NIKHEF activities and infrastructure

8th RD50 - Workshop
Prague, 25-28 June, 2006

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Contents

- General information about NIKHEF
- Scientific program
- Technological aspects of the main HEP experiments
  - ATLAS
    - R&D program for ATLAS SLHC upgrade
  - ALICE
  - LHC-b
  - ANTARES
- Current instrumentation R&D
  - ReLAXD
  - GOSSIP
  - RASNIK
- Facilities
  - Clean rooms, bonding room, 3D metrology, wafer prober, irradiation facility, characterisation station
- Technical departments
  - Computer technology
  - Electronics technology
  - Mechanical engineering
  - Mechanical workshop
- NIKHEF's interest in RD50 collaboration

General information about NIKHEF

- National Institute for Nuclear and High Energy Physics in the Netherlands (NIKHEF)
- Collaboration of
  1. Foundation for Fundamental Research on Matter (FOM)
  2. University of Amsterdam (UvA)
  3. Free university Amsterdam (VU)
  4. Radboud University Nijmegen (RU)
  5. University of Utrecht (UU)
- NIKHEF co-ordinates and supports all activities in experimental subatomic (high energy) physics in the Netherlands.

- Staff: around 173 (fte)
  - 73 physicsts
    - 33 permanent
    - 10 postdoc
    - 27 PHD
  - 78 technical staff
    - 20 computer technology
    - 29 electronics technology
    - 13 engineering department
    - 16 mechanical department
  - 22 support staff

Scientific program (only running and future experiments listed)

- HERA
  - Hermes
  - ZEUS
- LHC experiments
  - ALICE
  - ATLAS
    - Upgrade R&D for SLHC
  - LHC-b
- RHIC
  - STAR
- Tevatron
  - DØ
- BaBar (SLAC)
- Theoretical physics
- Detector R&D
  - Medipix
  - Gaseous micropattern detectors
  - Alignment
- ILC
  - Development GRIDPIX
  - Alignment
- Dutch GRID
  - BIGGRID starting
- Astro particle physics
  - ANTARES
  - Pierre Auger
  - HiSparc
- Gravitational physics
  - LISA

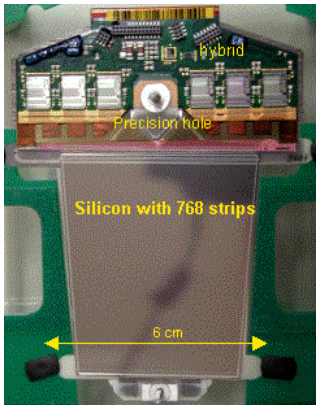
Technological aspects of the experiments

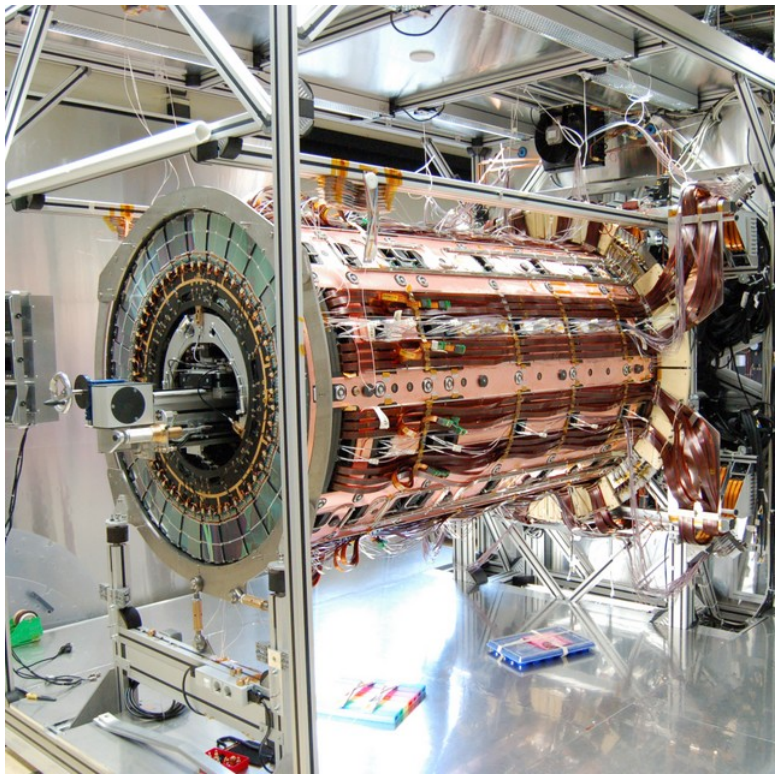
Large scale tracker assembly

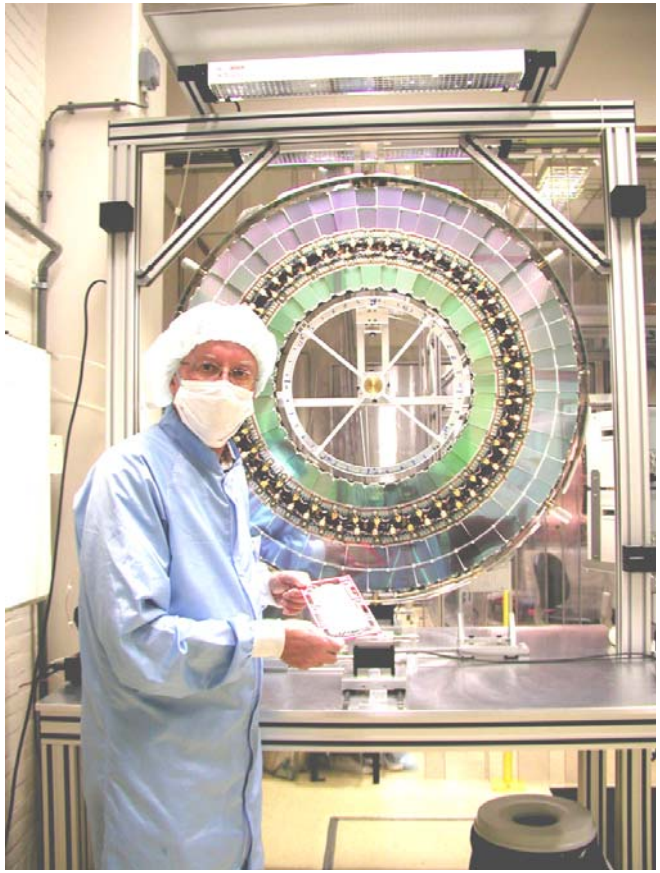
- NIKHEF has played and is still playing a major role in many large scale experiments, especially on the assembly of big detector structures
- Large wire chamber detectors
  - LEP experiments (L3, Delphi)
  - ATLAS: part of the muon tracker
  - LHC-b muon tracker
- Silicon vertex trackers
  - ZEUS inner tracker
  - ATLAS: SCT endcap A
  - LHC-b: VELO housing and CO_2 cooling
  - ALICE: assembly vertex tracker
- Micro pattern gas detectors
  - Hermes vertex tracker (MSGC technology)
  - Soft X ray detector (Dubble at ESRF, MSGC technology)
  - Now in development: GRIDPIX => GOSSIP: gaseous pixel detector

ATLAS SCT

- ATLAS: SCT endcap A
  - Containing 988 silicon modules
  - 100 inner modules assembled in house
  - Macro assembly of the SCT endcap

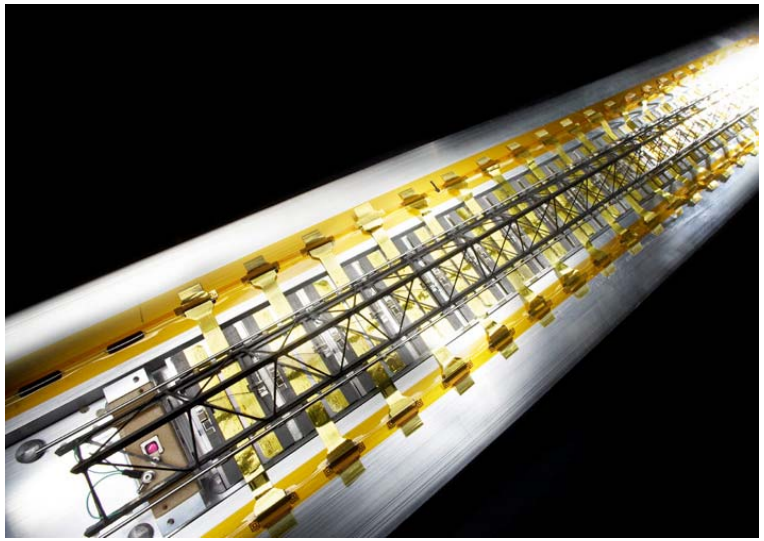






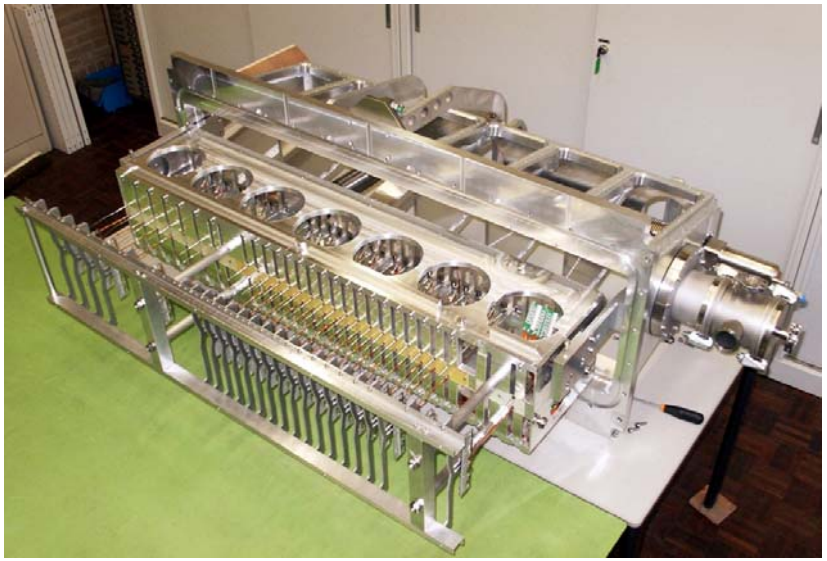
ALICE

- Assembling 72 ladders
  - In total 1698 modules
  - 5.5 m^2 silicon
- Positioning accuracy 30 μm (X,Y)



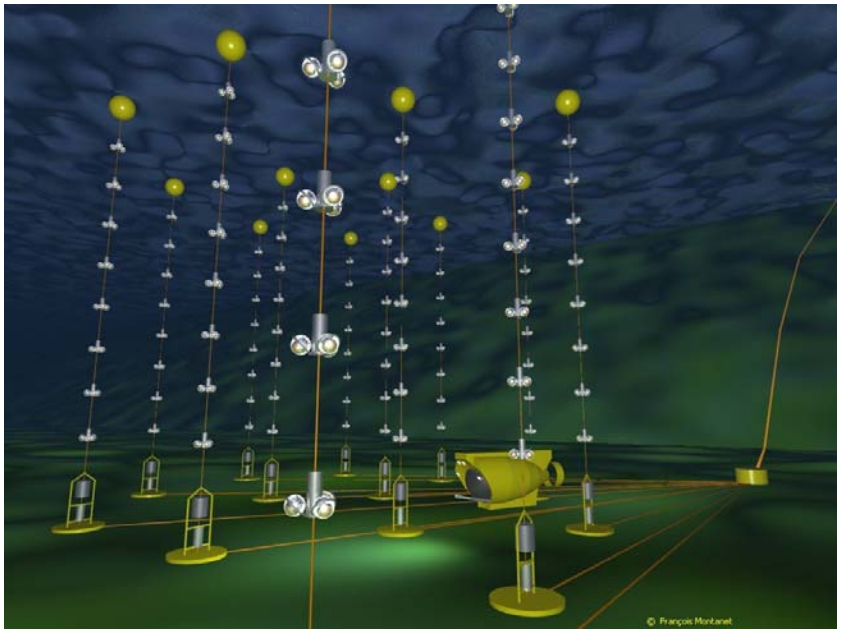
LHC-B

- VELO
  - Detector housing
  - CO_2 cooling
  - RF foil in beam vacuum



ANTARES

- Development and implementation of the DAQ
  - All Data to Shore concept
- Event display
- Reconstruction of muon tracks
- Directional trigger
- Software for the search for point sources.



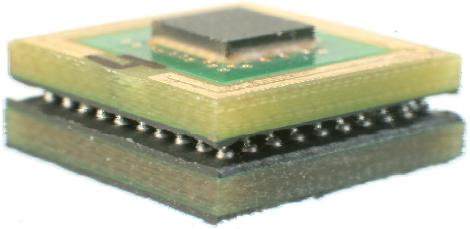
Current instrumentation R&D

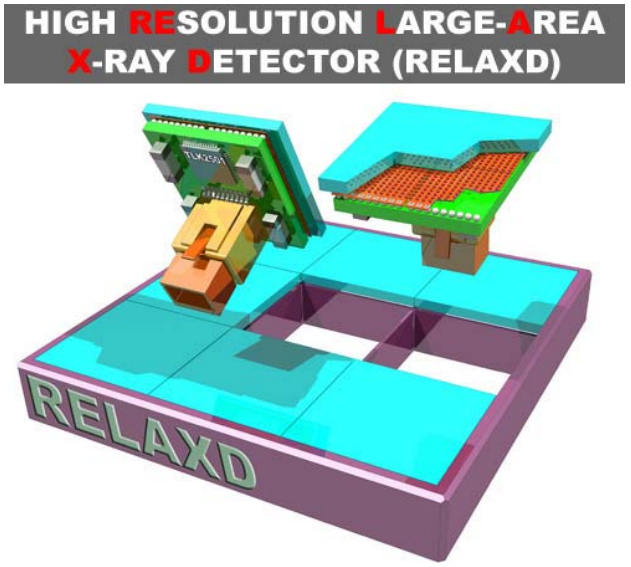
Current instrumentation R&D

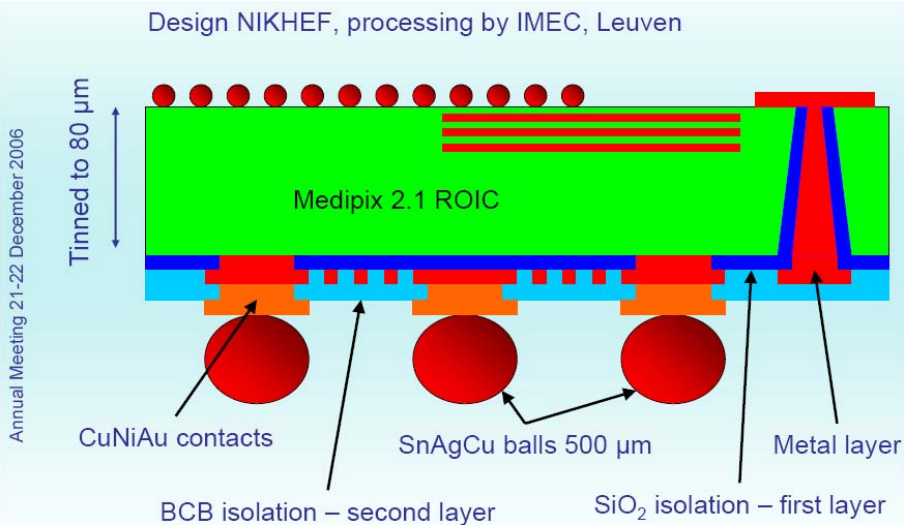
- Medipix
  - Member of Medipix-2 collaboration
    - X-ray silicon pixel detector
  - Member of ReLAXD collaboration
- Micropattern gasdetectors: Gridpix
  - Combination of pixel ROC and gas amplification stage (Micromegas => INGRID)
  - Using thin (1 mm) gas layer => GOSSIP
    - High rate mip detection
  - Investigation done in collaboration with Twente University (microelectronics development centre)
- Alignment systems: RASNIK
  - Large detector setups
  - Big accelerators

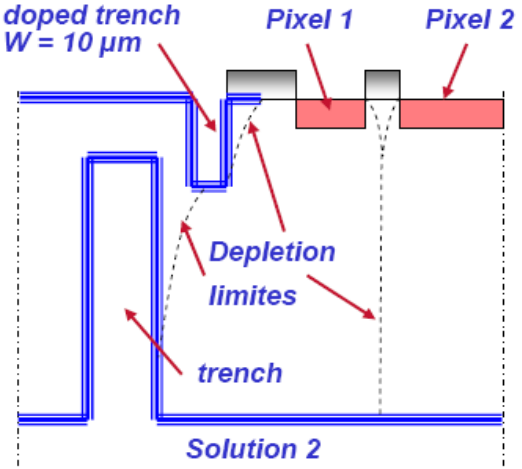
ReLAXD

- Edgeless sensors possible by trench at edge
- NIKHEF is doing/did
  - Part of ASIC design
  - Multi layer chip carrier
  - FPGA design
  - 3 GHz link (copper)



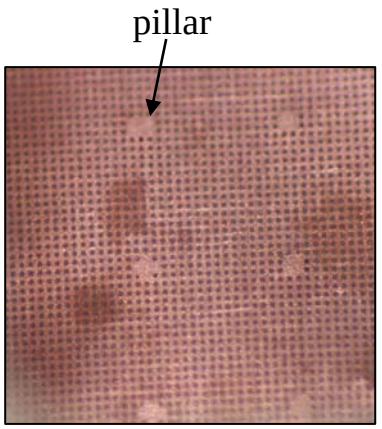




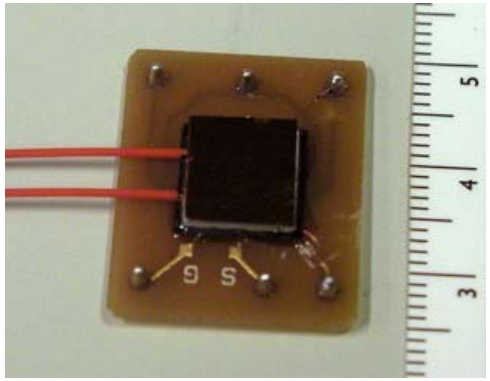


GOSSIP development

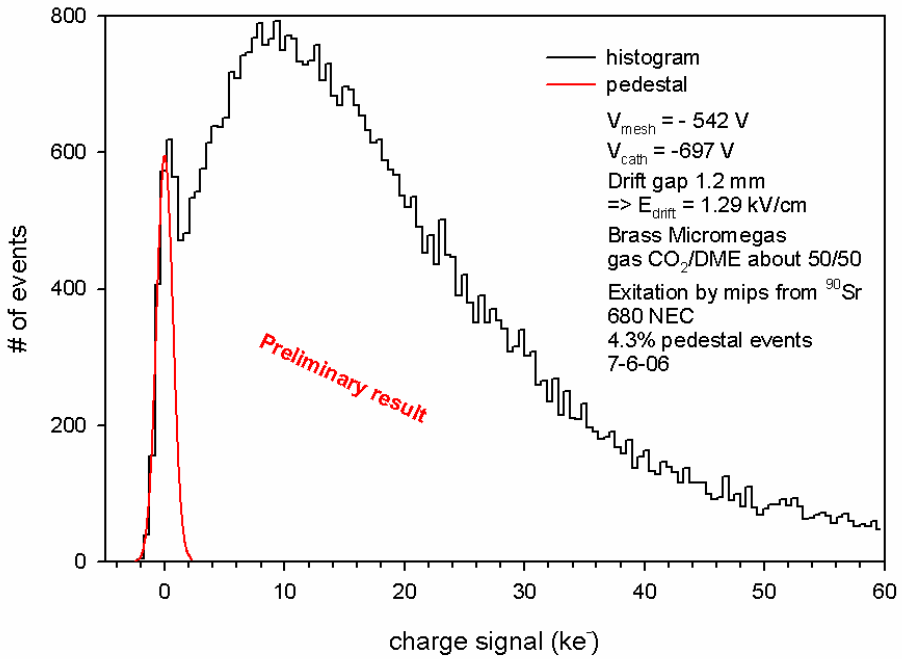
- High luminosity MIP detection
- Very recent MIP spectrum measured (preliminary)
  - 1 – 2 MeV e- from ^{90}Sr source
  - Using Micromegas foil
  - Most probable signal 9 ke$^-$
  - 4.3% pedestal events found
    - From about 2% from characterisation station (Bremstrahlung)
    - 2.1% from dead zone around pillar



Micromegas
130 µm wide pillars

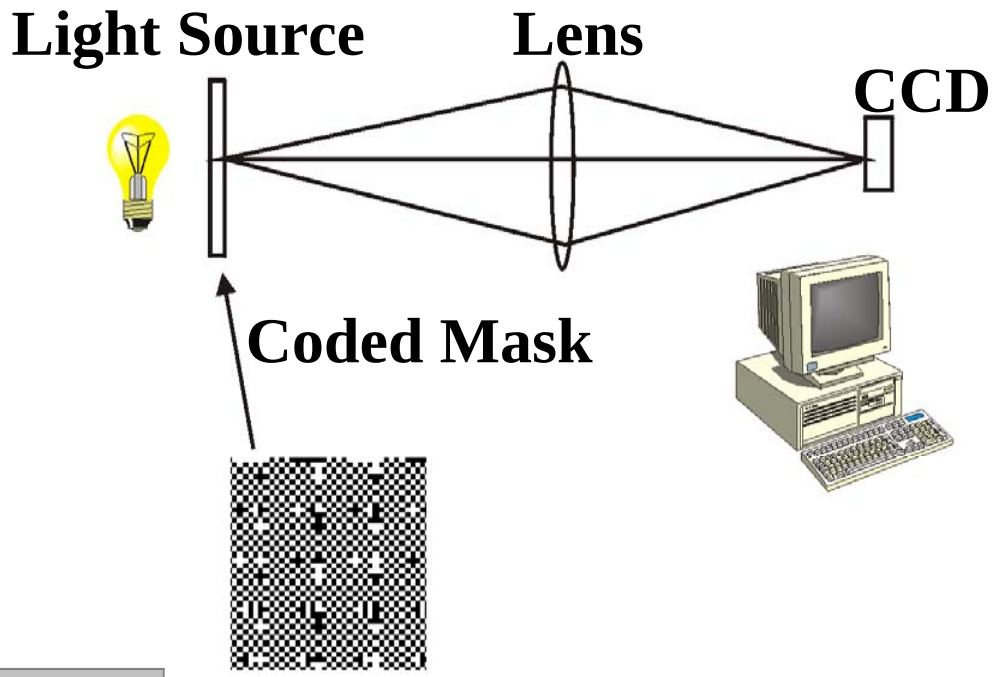


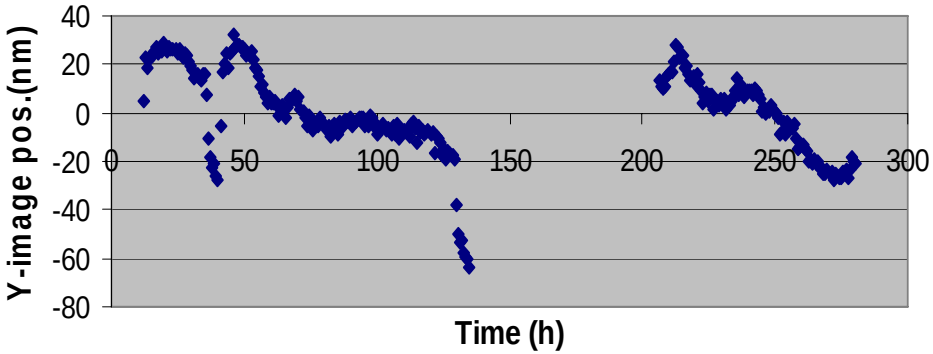
MIP response for GOSSIP7



Alignment: RASNIK

- Illuminated mask projected onto CCD sensor
- Mask image analysed by computer
- Achieved position resolution
  - σ_x = 0.05 µm
  - σ_y = 0.05 µm
  - $\sigma_{scale} = 2 \times 10^{-5}$
  - σ_{RotZ} = 20 µrad





Possible R&D program for ATLAS SLHC Upgrade

- **We didn't make up our mind, the R&D program is presently under discussion**

- Possible subjects
  - GOSSIP (gaseous pixel sensor for ATLAS b-physics layer)
    - Performance comparable to silicon devices but
    - Possibly better radiation hardness than silicon devices
    - Smaller material budget
    - No temperature constraints
  - CO_2 cooling
    - Down to -40 °C cooling temperature => -30 °C detector temperature
    - Thin cooling pipes
  - Mechanical support for pixel tracker
  - Contribution to the design of frontend chips

Facilities

Clean rooms

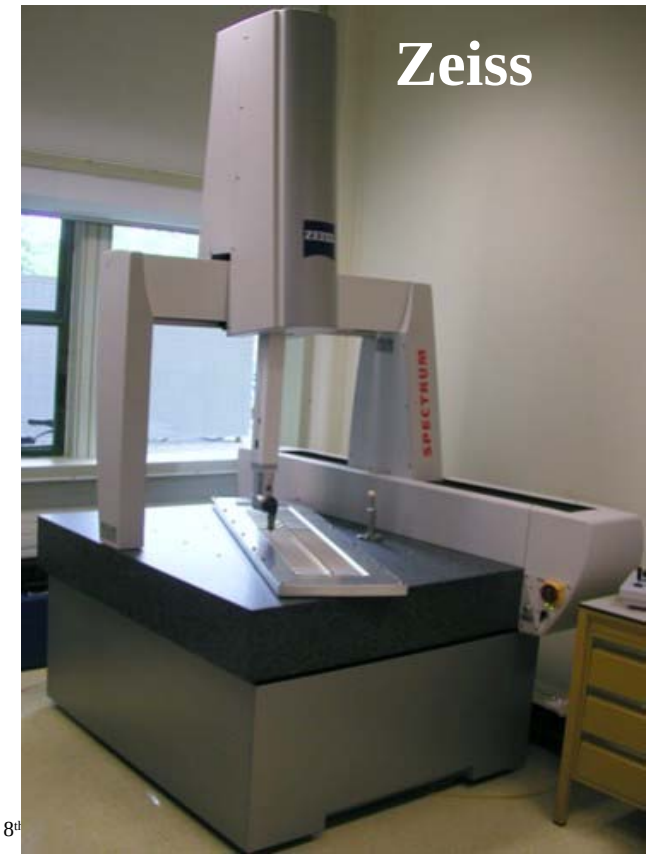
- Most class 10,000
- 5 medium size general use clean rooms
- 2 large clean rooms
- 1 clean room class 1000
- 2 clean rooms for 3D measuring devices

Bonding room

- Automatic wire bonder Delvotec type 3620 for 25 and 17 µm wire
- 2 manual wire bonders
- Pick-and-place station CAMMAX DB600
- Pull tester Royce 220
- Glop top station Essemtec

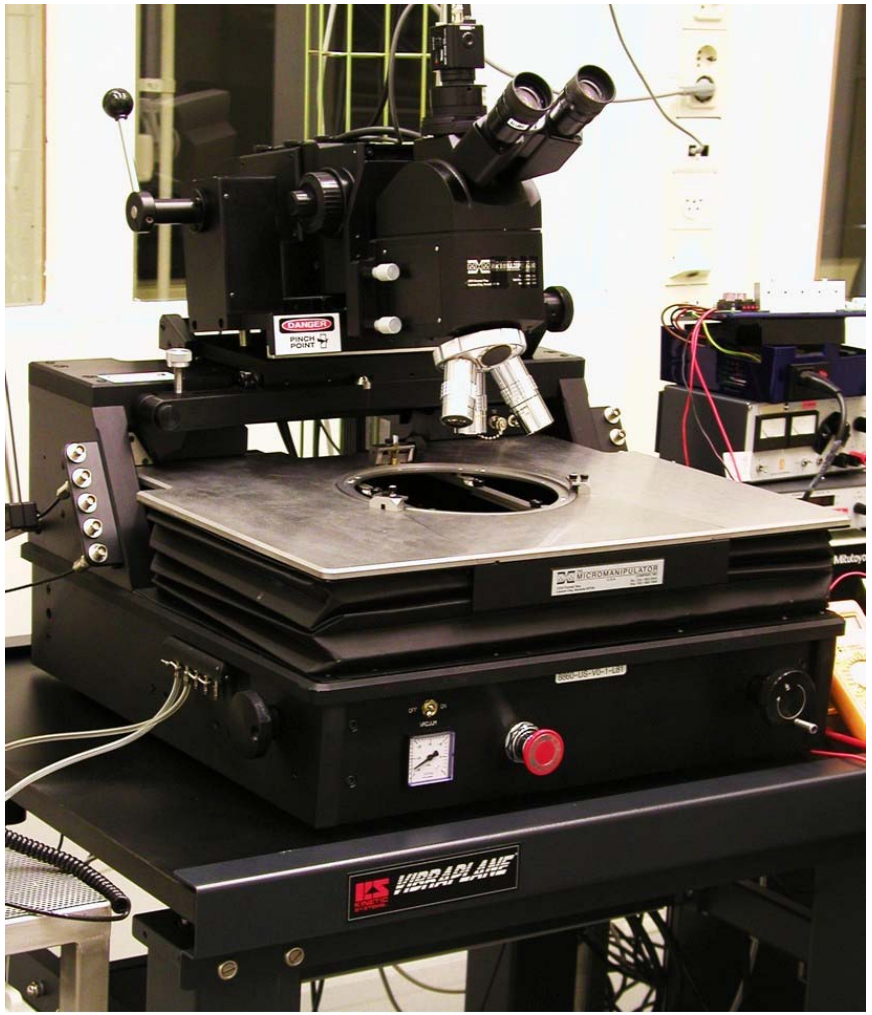
3 D metrology

- Zeiss Spectrum 3D measuring machine
  - Range 700 x 1000 x 580 mm
- Wenzel LH1210 3D measuring machine
  - Range 2000 x 1000 x 1000 mm
  - Accuracy 3 + L/350 µm



Wafer prober

- The Micromanipulator company
- Wafers until 8”
- DAQ using Keithley 4200

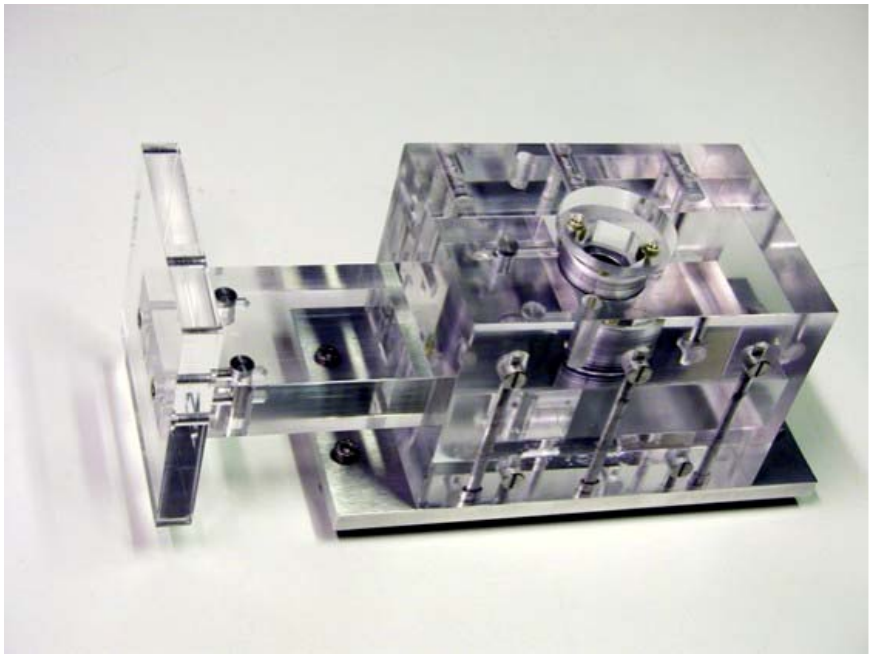


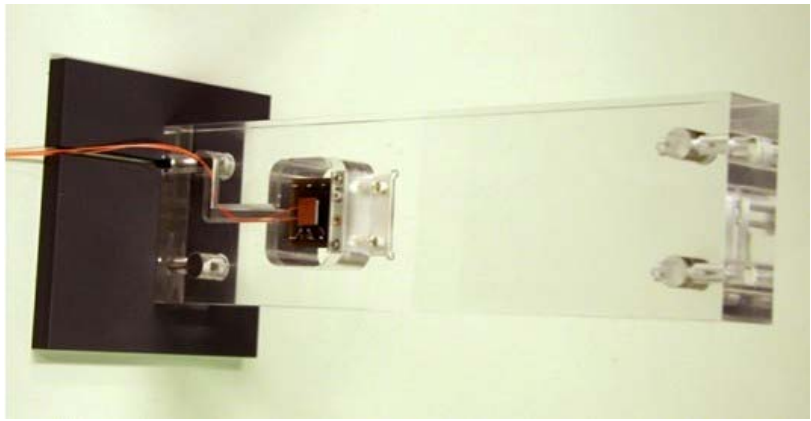
Prototype lab (former SCT lab)

- Alignment station
- Glue robot
- Now used for assembly prototype detectors

5 GBq ^{90}Sr irradiation facility

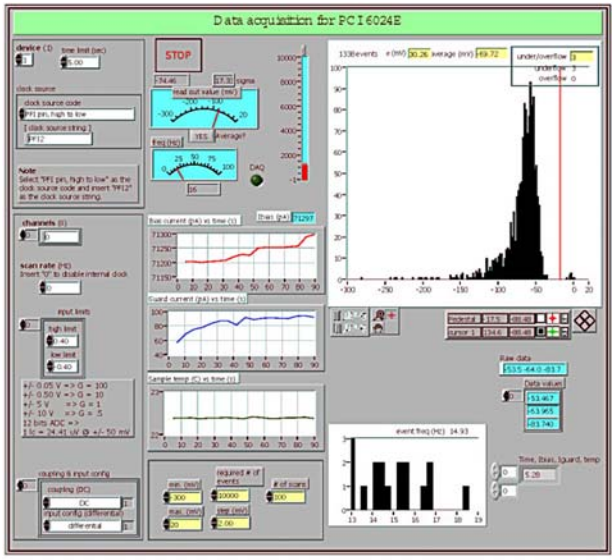
- For small prototypes (< 1.5 cm)
- Up to 3 x 10^{15} MIPs/cm^2 per month expected
- In preparation

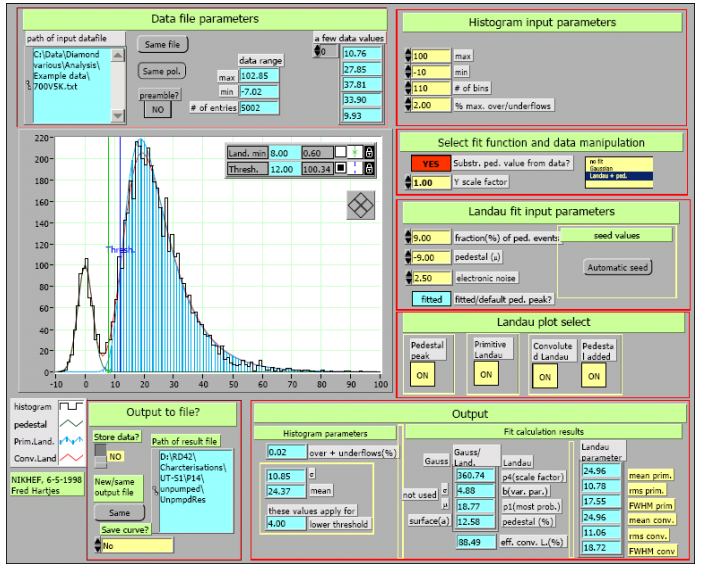




Characterisation station for solid state sensors

- Using mips from ^{90}Sr source
- NEC = 210 + 4.6/pF
- Temperature control –5 to 80 °C
- DAQ using LabView
- Analysis tool for fitting Landau and pedestal peak
- 2 stations are used by other RD50 groups
- Info: http://www.nikhef.nl/~i56/





Sample board

1 cm

Technical departments

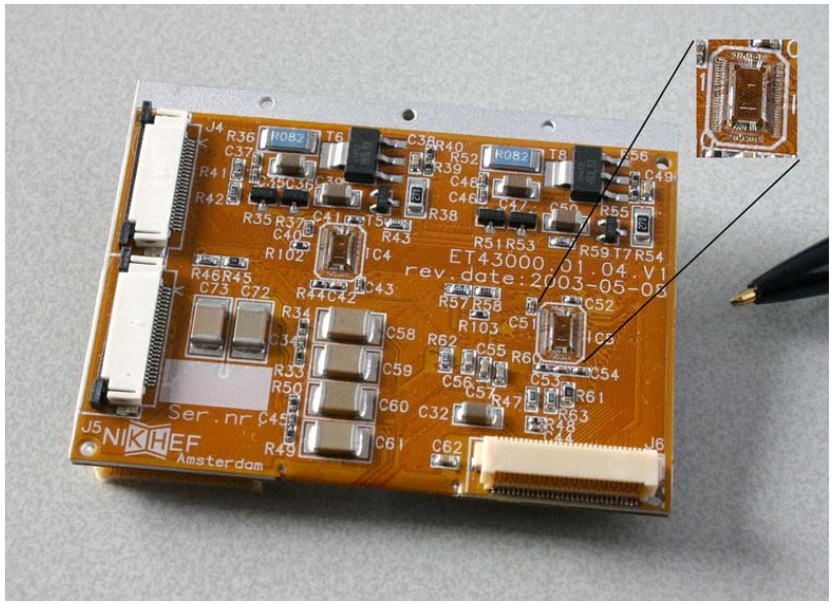
Computer technology

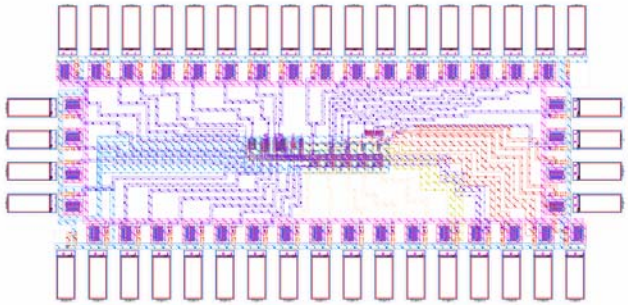
- Staff of 20 people (16 permanent)
  - 9 academic
- NIKHEF is one of the partners in Dutch GRID
  - Platform for GRID computing and technology in the Netherlands
  - BIGGRID approved
- CT is involved in amsix, the Amsterdam internet exchange

DutchGrid
Large-scale Distributed Computing in The Netherlands

Electronics division

- Staff 29 persons
  - 2 physicists
  - 16 engineers
  - 11 middle class technicians
- PCB design
  - Multilayer
  - Chip-on-board technology
- FPGA design for > 10^6 gates
  - Using VHDL
- ASIC design
  - 5 ASIC designers
  - 130 nm technology
  - Using CADENCE on 4 LINUX machines
  - Simulation tools

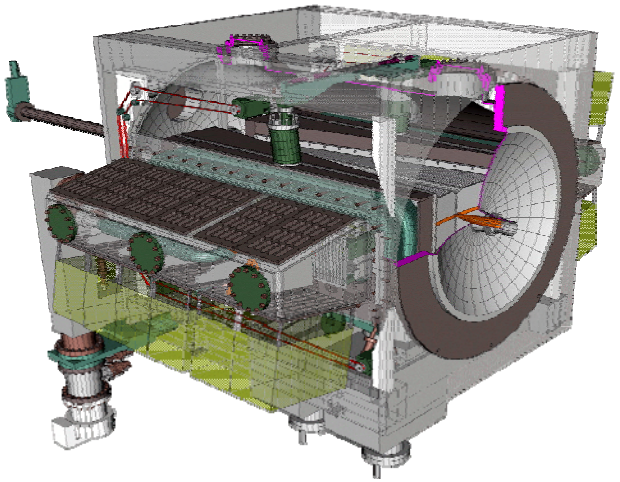


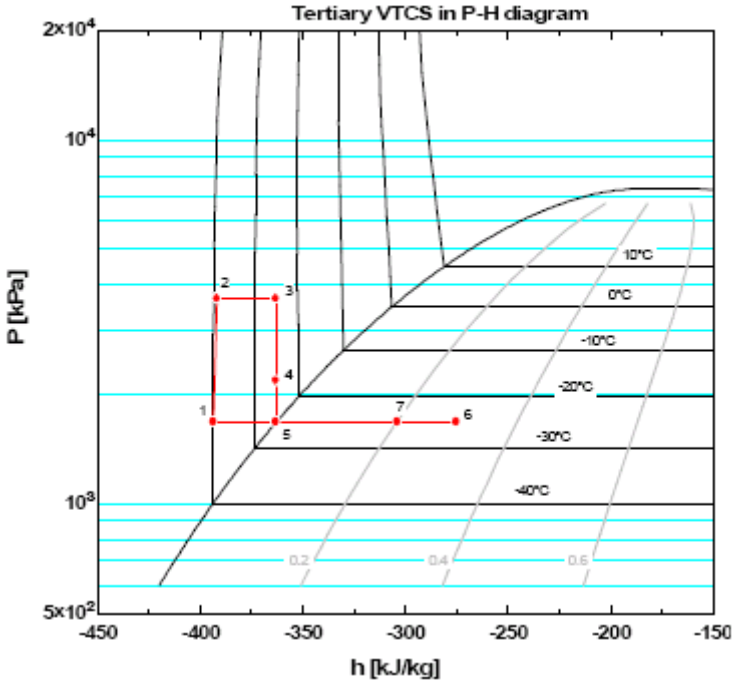


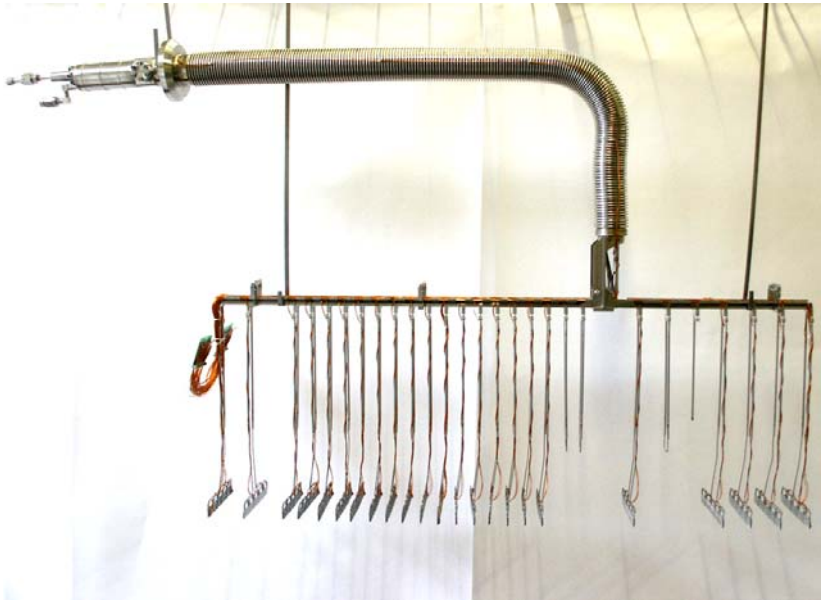
Mechanical engineering

- Staff 13 people
  - 11 engineers
- 3D design on 20 SUN workstations using IDEAS Master Series software packages
- Technology development
  - Cooling (CO_2) for ASM and LHC-b

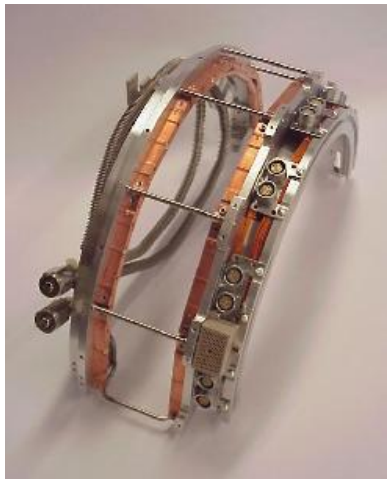
VELO

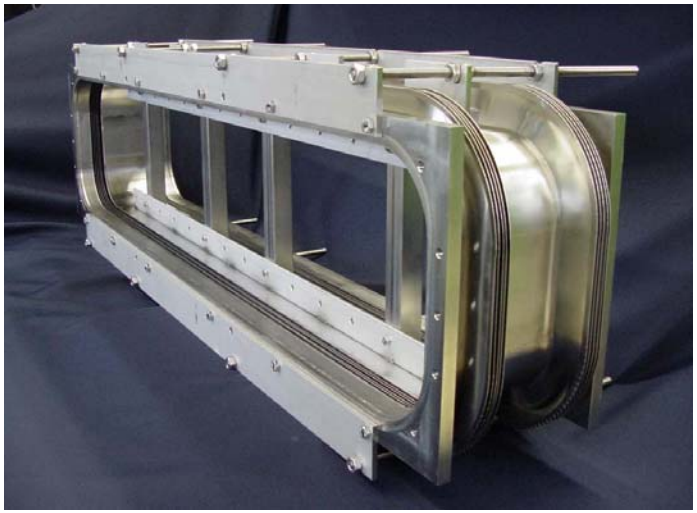






Mechanical workshop





- Staff 16 permanent
- Large construction hall

NIKHEF's interest in RD50 collaboration

- We consider RD50 as an important forum for presenting new sensor ideas
- Staying informed about latest developments on sensor development for high luminosity machines
- Prototype testing
  - Both the sensors we develop as those from other institutes
    - Gaseous sensors
    - Solid state sensors
- Taking part in test beam experiments
  - Especially for graduate/PHD students