Jefferson Lab
MAGNET GROUP

16th July 2019

v1.00

Ruben Fair

on behalf of

Probir Ghoshal, Sandesh Gopinath, David Kashy, Renuka Rajput-Ghoshal, Eric Sun, Randy Wilson, Dan Young

Outline

- **Contribution to Physics Division and Project Involvement**
  - **Hall A**
  - **Hall B**
  - **Hall C**
  - **EIC**
  - **Cryo**
  - **HD Ice**
  - **MOLLER**
  - **Other Work**
- **Publications**
- **Support for DOE reviews**
- **Team Strategic View**

HALL A

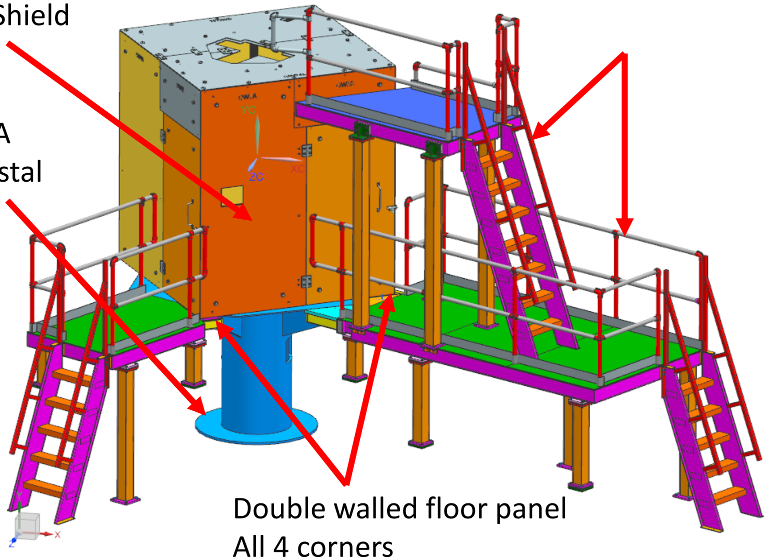
Dan Young

SBS GEn

Super BigBite Spectrometer

Target Magnetic Field Shielding

- The target is polarized 3He inside a magnetic holding field produced by a pair of Helmholtz coils.
- The shielding eliminates fringe fields.
- It is double walled in order to reduce the amount of material needed for this shielding as it reduces the strength of the field as it crosses the gap between shielding walls
- Shielding plates are 1008 Steel

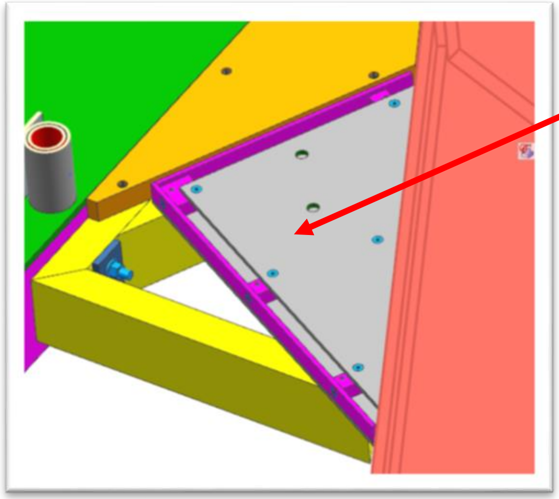


Target Magnetic Field Shield

Access Platforms

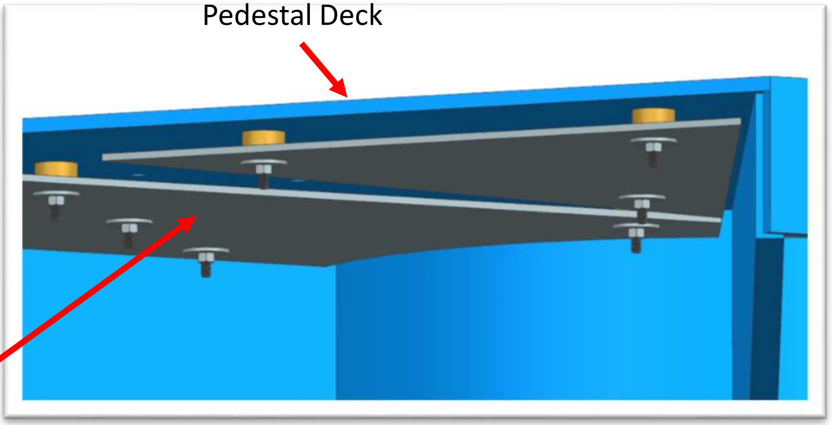
Hall-A Pedestal

Double walled floor panel All 4 corners



Double walled floor panel (4 Corners)

Designed and modeled Double Wall Floor Panels at the corners of the Target Magnetic Field Shield where it overhangs the pedestal deck.



Pedestal Deck

Pedestal Shielding Plates Typical for the underside of entire pedestal

Designed and modeled shielding plates for the underside of the pedestal to simulate the double wall shielding of Target Magnetic Field Shield

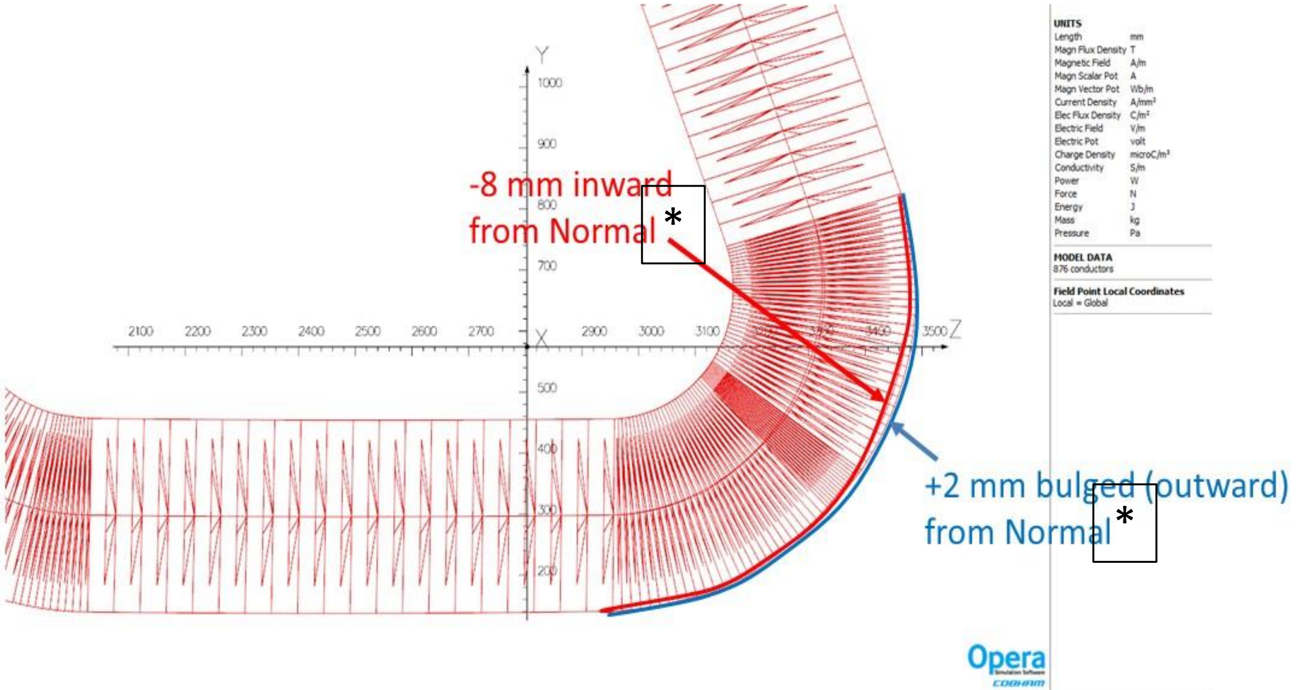
Torus – Modeling of the magnetic field

Modeling the actual conductor layout for the torus magnet in Hall B to improve matching with the measured field data

- ☐ **Step 1** - Actual averaged data from all coils significantly improved the comparison (0.05% at 46.5 cm on radius and 0.5% on 30 cm radius)
- ☐ **Step 2** – Varying the thickness of the modeled coils close to the hub near the bends

- Bulge the coil corners outwards (both DS and US ends) by 2 mm – results did not match field measurements sufficiently well.
- Theory postulated that perhaps the hub welds were magnetic. This was modeled and residual magnetism measurements were carried out – results were inconclusive
- Compress coil corners inward by 8mm only on the DS end of the torus coil near the hub – **Mapping data provided**, **Physicists are reviewing the calculation results**

Torus Coil A only – with +ve 2 mm and –ve 8 mm DS bend near the hub (worst case and aligns with the straight section)



UNITS	
Length	mm
Magn Flux Density	T
Magnetic Field	A/m
Magn Scalar Pot	A
Magn Vector Pot	Wb/m
Current Density	A/mm^2
Elec Flux Density	C/m^2
Electric Field	V/m
Electric Pot	volt
Charge Density	microC/m^3
Conductivity	S/m
Power	W
Force	N
Energy	J
Mass	kg
Pressure	Pa

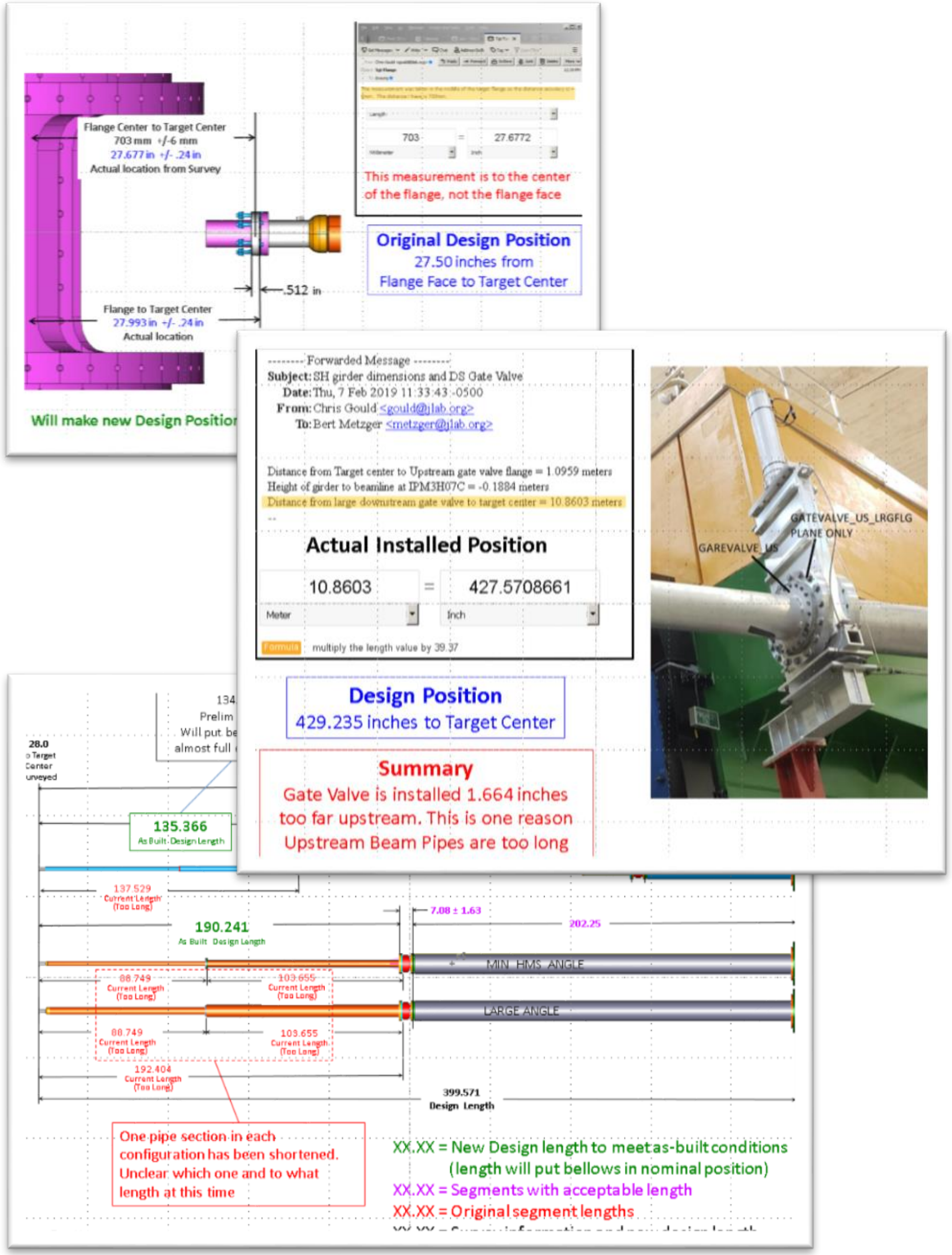
MODEL DATA
876 conductors

Field Point Local Coordinates
Local = Global

** - 'Normal ' refers to surveyed average coil dimensions with contraction from 300 K to 4.5K allowed for*

HALL C

Dan Young



--------- Forwarded Message ---------
Subject: SH girder dimensions and DS Gate Valve
Date: Thu, 7 Feb 2019 11:33:43 -0500
From: Chris Gould <gould@jlab.org>
To: Bert Metzger <metzger@jlab.org>

Distance from Target center to Upstream gate valve flange = 1.0959 meters
Height of girder to beamline at IPM3H07C = -0.1884 meters
Distance from large downstream gate valve to target center = 10.8603 meters

Actual Installed Position

10.8603 = 427.5708661
Meter Inch
Formula multiply the length value by 39.37

703 = 27.6772
Millimeter Inch

This measurement is to the center of the flange, not the flange face

Original Design Position
27.50 inches from
Flange Face to Target Center

Will make new Design Positior

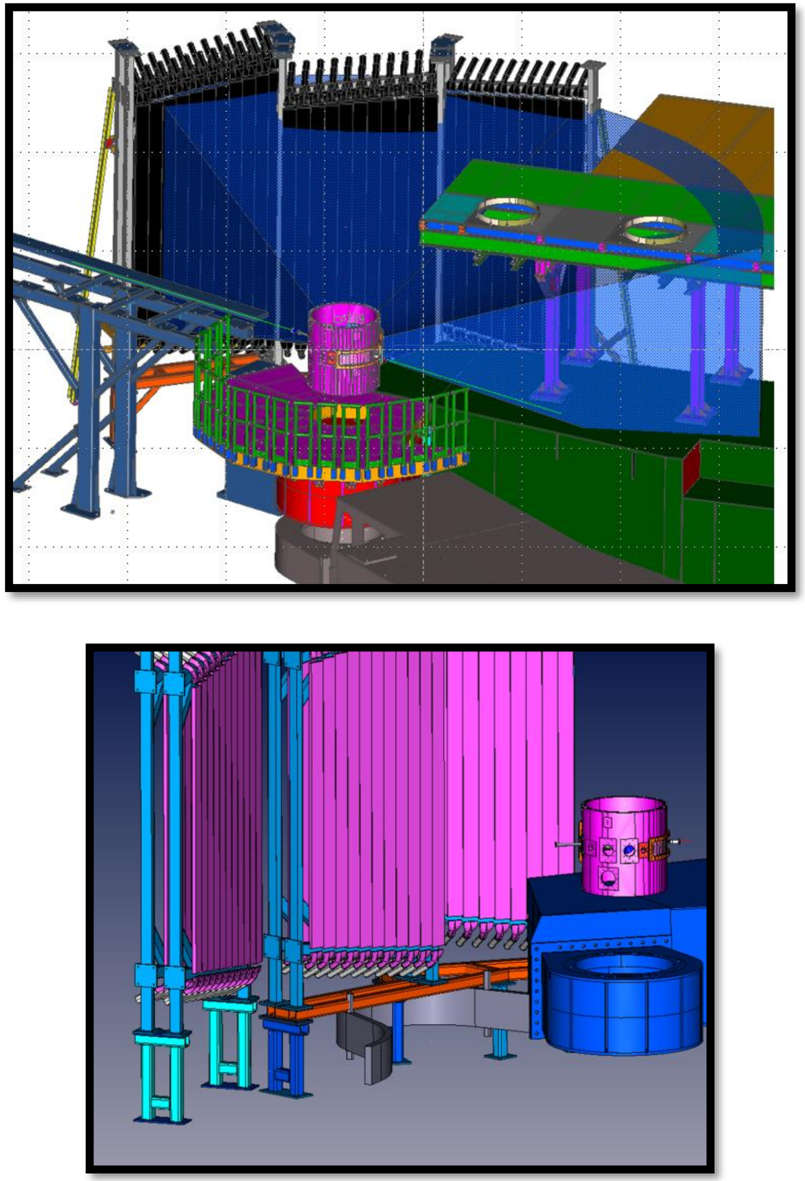
Design Position
429.235 inches to Target Center

Summary
Gate Valve is installed 1.664 inches too far upstream. This is one reason Upstream Beam Pipes are too long

One pipe section in each configuration has been shortened. Unclear which one and to what length at this time

XX.XX = New Design length to meet as-built conditions (length will put bellows in nominal position)
XX.XX = Segments with acceptable length
XX.XX = Original segment lengths

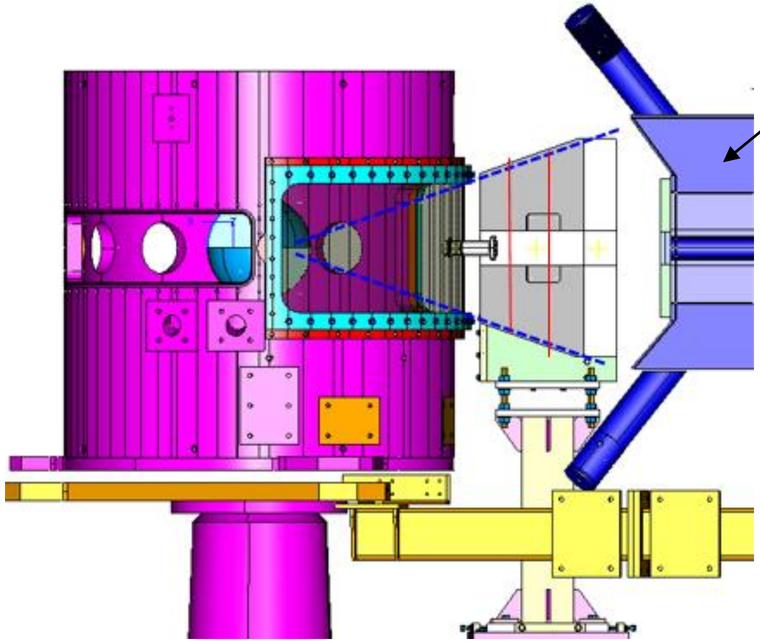
Downstream Beamline
Investigate and document As-Built condition
Investigate pipe configurations for future experiments



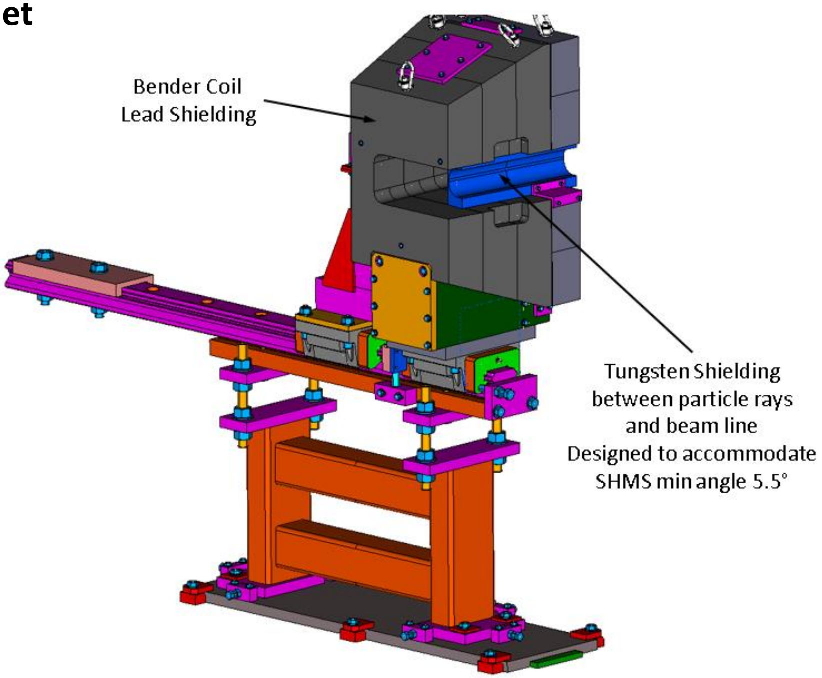
EMC-SRC Detectors
Detector mounts/positions to clear future experiments
Detector mounts to clear existing cable trays

HALL C

Dan Young



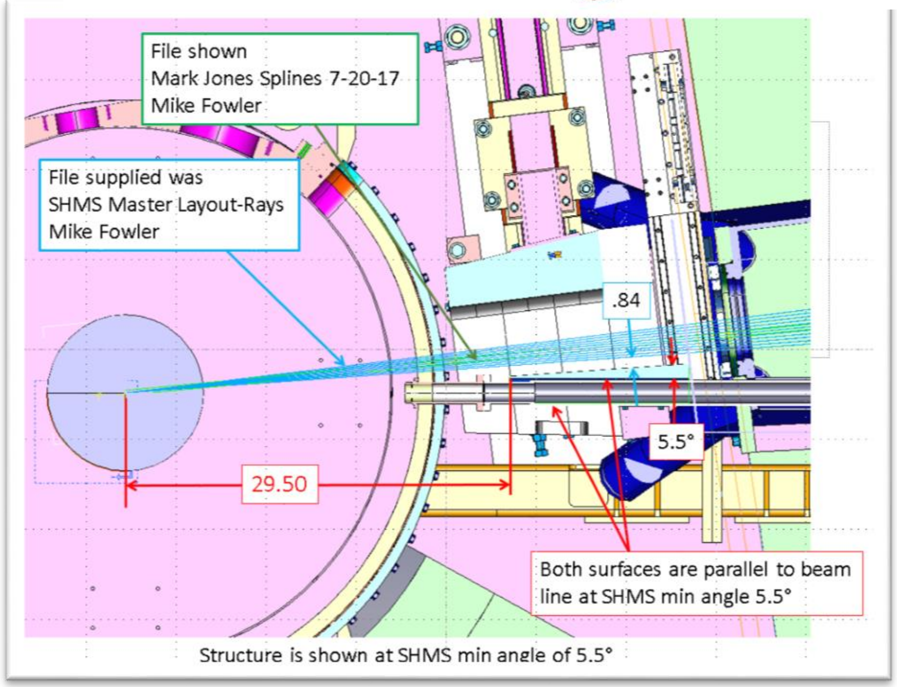
Bender Magnet



Bender Coil Lead Shielding

Tungsten Shielding between particle rays and beam line Designed to accommodate SHMS min angle 5.5°

Investigated and provided information regarding the particle path thru the Bender Magnet shielding as well as the location of the lead and tungsten shielding with the SHMS at min angle



File shown
Mark Jones Splines 7-20-17
Mike Fowler

File supplied was
SHMS Master Layout-Rays
Mike Fowler

Both surfaces are parallel to beam line at SHMS min angle 5.5°

Structure is shown at SHMS min angle of 5.5°

Eric Sun

Optimization of SHMS Magnet Dump Resistors

- Existing 75 mΩ dump resistors of SHMS Q2/3 and Dipole triggered quench-backs and induced long recovery time (Fig. 1) and high temperature rise (Fig. 2) with fast discharges from high currents.
- Fig. 3 shows that the critical currents of Q2/Q3 magnets are always larger than the decay current with 7.5 mΩ dump resistor. Fig. 4 illustrates the Dipole’s critical current is always larger than the decay current with a 25 mΩ dump resistor. No quench-back is expected for both of them.
- 7.5 mΩ and 25 mΩ dump resistors, manufactured by Switzerland’s Widcap AG, are now here at Jefferson Lab.
- Test schedule of modified dump resistors: early August 2019. Cryogenic impact to other Halls is not expected. Test currents will be 3660 A (Q2) and 3450 A (Dipole).
- Journal Paper: Quench-back Management for Fast Decaying Currents in SHMS Superconducting Magnets at Jefferson Lab
    - Accepted with minor revisions by *IEEE Transaction on Applied Superconductivity* Journal
    - Submitted the second revision on June 26, 2019.

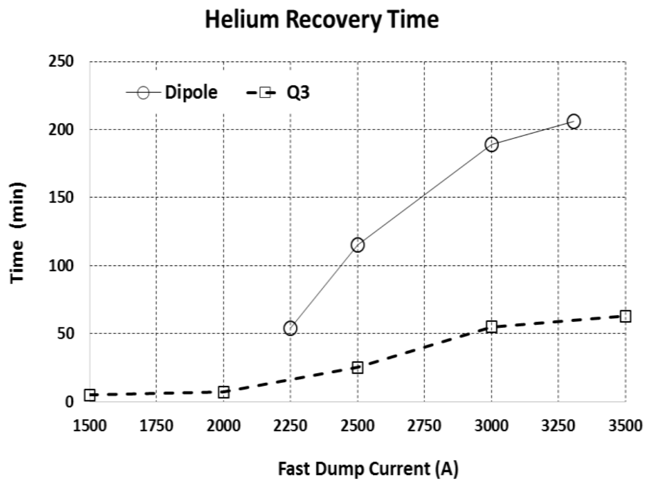


Fig. 1

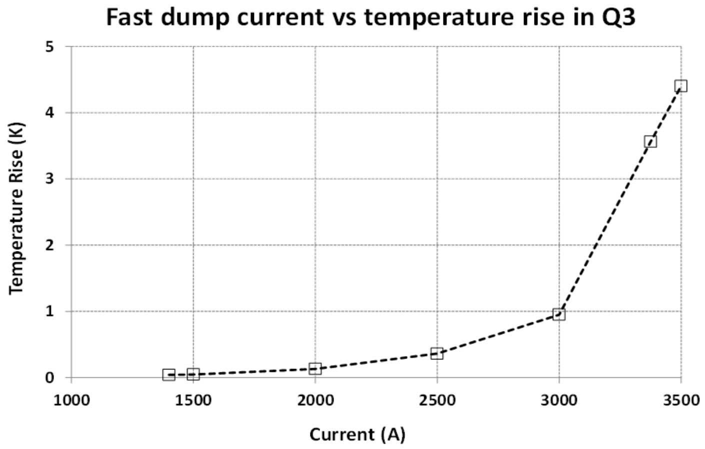


Fig. 2

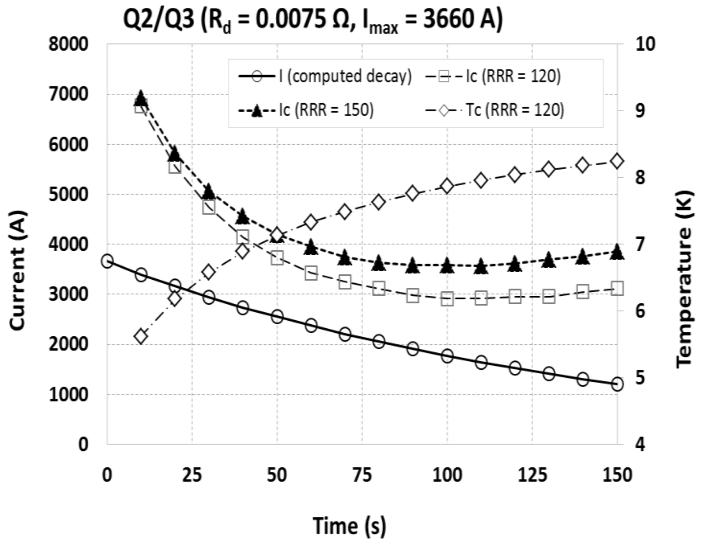


Fig. 3

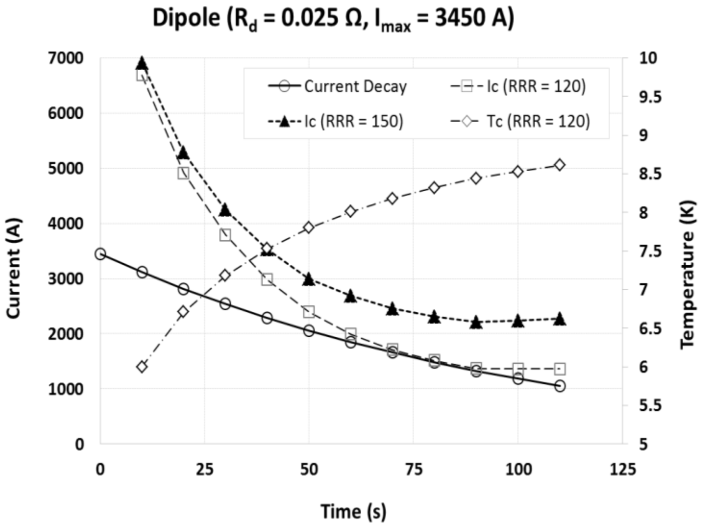
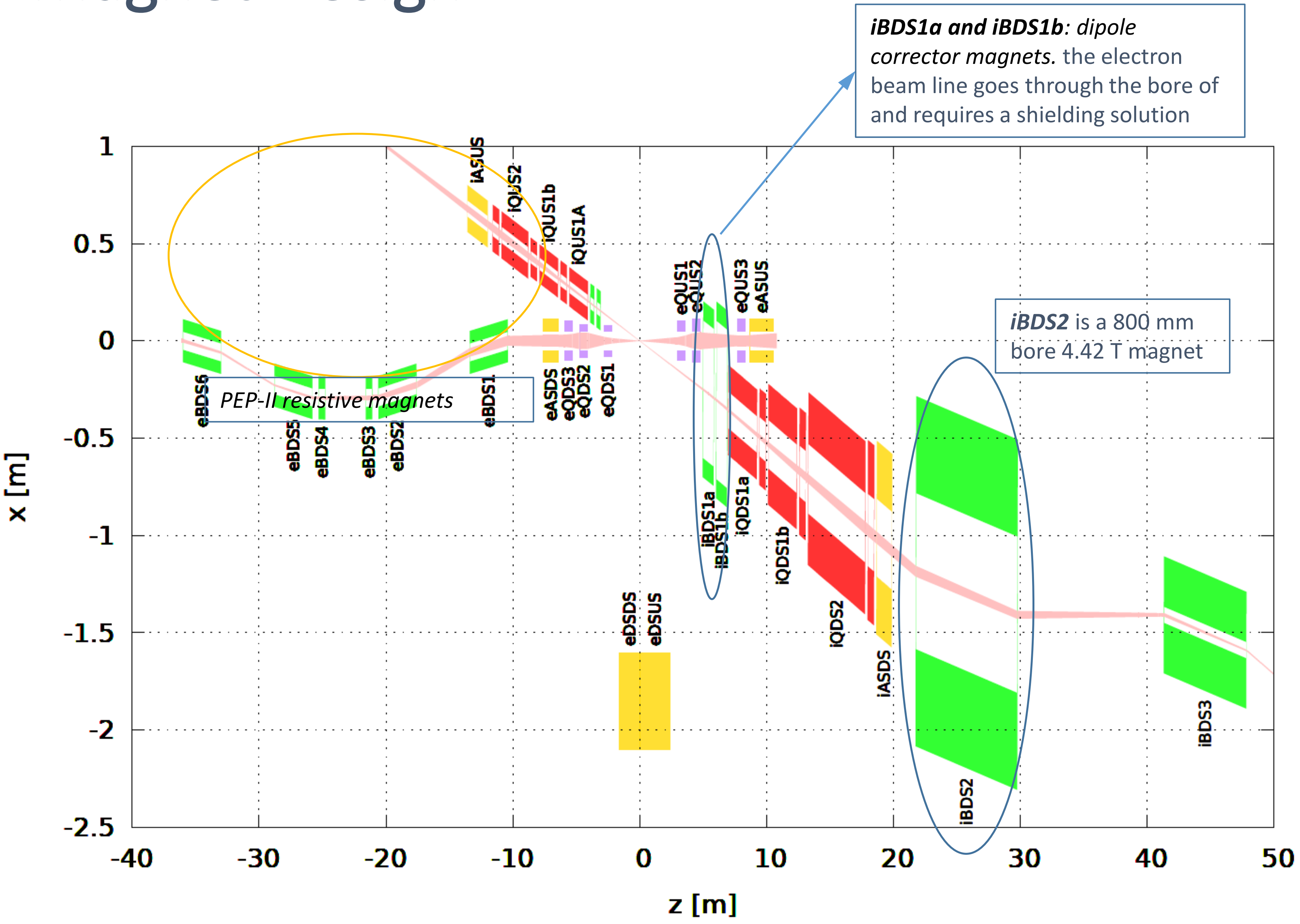


Fig. 4

Magnet Design

- Preliminary design completed for all quadrupoles, skew quadrupoles, solenoids, corrector magnets for Ion and Electron beam lines in the interaction region for the updated lattice file for higher COM energy.
- Updating the Interaction Region magnet design part of the p-CDR, magnet design section has been updated, magnet interaction and shielding work is in progress.
- Investigating design options for 7.6 T cooling solenoid (1 x 1.25 m long, 5 T; 1 x 2.5 m long, 7.6 T) and other ICR magnets (revisiting the coil length of magnets to fit into a 11.4m cryostat).



***iBDS1a and iBDS1b**: dipole corrector magnets.* the electron beam line goes through the bore of and requires a shielding solution

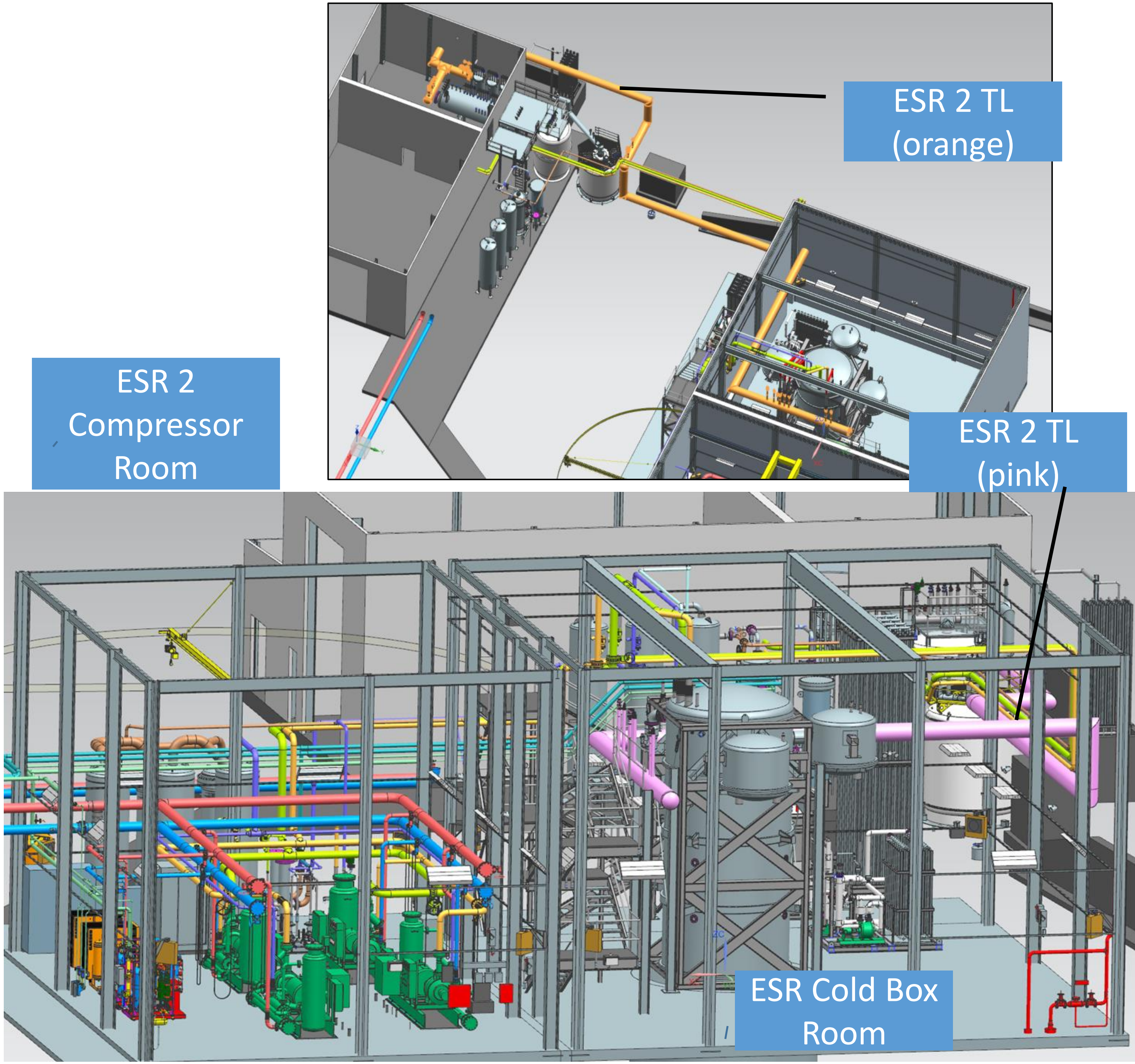
iBDS2 is a 800 mm bore 4.42 T magnet

PEP-II resistive magnets

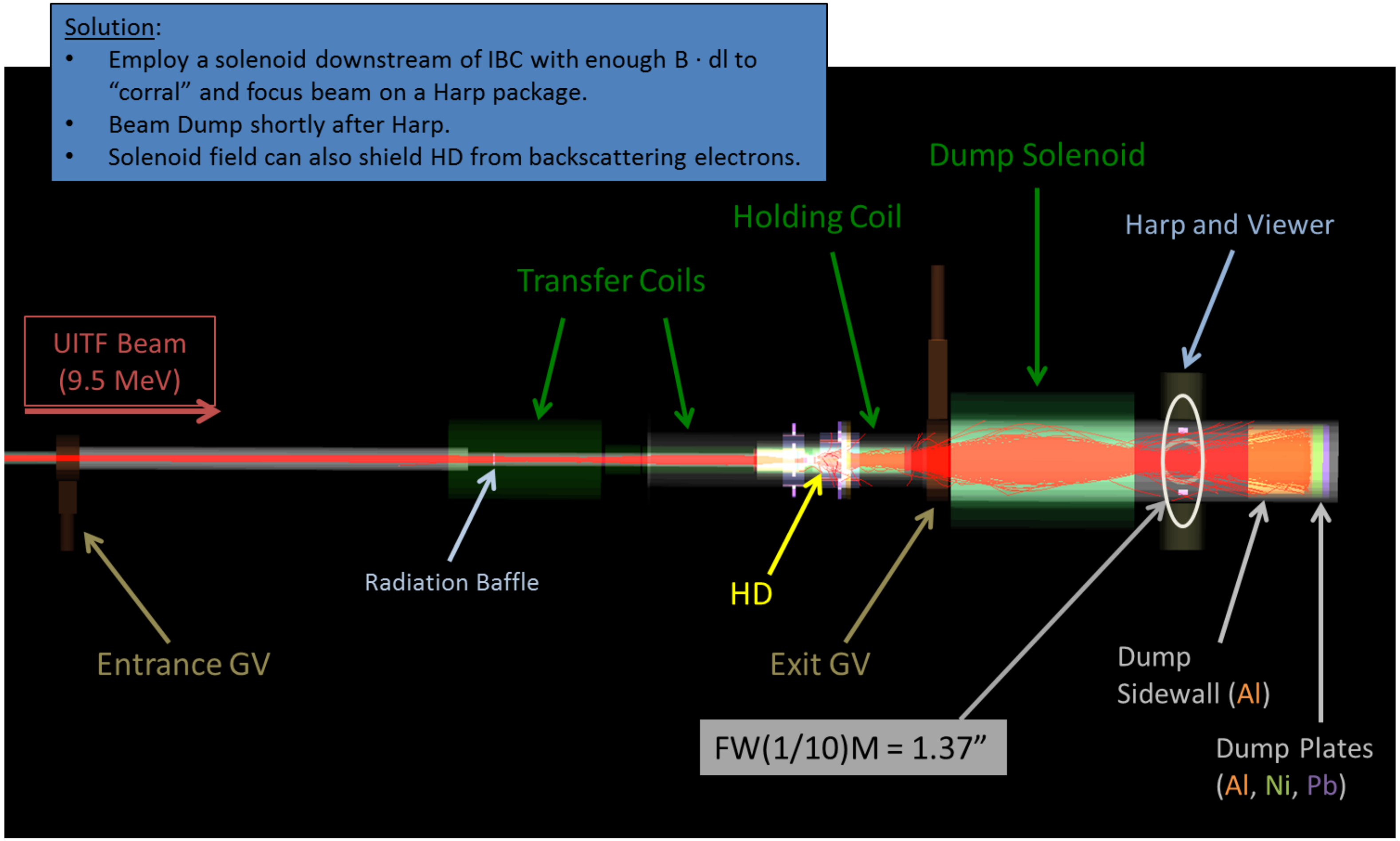
CRYO – ESR2

Dave Kashy

- Preliminary Design Review held June 19
- Team on the right path and making good progress
  - Cycle work
    - Max CHL support needed is 5g/s
    - 15K, 12K and 8.4K target supply temperatures all being incorporated with two and one time possible
    - 4K supply and return as now but more capacity
  - Building layout
    - Well along in hardware selection and location
    - Significant thought has gone into developing designs for safety and reliability and maintenance
  - Need to do hardware testing and refurbishment
    - Leak test the cold box – near future
    - Compressors maintenance and testing by a specialized vendor planned



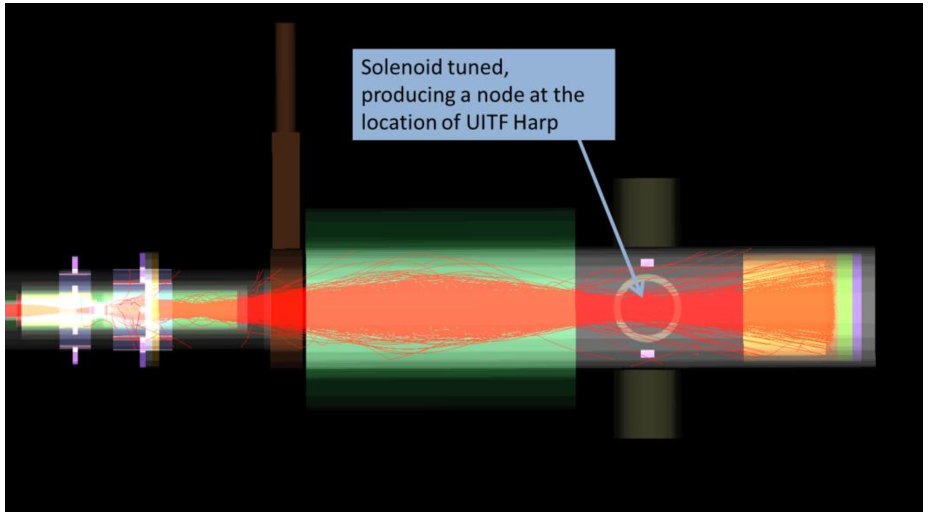
HD Ice Dump Solenoid (UITF)



Solution:
- Employ a solenoid downstream of IBC with enough B · dl to "corral" and focus beam on a Harp package.
- Beam Dump shortly after Harp.
- Solenoid field can also shield HD from backscattering electrons.

New project

- Required by the HD Ice Team to enable focusing of electron beam



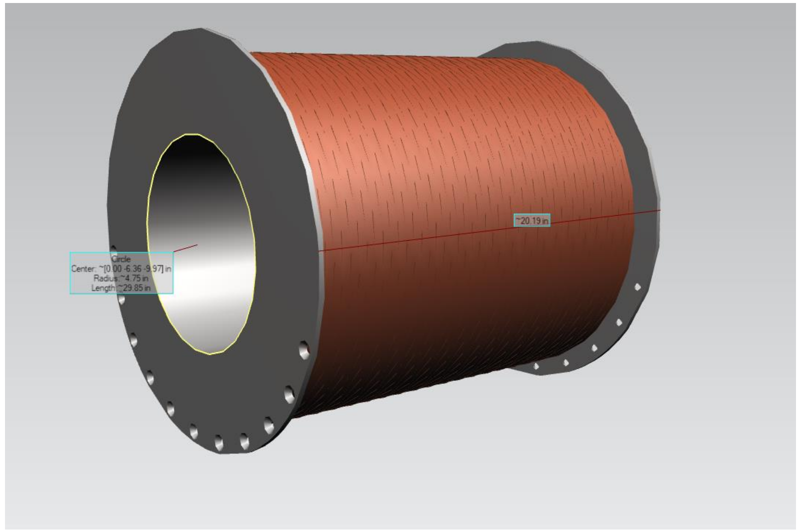
Solenoid tuned, producing a node at the location of UITF Harp

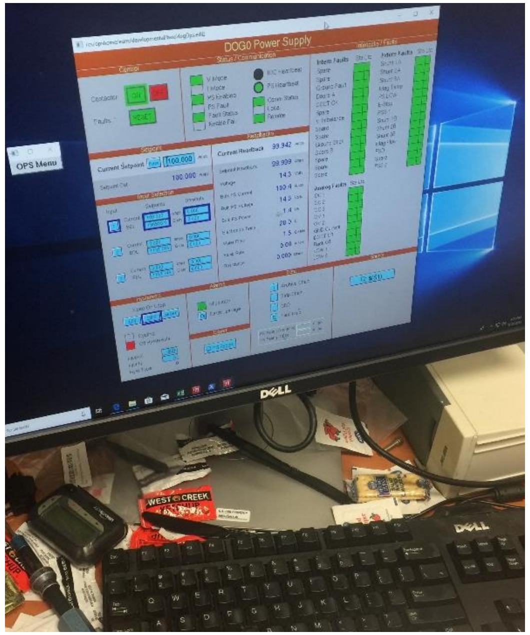
Dave Kashy

HD Ice Dump Solenoid

- New project
    - Multiple versions analyzed
    - Power supply identified and loan agreed to (spare from DC power group), EPICS programming complete, 480V welding outlet connection installed (plug and play)
    - This set the design parameters for the winding
    - Magnet needs to be operational in UITF by 9/30/19
    - Procurement plan: JLab to order major materials and have mandrel (spool) built, get a vendor to insulate/wind coil on mandrel

Parameter	Unit	Value
Bore	mm	254
Length	mm	500
Current	Amp	342
Voltage	V	43.2
Conductor	mm x mm x mm	10 x 10 x 7.5 id
LCW Flow	gpm	3





Probir Ghoshal

HD Ice Dump Solenoid

Transfer UP (1: US section)
I_{op} = 34 A, ~0.28 T

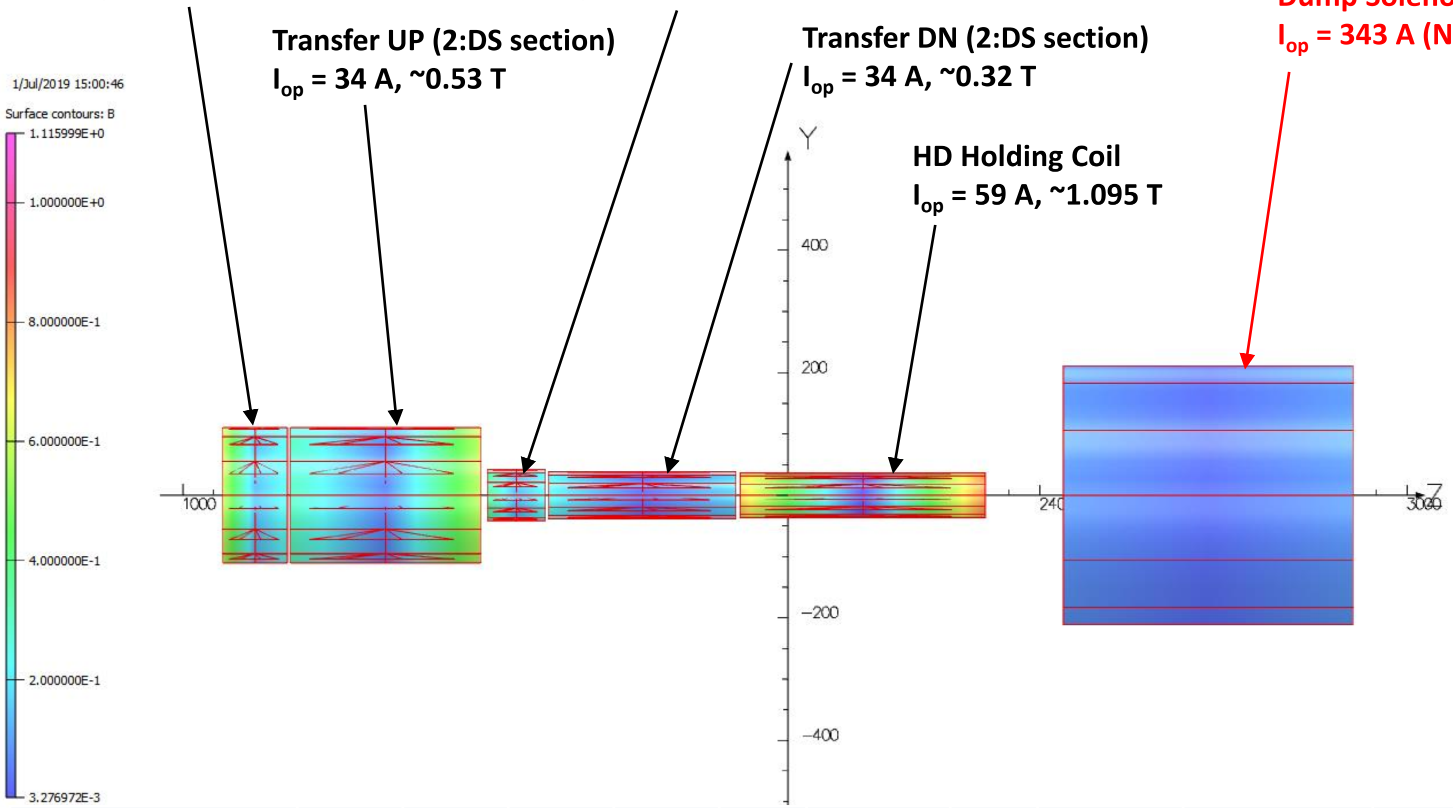
Transfer DN (1:US section)
I_{op} = 34 A, ~0.25 T

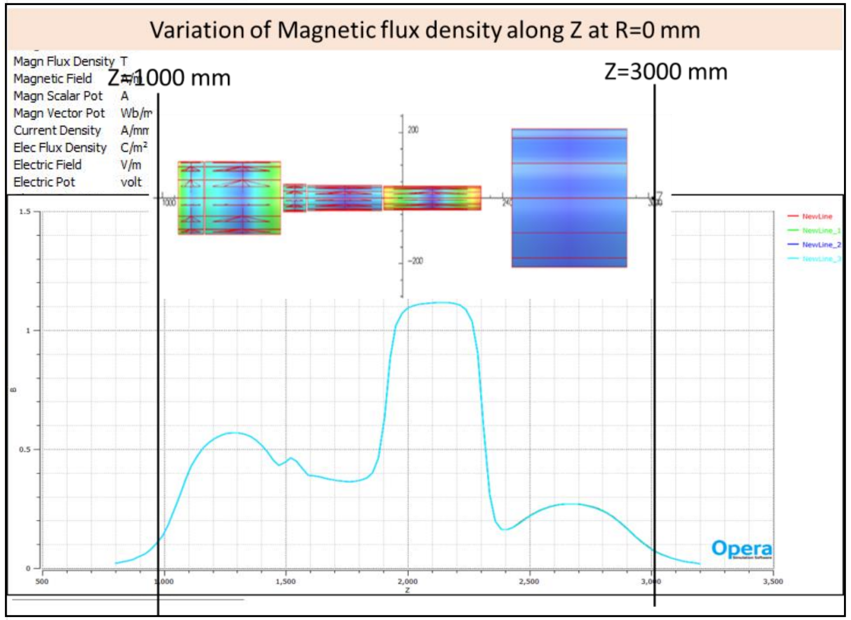
Transfer UP (2:DS section)
I_{op} = 34 A, ~0.53 T

Transfer DN (2:DS section)
I_{op} = 34 A, ~0.32 T

HD Holding Coil
I_{op} = 59 A, ~1.095 T

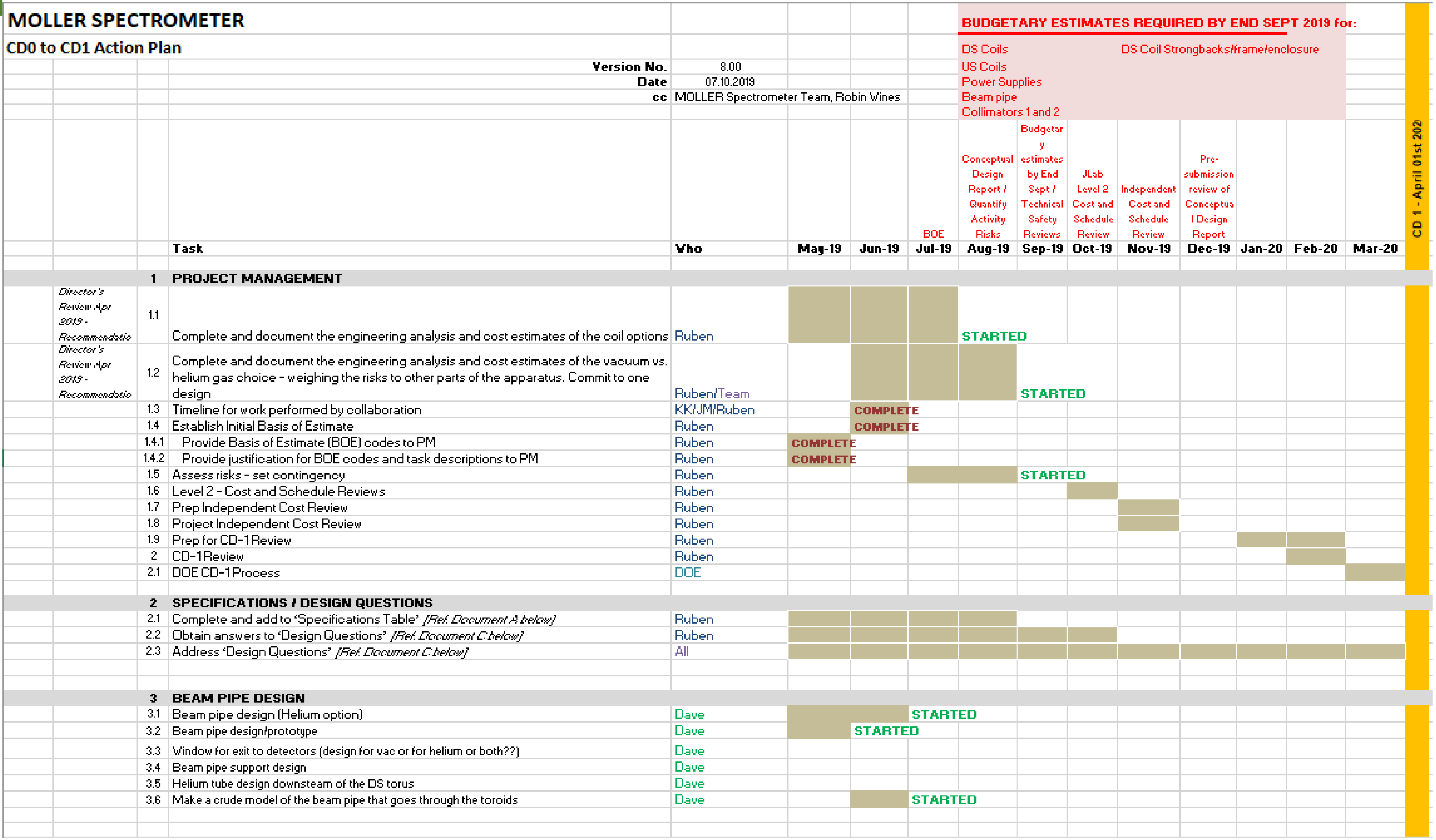
Dump Solenoid (Under Design)
I_{op} = 343 A (Nom), ~0.26 T





Magnet Type	r1 (mm)	r2 (mm)	z1 (mm)	z2 (mm)	N_lay	N_turns (Total)	I_A	Length (mm)	Length (mm)_as defined by Charles	Curr Den (A/mm^2)	Centre of Coil_Z (mm)	Central field (T)
Transfer UP (1: US section)	109.54	110.56	1065.42	1170.67	4	1603	34	105.25	105.30	507.68013	1118.05	0.280728
Transfer UP (2: DS section)	109.54	110.56	1175.92	1485.92	4	4675	34	310.00	310.00	502.68817	1330.92	0.525376
Transfer DN (1: US section)	41.33	41.83	1497.19	1592.41	2	746	34	95.22	95.22	532.74522	1544.80	0.251195
Transfer DN (2: DS section)	38.15	38.66	1597.98	1903.82	2	2395	34	305.84	305.84	522.05946	1750.90	0.324503
HD Holding coil	35.66	36.68	1910.82	2310.82	4	6004	59	400.00	400.00	868.22549	2110.82	1.095100
Dump solenoid	127.762	211.318	2438.4	2911.26	8	360	343.5	472.86	475.00	3.1298176	2674.83	0.267071

Spectrometer CD0 to CD1 Action Plan



MOLLER SPECTROMETER

CD0 to CD1 Action Plan

Version No. 8.00
Date 07.10.2019
cc MOLLER Spectrometer Team, Robin Wines

BUDGETARY ESTIMATES REQUIRED BY END SEPT 2019 for:

DS Coils
US Coils
Power Supplies
Beam pipe
Collimators 1 and 2
DS Coil Strongbacks/frame/enclosure

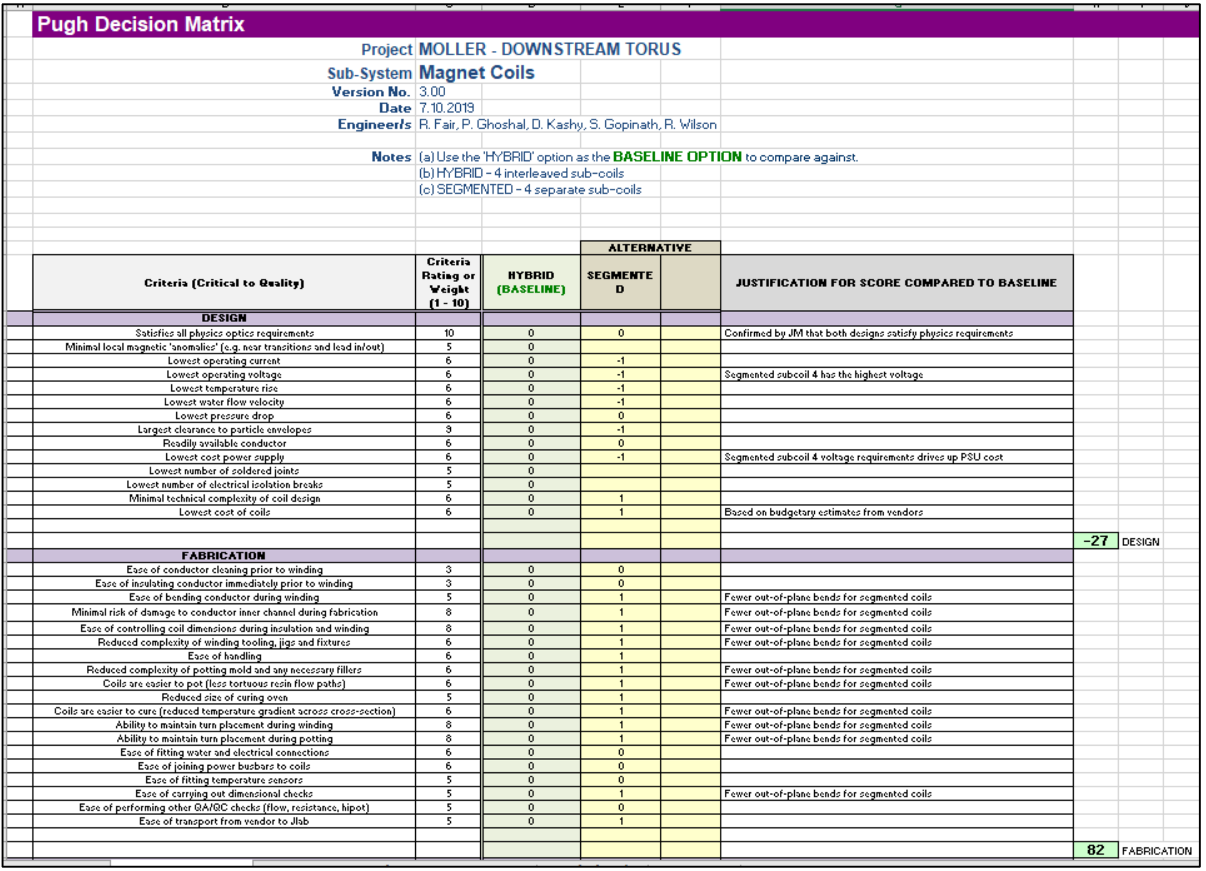
CD 1 - April 01st 202

		Task	Who	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19	Jan-20	Feb-20	Mar-20
						BOE	Conceptual Design Report / Quantify Activity Risks	Budgetary estimates by End Sept / Technical Safety Reviews	JLab Level 2 Cost and Schedule Review	Independent Cost and Schedule Review	Pre-submission review of Conceptual Design Report			
	1	**PROJECT MANAGEMENT**												
Director's Review Apr 2019 - Recommendatio	1.1	Complete and document the engineering analysis and cost estimates of the coil options	Ruben	▨	▨	▨	STARTED							
Director's Review Apr 2019 - Recommendatio	1.2	Complete and document the engineering analysis and cost estimates of the vacuum vs. helium gas choice - weighing the risks to other parts of the apparatus. Commit to one design	Ruben/Team		▨	▨	▨	STARTED						
	1.3	Timeline for work performed by collaboration	KK/JM/Ruben		COMPLETE									
	1.4	Establish Initial Basis of Estimate	Ruben		COMPLETE									
	1.4.1	Provide Basis of Estimate (BOE) codes to PM	Ruben	COMPLETE										
	1.4.2	Provide justification for BOE codes and task descriptions to PM	Ruben	COMPLETE										
	1.5	Assess risks - set contingency	Ruben			▨	▨	STARTED						
	1.6	Level 2 - Cost and Schedule Reviews	Ruben						▨					
	1.7	Prep Independent Cost Review	Ruben							▨				
	1.8	Project Independent Cost Review	Ruben							▨				
	1.9	Prep for CD-1 Review	Ruben									▨	▨	
	2	CD-1 Review	Ruben										▨	
	2.1	DOE CD-1 Process	DOE											▨
	2	**SPECIFICATIONS / DESIGN QUESTIONS**												
	2.1	Complete and add to 'Specifications Table' *[Ref. Document A below]*	Ruben	▨	▨	▨	▨							
	2.2	Obtain answers to 'Design Questions' *[Ref. Document C below]*	Ruben	▨	▨	▨	▨	▨	▨					
	2.3	Address 'Design Questions' *[Ref. Document C below]*	All	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨	▨
	3	**BEAM PIPE DESIGN**												
	3.1	Beam pipe design (Helium option)	Dave	▨	▨	STARTED								
	3.2	Beam pipe design/prototype	Dave	▨	STARTED									
	3.3	Window for exit to detectors (design for vac or for helium or both??)	Dave											
	3.4	Beam pipe support design	Dave											
	3.5	Helium tube design downsteam of the DS torus	Dave											
	3.6	Make a crude model of the beam pipe that goes through the toroids	Dave		▨	STARTED								

MOLLER

Ruben Fair

- ☐ Basis of Estimate complete
- ☐ Down select of DS Hybrid v Segmented coil design underway



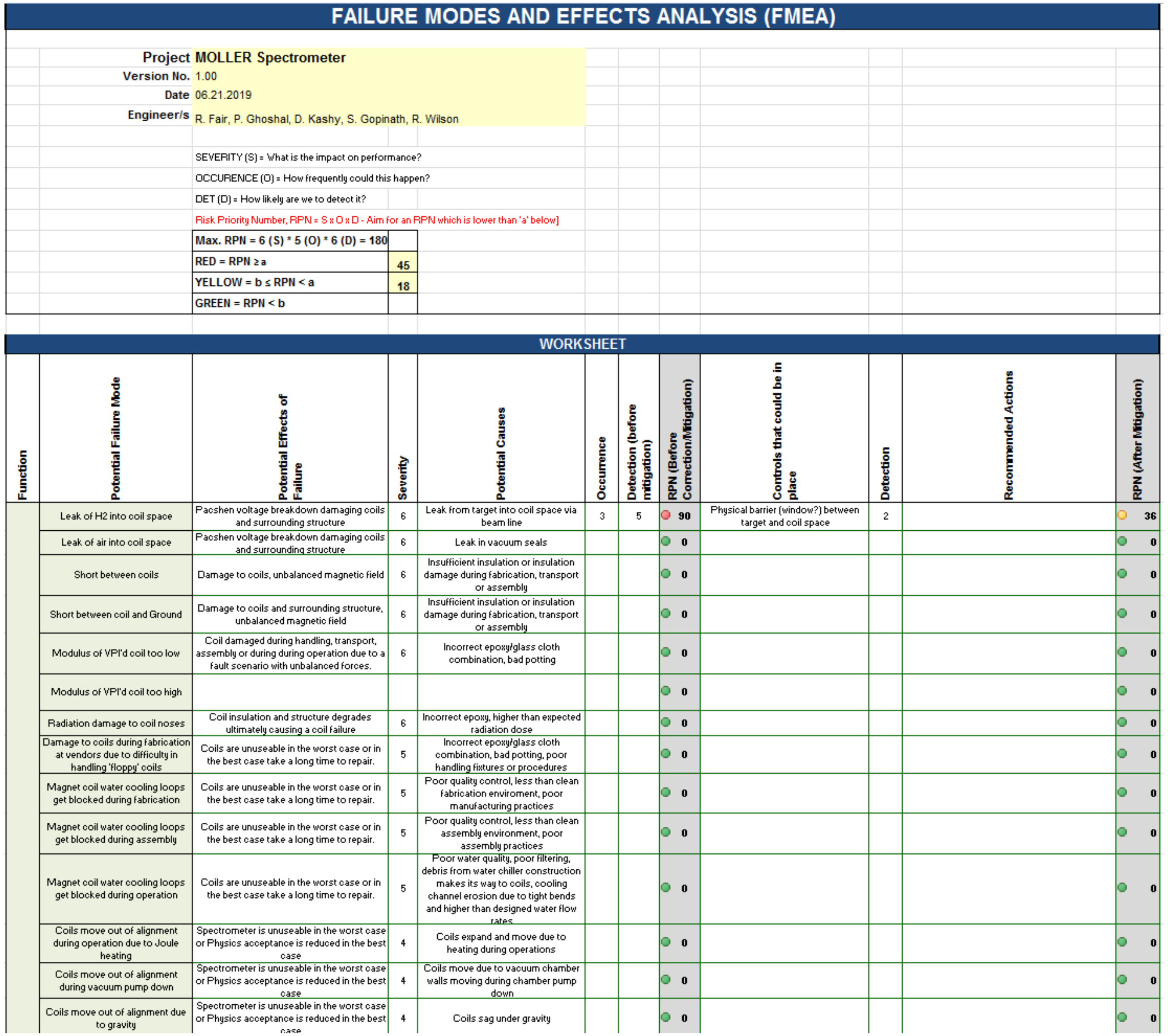
Pugh Decision Matrix

Project MOLLER - DOWNSTREAM TORUS
Sub-System Magnet Coils
Version No. 3.00
Date 7.10.2019
Engineer/s R. Fair, P. Ghoshal, D. Kashy, S. Gopinath, R. Wilson

Notes (a) Use the 'HYBRID' option as the **BASELINE OPTION** to compare against.
(b) HYBRID - 4 interleaved sub-coils
(c) SEGMENTED - 4 separate sub-coils

Criteria (Critical to Quality)	Criteria Rating or Weight (1 - 10)	HYBRID (BASELINE)	ALTERNATIVE SEGMENTED		JUSTIFICATION FOR SCORE COMPARED TO BASELINE	
DESIGN						
Satisfies all physics optics requirements	10	0	0		Confirmed by JM that both designs satisfy physics requirements	
Minimal local magnetic 'anomalies' (e.g. near transitions and lead in/out)	5	0				
Lowest operating current	6	0	-1			
Lowest operating voltage	6	0	-1		Segmented subcoil 4 has the highest voltage	
Lowest temperature rise	6	0	-1			
Lowest water flow velocity	6	0	-1			
Lowest pressure drop	6	0	0			
Largest clearance to particle envelopes	9	0	-1			
Readily available conductor	6	0	0			
Lowest cost power supply	6	0	-1		Segmented subcoil 4 voltage requirements drives up PSU cost	
Lowest number of soldered joints	5	0				
Lowest number of electrical isolation breaks	5	0				
Minimal technical complexity of coil design	6	0	1			
Lowest cost of coils	6	0	1		Based on budgetary estimates from vendors	
						-27 DESIGN
FABRICATION						
Ease of conductor cleaning prior to winding	3	0	0			
Ease of insulating conductor immediately prior to winding	3	0	0			
Ease of bending conductor during winding	5	0	1		Fewer out-of-plane bends for segmented coils	
Minimal risk of damage to conductor inner channel during fabrication	8	0	1		Fewer out-of-plane bends for segmented coils	
Ease of controlling coil dimensions during insulation and winding	8	0	1		Fewer out-of-plane bends for segmented coils	
Reduced complexity of winding tooling, jigs and fixtures	6	0	1		Fewer out-of-plane bends for segmented coils	
Ease of handling	6	0	1			
Reduced complexity of potting mold and any necessary fillers	6	0	1		Fewer out-of-plane bends for segmented coils	
Coils are easier to pot (less tortuous resin flow paths)	6	0	1		Fewer out-of-plane bends for segmented coils	
Reduced size of curing oven	5	0	1			
Coils are easier to cure (reduced temperature gradient across cross-section)	6	0	1		Fewer out-of-plane bends for segmented coils	
Ability to maintain turn placement during winding	8	0	1		Fewer out-of-plane bends for segmented coils	
Ability to maintain turn placement during potting	8	0	1		Fewer out-of-plane bends for segmented coils	
Ease of fitting water and electrical connections	6	0	0			
Ease of joining power busbars to coils	6	0	0			
Ease of fitting temperature sensors	5	0	0			
Ease of carrying out dimensional checks	5	0	1		Fewer out-of-plane bends for segmented coils	
Ease of performing other QA/QC checks (flow, resistance, hipot)	5	0	0			
Ease of transport from vendor to Jlab	5	0	1			
						82 FABRICATION

- ☐ FMEA underway → Risk Register



FAILURE MODES AND EFFECTS ANALYSIS (FMEA)

Project MOLLER Spectrometer
Version No. 1.00
Date 06.21.2019
Engineer/s R. Fair, P. Ghoshal, D. Kashy, S. Gopinath, R. Wilson

SEVERITY (S) = What is the impact on performance?
OCCURENCE (O) = How frequently could this happen?
DET (D) = How likely are we to detect it?
Risk Priority Number, RPN = S x O x D - Aim for an RPN which is lower than 'a' below]

Max. RPN = 6 (S) * 5 (O) * 6 (D) = 180	
RED = RPN ≥ a	**45**
YELLOW = b ≤ RPN < a	**18**
GREEN = RPN < b	

WORKSHEET

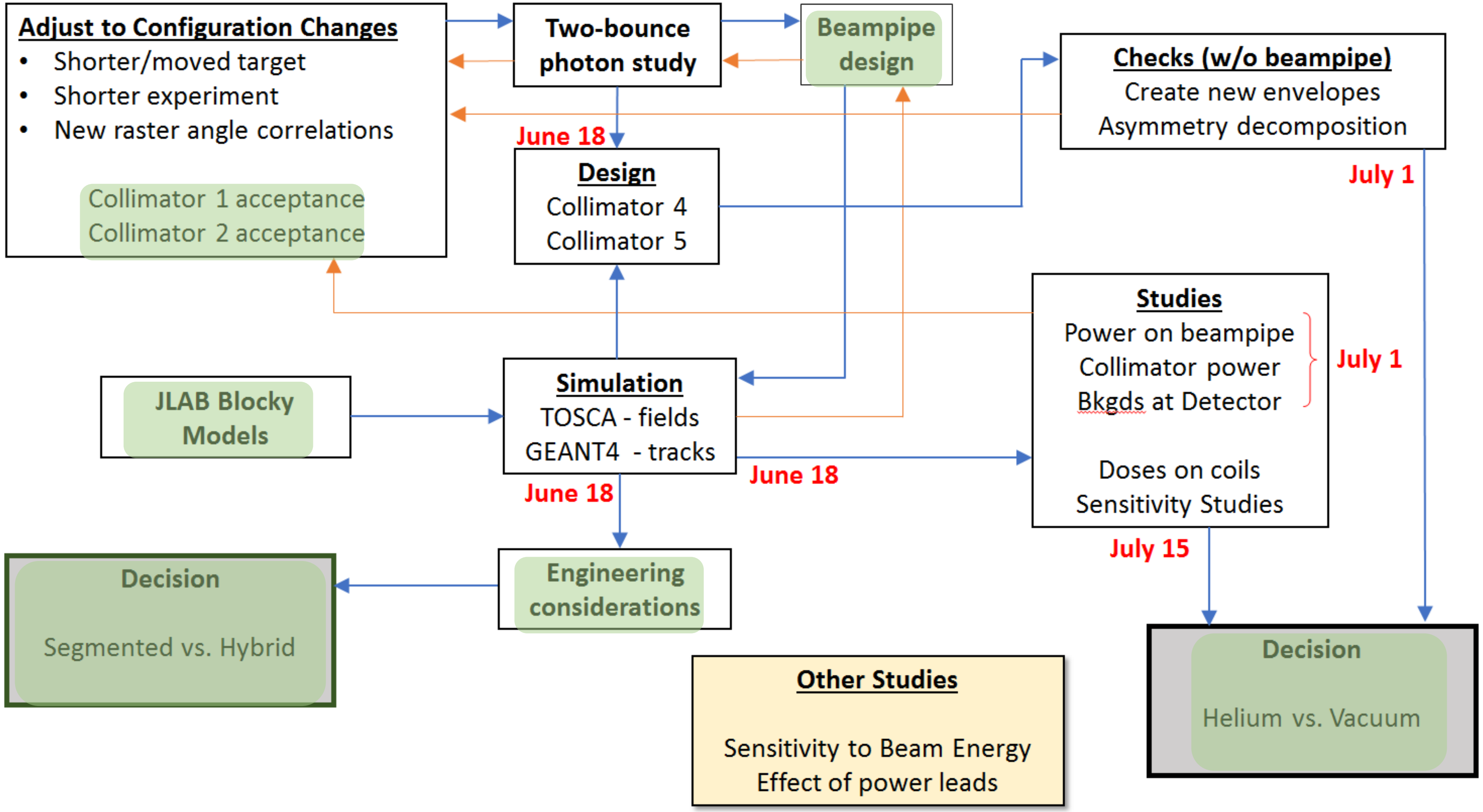
Function	Potential Failure Mode	Potential Effects of Failure	Severity	Potential Causes	Occurrence	Detection (before mitigation)	RPN (Before Correction/Mitigation)	Controls that could be in place	Detection	Recommended Actions	RPN (After Mitigation)
	Leak of H2 into coil space	Pacshen voltage breakdown damaging coils and surrounding structure	6	Leak from target into coil space via beam line	3	5	🔴 90	Physical barrier (window?) between target and coil space	2		🟡 36
	Leak of air into coil space	Pacshen voltage breakdown damaging coils and surrounding structure	6	Leak in vacuum seals			🟢 0				🟢 0
	Short between coils	Damage to coils, unbalanced magnetic field	6	Insufficient insulation or insulation damage during fabrication, transport or assembly			🟢 0				🟢 0
	Short between coil and Ground	Damage to coils and surrounding structure, unbalanced magnetic field	6	Insufficient insulation or insulation damage during fabrication, transport or assembly			🟢 0				🟢 0
	Modulus of VPI'd coil too low	Coil damaged during handling, transport, assembly or during during operation due to a fault scenario with unbalanced forces.	6	Incorrect epoxy/glass cloth combination, bad potting			🟢 0				🟢 0
	Modulus of VPI'd coil too high						🟢 0				🟢 0
	Radiation damage to coil noses	Coil insulation and structure degrades ultimately causing a coil failure	6	Incorrect epoxy, higher than expected radiation dose			🟢 0				🟢 0
	Damage to coils during fabrication at vendors due to difficulty in handling 'floppy' coils	Coils are unuseable in the worst case or in the best case take a long time to repair.	5	Incorrect epoxy/glass cloth combination, bad potting, poor handling fixtures or procedures			🟢 0				🟢 0
	Magnet coil water cooling loops get blocked during fabrication	Coils are unuseable in the worst case or in the best case take a long time to repair.	5	Poor quality control, less than clean fabrication enviroment, poor manufacturing practices			🟢 0				🟢 0
	Magnet coil water cooling loops get blocked during assembly	Coils are unuseable in the worst case or in the best case take a long time to repair.	5	Poor quality control, less than clean assembly environment, poor assembly practices			🟢 0				🟢 0
	Magnet coil water cooling loops get blocked during operation	Coils are unuseable in the worst case or in the best case take a long time to repair.	5	Poor water quality, poor filtering, debris from water chiller construction makes its way to coils, cooling channel erosion due to tight bends and higher than designed water flow rates			🟢 0				🟢 0
	Coils move out of alignment during operation due to Joule heating	Spectrometer is unuseable in the worst case or Physics acceptance is reduced in the best case	4	Coils expand and move due to heating during operations			🟢 0				🟢 0
	Coils move out of alignment during vacuum pump down	Spectrometer is unuseable in the worst case or Physics acceptance is reduced in the best case	4	Coils move due to vacuum chamber walls moving during chamber pump down			🟢 0				🟢 0
	Coils move out of alignment due to gravity	Spectrometer is unuseable in the worst case or Physics acceptance is reduced in the best case	4	Coils sag under gravity			🟢 0				🟢 0

MOLLER

Ruben Fair

☐ Down select of Helium v Vacuum environments underway

🟩 JLab team assisting with this task



Adjust to Configuration Changes
- Shorter/moved target
- Shorter experiment
- New raster angle correlations

Collimator 1 acceptance
Collimator 2 acceptance

Two-bounce photon study

Beampipe design

Checks (w/o beampipe)
Create new envelopes
Asymmetry decomposition

June 18

Design
Collimator 4
Collimator 5

July 1

Studies
Power on beampipe
Collimator power
Bkgds at Detector

July 1

Doses on coils
Sensitivity Studies

JLAB Blocky Models

Simulation
TOSCA - fields
GEANT4 - tracks

June 18

June 18

July 15

Decision

Segmented vs. Hybrid

Engineering considerations

Other Studies

Sensitivity to Beam Energy
Effect of power leads

Decision

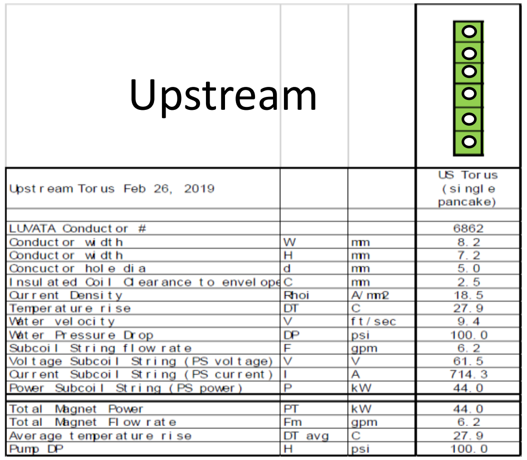
Helium vs. Vacuum

MOLLER

Dave Kashy / Randy Wilson / Sandesh Gopinath

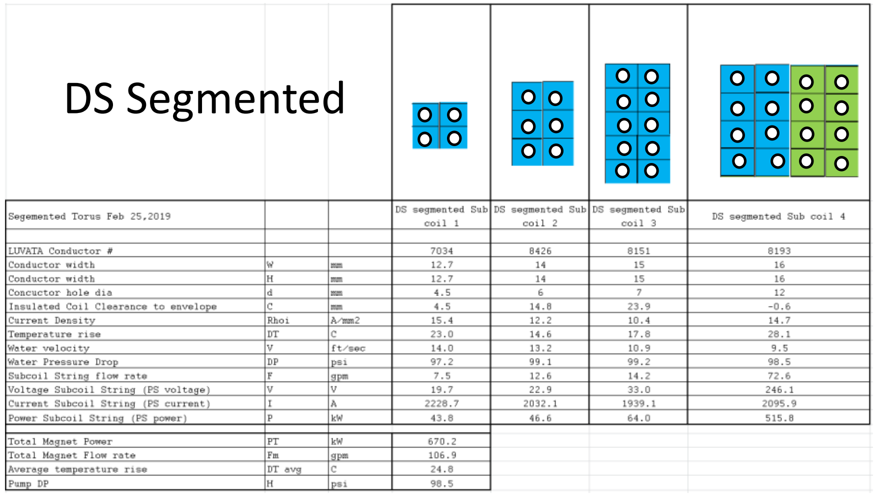
Magnet Designs

- Optimized coil designs for upstream magnet and two designs for downstream magnet, hybrid and segmented.
- All designed for 100psid LCW
- All meet all pre-set specs for current density and temperature rise
- All designs have simpler winding designs compared to previous designs



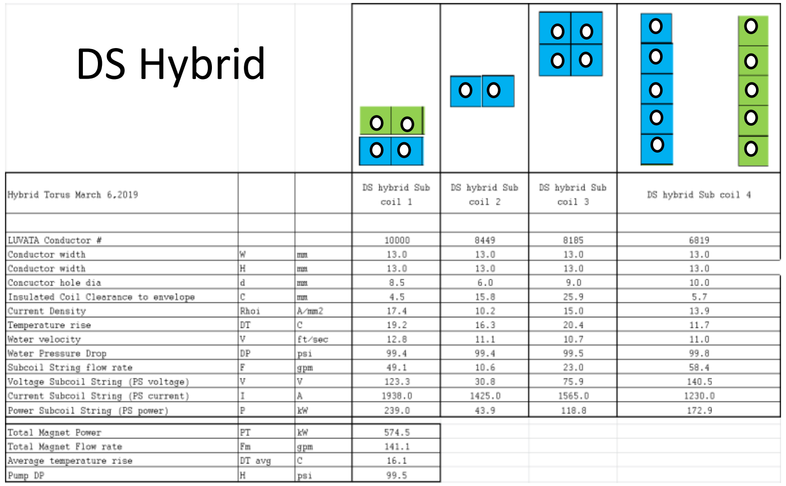
Upstream

Upstream Torus Feb 26, 2019			US Torus (single pancake)
LUVATA Conductor #			6862
Conductor width	W	mm	8.2
Conductor width	H	mm	7.2
Concuctor hole dia	d	mm	5.0
Insulated Coil Clearance to envelope	C	mm	2.5
Current Density	Rhoi	A/mm2	18.5
Temperature rise	DT	C	27.9
Water velocity	V	ft/sec	9.4
Water Pressure Drop	DP	psi	100.0
Subcoil String flow rate	F	gpm	6.2
Voltage Subcoil String (PS voltage)	V	V	61.5
Current Subcoil String (PS current)	I	A	714.3
Power Subcoil String (PS power)	P	kW	44.0
Total Magnet Power	PT	kW	44.0
Total Magnet Flow rate	Fm	gpm	6.2
Average temperature rise	DT avg	C	27.9
Pump DP	H	psi	100.0



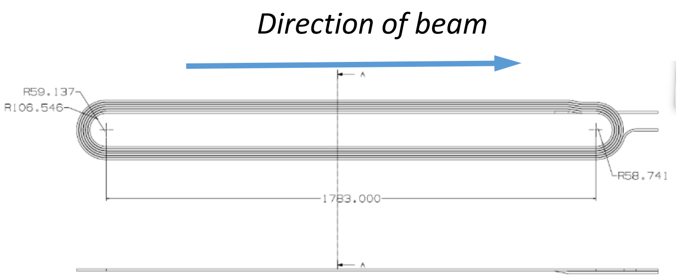
DS Segmented

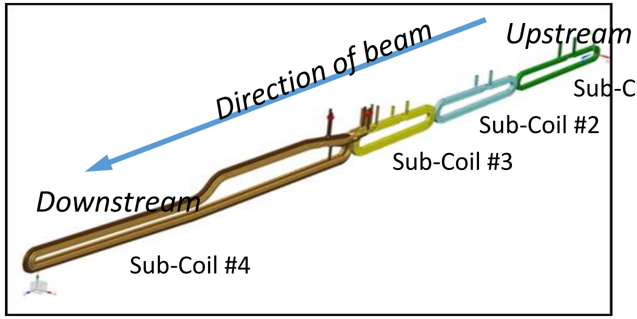
Segemented Torus Feb 25,2019			DS segmented Sub coil 1	DS segmented Sub coil 2	DS segmented Sub coil 3	DS segmented Sub coil 4
LUVATA Conductor #			7034	8426	8151	8193
Conductor width	W	mm	12.7	14	15	16
Conductor width	H	mm	12.7	14	15	16
Concuctor hole dia	d	mm	4.5	6	7	12
Insulated Coil Clearance to envelope	C	mm	4.5	14.8	23.9	-0.6
Current Density	Rhoi	A/mm2	15.4	12.2	10.4	14.7
Temperature rise	DT	C	23.0	14.6	17.8	28.1
Water velocity	V	ft/sec	14.0	13.2	10.9	9.5
Water Pressure Drop	DP	psi	97.2	99.1	99.2	98.5
Subcoil String flow rate	F	gpm	7.5	12.6	14.2	72.6
Voltage Subcoil String (PS voltage)	V	V	19.7	22.9	33.0	246.1
Current Subcoil String (PS current)	I	A	2228.7	2032.1	1939.1	2095.9
Power Subcoil String (PS power)	P	kW	43.8	46.6	64.0	515.8
Total Magnet Power	PT	kW	670.2			
Total Magnet Flow rate	Fm	gpm	106.9			
Average temperature rise	DT avg	C	24.8			
Pump DP	H	psi	98.5			

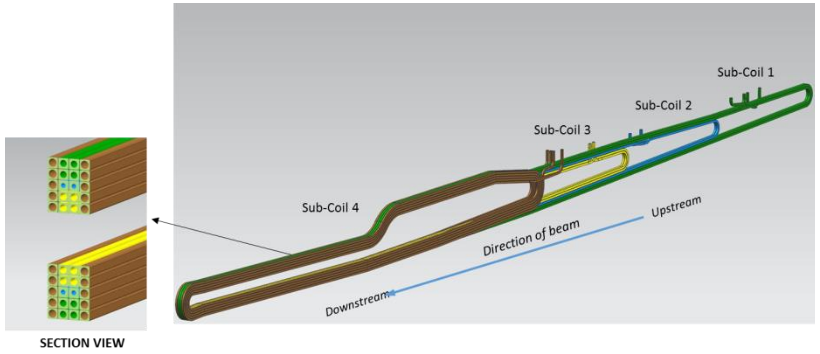


DS Hybrid

Hybrid Torus March 6,2019			DS hybrid Sub coil 1	DS hybrid Sub coil 2	DS hybrid Sub coil 3	DS hybrid Sub coil 4
LUVATA Conductor #			10000	8449	8185	6819
Conductor width	W	mm	13.0	13.0	13.0	13.0
Conductor width	H	mm	13.0	13.0	13.0	13.0
Concuctor hole dia	d	mm	8.5	6.0	9.0	10.0
Insulated Coil Clearance to envelope	C	mm	4.5	15.8	25.9	5.7
Current Density	Rhoi	A/mm2	17.4	10.2	15.0	13.9
Temperature rise	DT	C	19.2	16.3	20.4	11.7
Water velocity	V	ft/sec	12.8	11.1	10.7	11.0
Water Pressure Drop	DP	psi	99.4	99.4	99.5	99.8
Subcoil String flow rate	F	gpm	49.1	10.6	23.0	58.4
Voltage Subcoil String (PS voltage)	V	V	123.3	30.8	75.9	140.5
Current Subcoil String (PS current)	I	A	1938.0	1425.0	1565.0	1230.0
Power Subcoil String (PS power)	P	kW	239.0	43.9	118.8	172.9
Total Magnet Power	PT	kW	574.5			
Total Magnet Flow rate	Fm	gpm	141.1			
Average temperature rise	DT avg	C	16.1			
Pump DP	H	psi	99.5			







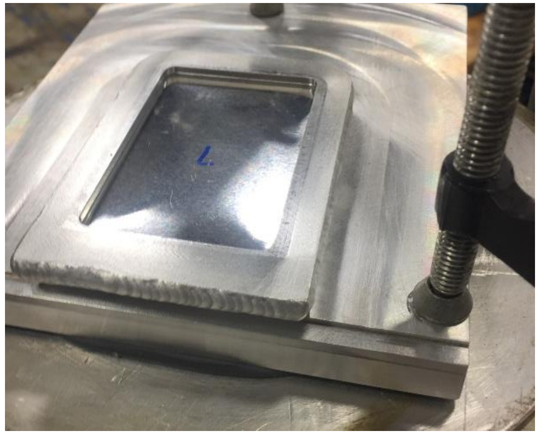
MOLLER

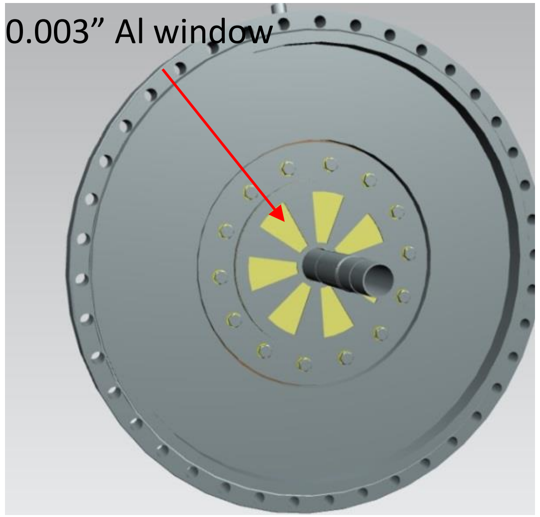
Dave Kashy / Randy Wilson

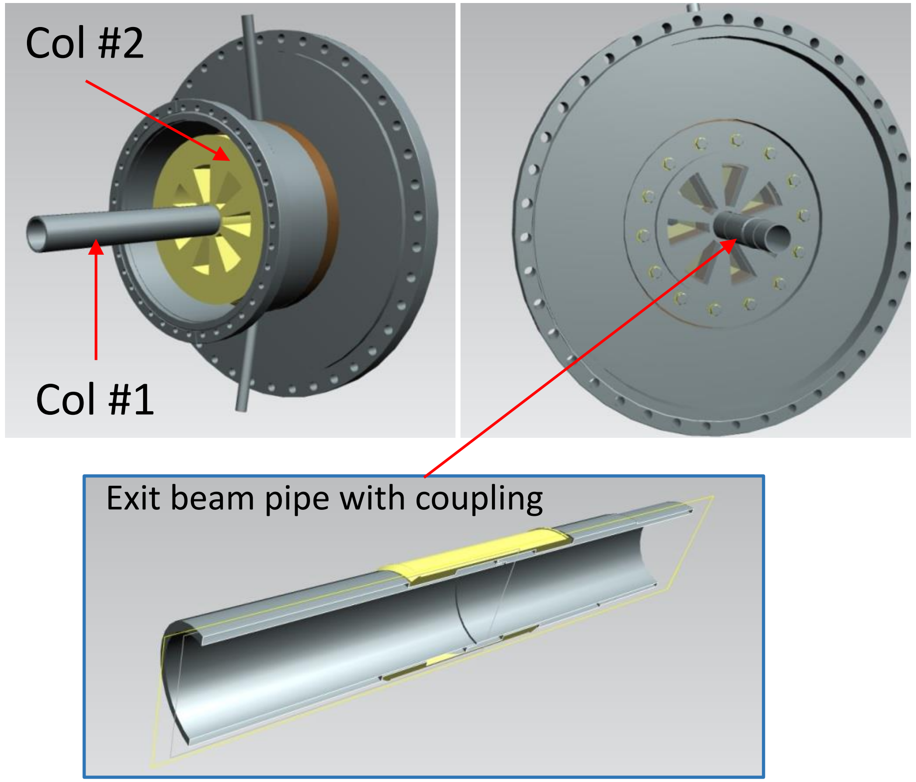
Collimators 1 and 2

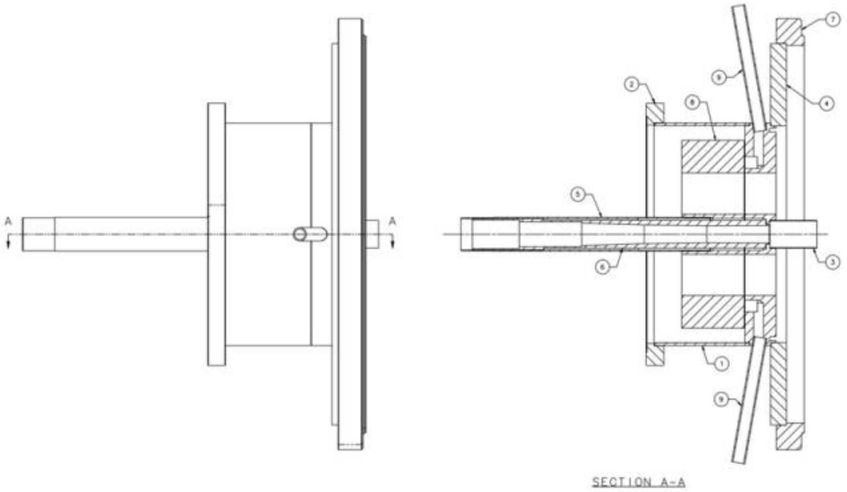
- Complete redesign (design) of collimators 1 and 2 for Moller
- Mating C1 and C2 eliminates possible alignment errors
- New design creates less background and has simpler water cooling connections
- All parts detailed to obtain updated cost estimates
- Helium to Vacuum window designed and some prototype welds attempted, E-beam welding is next, brazing an option
- Final design must wait until we get the heat load distribution along the length
- Invention disclosure of “Ultra-Compact Pipe Coupling” submitted

Weld demonstrator







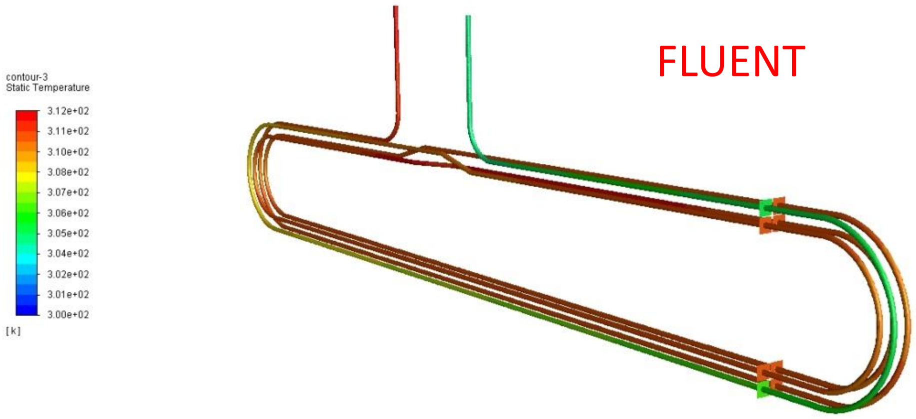


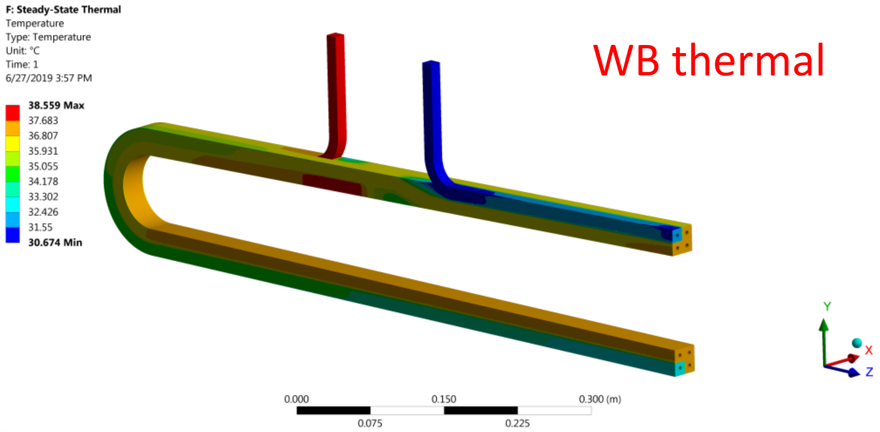
Beam Pipe

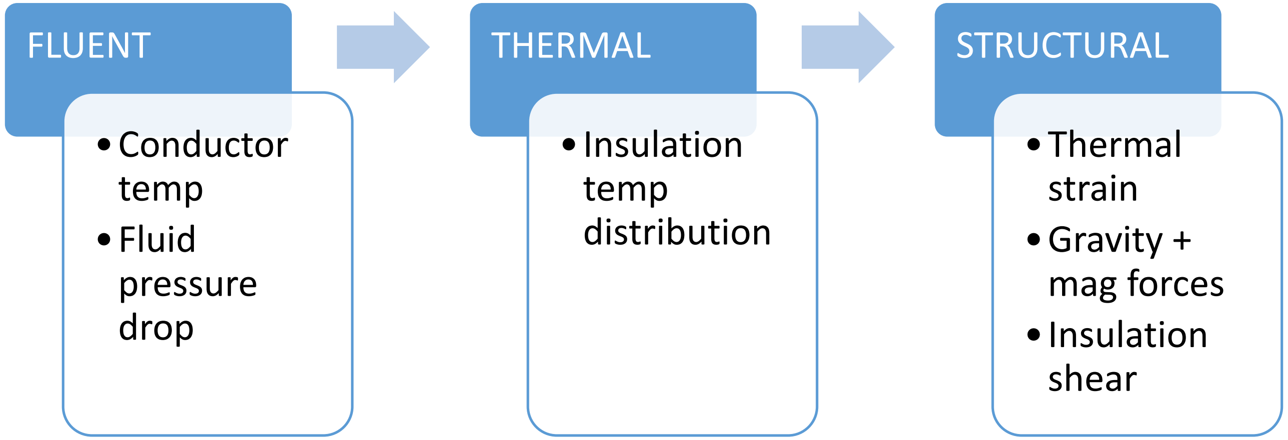
- Preliminary Design for helium pipe completed to allow simulations
- Materials for design confirmed available
- Weld demonstrator complete and successful:
    - 0.035” x 0.065” tube walls
    - Straight and leak tight

Magnet Coil Thermal Analysis

- **Objectives**: To understand thermal stress distribution in Moller Magnet coils, to estimate coil motion and shear stress in the coil insulation







FLUENT
- Conductor temp
- Fluid pressure drop

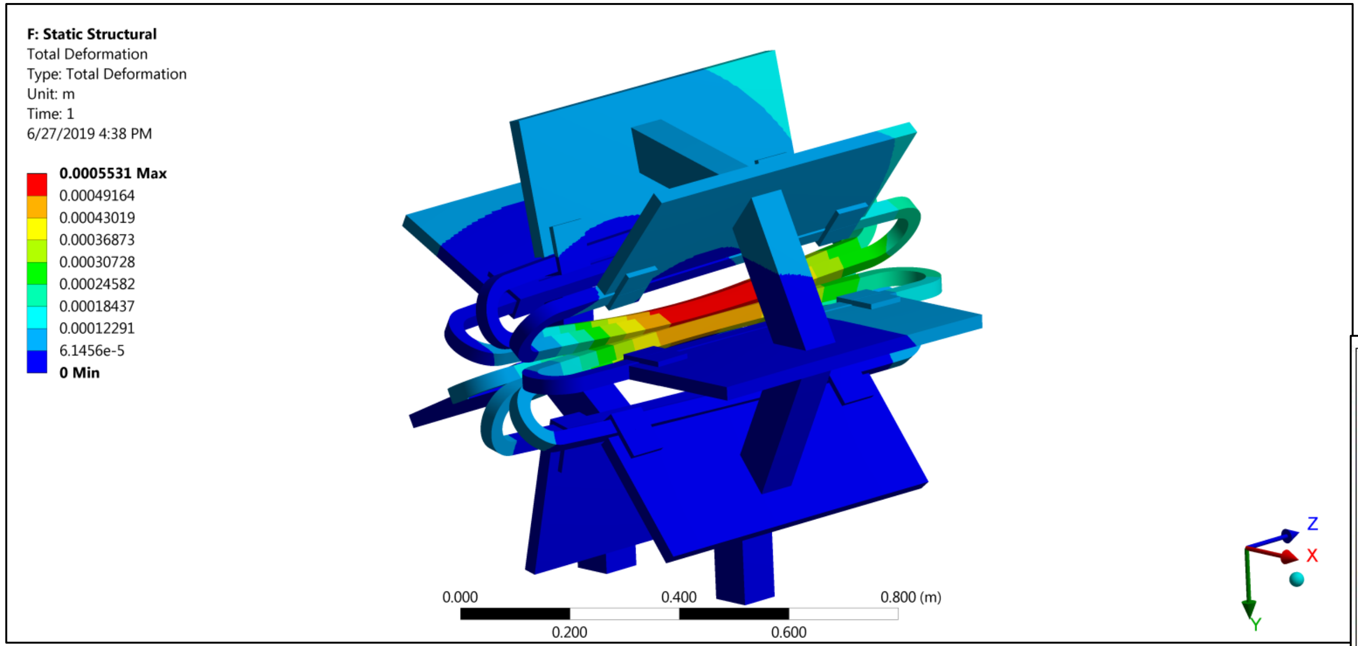
THERMAL
- Insulation temp distribution

STRUCTURAL
- Thermal strain
- Gravity + mag forces
- Insulation shear

Magnet Structural Analysis

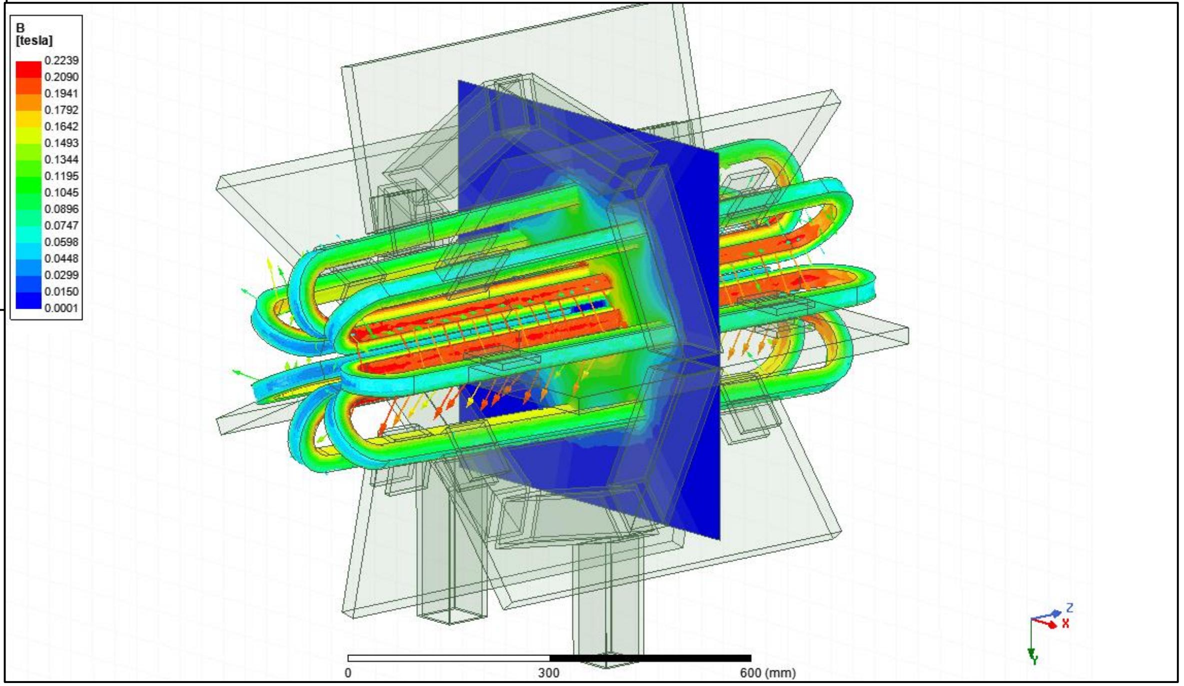
Utilizing ANSYS & MAXWELL
(magnetic field calcs from MAXWELL are a good match with results from OPERA)

US Torus - ANSYS structural (gravity + mag forces)



F: Static Structural
Total Deformation
Type: Total Deformation
Unit: m
Time: 1
6/27/2019 4:38 PM

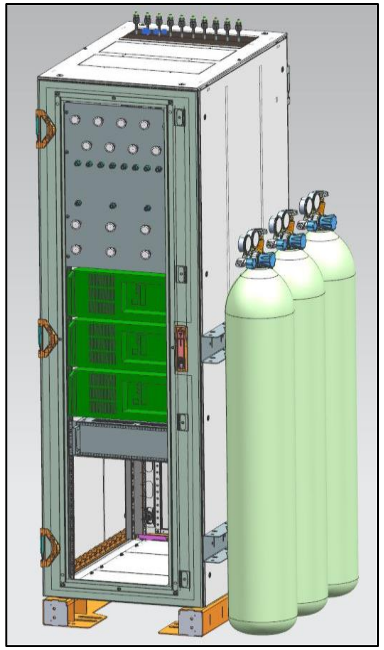
US Torus - MAXWELL (B field)



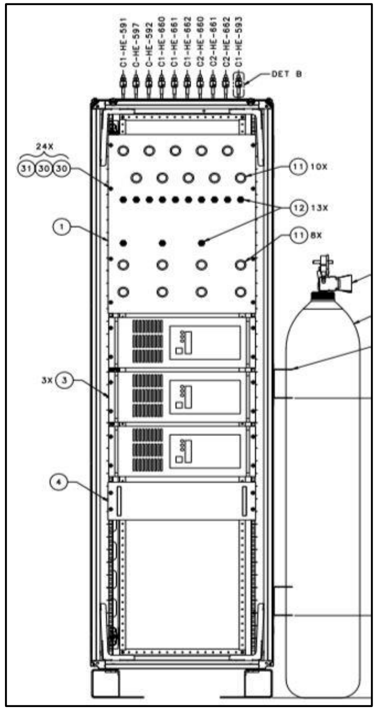
SLAC LCLSII + Test Lab

Randy Wilson

Final design task for the SLAC LCLS II project was a pair of seismic rated Gas Analyzer Cabinets. Fabricated at Jefferson Lab.

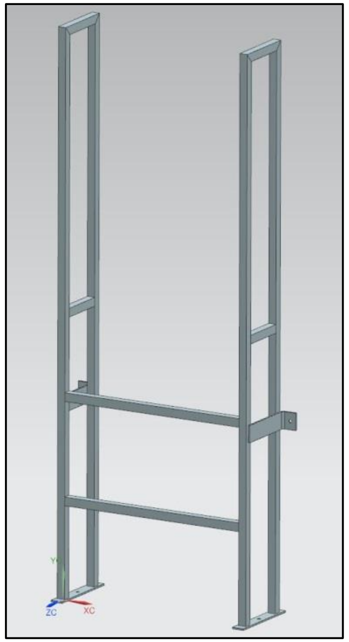


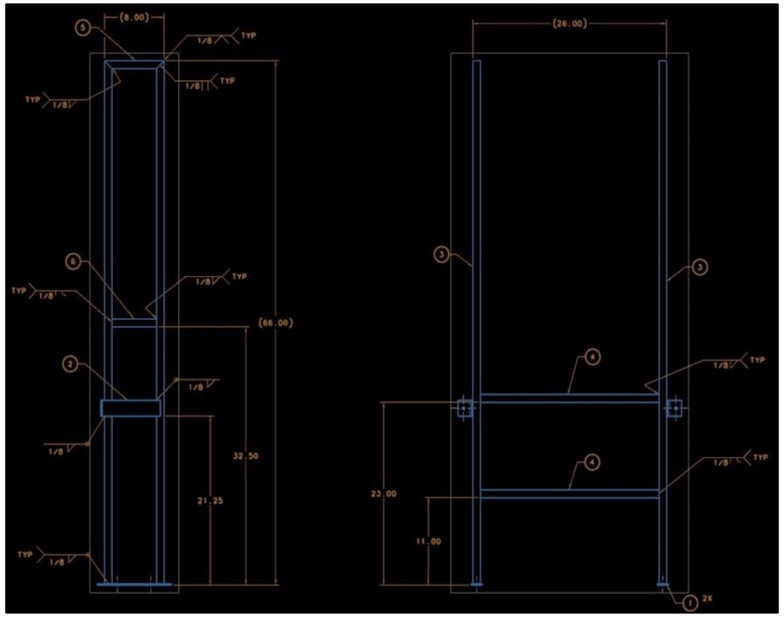
Cabinet Model



Finished Cabinet

Developed model and drawing of access ladder for test lab project .





Assembly/Detail drawing for JLab fabrication

Other Work

Dave Kashy / Ruben Fair / Probir Ghoshal / Renuka Rajput-Ghoshal

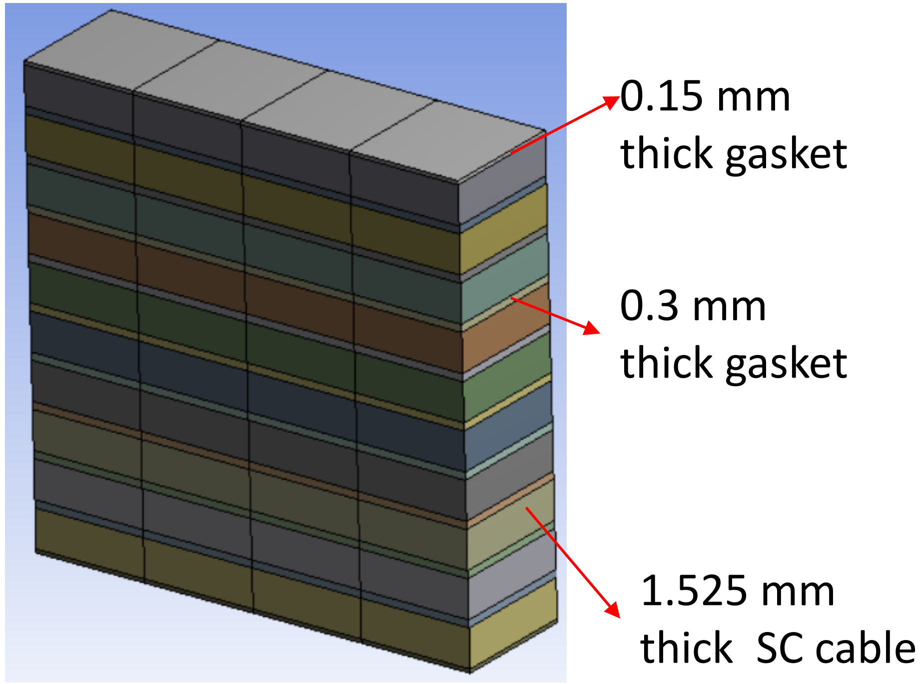
- ***Ruben/Probir:*** Hall B SC Magnets punch list: >90% completed
- ***Dave:*** Hall B Torus burped and warmed to 80K by D. Insley following the written procedure and no changes were required
- ***Dave****:* Hall B Solenoid helium level unstable, had techs pump u-tubes and solved
- ***Renuka****:* Involved in the Hall C NPS Experiment Readiness Review
- ***Renuka****:* Involved in the review of Injector solenoid spare coils/magnets
- ***Dave****:* Did preliminary cooling calcs on raster magnet for Jay Benesch
- ***Dave*** will be presenting an 'Introduction to Cryogenics' talk to the Graduate Students at the August 21 Pizza Luncheon
- ***Dave****:* Still working to get folks to communicate about cryo operations using the esr-users@jlab.org e-mail list, latest examples of missed communication:
  - Cryo did not communicate the 15K supply U-tube failure until prodded
  - Hall C target cool-down not communicated even after HCLOG was updated

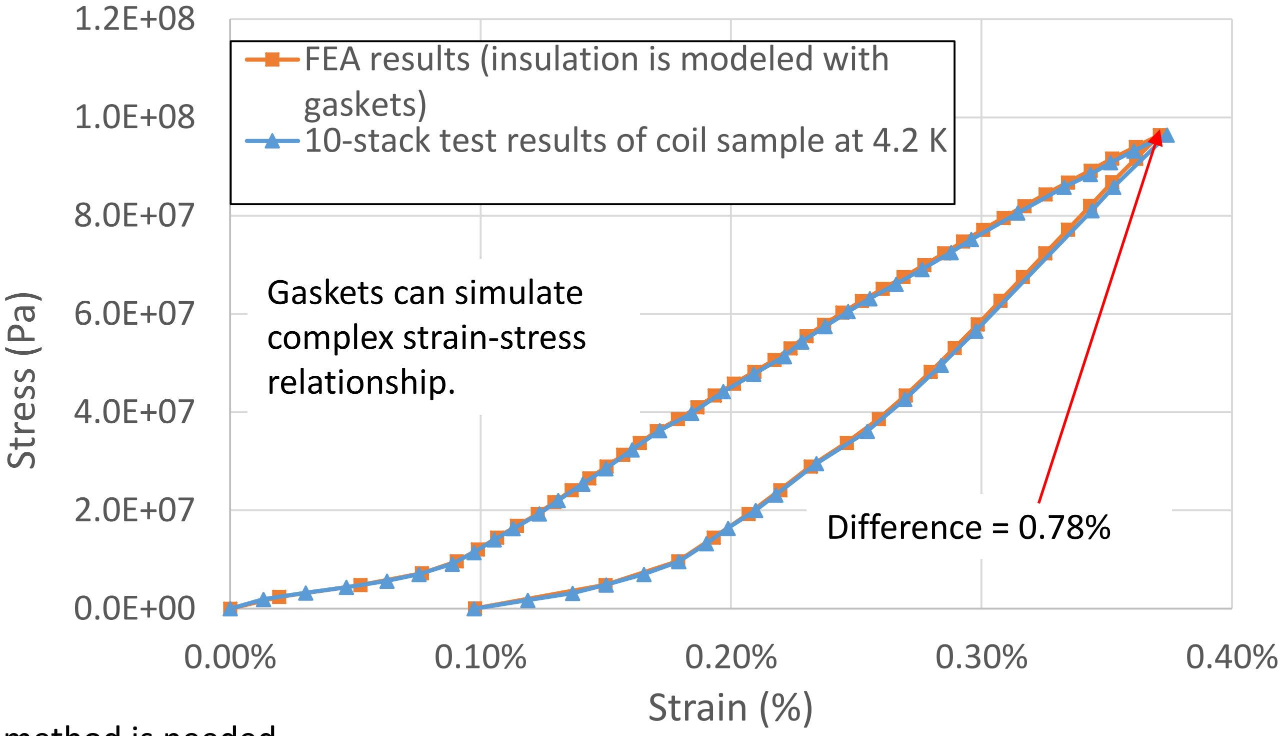
Other Work

Eric Sun

Mechanical Analysis of Coil

Novel Gasket-based Nonlinear Analysis of Superconducting Magnets





Gaskets can simulate complex strain-stress relationship.

- To better predict the overall stress/strain of a coil, a more accurate analysis method is needed.
- Present analysis methods assume the coil as either linear isotropic or linear orthotropic, which is far from reality.
- Gasket-based nonlinear analysis is the first of its kind to use the stress-strain curve of a 10-stack Nb_3Sn coil sample as an input to the nonlinear analysis.
- To implement it, the gasket material property is obtained by subtracting the property of the SC cable from the stress-strain curve of a 10-stack coil sample.
- Stress-strain relationship is computed using a 10-stack coil model (with gaskets). The FEA result is then compared with the test results to validate the property of the gaskets.
- The new method can improve the accuracy of the analysis by up to 45 times depending on the layer granularity of the model.

→ This type of analysis could prove to be crucial for designing high field magnets employing Nb_3Sn superconductor (EIC, Hi-Lumi, FCC……..)

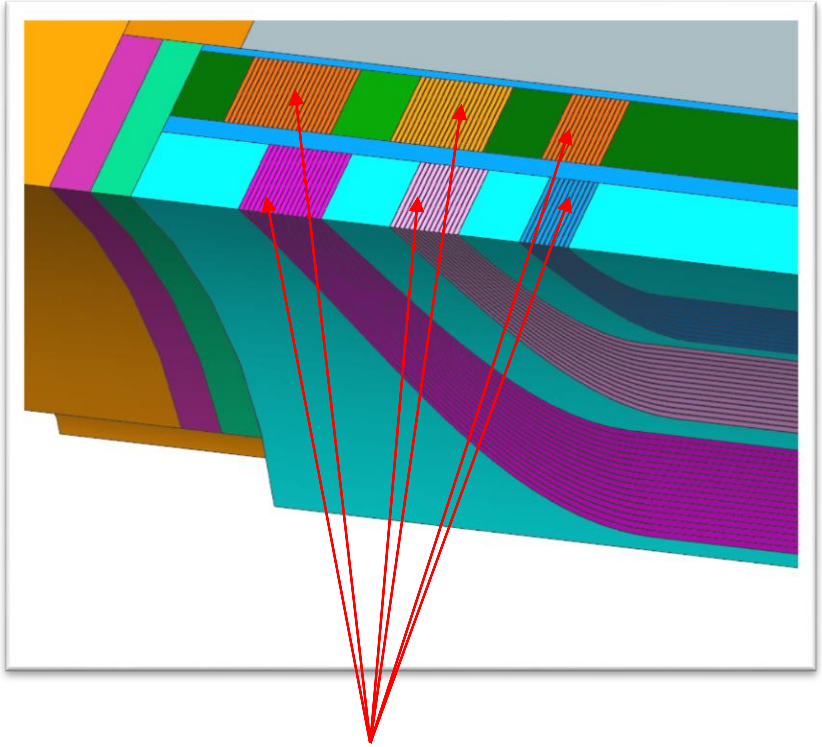
Other Work

Dan Young

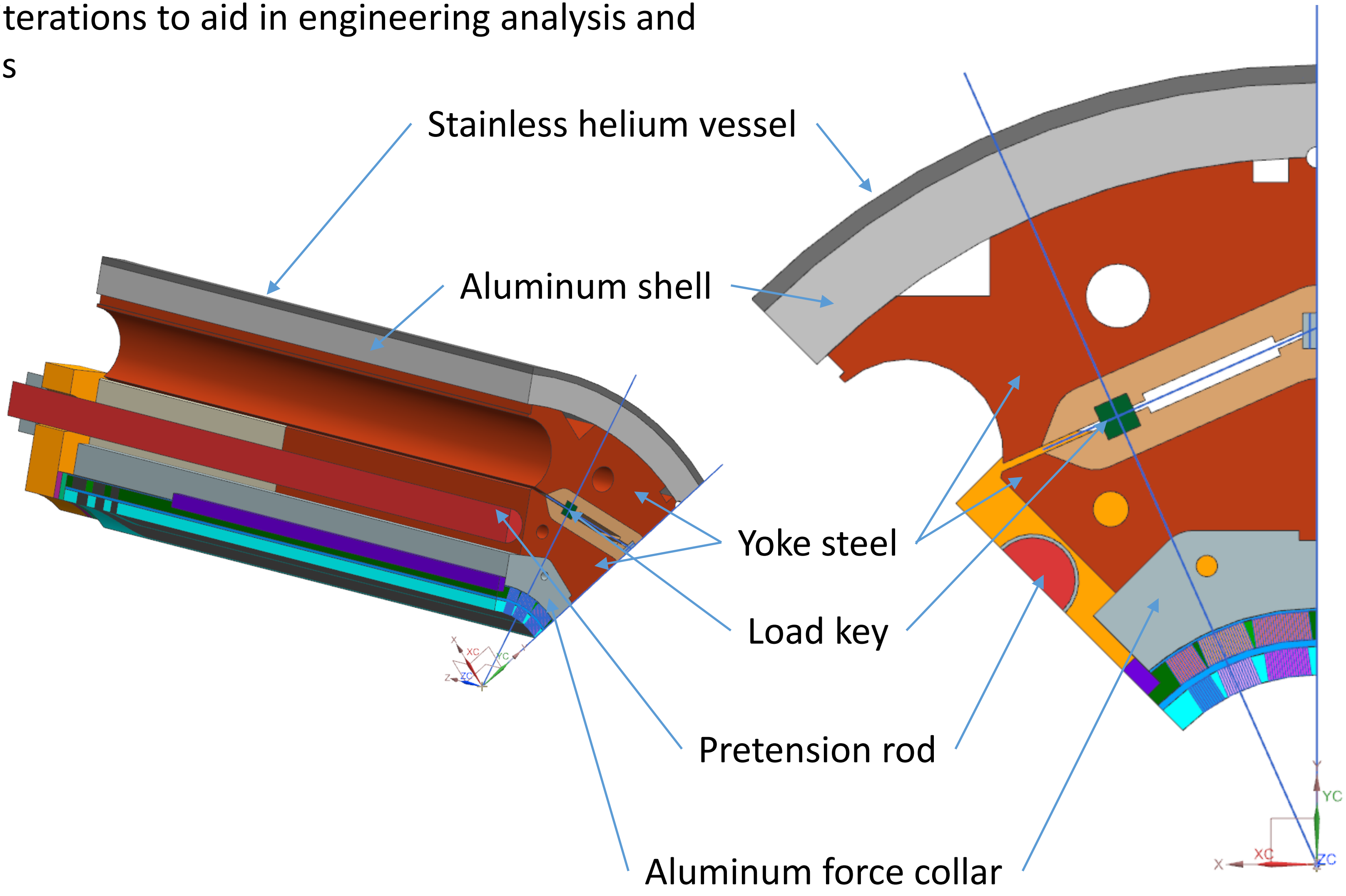
Coil Structure Modeling

(with Eric Sun)

Modeled and modified coil components to reflect a variety of iterations to aid in engineering analysis and simulations



Coil (SC cables + insulation)



Stainless helium vessel

Aluminum shell

Yoke steel

Load key

Pretension rod

Aluminum force collar

Publications / Conferences

1. Manuscripts Published and under review/accepted

☐ Mark Wiseman , Chuck Hutton , Fanglei Lin, Vasiliy Morozov, Renuka Rajput-Ghoshal, “Preliminary Design of the Interaction Region Beam Transport Systems for JLEIC” ”, *IEEE Trans on Appl. Superconductivity,* V29 (5), August 2019

☐ R. Rajput-Ghoshal, R Fair, P K Ghoshal, C Hutton, E Sun, M Wiseman,, “Conceptual Design of the Interaction Region Magnets for Future Electron-Ion Collider at Jefferson Lab”, *IEEE Trans on Appl. Superconductivity,* V29 (5), August 2019

☐ E Sun, P K Ghoshal, R Fair, S Lassiter, P Brindza, “Quench-back Management for Fast Decaying Currents in SHMS Superconducting Magnets at Jefferson Lab”, *IEEE Trans on Appl. Superconductivity* **(Accepted, June 2019)**

☐ P. K. Ghoshal, D. Chavez, R. Fair, S. Gopinath, D. Kashy, P. McIntyre, T. Michalski, R. Rajput-Ghoshal, A. Sattarov, “Preliminary Design Study of a Fast-Ramping magnet for Pre-concept Design of an Electron-Ion Collider at Jefferson Lab”, *IEEE Trans on Appl. Superconductivity* **(Accepted, June 2019)**

☐ V.S. Morozov, R. Ent, Y. Furletova, F. Lin, T.J. Michalski, R. Rajput-Ghoshal, M. Wiseman, R. Yoshida, Y. Zhang, G.L. Sabbi, Y. Cai, Y.M. Nosochkov, M.K. Sullivan, “Full Acceptance Interaction Region Design of JLEIC”, presented at 10th International Particle Accelerator Conference (IPAC’19)

2. Preparation in Progress for Submission to Magnet Technology (MT26) Conference (Vancouver, Canada) – Sept-Oct’2019 and NAPAC- Sept 2019

☐ R. Rajput-Ghoshal, R. Fair, P. K. Ghoshal, “Optimization of the Interaction Region Quadrupole Magnet for Future Electron-Ion Collider at Jefferson Lab, **Accepted ORAL Presentation**, *IEEE Trans on Appl. Superconductivity*

☐ E Sun, P Brindza, R Fair, P K Ghoshal, S Lassiter, “Test Results of Quench-back Management Due to Fast Decaying Current and AC Losses in SHMS Superconducting Magnet at Jefferson Lab”, **Accepted POSTER Presentation**, *IEEE Trans on Appl. Superconductivity*

☐ D. Kashy, R. Fair, P. K. Ghoshal, R. Rajput-Ghoshal, “An Investigation of the Electromagnetic Interactions between the CLAS12 Torus & Solenoid Superconducting Magnets at JLab”, **Accepted POSTER Presentation**, *IEEE Trans on Appl. Superconductivity*

☐ R. Rajput-Ghoshal, F. Lin, T.J. Michalski, V.S. Morozov, M. Wiseman, C. Hutton, “Interaction Region Magnets for Future Electron-Ion Collider at Jefferson Lab”, **Accepted ORAL Presentation**, North American Particle Accelerator Conference (NAPAC’19)

3. Preparation in Progress for Submission

☐ R. Fair, et al, “Superconducting Magnets for CLAS12”, In Progress (JLAB Internal review) for *NIM A* (Elsevier Publications)
- Revision 2 in progress after comments from Physics (Daniel and Volker) **by 6/27/2019**
- License approval/permission from IEEE (USA) complete and Institute of Physics (UK) in progress (with Rhonda and DeLisa, Legal)

Support for External DOE Reviews

- **FRIB – Facility for Rare Isotope Beams (MSU) – SC magnet design –** *R. Fair, P. Ghoshal*
- **NSTX-U – National Spherical Torus Experiment – Upgrade (PPPL) – Resistive coil design –** *R. Fair, R. Rajput-Ghoshal*
- **Mu2e – Muon to Electron Conversion Experiment (FNAL) – SC magnet design –** *R. Fair*
- **MPEX – Material Plasma Exposure Experiment (ORNL)** – **SC magnet design** - *R. Fair*
- **Hi-Lumi LHC – High Luminosity Large Hadron Collider (FNAL)** – **SC magnet design -** *R. Fair, P. Ghoshal*
- **LSST - Large Synoptic Survey Telescope – Cryogenics –** *D. Kashy*
- **US-ITER – US Contributions to the ITER Project – SC Magnet design –** *R. Fair*

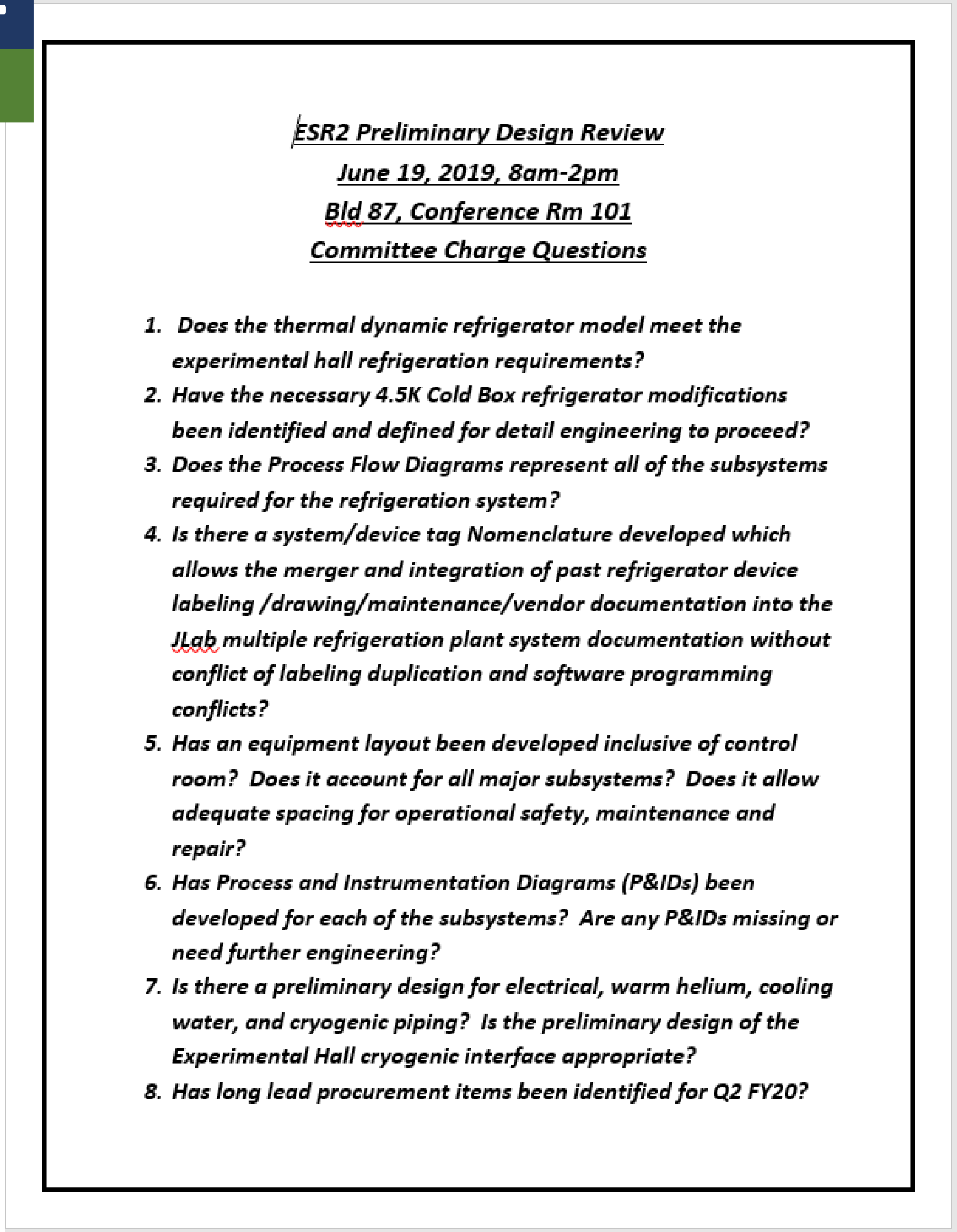
Team Medium – Long term Strategic View

1. **MOLLER–Related**
    a. Development of tool to translate information from NX CAD models to OPERA (*Sandesh, Randy, Probir*)
    b. Training on using MAXWELL and ANSYS for structural analysis (*Sandesh*)
2. **EIC-Related**
    a. Development of design tools to support magnet design iterations (*Ruben, Probir, Renuka*)
    b. Development of modelling techniques for coil structures (*Eric, Dan*)
    c. Training with LBNL on using ROXIE for accelerator magnet design optimization (*Renuka, Ruben*)
3. **General**
    a. Mentoring of engineers (*Dave*)
    b. Database of Magnet-Related Design Tools (*Probir*)
    c. Identification (development?) of local shops for ‘simple’ magnet fabrication projects (*Dave*)

Backup

CRYO – ESR2

Dave Kashy



ESR2 Preliminary Design Review
June 19, 2019, 8am-2pm
Bld 87, Conference Rm 101
Committee Charge Questions

1. *Does the thermal dynamic refrigerator model meet the experimental hall refrigeration requirements?*
2. *Have the necessary 4.5K Cold Box refrigerator modifications been identified and defined for detail engineering to proceed?*
3. *Does the Process Flow Diagrams represent all of the subsystems required for the refrigeration system?*
4. *Is there a system/device tag Nomenclature developed which allows the merger and integration of past refrigerator device labeling /drawing/maintenance/vendor documentation into the JLab multiple refrigeration plant system documentation without conflict of labeling duplication and software programming conflicts?*
5. *Has an equipment layout been developed inclusive of control room? Does it account for all major subsystems? Does it allow adequate spacing for operational safety, maintenance and repair?*
6. *Has Process and Instrumentation Diagrams (P&IDs) been developed for each of the subsystems? Are any P&IDs missing or need further engineering?*
7. *Is there a preliminary design for electrical, warm helium, cooling water, and cryogenic piping? Is the preliminary design of the Experimental Hall cryogenic interface appropriate?*
8. *Has long lead procurement items been identified for Q2 FY20?*

9. *Has the present engineering schedule and status been presented?*
10. *Has a preliminary Failure Mode Analysis been developed?*
11. *Are there any additional preliminary engineering which should be addressed by the design team?*
12. *Does adequate preliminary design exist for the start of detailed engineering?*

Committee Members:

Jonathan Creel, creel@jlab.org, Chair

Nate Laverdure, nal@jlab.org

David Kashy, kashy@jlab.org

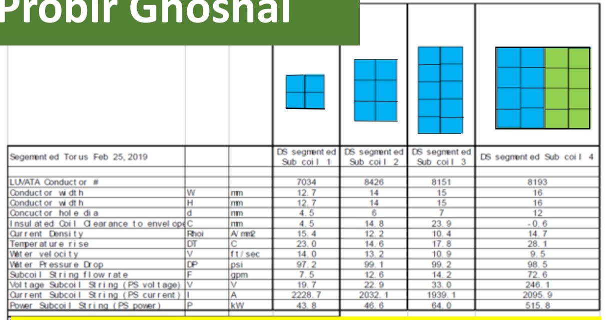
The committee is charged to evaluate the preliminary engineering status for the End Station Refrigeration System 2 in preparation of detailed engineering to be completed by the fall of 2020. Emphasis should be placed on

1. *issues of correctness of type and amount of refrigeration to be provided,*
2. *if all subsystems necessary for the operation/ maintenance/ repair of the refrigeration system has been accounted for*
3. *Preliminary documentation used as a baseline for final engineering design*

MOLLER

Probir Ghoshal

Magnets – Design data translation and control



Segemented Torus Feb 25, 2019			DS segmented Sub coil 1	DS segmented Sub coil 2	DS segmented Sub coil 3	DS segmented Sub coil 4
LUVATA Conductor #			7034	8426	8151	8193
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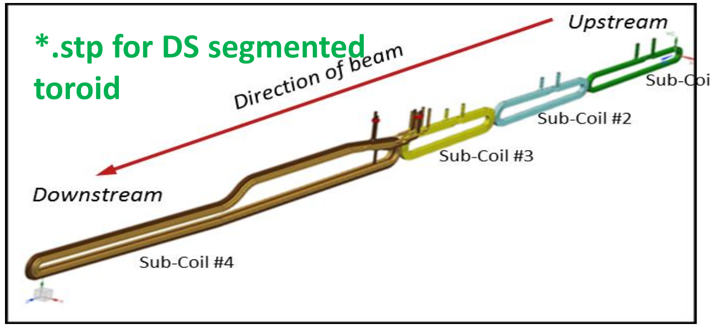
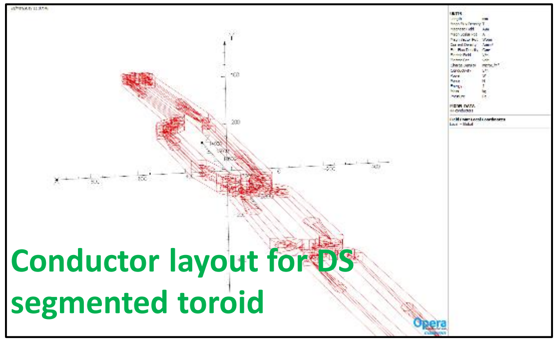
Conductor width	H	mm	12.7	14	15	16
Concuctor hole dia	d	mm	4.5	6	7	12
Insulated Coil Clearance to envelope	C	mm	4.5	14.8	23.9	-0.6
Current Density	Rhoi	A/mm2	15.4	12.2	10.4	14.7
Temperature rise	DT	C	23.0	14.6	17.8	28.1
Water velocity	V	ft/sec	14.0	13.2	10.9	9.5
Water Pressure Drop	DP	psi	97.2	99.1	99.2	98.5
Subcoil String flow rate	F	gpm	7.5	12.6	14.2	72.6
Voltage Subcoil String (PS voltage)	V	V	19.7	22.9	33.0	246.1
Current Subcoil String (PS current)	I	A	2228.7	2032.1	1939.1	2095.9
Power Subcoil String (PS power)	P	kW	43.8	46.6	64.0	515.8

JLab layout - Segmented DS torus



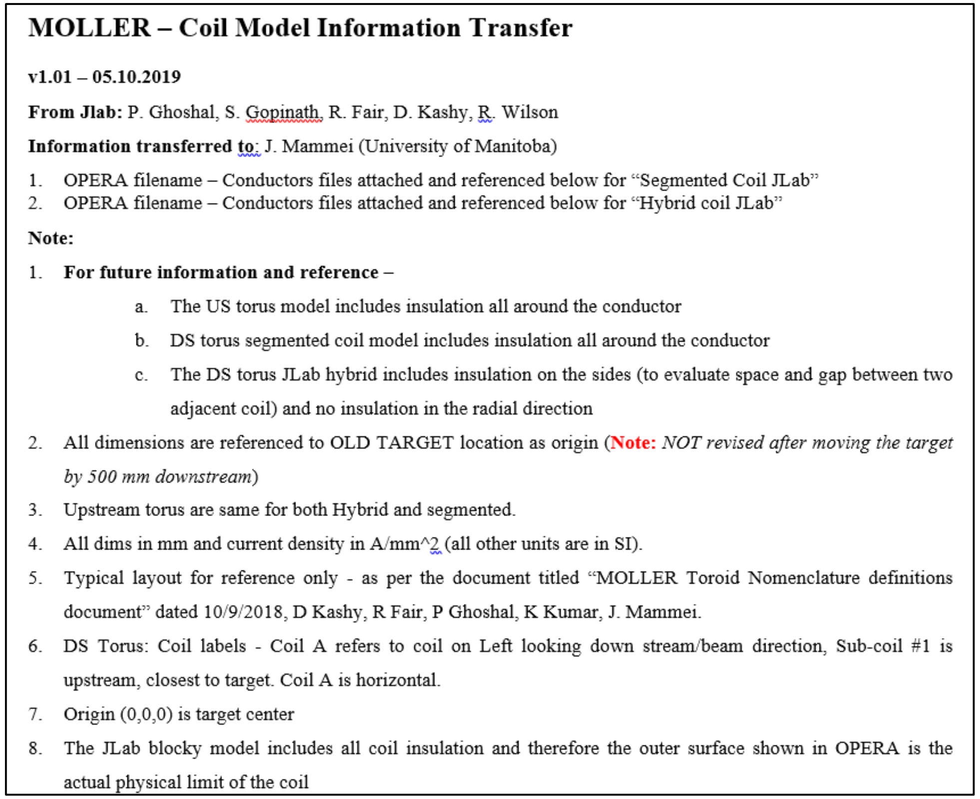
*.stp for DS segmented toroid



Conductor layout for DS segmented toroid

Transferred back to CAD designer to check that the coils are clear of all particle envelopes of interest

JLab *.cond and *.stp files are provided to the collaboration for particle tracking and GEANT analysis



MOLLER – Coil Model Information Transfer

v1.01 – 05.10.2019

From Jlab: P. Ghoshal, S. Gopinath, R. Fair, D. Kashy, R. Wilson

Information transferred to: J. Mammei (University of Manitoba)

1. OPERA filename – Conductors files attached and referenced below for "Segmented Coil JLab"
2. OPERA filename – Conductors files attached and referenced below for "Hybrid coil JLab"

Note:

1. **For future information and reference –**
    a. The US torus model includes insulation all around the conductor
    b. DS torus segmented coil model includes insulation all around the conductor
    c. The DS torus JLab hybrid includes insulation on the sides (to evaluate space and gap between two adjacent coil) and no insulation in the radial direction
2. All dimensions are referenced to OLD TARGET location as origin (**Note:** *NOT revised after moving the target by 500 mm downstream*)
3. Upstream torus are same for both Hybrid and segmented.
4. All dims in mm and current density in A/mm^2 (all other units are in SI).
5. Typical layout for reference only - as per the document titled "MOLLER Toroid Nomenclature definitions document" dated 10/9/2018, D Kashy, R Fair, P Ghoshal, K Kumar, J. Mammei.
6. DS Torus: Coil labels - Coil A refers to coil on Left looking down stream/beam direction, Sub-coil #1 is upstream, closest to target. Coil A is horizontal.
7. Origin (0,0,0) is target center
8. The JLab blocky model includes all coil insulation and therefore the outer surface shown in OPERA is the actual physical limit of the coil

EIC

Renuka Rajput-Ghoshal

Magnet Design

- Updated the preliminary design of all quadrupoles, skew quadrupoles, solenoids, corrector magnets for Ion and Electron beam lines in the interaction region for the updated lattice file for higher COM energy.
- Working on updating the Interaction Region magnet design part of the p-CDR, magnet design section has been updated, magnet interaction and shielding work is in progress.
- Currently main focus is on iBDS1 and iBDS2, the first two dipole magnets. The iBDS1 has 3 sets of coils and the electron beam line goes through the bore of this magnet, and requires a shielding solution for this magnet. The iBDS2 is a very large bore (800 mm) 4.42 T magnet, examining the design feasibility and option for this magnet - the coil layout for this magnet and some of the deign options are shown in the next slide.
- Investigating design options for 7.6 T cooling solenoid (there are 2 different types of cooling solenoid, one 1.25 m long and 5 T field and other one 2.5 m long and 7.6 T field) and other ICR magnets (current assumption is that 2 x 4m superconducting dipoles, a superconducting sextupole and superconducting quadrupole can be fitted into a single 11.4m long cryostat, present coil design and estimate for other components show that it would require just under 12.2 m of length to accommodate all these requisite elements. Revisiting all the coil length of these magnets again).
- Involved in the Hall C NPS Experiment Readiness Review
- Involved in the review of Injector solenoid spare coils/magnets

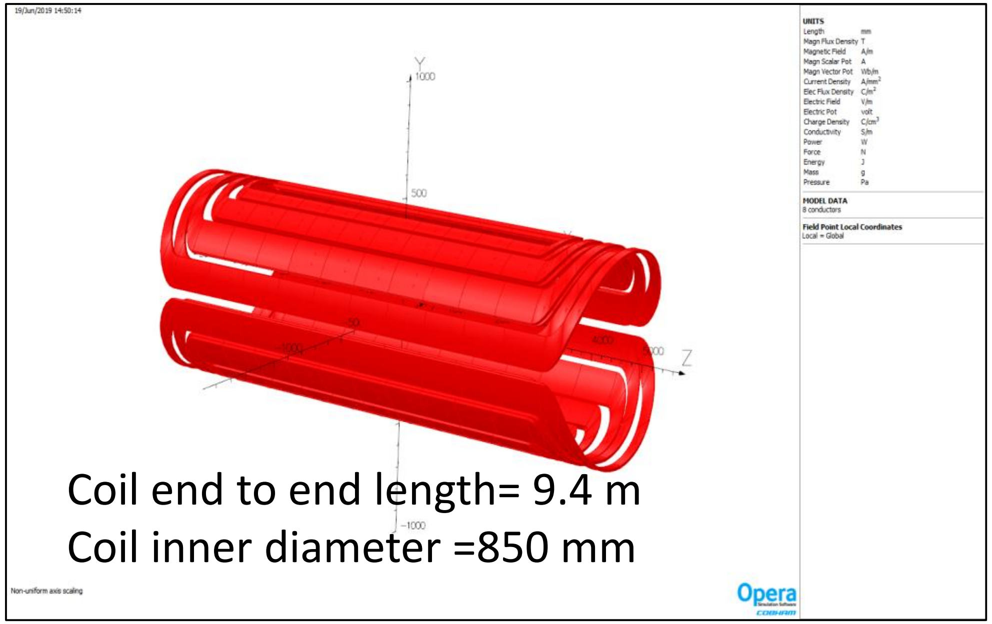
Magnet Design

Detector region ion elements													
200 GeV/c protons													
Element name	Type	Magnetic Length [m]	Good field radius [cm]	Beam Pipe radius [cm]	Outer Radius [cm]	Dipole field [T]		Solenoid [T]	Good field region	Field Homogeneity/ Multipole components	Warm bore/cold bore	Operating temperatute (K)	Thermal shield required (?)
						Bx	By						
iBDS1a	RBEND	0.75	4	38.5	48.5	0.22	1.32	0	TBD	TBD	Warm	4.5	TBD
iBDS1b	RBEND	0.75	4	38.5	48.5	-0.19	1.32	0	TBD	TBD	Warm	4.5	TBD
iBDS2	RBEND	8.00	4	40.0	90.0	0.00	-4.42	0	TBD	TBD	Warm	4.5	TBD
	Spin Rotator solenoid	2.5	TBD	5				7.64	TBD	TBD	Warm	4.5	TBD
	Spin Rotator solenoid	1.25	TBD	5				4.92	TBD	TBD	Warm	4.5	TBD

Coil Layout-iBDS2

Possible options

- **Option 1: Current Specification**
  - Possible with NbTi only if operating at lower temperature,
- **Option 2: Same bore size, same length and reduce the field**
  - Field reduced to 3.8 T,
  - Reduced field results in reduced integrated field
- **Option 3: Same bore size, reduce the field and increase the length for same integrated field**
  - Field is 3.8 T, magnetic length increased for same integrated field,
  - Solution is possible, but magnet coil end-to-end is 10.45 m
- **Option 4: Reduce the bore and keep the field and length same**
  - Field 4.42 T, magnetic length 8 m, possible solution reduced the coil bore by about 16% (from 400 mm bore radius to 330-340 mm bore radius)



UNITS	
Length	mm
Magn Flux Density	T
Magnetic Field	A/m
Magn Scalar Pot	A
Magn Vector Pot	Wb/m
Current Density	A/mm^2
Elec Flux Density	C/m^2
Electric Field	V/m
Electric Pot	volt
Charge Density	C/cm^3
Conductivity	S/m
Power	W
Force	N
Energy	J
Mass	g
Pressure	Pa

MODEL DATA
8 conductors

Field Point Local Coordinates
Local = Global

Coil end to end length= 9.4 m
Coil inner diameter =850 mm

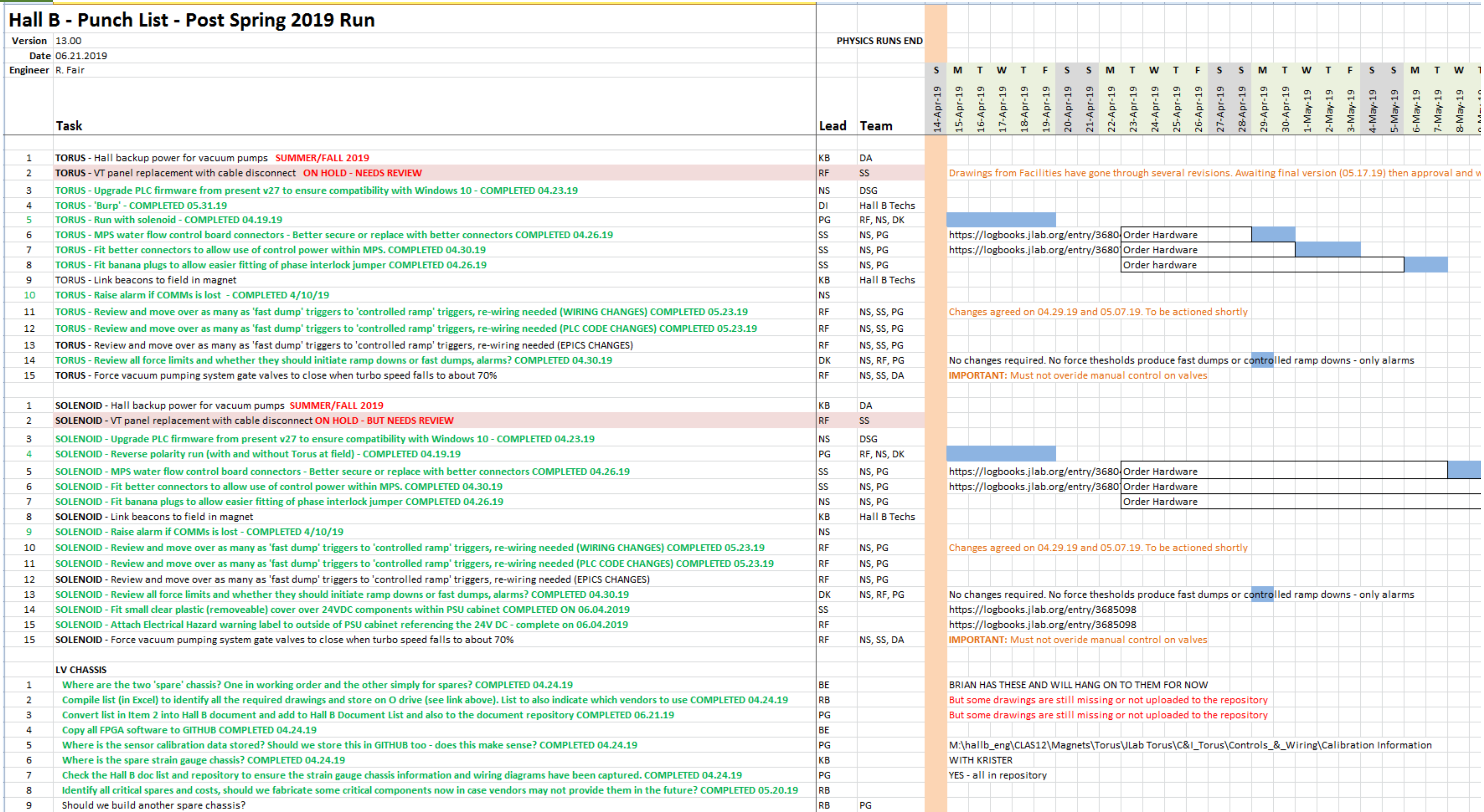
Summery of Possible Options

1. Reduced operating temperature
2. Reduced Integrated Field
3. Increased physical length of the magnet
4. Reduced bore

HALL B

Ruben Fair

SC Magnets Punch list



Hall B - Punch List - Post Spring 2019 Run

Version 13.00
Date 06.21.2019
Engineer R. Fair

PHYSICS RUNS END

S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W	T	F	S	S	M	T	W
14-Apr-19	15-Apr-19	16-Apr-19	17-Apr-19	18-Apr-19	19-Apr-19	20-Apr-19	21-Apr-19	22-Apr-19	23-Apr-19	24-Apr-19	25-Apr-19	26-Apr-19	27-Apr-19	28-Apr-19	29-Apr-19	30-Apr-19	1-May-19	2-May-19	3-May-19	4-May-19	5-May-19	6-May-19	7-May-19	8-May-19

	Task	Lead	Team	
1	**TORUS** - Hall backup power for vacuum pumps **SUMMER/FALL 2019**	KB	DA	
2	**TORUS** - VT panel replacement with cable disconnect **ON HOLD - NEEDS REVIEW**	RF	SS	Drawings from Facilities have gone through several revisions. Awaiting final version (05.17.19) then approval and w
3	TORUS - Upgrade PLC firmware from present v27 to ensure compatibility with Windows 10 - COMPLETED 04.23.19	NS	DSG	
4	TORUS - 'Burp' - COMPLETED 05.31.19	DI	Hall B Techs	
5	TORUS - Run with solenoid - COMPLETED 04.19.19	PG	RF, NS, DK	
6	TORUS - MPS water flow control board connectors - Better secure or replace with better connectors COMPLETED 04.26.19	SS	NS, PG	https://logbooks.jlab.org/entry/3680 Order Hardware
7	TORUS - Fit better connectors to allow use of control power within MPS. COMPLETED 04.30.19	SS	NS, PG	https://logbooks.jlab.org/entry/3680 Order Hardware
8	TORUS - Fit banana plugs to allow easier fitting of phase interlock jumper COMPLETED 04.26.19	SS	NS, PG	Order hardware
9	**TORUS** - Link beacons to field in magnet	KB	Hall B Techs	
10	TORUS - Raise alarm if COMMs is lost - COMPLETED 4/10/19	NS		
11	TORUS - Review and move over as many as 'fast dump' triggers to 'controlled ramp' triggers, re-wiring needed (WIRING CHANGES) COMPLETED 05.23.19	RF	NS, SS, PG	Changes agreed on 04.29.19 and 05.07.19. To be actioned shortly
12	TORUS - Review and move over as many as 'fast dump' triggers to 'controlled ramp' triggers, re-wiring needed (PLC CODE CHANGES) COMPLETED 05.23.19	RF	NS, SS, PG	
13	**TORUS** - Review and move over as many as 'fast dump' triggers to 'controlled ramp' triggers, re-wiring needed (EPICS CHANGES)	RF	NS, SS, PG	
14	TORUS - Review all force limits and whether they should initiate ramp downs or fast dumps, alarms? COMPLETED 04.30.19	DK	NS, RF, PG	No changes required. No force thesholds produce fast dumps or controlled ramp downs - only alarms
15	**TORUS** - Force vacuum pumping system gate valves to close when turbo speed falls to about 70%	RF	NS, SS, DA	**IMPORTANT:** Must not overide manual control on valves
1	**SOLENOID** - Hall backup power for vacuum pumps **SUMMER/FALL 2019**	KB	DA	
2	**SOLENOID** - VT panel replacement with cable disconnect **ON HOLD - BUT NEEDS REVIEW**	RF	SS	
3	SOLENOID - Upgrade PLC firmware from present v27 to ensure compatibility with Windows 10 - COMPLETED 04.23.19	NS	DSG	
4	SOLENOID - Reverse polarity run (with and without Torus at field) - COMPLETED 04.19.19	PG	RF, NS, DK	
5	SOLENOID - MPS water flow control board connectors - Better secure or replace with better connectors COMPLETED 04.26.19	SS	NS, PG	https://logbooks.jlab.org/entry/3680 Order Hardware
6	SOLENOID - Fit better connectors to allow use of control power within MPS. COMPLETED 04.30.19	SS	NS, PG	https://logbooks.jlab.org/entry/3680 Order Hardware
7	SOLENOID - Fit banana plugs to allow easier fitting of phase interlock jumper COMPLETED 04.26.19	NS	NS, PG	Order Hardware
8	**SOLENOID** - Link beacons to field in magnet	KB	Hall B Techs	
9	SOLENOID - Raise alarm if COMMs is lost - COMPLETED 4/10/19	NS		
10	SOLENOID - Review and move over as many as 'fast dump' triggers to 'controlled ramp' triggers, re-wiring needed (WIRING CHANGES) COMPLETED 05.23.19	RF	NS, PG	Changes agreed on 04.29.19 and 05.07.19. To be actioned shortly
11	SOLENOID - Review and move over as many as 'fast dump' triggers to 'controlled ramp' triggers, re-wiring needed (PLC CODE CHANGES) COMPLETED 05.23.19	RF	NS, PG	
12	**SOLENOID** - Review and move over as many as 'fast dump' triggers to 'controlled ramp' triggers, re-wiring needed (EPICS CHANGES)	RF	NS, PG	
13	SOLENOID - Review all force limits and whether they should initiate ramp downs or fast dumps, alarms? COMPLETED 04.30.19	DK	NS, RF, PG	No changes required. No force thesholds produce fast dumps or controlled ramp downs - only alarms
14	SOLENOID - Fit small clear plastic (removeable) cover over 24VDC components within PSU cabinet COMPLETED ON 06.04.2019	SS		https://logbooks.jlab.org/entry/3685098
15	SOLENOID - Attach Electrical Hazard warning label to outside of PSU cabinet referencing the 24V DC - complete on 06.04.2019	RF		https://logbooks.jlab.org/entry/3685098
15	**SOLENOID** - Force vacuum pumping system gate valves to close when turbo speed falls to about 70%	RF	NS, SS, DA	**IMPORTANT:** Must not overide manual control on valves
	LV CHASSIS			
1	Where are the two 'spare' chassis? One in working order and the other simply for spares? COMPLETED 04.24.19	BE		BRIAN HAS THESE AND WILL HANG ON TO THEM FOR NOW
2	Compile list (in Excel) to identify all the required drawings and store on O drive (see link above). List to also indicate which vendors to use COMPLETED 04.24.19	RB		But some drawings are still missing or not uploaded to the repository
3	Convert list in Item 2 into Hall B document and add to Hall B Document List and also to the document repository COMPLETED 06.21.19	PG		But some drawings are still missing or not uploaded to the repository
4	Copy all FPGA software to GITHUB COMPLETED 04.24.19	BE		
5	Where is the sensor calibration data stored? Should we store this in GITHUB too - does this make sense? COMPLETED 04.24.19	PG		M:\hallb_eng\CLAS12\Magnets\Torus\JLab Torus\C&I_Torus\Controls_&_Wiring\Calibration Information
6	Where is the spare strain gauge chassis? COMPLETED 04.24.19	KB		WITH KRISTER
7	Check the Hall B doc list and repository to ensure the strain gauge chassis information and wiring diagrams have been captured. COMPLETED 04.24.19	PG		YES - all in repository
8	Identify all critical spares and costs, should we fabricate some critical components now in case vendors may not provide them in the future? COMPLETED 05.20.19	RB		
9	Should we build another spare chassis?	RB	PG	