Meeting Minutes of the
59th FCC-ee MDI meeting

Indico: https://indico.cern.ch/event/1470162/
When: 28.10.2024 16:00-18:00 CET

Agenda

Presenter	Title
M. Boscolo	**General Information, News**
A. Ciarma	**Effect of the solenoidal fringing field on the lumical**
A. Frasca	**MDI Fluka model and preliminary beam-gas backgrounds**
M. Marchand	**FCC HTS IR Quads and Beampipe: R&D proposal**

1 M. Boscolo - General Information, News

M. Boscolo presents general information and news. The minutes of the previous meeting are approved and are available on the Indico page. The next MDI meeting is scheduled for the 11th of November.

Upcoming events:

- 2nd FCC Italy and France workshop in Venice in November 4-6
- FCC Physics week at CERN 13-16 January 2025.

2 A. Ciarma - Effect of the solenoidal fringing field on the lumical

A. Ciarma presents the results of first studies on the effect of the fringe fields due to the coupling correction anti-solenoids on the LumiCal.

The main conclusions are that:

- The fringes in the LumiCal can reach up to $B_r = 0.35$ T in the baseline scheme (-5 T solenoid). These can be reduced down to $B_r = 0.15$ T in the non-local scheme.
- Field maps for the baseline and non-local scheme have been produced to perform dedicated tracking in key4hep.
- Tracking of low P_t particles shows no significant effects for E>100 MeV electrons, while a small increase is observed in the baseline scheme for E>10 MeV electrons. The effects may become more relevant if an intense source of low energy particles is present.
- Preliminary IPC tracking show no significant background levels.

- The transverse kick on the Bhabha particles may affect the luminosity measurements – a feedback from the Lumical experts is required to better understand potential issues.
- The position of the innermost anti-solenoid is a key aspect for the optimization of the coupling compensation scheme.

M. Dam reports that he has started investigating the energy deposition in the LumiCal. In the configuration where the anti-solenoid is included, an increase of approximately 40% in energy deposition is observed. This increase is likely caused by very low-energy particles from IPC that curl with the field lines and impact the back corner of the LumiCal.

M. Dam notes that the importance of this effect is still under assessment. However, if this proves problematic, it may be mitigated by adding a few millimeters of tungsten shielding. Dedicated simulations are required to fully evaluate this scenario, but at first glance, no immediate show-stoppers have been identified.

A. Ciarma agrees with **M. Dam**, noting that neither the number of particles nor the energy deposition observed in his studies appears concerning.

M. Koratzinos comments that electrons with energies around 10 MeV are not a concern. However, particles at nominal energy that may suddenly change direction and impact sensitive components could pose a potential issue.

M. Dam disagrees with **M. Koratzinos**, arguing that it is not true that these 10 MeV electrons are harmless.

K. Oide asks whether the simulations conducted by **A. Ciarma** account for the boost due to the crossing angle. **A. Ciarma** confirms that they do.

3 A. Frasca - MDI Fluka model and preliminary beam-gas backgrounds

A. Frasca presents initial results of FLUKA simulations of beam-gas scattering in the interaction regions.

The main conclusions are that:

- The geometry of the FLUKA IR model has been updated including the IDEA detector with the vertex, the cryostats and SR collimators and masks. This will enable estimates of dose and fluence in the detector for the several sources.
- A FLUKA routine has been developed to simulate beam-gas bremsstrahlung interactions, allowing to study possible backgrounds from this source.
- Beam-gas interactions have been simulated for the incoming beamline in the range (s=-504 m, s=6 m). The results show a TID of the level of Gy/year with hotspots in the IR of the order of 1 kGy/year.
- Loss maps of touches from local bremsstrahlung interactions have been produced. The losses are concentrated in the SR collimators and masks. The losses registered on these devices are lower than those registered from multi-turn tracking.

A. Frasca notes that beam-gas interactions originate throughout the entire ring, although the presented results are restricted to the simulated IR range. He suggests implementing collimation upstream of the IPs to intercept the accumulation of beam-gas interaction products.

F. Palla comments that it is a nice development that the IDEA detector has now been integrated into the FLUKA IR model. He adds that it would be interesting to see **A. Frasca** results for each silicon layer of

the detector.

G. Lerner clarifies that it is important not to overlook the fact that there is more beam-gas interaction than what has been simulated by **A. Frasca**. Specifically, the contribution from the arcs has not been included. This means that the values of dose and fluence will increase when the contribution from the arcs is considered. However, he does not expect these values to change by orders of magnitude.

K. Oide observes that on Slide 10, there is a decrease in losses in a specific region when showers are enabled. He asks about the cause of this decrease. **A. Frasca** answers that it may be related to statistical fluctuations but will conduct further checks to confirm.

R. Kieffer comments that it would be interesting to examine the spectrum of photons emitted in beam-gas bremsstrahlung interactions.

4 M. Marchand - FCC HTS IR Quads and Beampipe: R&D proposal

M. Marchand presents an R&D proposal for a high-temperature superconducting (HTS) IR quadrupole and beam pipe.

The main conclusions are that:

- The HTS technology has a bright future for various applications (medical, nuclear, etc.), and the FCC project has the opportunity to play a key role in its development, leading to significant technological and economic benefits for the FCC.
- After the manufacturing of an HTS sextupole and pending its cold test, an HTS quadrupole is currently under study.
- The unique magnet design and its environmental constraints require the development of a specific cryostat and beam pipe compatible with the quadrupole.
- The first steps in the fabrication of both components have started with pre-prototyping, aimed at validating their concepts and anticipating large-scale prototyping.
- **Short-term actions:**
  - Improve the magnet design and fabrication process through the pre-prototyping project, focusing on groove and section design, fabrication tolerances, and strategy.
  - Enhance the tube design and fabrication process through the pre-prototyping project by adapting the design for turbulence, refining simulations, and starting detailed studies on the welding process for the tube.
  - Prepare for the manufacturing of the final prototypes (manufacturers have already been identified).
- **Mid-term actions:**
  - Manufacture the magnet and tube prototypes, including all necessary instrumental tests (metrology, vibration analysis, magnet cold tests, beam pipe cooling tests, etc.).

A. Faus Golfe asks whether the design for the turbulence of the beam pipe will work as intended, and if not, whether there is any backup plan in place.

M. Marchand answers that they are still working on the design for the turbulence in the beam pipe, but they believe it is feasible. The alternative approach would be to use water access on both sides.

A. Faus Golfe asks whether the beam pipe design they are studying is also applicable to the baseline quadrupoles.

M. Koratzinos answers that, yes, the design is applicable since the beam pipe diameter is the same.

F. Palla asks about the quadrupole prototype, which would be smaller than the final design. He inquires whether it is possible to produce these smaller pieces with sufficient machining precision.

M. Marchand answers that, yes, it is possible.

A. Frasca reminds to consider including some margin in the quadrupole design to accommodate the radiative Bhabha shielding.

M. Koratzinos answers that this is not possible, as it would result in a collision between the magnets for the two beams.

A. Frasca asks whether this would also be the case if the shielding were placed on only one side.

M. Koratzinos responds that, in his opinion, shielding for this quadrupole is not necessary, as the angle is large due to its proximity to the IP. In addition, **M. Koratzinos** notes that he has never seen any concerning numbers regarding power deposition on these quadrupoles.

A. Frasca clarifies that it is important to consider not only the absolute value of the energy deposition but also its distribution. FLUKA studies have shown that energy deposition is concentrated in certain hotspots, which is why tungsten shielding for the final focus quadrupoles was recommended.

M. Koratzinos replies that this is another reason why they are studying HTS quadrupoles, as they can withstand higher loads before quenching compared to standard superconducting quadrupoles.

A. Frasca adds that radiation damage should also be considered.

M. Koratzinos replies that he indeed proposes irradiating the first prototype at DAFNE, which would serve as a valuable test.

28 Participants:
K. André, M. Boscolo, G. Broggi, L. Brunetti, H. Burkhardt, C. Carli, A. Ciarma, M. Dam, A. Faus-Golfe, F. Fransesini, B. Francois, A. Frasca, P. Janot, R. Kieffer, M. Koratzinos, A. Lechner, G. Lerner, M. Marchand, G. Nigrelli, A. Novokhatski, K. Oide, F. Palla, F. Poirier, G. Roy, J. Salvesen, V. Schwan, J. Seeman, and L. Watrelot

Minutes prepared by **G. Broggi**