BNL LHC Hi-Lumi

QXF Vertical Test Facility Status Update

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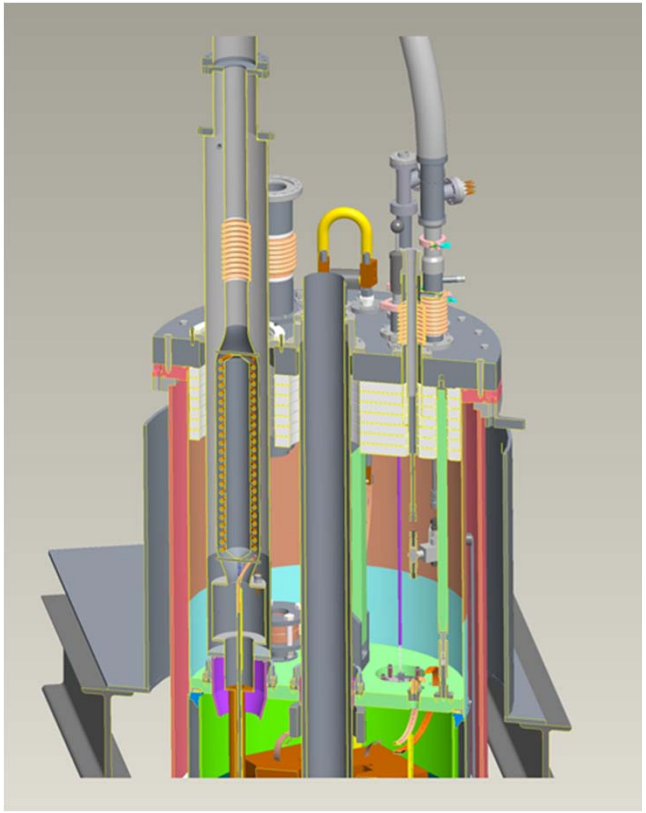
September 25, 2015



Outline

Cryogenic Facility

Power Supply

Test dewar

Schedule to Completion

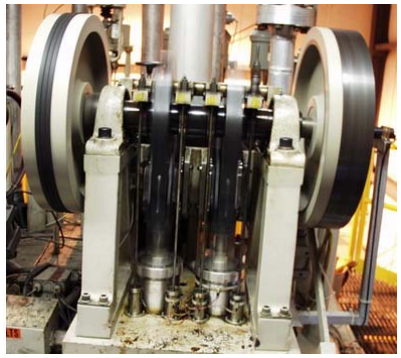
Budget Review

Outline

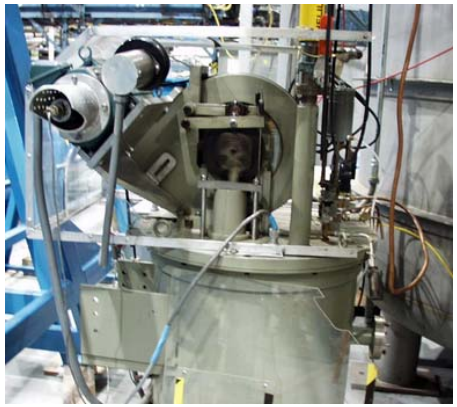
Cryogenic Facility

Cryogenic Facility p.1
Main Refrigeration Units

- CTI Model 4000 refrigerator (primary unit, 320 l/hr. uses (2) reciprocating engine expanders)
  - ✓ Rebuilt expander in 2013
  - ✓ Unit in good working condition



- Koch Model 1600 Wet Expander
  - ✓ Unit in good working condition
  - Seals, O-rings, etc. to be changed ~ October-November 2015



Note: all work is “off-Project”, i.e., BNL funded

Cryogenic Facility p.2
Compressors

- Mycom Compressor (primary unit, 2 stage, 800 hp, 160 g/s)
  - ✓ Purchased & received critical spares:
    - ✓ new 2nd stage compressor head
    - ✓ new 400 hp motor
    - ✓ new oil heat exchanger
    - ✓ new helium heat exchanger
  - ✓ Maintenance items completed:
    - ✓ Installed new oil filter & seals
    - ✓ Repaired oil leaks
    - ✓ Replaced oil line clamps
    - ✓ Refurbished & resealed heat exchanger

- Sullair 350 Compressor (single stage, 350 hp, 51 g/s)
  - ✓ Purchased & received critical spares:
    - ✓ new compressor screw
    - ✓ new oil pump

Note: all work is “off-Project”, i.e., BNL funded

Cryogenic Facility p.3
Secondary Refrigerator

- CVI Refrigerator (backup unit, 2 turbines, 160 l/hr)
  - ✓ Controls modernized in 2003
  - ✓ Replaced (1st stage nitrogen-helium) heat exchanger
  - ✓ Replaced turbine chilled water heat exchanger
  - ✓ Replaced temperature sensors
  - ✓ Updated temperature readout system

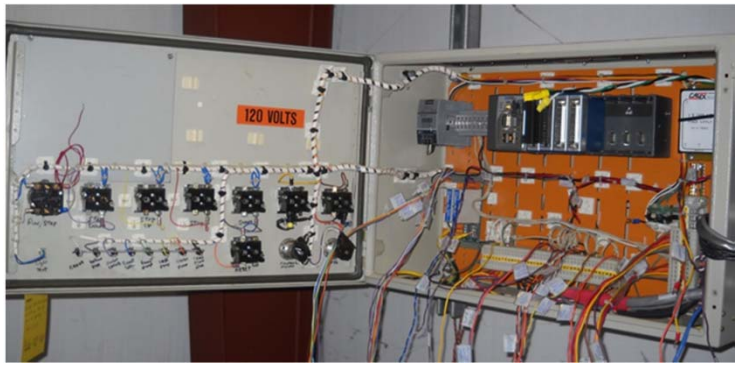
Note: all work is “off-Project”, i.e., BNL funded

Cryogenic Facility p.4
Nash Helium Vacuum Pump

- Nash Vacuum Pump (2.7 g/s @ 1.8K)
  - ✓ Connected helium exhaust gas line to 100 hp compressor and inline purifier, to reclaim helium gas (was previously routed to dirty gas facility)
  - ✓ Purchased ("off-Project") new 100 hp Sullair compressor (to be installed, October 2015)
  - ✓ Replaced legacy soldered copper water lines with welded stainless steel
  - ✓ Purchased new booster and liquid ring vacuum pumps
  - ✓ Refurbished / purchased spare chilled water heat exchangers
  - ✓ Replaced drive belts
  - ✓ Repaired service air supply line
  - ✓ Updated control system

  → Turn-on scheduled for October 2015

  - (FY16) Install new transfer line, valve to test dewar



Cryogenic Facility p.5

- Inline Purifiers
  - ✓ Replaced Polyflow lines
- Valve Boxes
  - ✓ Replaced Polyflow lines
- Quench Tank
  - ✓ Replaced valve & legacy soldered copper lines with stainless steel welded pipe; rerouted quench recovery line to improve flow
    - (Underway) Replace legacy soldered copper small diameter return manifold piping with large diameter welded stainless steel
    - (Underway) Purchase return manifold valves

"before"

"now"

Cryogenic Facility p.6

(FY16)*

- Re-commission Sullair Compressor (backup to Mycom, single stage, 500 hp, 94 g/s)

(FY17)*

- Re-commission Kinney Vacuum Pump (backup to or increased capacity for Nash Pump, 2.0 g/s He @ 1.8K)

* Pending final budget authorization

Outline

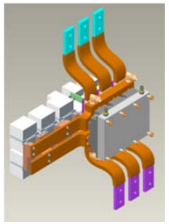
Power Supply

Power Supply Status p.1

All parts received, installation underway

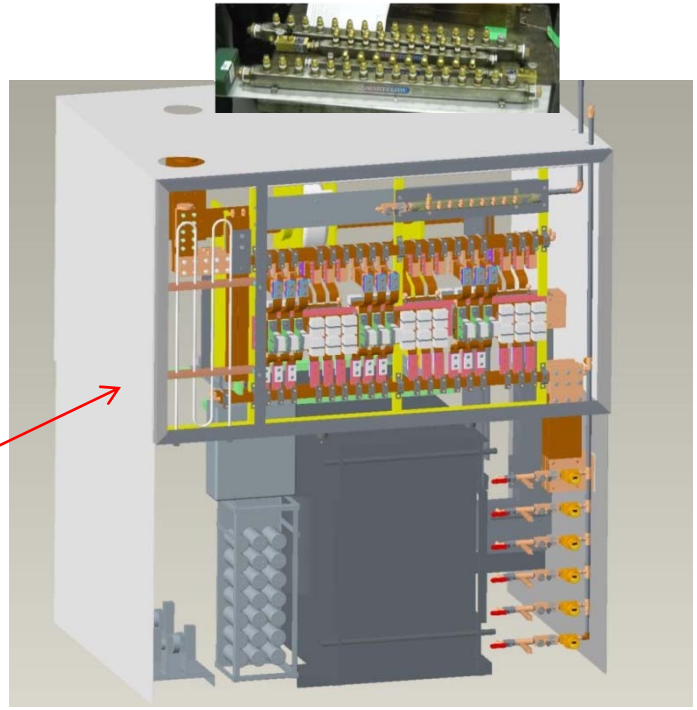
Using existing 30KA Power Supply:

- Upgrade IGBT based Energy Extraction Switch to 22KA capacity (<100 μsec shutoff)
- 1st 15KA cabinet complete, testing underway
  - Current sharing of (6) IGBT's verified
  - Operated in steady state to 12KA, shutoff tests
- 2nd 15KA cabinet assembly started



1st cabinet

2nd cabinet subassemblies



Power Supply Status p.2

Fast Data Acquisition System for Voltage Taps:

- 128 channels
- ✓ All isolators / pre-amplifiers assembled, calibrated & tested.
- ✓ Cable end connector assembly complete on dewar end.
- ✓ Acquisition software written/debugged/tested.

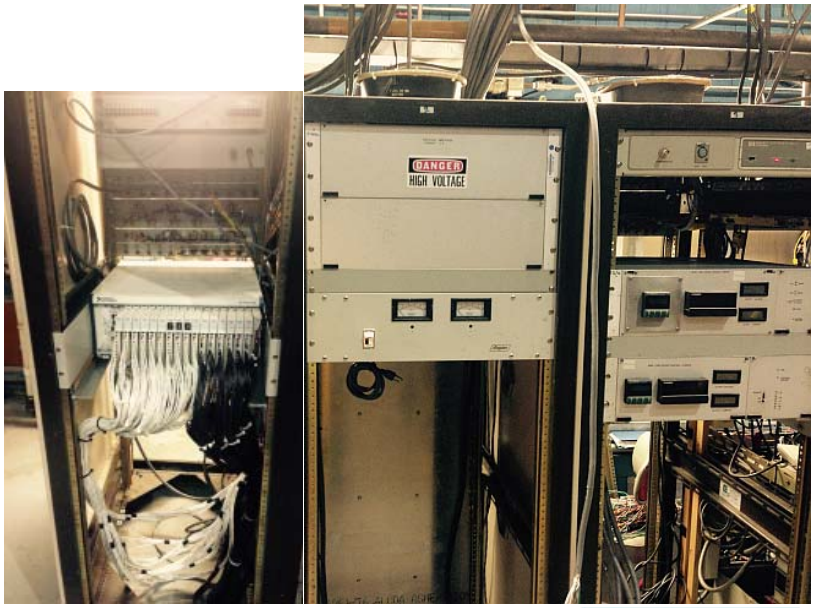
8 channel Quench Detector:

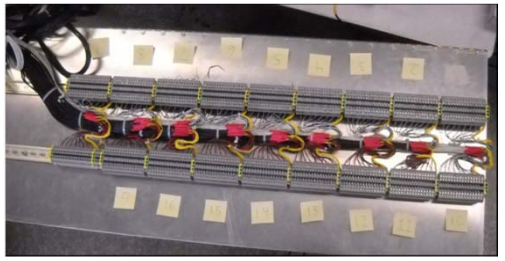
- ✓ Assembled & tested.
- ✓ Software written & tested.

Strain Gauge readout system:

- Assembly underway

(FY16) - Spike Detector & Quench Antenna Data Acquisition System to be designed & built



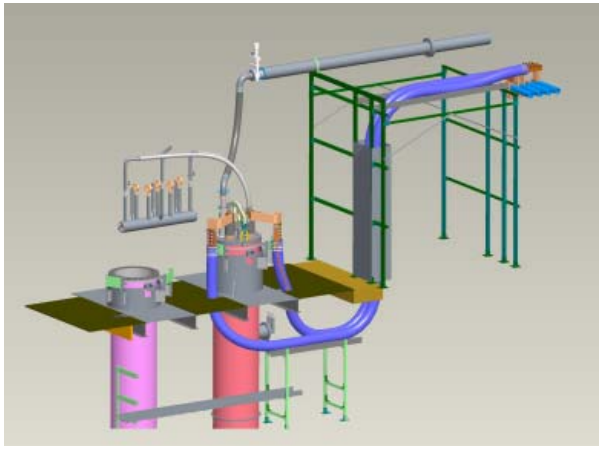


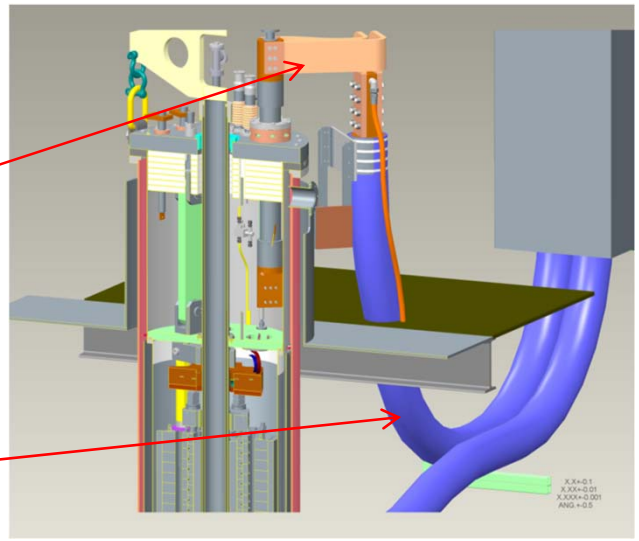
Power Supply Status p.3

All parts ordered/fabricated, installation October 2015

Using existing 30KA Power Supply:

- Extend 30KA water cooled power cables.
  - ✓ Water cooled bus received
  - ✓ Flexible copper top hat connectors received
- Build support framework for cables
  - ✓ Unistrut hardware & cable trays ordered
- Installation scheduled in October 2015

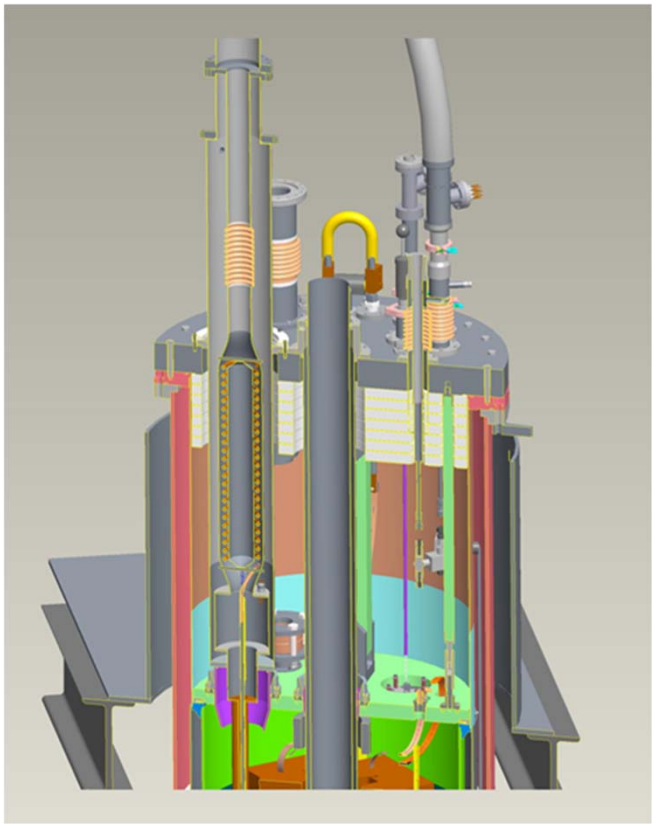




Outline

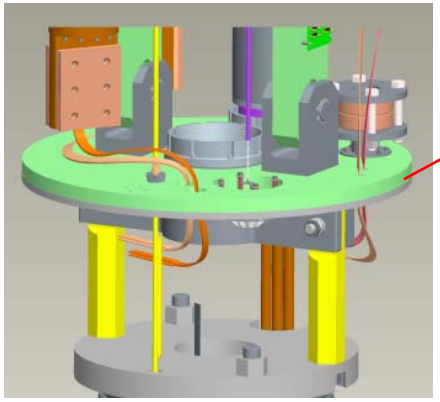
Test Dewar

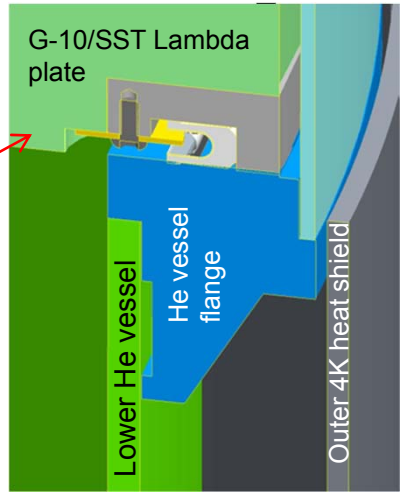
Test Dewar Status p.1
Overall design (final)



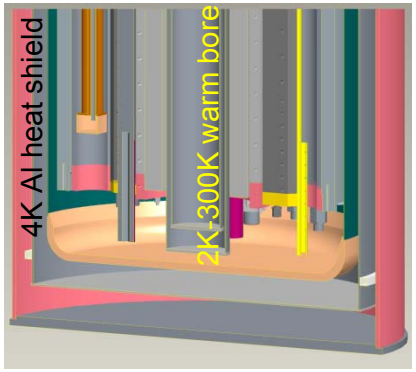
Upper dewar assembly:

- Vent *and* burst disc in lambda plate (for Safety Approval)
- Gravity seal at lambda plate (was bolted)



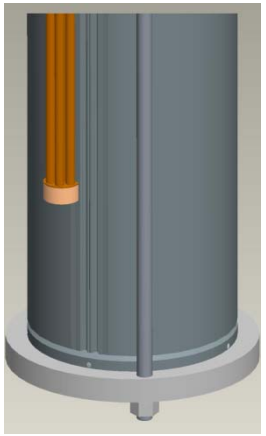


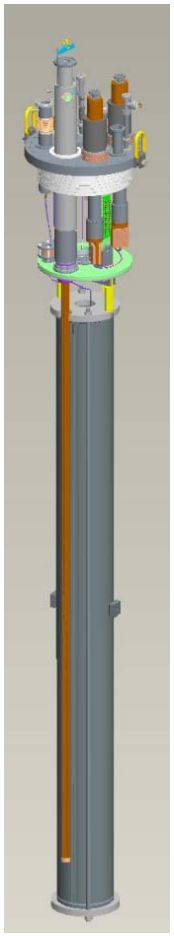
Lambda plate sealing detail



+200 mm extended helium dewar bottom

Heat exchanger in magnet helium passage (left) and outside Mirror O.D. (right)

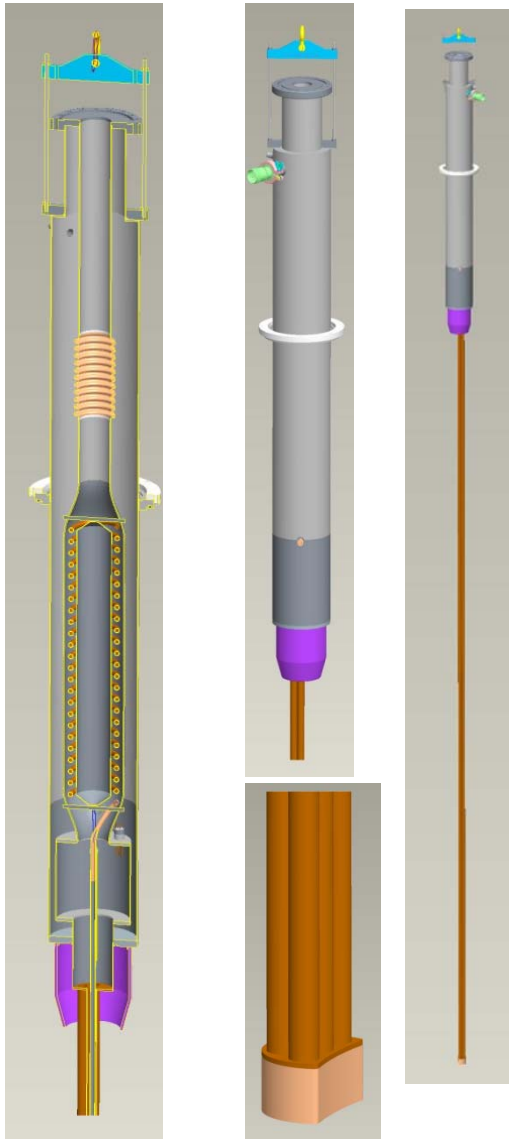




Overall hanging assembly (mirror shown)

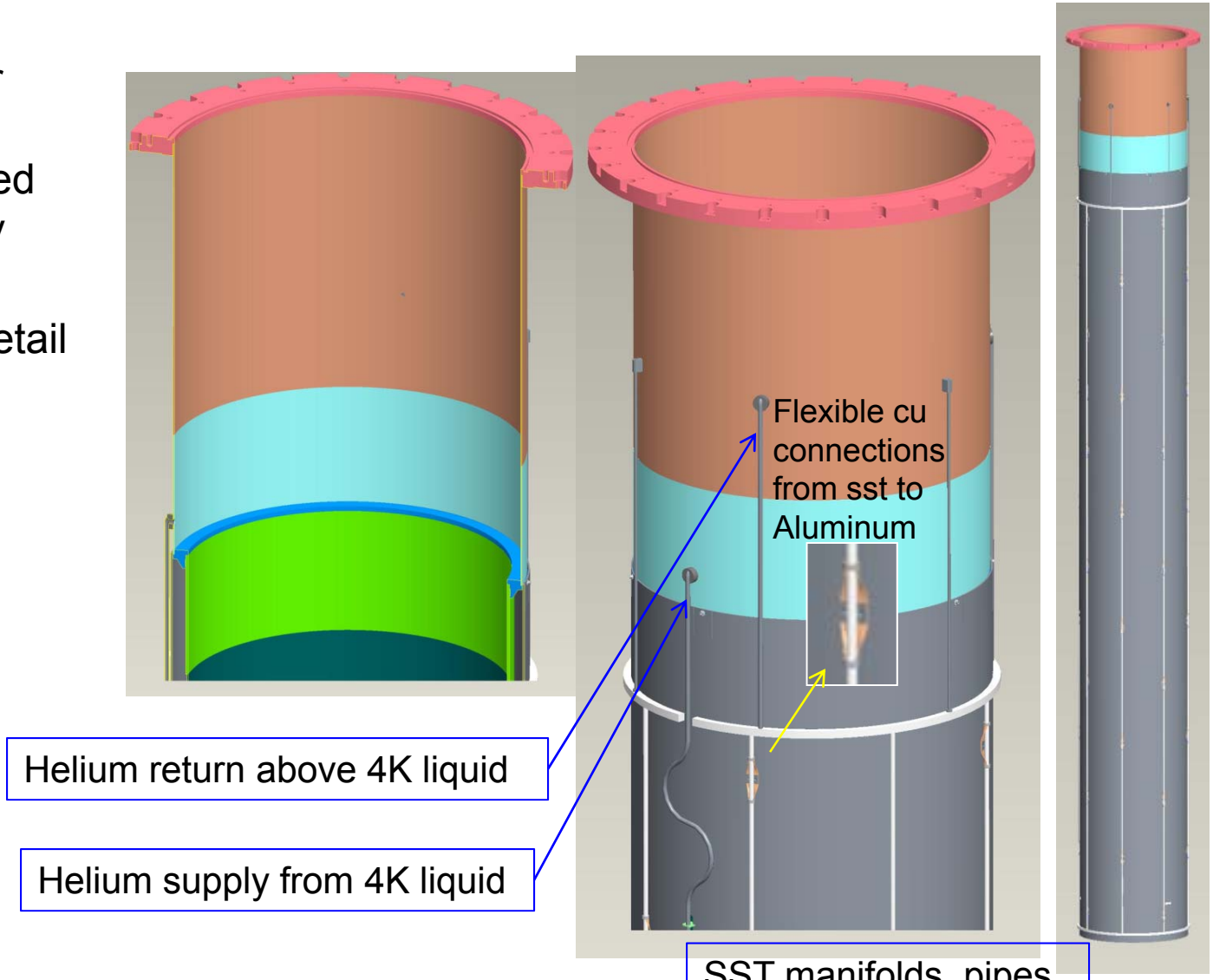
Test Dewar Status p.2
Heat Exchanger Assembly

- 24 detail parts drawings released for fabrication 9/24/15
- Purchase requisitions for precool heat exchanger, bellows submitted 9/28/15



Test Dewar Status p.3
Helium Dewar & Outer 4K Heat Shield

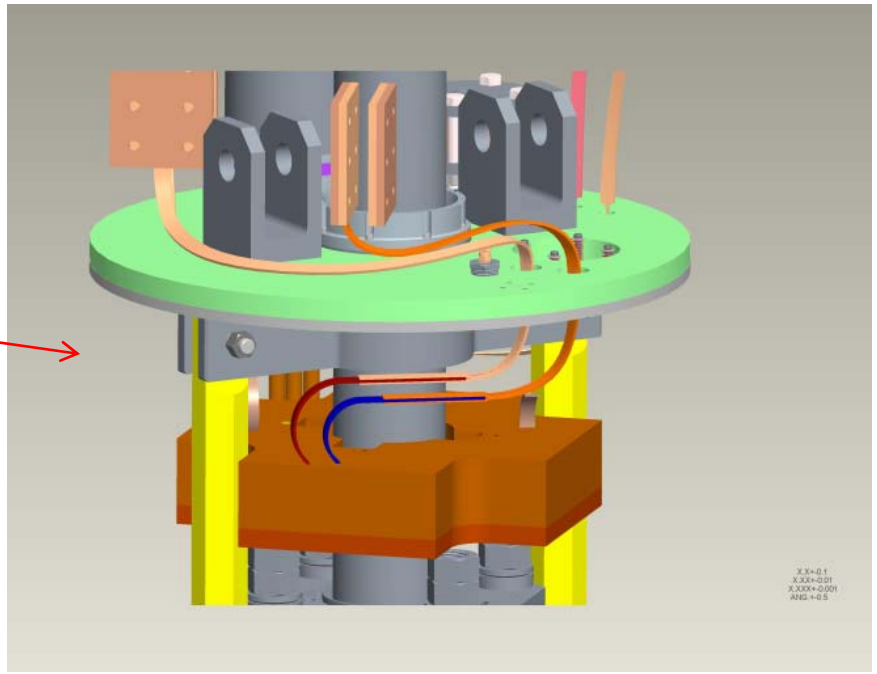
- 13 helium dewar detail parts drawings released for fabrication by 9/25/15
- 16 heat shield detail parts drawings released for fabrication by 10/1/15



Test Dewar Status p.4
Lambda Plate

- 24 lambda plate detail parts drawings released for fabrication by 10/13/15
- 4 magnet lead solder fixture drawings released for fabrication by 9/28/15

Note: exiting magnet leads will be cut to ~ 160 mm past splice box; is this acceptable?

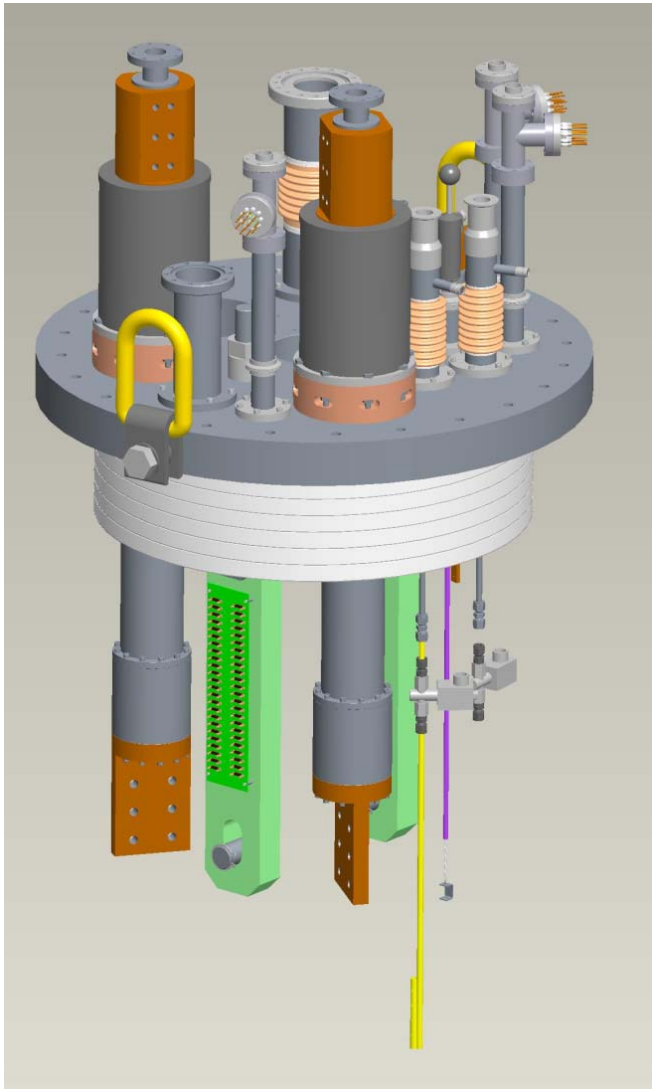


Test Dewar Status p.5
Top Hat & Warm Bore Tube

- 24KA vapor cooled leads:
  - Requisition approved 3/17/15
  - Vendor drawing approval 5/6/15
  - Delivery scheduled 11/4/15
- 46 top hat detail parts drawings released for fabrication by 11/3/15*
- Warm bore tube:
  - Tubes received from FNAL
  - 6 warm bore tube assembly detail parts drawings released for fabrication by 10/16/15**

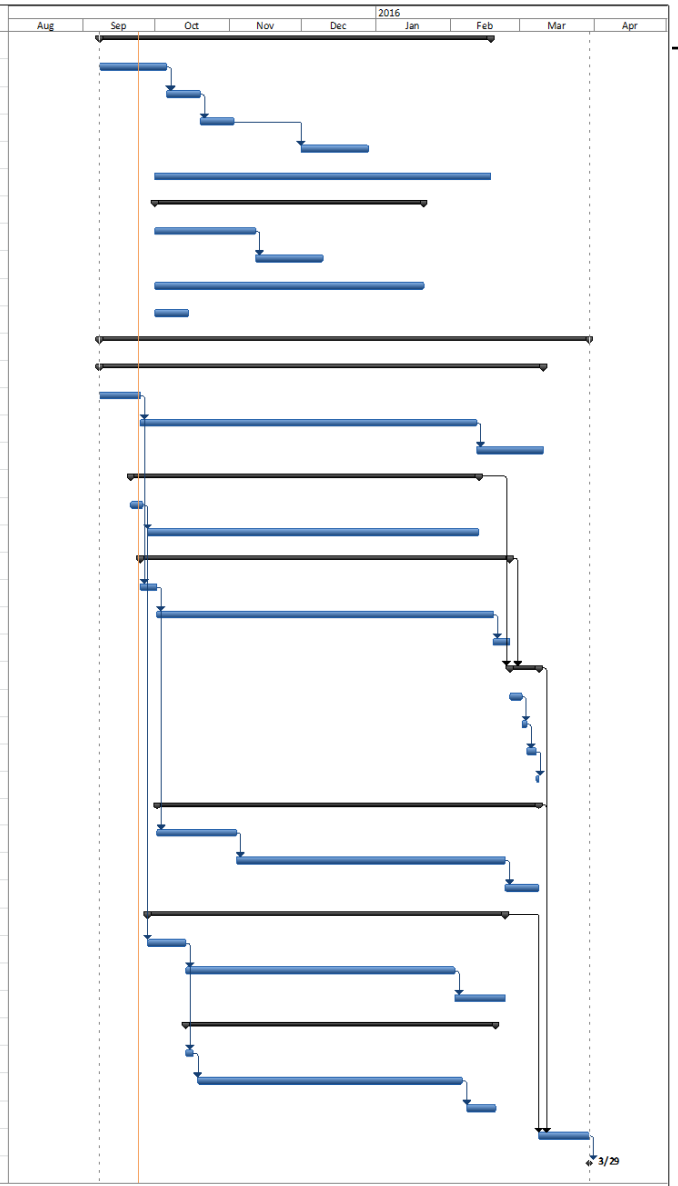
* Represents LAST DRAWINGS TO BE RELEASED

**Not needed for Mirror Assembly test

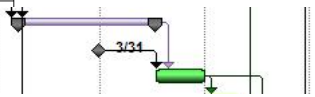


Schedule To Completion

ID	Task Mode	Task Name	Duration	Start	Finish	Predecessors	Resource Names
1		**cryogenic facility**	**117 day**	**Tue 9/8/15**	**Wed 2/17/16**		
2		install new quench vent lines and valves	20 days	Tue 9/8/15	Mon 10/5/15		
3		complete wet expander maintenance	10 days	Tue 10/6/15	Mon 10/19/15	2	
4		turn on / commission Nash pump	10 days	Tue 10/20/1	Mon 11/2/15	3	
5		turn on / commission CVI refrigerator	20 days	Tue 12/1/15	Mon 12/28/15	4FS+20 da	
6		buy, install transfer line from Nash to dewar	100 days	Thu 10/1/15	Wed 2/17/16		
7		**power supply**	**80 days**	**Thu 10/1/15**	**Wed 1/20/16**		
8		assemble, test 2nd 15KA IGBT cabinet	30 days	Thu 10/1/15	Wed 11/11/15		
9		complete DAQ etc. wiring installations	20 days	Thu 11/12/1	Wed 12/9/15	8	
10		design, assemble spike detector & quench antenna sys	80 days	Thu 10/1/15	Wed 1/20/16		
11		install water-cooled 22KA power cables	10 days	Thu 10/1/15	Wed 10/14/15		
12		**Test Dewar**	**146 day**	**Tue 9/8/15**	**Tue 3/29/16**		
13		**heat exchanger assembly**	**133 day**	**Tue 9/8/15**	**Thu 3/10/16**		HH
14		release drawings (24 details, 1 assembly)	13 days	Tue 9/8/15	Thu 9/24/15		
15		purchase / fabricate parts	100 days	Fri 9/25/15	Thu 2/11/16	14	
16		assemble	20 days	Fri 2/12/16	Thu 3/10/16	15	
17		**helium dewar**	**105 day**	**Mon 9/21/1**	**Fri 2/12/16**		PK
18		release drawings (13 details, 1 assembly)	5 days	Mon 9/21/1	Fri 9/25/15		
19		fabricate parts	100 days	Mon 9/28/1	Fri 2/12/16	18	
20		**outer 4K heat shield**	**110 day**	**Fri 9/25/15**	**Thu 2/25/16**		HH
21		release drawings (16 details, 1 assembly)	5 days	Fri 9/25/15	Thu 10/1/15	14	
22		fabricate parts	100 days	Fri 10/2/15	Thu 2/18/16	21	
23		assemble	5 days	Fri 2/19/16	Thu 2/25/16	22	
24		**assemble & install helium dewar & heat shield**	**8 days**	**Fri 2/26/16**	**Tue 3/8/16**	**17,20**	
25		wrap heat shield in MLI	3 days	Fri 2/26/16	Tue 3/1/16		
26		install heat shield to helium vessel	2 days	Wed 3/2/16	Thu 3/3/16	25	
27		weld supply & return lines	2 days	Fri 3/4/16	Mon 3/7/16	26	
28		install in dewar	1 day	Tue 3/8/16	Tue 3/8/16	27	
29		**top hat**	**113 day**	**Fri 10/2/15**	**Tue 3/8/16**		
30		release drawings (46 details, 1 assembly)	23 days	Fri 10/2/15	Tue 11/3/15	21	
31		fabricate parts	80 days	Wed 11/4/1	Tue 2/23/16	30	
32		assemble	10 days	Wed 2/24/1	Tue 3/8/16	31	
33		**lambda plate & magnet supports**	**107 day**	**Mon 9/28/1**	**Tue 2/23/16**		
34		release drawings (24 details, 1 assembly)	12 days	Mon 9/28/1	Tue 10/13/15	18	
35		fabricate parts	80 days	Wed 10/14/	Tue 2/2/16	34	
36		assemble	15 days	Wed 2/3/16	Tue 2/23/16	35	
37		**warm bore tube**	**93 days**	**Wed 10/14/**	**Fri 2/19/16**		
38		release drawings (6 details, 1 assembly)	3 days	Wed 10/14/	Fri 10/16/15	34	
39		fabricate parts	80 days	Mon 10/19/	Fri 2/5/16	38	
40		assemble	10 days	Mon 2/8/16	Fri 2/19/16	39	
41		commissioning tests	15 days	Wed 3/9/16	Tue 3/29/16	33,24,29	
42		TEST FACILITY OPERATIONAL	0 days	Tue 3/29/16	Tue 3/29/16	41	



MQXFL Mirror assembly & shipm	85 days	Thu 1/21/16	Wed 5/18/16
BNL Test facility commisioned	0 days	Thu 3/31/16	Thu 3/31/16
Mirror test	6 wks	Thu 5/19/16	Thu 6/30/16



Agrees with latest LARP Mirror Test Schedule

Budget Review

I. BNL (non-LARP) FY15 funded cryogenic infrastructure costs incurred:

I)	Purchase / Install Spare Components	$312K
II)	Refurbish CVI refrigerator	$135K
	Total	$447K

II. BNL (non-LARP) FY16 expected cryogenic infrastructure funding:

I)	Commission Sullair 500 compressor	$308K

III. BNL (non-LARP) FY17 requested cryogenic infrastructure funding:

I.	Commission Kinney Vacuum Pump	$221K

BNL non-LARP funding
= $976K total

LARP FUNDING:

$347,971	FY16 Material to go
$107,457	+ FY16 Labor to go
$455,428	= TOTAL cost to go
-$347,580	- BNL LARP FY15 Carry-forward
$107,848	= FY16 LARP Funding needed*

*Note: FY16 funding restores overrun, but (again) provides no contingency; based on performance to date, ~ $200K additional funding may be required

- Good news – high risk activity (power supply development) risk is retired
- Less good news – all of fabricated dewar parts remain (although prices are based on machine shop quotes, not engineering estimates)