A Large Ion Collider Experiment

Simulation studies for the Forward Conversion Tracker for ALICE 3

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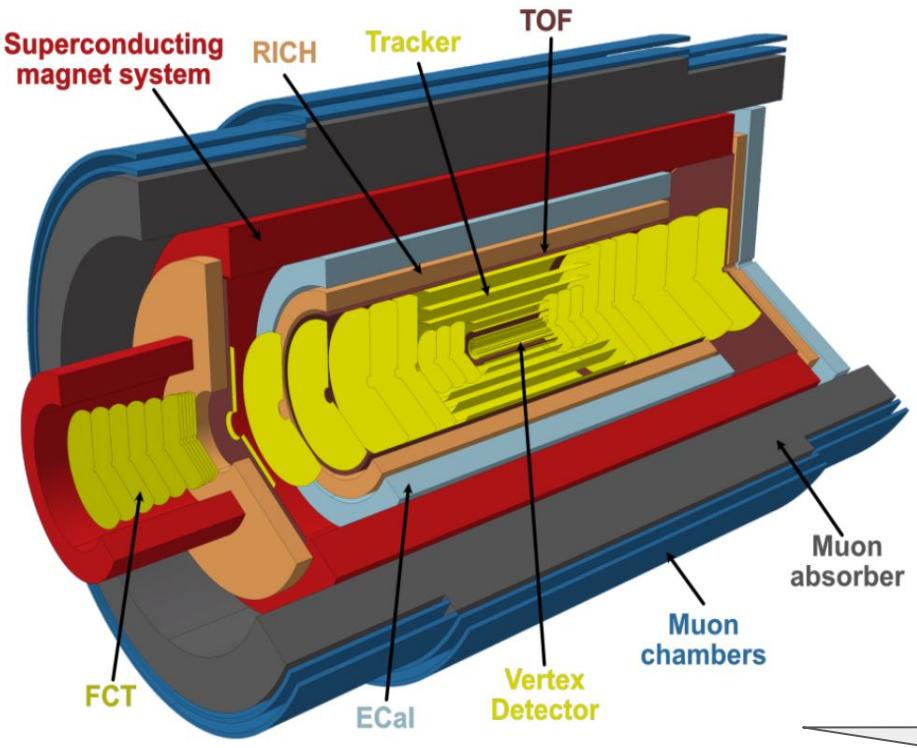
Outline of the presentation

- Introduction of the FCT in ALICE 3
- Latest developments
- Open issues
- Future developments and prospects

Introduction of the FCT in ALICE 3

ALICE 3 detector concept & The Forward Conversion Tracker



ALICE 3 will have an all silicon vertex detector and tracker

The FCT will measure soft photons in the forward direction via photon conversion

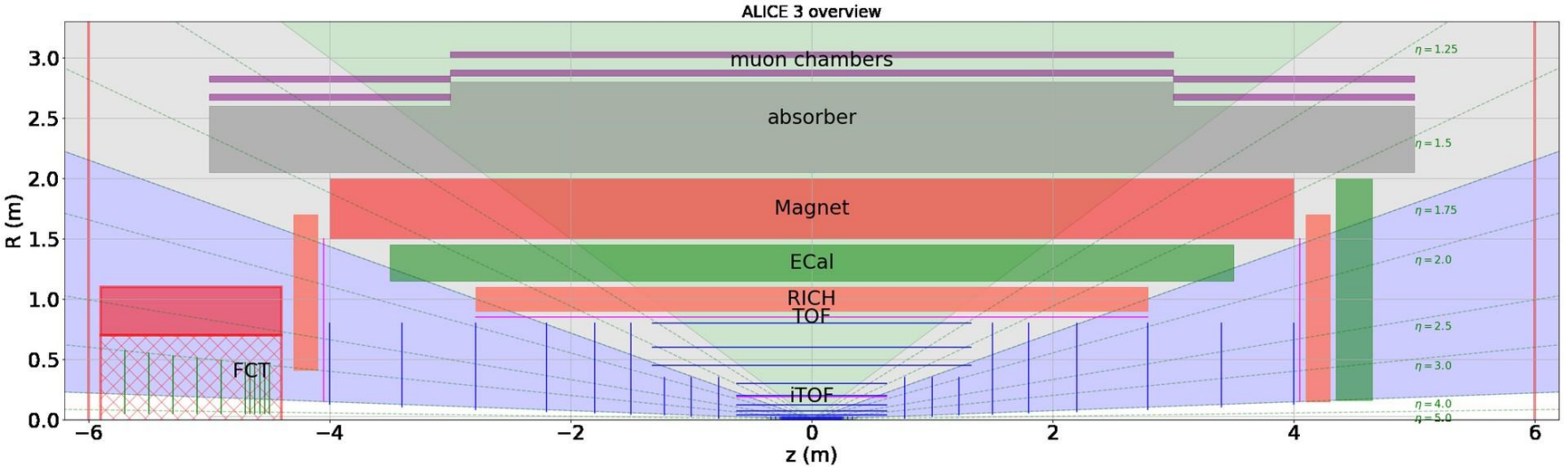
$$-3 > \eta > -5$$

~9 consecutive silicon discs

Small mistake: the FCT will have a dipole magnet instead of a solenoid

ALICE 3 & The FCT sideview

The FCT will be placed at a distance of z = -4 to -6m with a dipole magnet to provide a magnetic field in the y-direction.



The FCT to test Low's theorem and solve the soft photon puzzle

Low's theorem predicts $1/k_T$ leading term for the soft photon spectrum

To measure the photons at p_{T} ~2 MeV/c, exploit the Lorentz Boost in forward direction

$$p_T \sim 2\,\mathrm{MeV}/c \rightarrow E_\gamma \sim 50\,\mathrm{MeV}\ \mathrm{at}\,\eta = 4$$

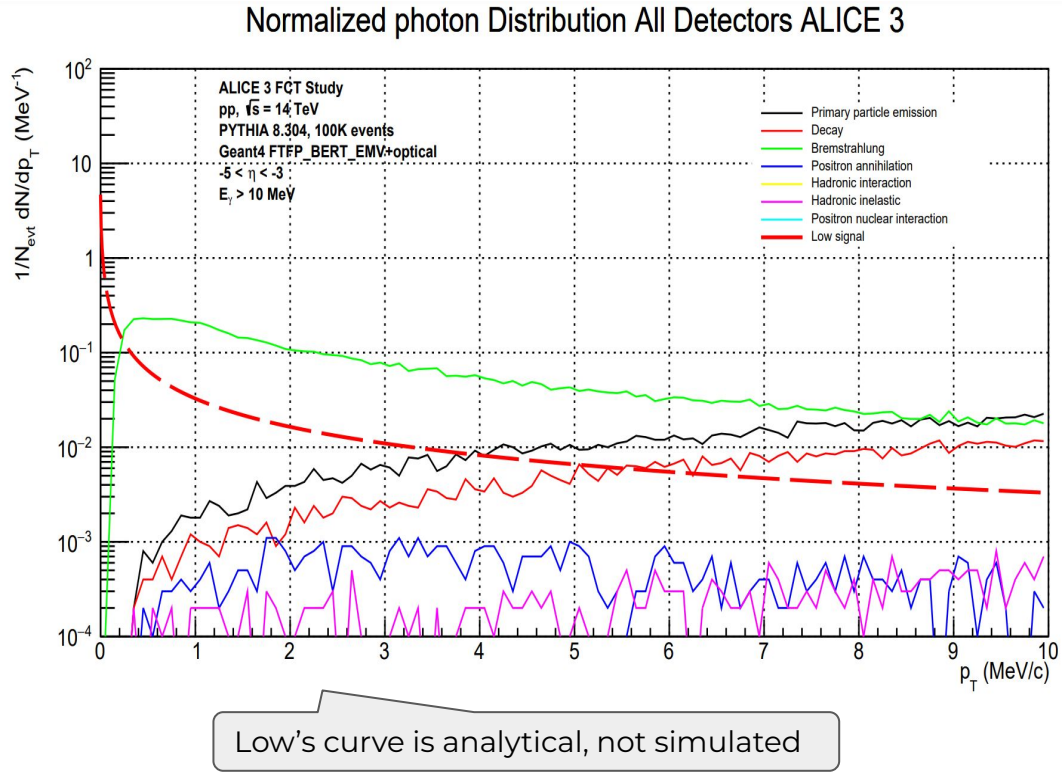
To measure these photons via pair production, electrons need to be reconstructed down to a few MeV/c.

The goal of the FCT is to shine light on the soft photon puzzle and Low's theorem

Latest developments
&
Simulation studies using O2

What is O2?

Simulation of the soft photon spectrum to reach the FCT



Low's curve is analytical, not simulated

"All detectors" includes (O2 names)

- TRK (Barrel layers of Tracker)
- FT3 (Disc layers of Tracker)
- A3IP (ALICE 3 Beam Pipe)
- FCT

Decent agreement with previous simulations

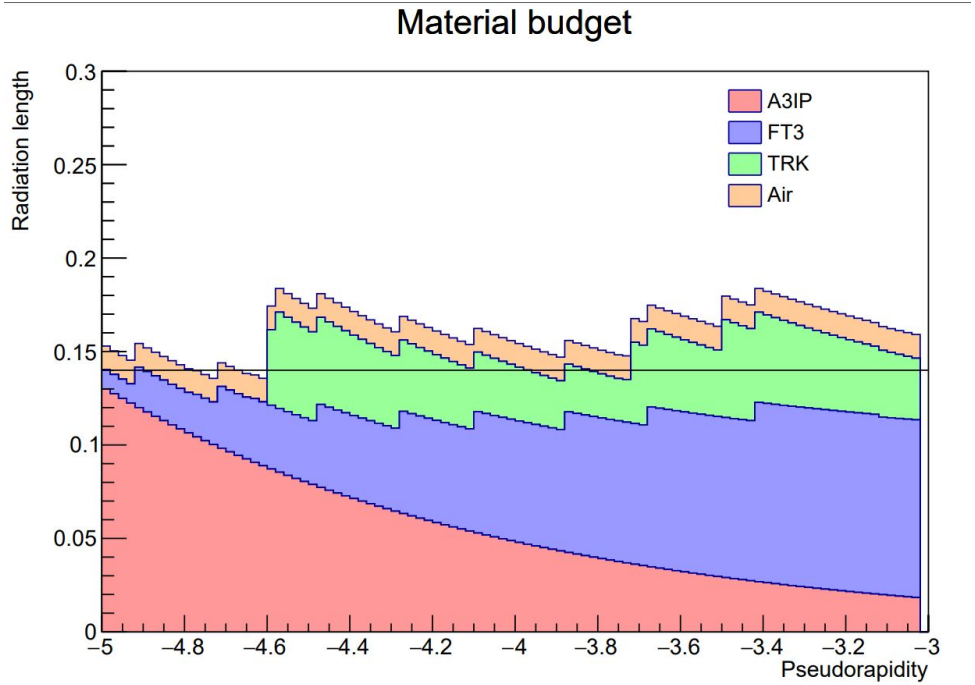
Background is very prevalent. What about the signal? Will we see it?

Contribution from UPC not significant

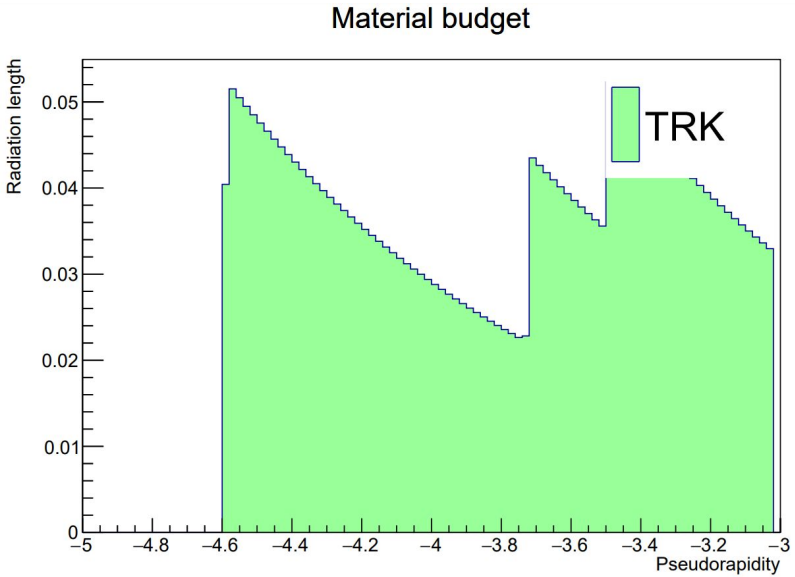
Material in front of the FCT

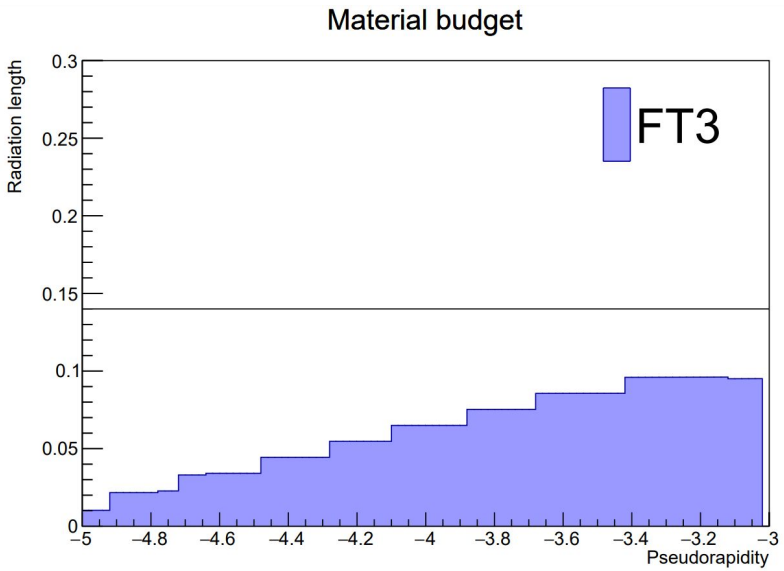
Layer	Material thickness ($\%X_0$)	Intrinsic resolution (μm)	Barrel layers Length ($\pm z$) (cm)	Barrel layers Radius (r) (cm)	Forward discs Position ($\lvert z \rvert$) (cm)	Forward discs R_{in} (cm)	Forward discs R_{out} (cm)
0	0.1	2.5	50	0.50	26	0.005	3
1	0.1	2.5	50	1.20	30	0.005	3
2	0.1	2.5	50	2.50	34	0.005	3
3	1	10	124	3.75	77	0.05	35
4	1	10	124	7	100	0.05	35
5	1	10	124	12	122	0.05	35
6	1	10	124	20	150	0.05	80
7	1	10	124	30	180	0.05	80
8	1	10	264	45	220	0.05	80
9	1	10	264	60	279	0.05	80
10	1	10	264	80	340	0.05	80
11	1				400	0.05	80

Table 8: Geometry and key specifications of the tracker.

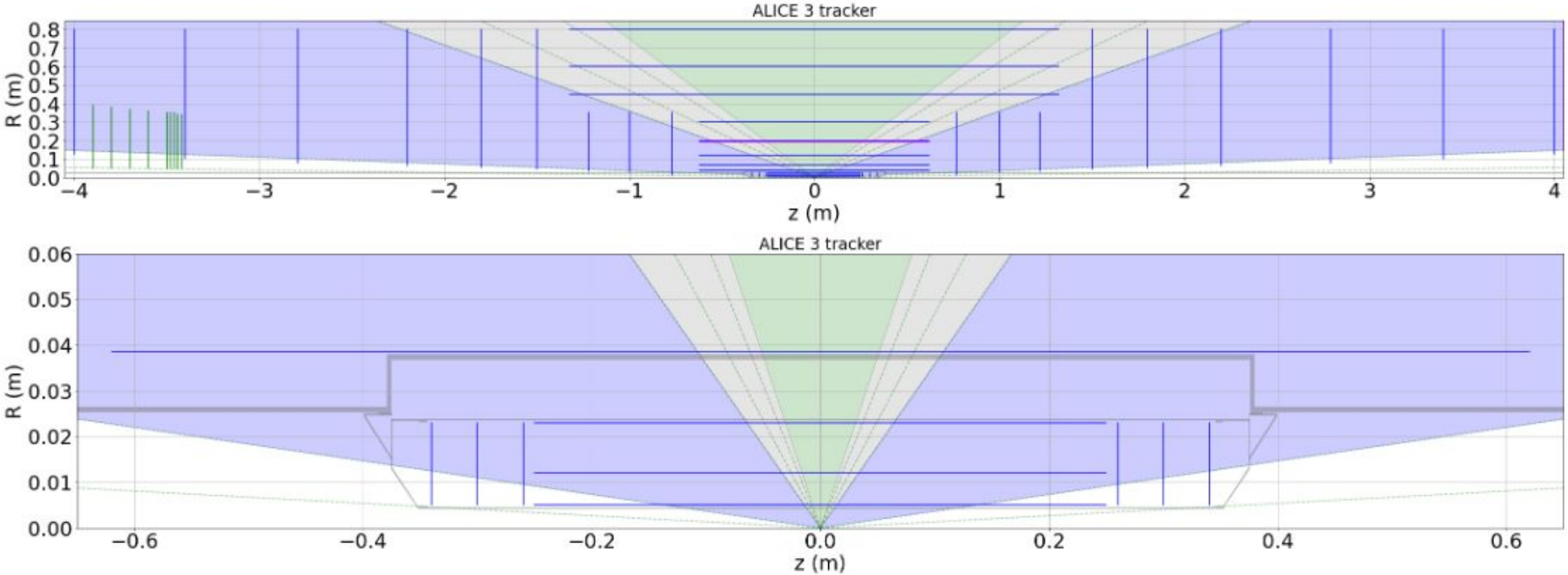


Material in front of FCT - TRK and FT3 specific





Zoom in on Vertex Locator



Open issues

Background reduction strategies - 1/2

- Select events without primary e+/e-
  - Low's photons are generated close to a charged particle which is not necessarily an electron.
  - No ePID in forward direction (except Time-Of-Flight up to 0.5 GeV/c) in current setup
    - -> Study effect of ePID in the forward direction

- Reduce material in front of the FCT
  - Either very expensive or impedes physics programs of other detectors
    - -> Displacement of the interaction vertex in z?
  - Reshaping of the beam pipe is being considered

- Check if a charged particle and photon originate from within a detector layer
  - Pointing angle resolution is probably not good enough

Background reduction strategies - 2/2

- Cut on opening angle such that photons originate from the Primary Vertex
  - Should reduce the amount of decay photons, but will have limited impact since bremsstrahlung photons are generated close to the charged particle

- When a V0 is produced in the FT3, veto the event
  - A lot of photons are created by bremsstrahlung coming from electrons which come from photon conversions

- Ideas from the audience? Would be highly appreciated

Future developments and prospects

V0 reconstruction

- Assume V0 finding for now
- Smear hits in detector to simulate pixels
- Reconstruct V0 (Fast Circle Fit (Hansroul, Jeremie, Savard, 1987)
  - Figure out resolutions
    - Energy resolution of photon
    - Pointing resolution
  - Use this to cut on the background and see the effect

ACTS - A Common Track reconstruction Software

- Used in ATLAS
- Claimed to be detector independent
- Provides both Track Finding and Track Reconstruction
- Pavel Larionov is looking at how to integrate it in O2

- Github: https://acts-project.github.io/
- Paper: https://cds.cern.ch/record/2243297

Digitization of the FCT - Towards a realistic detector

Transform the current silicon layers of the FCT into layers containing

- Pixels (which come with charge sharing, fake hits and all things pixel)
- “Passive” material (including support structures, electronics and all that makes up a detector)

To do this, design of the FCT must be studied. Will require a lot of R&D.

Design of the pixels ongoing!

When done, do the analysis again and see if the results still hold.

Questions?