More on Synchrotron Radiation

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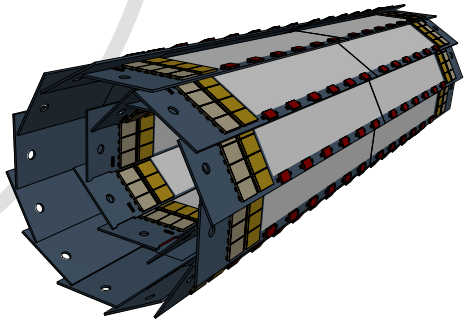
Max-Planck-Institut für Physik
(Werner-Heisenberg-Institut)

DEPFET
Active Pixel Detector



Simulation of Synchrotron Radiation

use Geant4 directly (see Yuris talk)

- allows for complicated magnetic fields (leak/fringe fields)
- well tested, already available
- time consuming to simulate that many electrons

Use SRGEN (Belle, CLEO)

- specialized generator, fast
- uses simplified magnetic field calculation
- requires its own beampipe geomentry

⇨ PySynRad, python based synchrotron radiation generator

- based on SRGEN
- uses SuperKEKB lattice from SAD
- beampipe geometry independent
- not fully validated

PySynRad

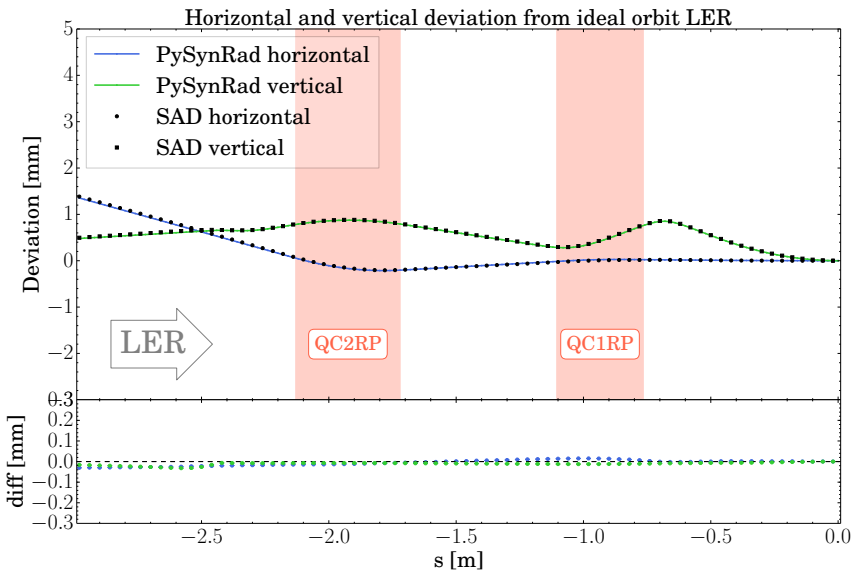
- written by Andreas Moll
- available at `https://github.com/portrain/PySynRad`

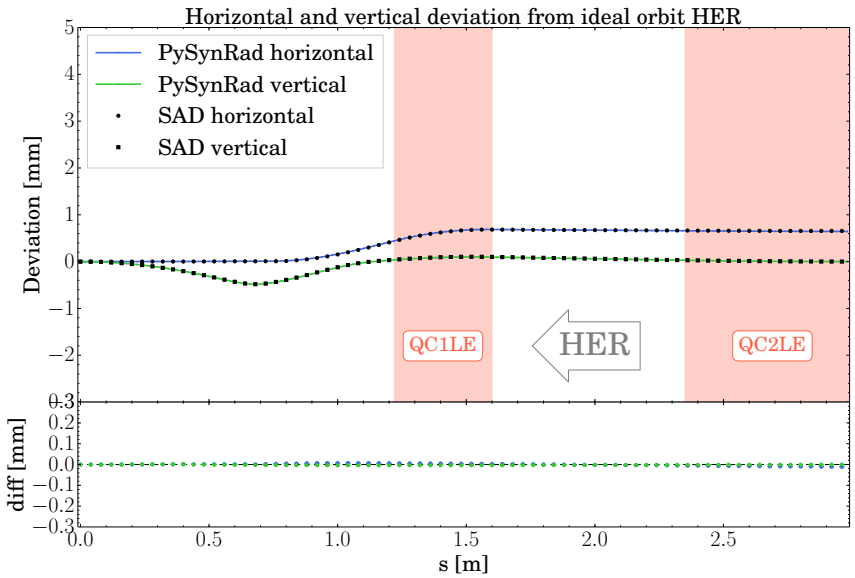
Principle:

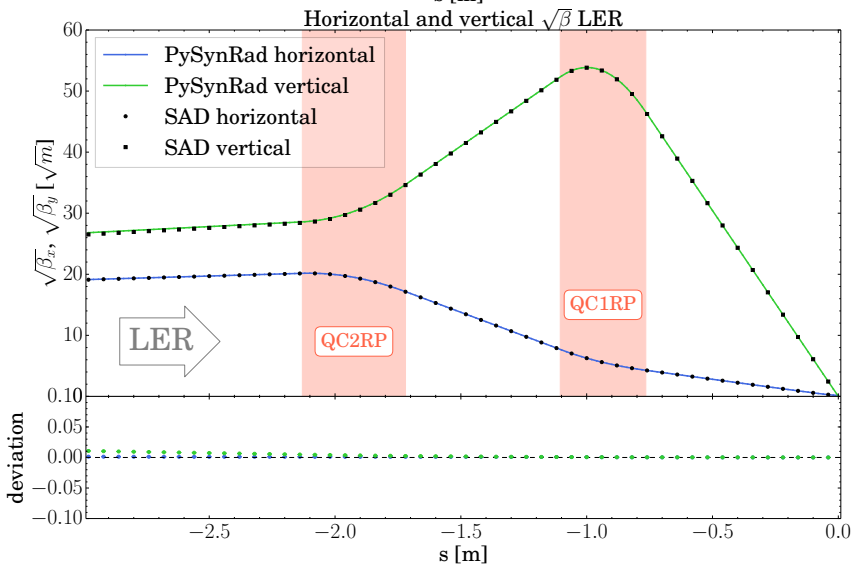
1. load SuperKEKB magnet lattice (+ HER leak field)
2. start at IP using SuperKEKB design twiss parameters
3. generate and save synchrotron radiation energy spectrum
4. propagate stepwise and calculate optimal orbit, deviation, twiss parameters
5. on each step, integrate over 10 sigma in 200×200 steps, at each point calculate the local curvature, radiation cone and the number of emitted photons.
6. discard points with radiation cone not pointing towards the IP
7. save position, direction and number of photons at each point.

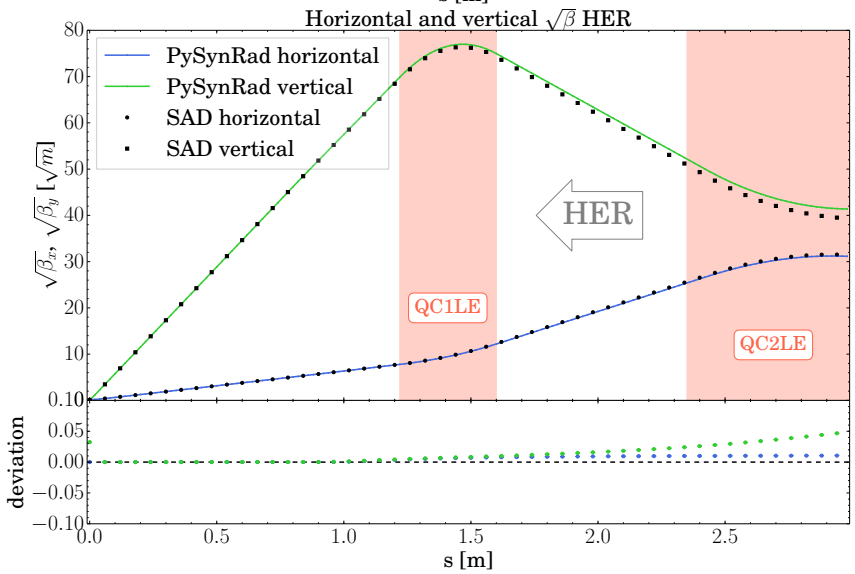
➡ simulate photons using Geant4

PySynRad vs. SAD

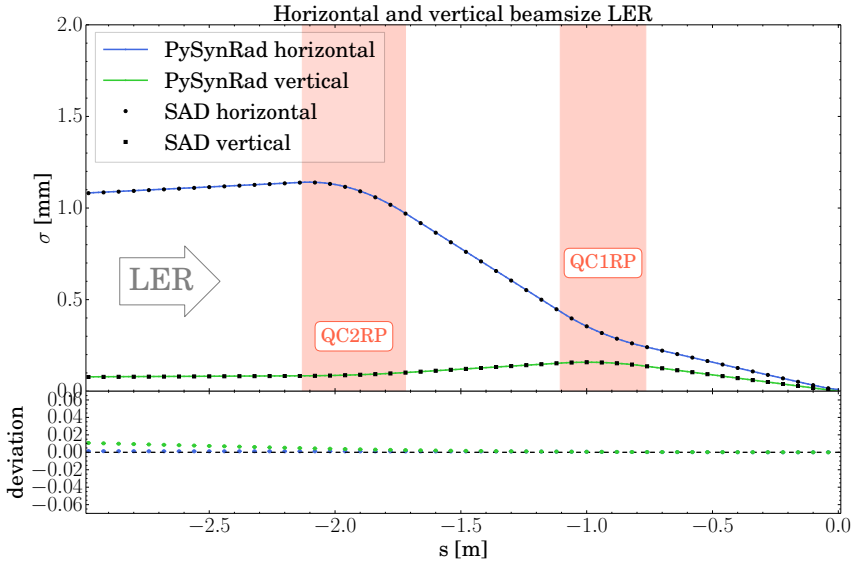


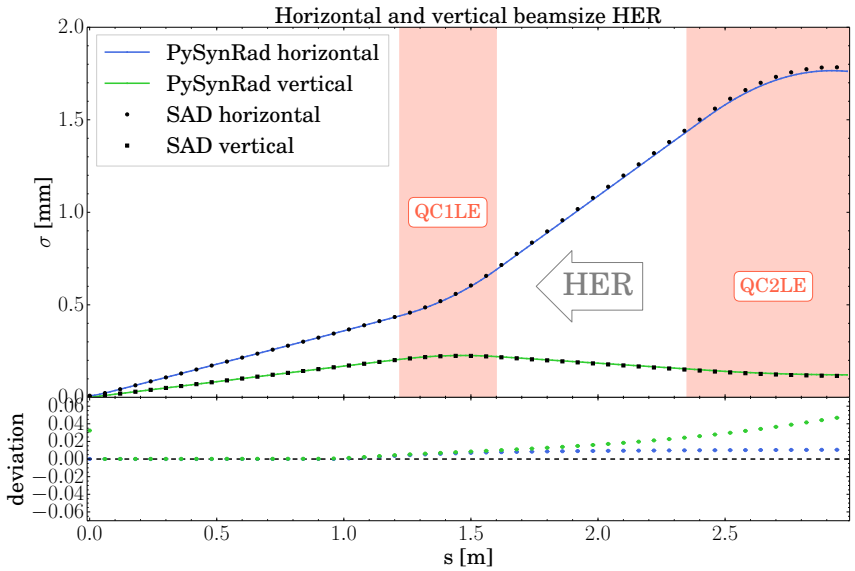






PySynRad vs. SAD



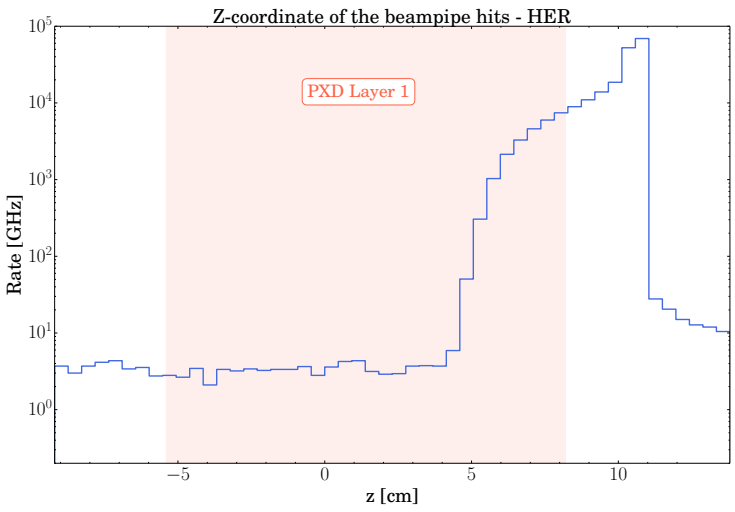


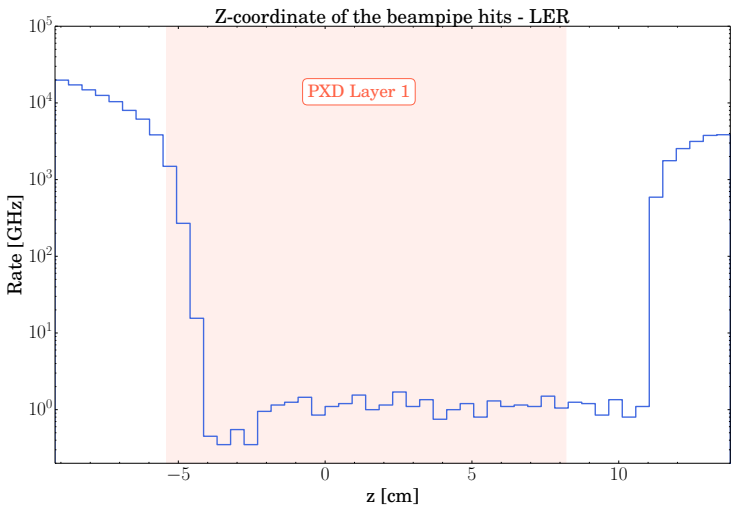
- very good agreement with SAD
- deviations at large $|s|$ due to accumulation of inaccuracies

Geant4 Simulation

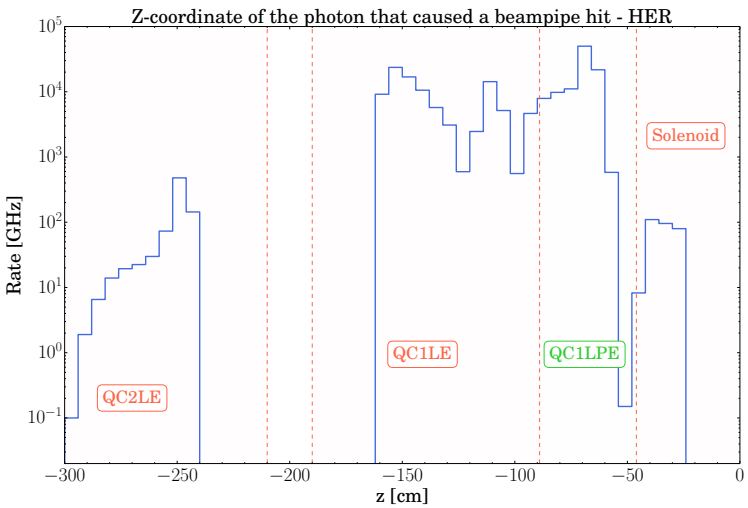
photons are simulated using Geant4 (integrated 20 ns)

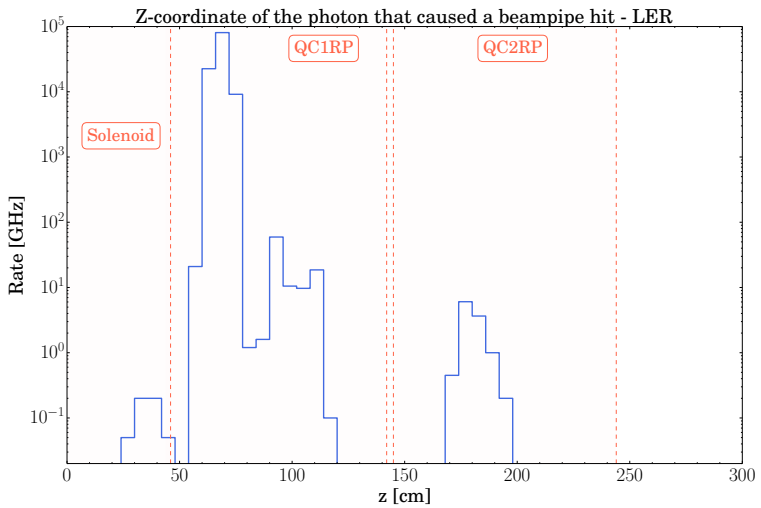
- load energy spectrum and sample points from file
- for each point
  - determine energy of photons from spectrum, cut at 5 keV
  - distribute direction evenly in radiation cone
- simulate generated photons
- save hit positons on beampipe





Geant4 Simulation





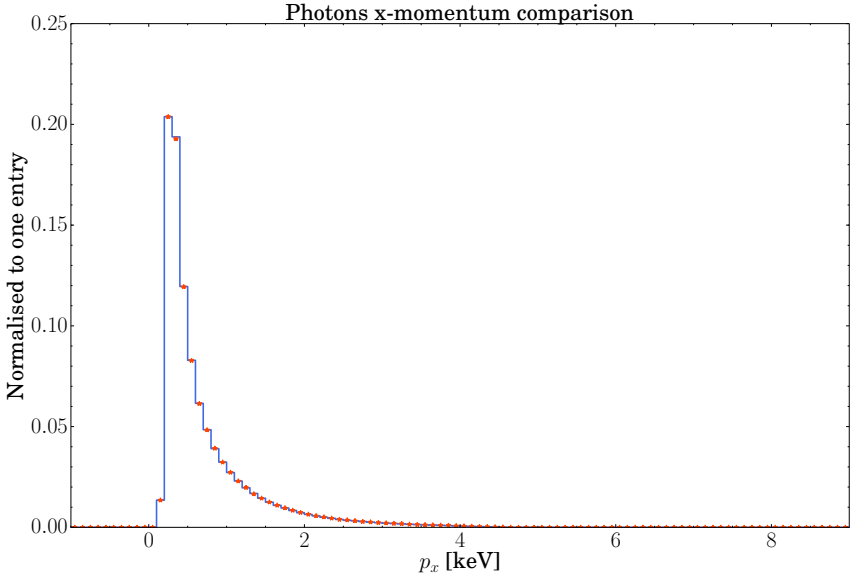
- so far, everything looks consistent with Yuris study
- majority of beampipe hits at $\phi = 0$

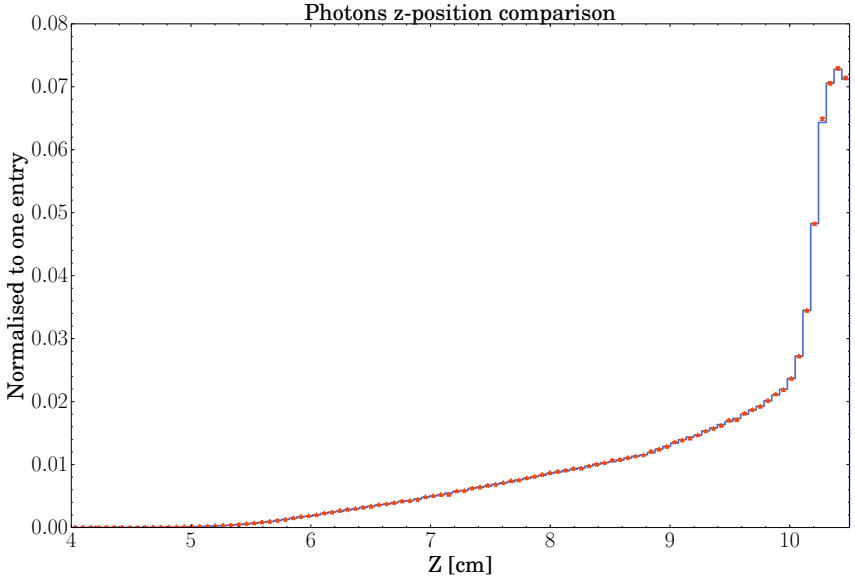
ToyMC

To extrapolate to PXD readout frame (20 µs) Andreas used ToyMC

- use ϕ, z, p_x, p_y, p_z of beampipe hits
- divide in three bins in z and ϕ respectively
- model correlations

Comparision between z position and momentum for HER

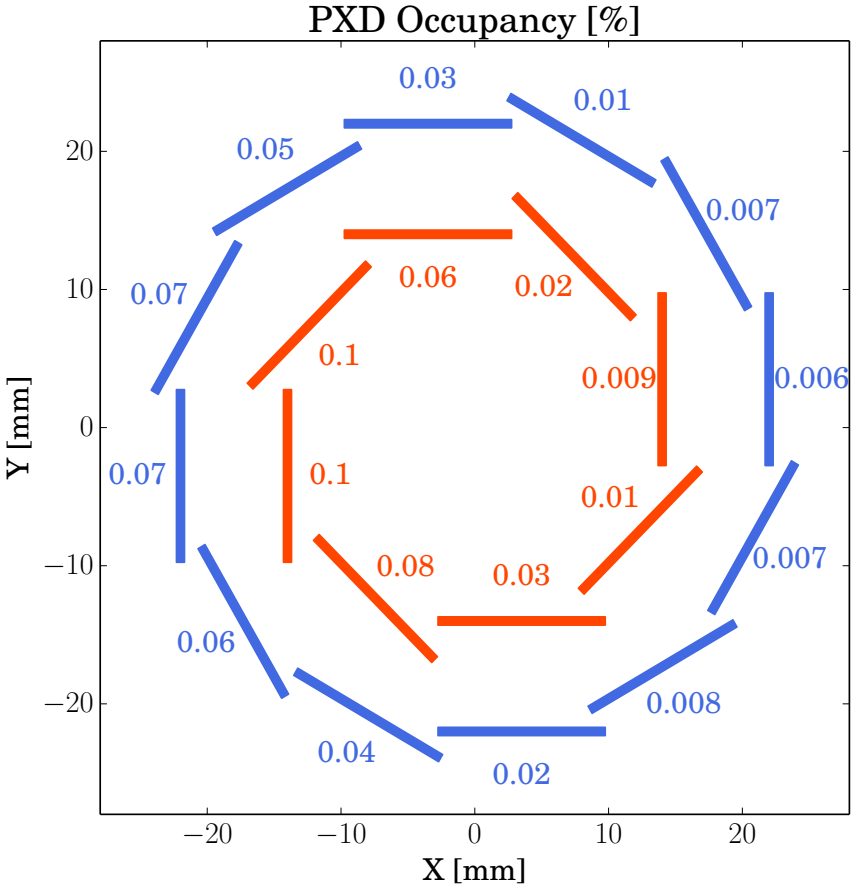




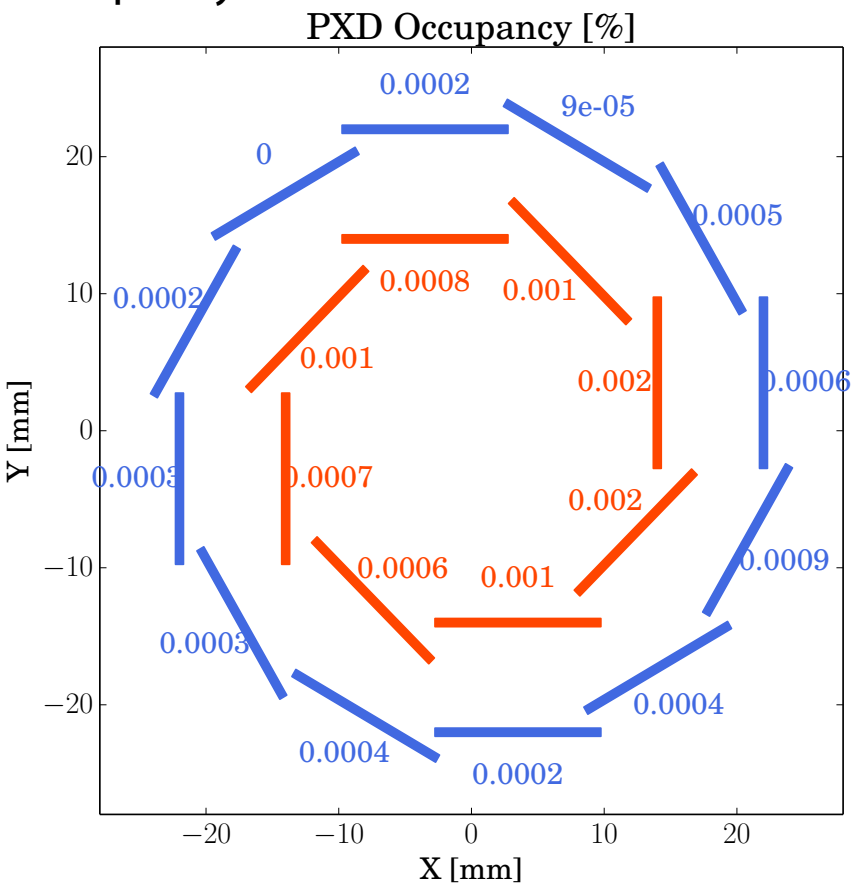
use Geant4 to simulate photons according to ToyMC PDF

Results

Occupancy HER

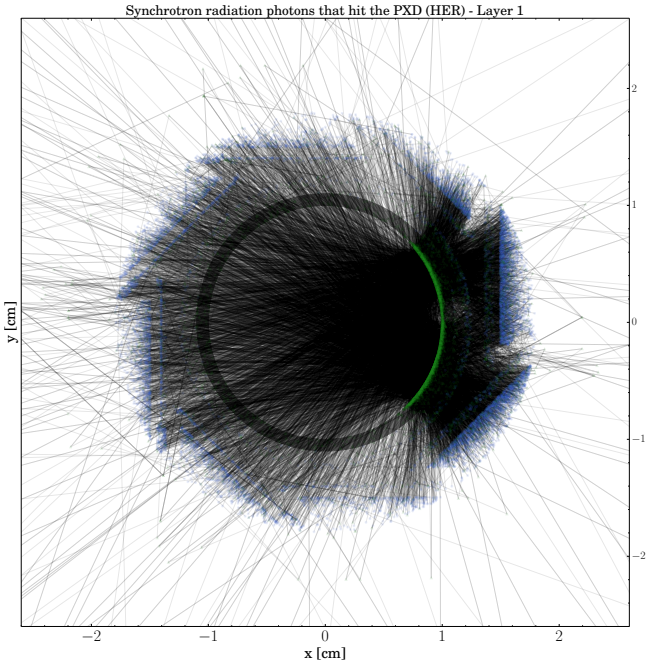


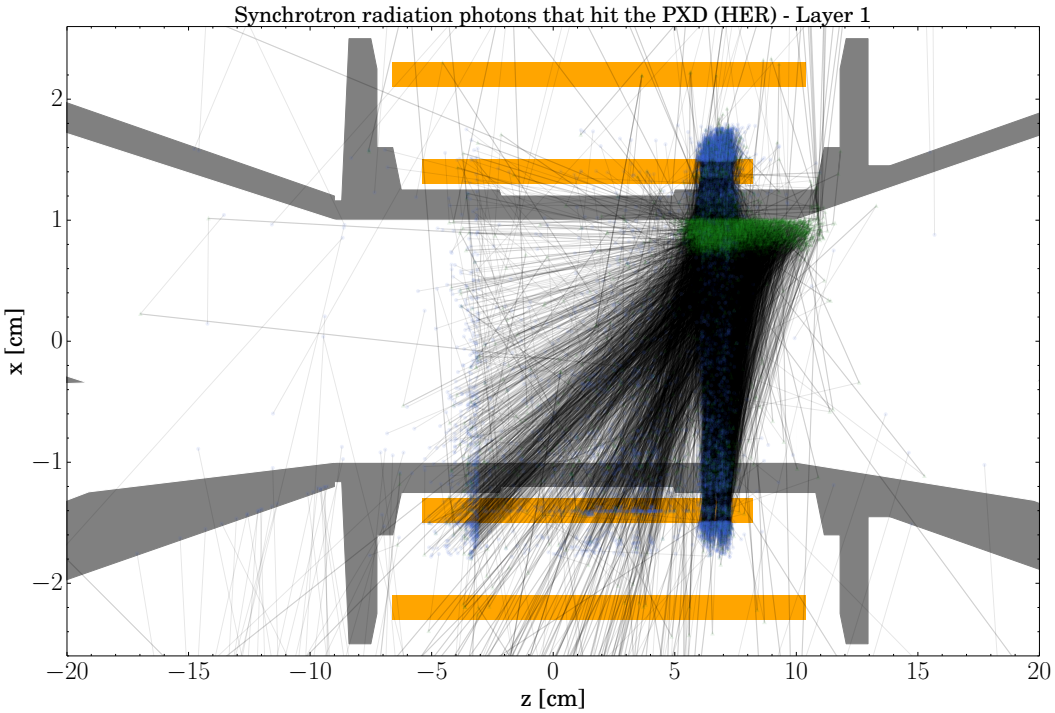
Occupancy LER



- LER: not important
- HER: highest occupancy around 180 degree
- HER: much larger than Yuris estimation

Results, examined

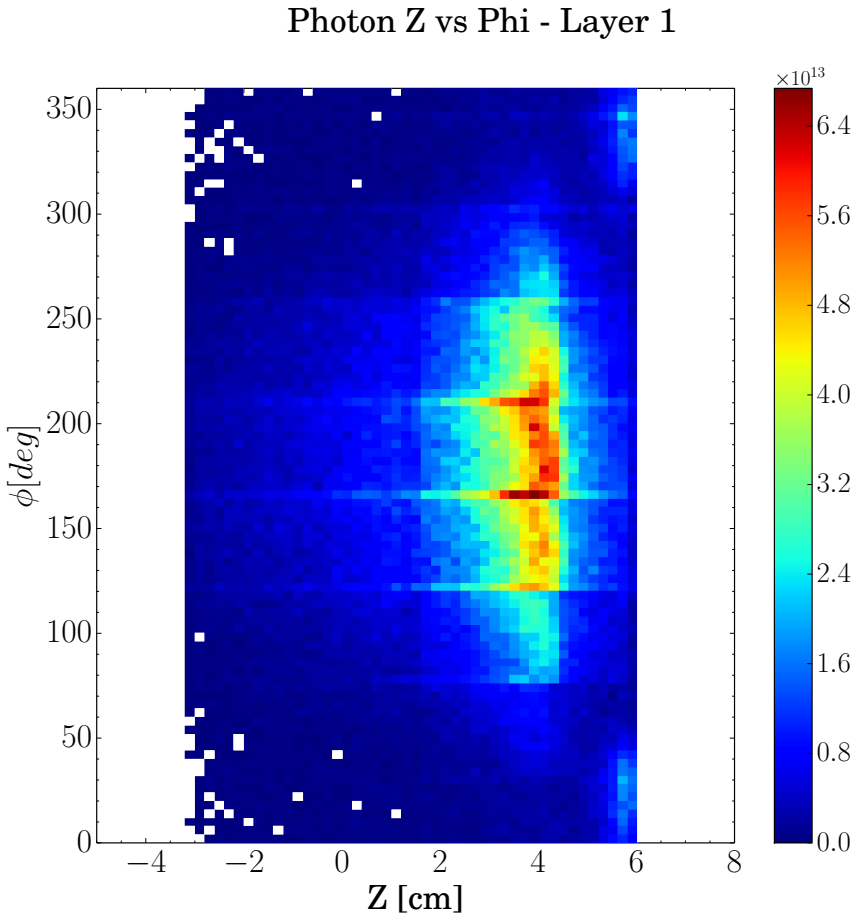


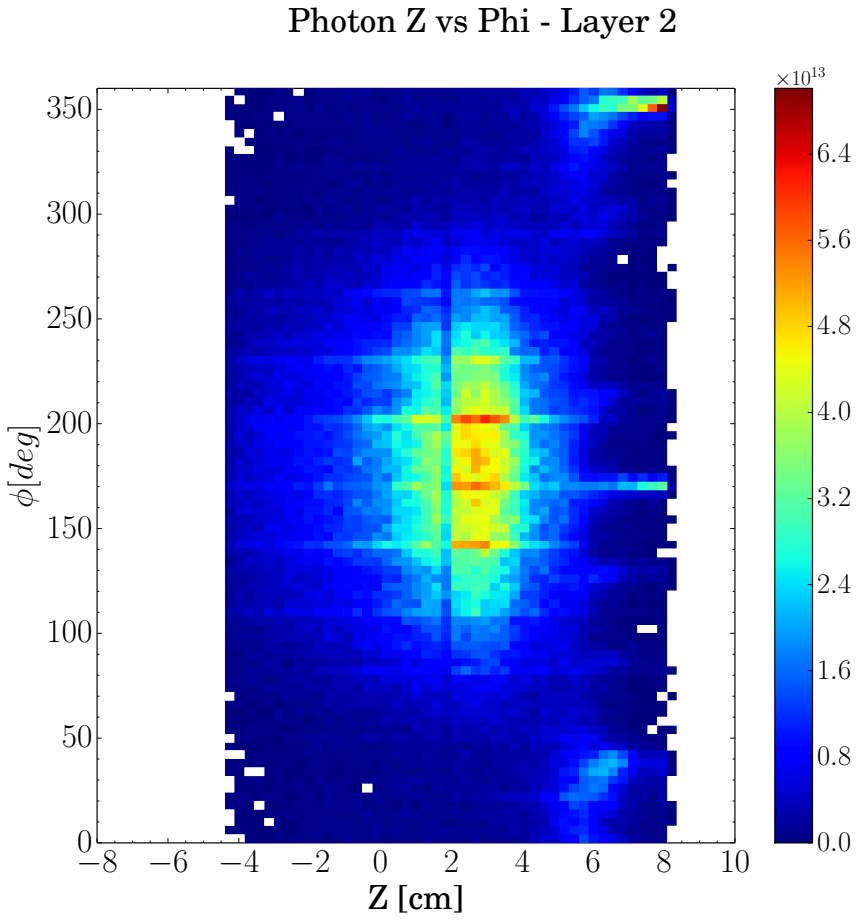


- blue dots: photoelectric effect, green dots: compton scattering
- large occupancy due to backscattered photons

Results, examined

- large occupancy around $\phi = 180°$ due to backscattering
- shape consistent with study by Pit (using Yuris results)
- occupancy much larger than previous studies





Conclusions

PySynRad

- optimized synchrotron radiation generator based on SRGEN
- use full SAD SuperKEKB lattice

Occupancy

- larger occupancy at 180°
- distribution consistent with studies by Pit Vanhoefer
- occupancy rather large (0.1 %)
- need to localize possible differences

Thank you
for your attention