

Hall C SHMS Progress

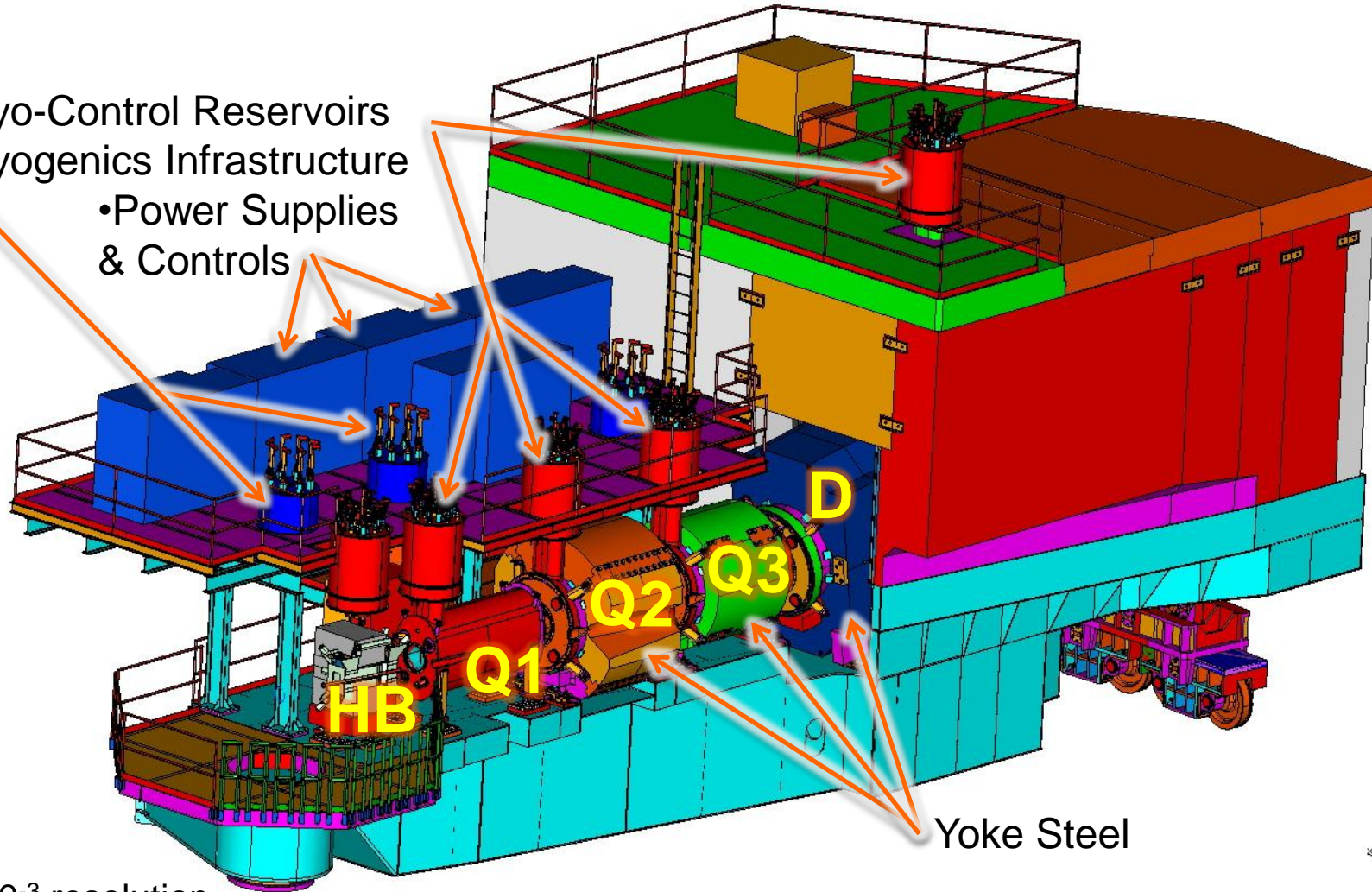
Paul Brindza

Hall C Senior Engineer

January 25, 2013

SHMS and Magnet Systems Overview

- Cryo-Control Reservoirs
- Cryogenics Infrastructure
 - Power Supplies & Controls

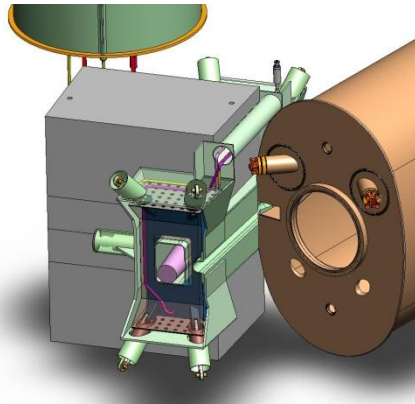


1×10^{-3} resolution
4 mSr Acceptance
1 to 11 GeV/c

Conductor
Supports w/Alignment

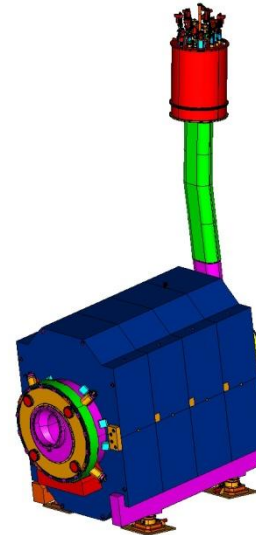
Coils + Cryostats

SHMS Magnets



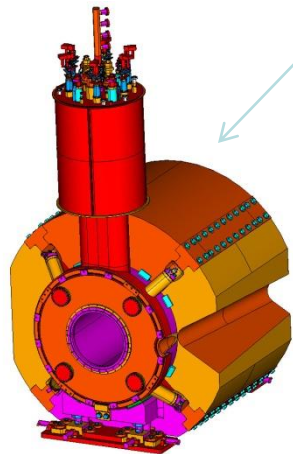
HB @ MSU/FRIB (Horizontal-Bend Dipole)

- Superferric "C" magnet
- 2.6 Tesla
- 21 cm x 25 cm warm bore
- 0.75 m EFL
- 1.93 Tm
- 19 % design margin
- 220 kJ stored Energy
- SC is SSC outer cable



Dipole @ SigmaPhi-France

- 3.86 Tesla Cosine(Θ) dipole
- 60 cm warm bore
- 2.85 m EFL
- 11.2 Tm Integral B.dL
- 10 % Test margin
- 13.7 MJ stored Energy
- 4800 A/cm²
- 11 GeV/c
- Iron Yoke: 126 Tons



Q2/Q3 @ SigmaPhi-France

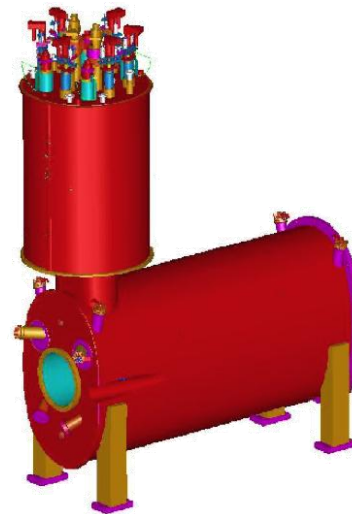
Q2 11.8 T/m cos(2 Θ) Quad

- 60 cm. warm bore
- 1.64 m EFL
- 10 % Test margin
- 7.6 MJ stored Energy
- Iron Yoke: 72 Tons

Q3 identical to Q2 but runs at 7.9 T/m

- Iron Yoke: 18 Tons

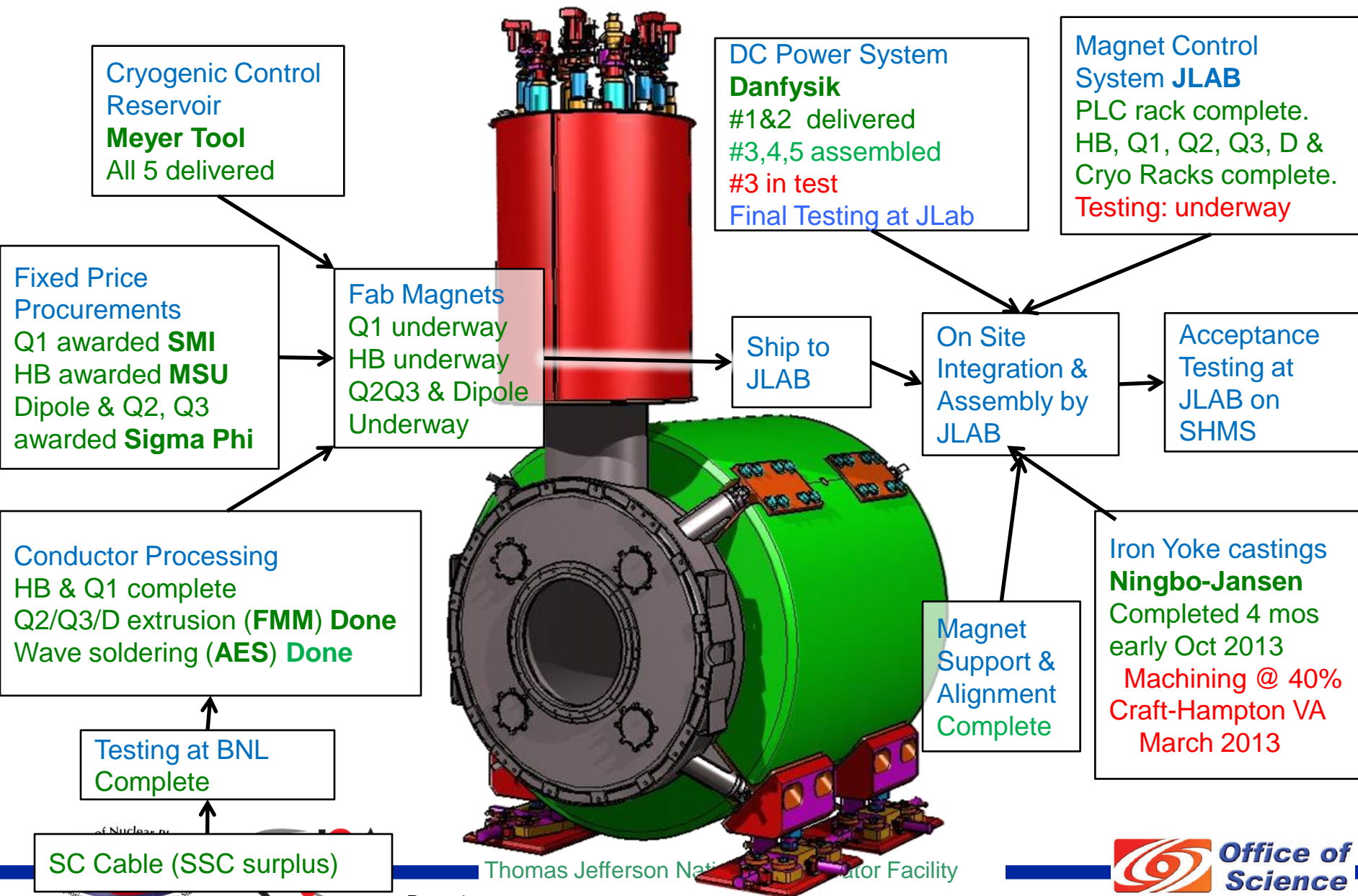
Both use same conductor as dipole (Cu + SSC outer)



Q1 Quad @ Scientific Magnetics - UK

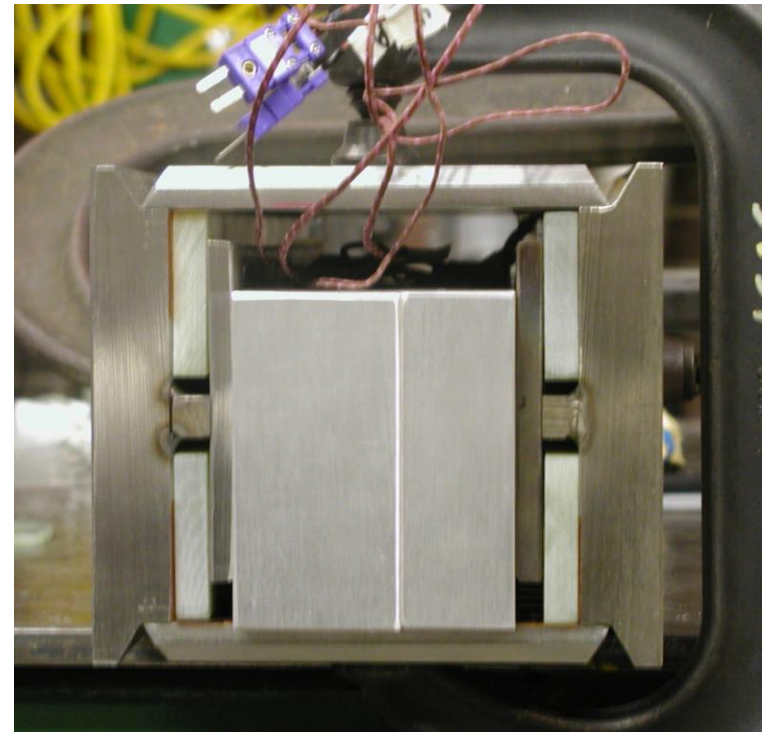
- JLab Cold Iron Design
- Clone of HMS Q1
- 11 GeV/c performance
- 7.9 T/m Gradient
- 40 cm warm bore
- 1.86 m EFL
- 14.75 (T/m)m Int. Grad.
- 398 kJ Stored Energy
- 25 % design margin
- SC is SSC outer

SHMS SC Magnet System Plan

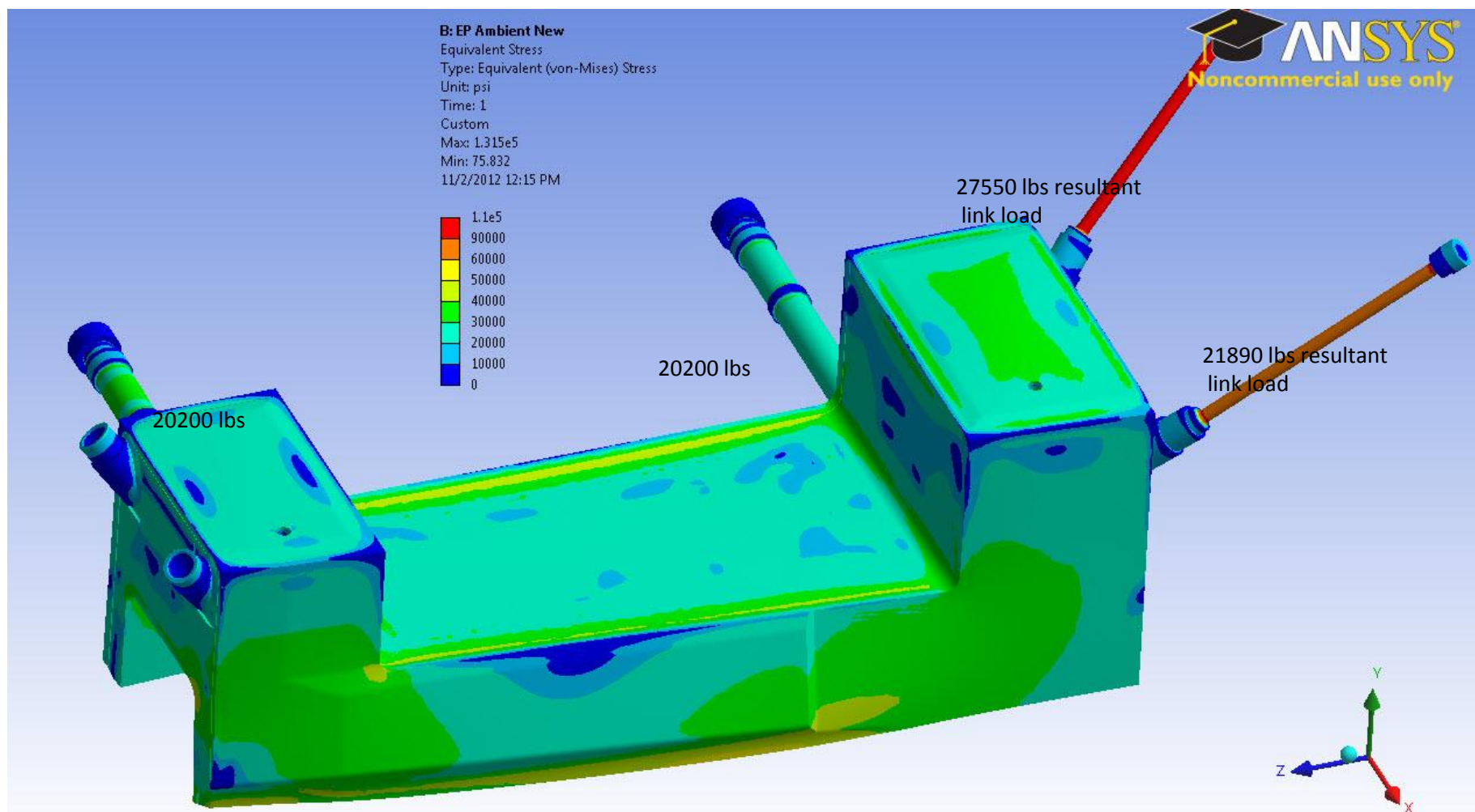


HB Magnet Progress at MSU

- Coils wound and Helium tested
 - JLab site inspection
- BPVC elastic-plastic analysis complete- design ASME compliant
 - JLab site inspection
- He Vessels mill run 316L steel on site
- Weld tests complete
- He vessel parts fab underway
 - Bending, rough cut, grinding
- Welder qualification complete
 - JLab site inspection
- He Vessel machining started



HB Equivalent Stress Plot from ASME elastic-plastic He Vessel analysis



Elastic-plastic analysis converged successfully in accordance with design-by-analysis rules of ASME Section VIII, Division 2.

JLab 12 GeV HB Magnet Project

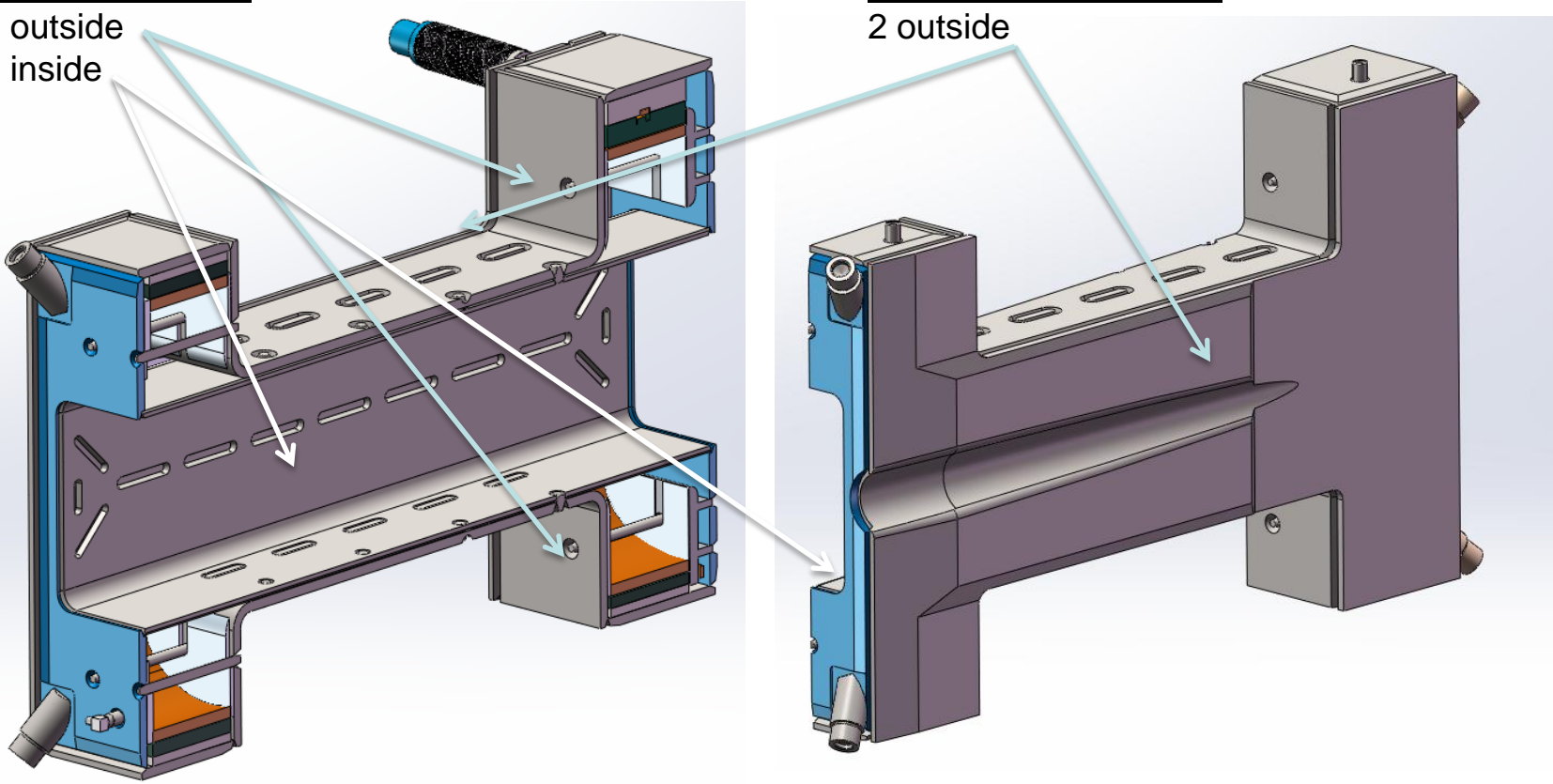
Helium Vessel fabrication

"Bent Pieces"

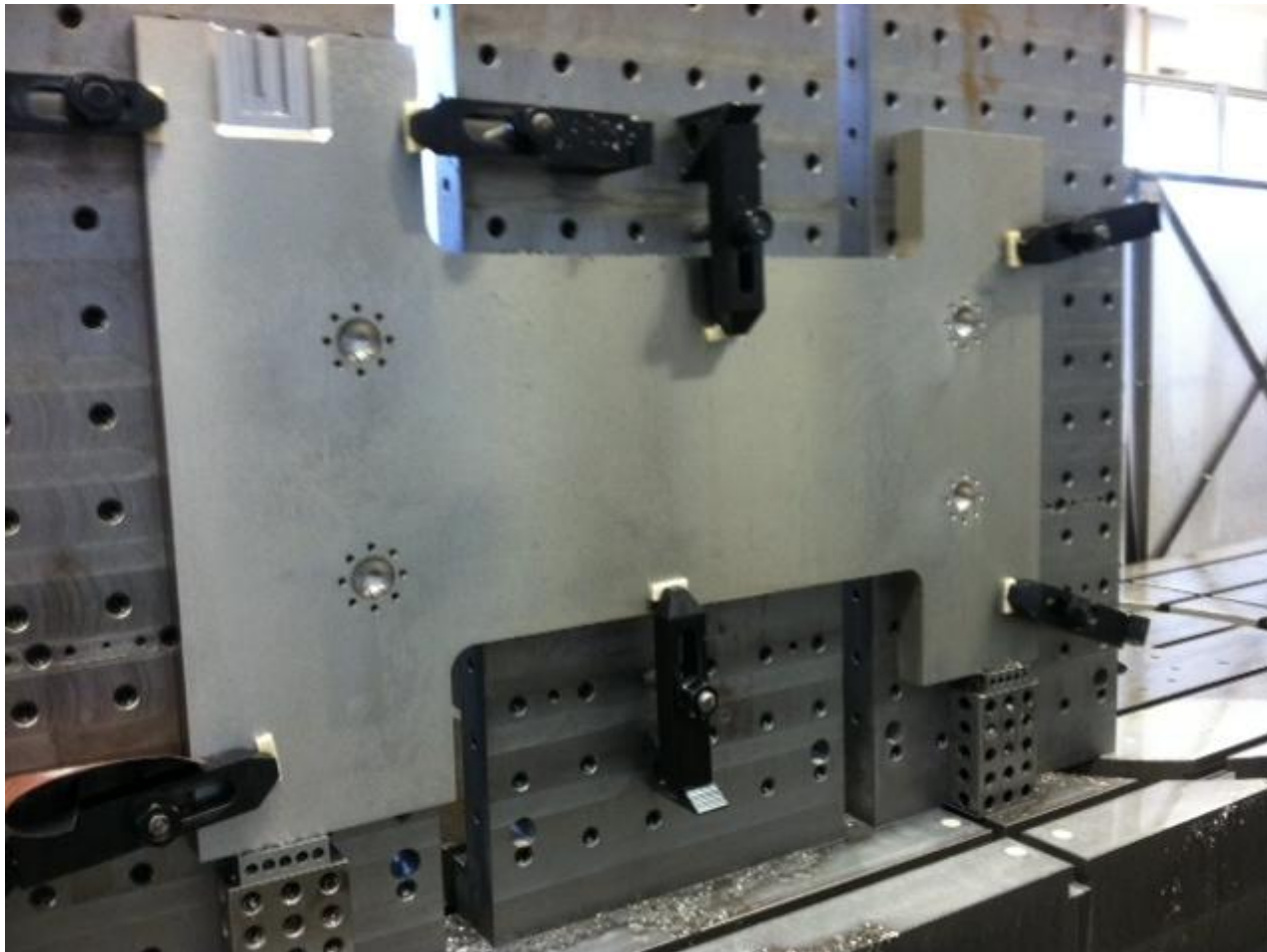
2 outside
2 inside

"Flat Side Pieces"

2 outside

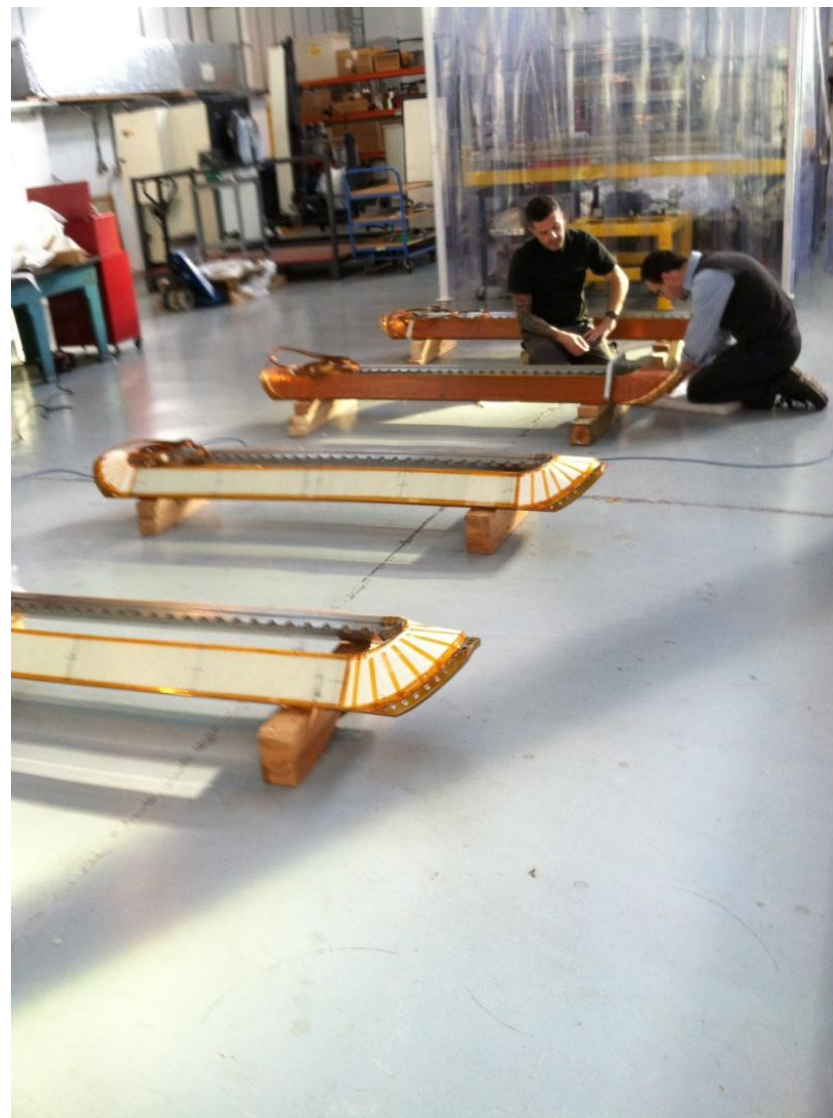


HB Helium Vessel Machining at MSU

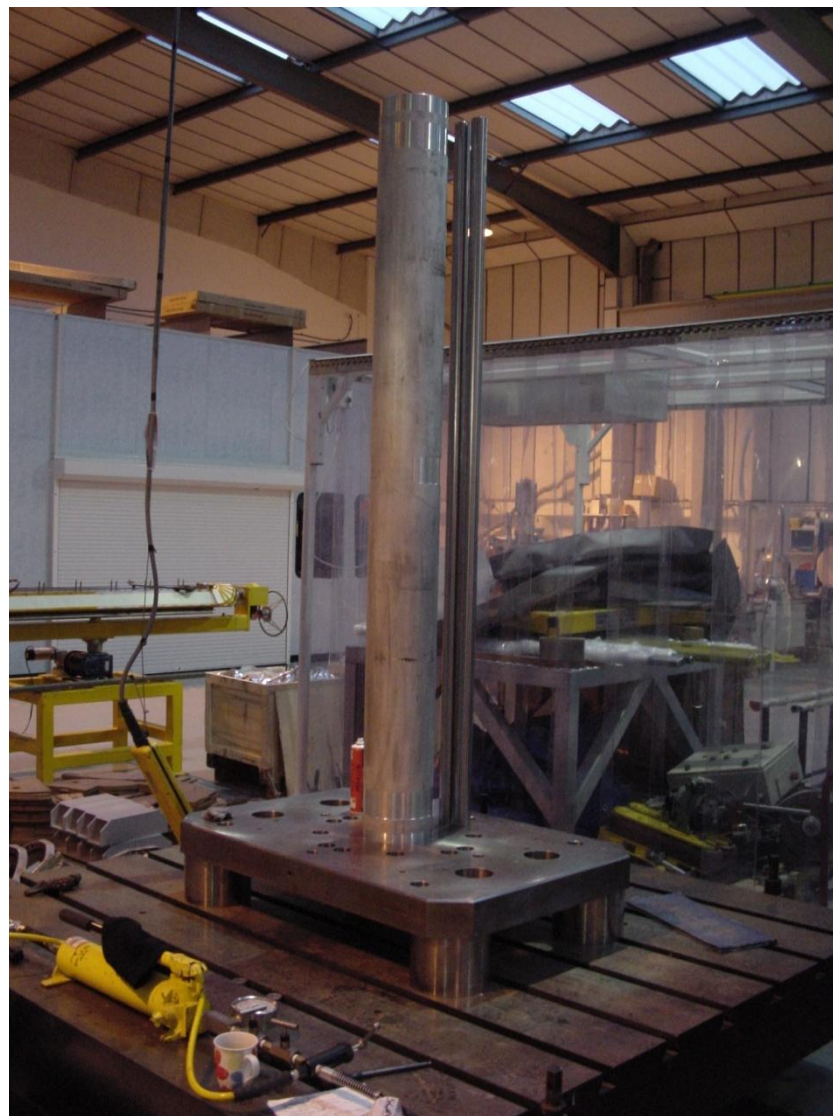
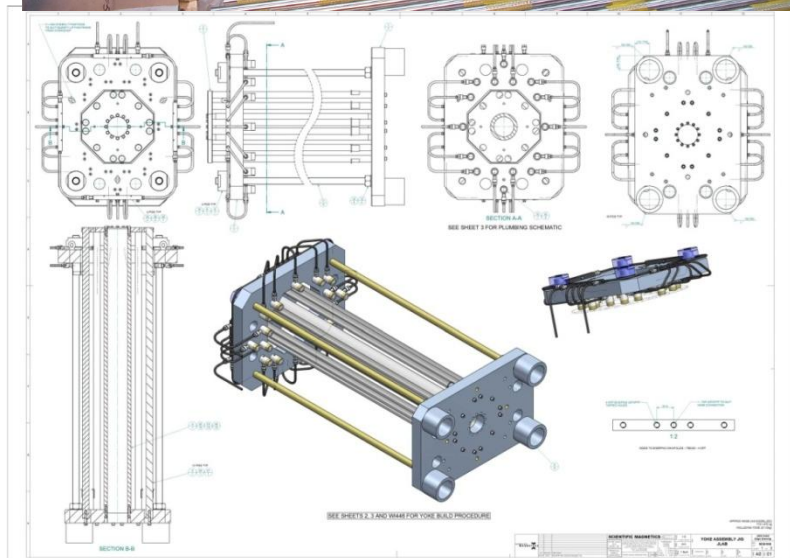
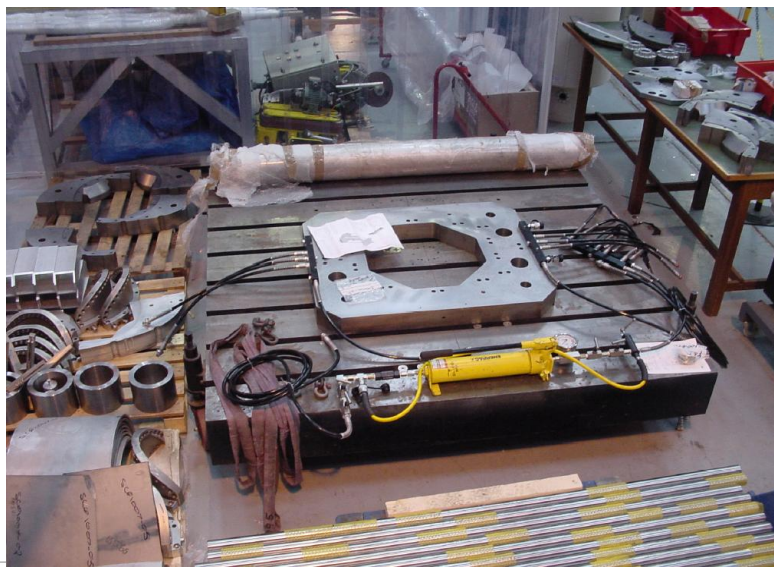


Q1 SC Quad progress at Scientific Magnetics

- 4 coils wound, tested and measured
 - JLab site inspection)
- Yoke lams trial water jet cutting(WJC) successful
- Production WJC complete
- Replacement for stolen steel at SMI
- Yoke stacking fixture complete
- Yoke Assembly starts Jan 2013
 - JLab site inspection
- Stainless Metal Craft has Helium, Nitrogen, Vacuum and final assembly

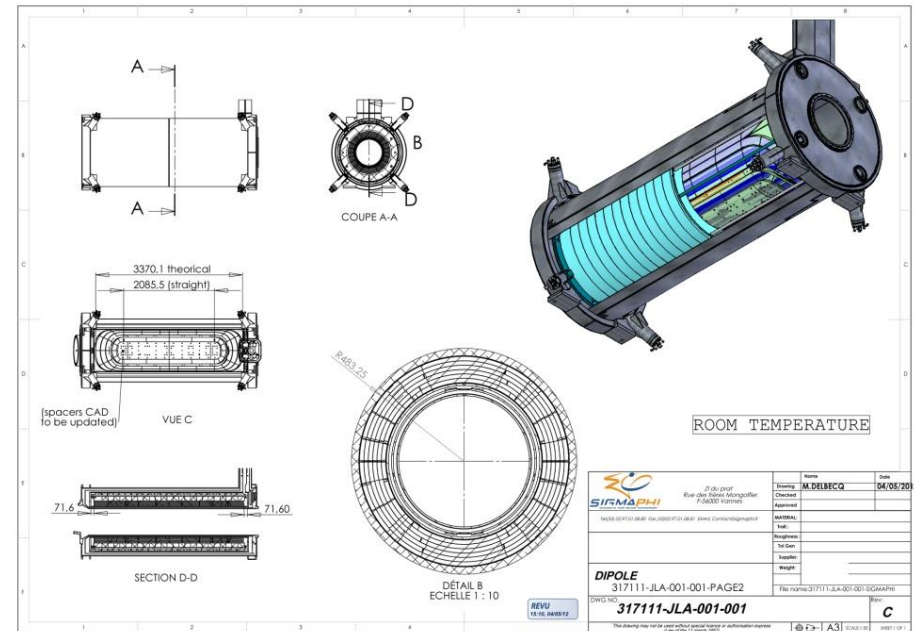


Q1 Cold Yoke Assembly Tooling



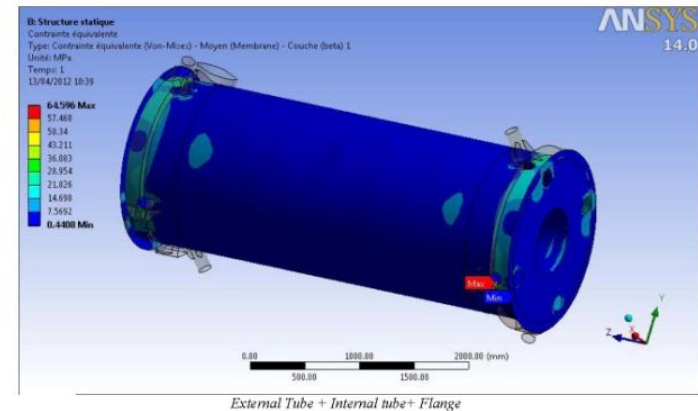
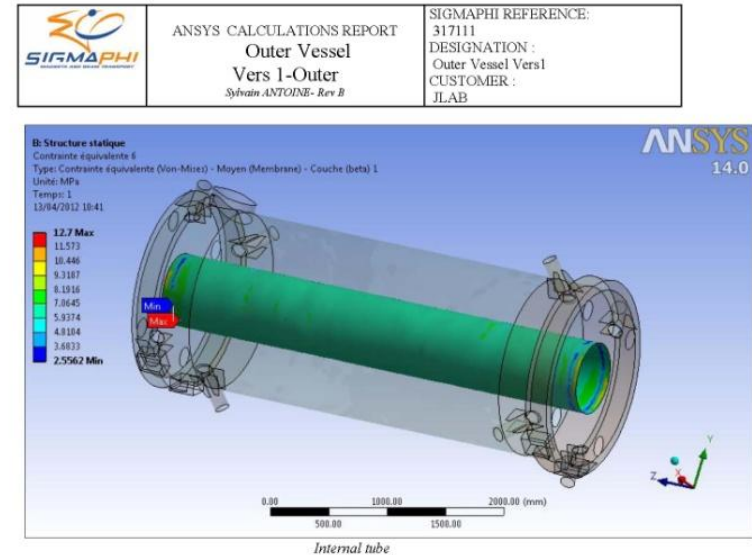
Dipole Design at SP Q2/Q3 similar

- **Cold mass complete**
 - Coil complete
 - Collars complete
 - Coil keys & spacers complete: may change pending coil pre-load.
- **LHE cryostat complete**
- **LN2 shield complete**
- **Vacuum vessel complete**
 - Support rods complete
 - Ship fixtures complete
- **Final assembly with JLab Cryo-Control Reservoir ~ 75 %**



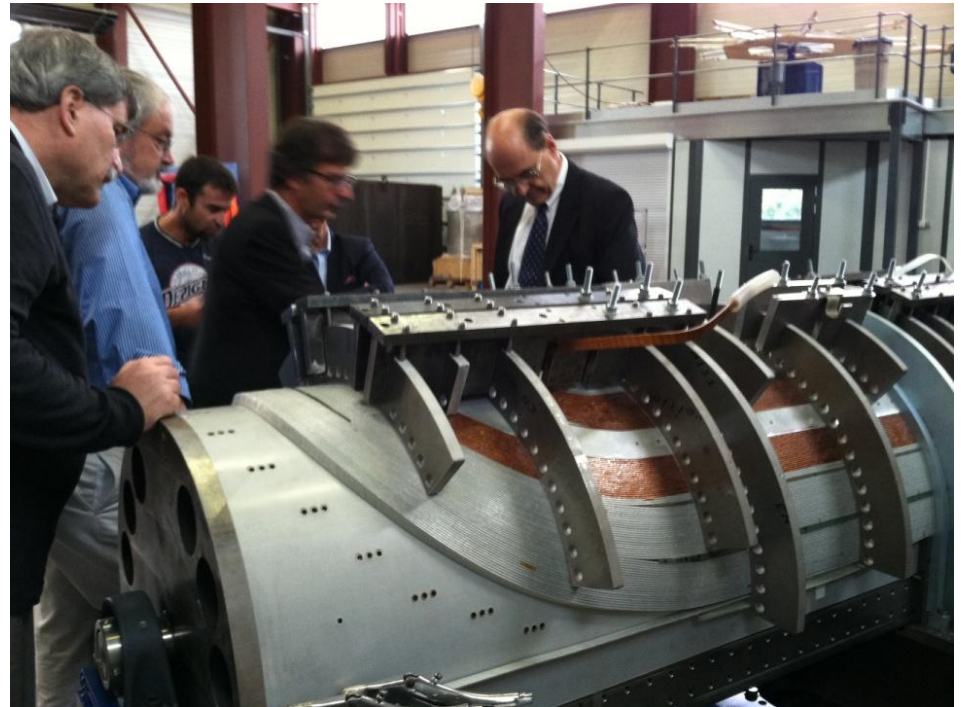
Dipole Vessel Analysis Q2/Q3 similar

- Magnetic analysis complete
- Quench, MQE, protection analysis complete
- BPVC analysis of vessels complete
- Pressure event analysis complete



SHMS Dipole prototyping at Sigma Phi

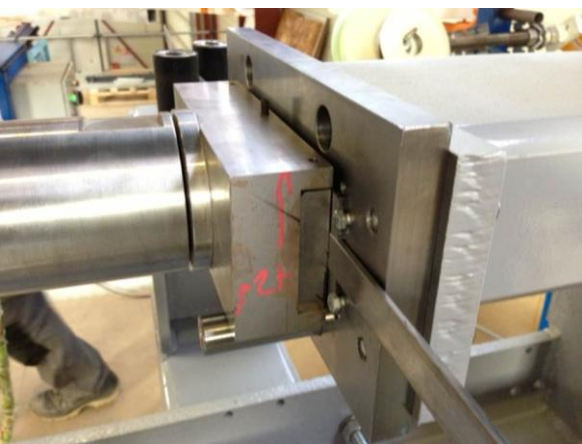
- **Winding prototyping proceeding well**
1 meter coil complete
- **Tensioning, b-stage, insulation, tooling tests and prototyping all went OK**



Prototyping activities at Sigma Phi

- Sigma Phi is re-designing the winding tooling to incorporate Vacuum Impregnation(VPI) and Pre-pressed conductor for better mechanical properties
- Prototype double pancake coil completion
 - Design of tooling mods
 - Fabrication of tooling mods
 - Assembly and test of tooling mods
 - Prototype manual conductor pressing
 - Revised width coil spacers and shims
 - Double pancake coil winding
 - Vacuum impregnation
 - Prototype coil complete August 2013

Prototype Conductor Press at Sigma Phi



Prototype double pancake coil will be full length



Magnet Components by JLab

- **HB/Q1/Q2/Q3/Dipole Conductor**
- **Cryogenic Control Reservoir** (5 magnets)
- **Warm Yoke Steel** (3 magnets); Q1 cold yoke by SMI; HB by MSU
- **DC Power Systems** (5 magnets)
- **Instrument and Controls** (5 magnets)
- **Stands and Mounts** (5 magnets)

Magnet Components by JLab

fixed price contracts

Contract	Vendor	PO #	Cost K\$	Delivery	Status
DC System	Danfysik	10-C3491	922	Jan 2013 Apr 2013	2 delivered 3 complete/1in test
CryoReservoir	Meyer Tool	10-C0505	1,067	Jan 2012	Complete
Current Leads	AMI	09-P2571	94	Feb 2010	Complete
Controls	JLAB	Multiple	1,009	Oct 2013	6 Racks Complete Testing Underway
Yoke Castings	Ningbo-Jansen	12-C3425	1,298	Oct 2012	Complete/delivered
Yoke Machining	Craft Machine	12-C1004	125	June 2013	40% complete Jan 15, 2013
SC Cable	SSC surplus	NA	NA	NA	Complete
SC Cable Testing	BNL	07-F0533	91	Nov 2007	Complete
Copper Channel	FMM	10-C1246	266	Feb 2012	Complete
Redraw Channel	FMM	10-C1246	15	Feb 2012	Complete
Wave solder	AES	10-C3362	284	Oct 2012	Complete
Magnet supports	Various	12-P1964,P1814,P1966	154	Oct 2012	Complete

Dipole/Q2/Q3 Conductor

- Hall C Soldering completed by AES 10/30/12
- 2 large shipments (50% of total) already in France
- Balance stored until required
- Solder line being converted for Hall B



Cryogenic Control Reservoirs

(Meyer Tool)

- 7 prototypes operating at JLab some for 19 years
(HMS,G0,Septums,HallD solenoid test)
- 6 cryo-control reservoirs(CCR) completed by Meyer Tool, Feb 2012
- 1 used on Hall D solenoid test
- 1 shipped to MSU 8/11
- 3 shipped to Sigma Phi 5/12
- Q1 CCR held at JLab to avoid UK VAT-ship April 2013
- Burnout proof current leads by AMI-complete at JLab awaiting shipment



Q2/Q3/Dipole Yoke steel

- Contract awarded to Ningbo Jansen Jan '12
- 1st article pass May '12
- Complete August '12
- Delivered Oct '12
4 months early
- Steel at Craft, Hampton VA for final machining 40 % complete
- Dipole top/bottom plates and Field Clamp by Pioneer Steel-delivered



Q2/Q3/Dipole Yoke Steel

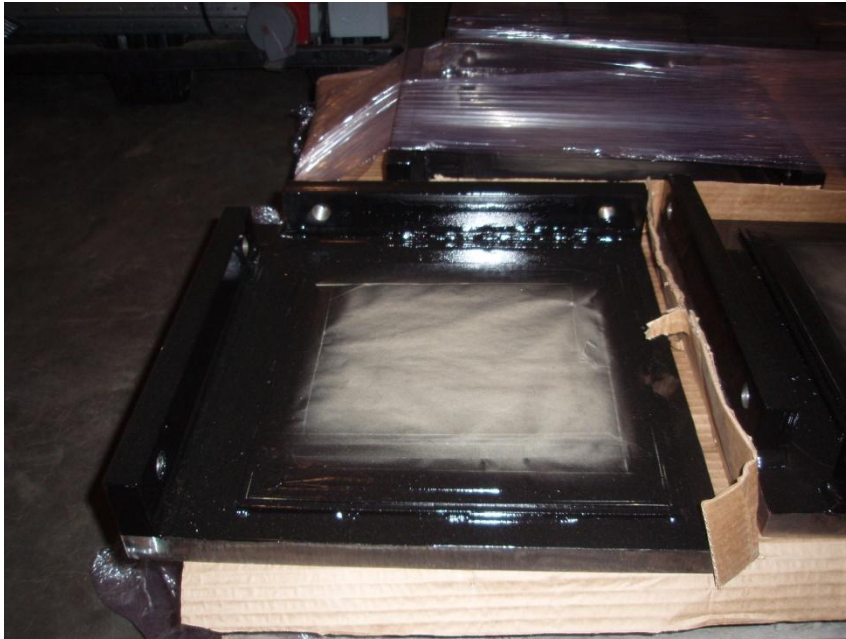
Steel at Ningbo-Jansen



Steel at Craft/Hampton VA



SHMS Magnet Stands



DC Power Systems @ Danfysik

- **DC Systems 1 and 2 tested Nov 12-16, 2012**
- **DC systems 1&2 at JLAB Jan 2013**
- **DC systems 3,4 &5 assembled Jan 2013**
- **DC 3 in test Jan 2013**
- **DC 3,4&5 ship to JLAB April 2013**

Christian Nielsen, DC system
Project Manager and DC unit #3



Instrument and Control systems @ JLab

- 5 Magnet control racks assembled, in testing and calibration
- Cryo rack assembled and tested
- Calibration ~ 50 % complete
- Software for 5 magnets
- Installation components & cables at JLAB
- NMR/Hall/multiplexer and SHMS licenses ordered



SHMS Cryo System

- Re-use G0 transfer line- Mods by Hall C
- Re-use G0 flex transfer line around pivot
- Re-use G0 warm gas return lines(see below)
- New SHMS transfer line- delivered
- New U-tubes,L-tubes magnet connections complete and delivered
- Warm gas return system design in progress – re-assembly and mods in place by Hall C

SHMS Transfer Line at Meyer Tool

Leak Testing the transfer line



Leak testing an “L” tune



Installation in Hall C

- **SOS slowly disappearing**
- **Rail installation started Jan 9**
- **Steel Structure assembly**
 - **Bids in/ under evaluation**
 - **Expected start ~ Mach 1, 2013 (3mo duration)**
- **Shield House in procurement**
 - **Bid release Feb 13**
 - **Award ~ April 15**
 - **Start ~ June 1, 2013 (3 mo duration)**
 - **B4C on site**
 - **Plastic on order**
- **SHMS Equipment Deck and Stairs Sept 2013**
- **SHMS ready for JLAB equipment by Oct 1 2013**

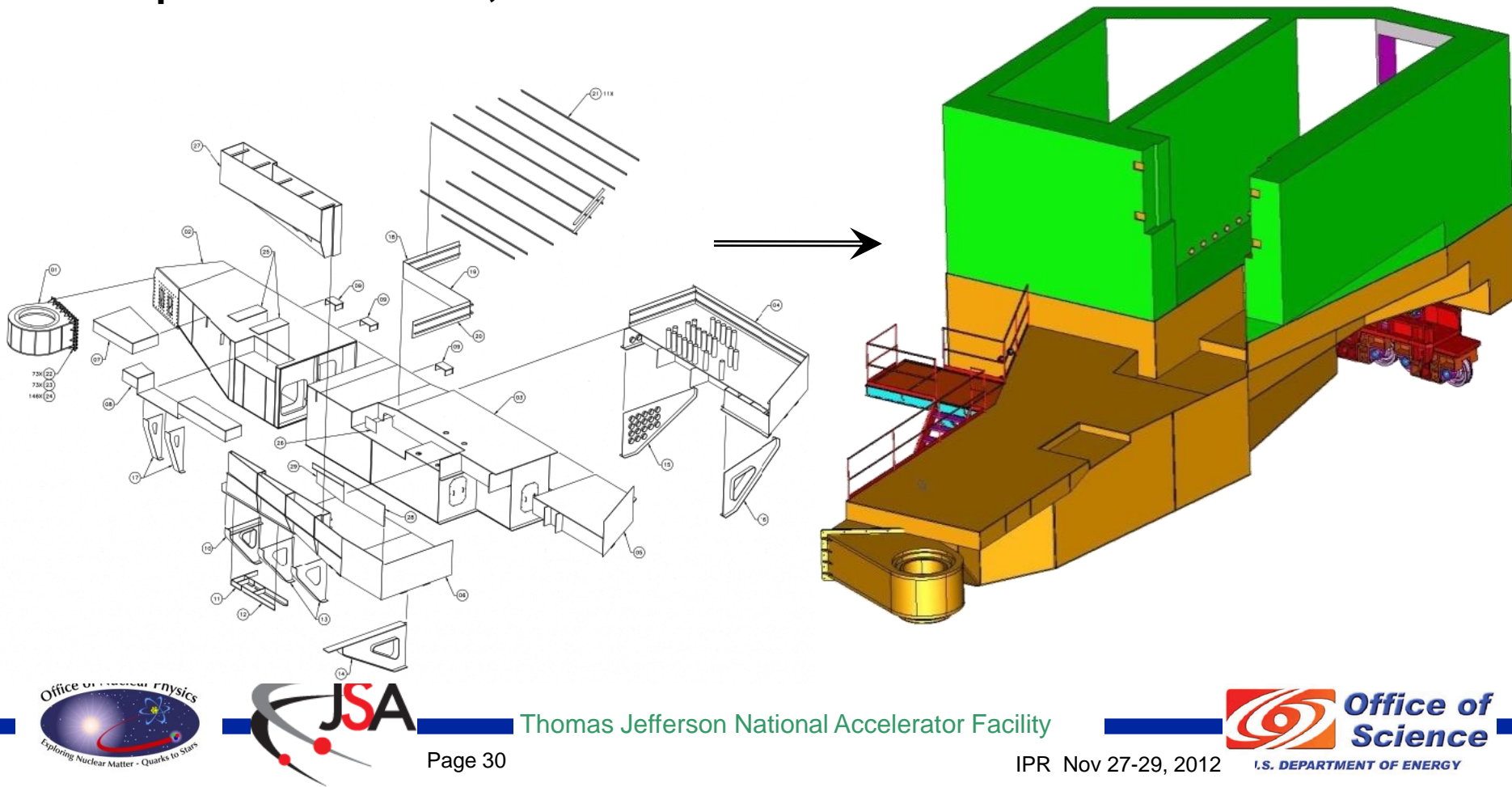
Rail Installation

Contract for rail installation started
January 8, 2013



Support Structure

- All steel structure parts are on site and ready for installation.
 - Wheels & Bogies are finished and in Final QA at Craft.
- Bids in evaluation for installation/assembly contract.
- Expect start March 1, 2013





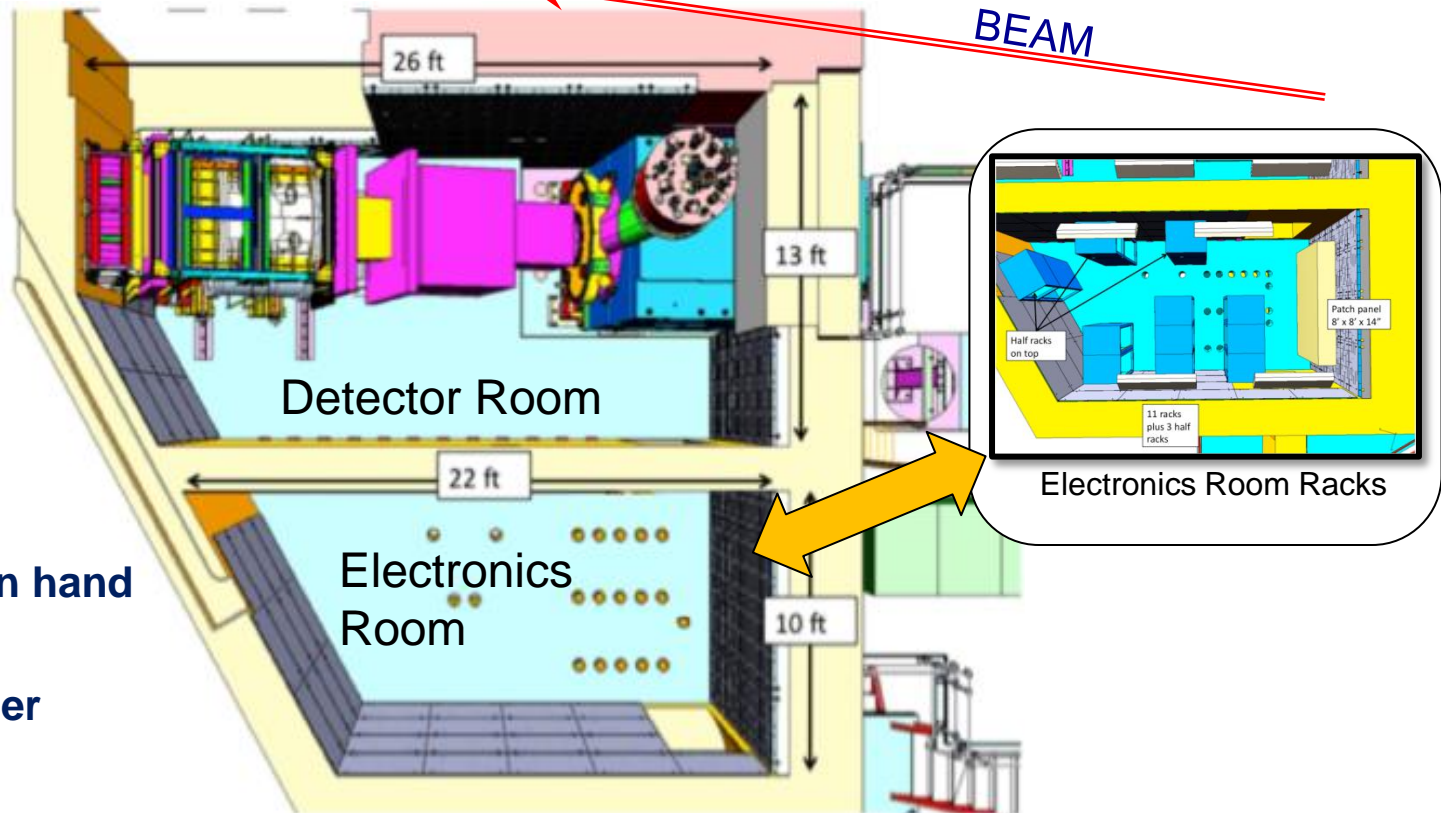
Shield House

Two-room Concrete Bunker. Materials optimized for shielding.

Cast-in-place on support carriage.

Removable roof blocks and beam-side wall blocks.

Bid Documents in procurement-release Feb 15 2013



- **Shielding**

- Lead bricks: on hand
- B_4C : at JLAB
- Plastic: on order

Installation in Hall C part II

- **After Support structure and shield house**
 - AC Power
 - LCW
 - Fire protection/detection
 - SHMS Cryo
 - SHMS DC supplies
 - SHMS Magnet controls and wiring
 - SHMS warm gas return (concurrent with structure assembly)
 - SHMS/Go Xfer line mod (concurrent with structure assembly)
 - SHMS Flex transfer line supports and installation
 - SHMS Magnet stands
 - SHMS Magnet warm yoke steel
- **Ready for the first magnet!! April 2014**

Conclusions

- Magnet schedules remain a challenge
- Increased contact with vendors, especially SMI for Q1 and MSU for the HB magnets, has produced significant progress due to better and more attentive organization and staffing on JLab projects
- Expect to forge an agreement on path forward next week at Sigma Phi on Dipole & Q2Q3
- Magnet components by JLAB on track
- SHMS Cryogenic system on track
- SHMS structure and infrastructure all on track
- Installation has started