Magnet Stations: introduction

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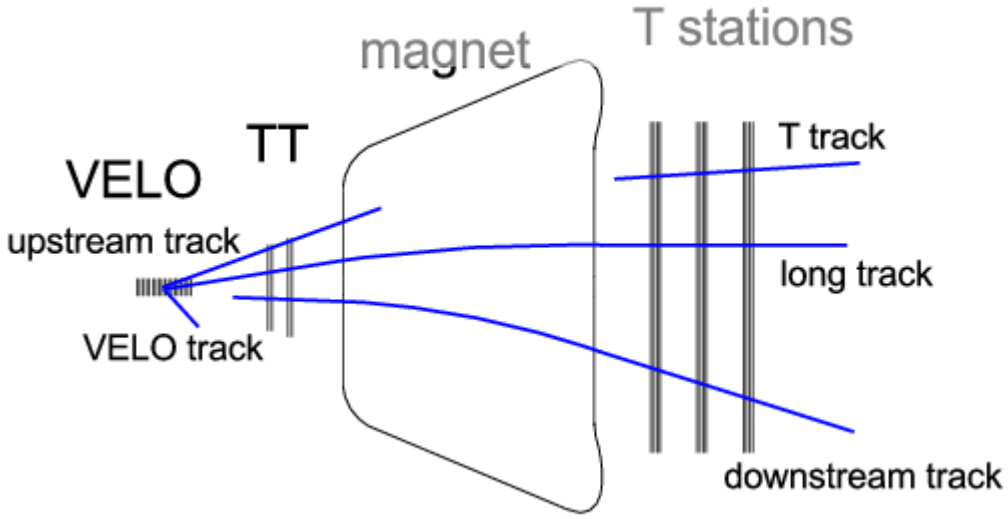
(University of Manchester)
Maurizio Martinelli (EPFL)
Marc-Olivier Bettler (CERN)

Improve the tracking for low momentum particles.



Tracks with hits in the vertex locator and the TT/UT and not in the T-stations: UPSTREAM tracks.

Those are bend outside of the T-stations acceptance by the magnetic field because of their low-momentum.

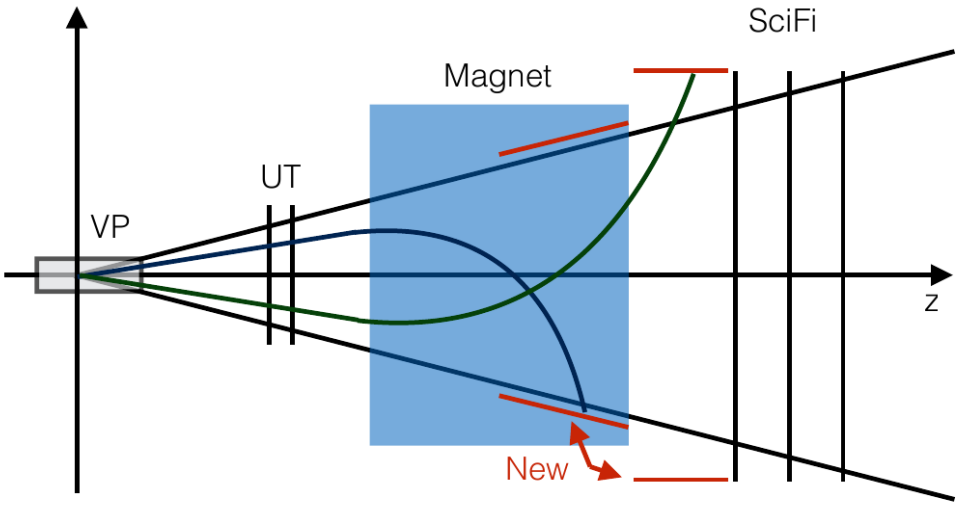
The reduced amount of field between the VeLo and the TT, means that their momentum is computed with a large uncertainty.
$\Delta p/p$ = 20-25% current, $\Delta p/p$ = 15-20% upgrade

Extensive examples in the presentation of Sheldon Stone, Paolo Gandini, Liming Zhang
[Tuesday meeting Sept 2nd 2014]

High multiplicity decays
such as Bs -> Ds^+ (-> $K^+K^-\pi^+$) Ds^- (-> $K^+K^-\pi^-$)

Low-mass decays
such as decays of strange mesons and baryons, Kaons and Sigmas

decays involving a low-momentum track
such as $B^{**0}s$ -> $K^{-+}B^{+-}$ or D^{*+} -> $\pi^+ D^0$ or Σ^+b-> $\pi^+ \Lambda^0b$ or B*c -> Bc γ (-> ee)
(kinematical constrains allows to probe decays with missing particles)



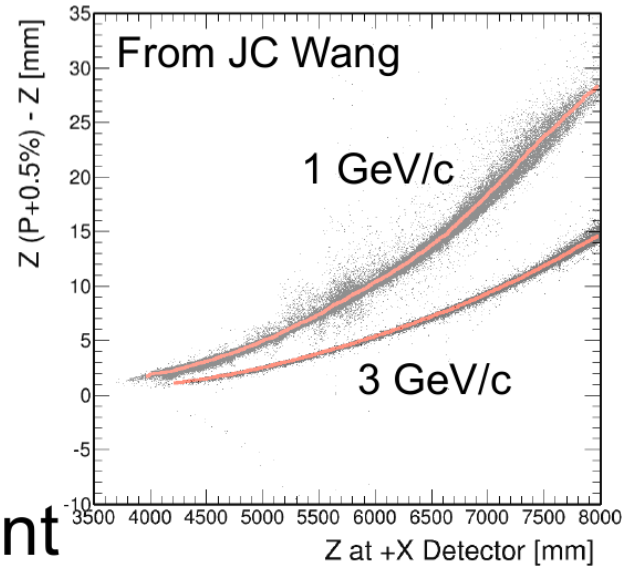
Sketch from Maurizio

Ideally, extending the tracking acceptance of the T-stations, with the **instrumentation of the magnet internal sides** and outside the magnet extending to T1.

Outside of LHCb acceptance (no added X0),
z-coordinate of hits is possibly enough (depending on capacity to match hit to Upstream track),
moderate resolution is enough (o(mm))

Chamber resolution

- Approximate magnet sides by vertical planes at x=±1.5 m. Generate particles from inclusive b events at "fixed" momenta of 1 & 3 GeV/c
- Find impact point on magnet sides
- Then raise p by 0.5%, roughly the multiple scattering error
- Plot difference. This is more or less the required chamber resolution
- See that >mm level σ is sufficient



From Stone, Wang, [Tuesday meeting Sept 2nd 2014]

Action plan

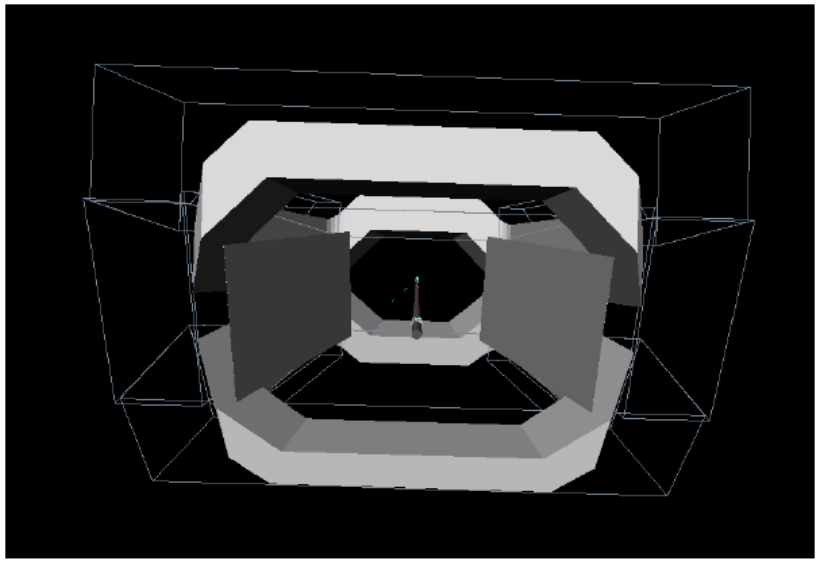
Marc-Olivier Bettler

o **Characterise the upstream tracks** and extend the definition with existing geometry (presentation by **Maurizio Martinelli**)

o **Study the constraints from the infrastructure** (yours)

o **Study of the particular environment** with simulation with a simplified detector (by **Igor Babuschkin**)

- get occupancy
- understand the nature of the particle deposing hits (secondaries)
- particular location in the magnetic field (trapped spiraling electrons)
- get fluence



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o **Study some physics channels** with simulation with a simplified detector, input to requested resolution and spatial coverage.

=> Enough information to choose a technology

o **Create realistic model for simulation**
- confirm/correct previous studies
- assess impact on other detectors (generation of secondaries)
- implement reconstruction algorithm.

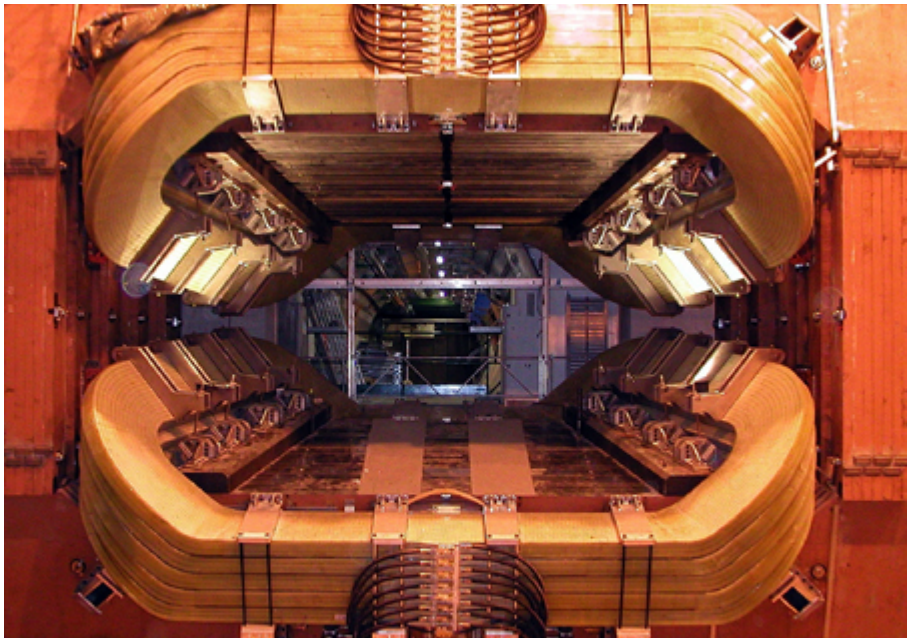
The magnet seems empty space!

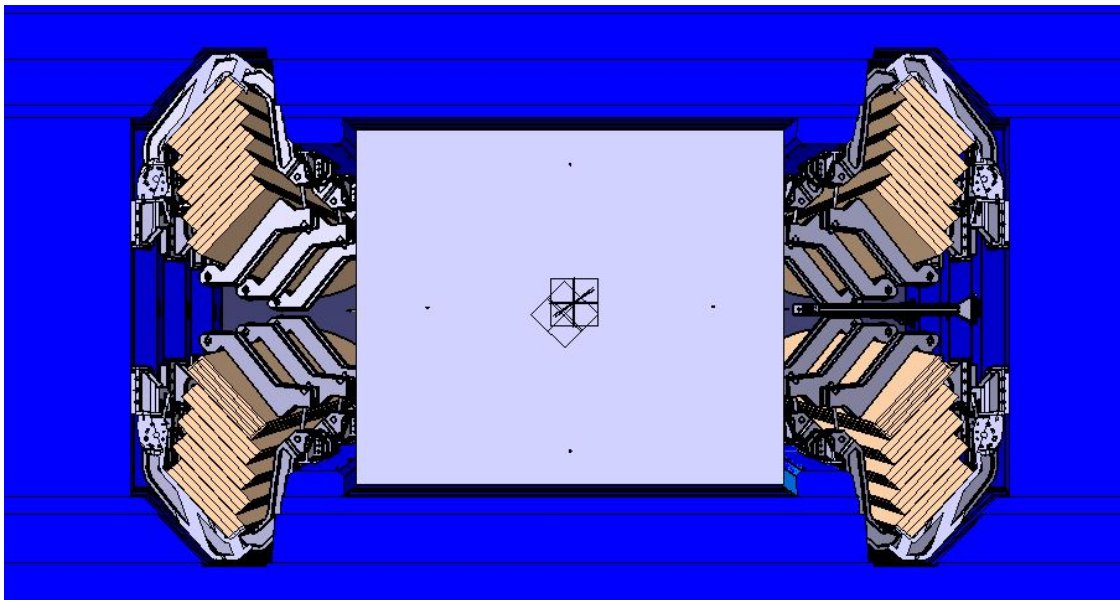
Not at all,

it is full of LHCb acceptance!

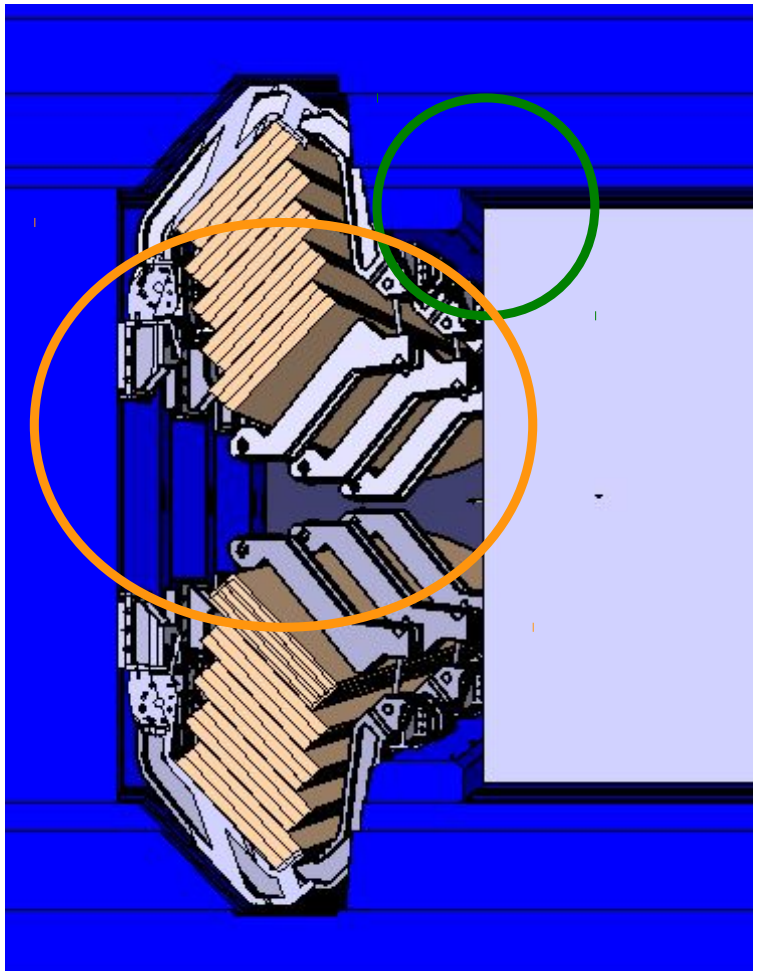
it is full of magnetic field!

it is full of beam pipe support structures.





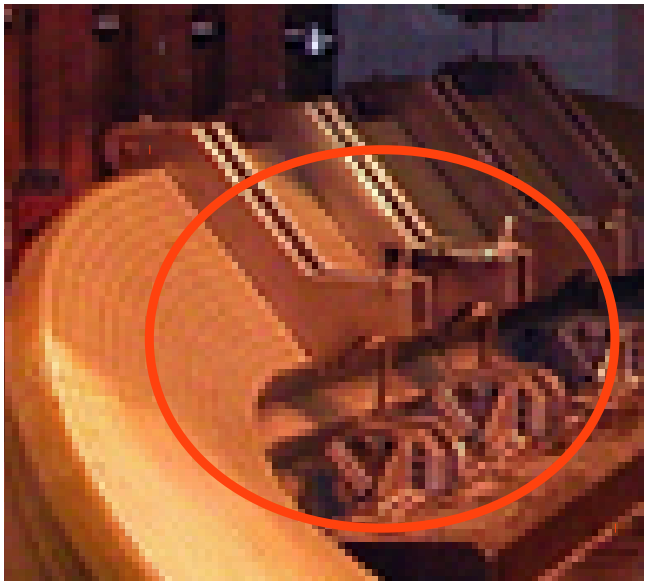
Infrastructure, Spatial constraints



The minimal clearance between the magnet and the acceptance is 105 mm (at the top/bottom and sides' corners)

More clearance towards y=0.

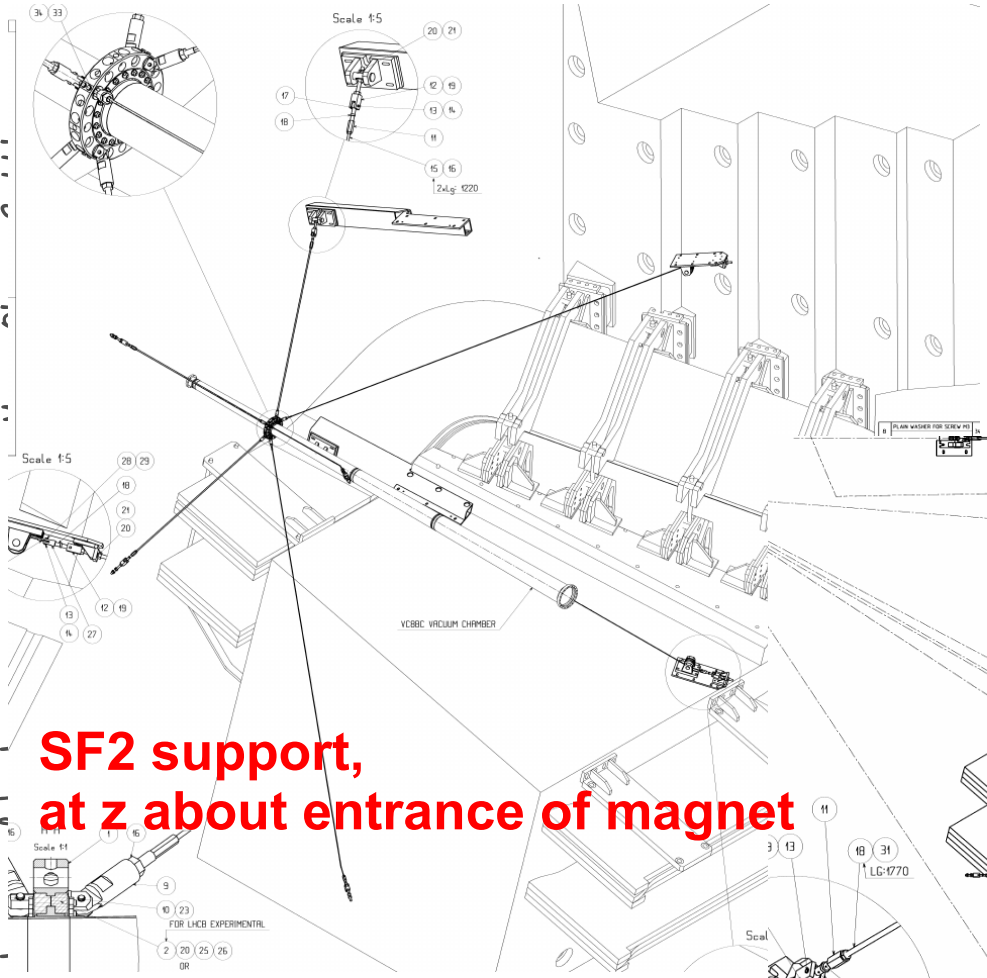
Movement of the coils can damage the shims
Must be accessible to check their tension and potentially open.



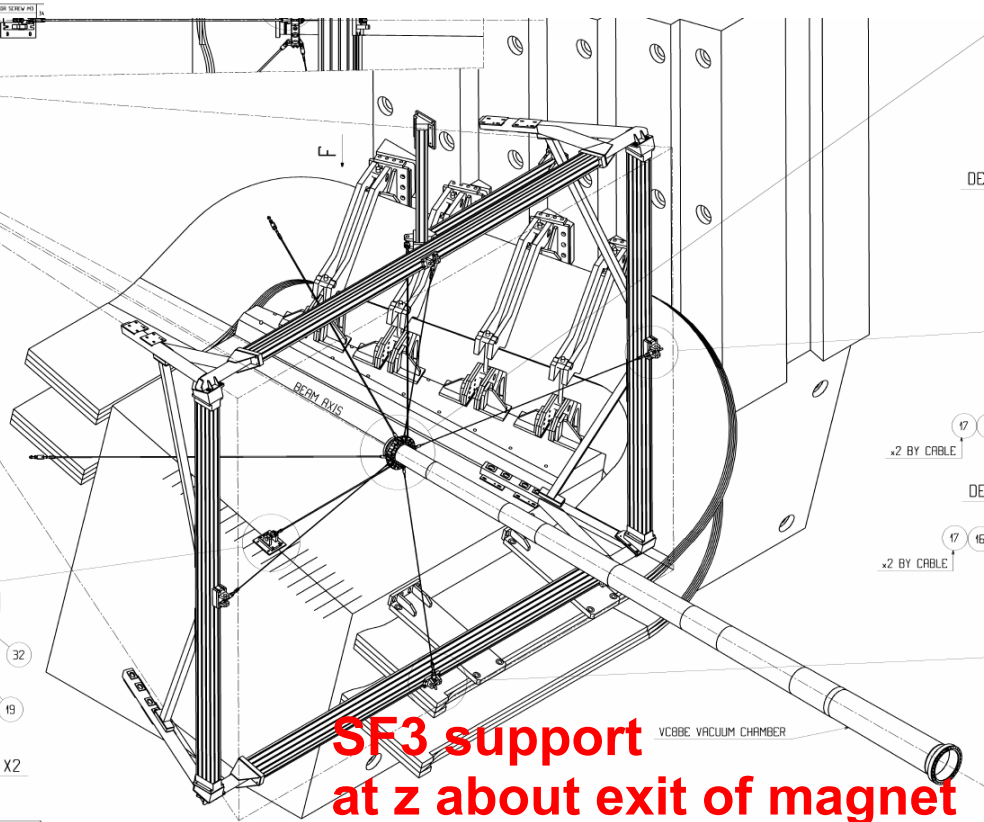
Infrastructure, Spatial constraints

Beam pipe is held in position by rods and cables. Spiderweb to avoid.

Some 'only' mean difficult access. Two will be challenging.. designed around them.



SF2 support,
at z about entrance of magnet



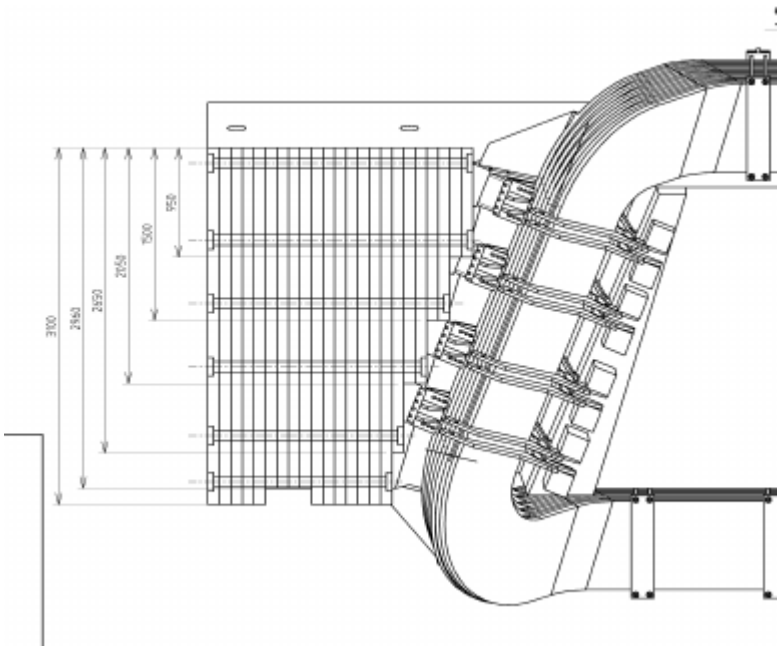
SF3 support
at z about exit of magnet

HL-LHC Rare

Support

Under the the effect of the magnetic field, the coils move.
The plates the yoke is made of move as well.

Need a clever way to design the support, with 1 true fixed point and while other points allow for the small displacement of the yoke.



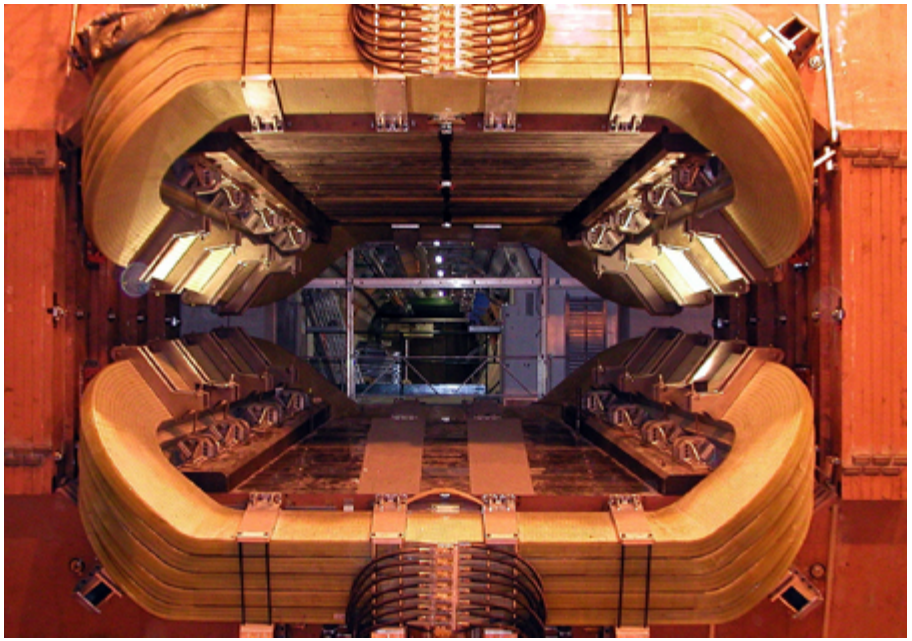
Alignment

Cannot be aligned the way TT and T1-T3 are.
Rely on survey?
Need to account for it in the pattern recognition/reconstruction simulation (added uncertainty to the hit location)

Temperature

The cooling water circulating in the **coils** enters at about room temperature and exits at **about 60 deg C.**

The **air temperature** in the volume of the magnet is around **20-25 deg C** (4 probes).



Summary so far

My personal view so far:

o This detector should **not be expensive**.

o **No active cooling** as a target. Limited space for impedimenta. Reduce the complexity of the design ($), reduce the M&O ($).

o **No Gas** as a target. idem

o **resolution** of the order of the **millimeter**

o large magnetic field.

Scintillating fibres ?

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o This detector should **not be expensive**.

re-cycling of knowledge, casting machines

o **No active cooling** as a target. Limited space for impedimenta. Reduce the complexity of the design ($), reduce the M&O ($).

Study the **neutron fluence** (disturbing the Si lattice) if not << 10^10 n/cm2, would required cooling the SiPM.

o **No Gas** as a target. idem

No gas required.

o **resolution** of the order of the **millimeter**

Fibres exist of widths ranging 0.2 to 3 mm, **the larger the fibre the easier** is the assembly of the mats

o large magnetic field.

SiPM **not sensitive to B field**