Some of the Detector R&D until 2025

Bjarne Stugu

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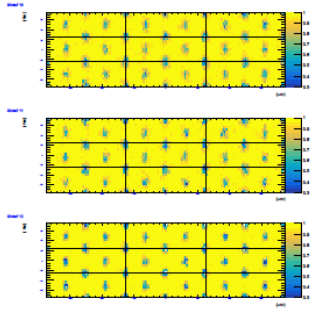
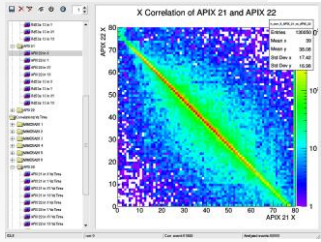
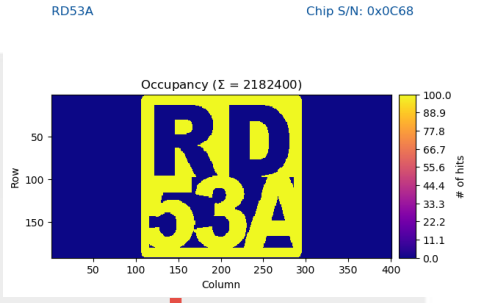


Rad. Hard pixel sensors for ATLAS ITk

- ITk installation: During LHC Long Shutdown 3, 2024-2025
  - Development of radiation hard silicon sensors in ‘3D’
  - Sintef Run3:
    - Working sensors compatible with use in the ATLAS IBL (FEI4-compatible), but low yield
  - Sintef Run4:
    - Wafer measurements show very good yield
    - Some 50 µm thickness FEI4 sensors already tested in testbeam
    - 100 µm FEI4 sensors in testbeam next week
    - RD53A sensors ready for testing within 1-2 weeks
  - Sintef Run5:
    - Prototyping and qualification run for possible deliveries
    - Design work is ongoing
- We are facing a period of intense testing and evaluation activities
  - Lab tests, testbeams, irradiation campaigns





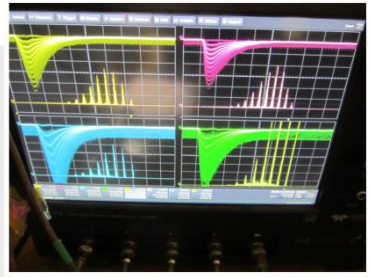
ATLAS Itk and the RD53 collaboration

- RD53 is a collaboration for developing radiation hard ASICS for the readout of pixel detectors in ATLAS and CMS in the HL-LHC
- Bergen is member since last year (Attiq, Magne and Bjarne)
  - Attiq Uhr Rehman: IC designer
  - Magne Lauritzen: Testing and debugging
- First prototype has been delivered: The RD53A chip
  - Magne has taken part in testing and debugging, and has thus gained expertise in usage of the system -> Essential knowledge for the ongoing sensor development programme.
- Attiq is involved in developing the next chip, the RD53B, which is the readout chip that will be used by Itk.
- RD53B Chip submission: mid 2019

RD 42: Diamond detectors

- Diamond detectors are extremely radiation hard
- Have been used for radiation monitoring in very limited scope
- **Justas Zalieckas:** NFR project for in-house production of diamond through Chemical Vapor Deposition
  - Issue: charge collection distance (CCD)
  - Justas can vary processing parameters in order to optimise the CCD

Calorimeter R&D (Gerald et al.)

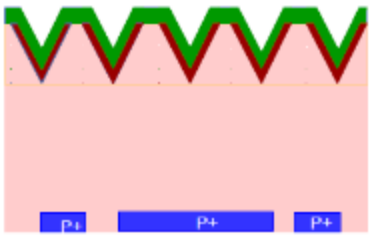


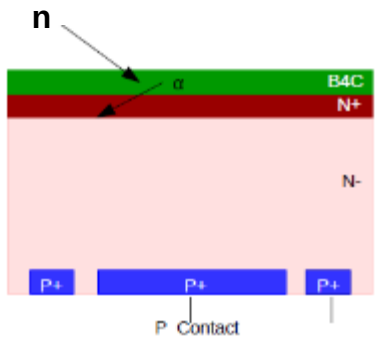
- ATLAS studies for Tile Calorimeter
  - Measure light yield of different-size tiles with SiPMs and compare this to PM readout
  - Study light uniformity in tile and understand light losses in scintillator tile, wavelength shifting fiber, photodetector
  - Participation in the phase II upgrade
  - Simulation of the light yield measurements
  - Participation in radiation hardness studies
  - Participation in test beams at CERN

- R&D for analog hadron calorimeter at ILC
  - Light yields studies of different tile geometries (hexagonal vs square tile)
  - Uniformity studies of different read outs (position of SiPM, readout w and w/o wavelength shifting fiber)
  - Characterization of new SiPMs
  - Simulation of light transport
  - Simulation of performance of analog hadron calorimeters with hexagonal tiles compared to one with square tiles
  - Participation in test beams

Detector R&D (Dieter et al.)

- **ESS**
  - **High spatial resolution silicon-based neutron detectors**
    - **Exploit 3D structures to increase efficiency (SINTEF)**
    - **ALPIDE + converter**

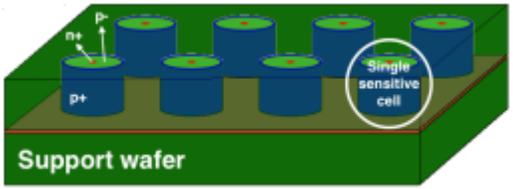




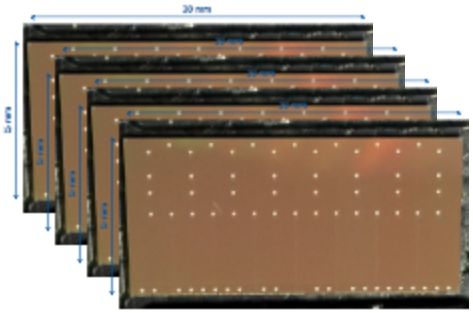
$^{10}B+n \rightarrow {}^{7}Li+ \alpha$ (1.48 MeV)

- **Medical Physics**
  - **Microdosimetry**
    - **Characterization of 3D Si-microdosimeters (SINTEF/Wollongong)**

Microdosimetry development started with the '3DMiMiC' project, that also included production of ultrathin X-ray microbeam intensity monitors.



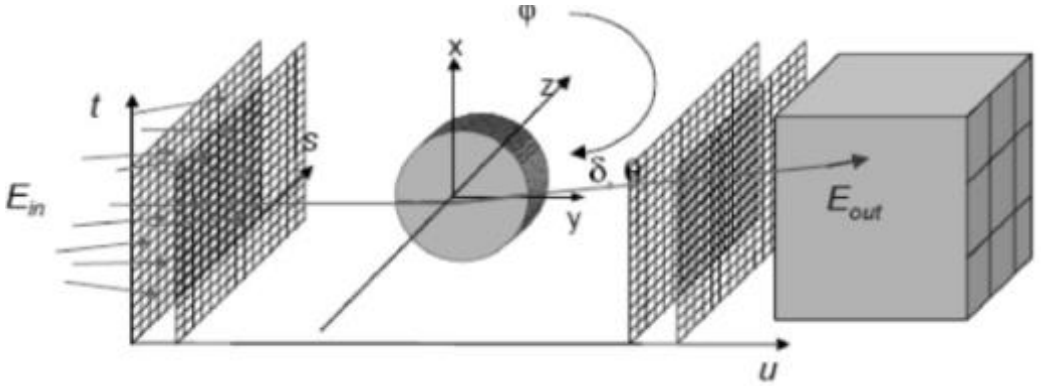
    - **ALPIDE stacks**



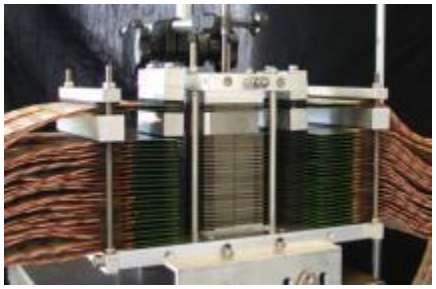
Detector R&D - medical physics (Dieter et al.)

Proton-CT

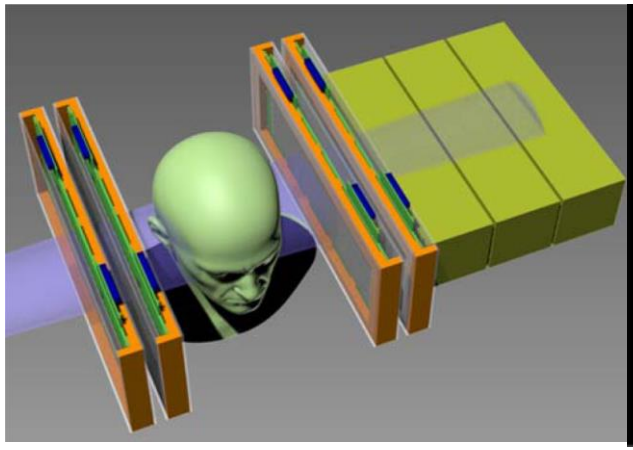
- **novel diagnostic tool for online dose plan verification in particle therapy**

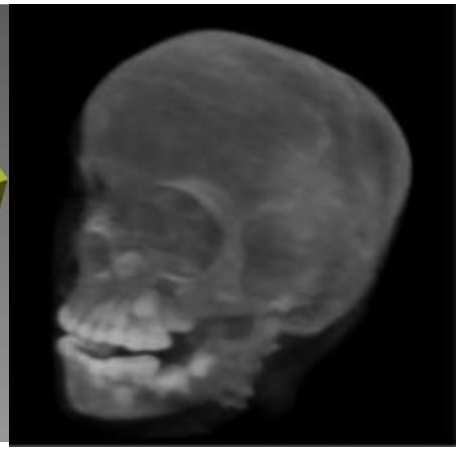


- **key detector**
  – high-granularity digital tracking calorimeter



- **key technology**
  – ALICE ALPIDE silicon pixel sensors





H.F.-W. Sadrozinski / Nuclear Instruments and Methods in Physics Research A 732 (2013) 34–39

Fig. 14. 3D rendering of the pCT-reconstructed RSP map of a pediatric anthropomorphic head phantom.

V.A. Bashkirov et al. / Nuclear Instruments and Methods in Physics Research A 809 (2016) 120–129

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