



MICE CM29

Magnets Summary

Mike Courthold

18Feb11



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AFC Update & Plans





Recent Progress

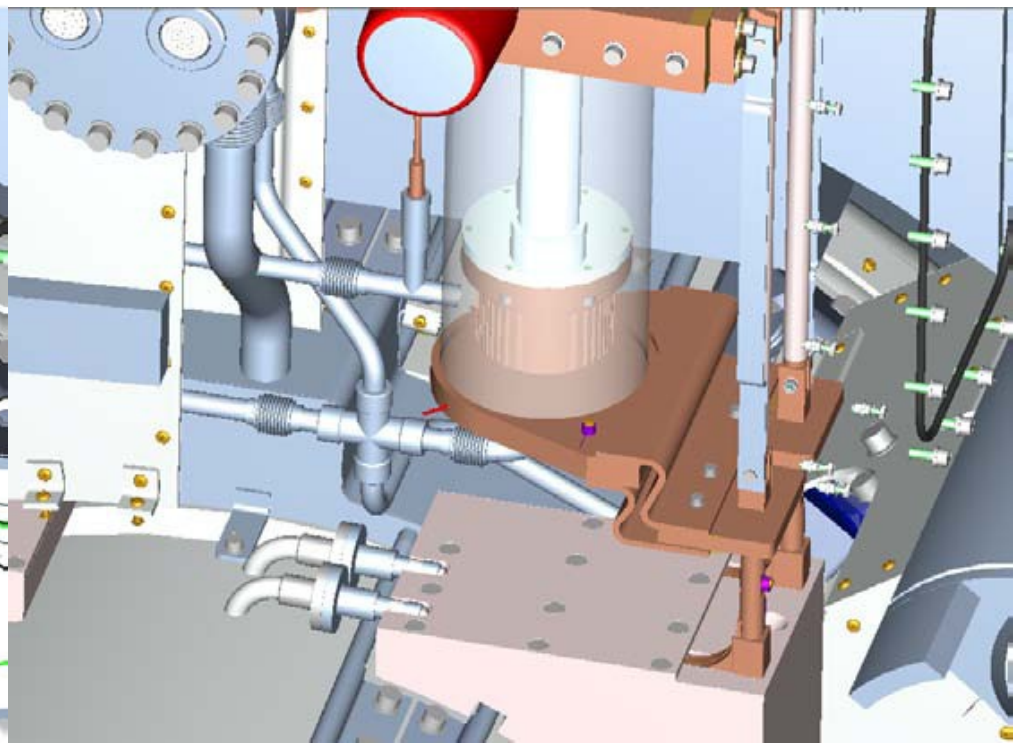
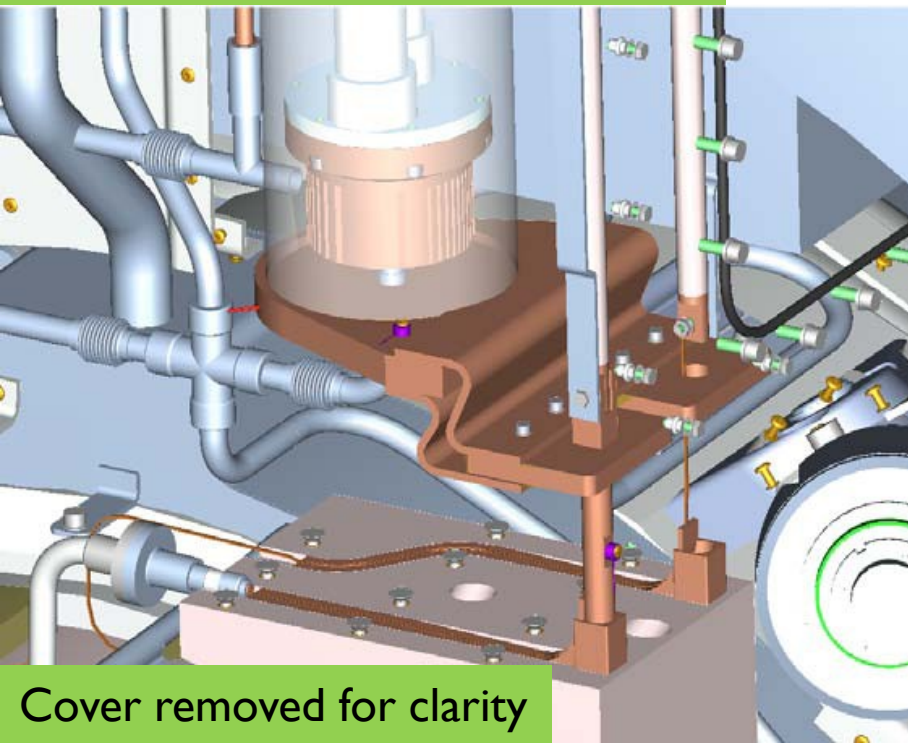
- Recent Issues –slow getting the winding started
- Reported last meeting that there was some concern over the loss of bobbin temper after application of insulation. This was completed but there was a delay with remake of G10 insulation.
- Some high voltage tests have been done on current insulation system
- Tests completed on splice – results obtained in the nano-ohm region. These are being repeated but first indications are excellent.
- Improved thermal contact at top of HTS leads to improve the temperature margin.
- Personnel changes at Tesla have led to a review of items prior to winding to check that issues have not been forgotten.



Recent Progress

Conductor tails - These now exit the coil in a copper half tube which provides good thermal sinking and mechanical support. Analysis suggests that this is a good solution and is required.

These are slightly old drawings – the copper channels extend directly into the coil



Cover removed for clarity



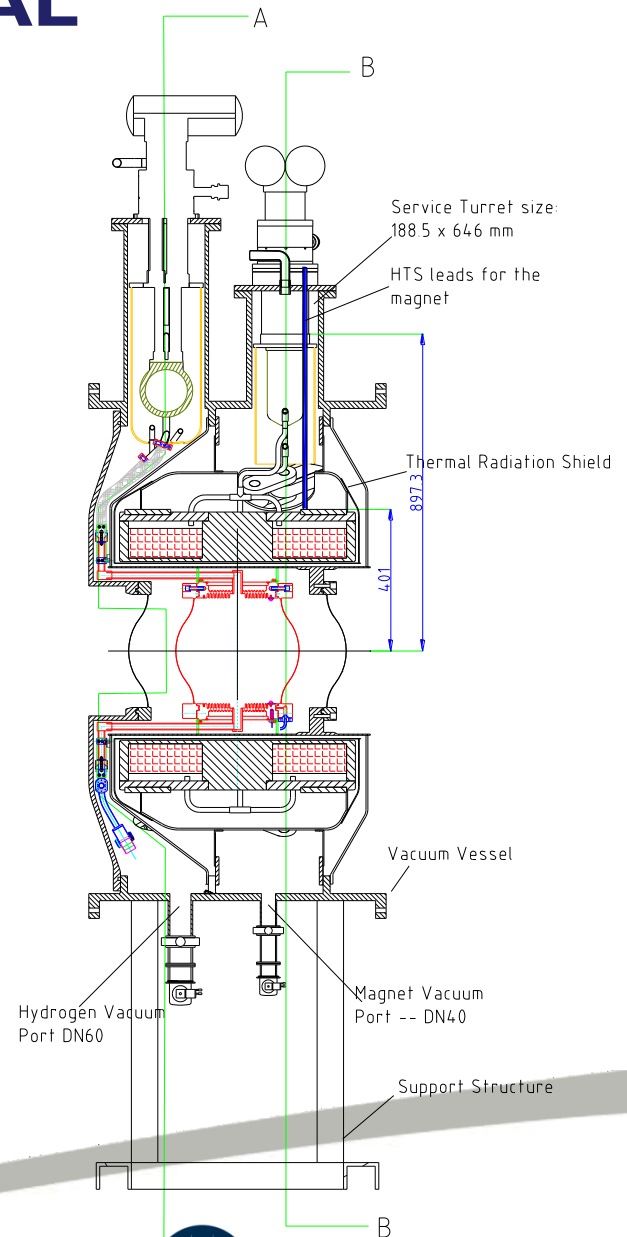
Recent Progress

- Assembly sequence still being refined
- Still need Mississippi to scrap a safety window to act as test piece.
- Quench protection heater sizing is ongoing.
- Test cryostat, for checking that the crycoolers meet specification before installation, now at Tesla, waiting for a window of opportunity to start tests.
- The recent leaving of Tom Frame (lead engineer), and a frank discussion with TESLA senior management re lack of progress, has precipitated a change of personnel and a reorganisation at TESLA.



Test Plan at RAL

- Outline test plan for the AFC when at RAL was presented
 - Assumes delivery in early July
- Special conditions of testing without the lattice means that a support structure will be required for operation of the magnet in the MICE Hall
 - The same/similar support will be required for transport.
- Assume that the tests will first be done with hydrogen and the absorber.
- It may be that the absorber will have to be taken out at the end of the tests to fit a solid one.





Status of MICE Coupling Coil Magnets

D. Li and M. Zisman
Center for Beam Physics
Lawrence Berkeley National Laboratory



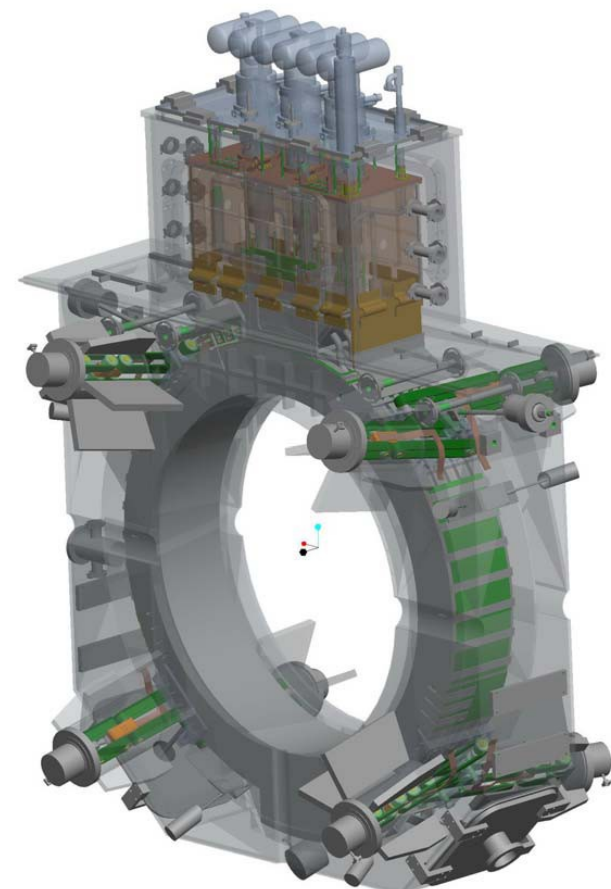
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Current Status of the CC Magnets

1st coil winding complete in Dec. 2010



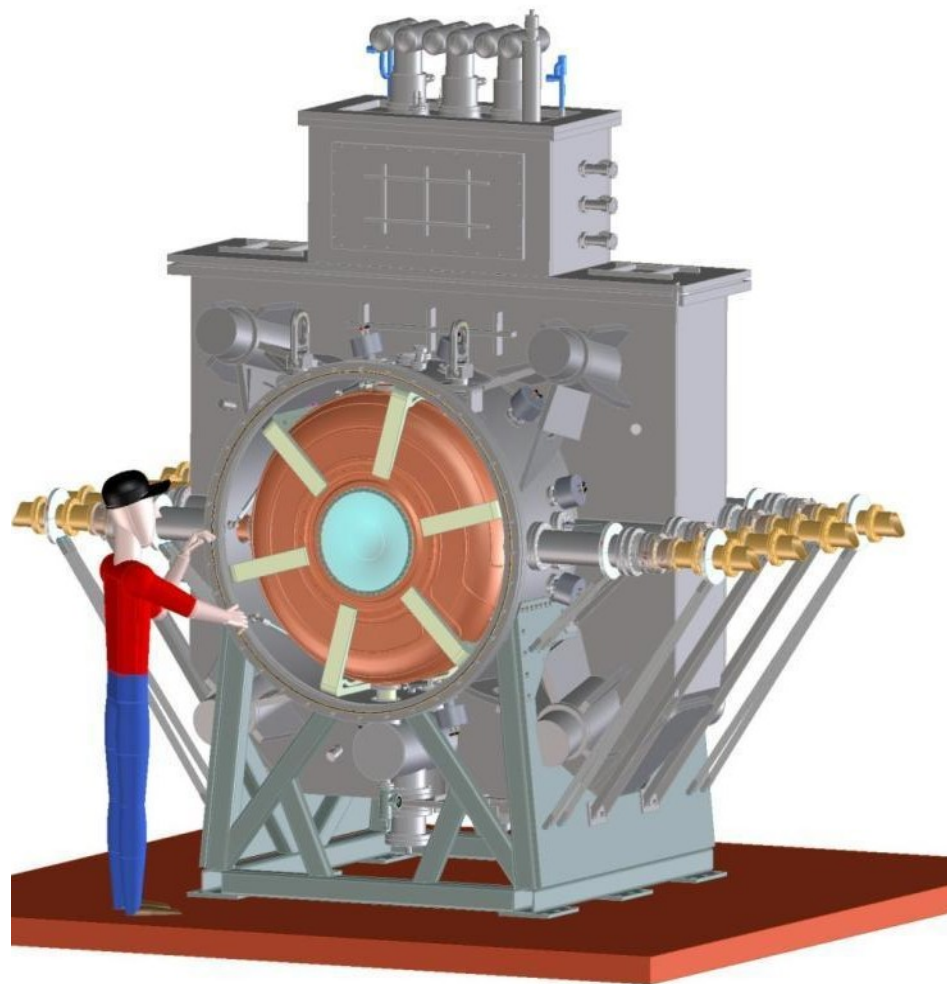
Coil winding at Qi Huan: last layer of SC wire (left) and finished Al banding (right)



Latest cryostat design with 3 cryocoolers

Summary of the Cryostat Design

- Updated design significantly improves performance
 - Three cryocoolers
 - More robust structure
 - More spacing for MLI shielding and assembly
 - Improved cooling circuit
 - Easier assembly
 - Easier access for repair and adjustment (if needed)
 - Direct method to reference cold mass position to outside survey fiducial





Summary of the HIT Tests

- Cryogenic system modified and rebuilt successfully
 - new transfer lines and good vacuum
- Upgraded system able to cool dummy load to 4.2 K
 - produced LHe accumulation (25% of the volume)
- Both current leads tested from 0 to 500 A
 - very stable during 1 hour test period
- All cryogenic components tested successfully
 - transfer lines, bayonets, cryogenic valve, insulators, feed-through and current leads
 - all can be used for testing the large test coil and CC magnets

Status of MICE CC
magnets, D. Li and
M. Zisman, LBNL, Feb.
15-18, 2011



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Summary

- MICE CC magnet fabrication plan under way
 - Slow to start, but has been progressing during past year
 - Organization and responsibilities redefined
 - LBNL has overall responsibility for MICE CC magnets
- Coil winding status indicated
 - 1st MuCool coil winding complete at Qi Huan Corp. in Beijing, China
 - Mandrels & cover plates for coils 2 & 3 fabricated
- MICE CC Cryostat design reviews completed at SINAP (Shanghai INstitute of Applied Physics)
 - Two design reviews held in Sept. and Dec. 2010, respectively
 - Three cryocoolers, improved cryostat and cooling circuit design
 - 3D and 2D drawings to be completed at end of March 2011
- Status of HIT (Harbin Institute of Technology) activities presented
 - Update of ICST test system complete and initial tests done
 - Preparations for welding of cold-mass cover plate in progress
- Updated plans to provide CCs being developed as part of MAP

Status of MICE CC magnets, D. Li and M. Zisman,
LBNL, Feb. 15-18, 2011



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Spectrometer Solenoid Plans

Steve Virostek

Lawrence Berkeley National Lab



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- MICE technical review held on 10/27/10
- Final report w/recommendations issued 12/14/10
- LBNL has reviewed the recommendations and prepared preliminary responses
- The committee recommended implementation of an active quench and lead protection system
- LBNL is conducting analyses to determine if an active system is necessary
- Other recommendations are related to the heat load calculations





- A preliminary design modification plan has been developed by LBNL. The plan includes the following:
 - reduction of heat leaks to the cold mass
 - the addition of more cryo cooling power
 - assessment of the suitability of the passive quench protection system
 - modification of the LTS leads to prevent burn-out
- The plan has been detailed in a separate document
- The plan will be finalized once the quench analysis and design modification (if necessary) are complete





- A series of tasks to start immediately were proposed and have been approved by MICE management:
- Modify Shield 1 to match previous mods to Shield 2
- Generate design layout of the 5 + 1 cooler arrangement and provide a spec to Wang NMR
- Develop a procedure for improved MLI bore wrapping
- Install a new 4" vacuum port on the cryostats
- After the 5+1 design layout is complete: modify the vacuum vessels and tower plates for the 5 + 1 design, add cryocooler holes in cold mass #2





- The electromagnetic and heat load analyses are under way and expected to be completed in the coming days
- The quench and lead protection issue presents a major uncertainty in the completion of the plan
- Upon finalizing the modification plan, the Spectrometer Solenoid team will present the plan to MAP and subsequently the MICE tech board
- LBNL has been meeting with the vendor to begin preliminary work (approved by MICE) and to ensure the project restarts promptly when the plan is complete





Spectrometer solenoid quench protection

MICE Collaboration Meeting #29
Rutherford Appleton Laboratory

Soren Prestemon
Lawrence Berkeley National Lab



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Review

- The review committee recommends:
 - to continue the analysis of the quench protection system, including Coupled transient magnetic and thermal calculations, eddy currents in the Aluminium mandrel, external circuits with shunt resistors.
 - Investigation of different quench scenarios and definition of the hotspot temperatures of coils, leads and shunts.
 - Definition of peak voltages: to ground, and layer to layer.
 - Definition of the optimal shunt resistor values for all coils to reduce risk.
 - Definition of the allowable peak operating current to eliminate the risk of coil damage.
 - Measurement of the leakage current to ground for each coil, to check the status of electrical insulation.
 - Limitation of the test current to 200 A until all points above are verified and understood.
 - Design of the magnet test procedure ensuring a minimal risk of cold mass damage.





Planned simulations

Code validation:

- Comparison with Wilson code for single coil case

Evaluate current fluctuations, decay, voltages, hot-spot temperature throughout circuit in:

- Test configuration
- Operating configuration

Evaluate role of quench-back from mandrel:

- Temperature rise and distribution in mandrel during a coil quench





Goals of simulations

Main questions to be answered by 3D simulations:

- What are the maximum turn-to-turn and coil-to-ground voltages seen during a quench?
- Are there scenarios where a subset of coils quench, but others remain superconducting, resulting in slow decay through bypass diodes and resistors?
- What dl/dt will be “certain” to generate quench-back?
- What modifications to the existing system should be incorporated to minimize/eliminate risk to the system in case of quench





General approach towards repair

Address reviewer concerns

- essentially same as the project team's

Use simulations to guide final decision on protection system repairs

- Allow repair strategy to crystallize based on results

Develop clear strategy for protection modifications

Develop test and operational controls to support magnet protection





Magnetic Measurement Plans

Pierrick Hanlet



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Purpose

- **Characterization of magnets**
 - **Two Sets of Measurements**
 - **At vendors:**
 - **Determine magnets operate according to specifications**
 - **In situ in MICE hall**
 - **real configurations & real environment**
 - **check field alignment**
 - **check field uniformity**
 - **check field consistent with Maxwell**
 - **fringe fields**





Purpose

Additional reasons:

- **Determine if simulation matches data**
- **Fringe fields**
 - • Force models
 - • Nearby equipment (pumps, electronics, ...)
 - • Global tracking
- **Relative and global alignment**
- **Scale with fixed hall probes**





Tasks – before mapping

- What do we need to know?
 - How do we quantify field error contributions to emittance?
 - Uniformity, positions, magnitudes
- What can we do analytically?
- What simulations do we need?
- How to convert map to G4MICE map?
 - Introduce conversion errors?
 - What grid step size?





Magnet Measurement Device for MICE

F. Garnier, P-A. Giudici, F.Bergsma
CERN

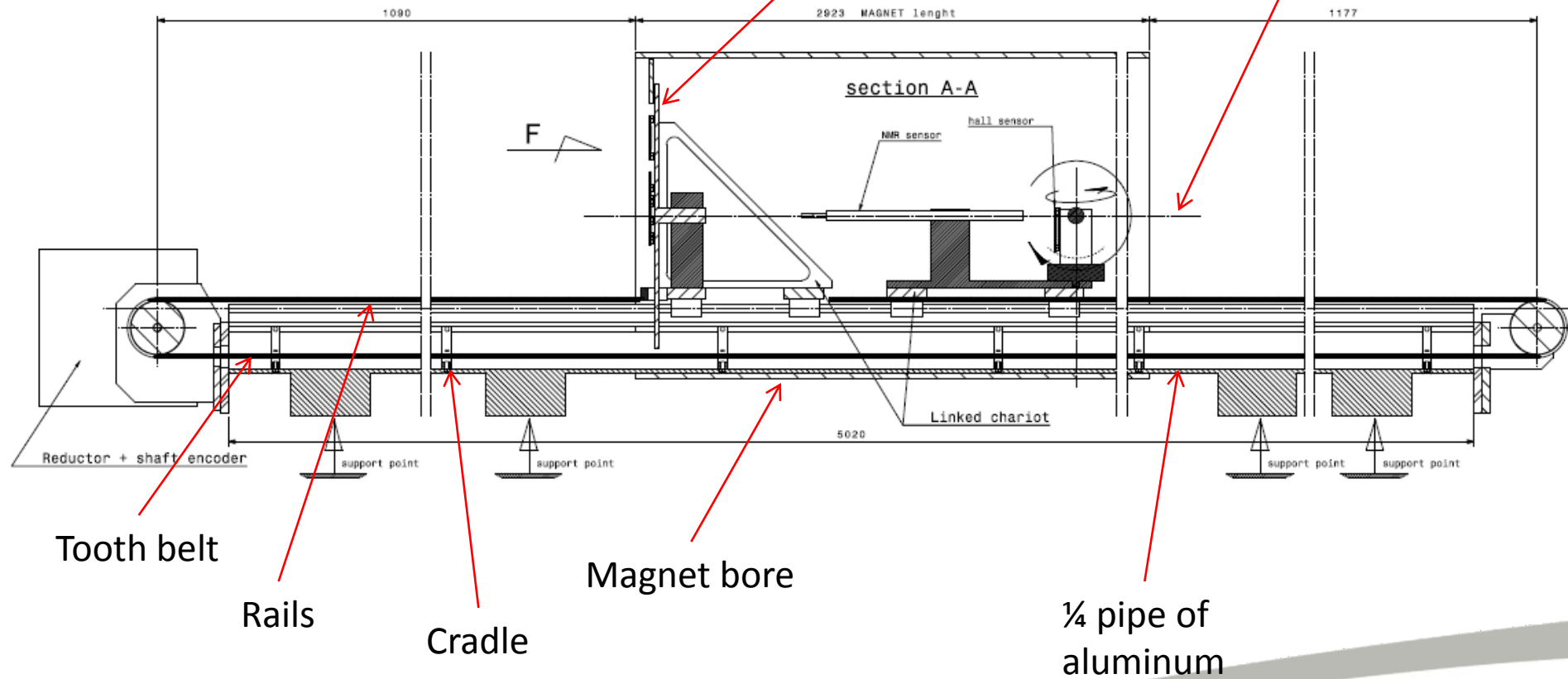


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Disk with 7 B-sensors calibrated at 4.5 Tesla

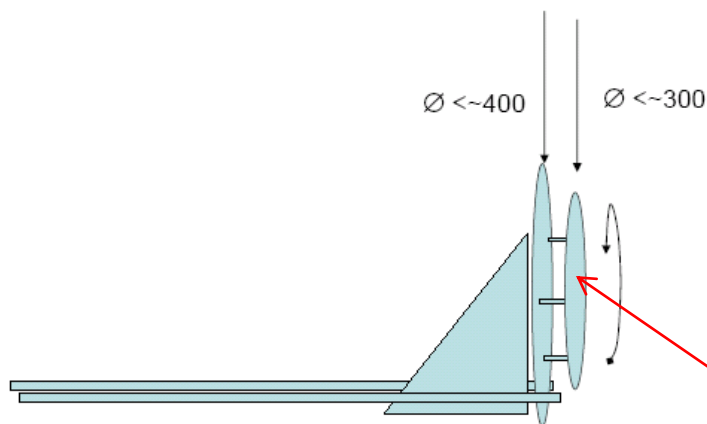
Beam axis



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This flange cannot be removed and cannot be surpassed by rail support



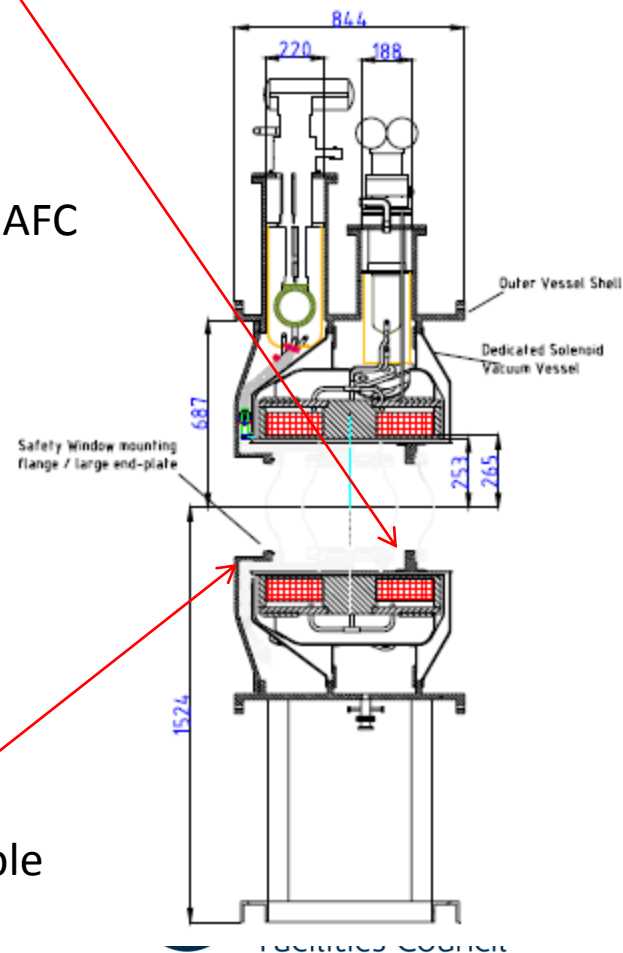
Extension disk for AFC

5m version for spectrometer solenoids
2m version for focus absorber solenoids.

Extension disk to by-pass internal flange AFC
Need to measure from both sides

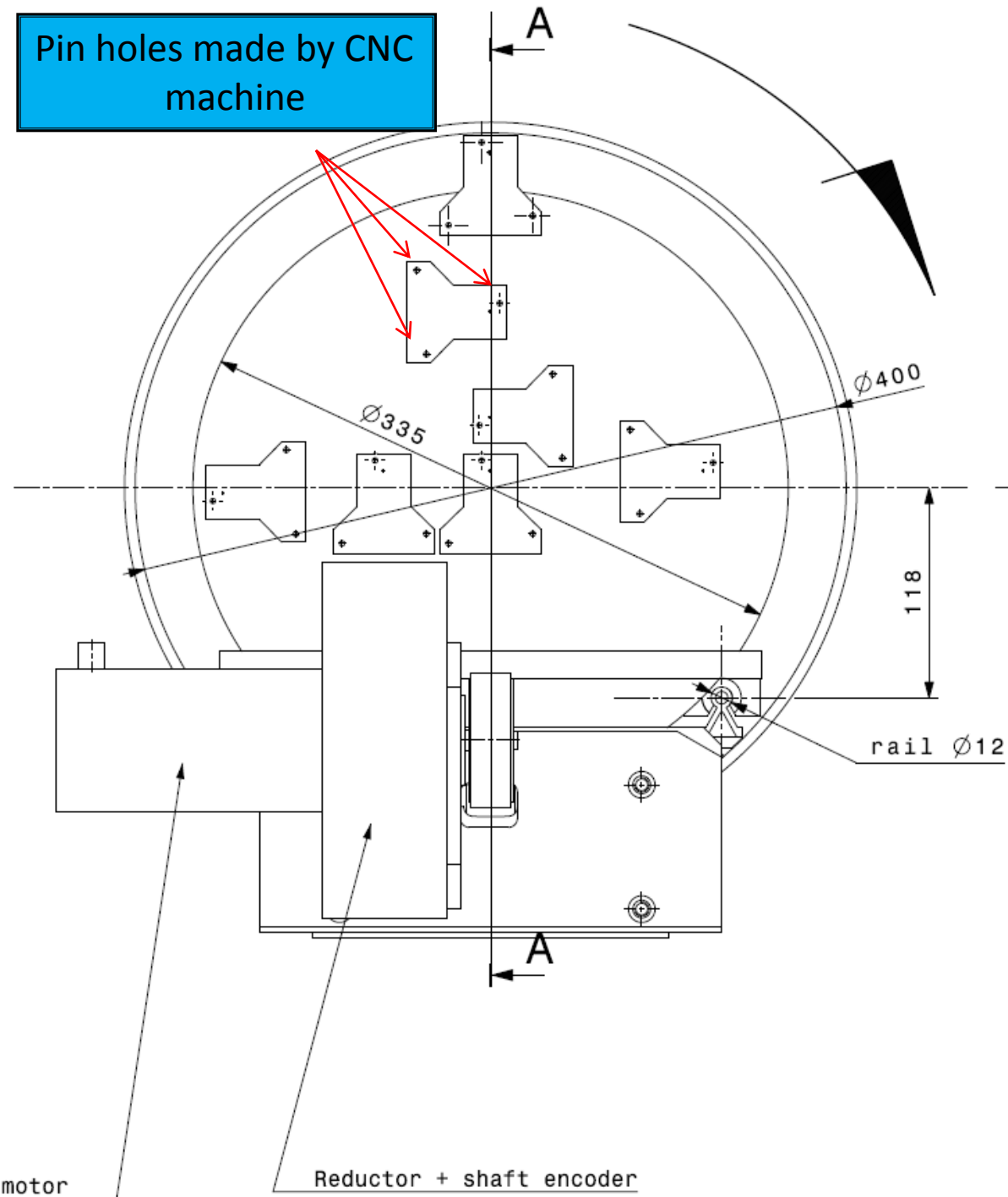
2m version could be used to measure eventually
coupling coils

dismountable





Pin holes made by CNC machine





Strategy mechanics:

- 1 build 5 m version , test precision with laser tracker
- 2 if precision insufficient add encoder and rack and/or foresee laser tracker during measurements etc
- 3 build 2 m version

DAQ:

Build simple read-out for 7 B-sensors

Anticipate to have interface outside high field region

Accuracy:

< 0.5 mm longitudinal

+/- 0.5mm radial

Theta +/- 1 mrad

Bx,By,Bz +/- 2 mT Check in situ with NMR on service module





Status

6 m Alu pipe of 40 cm bore arrived, segment cut, principle seems to work

Cradles: designed, will be produced outside CERN, rectified inside CERN

Rails: ordered , will arrive in one month

Chariot: designed, must be build

Motion: standard BALDOR motion controller, drive and motor (available)

Maybe encoder on rack (unlikely), encoder exist, rack must be ordered

B-sensors ready and calibrated

should be send to CERN !

Read-out: basics exist (used in calibrator with 4 cards), parts exist
duplicate electronics board

Ready at August 2011 for AFC (small version)



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Other Magnet Considerations

- Global hardware/software solutions where possible
- Coordinating magnet integration includes:
 - Ability to move magnets between Steps
 - Need to consider practicalities of performing field-mapping of individual magnets in the MICE Hall
 - Mapping machine requires 0.5m minimum clearance at one end, and ~1m at the other