FUTURE CIRCULAR COLLIDER

FCC-EIC Joint & MDI workshop summary: Detector Backgrounds

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Detector Concepts Meeting - 07/11/2022

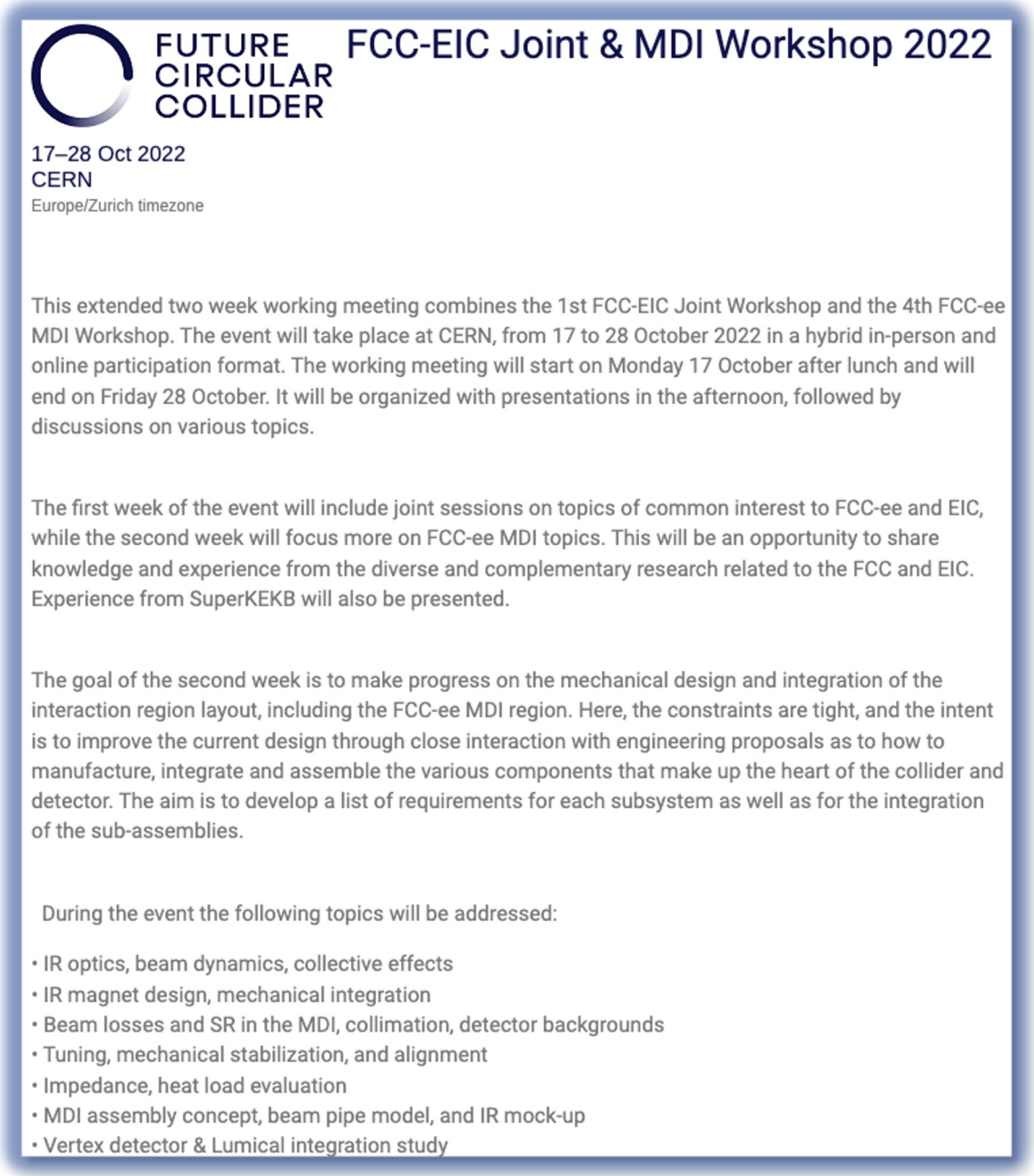
Overview

FCC-EIC Joint & MDI Workshop 2022

- **Took place 17-28 October**
- 2-week workshop
- First week joint FCC-EIC topics
- Second week FCC-ee MDI topics
- Working meeting format
- Hybrid participation format
- Sessions in the afternoon

- 91 registered participants
- 64 contributions
- International participation

Indico page of the event:
https://indico.cern.ch/event/1186798/



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FCC-EIC Joint & MDI Workshop 2022

17–28 Oct 2022
CERN
Europe/Zurich timezone

This extended two week working meeting combines the 1st FCC-EIC Joint Workshop and the 4th FCC-ee MDI Workshop. The event will take place at CERN, from 17 to 28 October 2022 in a hybrid in-person and online participation format. The working meeting will start on Monday 17 October after lunch and will end on Friday 28 October. It will be organized with presentations in the afternoon, followed by discussions on various topics.

The first week of the event will include joint sessions on topics of common interest to FCC-ee and EIC, while the second week will focus more on FCC-ee MDI topics. This will be an opportunity to share knowledge and experience from the diverse and complementary research related to the FCC and EIC. Experience from SuperKEKB will also be presented.

The goal of the second week is to make progress on the mechanical design and integration of the interaction region layout, including the FCC-ee MDI region. Here, the constraints are tight, and the intent is to improve the current design through close interaction with engineering proposals as to how to manufacture, integrate and assemble the various components that make up the heart of the collider and detector. The aim is to develop a list of requirements for each subsystem as well as for the integration of the sub-assemblies.

During the event the following topics will be addressed:

- IR optics, beam dynamics, collective effects
- IR magnet design, mechanical integration
- Beam losses and SR in the MDI, collimation, detector backgrounds
- Tuning, mechanical stabilization, and alignment
- Impedance, heat load evaluation
- MDI assembly concept, beam pipe model, and IR mock-up
- Vertex detector & Lumical integration study

Agenda

1st Week - FCC-EIC Workshop

Monday, 17 October 2022	Tuesday, 18 October 2022	Wednesday, 19 October 2022	Thursday, 20 October 2022	Friday, 21 October 2022
14:00 Welcome and Opening	14:00 IR Magnet Design	14:00 Backgrounds, Global Collimation	14:00 Beam-beam Effects Modelling, Lifetime, DA	14:00 Tuning
15:20				
15:50 Coffee Break	15:50 Coffee break	15:50 Coffee break	15:50 Coffee break	15:50 Coffee break
16:10 IR and MDI Overview	16:10	16:10 Collimator Design	16:10 Impedance	16:10
	17:00 Beam Instrumentation	17:40 Software Development		17:10 1st Week Close

Summary today

2nd Week – FCC-ee MDI Workshop

Monday, 24 October 2022	Tuesday, 25 October 2022	Wednesday, 26 October 2022	Thursday, 27 October 2022	Friday, 28 October 2022
14:00 Opening of MDI Workshop	14:00 IR Tolerances, Alignment, Stabilization	14:00 IR Mechanical Model and Mock-up	14:00 MDI Assembly, Detector Integration	14:00
14:30				14:30 Workshop Close
15:50 Coffee break	15:50 Coffee break	15:50 Coffee break	15:50 Coffee break	15:30
16:10 IR Collimation, Detector Backgrounds	16:10	16:10 IR Mechanical Model and Mock-up	16:10 Beamstrahlung Dump	15:50 Coffee break
	16:50 IR Magnet Design			

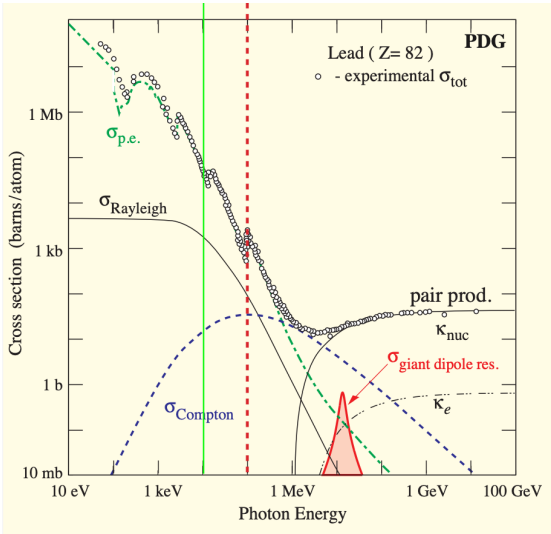
Timetable:

https://indico.cern.ch/event/1186798/timetable/

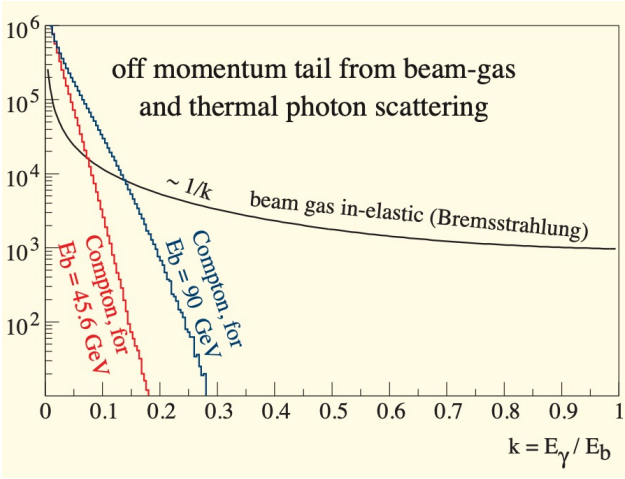
Background sources

H. Burkhardt (talk)

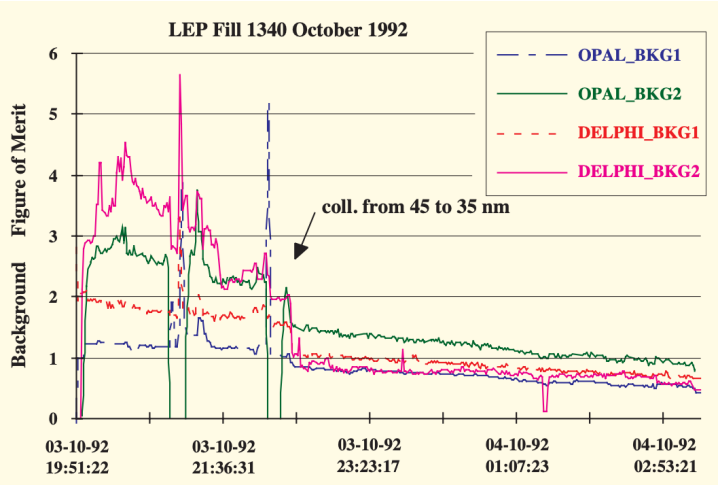
- **Single beam background process**
  - **Primary:**
    - Synchrotron radiation, Beam gas, Thermal photon
  - **Secondary:**
    - Compton, Rayleigh, specular reflection, nuclear
- **Machine-induced**
  - Top-up injection
  - Halo generation
- **Collisions**
  - Beamstrahlung
  - Bhabba scattering



Photon cross-section



Beam tails

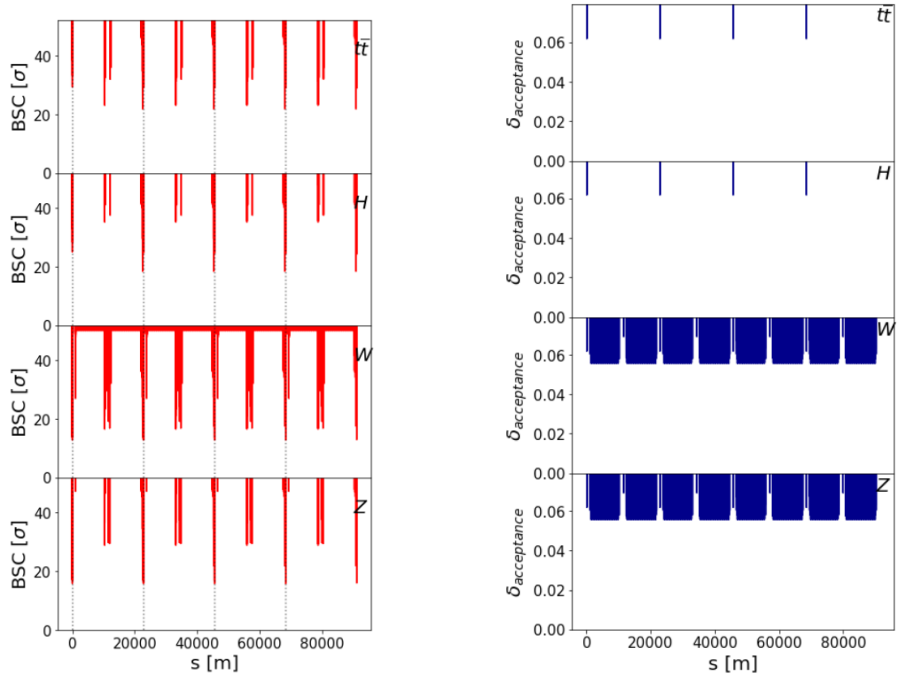


LEP experience

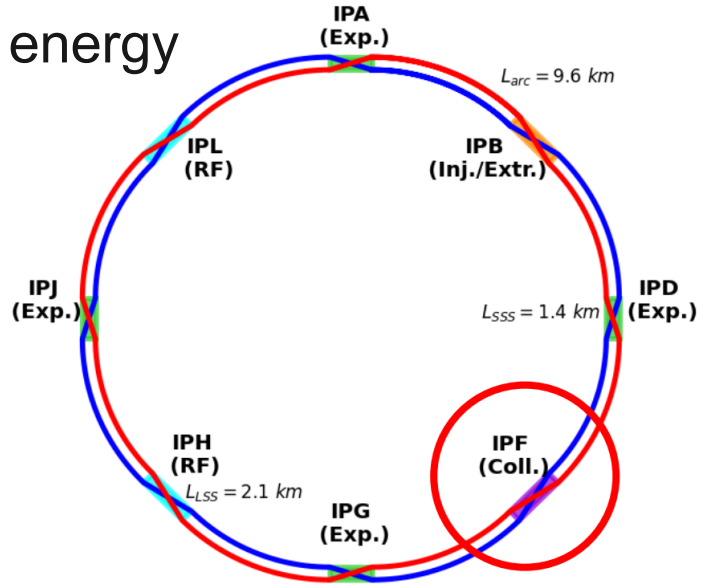
Global collimation

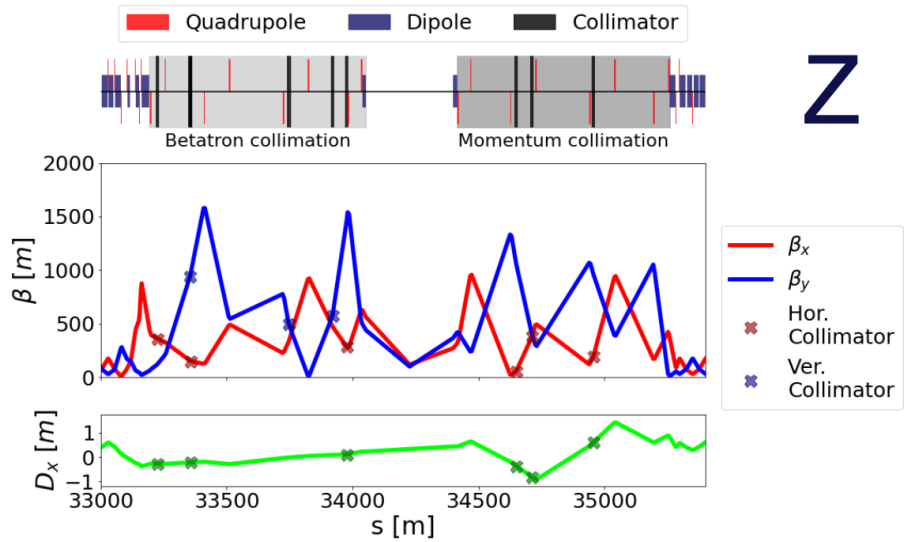
M. Hofer (talk)

- Need to protect the FCC-ee from up to 20.7 MJ stored beam energy
- Aperture studies ongoing
- Halo collimation system implemented in PF
- Two-stage collimation system per plane
  - Horizontal and vertical betatron, off-momentum
  - Must protect the SR collimators and aperture bottlenecks



Aperture bottlenecks for the different operating modes



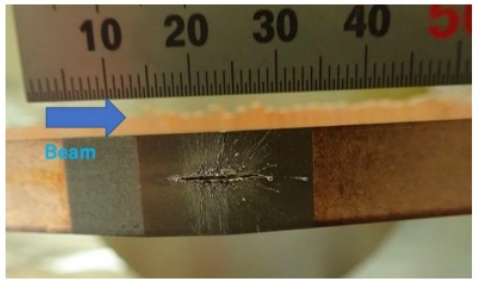


Collimation optics for the Z

Collimation studies

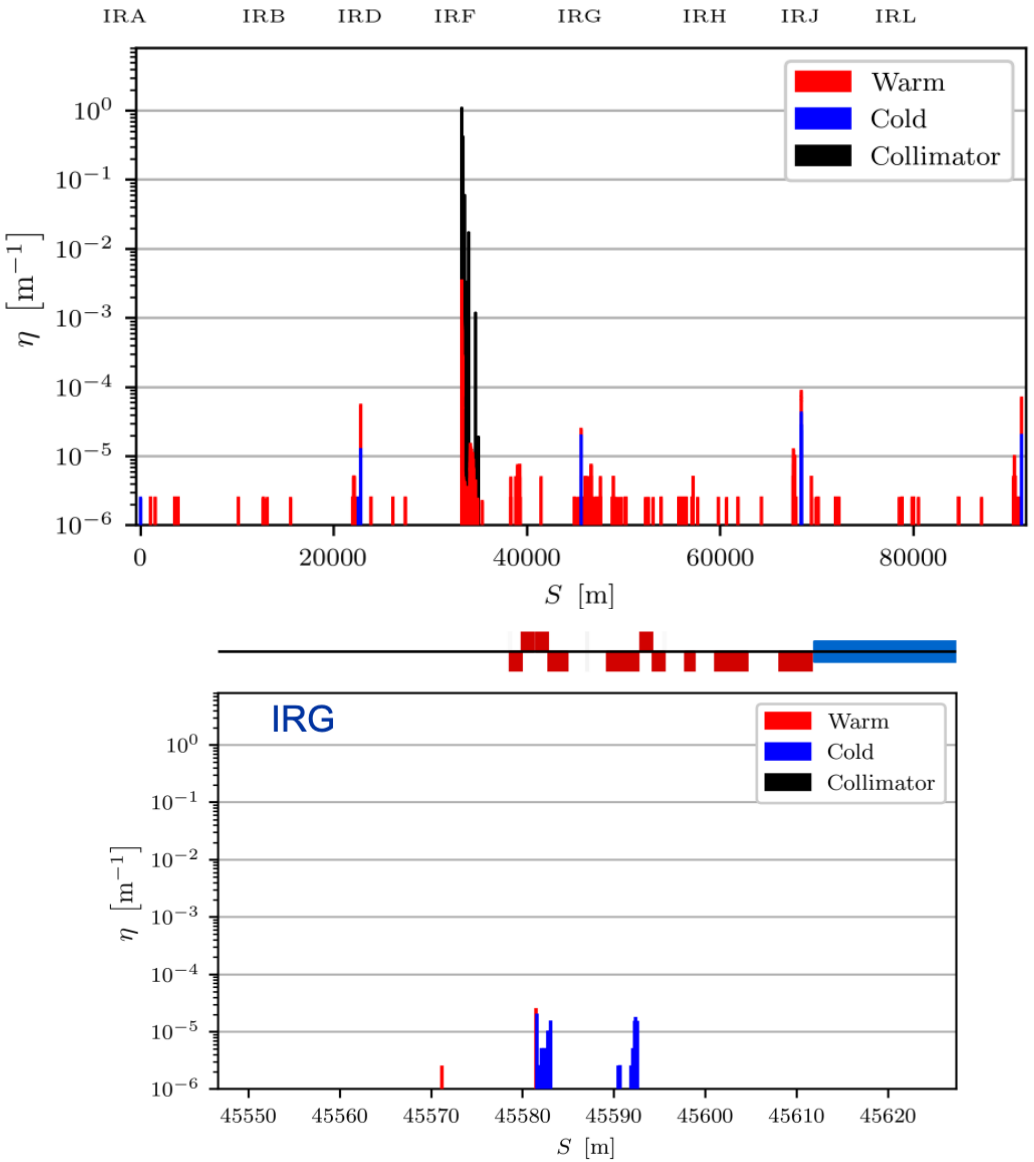
- Using newly-developed simulation tools to study collimation for the FCC-ee (talk)
- First considerations for collimator parameters (**G. Broggi**, talk)
- Currently focussing on beam halo losses:
  - Workflow similar to LHC studies (**B. Lindstrom**, talk)
  - IR losses mostly in the vertical plane on FF quads
  - No statement on the performance yet
- Other beam loss scenarios are critical:
  - Spent beam, injected beam, failures

Damaged jaw of D02V1 in LER due to the sudden beam loss



SuperKEKB experience
T. Ishibashi (talk)

A. Abramov (talk)

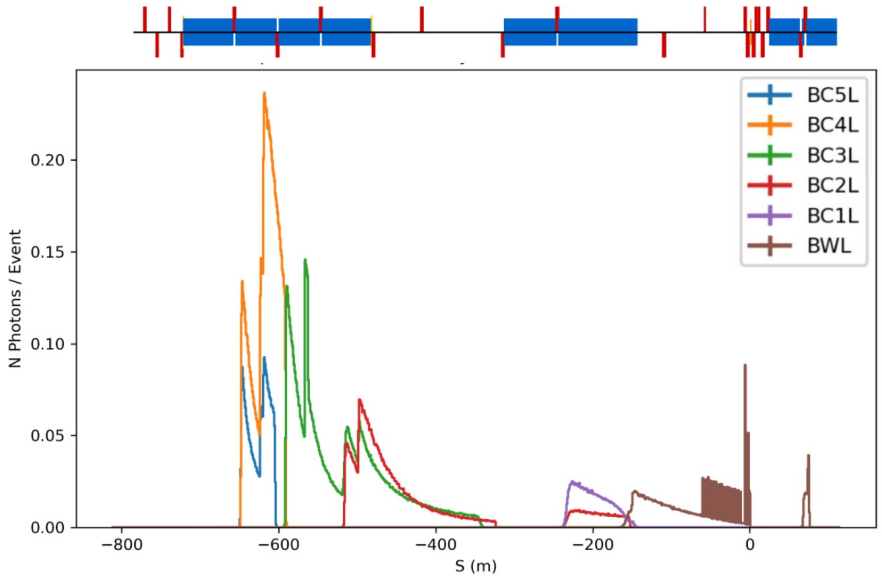


Loss maps for Z mode, Beam 1 Horizontal

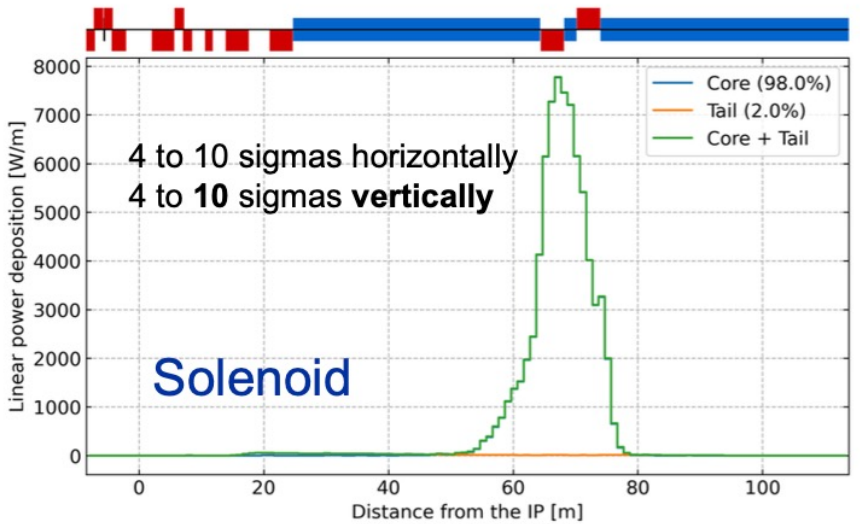
SR backgrounds

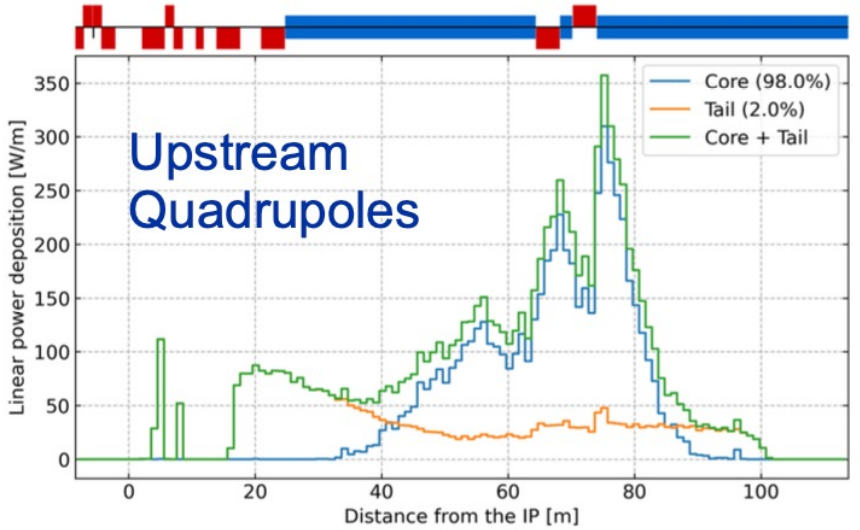
K.D.J. André (talk)

- Interaction region lattices for the 4 operation modes implemented in BDSIM
- Dipole, solenoid and quadrupole radiation evaluated
- Radiation from last bend reaches the IP
- SR photons from solenoid do not hit near the IP
- SR from FF quadrupoles leads to losses near the IP, in particular when beam tails are considered



SR from dipoles



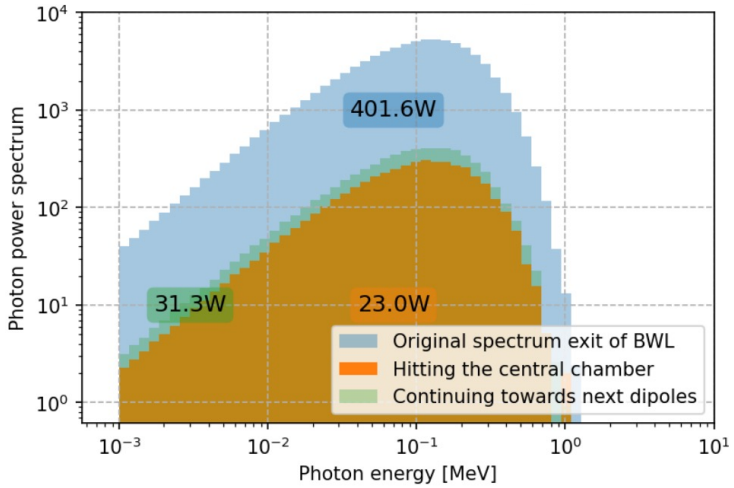


SR from beam tails in quads and solenoid for Z

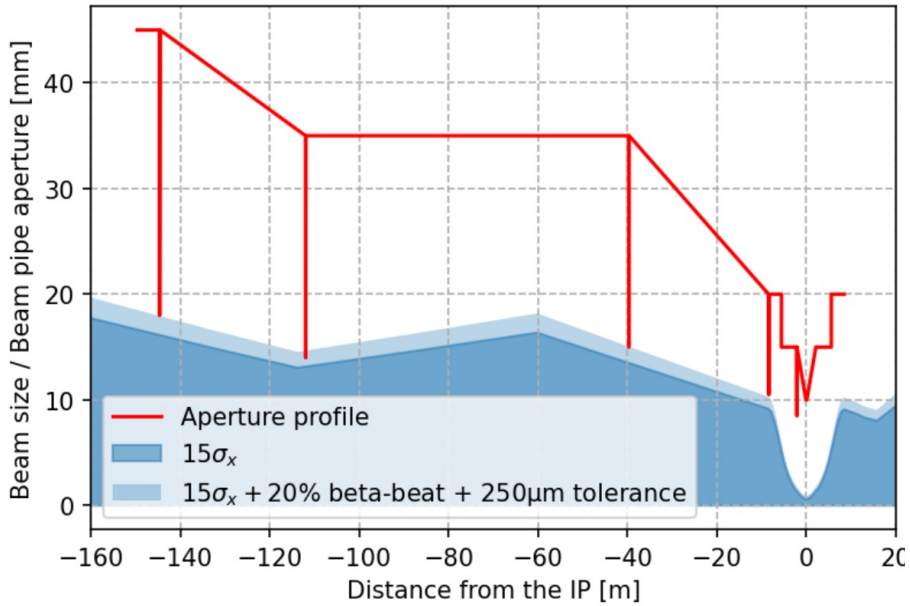
IR collimation and masking

K.D.J. André (talk)

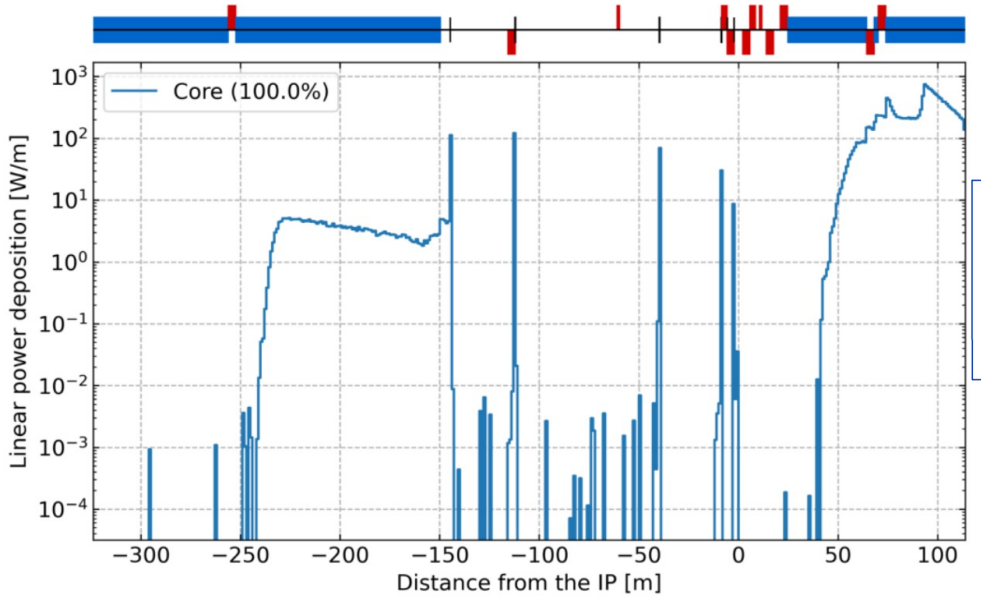
- Collimators and masks are placed to protect the beampipe, FF quads, and detector from SR
- 4 horizontal and 2 vertical collimators, 2 masks, per IP
- The settings are studied for all beam modes
- Configuration for ttbar and Z feasible, W is a challenge



Unshielded case



Horizontal IR collimators and masks for ttbar



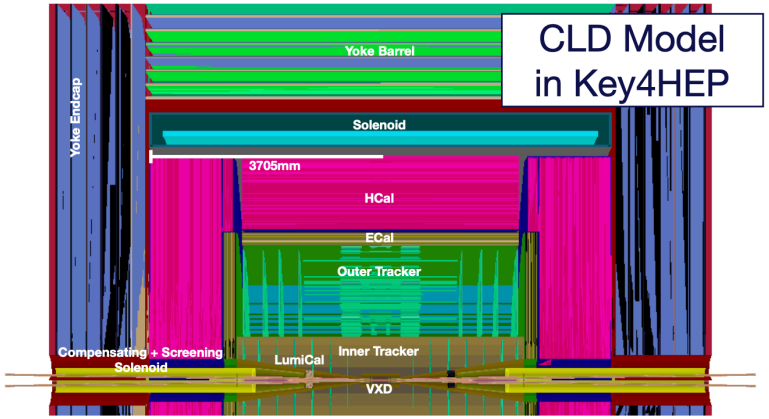
Power deposition from BWL radiation for ttbar

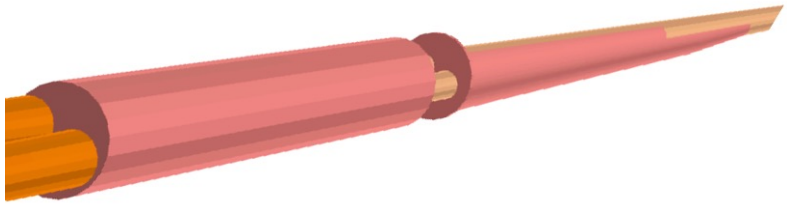
COLL.BWL is 10cm of tungsten absorbing **124W**
COLL.QC3L is 10cm of tungsten absorbing **124W**
COLL.QT1L is 10cm of tungsten absorbing **70W**
COLL.PQC2LE is 10cm of tungsten absorbing **25W**
MSK.QC2L is 2cm of tungsten absorbing **0.1mW**
MSK.QC1L is 2cm of tungsten absorbing **10W**

Detector impact

A. Ciarma (talk)

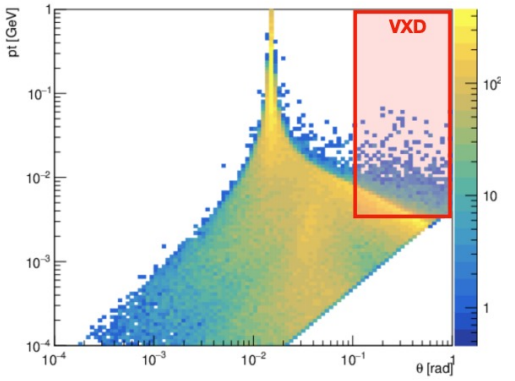
- CLD detector and MDI model in Geant4 adapted to 10 mm beampipe
- Collision products, beam, and photon losses are now studied
- Occupancy from incoherent pair production tolerable
- Occupancy from beam halo losses only concerning at ttbar
- Preliminary studies show little quench risk for the FF quads due to halo losses.
- Preliminary studies show photon losses absorbed or deflected by mask
- The shielding has come up in discussions – 180 kg of Tungsten. Is it needed/possible?



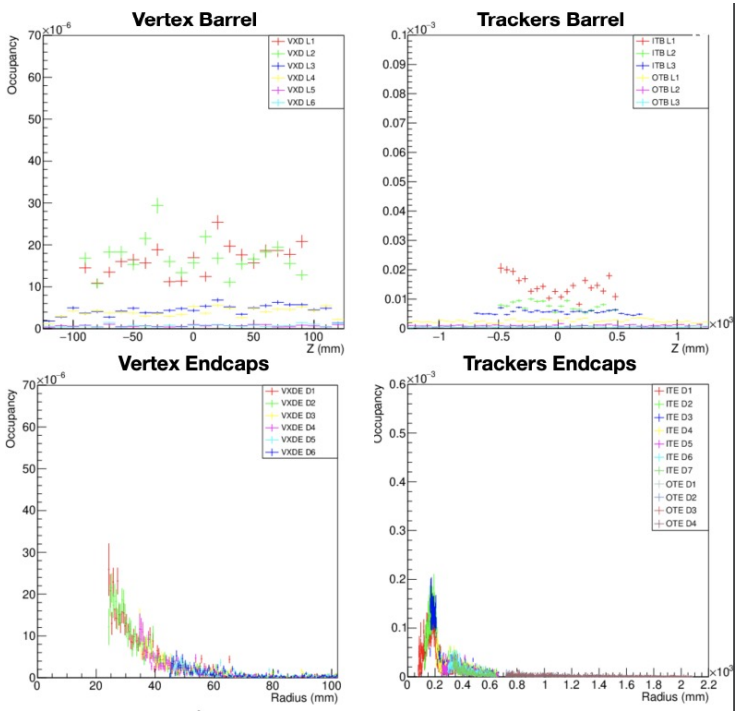


Shielding

	Z	WW	ZH	Top
Pairs/BX	1300	1800	2700	3300
Max occup. VXDB	70e-6	280e-6	410e-6	1150e-6
Max occup. VXDE	22.5e-6	95e-6	140e-6	220e-6
Max occup. TRKB	9e-6	20e-6	38e-6	40e-6
Max occup. TRKE	110e-6	150e-6	230e-6	290e-6



Incoherent pair creation



Beam halo losses at the Z

Summary

- State of the FCC-ee backgrounds studies presented at the workshop:
  - The studies of backgrounds in the FCC-ee are ongoing
  - The global collimation model is under study and iteration
  - The first configuration of the synchrotron radiation collimators is available
  - Studies of the detector impact are investigating the effect of collision products, halo beam losses, and synchrotron radiation

- Next steps:
  - Iterate on the SR collimator design and settings
  - Integrate the SR collimators with the global collimation for beam loss studies
  - Improve the detector and MDI models used for background studies
  - Investigate different sources of backgrounds, beam loss scenarios, and failure modes

Thank you!