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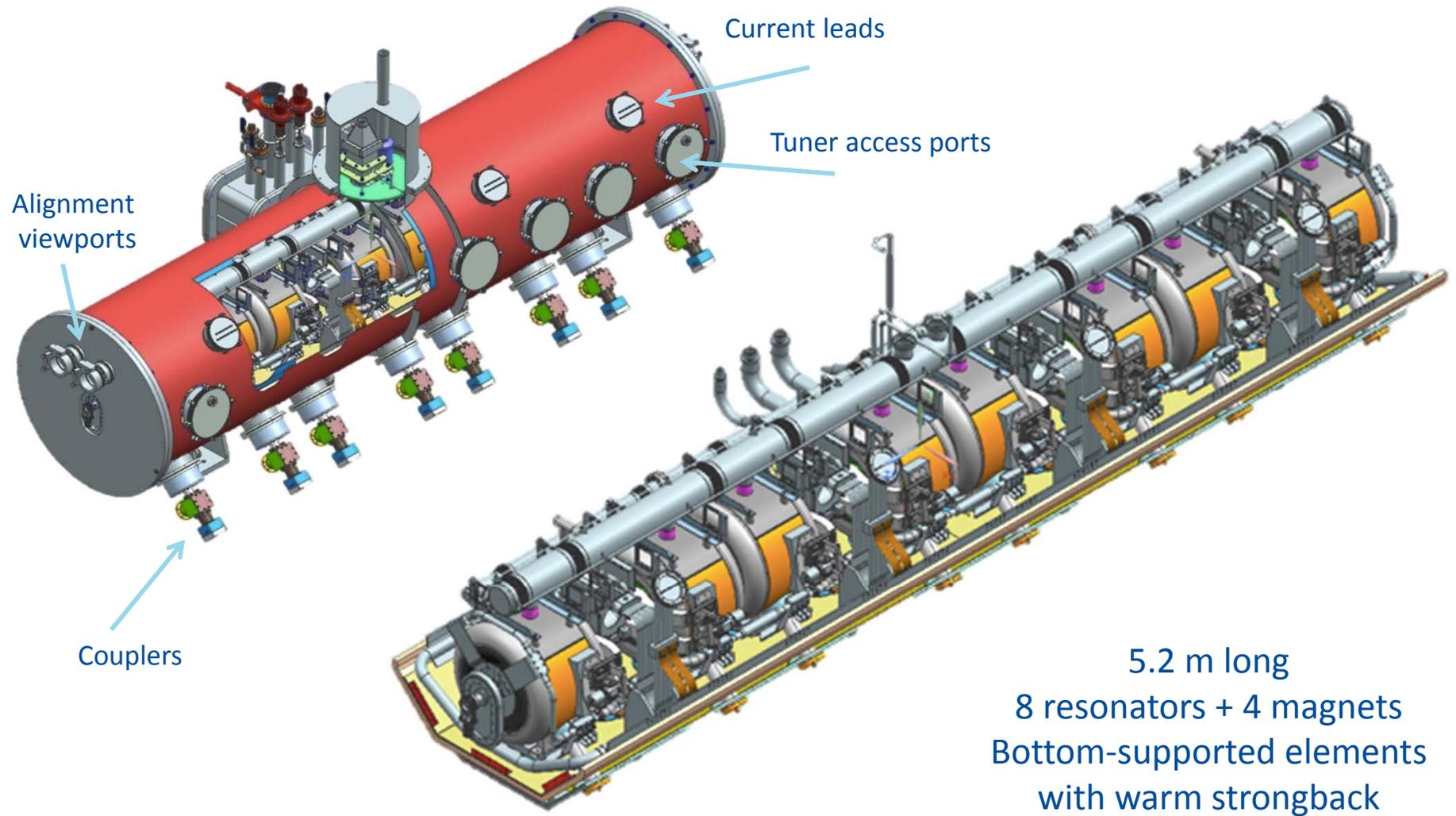
Status of SSR1 Cryomodule Development

Leonardo Ristori

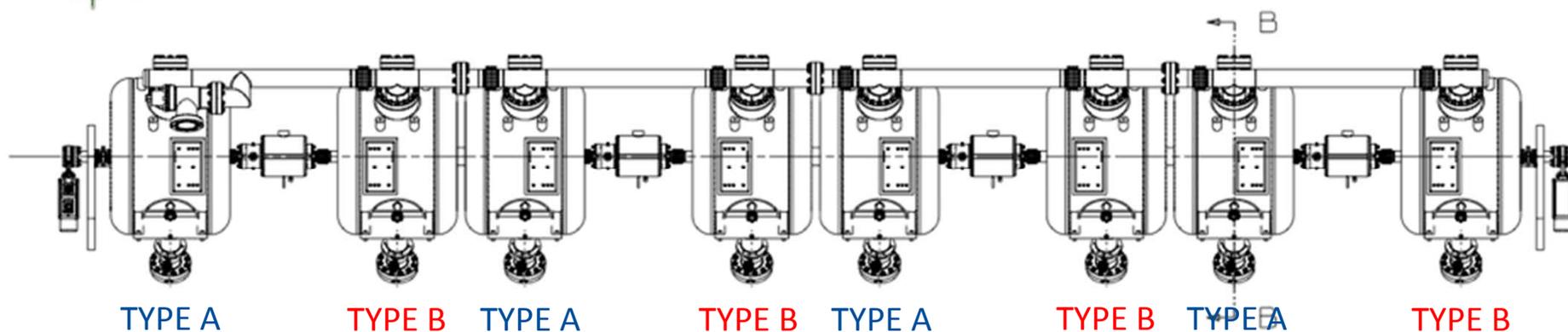
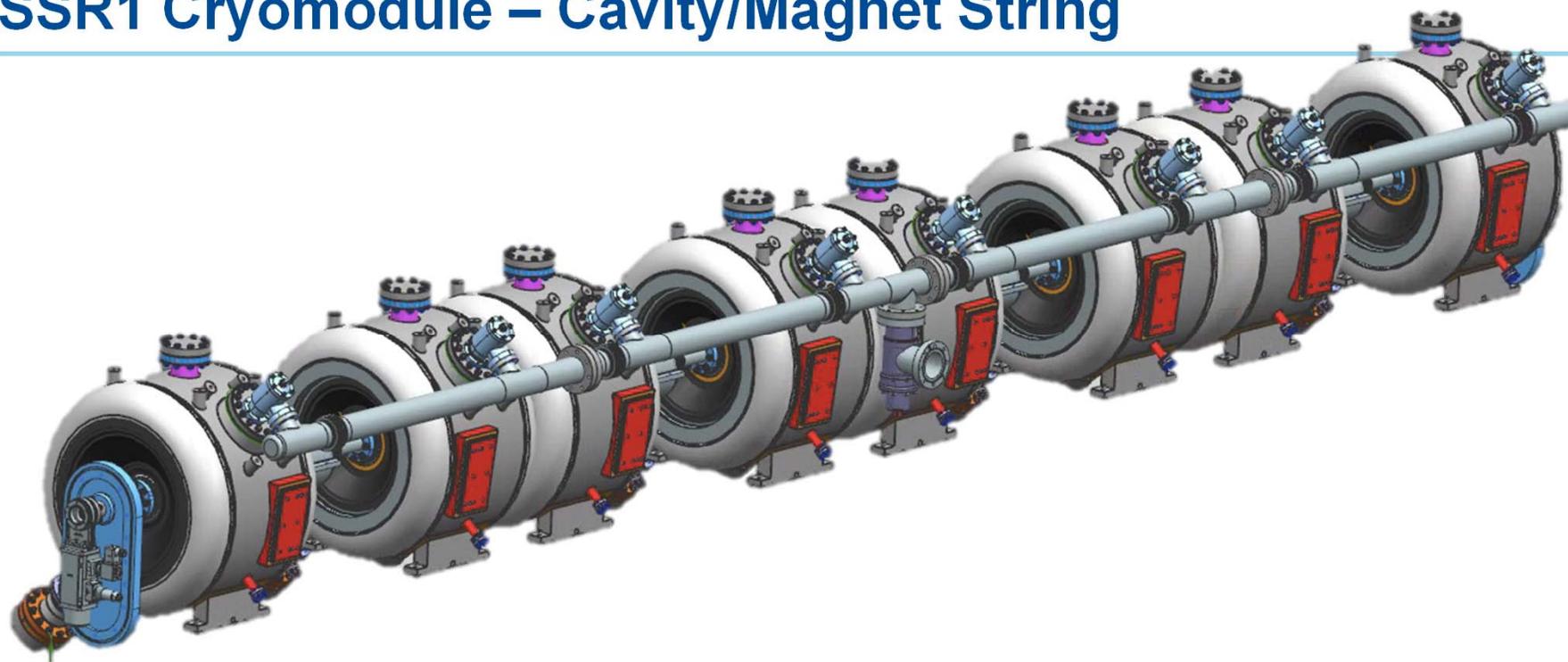
PIP-II Meeting

3 Feb 2015

SSR1 Cryomodule



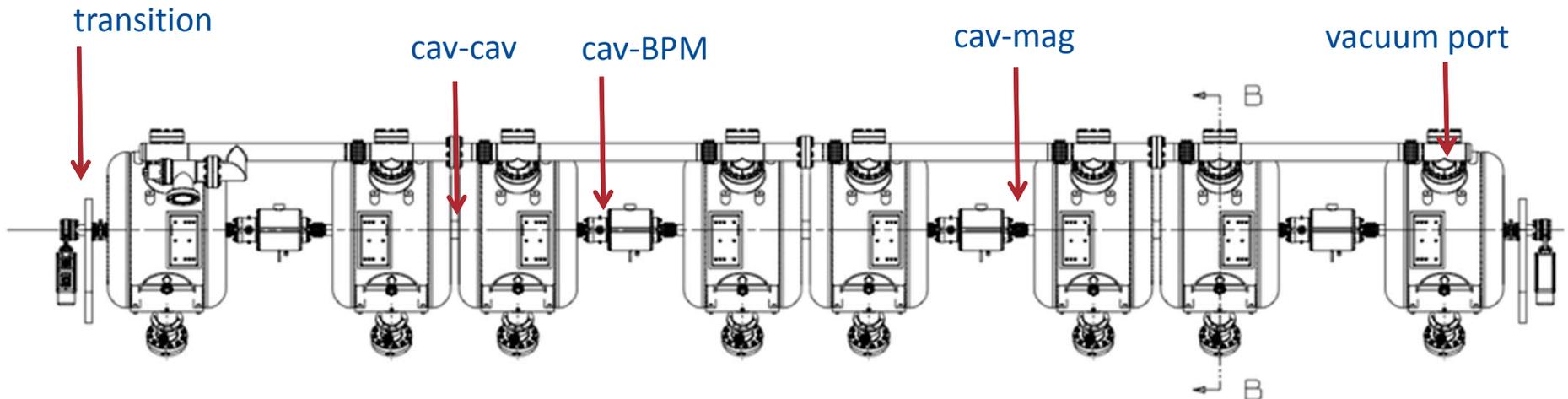
SSR1 Cryomodule – Cavity/Magnet String



Two types of helium vessels (mirror versions)

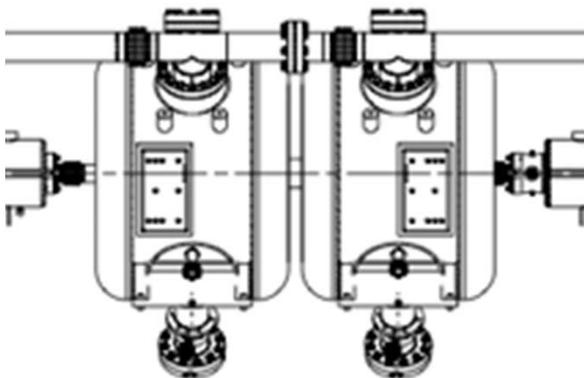
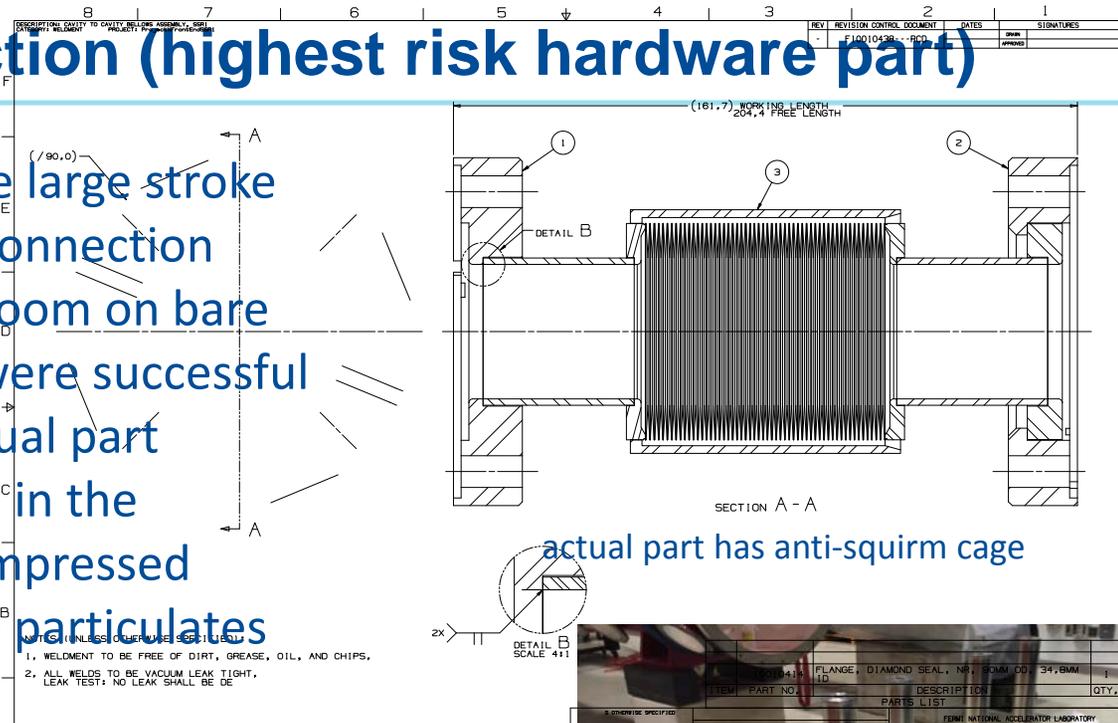
Recent design efforts - String Hardware

- 2x warm-cold transitions (includes gate valve)
- 3x cavity-cavity bellows (edge-welded)
- 4x cavity-BPM bellows (hydroformed)
- 4x cavity-magnet bellows (hydroformed)
- 8x Vacuum port assemblies (includes RAV and field probe)



Cavity-cavity connection (highest risk hardware part)

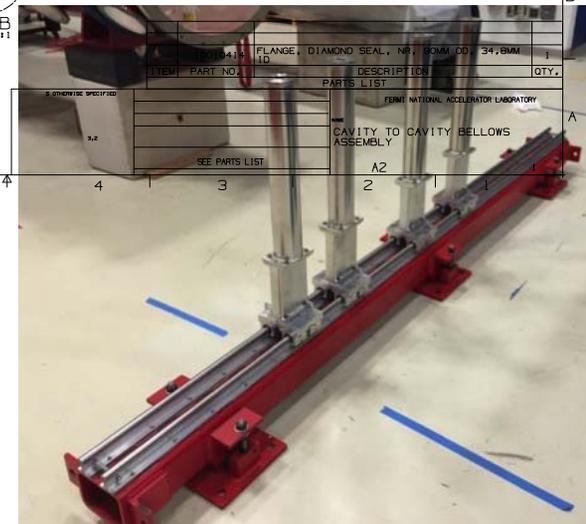
- welded bellows provide large stroke needed for this tricky connection
- cleaning tests in cleanroom on bare edge-welded bellows were successful
- will repeat tests on actual part
- bellows will be cleaned in the stretched state and compressed afterwards to minimize particulates



cavities sit very closely in the final configuration



bare bellows (1/2 length) successfully tested in cleanroom



rail replica in ICB for rehearsals

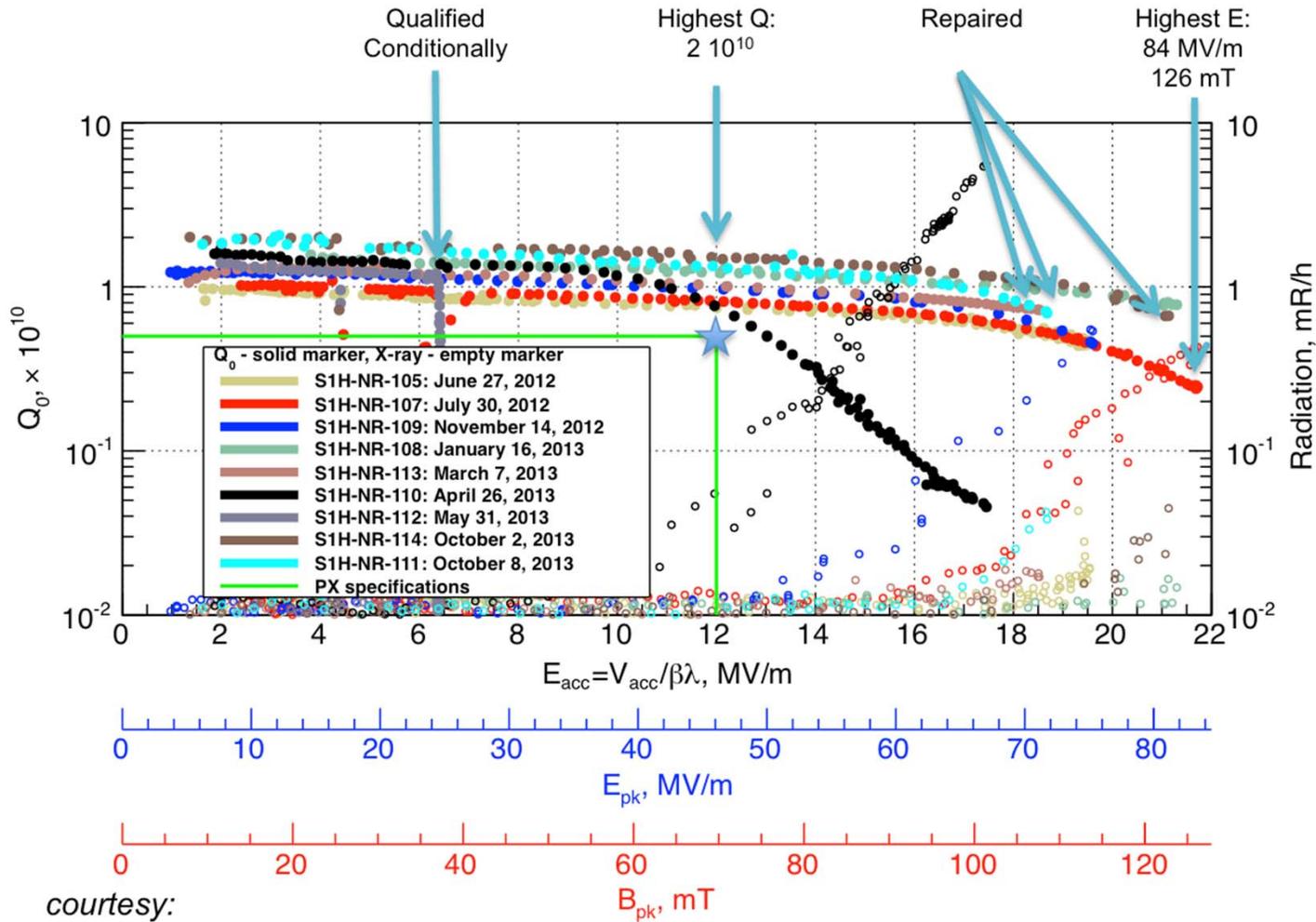
Status of SSR1 cavities

LOCATION		IB4	ANL	MP9	IB4	ANL	ANL	VTS (IB1)	ROARK	IB4	MEYER TOOL	IB4	IB4	ICB	ANL	ANL	MP9	STC (MDB)
ACTIVITY	Delivery to FNAL	Incoming QC	Bulk BCP + HPR	600 C Bake	RF Tune	Light BCP + HPR	Prep for VTS	VTS Tests	Ring EBW	RF Tune	Jacketing	Incoming QC	RF Tune	Flange Polishing	Light BCP	Prep for STC	120 C Bake	STC Tests
Contact Person		Donato	Brent	Margherita	Paolo Mohamed	Brent	Brent	Anna	Leonardo	Paolo Mohamed	Donato	Derek	Paolo Mohamed	Damon	Brent	Brian	Margherita	Andy, Joe
S1 NR 105*	no estimate										type A							
S1H-NR-106*	8-Jan-14										type B							
S1H-NR-107	4-Nov-11							22 MV/m			type A							in proc
S1H-NR-108	4-Nov-11							21 MV/m			type A							
S1H-NR-109	19-Dec-11							20 MV/m			type A	in proc						
S1H-NR-110	19-Dec-11							17 MV/m			type A							
S1H-NR-111	31-Dec-12							19 MV/m			type B							
S1H-NR-112	10-Dec-12							17 MV/m			type B							
S1H-NR-113	10-Dec-12							19 MV/m			type B							
S1H-NR-114	31-Dec-12							21 MV/m			type B							
S1H-RK-115	no estimate																	

- Most of the 10 production cavities are in the jacketing stage
- S107 is leading the group, 2nd test in STC planned this month to qualify prototype coupler and tuner
- S106 and S105 are trailing due to repairs
- Plastic deformation is performed at various moments throughout the lifetime of cavities to ensure proper tune

Vertical Test Stand (VTS)

2012-2013: Successful qualification of production cavities for PXIE cryomodule



courtesy:
A. Sukhanov



Jacketing operations



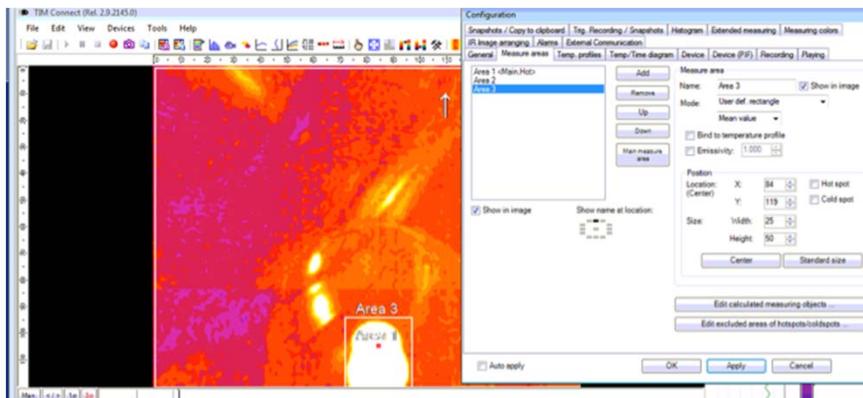
Thermal cameras insertion tubes (above)



Welding inch-by-inch on 6 mm thick steel

Large fixtures needed to control warping

Screenshot of remote connection from FNAL

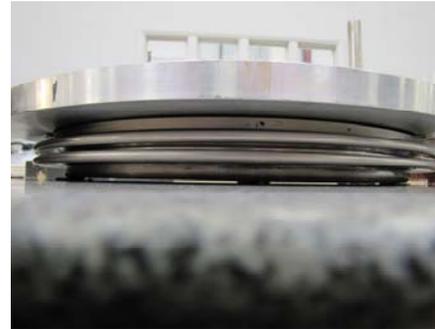


Pressure sensitivity (df/dp) in SSR1 cavities

Acceptable range of df/dp in CW operation for PXIE: $-25 \leq \frac{df}{dp} \leq +25 \text{ Hz/Torr}$

A passive compensation solution was studied and developed for these cavities, in order to minimize the sensitivity to pressure fluctuations: $\frac{df}{dp} \rightarrow 0$.

The bellows plays the major role and high attention was spent on its design and manufacturing. The characterization and qualification of each unit was done performing experimental tests, visual inspection and dimensional checks.



The results of the first three jacketed SSR1 cavities at room temperature are very good:

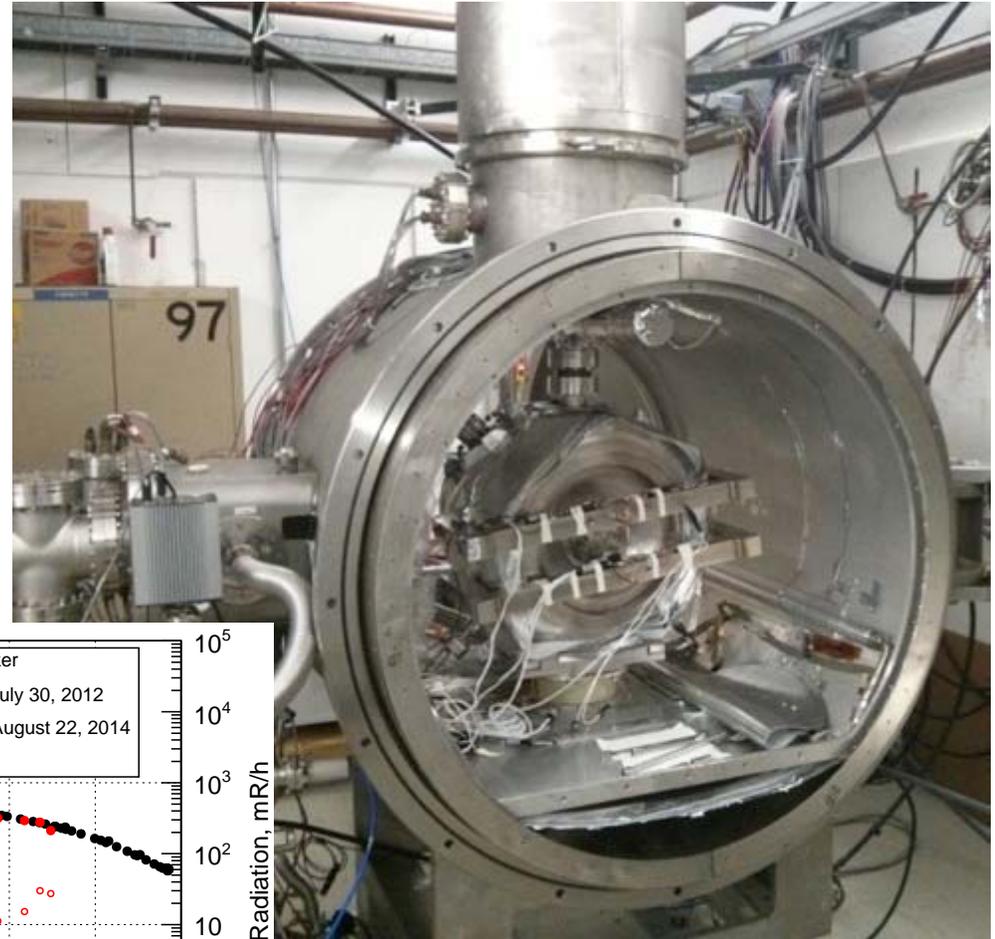
SSR1-107: $df/dp = +4 \text{ Hz/Torr}$

SSR1-108: $df/dp = +1 \text{ Hz/Torr}$

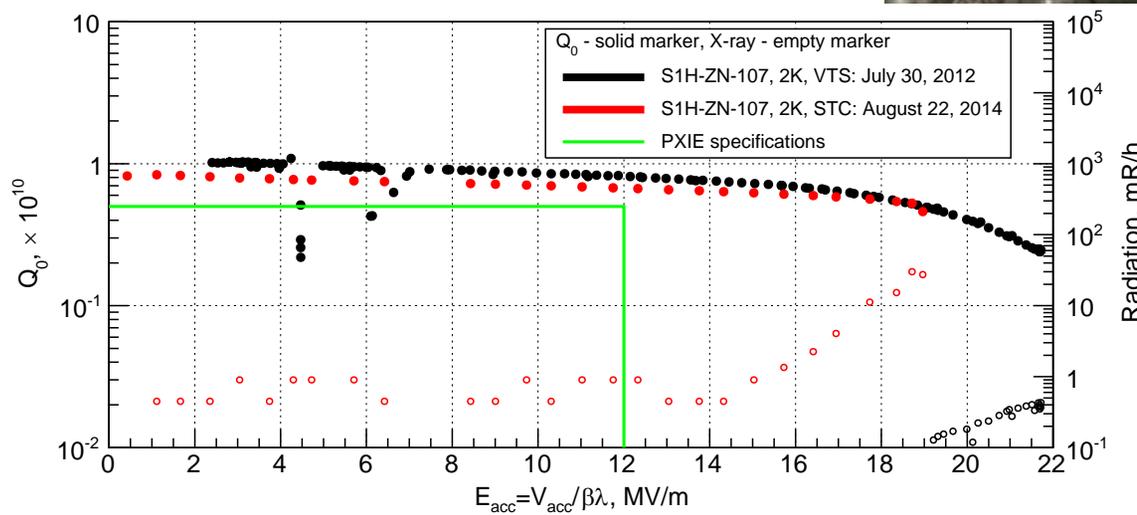
SSR1-109: $df/dp = +4 \text{ Hz/Torr}$

Spoke Test-Cryostat (STC) – S107 Run 1

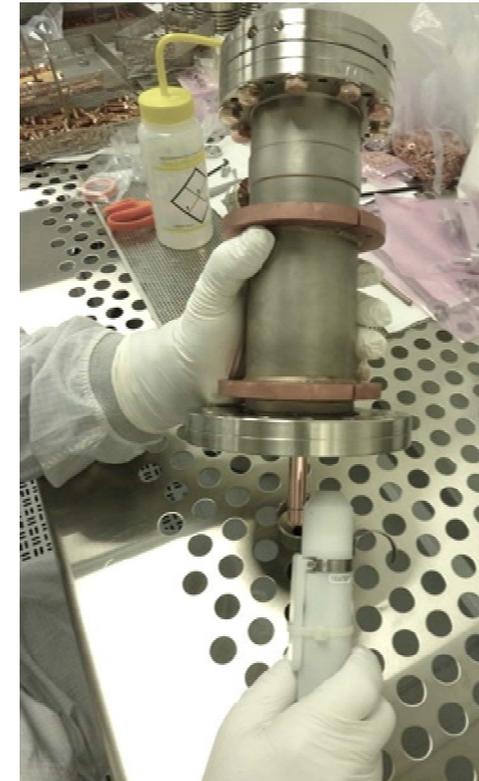
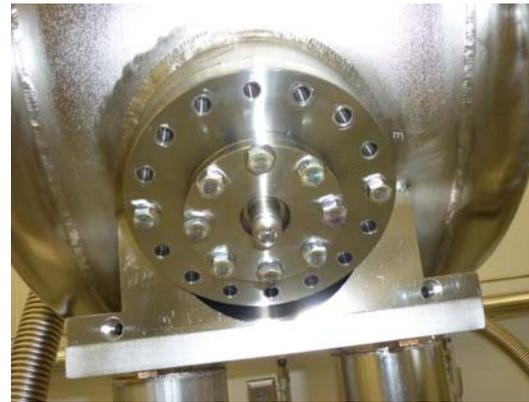
A. Hocker, A. Sukhanov



Sep-Oct 2014
Successful cold tests of first production
SSR1 (S107) and piezo encapsulations



Preparations for Run 2 – Installation of prototype coupler

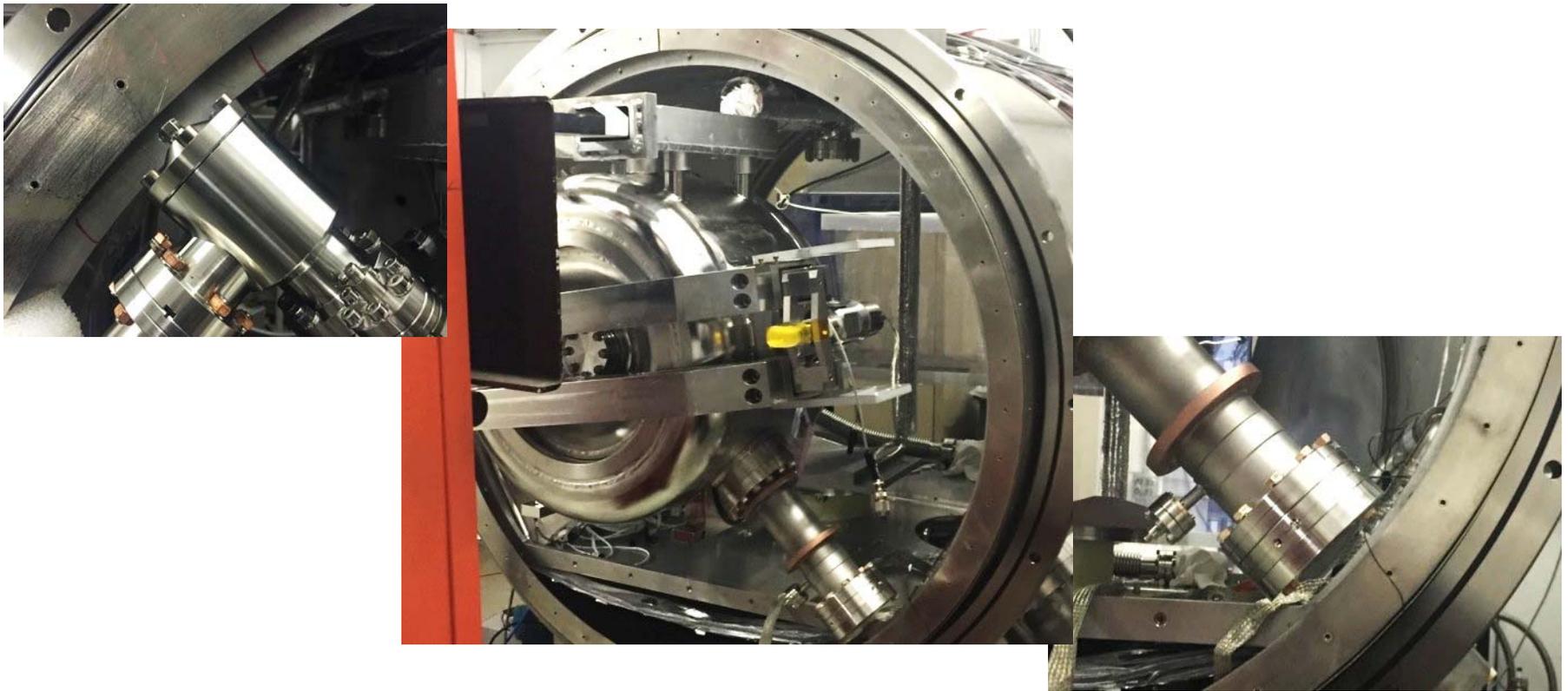


- All work done at MP9
- Unity coupler was replaced with prototype high-power coupler

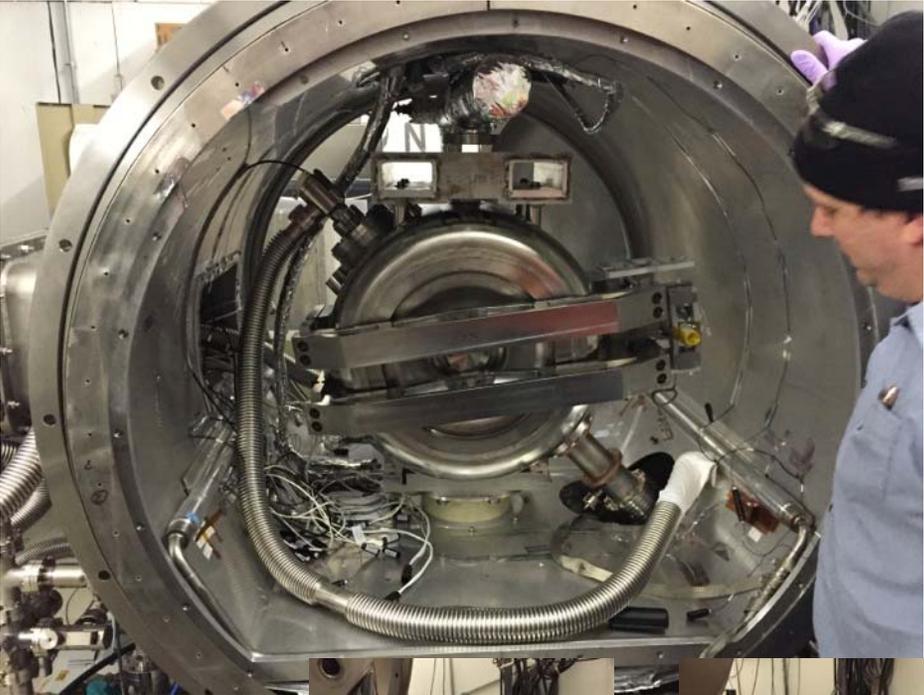


Shutdown challenges

- High-power coupler never tested in cryostat before, turned out to be a little too long to fit as-is
- Necessary to cut back a portion of thermal shielding and it was still a very tight fit
- Working on small improvements to make future installations easier



Shutdown challenges (continued)



S107 – Run 2

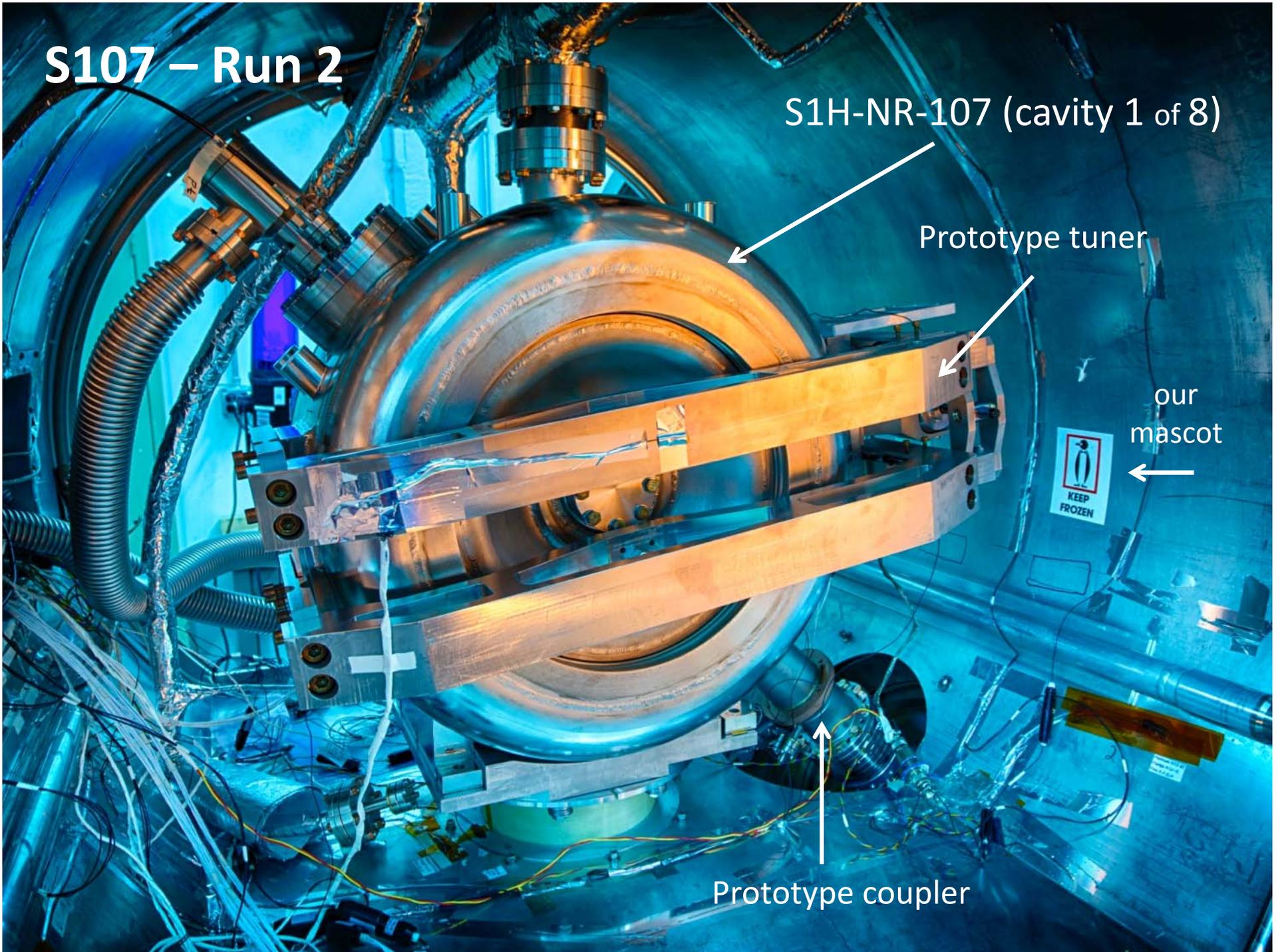
S1H-NR-107 (cavity 1 of 8)

Prototype tuner

our mascot



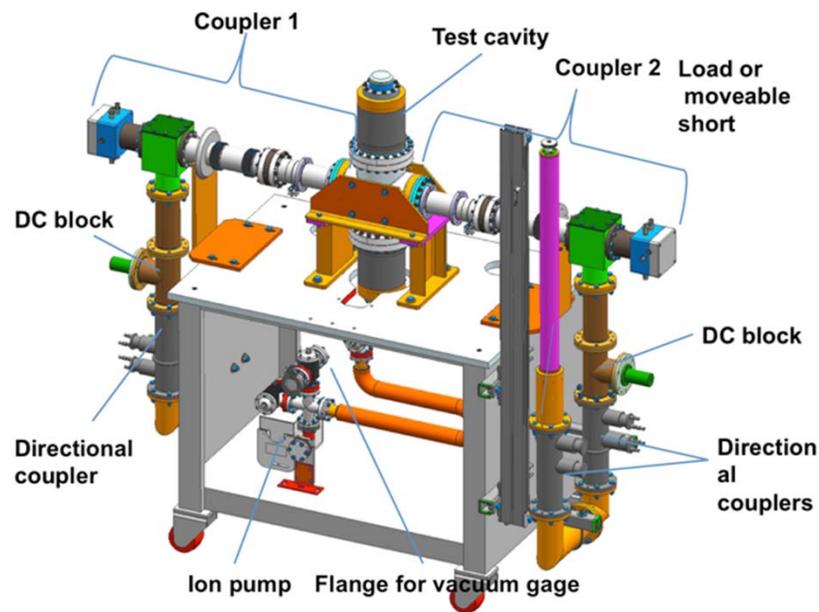
Prototype coupler



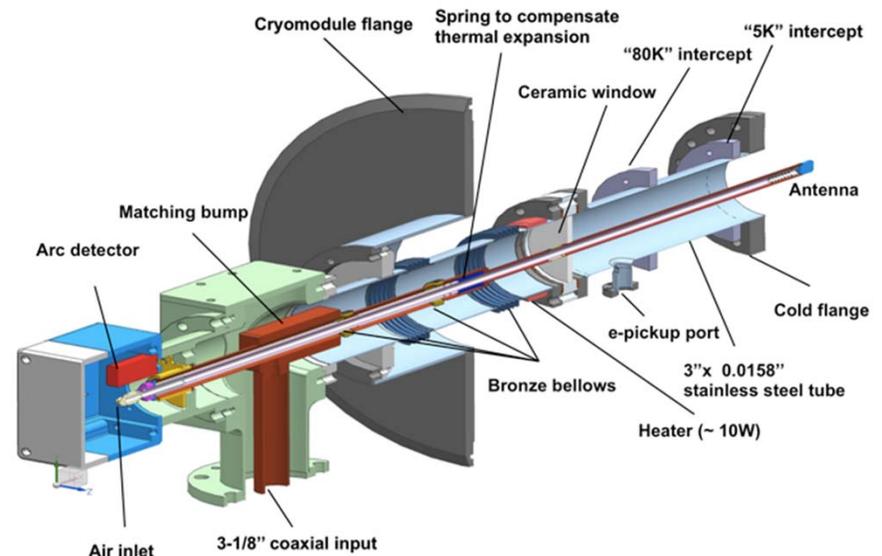
Couplers

- We have 3 prototypes
 - 2 installed on RF test stand, 1 installed on first production cavity in STC
- Design was changed to address several issues
 - upgrade to aluminum seals, increase thickness of electro-deposited bellows,...
- All components for 10 production couplers have been ordered
 - cold-ends are needed for qualification of cavities

325 MHz Test Stand



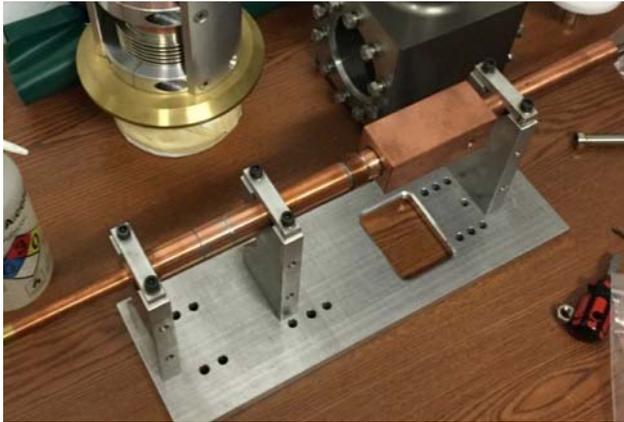
325 MHz coupler anatomy



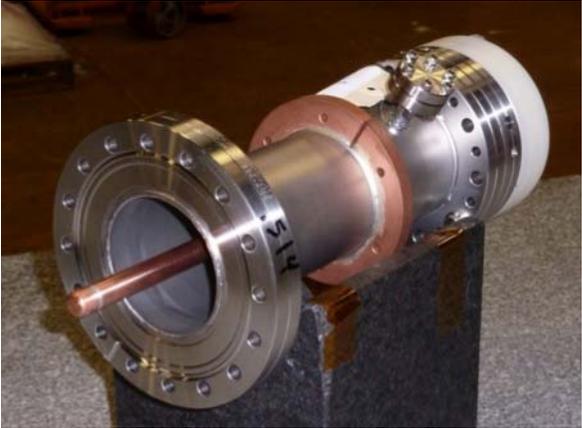
Prototype couplers



Outer conductor



Inner conductor

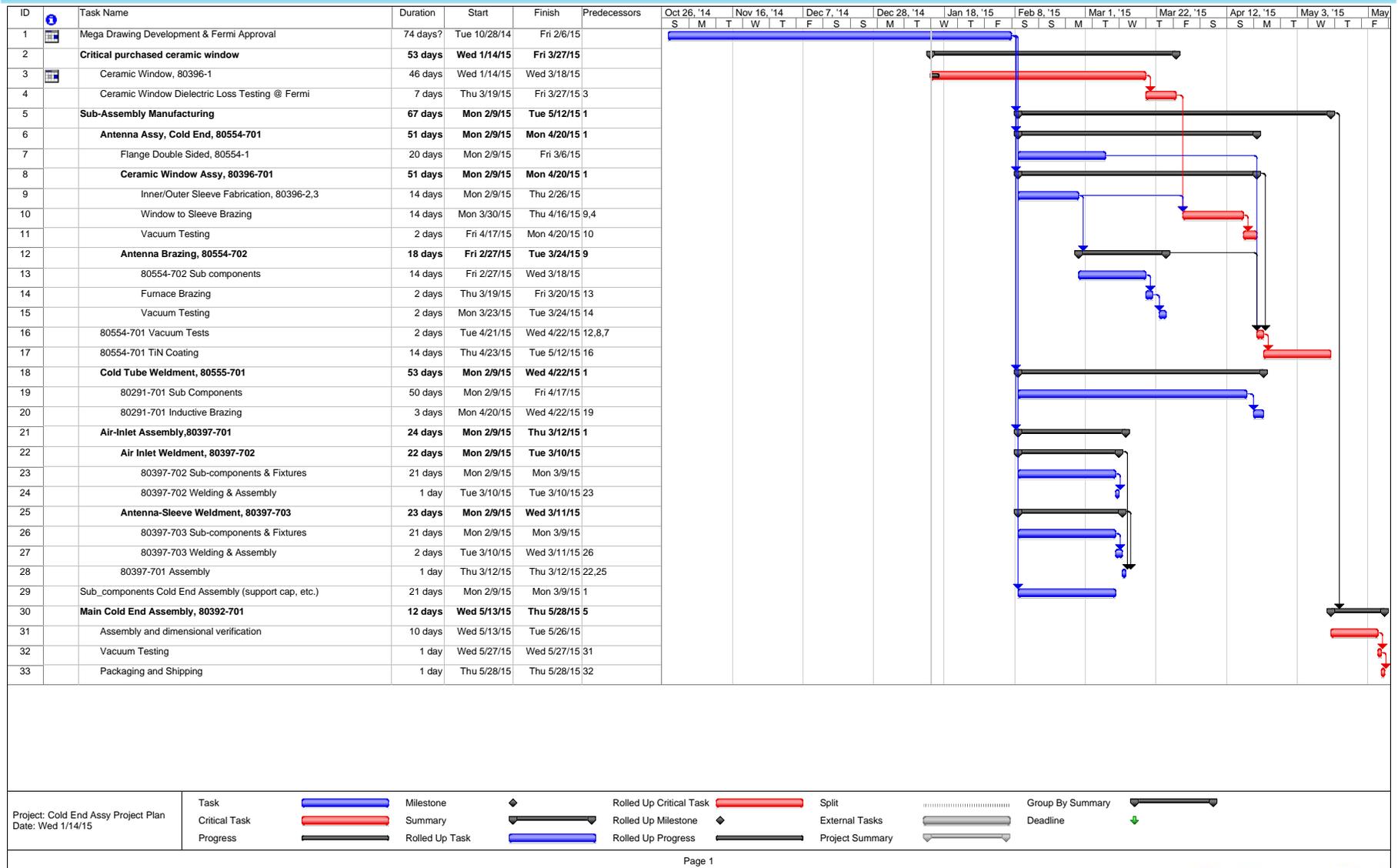


Cold-end assembly

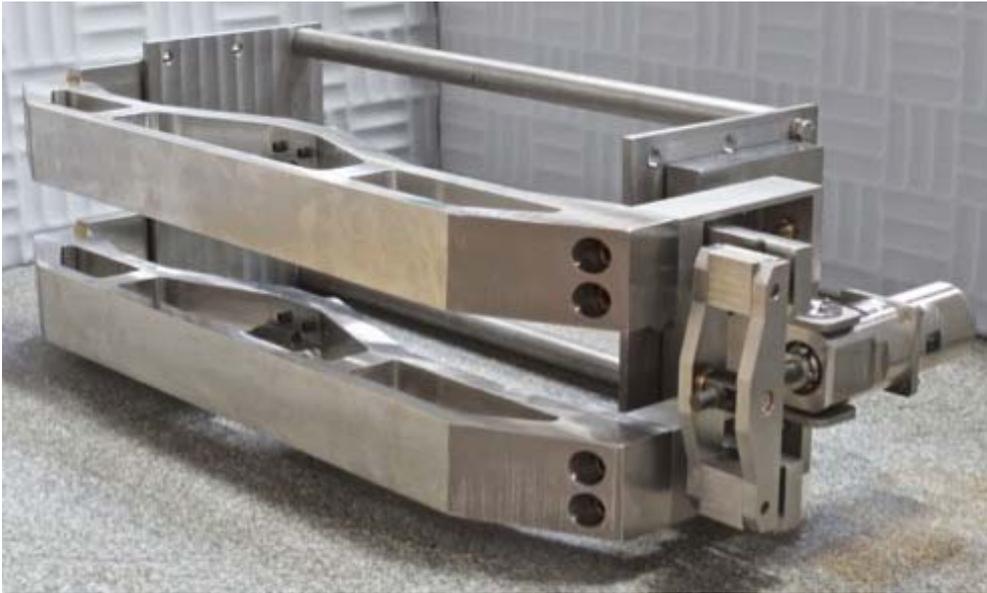


RF test stand

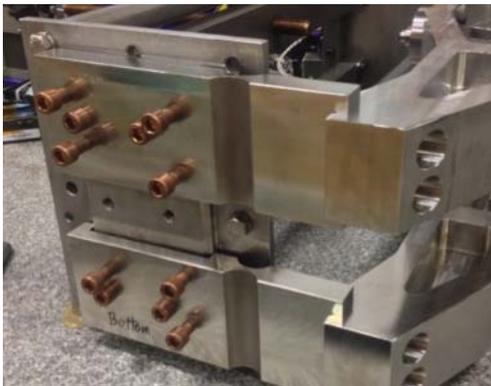
Schedule for cold-ends (delivery end of May)



Prototype Tuner



Alignment system for main arms



Piezo encapsulations include bellows for retainment

Cartridge with motor and piezos

Installation of cartridge

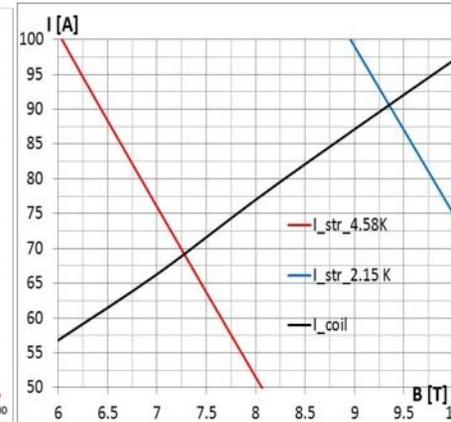
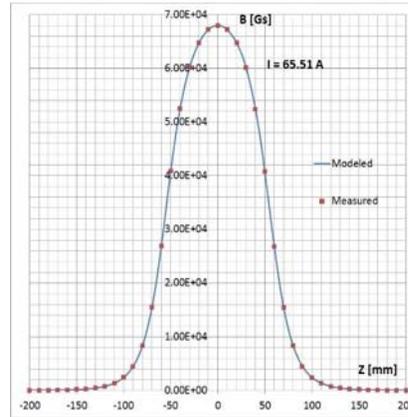


Focusing Lens

Prototype FL

1. Prototype lens' cold mass procured and tested at 2 K
2. The lens assembled and re-tested

Fringe field specification requirements marginally met.
Correction measured specified



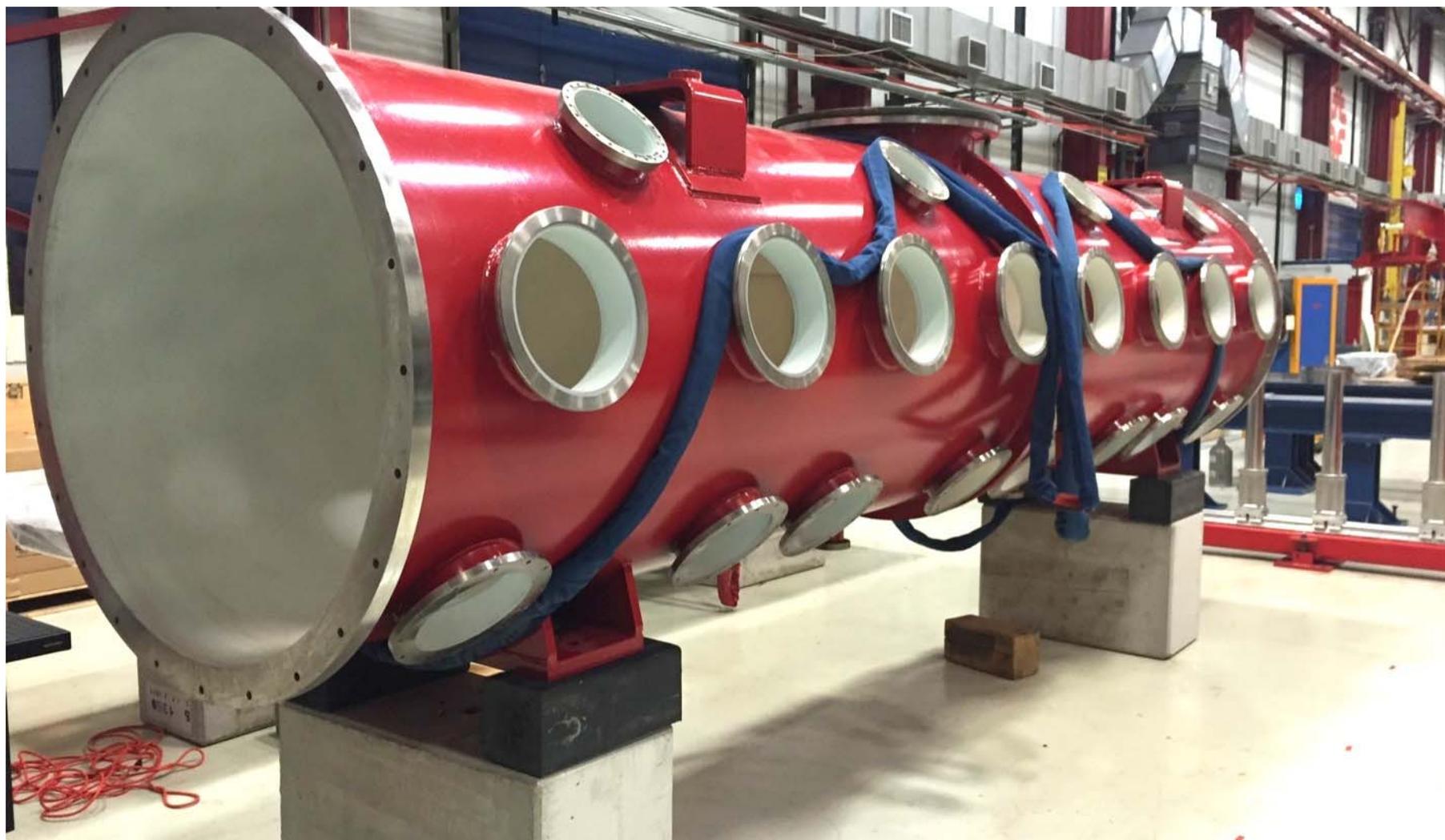
Production FL

1. Four production lenses' cold masses procured and tested at 4 K by the vendor.
2. Four LHe vessels procured.
3. Lens assembly is ongoing.
4. Lens testing at 2 K will be scheduled after the assembly is complete and the leak check made.

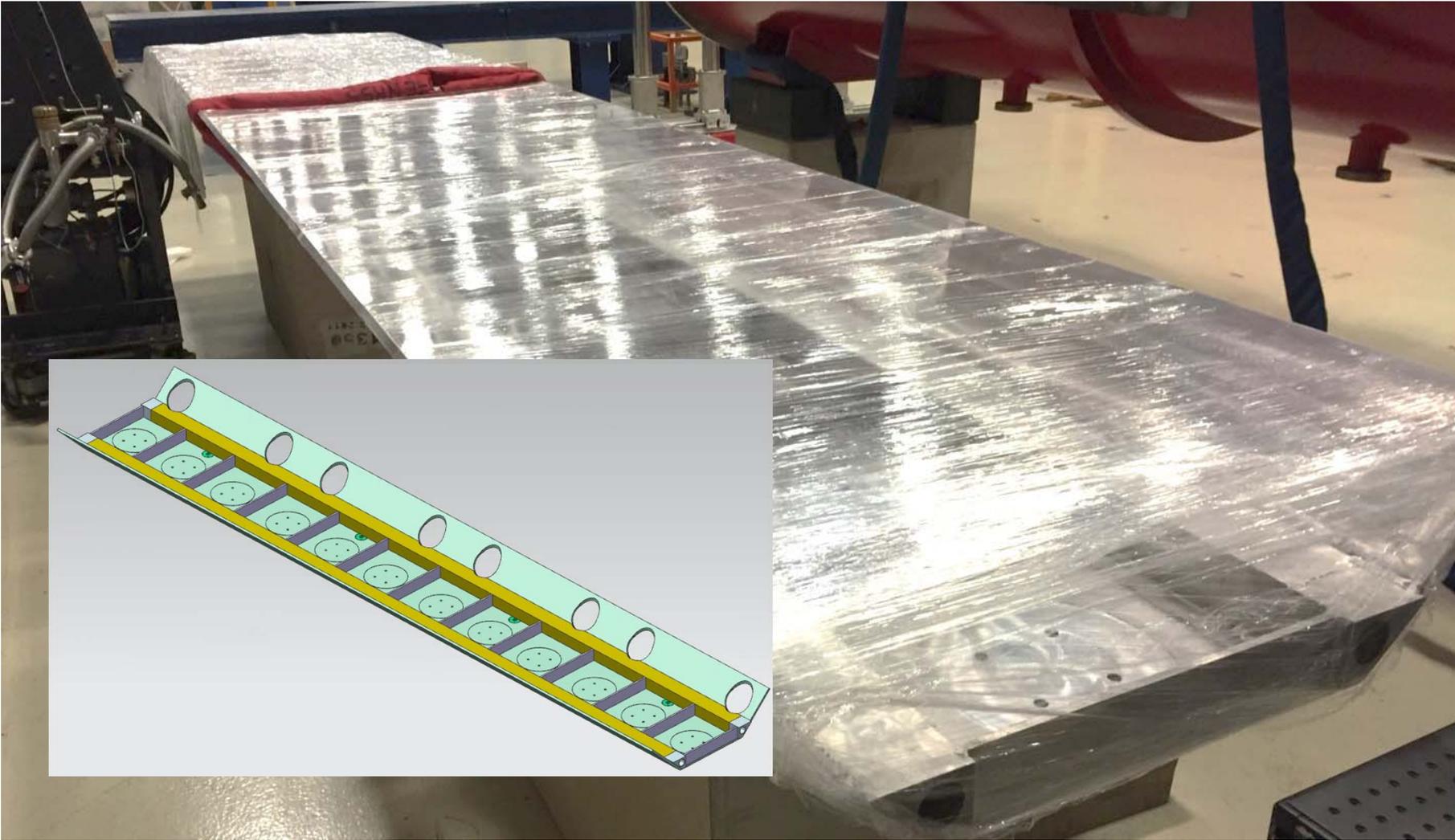


Production #1 in preparation for the axis position measurement.

Vacuum vessel (incoming inspection)



Strong-back (rework planned to facilitate string installation)



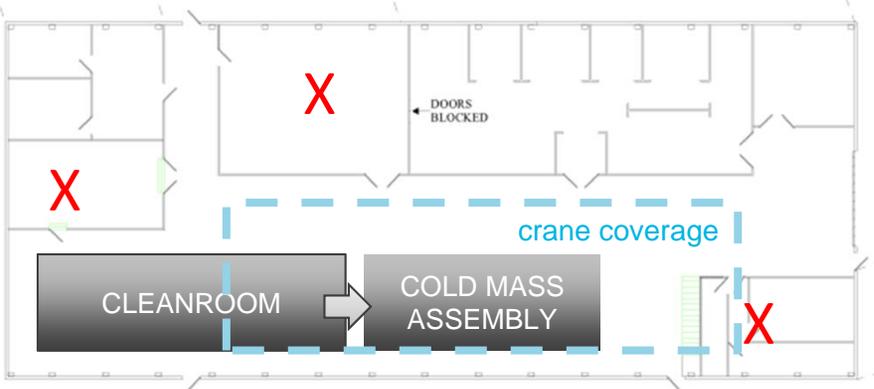
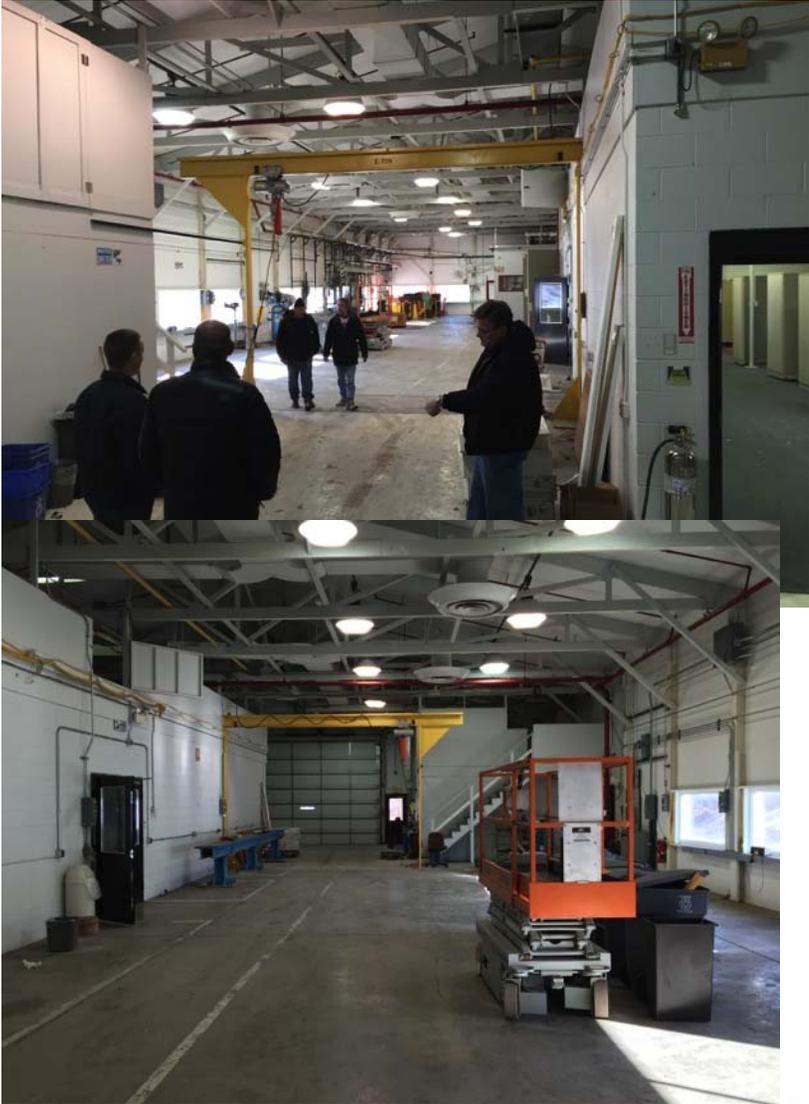
Components delivered or in procurement

- Cavity string
 - Cavities, He Vessels, Vacuum ports, Couplers
 - Magnets, He Vessels
 - BPM's (ANL)
 - Beamline bellows, Warm-cold transitions, Valves, Seals
- Cold mass
 - Strong-back, support posts, cavity alignment, solenoid supports
- Cryomodule
 - Vacuum vessel

Logistics

- Production floor currently in ICB (temporary)
 - 2 cavity test
 - Full string shake down test (before chemistry)
- MP9 vs LAB2
 - LAB2 is being refurbished for PIP-II. Building ready as early as Summer 2015 (demolition work, crane install and floor resurfacing).
 - Softwall cleanroom repurposed from IARC is available to us
 - Need RO water, Nitrogen etc..
 - We can move directly from ICB to LAB2 (early 2016)
 - MP9 cleanroom not the best option for SSR1 (schedule conflicts, string handling)
- Move to LAB2 for string assembly (after chemistry)
- ANL: processing + STC preparations
- MP9 will continue to help with resources and small cleanroom work if needed

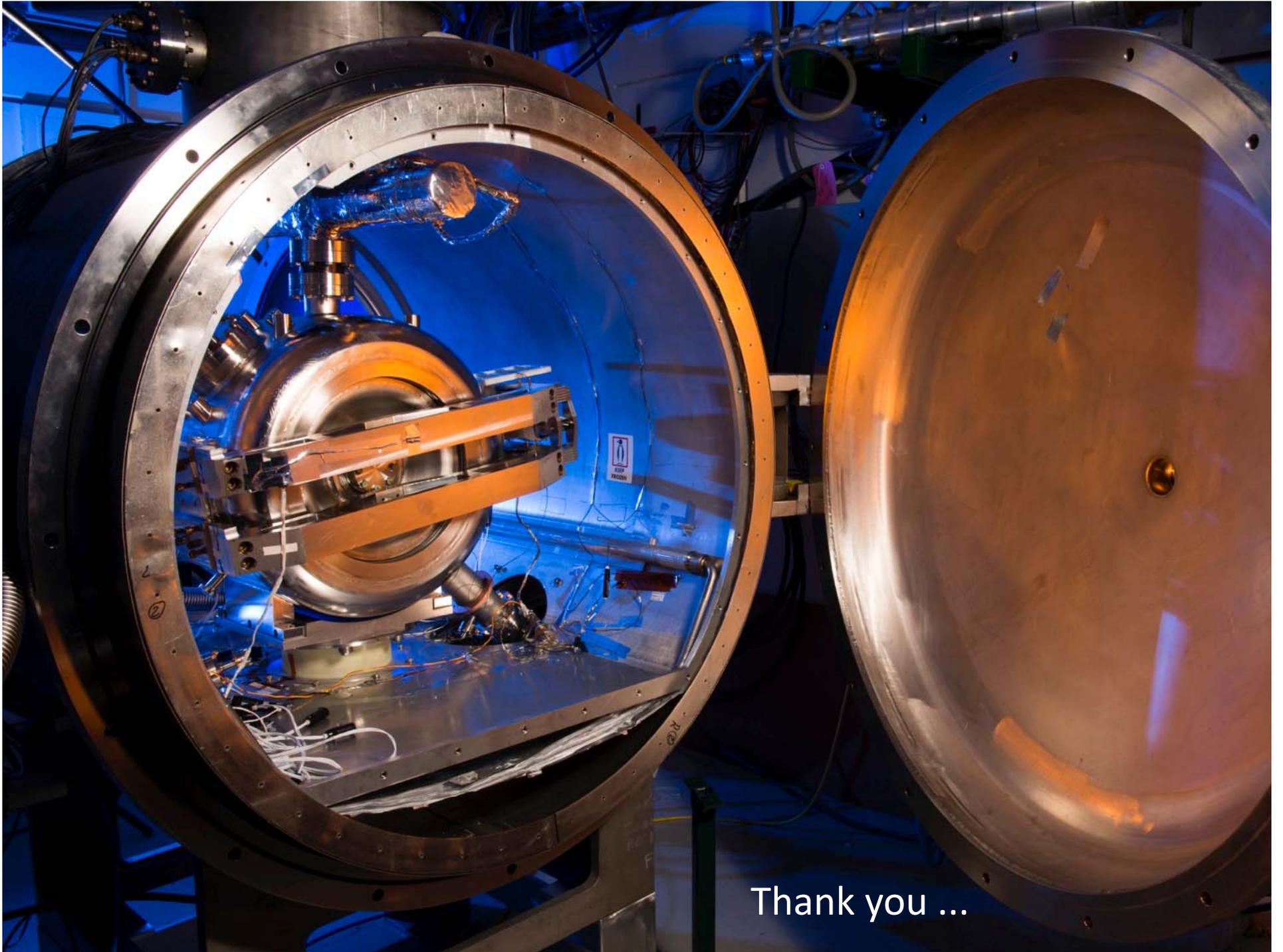
LAB2 today



X: demolition in process

Penciled-in dates..we can speed up if we secure more FTEs

- Delivery of 8 jacketed cavities: MAY 2015
- Solenoids completion: MAR 2015
- Solenoid testing: Summer 2015
- **String shake down in ICB: JUN-JULY 2015**
- Delivery of 8 couplers: JULY 2015
- Processing campaign at ANL: JULY 2015 – FEB 2016
- STC qualifications: AUG 2015 – MAR 2016
- **String assembly in LAB2: MAR -MAY 2016**



Thank you ...