Calculations for Muon-Filter and Field-Clamp

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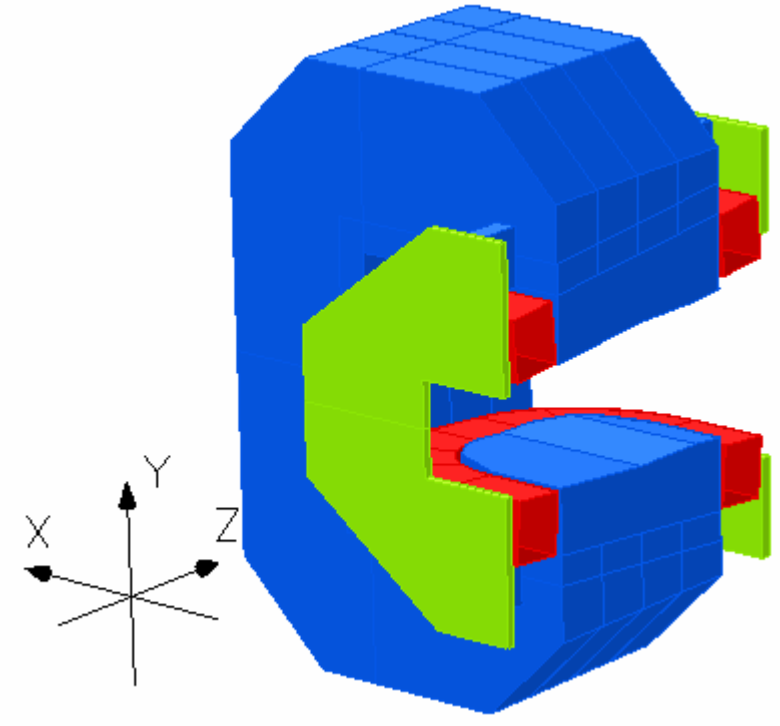
Advantages of a Field-Clamp between Muon-Filter and Dipole

Any iron plate next to the dipole is subjected to a big magnetic attraction force, and it has a influence on the dipole field that cannot be neglected.

Advantages of a field clamp:

1. A proper field-clamp screens the stray field induced by the dipole so much that the magnetic attraction on the Muon-Filter can be neglected.
2. The field mapping becomes easier because a field clamp makes the presence of the muon-filter dispensable.



Half of the dipole, view from upstream side

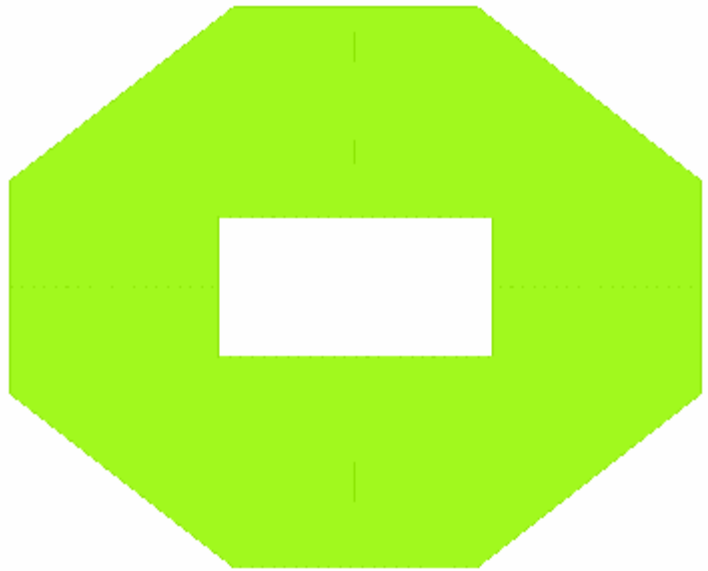
yoke iron (blue), coils (red), field clamp iron (green)

Field-Clamp Dimensions

- Thickness 60 mm (z-extension from 340cm to 346cm w.r.t. IP)

- Horizontal extension (x-direction) ± 160 cm (minimum)
- Vertical extension (y-direction) ± 125 cm (minimum)

- Aperture horizontal ± 64 cm
(± [346cm * tan(10°) + 2cm (tolerance)])
- Aperture vertical ± 32 cm
(± [346cm * tan(5°) + 1.5cm])



The smaller the aperture can be made the better is the magnetic shielding.

Field and Forces on the Field-Clamp and on the Muon-Filter

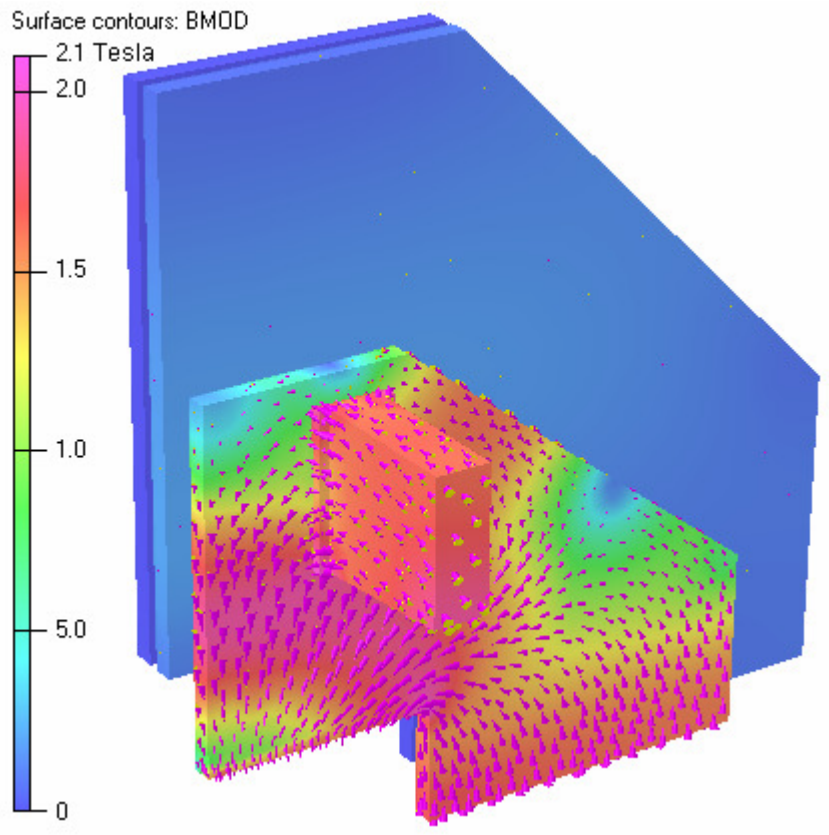
The figure on the right shows the field on one quarter of the field-clamp and on the 2 plates of the muon-filter which are next to the field-clamp (view from downstream, iron yoke not shown).

The plates of the muon-filter are 6cm thick, the distance between them is 3cm. The aperture (adjusted to the needs of the MDC-frames) is ± 77 cm horizontally and ± 51 cm vertically.

The distance between the field clamp and the next plate is 11cm.

The maximum field is 2.1 T on the field-clamp and 0.3 T on the next muon-filter plate.

The force on one half of the field-clamp is 80kN and 0.3kN on each half of the muon-filter.



Requirements for the support of the Muon-Filter

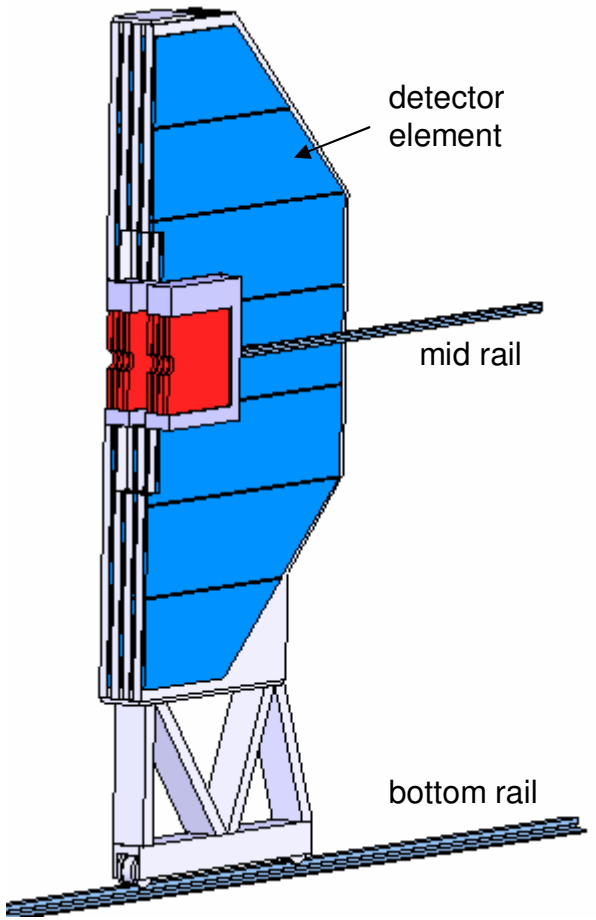
Each half of the Muon-Filter has a mass of about 16 metric tons. The center of gravity (c.o.g.) of the MF is located at about x=100cm and in y-direction about 340cm above the floor.
The seismic accelerations to be taken into account are 0.15*g in the x- and z-direction.

All forces on each half of the MF:
- F_x = 24kN (mass * 0.15*g)
- F_y = 160kN
- F_z = 24kN

The neat center point to support the MF is the floor below the c.o.g. of the MF. In this case the following tilt moments have to be taken into account:
M_x= M_z= 82kNm (24kN * 340cm)

M_z can be fixed with 2 wheels which are at least 51cm (0.15*340cm) away from each side of the x-coordinate of the c.o.g. (s. figure on the right, wheels on bottom rail)

In order to fix M_z there is not enough space on the floor. Therefore another point has to be provided far above the floor, for instance a roller fixed to the muon-filter at the c.o.g., sliding on a mid rail (s. figure). The mid rail might be attached to the field-clamp.



Proposed support for the muon-filter (view from downstream). MDCs (red) and mid rail could be supported at the field clamp (not shown).

Comparison of Dipole Field Measurement Configurations

In order to get the exact field maps for the dipole a realistic configuration has to be provided. If it is not suitable to bring the Muon-filter to the right position for the measurement procedure a substitute representing the Muon-filter can be applied. The substitute could be a frame (same z-position, same aperture) like shown below (red color) with a cross section of 6cm * 15cm.

The diagram on the right shows the field on the beam axis. The black curve represents the full configuration (with Muon-filter), the red curve (with substitute) is almost identical. The blue curve is without substitute, and the green one even without field-clamp.

If the aperture of the field-clamp would be as big as that one of the Muon-filter (in order to incorporate a part of the MDC2) the field integral on the beam-axis between z=3m and z=3.5m would be 60% higher. In this case a Muon-Filter substitute would require a cross section of 6cm * 25cm.