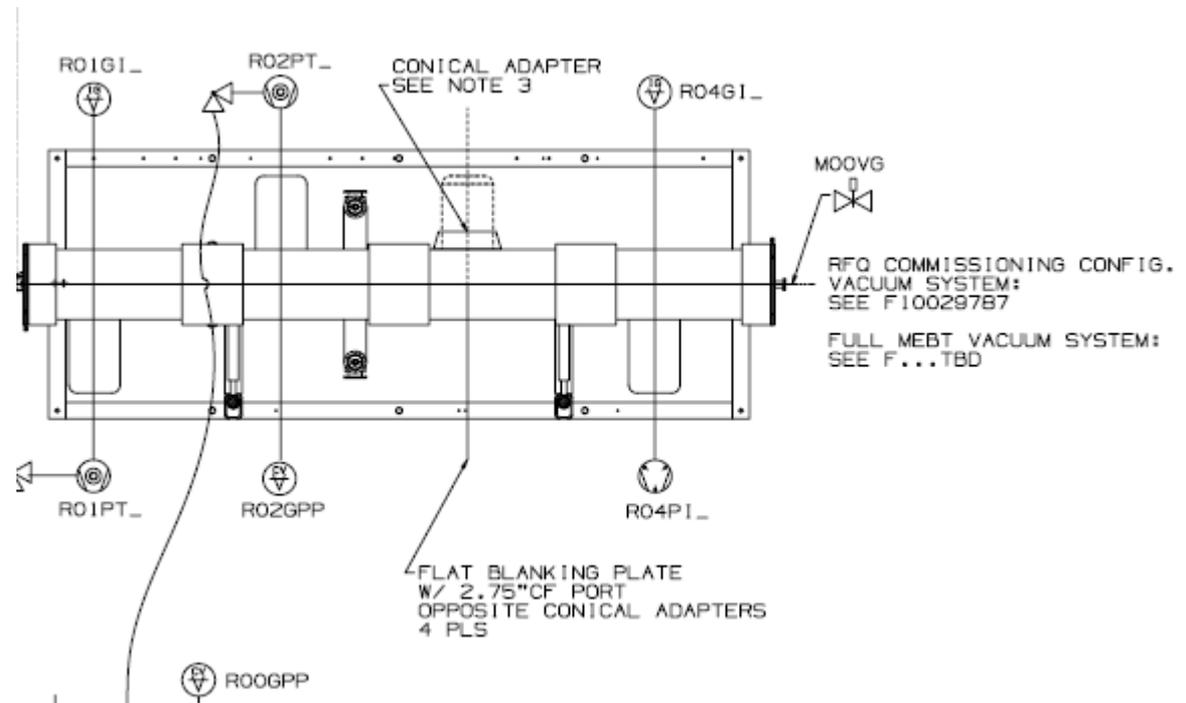
- Just about ready to launch a 13 month program with Colorado State University to simulate and design CW RFQ resonant control system using variable water temperature.
- Some transient simulations already started at LBNL.

Resonant Frequency after 2% Stepped Field Increase from Design



Vacuum System Design

- Plan to use two turbo pumps (at LEBT end).
- Ion getter pump will be tested at MEBT end.
- Third pump port can be fitted with a third turbo pump if necessary.
- Turbo pumps are on hand from HINS equipment.



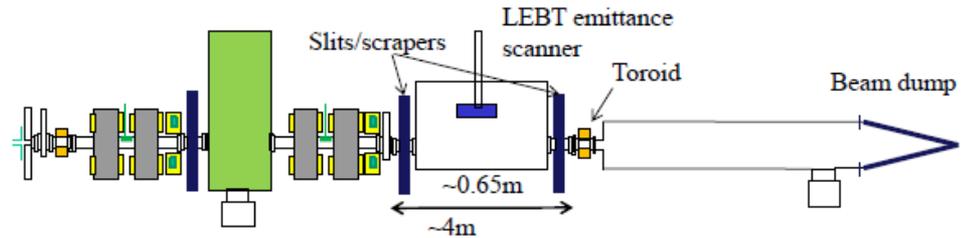
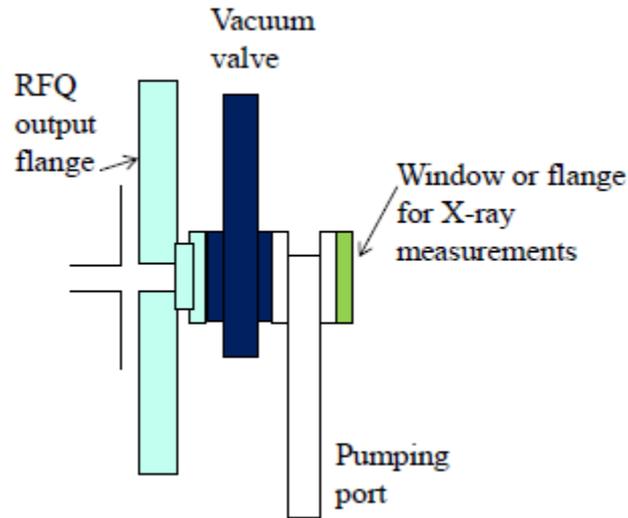
Interlocks and Machine Protection

- RF interlock specifications not complete, but design will be similar to HINS RFQ interlocks.
- RFQ commissioning machine protection specifications not complete, but system will be modelled after ASTA protection system.

Commissioning Steps

- Commission RFQ to full CW field without beam. LLRF system tracks resonant frequency of RFQ.
- Commission long pulsed (possibly CW) beam to thermal limit of beam dump. LLRF system tracks resonant frequency of RFQ.
- Commission pulsed beam with LLRF system maintaining RFQ resonant frequency at 162.5 MHz by varying RF pulse width.
- Commission CW beam with LLRF system maintaining RFQ resonant frequency at 162.5 MHz using water cooling resonant control system.

Plans for RFQ Diagnostic Lines



This configuration will not be used for beam. It will examine x-ray spectrum to determine internal field strength.

This configuration would be used to measure emittance of pulsed beam at moderate beam current. Removing scanner will allow full beam current testing.

Final Schedule

Goal	Milestones	Start Month	End Month	Work Days (Excl)	OCT-FY15	NOV-FY15	DEC-FY15	JAN-FY15	FEB-FY15	MAR-FY15	APR-FY15	MAY-FY15	JUN-FY15	JUL-FY15	AUG-FY15	SEP-FY15
Commission RFQ Beam - Maintain communication with Lawrence Berkeley National Laboratory (LBNL) to insure proper delivery preparations																
	Design and Construct Support Stand	DEC-FY15	FEB-FY15	61												
	RFQ Modules Mounted on Stand	FEB-FY15	MAR-FY15	42												
	Complete Tuning	MAR-FY15	MAR-FY15	22												
	Construct and Install Fixed Tuners	MAR-FY15	APR-FY15	44												
	Vacuum Check	APR-FY15	MAY-FY15	42												
Ship RFQ to FNAL	MAY-FY15	MAY-FY15	20													
Commission RFQ Beam - Test and commission RFQ couplers																
	Receive and Clean Test Cavity	NOV-FY15	NOV-FY15	18												
	Receive Input Couplers from Vendor	MAR-FY15	MAR-FY15	22												
	Install Test Stand Vacuum	MAR-FY15	MAR-FY15	22												
	Install Test Stand Cooling Equipment and Interlocks	MAR-FY15	MAR-FY15	22												
Commission Input Couplers to Full Power in Test Stand	MAR-FY15	APR-FY15	44													
Commission RFQ Beam - Commission RFQ to full, continuous wave (CW) field																
	Design and Construct RF Instrumentation and Interlocks	NOV-FY15	FEB-FY15	79												
	Construct Cooling System and Install Vacuum Equipment and	MAY-FY15	JUN-FY15	42												
	Condition RFQ to full CW field specifications	JUN-FY15	JUN-FY15	22												
Commission RFQ Beam - Commission CW beam through RFQ in tracking mode (not																

Final Schedule Cont'd

Goal	Milestones	Start Month	End Month	Work Days (Excl)	OCT-FY15	NOV-FY15	DEC-FY15	JAN-FY15	FEB-FY15	MAR-FY15	APR-FY15	MAY-FY15	JUN-FY15	JUL-FY15	AUG-FY15	SEP-FY15
	Commission Input Couplers to Full Power in Test Stand	MAR-FY15	APR-FY15	44												
Commission RFQ Beam - Commission RFQ to full, continuous wave (CW) field																
	Design and Construct RF Instrumentation and Interlocks	NOV-FY15	FEB-FY15	79												
	Construct Cooling System and Install Vacuum Equipment and Condition RFQ to full CW field specifications	MAY-FY15	JUN-FY15	42												
		JUN-FY15	JUN-FY15	22												
		JUL-FY15	JUL-FY15	22												
Commission RFQ Beam - Commission CW beam through RFQ in tracking mode (not locked to 162.5 MHz)																
	Design and Construct LLRF System	NOV-FY15	JUN-FY15	165												
	Construct Diagnostic Beam Line and Connect and Align RFQ to LEPT and Diagnostic Line	MAY-FY15	JUL-FY15	64												
		JUN-FY15	AUG-FY15	65												
	Commission and Tune unlocked pulsed beam through RFQ	AUG-FY15	SEP-FY15	42												
	Commission CW beam through RFQ	SEP-FY15	SEP-FY15	21												
Commission RFQ Beam - Commission pulsed beam through RFQ in locked mode (locked to 162.5 MHz reference)																
	Commission LLRF System for RF pulse width resonant tuning	AUG-FY15	AUG-FY15	21												
	Commission and Tune locked mode pulsed beam through RFQ.	SEP-FY15	OCT-FY16	43												