# IDEA vertex detector simulation and first work on Si wrapper

## FCC Detector Concepts Meeting

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University of Zürich

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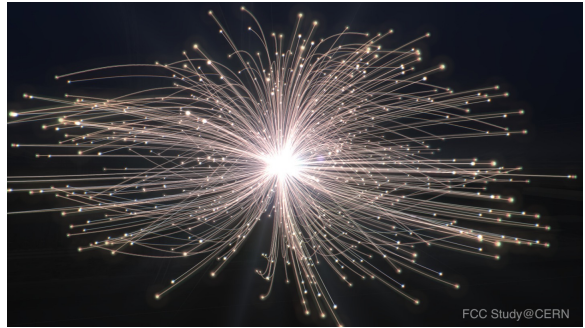



University of Zurich[UZH]

FUTURE CIRCULAR COLLIDER

# Status of IDEA vertex in full simulation at last meeting

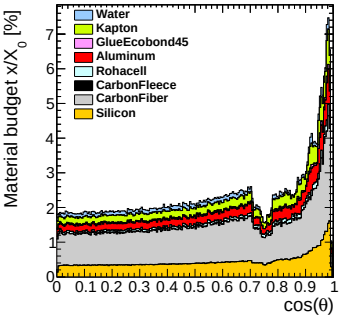
University of Zurich[UZH]

**Vertex detector design** (F. Palla, F. Bosi, more details here):

- *Inner barrel*: Three layers made up of staves of dual ARCADIA DMAPS, with pixels of $25 \times 25\,\mu\text{m}^2$ ($\sim 3\,\mu$m single point resolution), down to $r = 13.7$ mm
- Two *outer barrel* layers and three *disks* made of quad modules inspired by ATLASPix3 DMAPS with $50 \times 50\,\mu\text{m}^2$ pixels

Status of full simulation discussed at S&C and Detector Concepts meeting 31.07

- First simulation of realistic vertex detector for FCC-ee, with cooling pipes, flexes, various layers of support, overlapping staves, etc.
- Vertex inner barrel is described in most detail, $X/X_0 \sim$ matching expectation from spreadsheet calculation




Material budget in IDEA vertex

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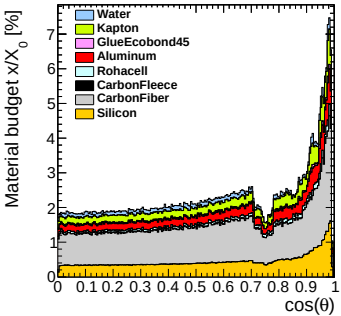
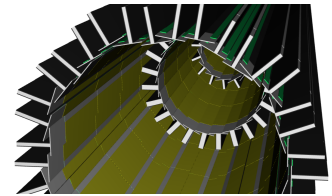
Today discuss updates and first look at IDEA silicon wrapper!

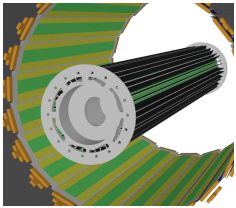



Material budget in IDEA vertex

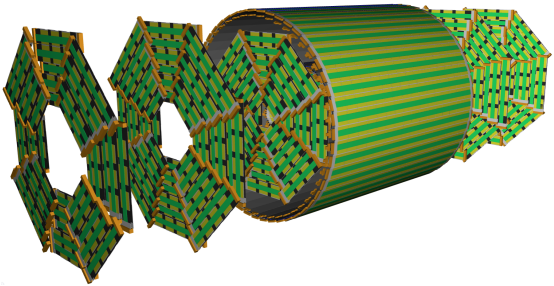
# IDEA vertex simulation: Some pictures



Inner barrel without vertex support



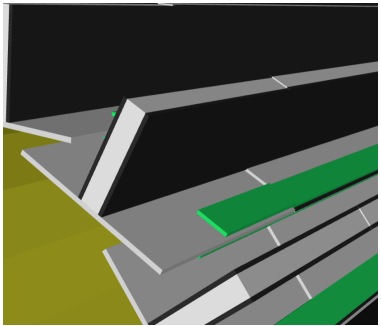
Inner barrel with vertex support imported by DDCAD



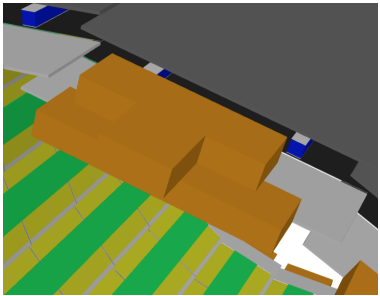
Complete IDEA vertex in DD4hep/Key4hep

→ Estimate material budget (done) and angular coverage (not done yet) of *realistic* vertex detector at FCC-ee

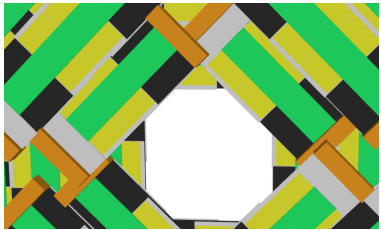
# IDEA vertex simulation: "End-of'-stave" structures



In inner vertex barrel



In outer vertex barrel

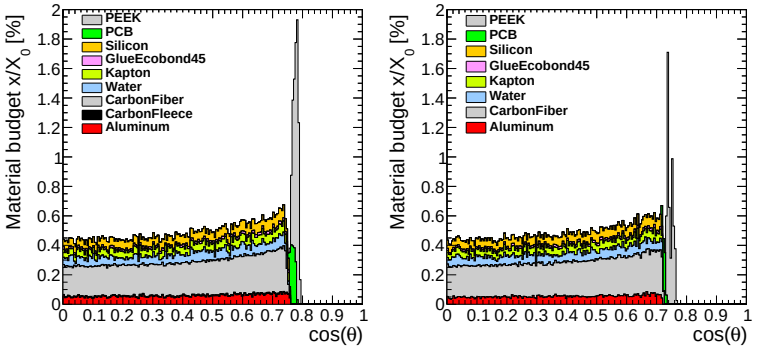


In outer vertex disk

Added "end-of-stave" structures to all subdetectors (orange in outer vertex)

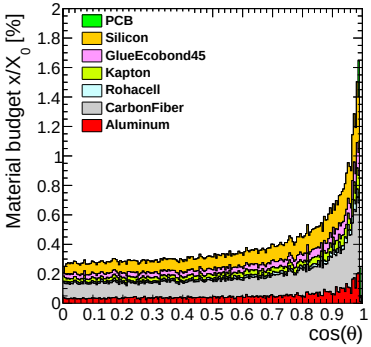
- Approximated structure in outer vertex barrel. Optimised by Fabrizio and Filippo after having seen impact in material budget!

# Material budget in outer vertex barrel

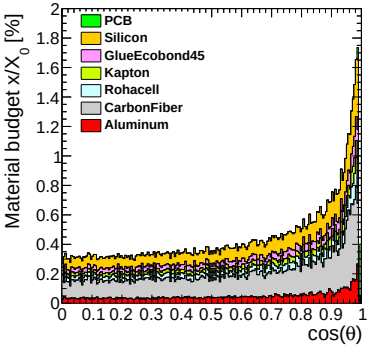



→ Significant impact of PEEK support structure at the end of the staves at $\cos(\theta) \approx 0.75$

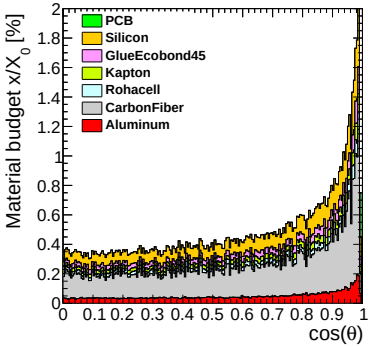
# Material budget in inner vertex barrel




Layer 1



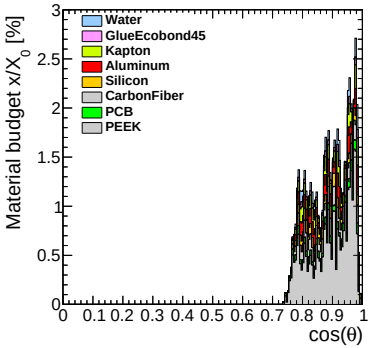

Layer 2



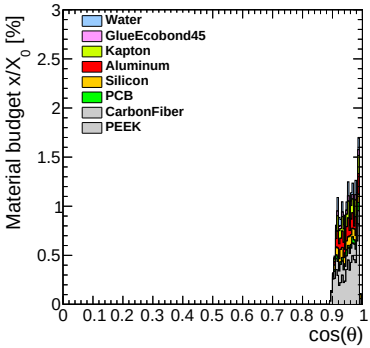

Layer 3

$\rightarrow$ in line with 0.3% per layer at $\cos(\theta) = 0$ (CDR assumption)

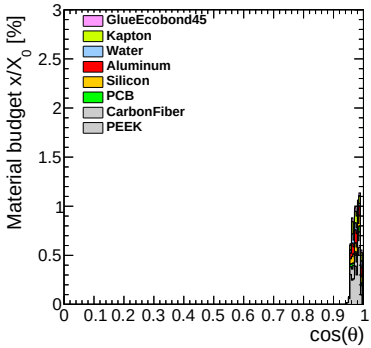
# Material budget in outer vertex disks




Disk 1



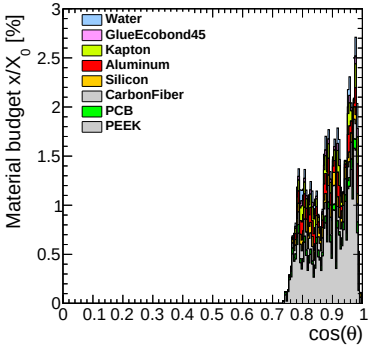

Disk 2



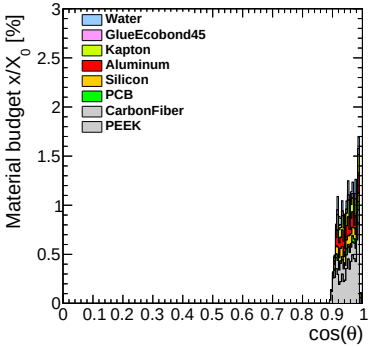

Disk 3

→ PEEK from end-of-staves structures also here gives significant contribution

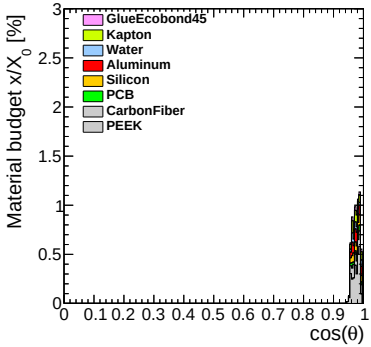
# Material budget in outer vertex disks




Disk 1




Disk 2




Disk 3

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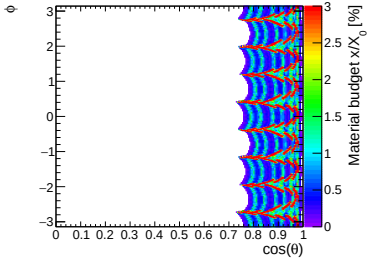
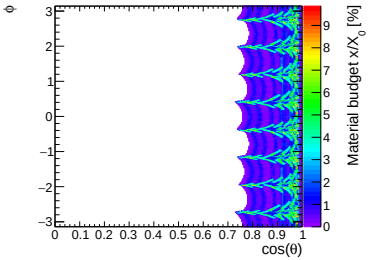
→ Let's look at cos($\theta$) vs. $\phi$

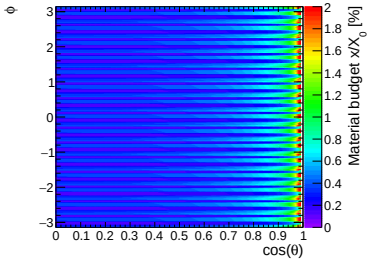
# Material budget in outer vertex disks



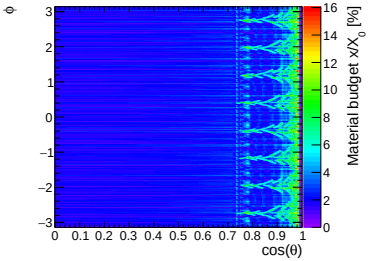

Disk 1




All disks



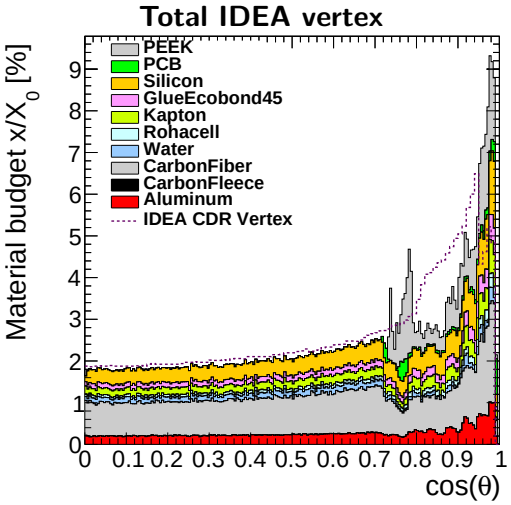

Vertex inner barrel layer 1




Complete IDEA vertex

- Can clearly recognise the end-of-stave structures in disks
- More uniform when looking at complete IDEA vertex

# IDEA vertex detector: Material budget




Take this as **lower limit** on the material budget, as not all material is considered yet

- Global disks support structure
- Off-detector cabling (not designed yet)

Results roughly in line with estimation of (old) Geant4 vertex model (try to optimise disks)

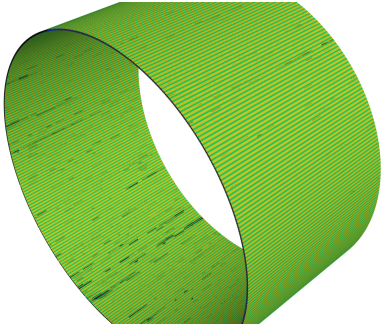
Todo:

- Implement last changes to inner vertex barrel L3 changes
- Estimate material budget of DDCAD imported volumes

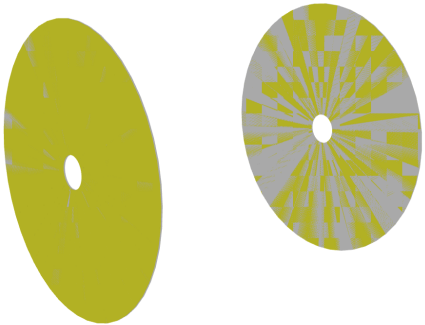
IDEA vertex detector geometry is available in k4geo/FCCee/IDEA/compact/IDEA_o1_v02

# IDEA silicon wrapper

Should have a silicon wrapper model in full simulation as well, even if not engineered yet
→ Reuse IDEA vertex barrel and CLD vertex disk constructor code for now
Using IDEA vertex barrel constructor Using CLD vertex endcap constructor



Barrel



Disks

→ Push to k4geo when first version is done, discuss how such a detector should be designed to feature low material budget

# Digitisation of silicon hits in Key4hep

Couple of possibilities

- I wrote a simple digitisation of Si hits in k4RecTracker

→ Works with IDEA vertex and Si wrapper

→ More work needed though (projection of hit onto Si surface e.g.)

- Using DDPlanarDigiProcessor.cc from Marlin through k4MarlinWrapper

→ Need to make some adaptions to IDEA vertex implementation still to be compatible

- Port of DDPlanarDigiProcessor as a Gaudi algorithm in k4Reco

→ Work in progress

# Thanks!