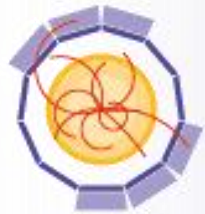


# Status Report on Irradiations at KIT (WP 7 TA)

Alexander Dierlamm and Wim de Boer

INSTITUT FÜR EXPERIMENTELLE KERNPHYSIK

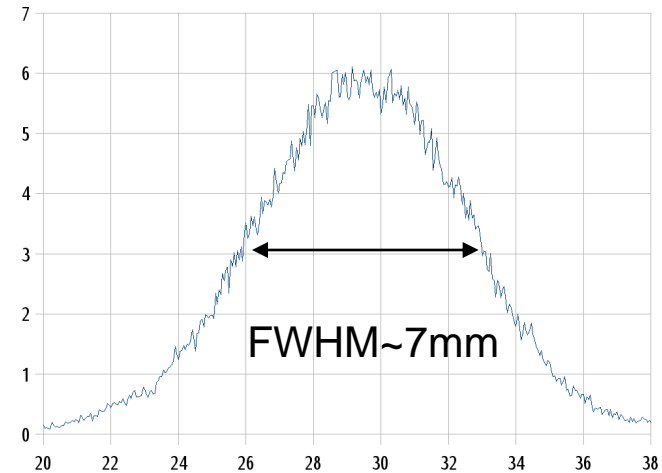


# AIDA

Advanced European Infrastructures  
for Detectors at Accelerators

# The Karlsruhe Proton Cyclotron KAZ

- Run by private company ZAG
- We are customers and have to pay per beam time
- Proton energy at extraction: 25.3MeV
- Energy at samples: ~23MeV in first layer
- Typical proton current: 1.5 $\mu$ A
- Temperature in box: ~ -25°C
- Beam spot ~ 7mm (varying)
- Flux ~ 2.5e13 p/(s·cm<sup>2</sup>)



Sample box on XY-stage with beam line



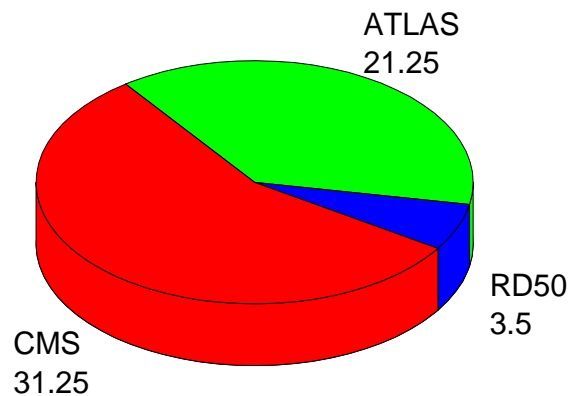
Man placing LN<sub>2</sub> box



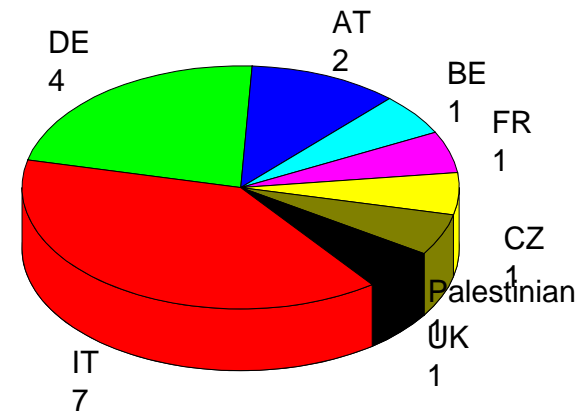
Control room

# Irradiation Summary

- 10 projects with a total of 56 hours beam time
- 18 users
- No visitors
  
- We mainly had high fluence irradiations of  $1e15 - 1e16 n_{eq}/cm^2$



Beam time per experiment (in hours)



Users per nationality

# AIDA-KIT-2011-02

- Title: RD50 Development of 3D silicon detectors
- Group leader: R. Bates, Glasgow
- Beam time: 3.5h
  
- 4 samples from CNM irradiated to  $1e16n_{eq}/cm^2$

# AIDA-KIT-2011-03

- Title: Irradiation of Silicon Pixel modules for ATLAS-IBL project at CERN
- Group leader: A. La Rosa, CERN
- Beam time: 13.6h
  
- 4 batches with in total 13 SCA up to  $5e15n_{eq}/cm^2$

# AIDA-KIT-2011-04

- Title: CMS HPK irradiation campaign – Protons
- Group leader: D. Abbaneo, CERN
- Beam time: 2.5h
  
- First irradiation step of several samples for 2011 combined in this application
- On request by the selection panel chair the application was split to six applications covering individual samples/topics
  - AIDA-KIT-2011-06: CMS Test-structure Irradiations
  - AIDA-KIT-2011-07: CMS Silicon Material Evaluation  $R > 5\text{cm}$
  - AIDA-KIT-2011-08: CMS Short Strip Sensor Evaluation
  - AIDA-KIT-2011-09: CMS Strip Sensor Geometry Evaluation
  - AIDA-KIT-2011-10: CMS Silicon LA Study
  - AIDA-KIT-2012-01: CMS Silicon Material Evaluation  $R = 5\text{cm}$

# AIDA-KIT-2011-05

- Title: Irradiation of Silicon Pixel FE chips for ATLAS-IBL project at CERN
- Group leader: J. Weingarten, Göttingen
- Beam time: 5.4h
  
- 2 FE-I4 bare chips up to  $5e15n_{eq}/cm^2$

# AIDA-KIT-2011-06

- Title: CMS test-structure Irradiations
- Group leader: M. Dragicevic, Vienna
- Beam time: 2.3h
  
- 9 samples of process test-structures of different materials up to  $1.5e15n_{eq}/cm^2$



# AIDA-KIT-2011-07

- Title: CMS Silicon Material Evaluation  $R > 5\text{cm}$
- Group leader: D. Abbaneo, CERN
- Beam time: 2.3h
  
- 9 mini strip sensors and 27 diodes of different materials up to  $1.5 \times 10^{15} n_{\text{eq}}/\text{cm}^2$

# AIDA-KIT-2011-08

- Title: CMS Short Strip Sensor Evaluation
- Group leader: S. My, Bari
- Beam time: 2.3h
  
- 9 test sensors with 1-2mm long strips of different materials up to  $1.5e15n_{eq}/cm^2$

# AIDA-KIT-2011-09

- Title: CMS Strip Sensor Geometry Evaluation
- Group leader: M. Meschini, Florence
- Beam time: 2.3h
  
- 9 strips sensors with various widths and pitches of different materials up to  $1.5e15 n_{eq}/cm^2$

# AIDA-KIT-2011-10

- Title: CMS Silicon LA Study
- Group leader: C. Vander Velde, Brussels
- Beam time: 19.5h
  
- About 40 mini strip sensors of different materials up to  $7e15n_{eq}/cm^2$

# AIDA-KIT-2011-11

- Title: Irradiation of Silicon Pixel modules for the ATLAS-Upgrades
- Group leader: A. Lounis, Orsay
- Beam time: 2.3h
  
- 3 planar n-in-p pixel modules up to  $2e15n_{eq}/cm^2$

# Publications

- A. Dierlamm, “Silicon sensor developments for the CMS Tracker upgrade”, 2012 JINST 7 C01110
  - <http://iopscience.iop.org/1748-0221/7/01/C01110>
  - Covering AIDA-KIT-2011-04 and AIDA-KIT-2011-10
- M. Bernard-Schwarz, “Future Silicon Sensors for the CMS Tracker Upgrade”, to be published in NIM
  - Covering AIDA-KIT-2011-04
- Customers reminded about acknowledgement policy
- No information about further publications from customers

# Outlook for 2012

- Projects to be continued:
  - AIDA-KIT-2011-06: CMS Test-structure Irradiations
  - AIDA-KIT-2011-07: CMS Silicon Material Evaluation  $R > 5\text{cm}$
  - AIDA-KIT-2011-08: CMS Short Strip Sensor Evaluation
  - AIDA-KIT-2011-09: CMS Strip Sensor Geometry Evaluation
  - AIDA-KIT-2011-10: CMS Silicon LA Study
- New project already started:
  - AIDA-KIT-2012-02: Irradiation for CERN-RD50 Collaboration
    - Group leader: Gianluigi Casse, Liverpool
    - Investigates charge multiplication with special sensors
- New projects planned:
  - AIDA-KIT-2012-01: CMS Silicon Material Evaluation  $R = 5\text{cm}$ 
    - Group leader: Michael Moll, CERN
    - High fluence irradiation of  $1.6n_{\text{eq}}/\text{cm}^2$  to evaluate materials for most inner vertexing region
  - AIDA-KIT-2011-01: ATLAS pixel upgrade
    - Group leader: Alexadre Rosanov, Marseille
    - Study of SEU effects in FE-I4; requires online measurements
    - Probably found a better source for this

# Backup

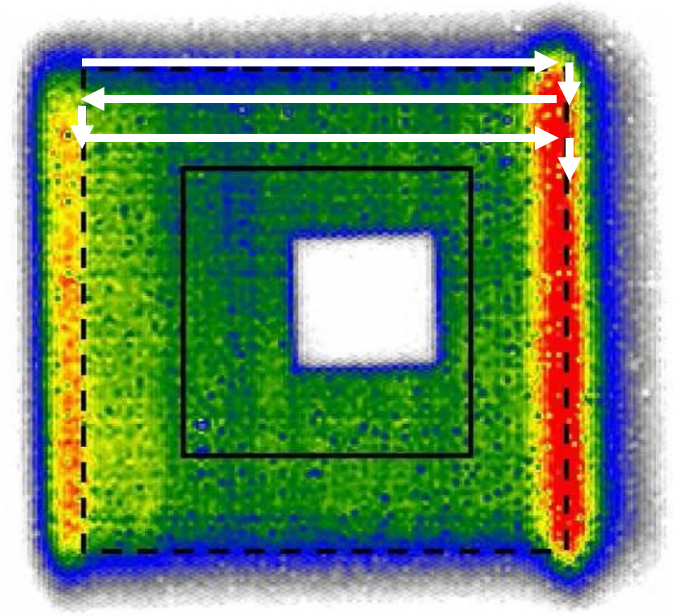


## Scanning Procedure

- Samples are scanned in 1mm spaced rows
- Edge regions are inhomogeneous and a margin of  $\sim 1\text{cm}$  is used
- Proton fluence is calculated by:

$$F_{est} = n_{scan} \cdot \frac{I_p}{q_{el} \cdot v_x \cdot \Delta y}$$

- The proton current  $I_p$  is always measured at the last beam stop
- At the nominal values of  $I_p=1.5\mu\text{A}$  and  $v_x=115\text{mm/s}$  we generate  $1.5e13n_{eq}/\text{cm}^2$  per scan



Autoradiographic image of a large Ni-foil scanned in the described procedure. The white area is a cut out for further dosimetry.

# Energy at Target

- 25.3MeV is the energy in the beam line
- Protons have to pass several materials until they hit the samples
- SRIM gives us a proton energy entering the samples of about 23.8MeV and on average in the sample: **22.9MeV**
- Samples covered by Nickel foils see lower energy  $\sim$ 22.8MeV

