

Status of VLDT Karlsruhe

A. Dierlamm

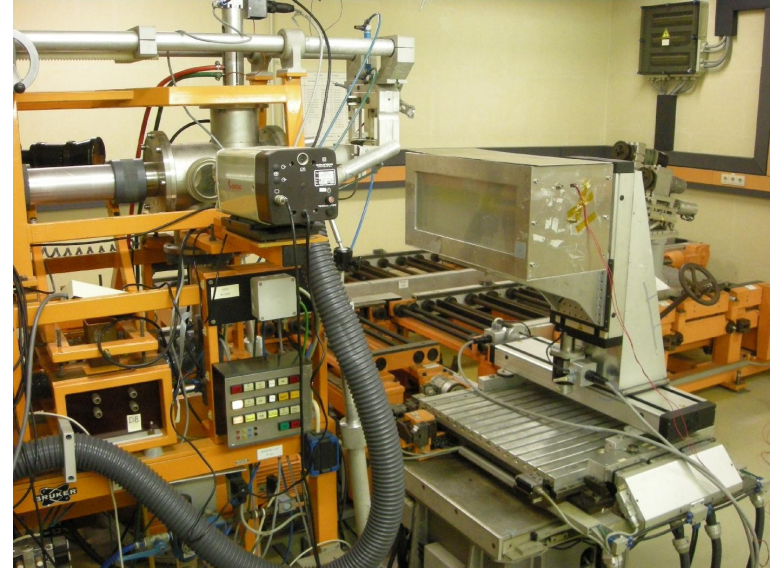
Institut für Experimentelle Kernphysik

Alliance Detector Workshop, DESY

April 2009

Cyclotron

- Proton energy: 25MeV
- Irradiation procedures well established
- Scanning of objects up to 20cm x 40cm
- Temperature controlled to -50 ± 5 °C to prevent annealing
- Fluence measurement by activation of Ni^{57} foils
- Usually fast access (within 2-3 weeks)
- Short irradiation time:
1x1cm² structure to 10^{15} n_{eq}/cm² @ 1.5μA proton current in 15 min. !
- Run by a private company:
ZAG Zyklotron AG



Insulated box in front of beam pipe

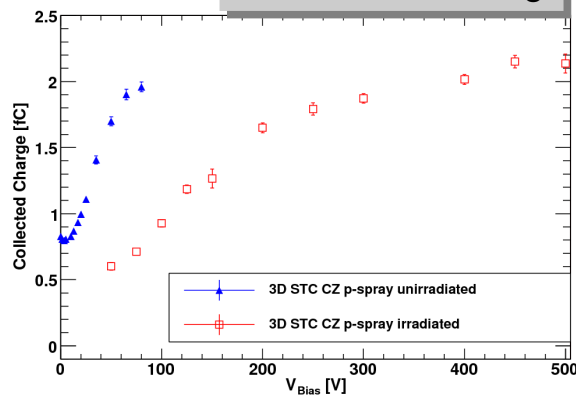


Control room

Cyclotron Customers

- Freiburg:
 - 3D sensors (S-LHC)
- HLL München:
 - DEPFET (ILC)
 - Strip isolation (S-LHC)
- Karlsruhe:
 - MCz sensors for Testbeam (S-LHC)
 - Mini sensors within RD50 (S-LHC)
 - ICs for BCM2F (LHC)
- Bonn:
 - 3D and diamond sensors (S-LHC)

Parzefall, Freiburg



Rühle, IEKP

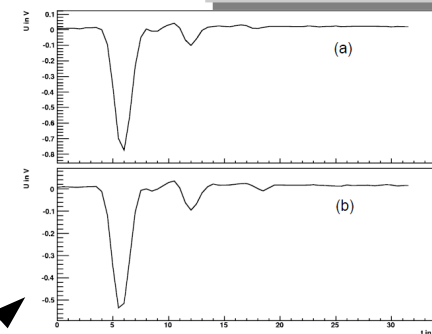
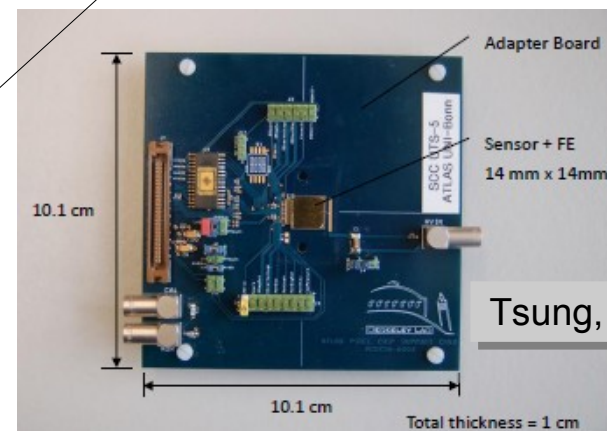


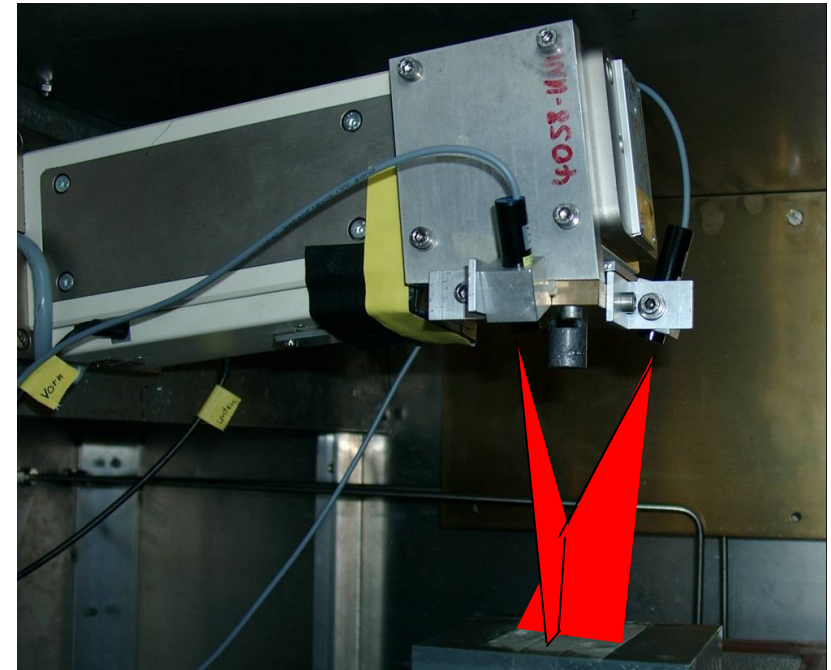
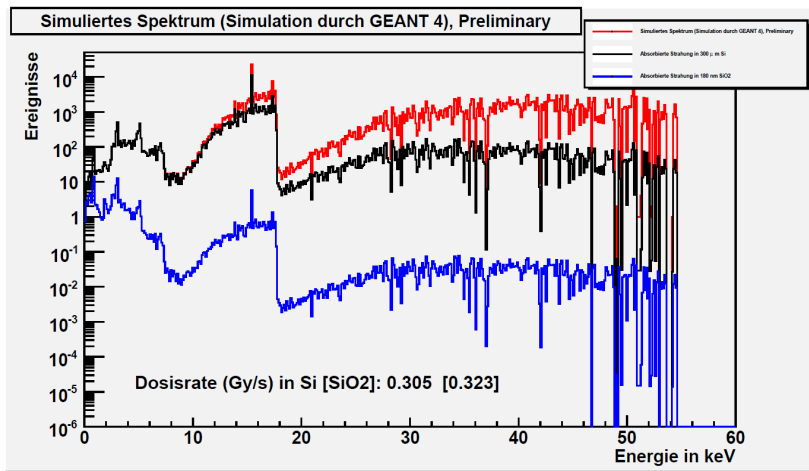
Abb. 8.1.2.: gemessene Pulse an einem BV mit unbestrahlten (a) und mit $5 \cdot 10^{14}$ Protonen $1/\text{cm}^2$ bestrahlten Bauteilen



Tsung, Bonn

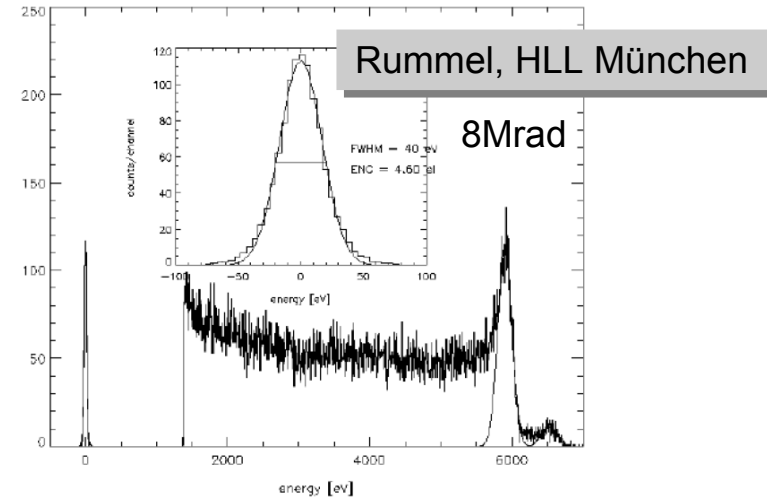
X-Ray Setup

- Dose estimation by measurement of leakage current of Si diode and conversion to SiO_2 . For this we need to know the x-ray spectrum. A preliminary simulation is done and will be verified soon.



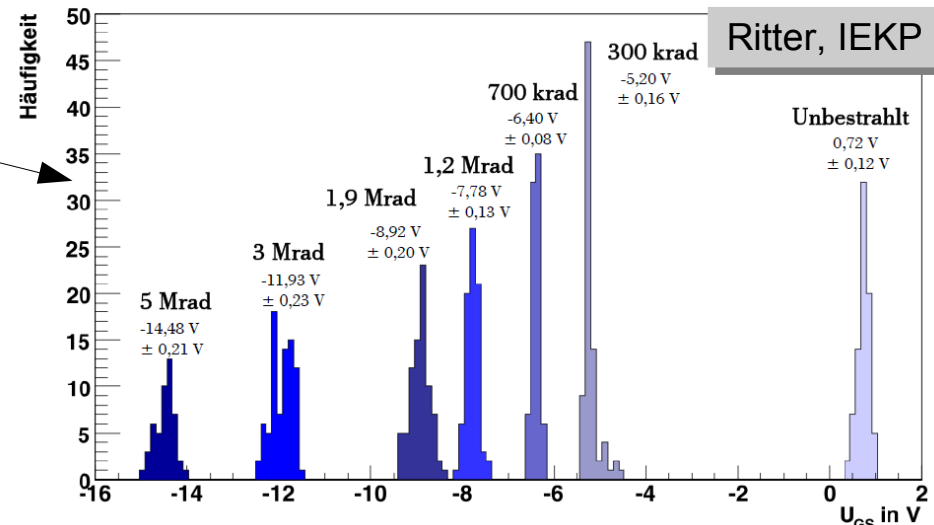
X-Ray Customers

- HLL München
 - DEPFET (ILC)
 - Strip isolation (S-LHC)
- Heidelberg
 - Switcher (ILC)
- Karlsruhe
 - DEPFET (ILC)
- Darmstadt
 - Readout chips (S-LHC)



(a) Fe^{55} spectrum after irradiation

Verteilung der Schwellspannungen bei verschiedenen Strahlendosen



More projects making use of the VLDT

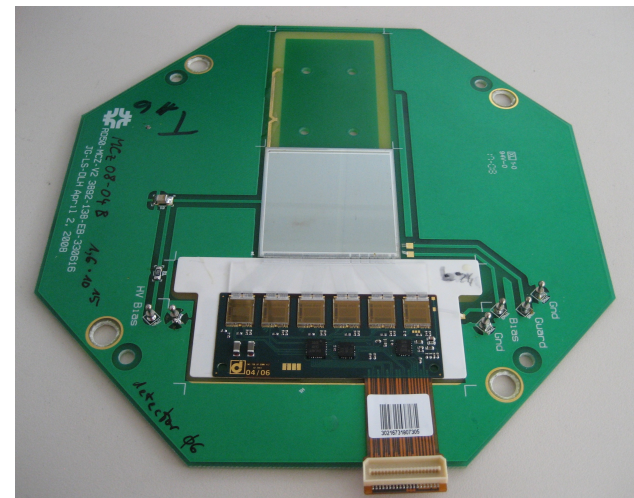
- Testbeam of MCz strip sensors (SiBT/WP2.4)
- Mixed irradiation of MCz samples (WP2.4)
- Central European Consortium (WP2.4)
- SiLC (TPC/ILC)

SiBT: Silicon Beam Telescope; Collaboration formed to run beam tests with telescope provided by HIP

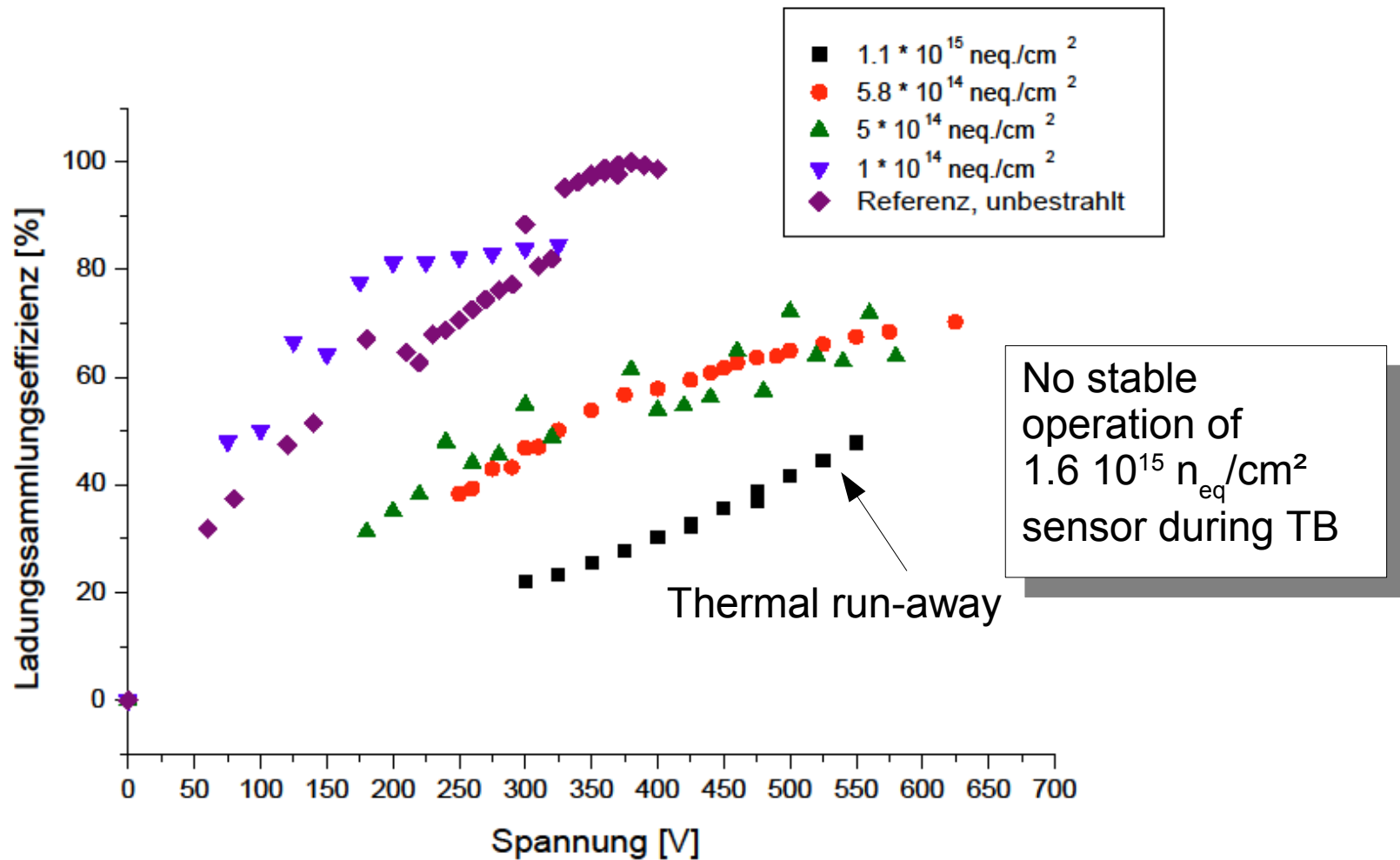
WP2.4: Radiation hard silicon sensors for the sLHC

Modules from MCz in Testbeam

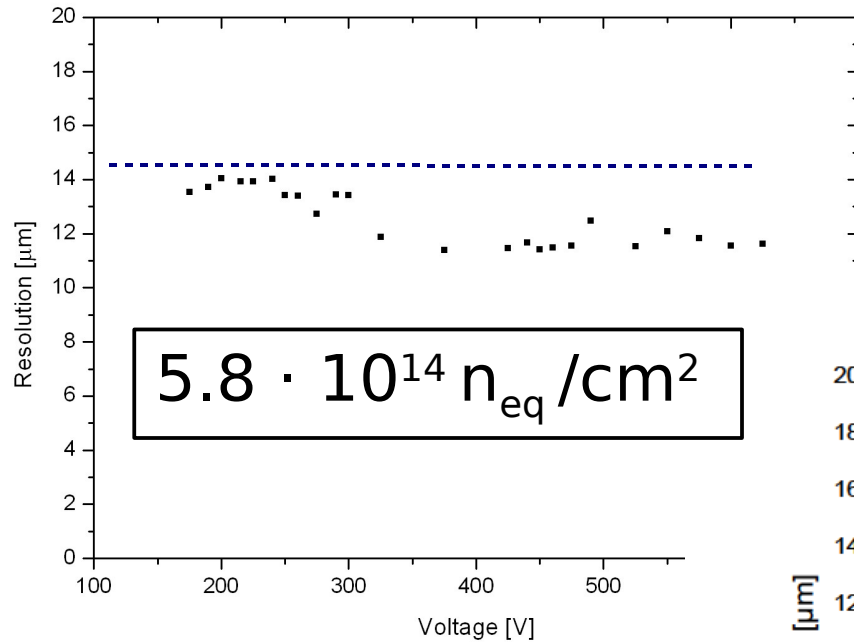
- n-type MCz strip sensors (50 μm pitch; 300 μm thick) fabricated at HIP
- Sensors probed at KA
- Neutron irradiation at LLN
- Proton irradiation at KA
- Sensors probed cold at KA after irradiation
- Modules assembled at KA from sensors, PCBs and CMS Tracker hybrids using automated bonding machine and coordinate measuring machine
- Testbeam carried out together with SiBT collaboration at CERN
- Testbeam analysis done at KA as well
- Additional measurements at KA with “home-made” APV readout system using a Sr90 source



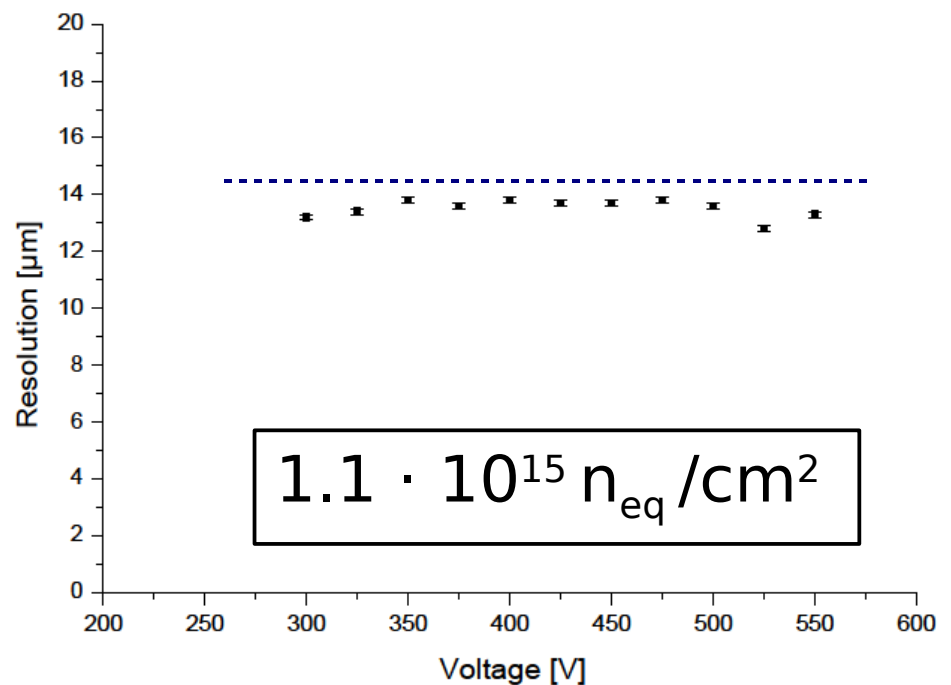
CCE of Tracked Clusters



Resolution



--- Binary resolution
for 50 μm pitch ($\sigma=14.4\mu\text{m}$)



Still room for improvements:

- η -correction for reference sensors
- better alignment

APV Readout Station

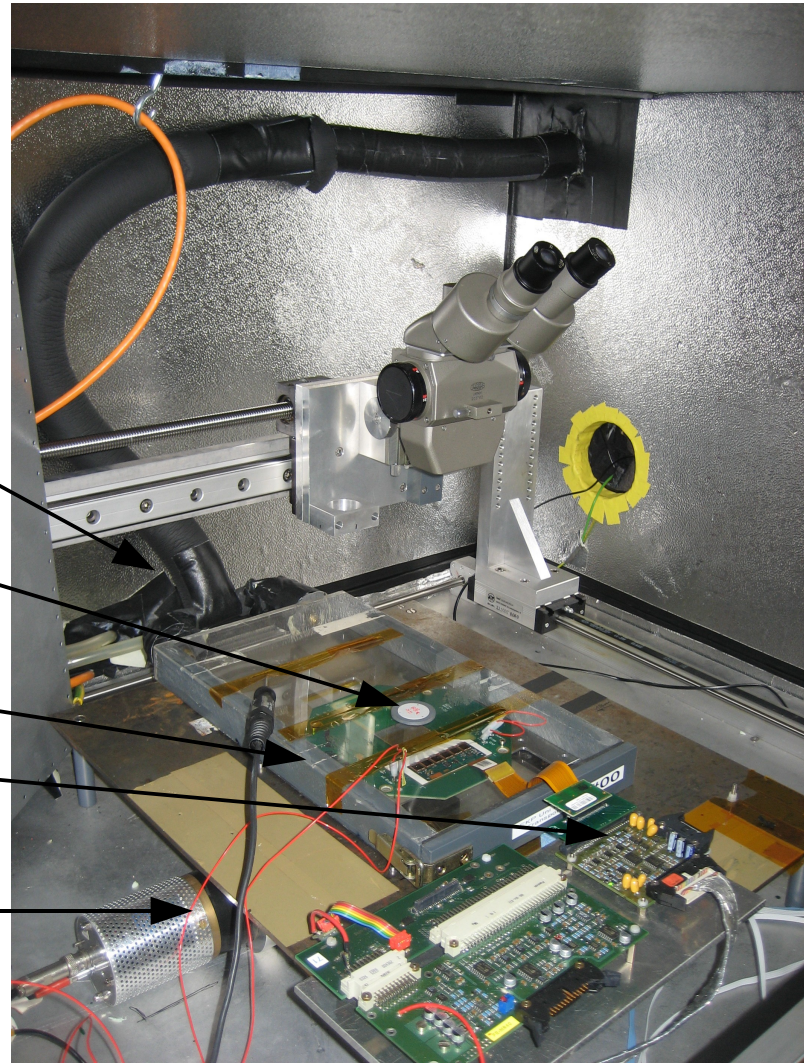
Cold dry air

Sr90 source

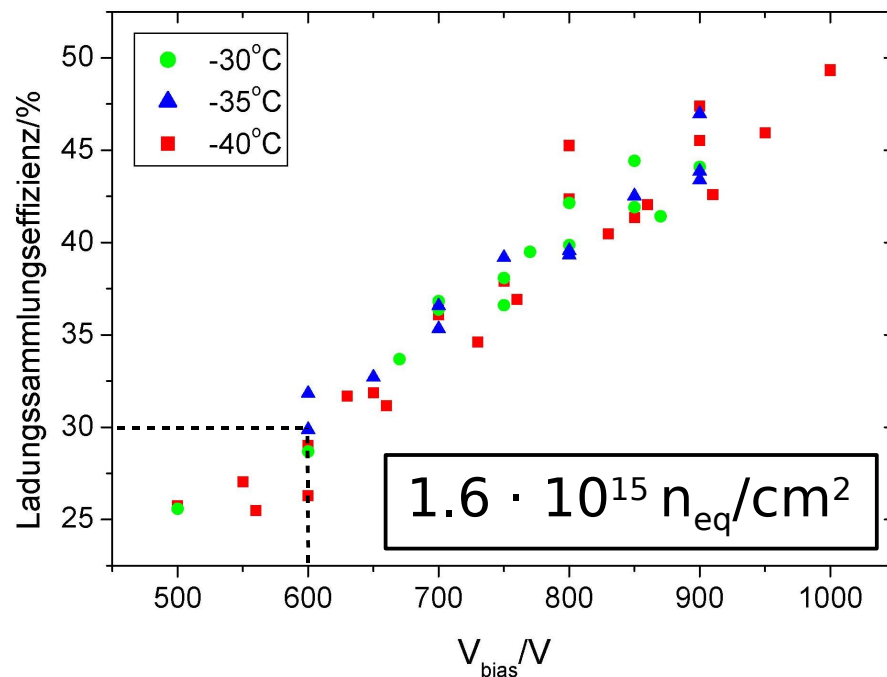
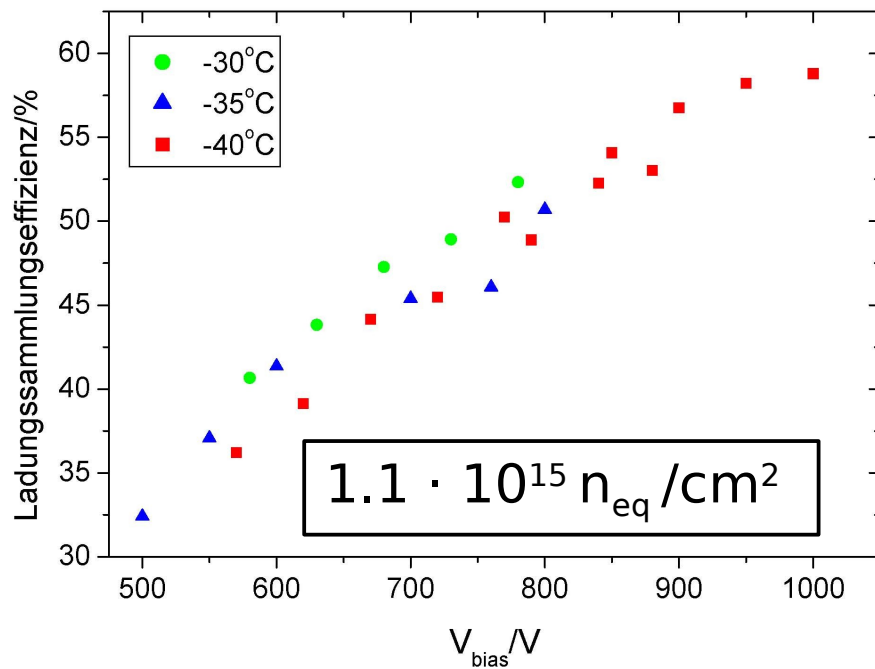
Module

Repeater card

Scintillator



CCE from Readout Station



Summary TB

- The tested MCz strip sensors showed sufficient signal charge ($>7000e^-$) at 600V after $1.6 \cdot 10^{15} n_{eq}/cm^2$
- Essential is an efficient cooling to prevent thermal runaway at these fluences
- Resolution of better than $14\mu m$ could be measured for a module with $F=1.1 \cdot 10^{15} n_{eq}/cm^2$
- These fluences correspond to 22cm and 15cm thus reaching into the pixel envelope
- These results demonstrate the possible usage of n-type MCz silicon for the whole strip tracker part of CMS
- This summer: TB with p-type MCz strip sensors

Mixed Irradiation

- Studies from RD50 showed compensating effects of neutron and proton irradiation on the full depletion voltage of MCz silicon
- Now, detailed study with SLHC ratios of p/n
- Materials minis: n-MCz, p-MCz, n-FZ, p-FZ
- Materials diodes: n-MCz, p-MCz
- 5 sets of mini strip sensors and diodes to be irradiated to:

Radius cm	Ch. Had. $10^{14} n_{eq}/cm^2$	Neutrons $10^{14} n_{eq}/cm^2$	Total $10^{14} n_{eq}/cm^2$
5	140	10	150
10	27.4	5.5	33.0
20	7.4	4.5	11.9
35	2.8	4.0	6.7
55	1.1	3.8	4.9

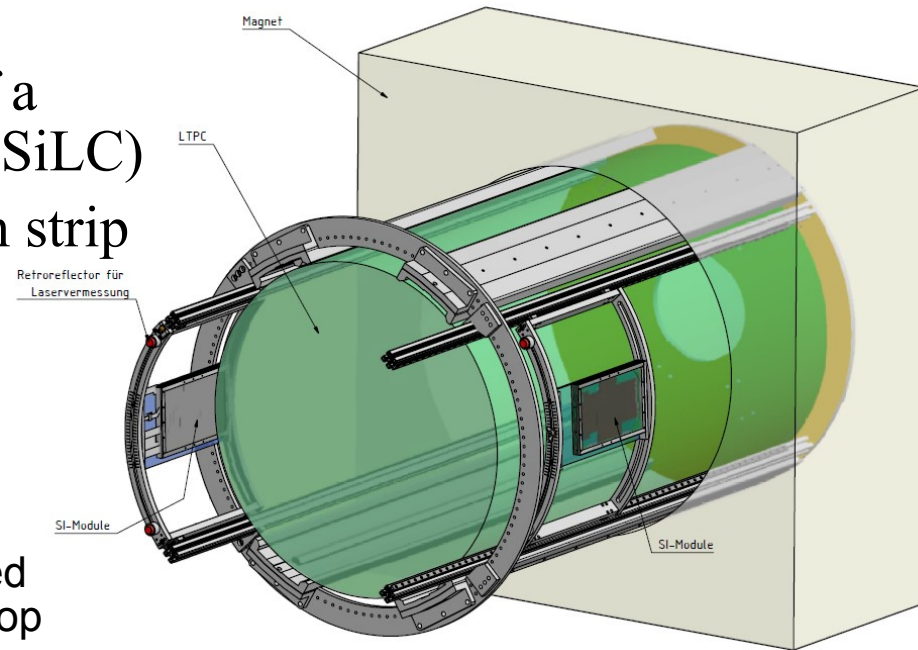
- Neutron irradiation done; sensors are being probed

Work within CEC

- The Central European Consortium combines the effort of several institutes:
Aachen, DESY, Hamburg, Karlsruhe, Louvain-la-Neuve, Santander, Vienna, Vilnius, Warsaw
- The aim is:
“to develop materials, technologies and simulations for silicon sensor modules at intermediate to large radii of a new CMS tracker for SLHC”
- The VLDT Karlsruhe contributes by:
 - performing proton and neutron irradiations
 - characterizing sensors and test-structures
 - building modules
 - producing layouts of new sensors and test-structures
(GDSII files for manufacturers)

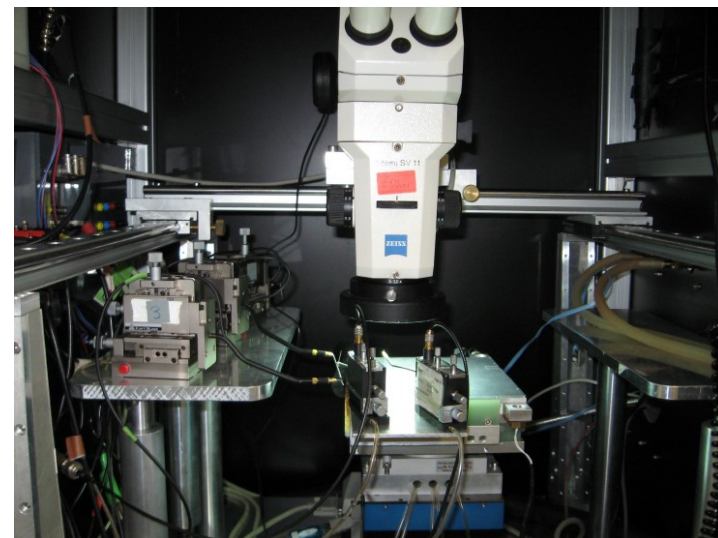
Contribution to LPTPC

- It was planned to test the benefit of a silicon envelope around a TPC (SiLC)
- A hodoscope consisting of 4 silicon strip modules is being built together with Vienna
- Modules are built at Vienna
- KA contributions:
 - The support structure was designed and is being built in our workshop
 - The DAQ hardware was set up using spare components from CMS tracker construction phase
 - Additional electronics board has been designed and built
 - DAQ software was adapted to work with TLU
 - Data conversion to slcio
 - Precise coordinate measurements

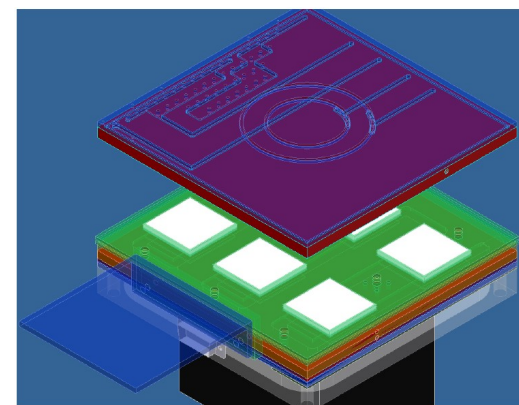


Upgrades

- Probe stations improved for qualifications after irradiation
 - Good microscope with camera
 - Chillers and cold chucks with peltier elements
 - HV source
- TCT setup
 - Fast IR laser
 - Focussing optics
 - Attenuator for defined MIP pulses
- Additional read-out system for mini-strips



Current probestation



Cold chuck

Summary

- VLDT Karlsruhe is used by many projects
- Irradiation is well established
- Infrastructure is being improved
- Staff available to support usage of VLDT

(please contact me)