MDI Status Report

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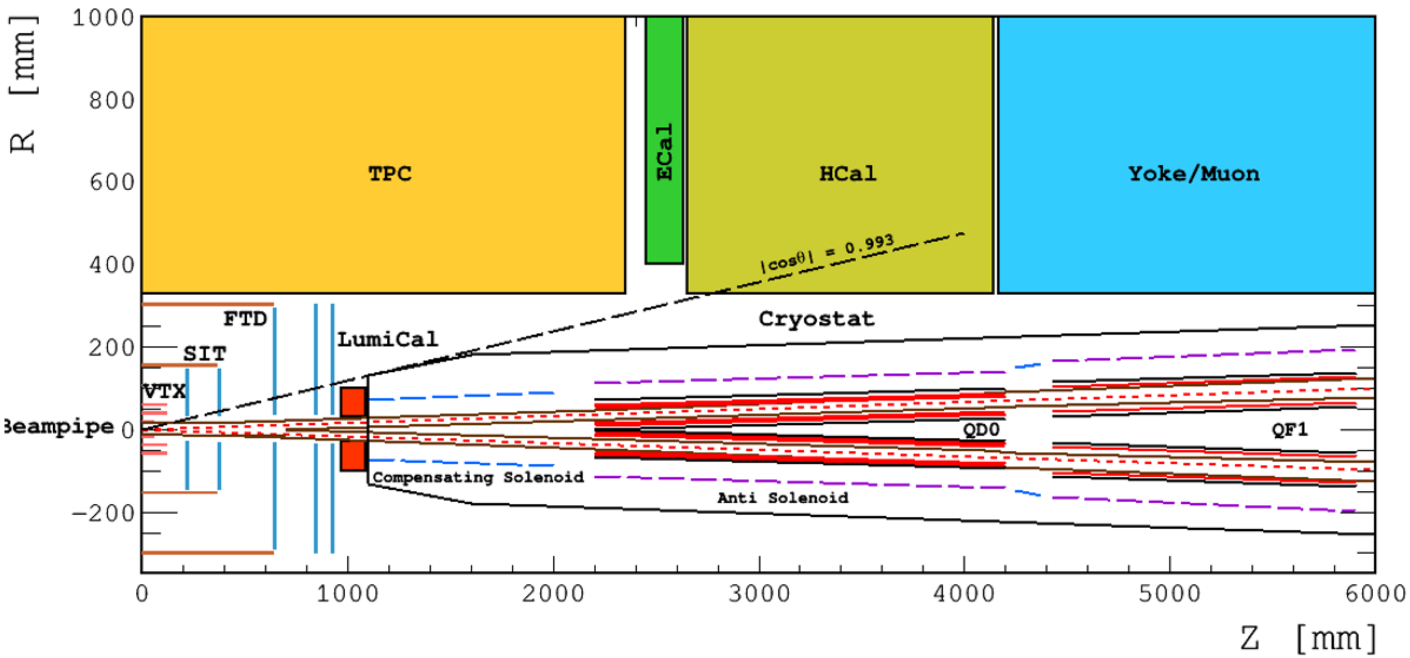
13 July 2018

MDI CDR Content

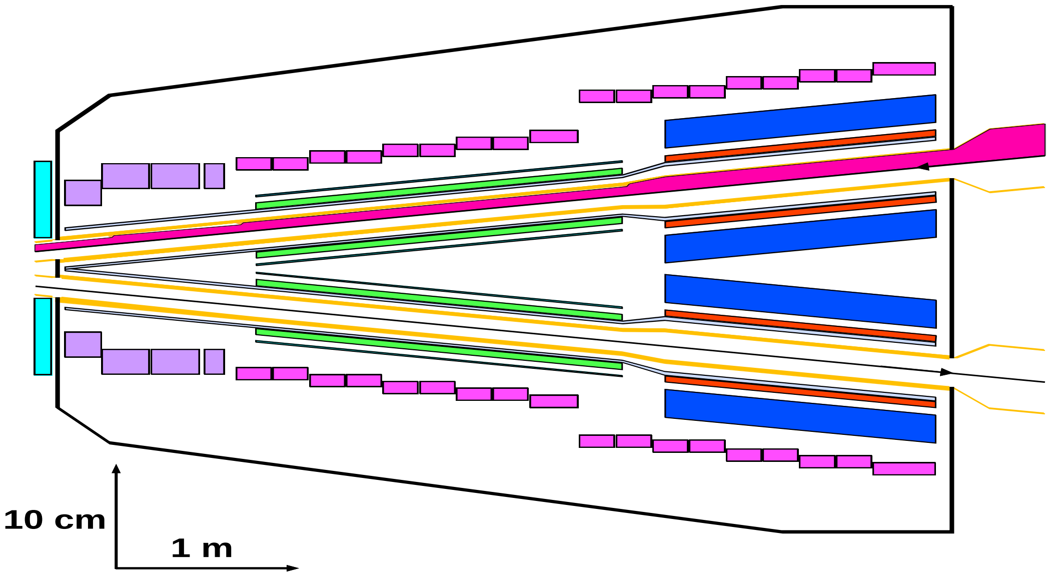
Interaction Region

- Small update to the interaction region layout → Missing Yoke plug-in, inner radii of HCal and Yoke/Muon not exactly the same as implemented in Mokka



Final Focusing

- To follow up necessary updates (e.g. improved layout of the compensating magnet) and take some texts from the Acc CDR (reviewed)

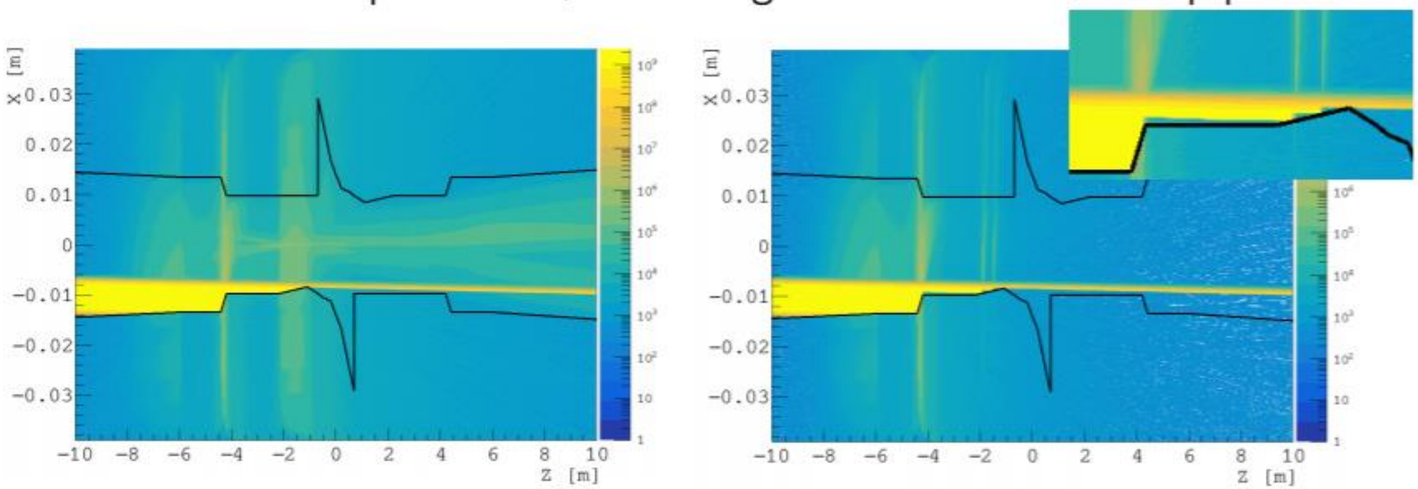


Radiation Backgrounds

Synchrotron Radiation

- Studies for CDR considered completed, updating the mask design description

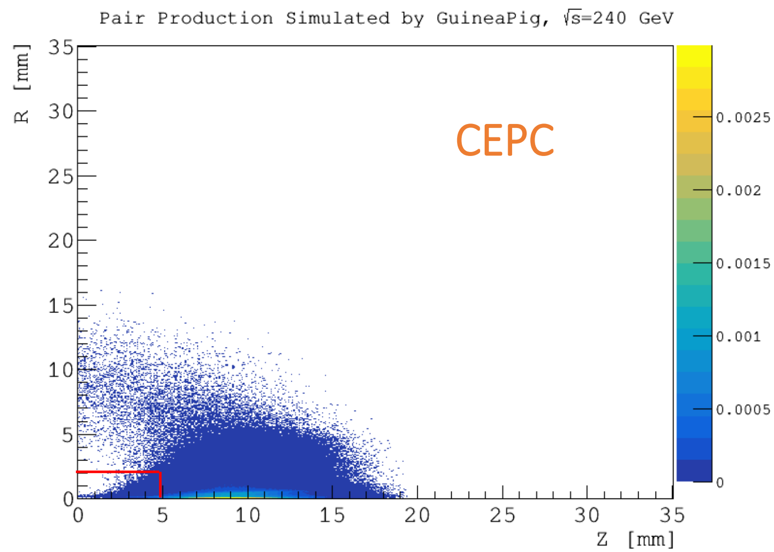
- Three masks at 1.51, 1.93 and 4.2 m along the beam pipe to the IP to block SR photons → shielding to the central beam pipe

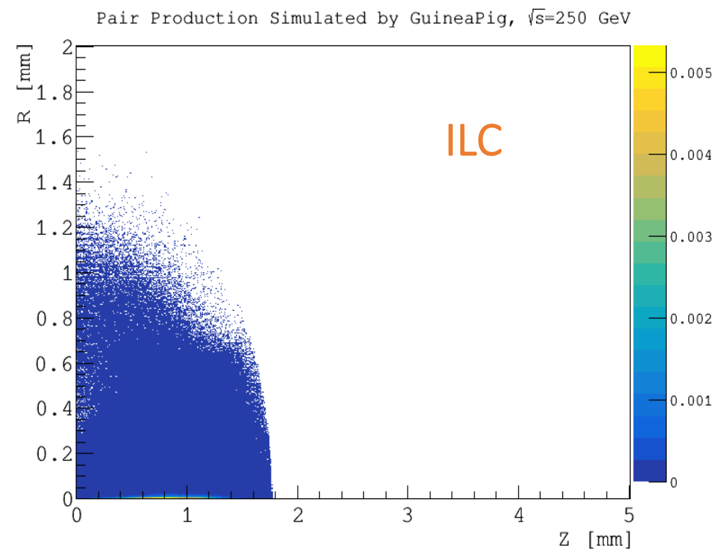


- Number of photons per bunch hitting the central beam pipe dropping from 40, 000 to 80; power deposition reduced considerably

Beamstrahlung/Pair Production

- Missing feature of external field in simulation





- GuineaPig tracks charged particles to $n*\sigma_{x/y}$, approximated 2D magnetic field in the transverse plane → even more problematic for larger beam size, e.g. W/Z
- Request sent to the authors and promised to implement the feature when having time in June, but did not happen

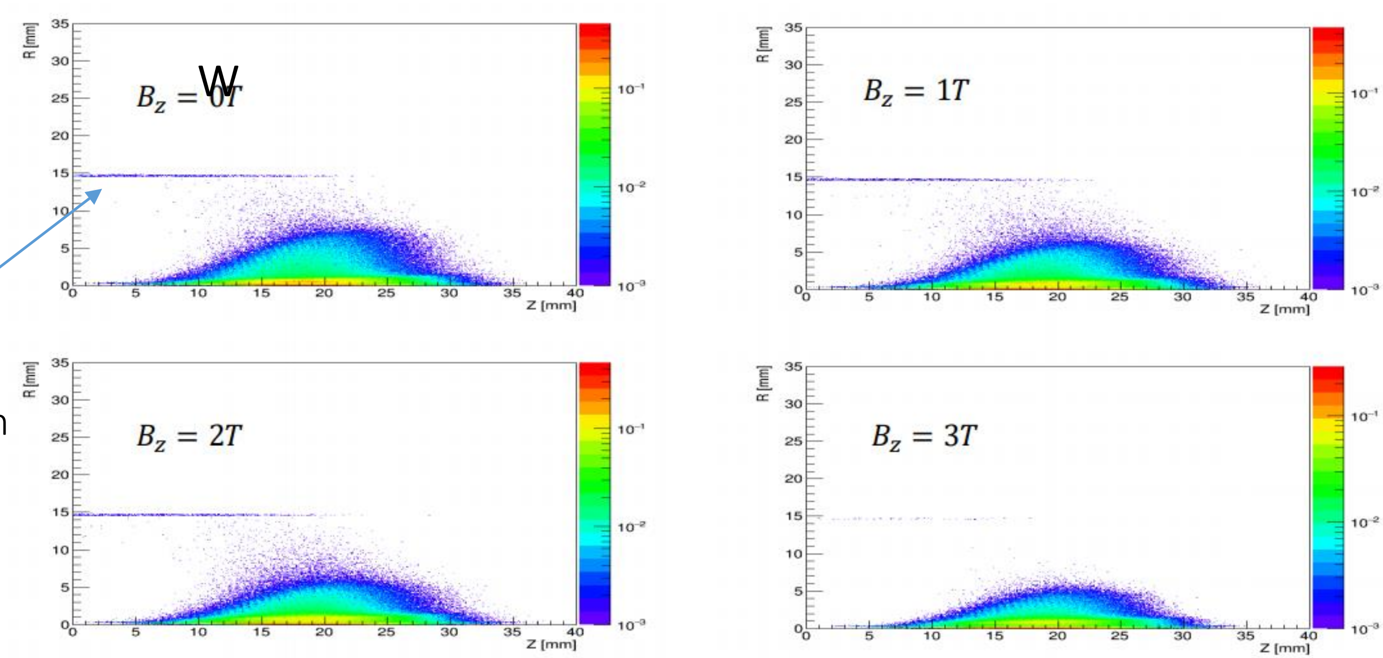
Temp Fix

- W. Xu dug deep into the code and read relevant papers in the hope to extend the field to 3D, exploring the x->y->z symmetry

$$\begin{pmatrix} v'_x \\ v'_y \\ v'_z \end{pmatrix} = \begin{pmatrix} 1-0.5\theta^2+0.5\theta^2 b_x^2 & b_z\theta+0.5\theta^2 b_x b_y & -\theta b_y+0.5\theta b_x b_z \\ -b_z\theta+0.5\theta^2 b_x b_y & 1-0.5\theta^2+0.5\theta^2\, b_y^2 & b_x\theta+0.5\theta b_z b_y \\ \theta b_y+0.5\theta b_x b_z & -b_x\theta+0.5\theta b_y b_z & 1-0.5\theta^2+0.5\theta^2 {b_z}^2 \end{pmatrix} \begin{pmatrix} v_x \\ v_y \\ v_z \end{pmatrix}$$

Temp Fix

- Not fully validated (contacting the author to confirm if the implementation is right or not), but seems to be in the right direction …



Part of the particles are soft but created early so that they can reach the beampipe if allowed to move with Bz.

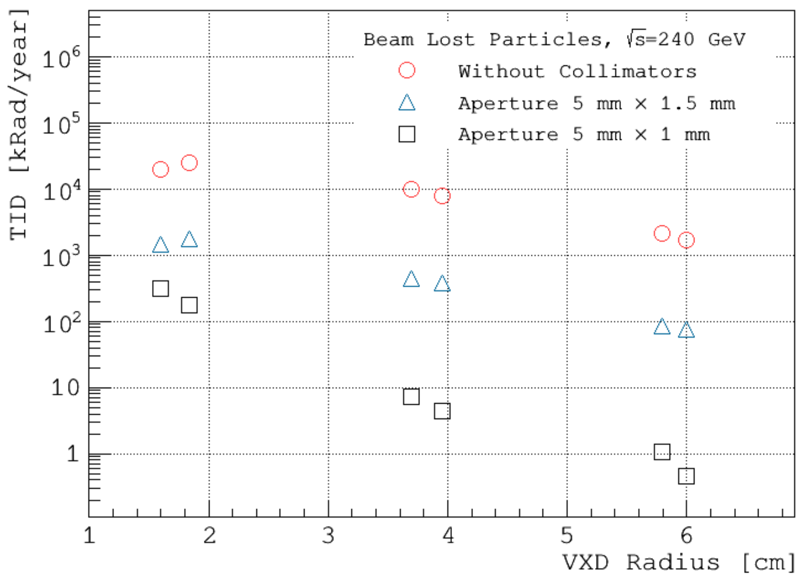
- Stronger field confines better soft charged particles… One more important fix: stop tracking particles before hitting the beampipe

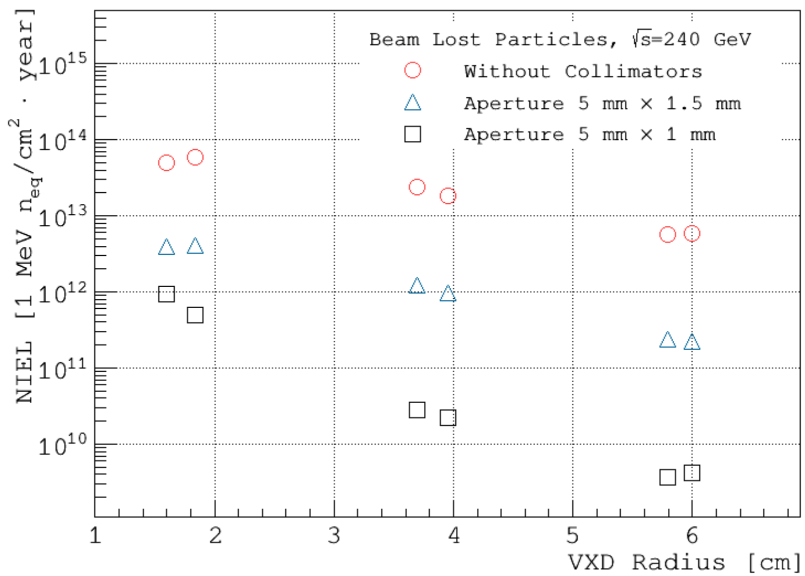
Next

- Launch more Higgs jobs to evaluate the impact of the temp fix (may have to stay with it for the CDR results, to-our-best-knowledge)
- GuineaPig simulation CPU hungry (cannot be optimized) → heavy load to the batch system but for days …
  - Generating samples: Higgs -> Z (2T) -> Z(3T) -> W
- Updating the texts as much as possible (this weekend) but will have to wait for the updated results

Beam Loss Particles

- Results for Higgs available, to be put into CDR together with text updates
- W/Z samples are being produced by acc colleagues

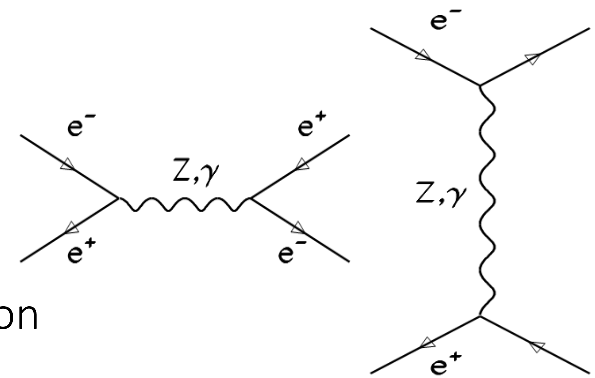




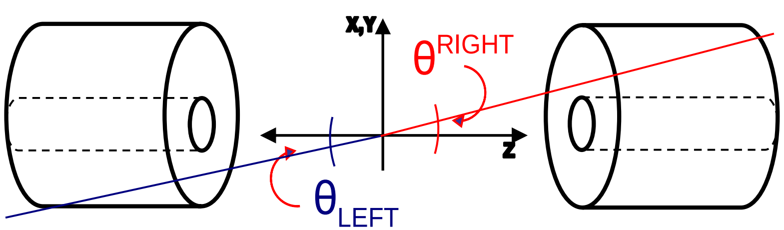
Luminosity measurement

- Z lineshape, $e^+e^- \to Z \to q\bar{q}$ is dominant, **$\sigma = 41$ nb**
- Luminosity is best provided by detecting Bhabha, $e^+e^- \to e^+e^-$, elastics scattering
  - a pure QED process, theoretical MC to *<0.1%* precision
  - triggering on a pair of scattered e^+e^-

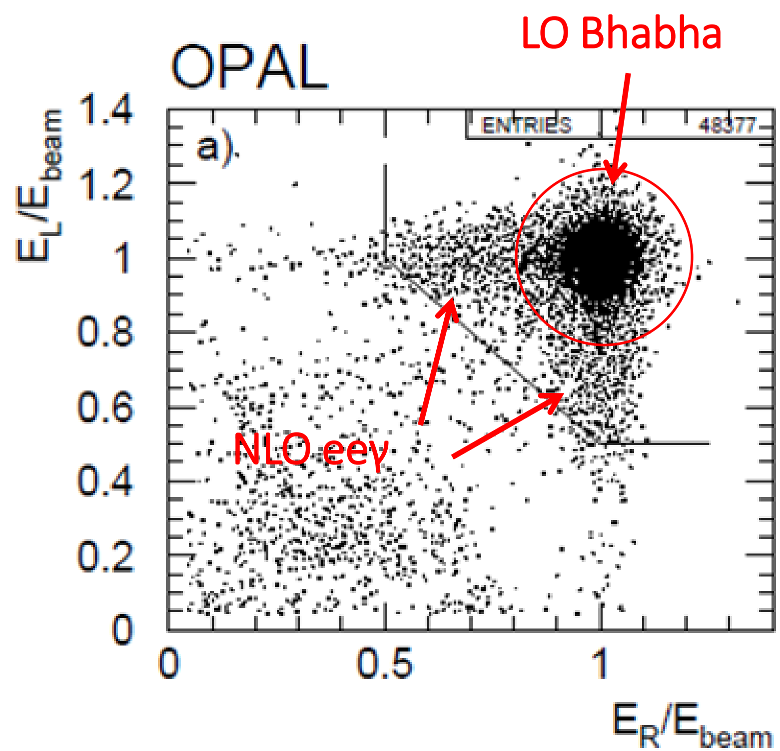
  $E(e^\pm) \sim E_{beam}$, Back-to-Back



$$\sigma = \frac{16\pi\alpha^2}{s}\left(\frac{1}{\theta_{min}^2} - \frac{1}{\theta_{max}^2}\right)$$



$\Delta\theta \equiv \theta_{RIGHT} - \theta_{LEFT}$



LumiCal precision

Luminosity is by counting Bhabha events

In a fiducial θ region $\mathcal{L} = \frac{1}{\varepsilon}\frac{N_{\mathrm{acc}}}{\sigma^{\mathrm{vis}}}$ $\sigma = \frac{16\pi\alpha^2}{s}\left(\frac{1}{\theta^2_{min}} - \frac{1}{\theta^2_{max}}\right)$

Dominant systematic error

$\delta L/L \sim 2\ \delta\vartheta/\vartheta_{min}$

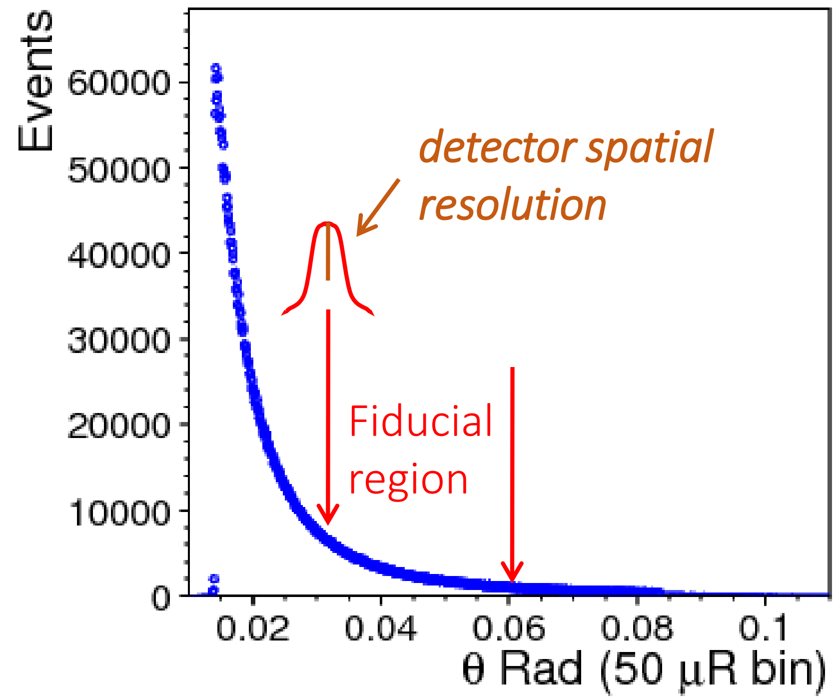
For a precision of $\boldsymbol{\delta L/L < 10^{-3}}$

LumiCal at **z = ±1 m,** θ_{min} = 30 mRad

→ *δϑ = 15 μRad* or ***dr = 15 μm***

Error due to offset on Z

→ *0.1 mm on z* or *dr = δ Rxϑ* ***= 3 μm***



offset on the ***mean***
of spatial resolution = offset on $\boldsymbol{\theta_{min}}$

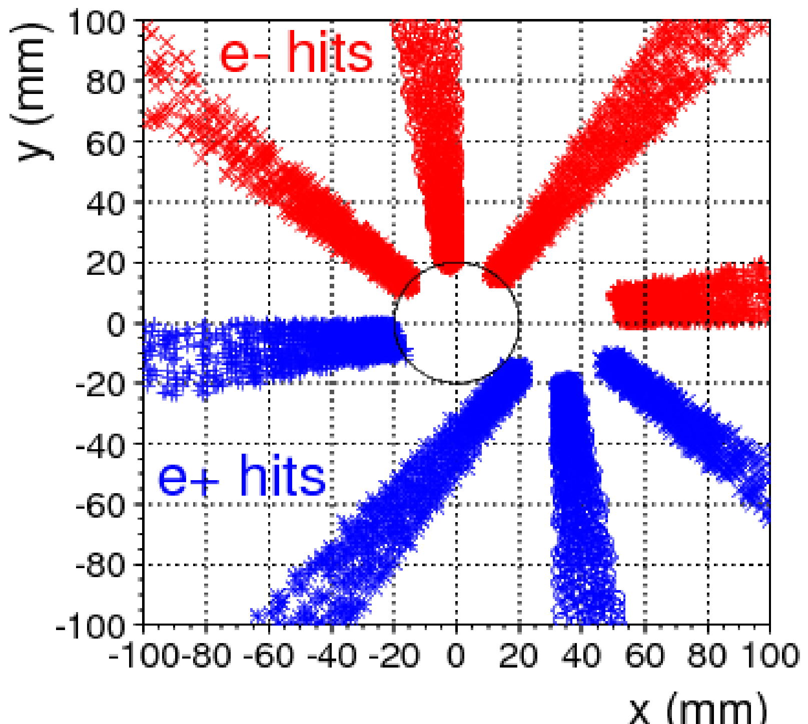
→ *dominant* ***LUMINOSITY error***

Boosted Bhabha

BHLUMI colliding e+ e- are back to back
Boost CEPC crossing angle of 33 mRad
Boost Bhlumi e+, e- to CEPC → *E is larger by ~.01%*
Ebeam = 50 GeV → boosted E = 50.0068 GeV

- Boosted LO Bhabha, (e^+e^-, no γ)
- e^+, e^- detected in ***fiducial acceptance of r > 20 mm***
- r-ϕ plotted in bands (every 45 deg in ϕ)
- event loss ***163 nb → 98 nb***

➔ **loss is SIGNIFICANT**
➔ ***LumiCal wants a small inner r, in OVAL shape if feasible***



Hits on detector x-y planes @z=1m

LumiCal detector options

Luminosity precision = $e^{\pm}$ detection in ***r***, at inner radius of fiducial

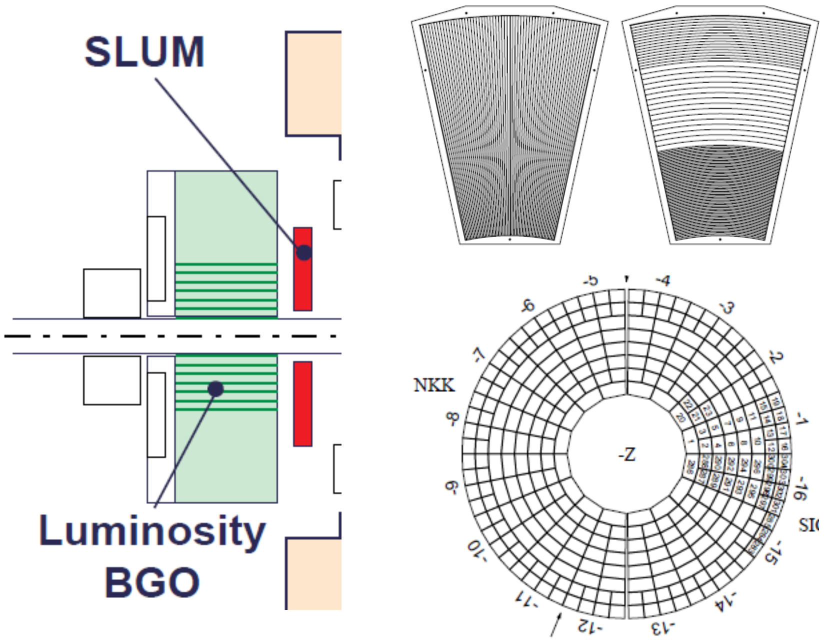
➔ **Silicon strip** is the choice!

➔ ***Alignment*** *CAN NOT reach 1 μm*

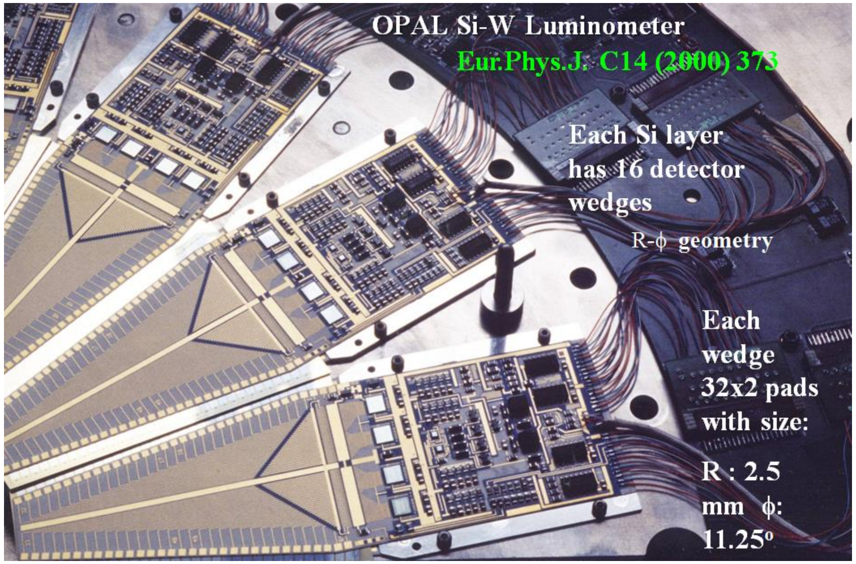
➔ ***wide strip*** *(~2mm) CAN NOT reach 10 μm resolution*

➔ *A* ***stand-alone LumiCal*** *CAN NOT calibrate its offsets to IP*

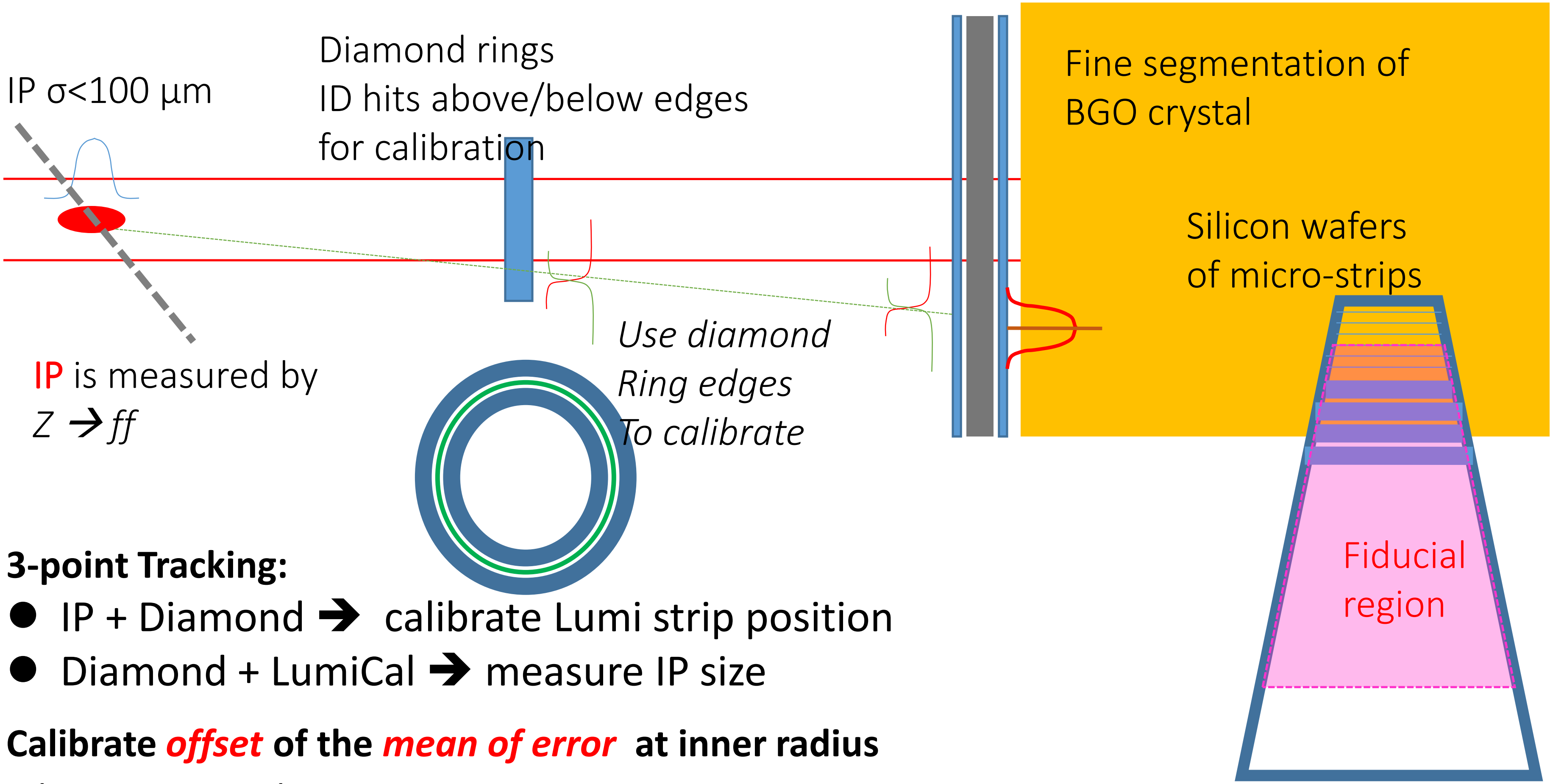
L3 Silicon layer + BGO



OPAL Si-W sandwich



LumiCal with a simple tracking ring



3-point Tracking:

- IP + Diamond → calibrate Lumi strip position
- Diamond + LumiCal → measure IP size

Calibrate *offset* of the *mean of error* at inner radius

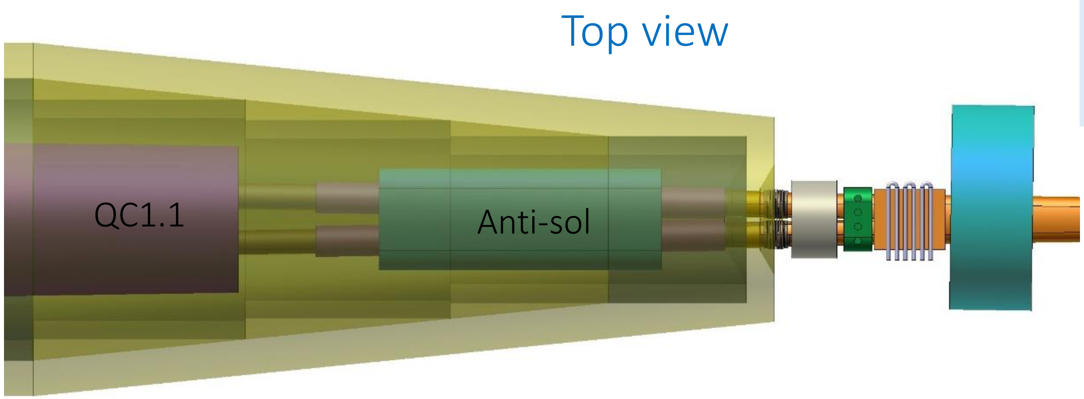
*Silicon strip resolution **~ 5 um,***

*error on mean is much smaller, **CAN reach 1 µm, δL/L ~ 0.01 %***

Detector Integration

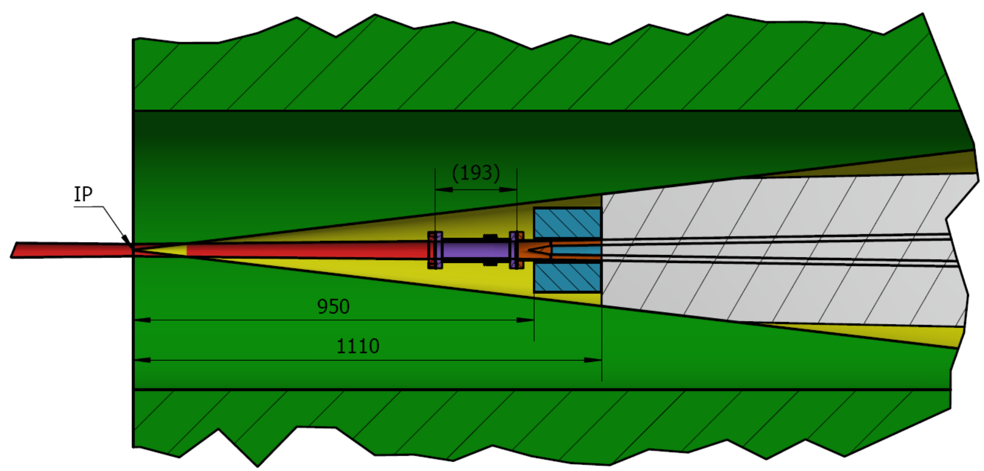
- No easy solution for the moment but will discuss this in the CDR

FCC-ee



Mounting the heavy LumiCal on the light tracker – not acceptable

CEPC



Mounting LumiCal on the magnet but with “materials” in front – not acceptable