A possible test of MICE RF cavities in a magnet at CERN

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Plan

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- Experimental area description
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History

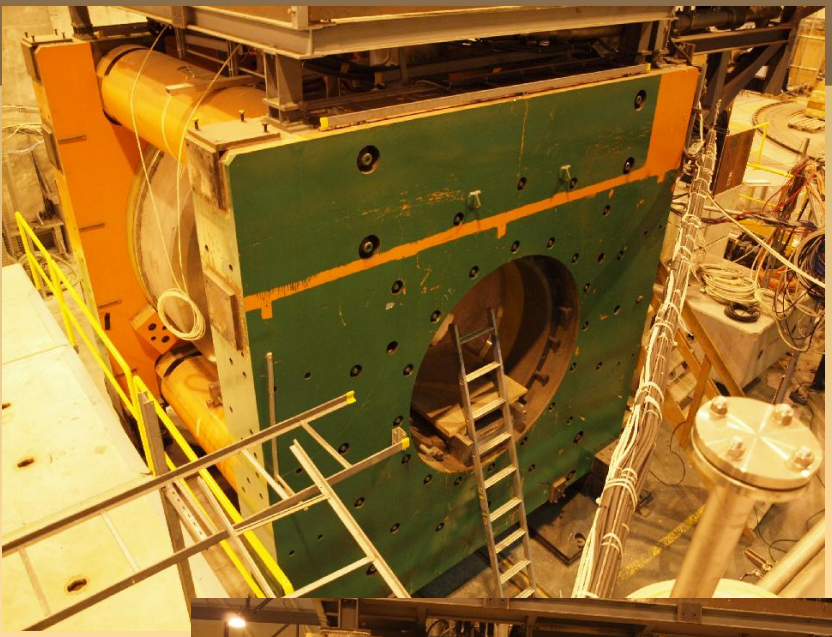
In 2009, following a discussion in the muon front-end group, I started to look for a large bore (R > 60 cm) magnet able to provide a 2 T solenoid field on axis, which could be either shipped to the MTA at FNAL or used at CERN for an RF R&D experiment in support of the MTA.

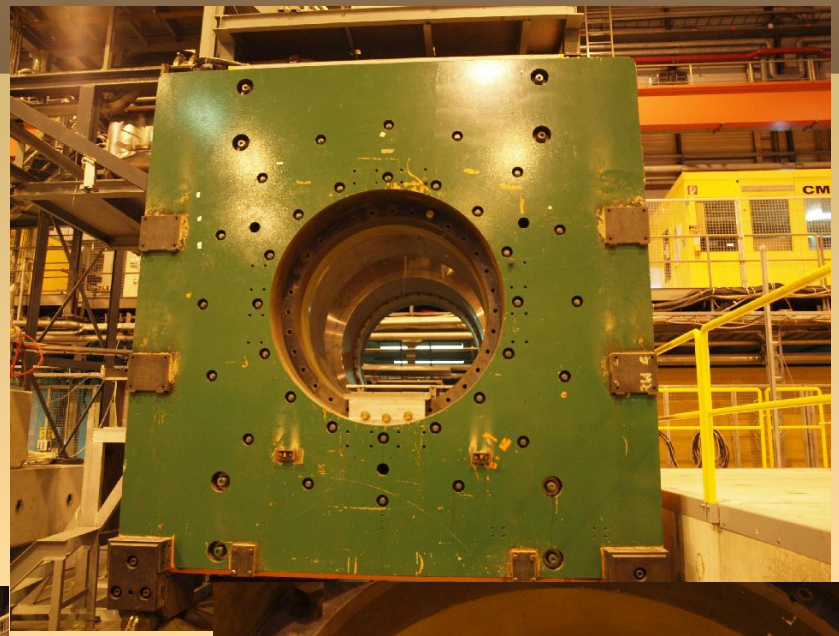
The M1 CERN magnet is a ~40 years old Helmholtz-type magnet composed of two SC coils mounted on squared Fe plates held apart by four cylindrical bars. Provides 3 T on axis in the center. The distance between the coil is 82 cm and the coil inner/outer diameter is 140 cm/210 cm.

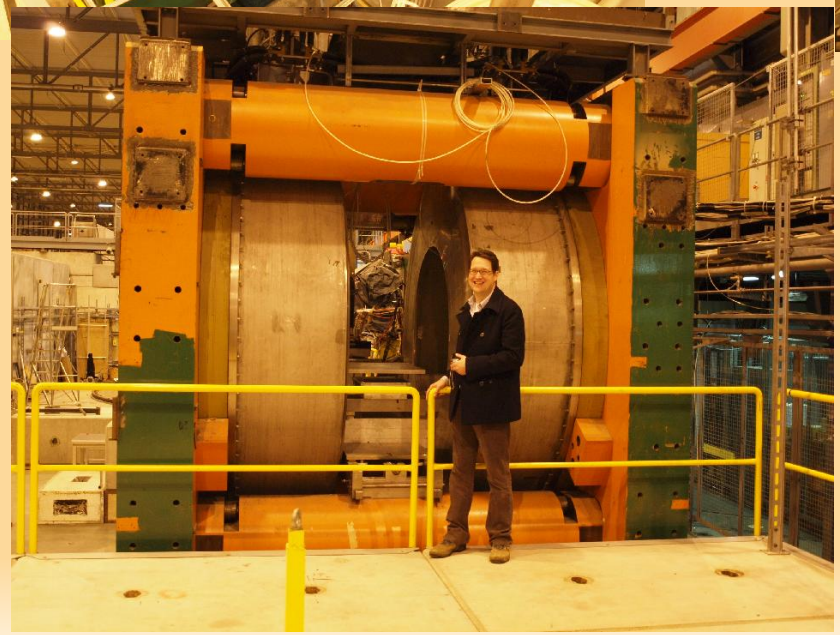
Shipping would turn to be more than difficult and we are not even sure it would fit in the MTA.

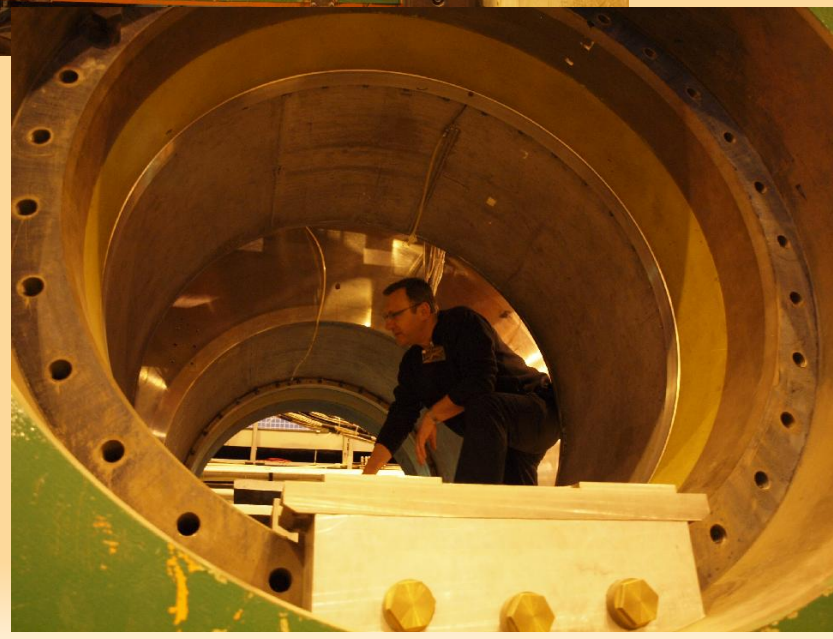
MICE EB (May 21st 2010) gave a positive response (and stated some of the limitations) to the idea of using the magnet in support of MICE RF activities.

M1 Magnet









M1 Magnet

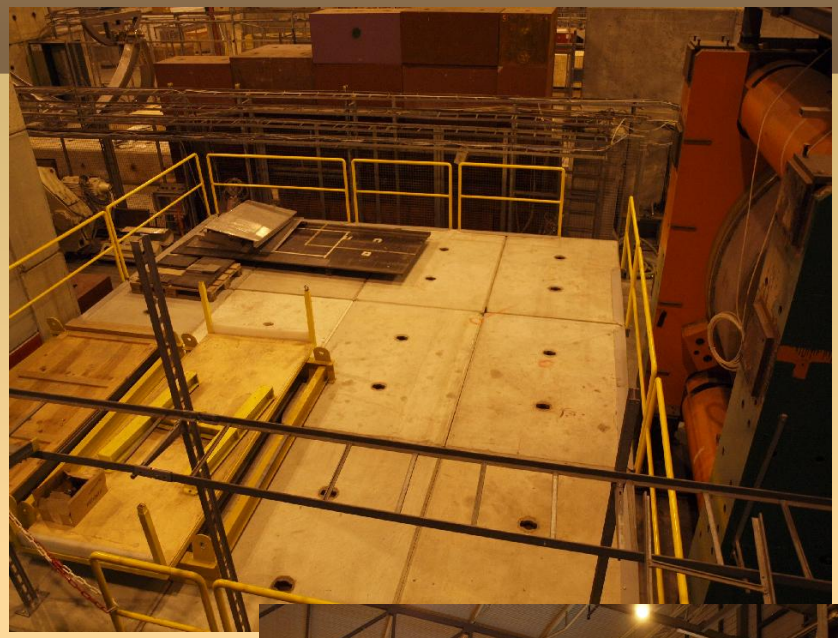
Configuration:

- field direction can be inverted.
- magnet can be rotated to have the field parallel to the beam direction.
- coil currents coupled: 1 coil on + 1 coil off or different current on the coils or current in different direction on each coil seems to be a dangerous configuration (structural forces calculation to be examined).
- no return yoke, stray field quite important.

Access:

- sideways in a useful square of 82 cm x 220 cm.
- from the bores in a useful circle of 140 cm diameter.
- from the top in a useful square of 82 cm x 155 cm.
- from the bottom – exact access size tbc.

Experimental area



Experimental area

T2-H2 beamline:

- upstream of the magnet area is occupied by NA61 experiment. When NA61 takes the beam we can enter (beam stopper upstream).
- in the magnet area, 2010 occupancy was for CMS hardware R&D pixels (need the magnet) + others (magnet field off).
- downstream of the magnet area in 2010 no experiments with need for beam.

need to time well to avoid interference with other users of the area

Services:

- electrical power available.
- water (demineralized, chilled, normal) available.
- concrete blocks for shielding available.
- empty control rooms on first floor available.
- additional shielding from RF electrons/x-rays tbd.

RF cavities options

Option 1- MTA prototype cavity:

- deprives the MTA of their 201 MHz cavity
- requires breaking of the shielding
- needs to be shipped from FNAL to CERN and back (?)

Option 2- MICE spare cavity:

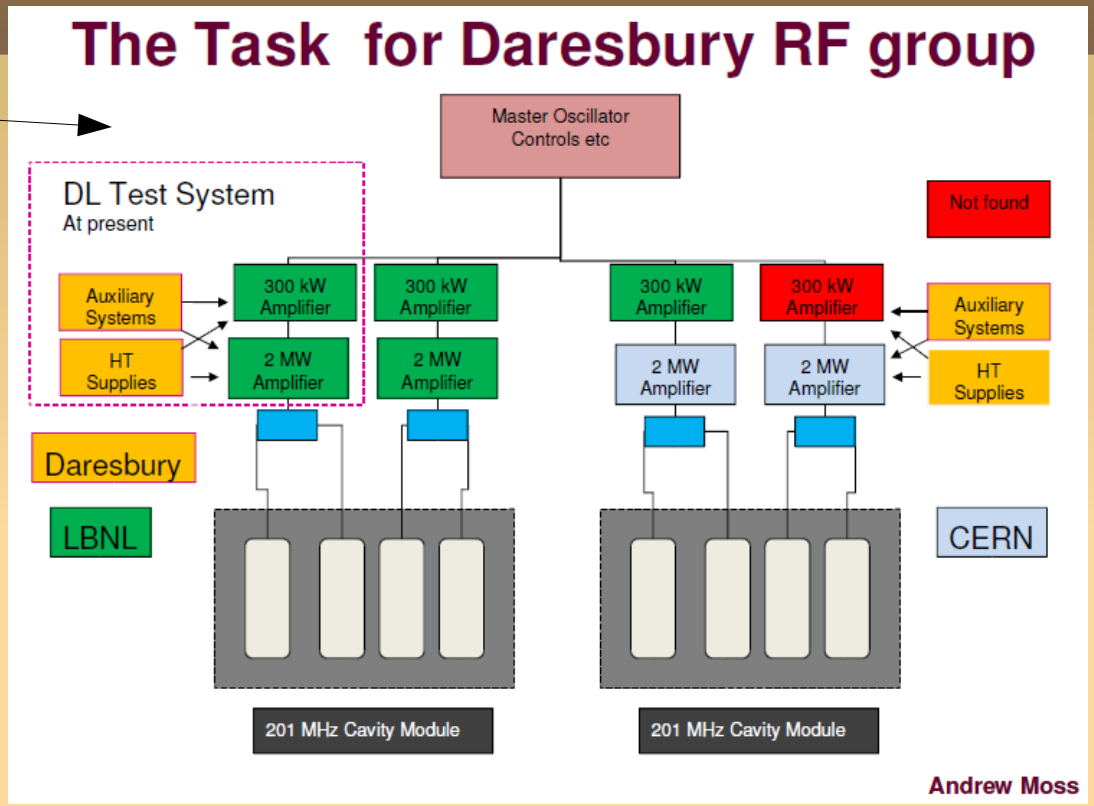
- needs a vacuum pressure vessel
- one of two spare less for MICE during the tests at CERN
- needs to be shipped from LBNL to CERN, then CERN to RAL

Option 1 seems difficult

Option 2 valuable if CERN exp. area could be ready on-time

RF amplifiers options

MICE amplifier chain



Test @CERN needs the equivalent of the DL test system:

- 300 kW amplifier
- 2 MW amplifier
- auxiliary systems
- HT supplies
- …

Identifying if/what material & people available at CERN.

Shipping back at CERN one of the 2 MW units probably feasible.

Shielding work

Need to identify what shielding and where to protect:

- RF amplifiers from magnetic field
- people or sensitive electronics against electrons/x-rays
- magnet from particles leaving the cavity ?

Space in the experimental hall is not too limited but magnet stray field quite extended.

Need to work on shielding options really close to the cavity (space limited).

Daresbury Lab. test area

Costing

Need to make a full evaluation of cost induced for:

- One 201 MHz RF cavity preparation (vacuum vessel if MICE, shielding wall removal if MTA) and shipment.
- One complete stage of RF amplifier and auxiliary systems installation (included shipment/acquisition of some parts).
- Shielding preparation and installation in the exp. Hall.
- Instrumentation for RF measurement preparation and installation.
- Magnet operation and services.
- RF operation and services.
- ...

Conclusion

What can be used:

- a 3 T magnet in an experimental area which can be shared with minimum interference to perform RF tests in magnetic field..

Benefit, if area ready on time (summer 2011) and RF cavity + amplifiers systems available:

- MICE first coupling coil could be shipped directly to RAL (6 months gain on schedule)
- MTA prototype or MICE RF could be tested in 3 T – up to 12 MV/m peak gradient

Dangers: we should not drain/distract people as we know how much manpower is an issue in IDS-NF/EUROnu/CERN/DL... and MICE.

Need very good agreement/understanding on what we can/should do from MUCOOL/MICE/CERN/DL and identify cost and persons needed thoroughly.