

New BeamCal Layout and Radiation Dose to Beamcal Sensors at CLIC

André Sailer

CERN-PH-LCD,
Humboldt-Universität zu Berlin

FCal Collaboration Workshop, Tel-Aviv Israel
October 3-5, 2010

1 Updated BeamCal Layout in MOKKA

2 Radiation dose in BeamCal at CLIC

Updated Absorber Geometry (ILC)

■ Old driver

- ▶ Had Single transverse geometry
- ▶ Keyhole shaped cut-out for the incoming beam pipe
- ▶ No absorber material between the beam pipes

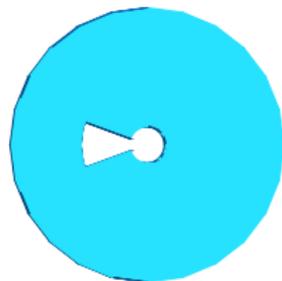
■ New Driver

- ▶ Maximal absorber coverage
- ▶ Only passage through the two beam pipes
- ▶ All absorber plates are slightly different (location of hole for incoming beam-pipe)

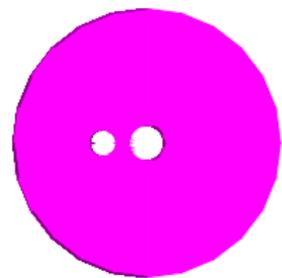
■ Layers:

Tungsten	3.5 mm
Diamond sensor	0.3004 mm
Gold metalization	0.0004 mm
PCB	0.15 mm
Air gap	0.05 mm

Old W and Graphite Absorber



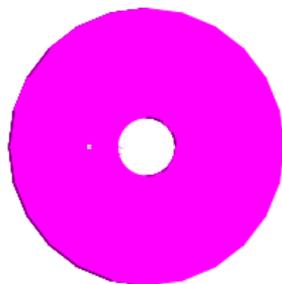
New Absorber



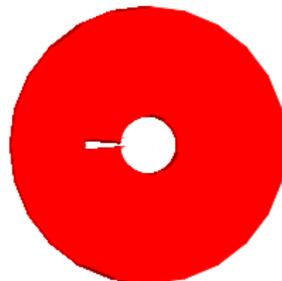
BeamCal in CLIC_ILD

- Inner Radius $R_{in} = 3.2$ cm
- Outer Radius $R_{out} = 15$ cm
- Number of Layers 40
- Radius of incoming beam-pipe 3.7 mm
- Angular coverage 350°
- Crossing Angle 20 mrad

Absorber

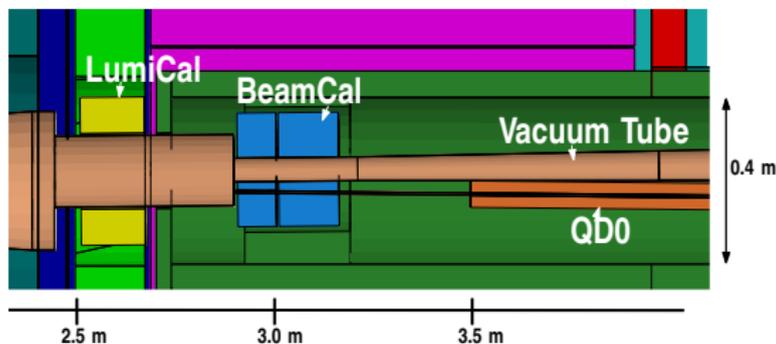


Sensor



Simulation of the Radiation Dose in BeamCal at CLIC

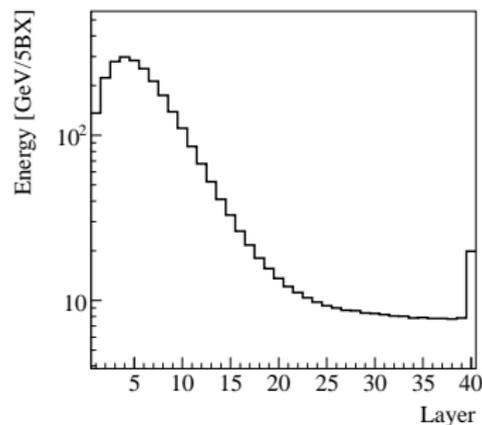
- GEANT4 9.3p01 with QGSP_BERT_HP and 5 μm rangeCut
- Simulated 10 bunch crossings (BX) of incoherent pairs for nominal 3 TeV CLIC parameters
- Pairs generated with GUINEAPIG, incoherent pairs only
- Extracted ionizing energy deposit and neutron flux
- CLIC year = 200 days with 50% efficiency



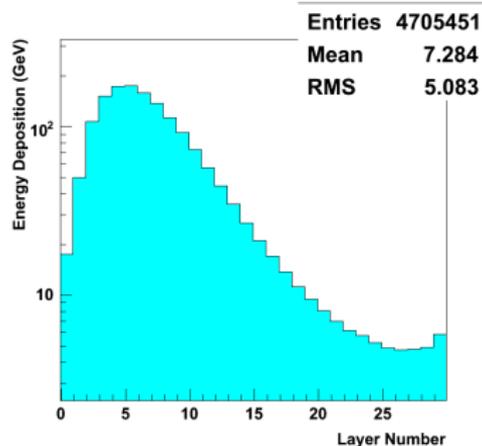
Electromagnetic Dose in BeamCal I

- Energy deposit slightly larger at CLIC, despite larger inner radii
- Larger energy deposit in last layer from scattering in other components downstream of BeamCal

Energy deposit in CLIC BeamCal



Energy deposited in ILC BeamCal

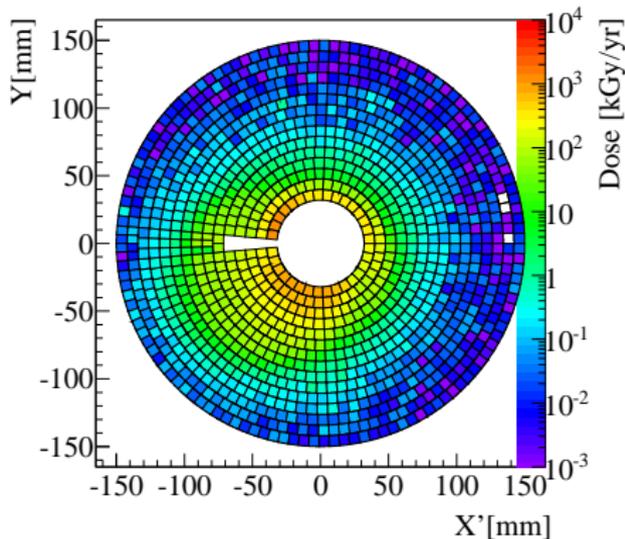


(Coca et al., Expected electromagnetic and neutron dose for the BeamCal at ILD, RJP 2009) Also for 5BX

Electromagnetic Dose in BeamCal II

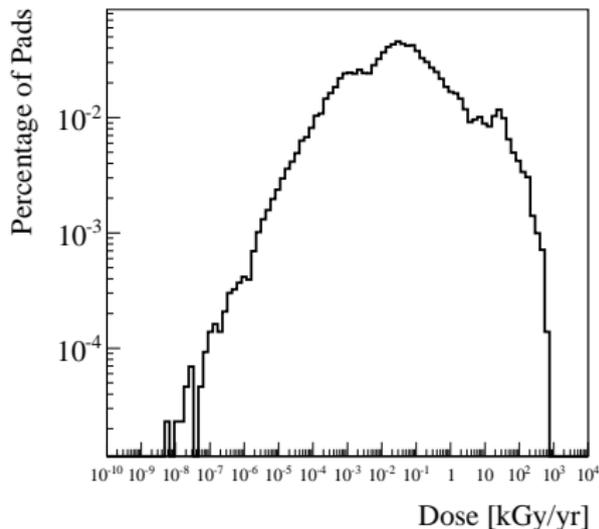
- Slightly asymmetric energy distribution, because of pure solenoid field
- Radial and azimuthal dependence

Radiation dose in the 5th layer of BeamCal



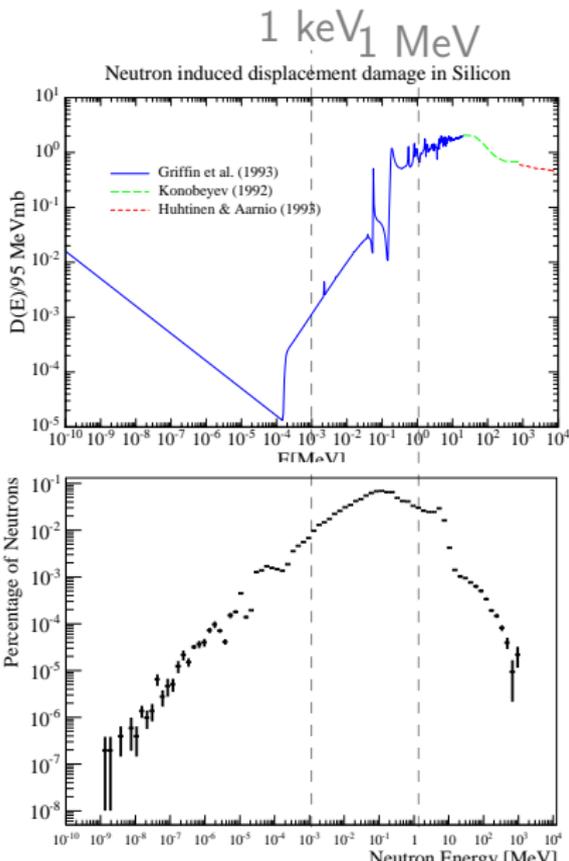
Electromagnetic Dose in BeamCal III

- The dose for each individual pad
- Maximum dose of almost 1 MGy/yr (Inner most pads of Layer 5)
- Most Pads receive much smaller dose



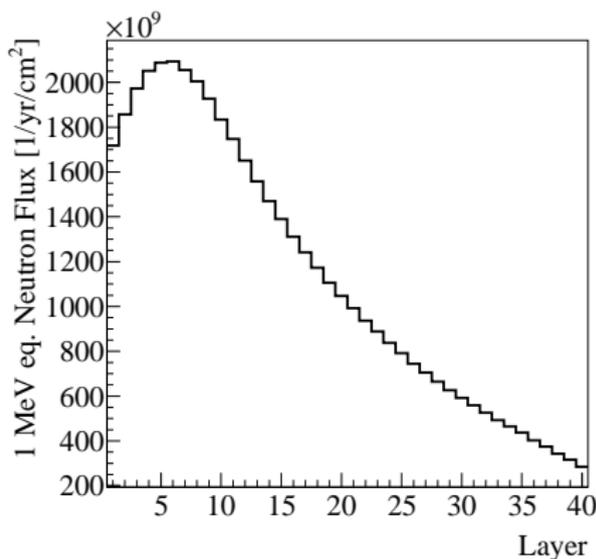
Neutron Flux

- Calculate 1 MeV equivalent Neutron Flux (F_{neq})
- Approximation using the damage factors for Silicon from A. Vasilescu (INPE Bucharest) and G. Lindstroem (University of Hamburg), Displacement damage in silicon, on-line compilation <http://sesam.desy.de/members/gunnar/Si-dfuncs.html>
- Running Mokka with custom SensitiveDetector
- Store every passing Neutron with weight according to its energy



Neutron Flux in BeamCal I

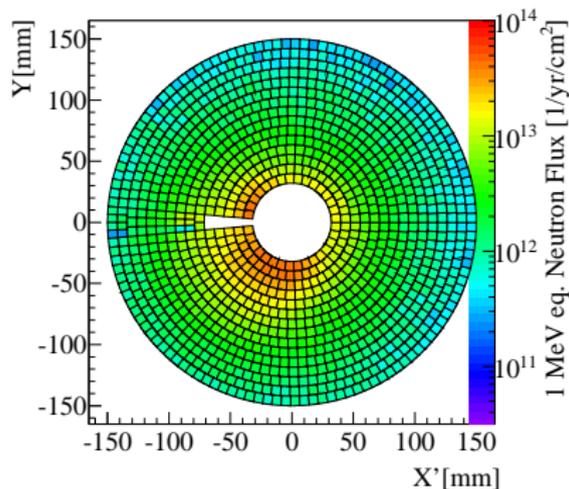
- Maximum of the neutron flux in the 5th layer (flux averaged over the complete layer)



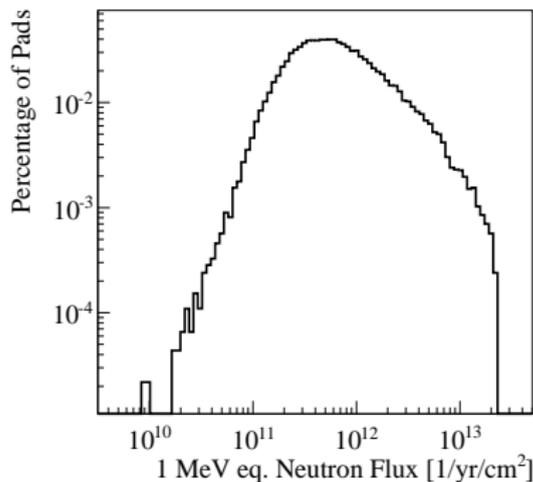
Neutron flux averaged for each layer.

Neutron Flux in BeamCal II

- Neutron flux in layer 5 of BeamCal
- Radial and azimuthal dependence clearly visible



- Neutron flux for all pads in BeamCal
- Maximum flux around $F_{\text{neq}} = 10^{13} / \text{yr} / \text{cm}^2$



LHC Background rates

- Comparison with Atlas estimates (2008 JINST 3 S08003)
- Atlas values for the innermost pixel layer, nominal luminosity at 14 TeV
- CLIC: Incoherent Pairs only
- Definition of year differs (15%, 100 days vs. 10^7 s)

	CLIC	Atlas
$F_{\text{neq}} [10^{13} / \text{cm}^2 / \text{yr}]$	2	27
Ionizing Dose [kGy/yr]	1000	158

Summary

- Briefly introduced the new absorber structure in the MOKKA simulation software
- Used MOKKA to simulate incoherent pairs and extract the radiation dose and the neutron flux at CLIC
- Found a maximum dose of almost 1 MGy/yr for the inner most pads
- Found an equivalent neutron flux $F_{\text{neq}} = 10^{13}/\text{yr}/\text{cm}^2$
- Simulations only done with incoherent pairs only (see my next Talk)