Meeting Minutes of the
62nd FCC-ee MDI meeting

Indico: https://indico.cern.ch/event/1484671/
When: 16.12.2024 10:00-12:20 CET

Agenda

Presenter	Title
M. Boscolo and F. Palla	**General Information, News**
M. Dam	**Effects of residual magnetic fields on the Luminosity Calorimeter performance and backgrounds**
Y. Benhammou	**Beamstrahlung studies at future colliders and impacts on LumiCal**
R. Kieffer	**Beamstrahlung monitoring**
B. Francois	**Synchrotron radiation in the detectors**
G. Nigrelli	**Fast instability simulations**
A. Frasca	**Preliminary radiation levels in the detector from Radiative Bhabhas and IPC**

1 F. Palla and M. Boscolo - General Information, News

F. Palla 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 tentatively scheduled for the 3rd of February.

Upcoming events:

- FCC Physics week at CERN, 13-17 January 2025.
- FCC week 2025 in Vienna, 19-23 May.
- ESPPU general meeting in Venice, 23-27 June.

2 M. Dam - Effects of residual magnetic fields on the Luminosity Calorimeter performance and backgrounds

M. Dam presents a study of the signals in the LumiCal arising from Incoherent Pairs.

A new CAD model of the beam pipe has been included in the studies presented by **M. Dam**, which turn out to be a major improvement.

The conclusions are:

- A non-negligible negligible energy deposition from beamstrahlung is observed in the LumiCal.
- It is needed to assess if the observed energy deposition is a problem for radiation-to-electronics and/or for precision luminosit measurements.

3 Y. Benhammou - Beamstrahlung studies at future colliders and impacts on LumiCal

Y. Benhammou presents an overview of beamstruhlung studies in future colliders and of the impacts on LumiCal.

The study of the beamstrahlung signal in LumiCal for FCC-ee has started using full simulation, with a comparative analysis vs. ILC. Preliminary findings indicate that the number of hits in the LumiCal in FCC-ee is lower than in the ILC. However, the overall shape of the energy deposition is consistent between the two machines. Notably, the position of hits within LumiCal differs between FCC-ee and ILC, particularly in terms of the front-end and right-left distribution. Additionally, at FCC-ee, when considering the effects of screening and the compensation coil, the number of pads hit per layer at the Z peak per bunch crossing (BX) ranges between 2 and 10.

The next steps in the study include increasing statistics by generating and simulating more bunch crossings (BX), if needed. The background study will continue, along with an investigation of the e+e- –> gamma-gamma signal. Additionally, Bhabha event generation and simulation will be conducted across all relevant configurations

4 R. Kieffer - Beamstrahlung monitoring

R. Kieffer presents an overview of the studies for beamstrahlung monitoring in the FCC-ee.

The work on beamstrahlung extraction line instrumentation has begun. A BTV to monitor the beamstrahlung peak position appears to be a feasible approach. However, due to the scintillation relaxation time, this technique does not allow for bunch-by-bunch monitoring, and an evaluation of the thermal dissipation of the screen is required.

Additionally, an experimental test will be necessary to assess the suitability of screen materials for MeV-range gamma detection and to verify the expected signal-to-noise ratio (SNR) between synchrotron radiation (SR) and beamstrahlung (BS). A better understanding of SR contamination in the beamstrahlung channel is also needed.

As a next step, the evaluation of Bhabha beam-loss intensity on a bunch-by-bunch basis will be conducted to determine its potential relevance for interaction point (IP) tuning.

5 B. Francois - Synchrotron radiation in the detectors

B. Francois presents an update on the studies to evaluate the synchrotron radiation backgrounds in the detectors.

The synchrotron radiation (SR) simulation from BDSIM has been successfully interfaced with the full detector simulation (hepevt). The first detector response has been simulated using various SR files for both

the IDEA and ALLEGRO detectors. Initial results indicate that both the beam halo and core contribute to detector occupancies. Additionally, occupancy levels in the drift chamber (DCH) at the Z-pole appear similar to those observed at the top threshold. The study has also identified potential areas for improvement in the CAD model of the beampipe, particularly the version currently implemented in k4geo.

The next steps involve further analysis to better understand the results and refine the interface between BDSIM and the detector simulation if necessary. A full-statistics sample, including BDSIM simulations with all positrons from the beam, may be required for more accurate assessments. Preliminary findings confirm that running with half the statistics results in approximately half the occupancy. Future work will also include incorporating the calorimeter into the study and implementing background mitigation strategies at both the detector and Machine-Detector Interface (MDI) levels.

6 G. Nigrelli - Fast instability simulations

G. Nigrelli presents the results of simulations performed to study fast instabilities in the FCC-ee.

A fast instability has been modeled using synchronized kicks along the FCC-ee ring with increasing strength. This approach successfully reproduced the exponential growth of betatron oscillation amplitudes and allowed for a detailed study of beam loss distributions around the ring and across multiple turns.

This study is ongoing and remains influenced by updates to collimation optics, impedance modelling, and potential adjustments to the vertical halo collimator cut. The fast instability poses a significant risk if the feedback system fails, with the potential for full beam loss within just a few turns. Nearly 50% of the beam energy could be lost in a single turn, leading to losses on the order of MJ in the collimators. The effects of this instability are also dependent on phase advance, with particularly high losses observed in tertiary local protection collimators, which are located upstream the experimental areas. Given the potential for damage to both the machine and detectors, further investigation is necessary.

As next steps, energy deposition studies will be performed – the impacting distributions on the collimator jaws have been provided to the FLUKA team. Given the high losses upstream of the experiments, shower calculations in detector regions are required.

To mitigate potential damage, the machine must be designed to prevent this instability from occurring. This will involve:

- Ensuring redundancy in the damper system,
- Implementing interlocks,
- Reducing impedance,
- Operating with high chromaticity.

7 A. Frasca - Preliminary radiation levels in the detector from Radiative Bhabhas and IPCs

A. Frasca presents a preliminary evaluation of radiation levels in the detector from Radiative Bhabhas (RB) and Incoherent Pairs Creation (IPC).

An analysis of detector radiation levels from IPC and RB at the Z-pole has been conducted. The estimated total ionizing dose (TID) and particle fluence per year are as follows:

- **Vertex layers (average):** TID = 0.1–10 kGy/year, fluence = 10^{11}˜10^{12} cm^{-2}/year
- **Drift chamber:** TID = 100 Gy/year, fluence = 10^{11} cm^{-2}/year

- **Calorimeter:** TID < 100 Gy/year, fluence < 10^{10} cm^{-2}/year

Radiation levels are primarily driven by radiative Bhabha events, with IPC contributing significantly only in the central region of the inner vertex. However, asymmetric RB losses lead to critical hotspots:

- **Inner vertex layer 2:** TID > 800 kGy/year, fluence = 2.5×10^{14} cm^{-2}/year
- **Disk 1:** TID = 350 kGy/year, fluence = 10^{14} cm^{-2}/year
- **LumiCal:** TID > 2.5 MGy/year, fluence = 6.5×10^{14} cm^{-2}/year

These results are preliminary but offer valuable insights for the feasibility study report. Further refinements will be made in preparation for the upcoming physics workshop in January.

Disclaimer: Following discussions after the meeting, it was determined that the results presented were affected by a simulation bug. As a result, the reported numbers should not be considered conclusive or quantitatively reliable. Updated results, along with an explanation of the simulation bug, will be presented at the next 63rd FCC-ee MDI meeting.

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**