FCAL Report

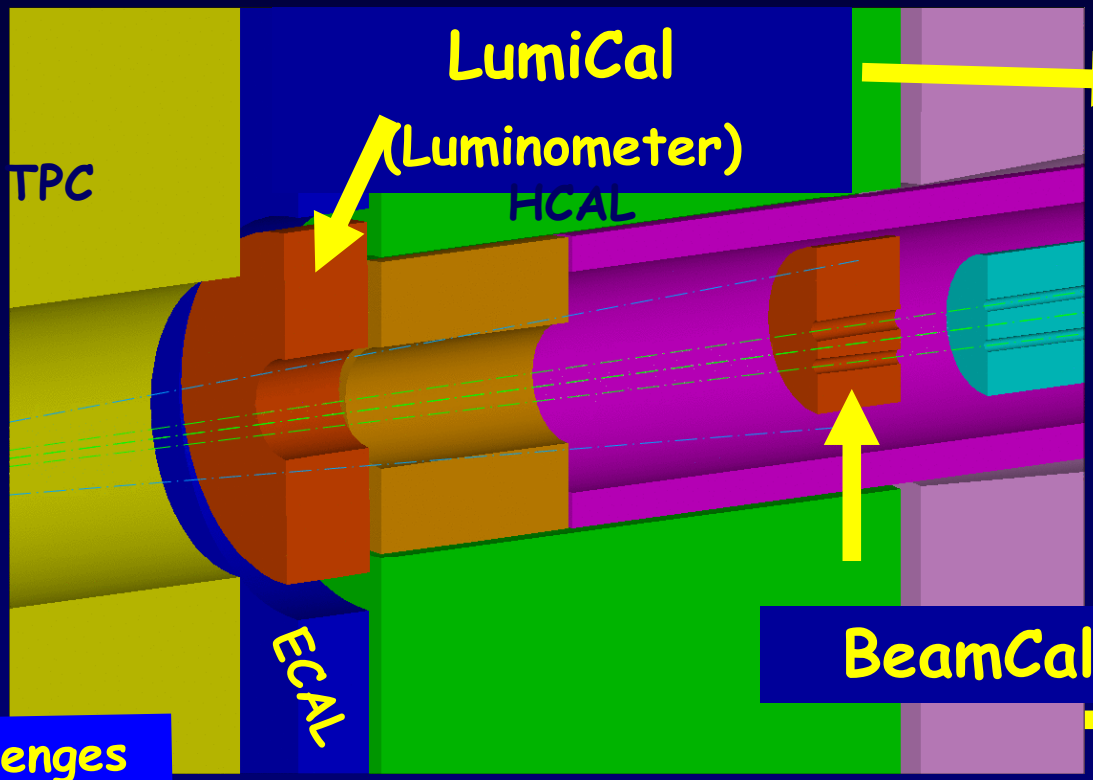
W. Lohmann, DESY

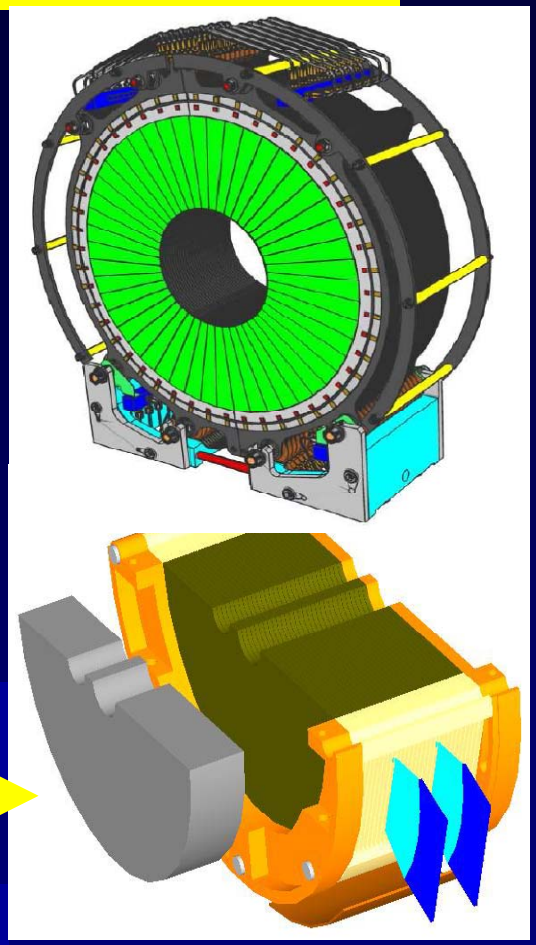
- Design
- FE Electronics
- Sensors and Sensor Tests
- Plans

Labs involved: Argonne, BNL, Vinca Inst, Belgrade, Bukharest Univ. of Colorado, Cracow UST, Cracow INP, JINR, Royal Holloway, NCPHEP, Prague(AS), LAL Orsay, Tuhoku Univ., Tel Aviv Univ. , West Univ. Timisoara, Yale Univ. DESY (Z.)

Associated: Stanford Univ. IKP Dresden
Guests from : CERN

Current design (Example ILD, 14 mrad):





Challenges

LumiCal: -control of position on ~100 μm level
-control of the inner acceptance radius on ~μm level

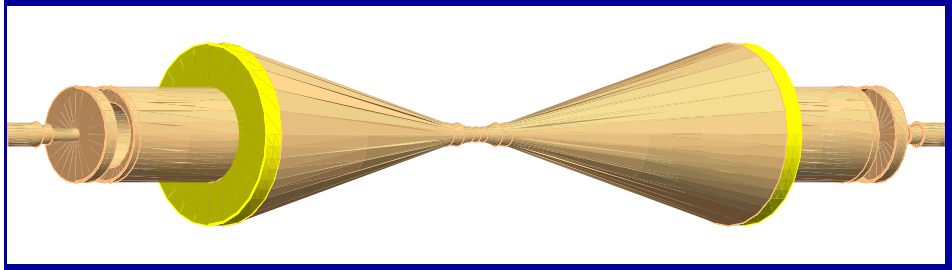
BeamCal: -radiation hard sensors (~10 MGy/year)

Both: -compact (smallest possible Moliere radius)
-readout after each BX

FCAL Collaboration
High precision design

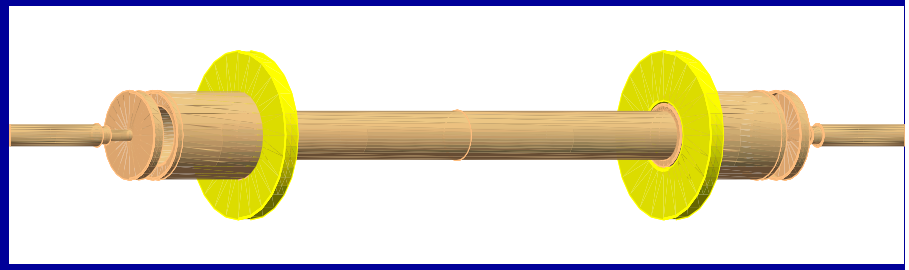
Beampipe

Conical,
central part Be, stainless steel



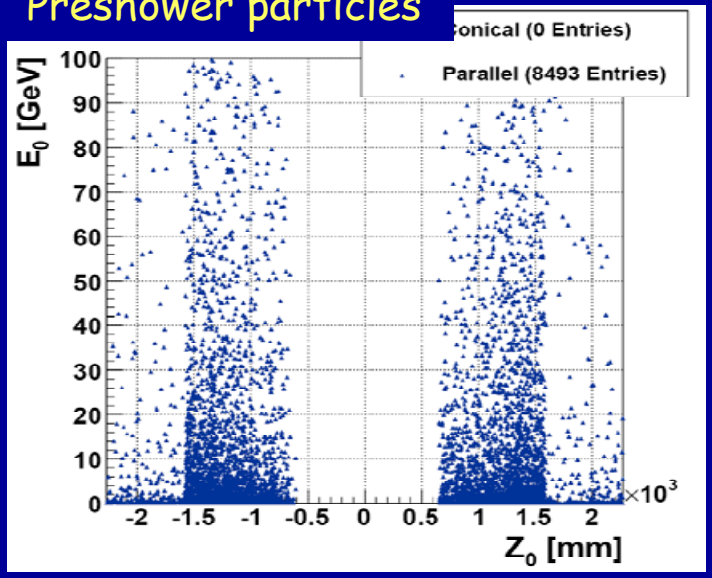
Pro: minimum material in front of LumiCal
Contra: vacuum, HOM, mechanics

Cylindrical, full Be, inner radius 5.5 cm
(14 mrad crossing angle)



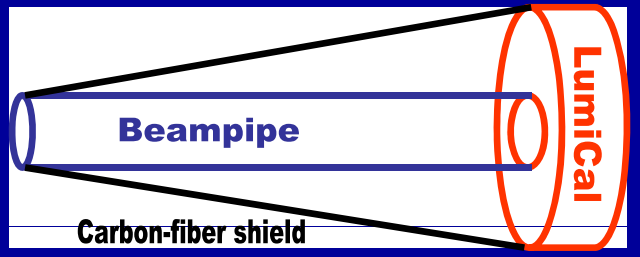
Pro: facilitates mechanics, vacuum
Contra: material in front of LumiCal, pre-showering, electron measurement?

Preshower particles



Difference in the Bhabha count rate:
$(1 \pm 2) \times 10^{-4}$; uncritical !

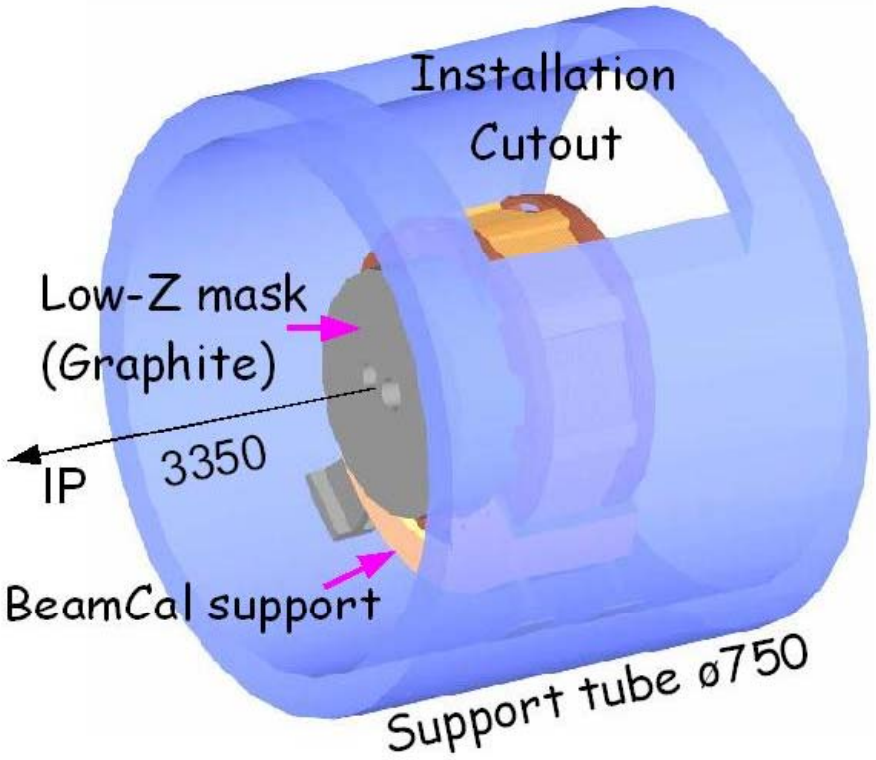
However: don't use the 'free space' for other purposes!

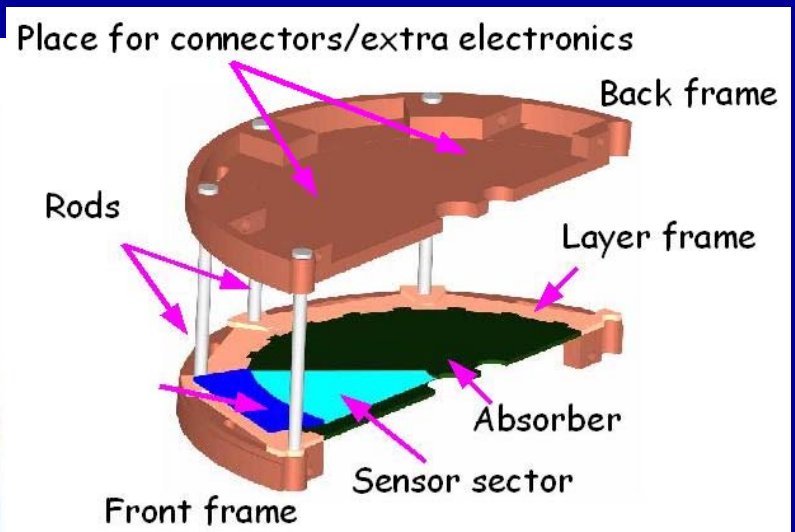


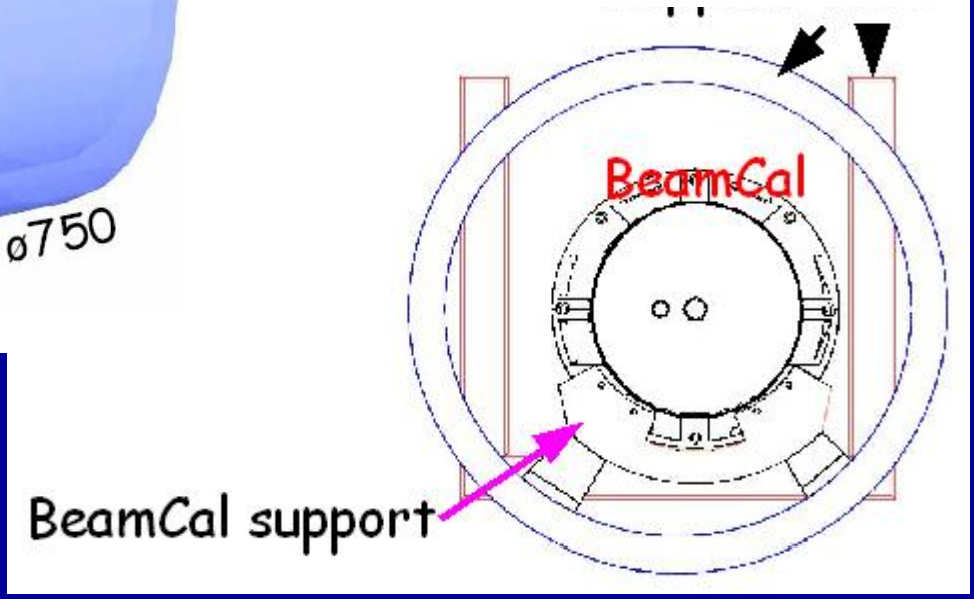
Possible solution

BeamCal Mechanics

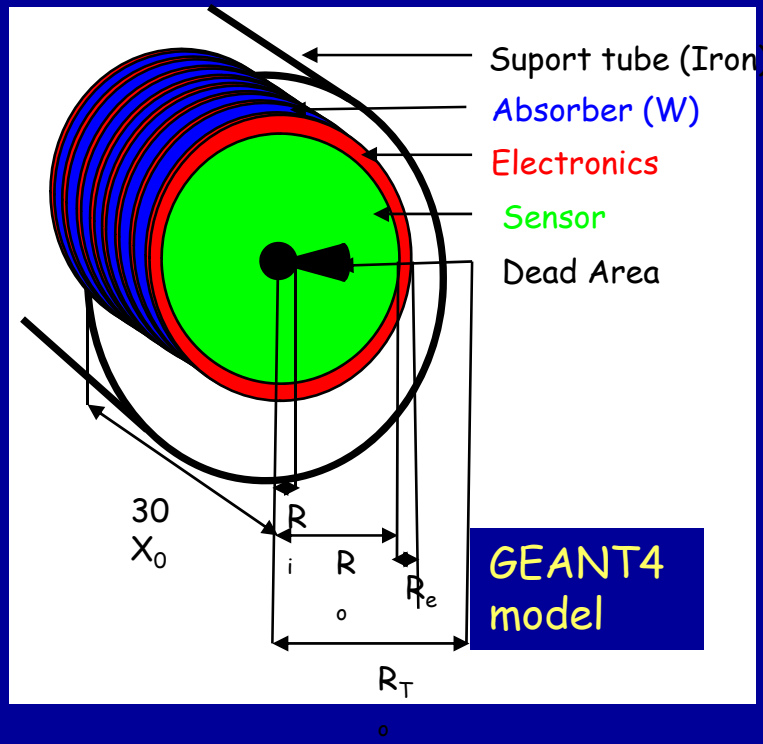
http://www-zeuthen.desy.de/ILC/fcal/







Radiation Dose and neutron fluxes

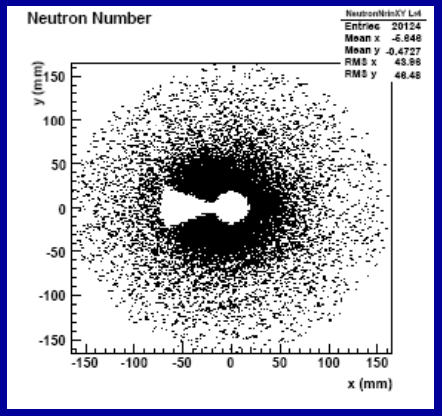


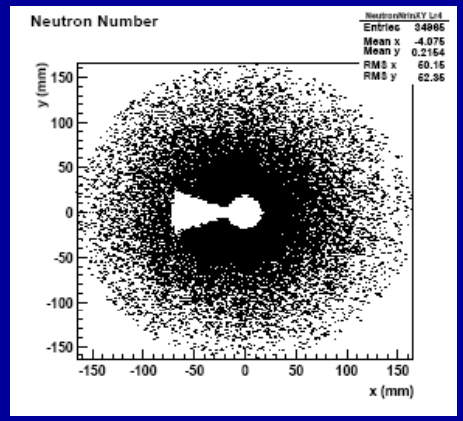
GEANT4 model

Electromagnetic dose for FE electronics:

< 100 Gy /year

Neutron flux inside sensors:





Two different 'physics lists'

Neutron flux through FE electronics:

10^{10} - 10^{11} neutrons/mm^2/year

10^{12} - 10^{13} neutrons/mm^2/year
(needs more detailed studies)

Possible solution

Sensor R&D BeamCal

pCVD diamonds:

- radiation hardness under investigation (e.g. LHC beam monitors, pixel detectors)
- advantageous properties like: high mobility, low ε_R = 5.7, thermal conductivity

GaAs:

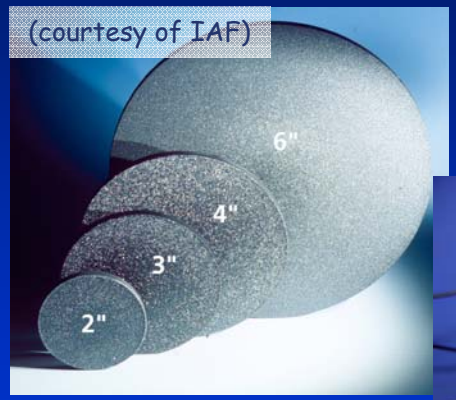
- semi-insulating GaAs, doped with Sn and compensated by Cr
- produced by the Siberian Institute of Technology

SC CVD diamonds:

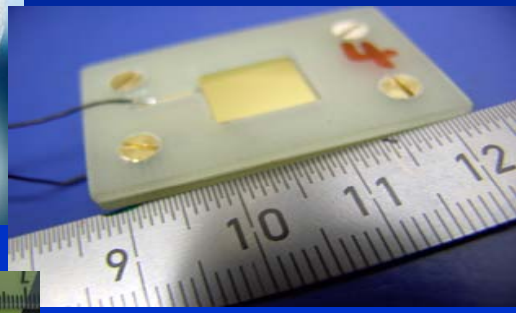
- available in sizes of mm^2

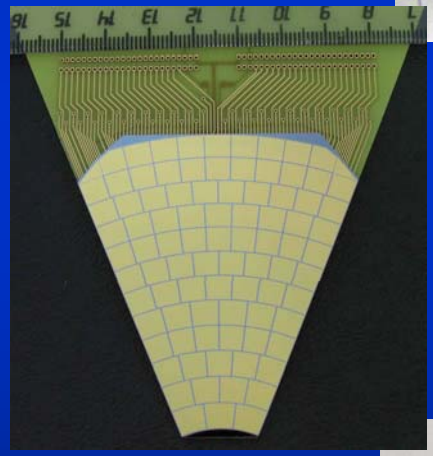
Radiation hard silicon

CVD: Chemical Vapor Deposition

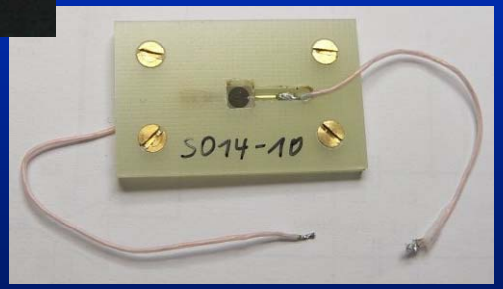


polycrystalline CVD diamond





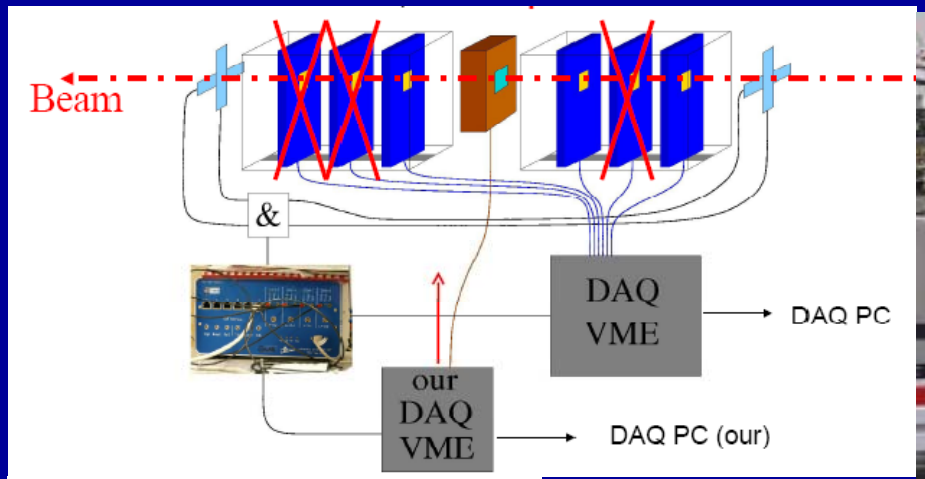
GaAs

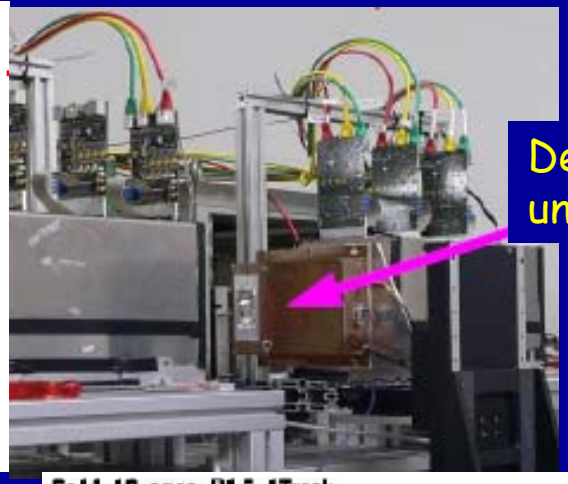


Single crystal CVD diamond

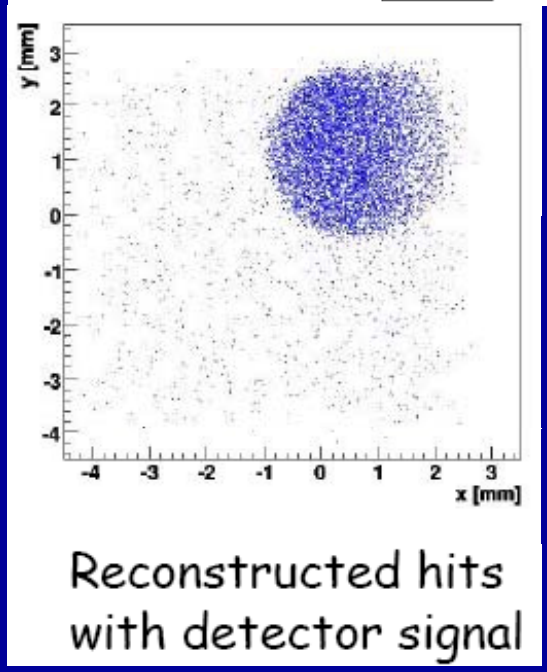
Sensor Tests

Testbeam equipment for sensor performance studies using the EUDET telescope



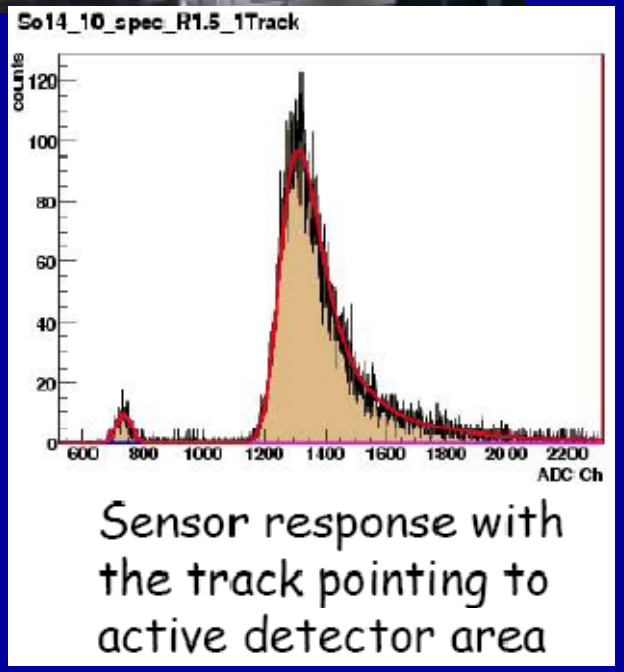


Detector under test



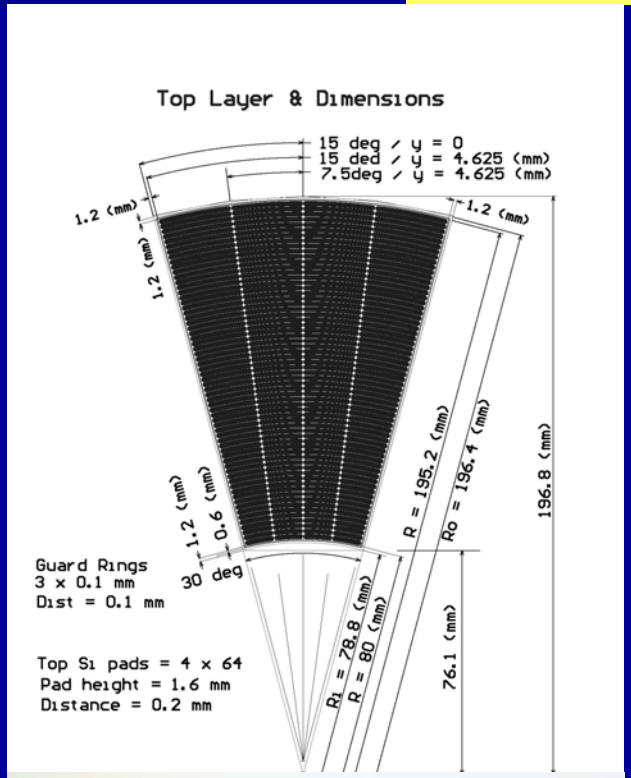
Reconstructed hits with detector signal

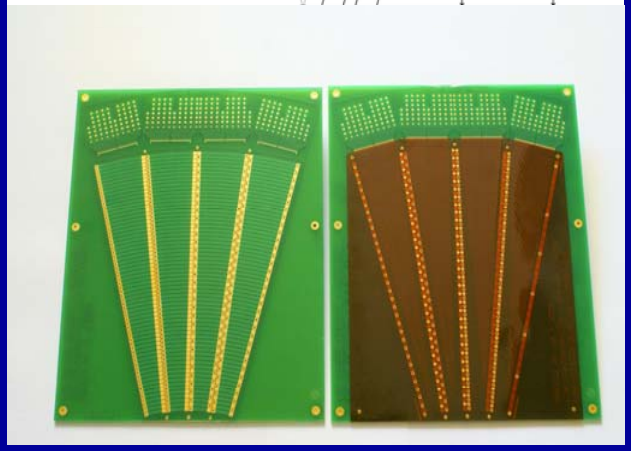
Goal: precise measuremnt of the reponse of sCVD diamonds Data analysis in progress



Sensor response with the track pointing to active detector area

Sensor Production



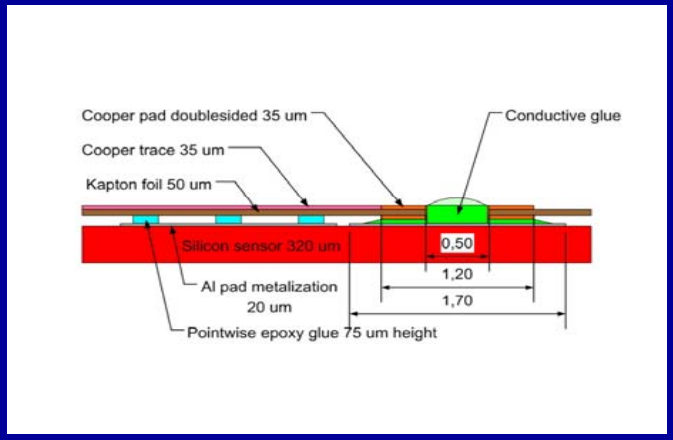


N-type silicon, p^+ strips, n^+ backplane,
Crystal Orientation <100>
320 μm thickness ± 15 μm
Strip pitch: 1800 μm
Strip p^+ width: 1600 μm
Strip Al width: 1700 μm

Masks for prototypes ready (Hamamatsu)

Prototype sensors just in the process to be ordered

In parallel: development of the fanout

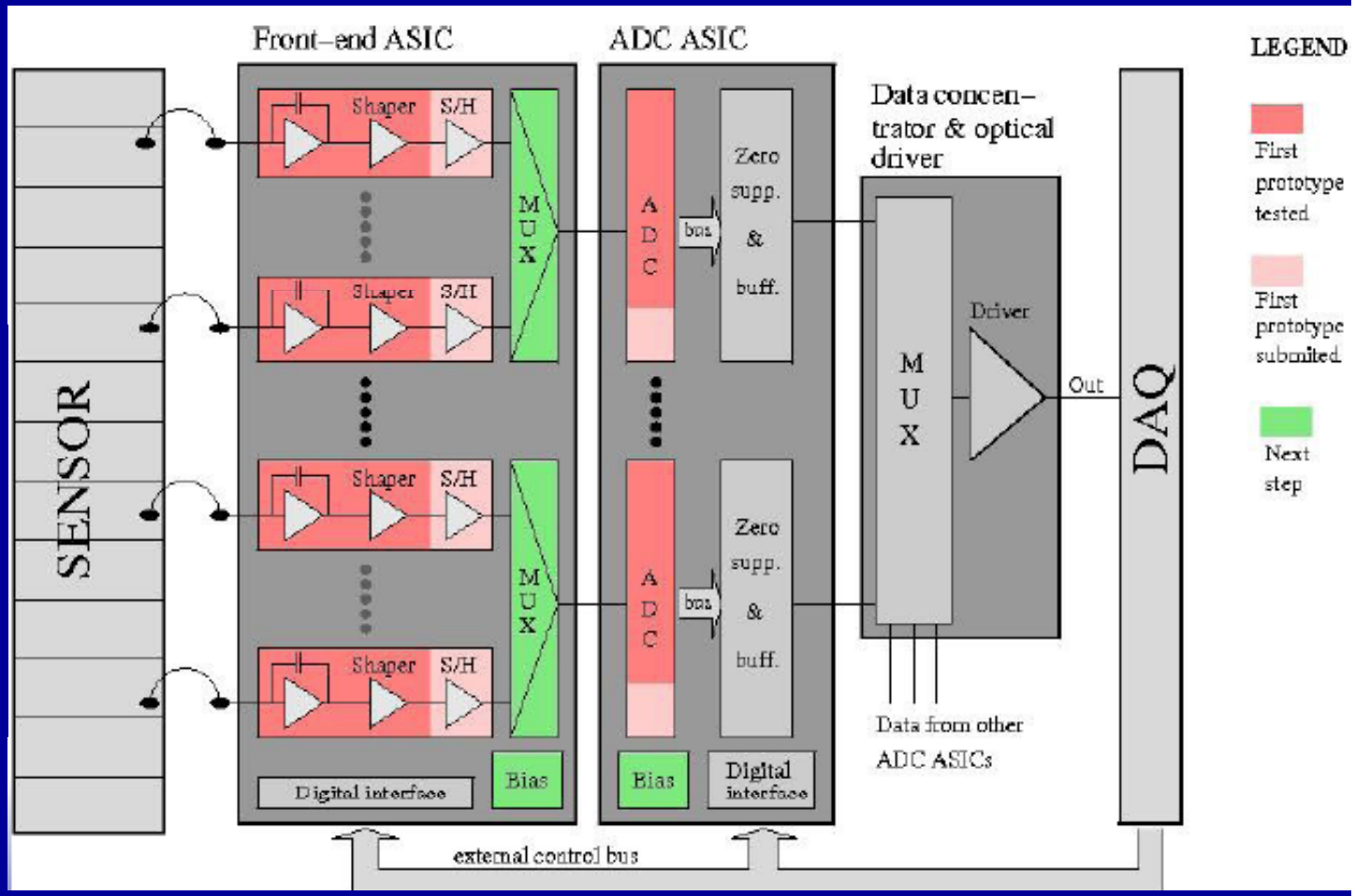


FE Electronics

Cracow UST

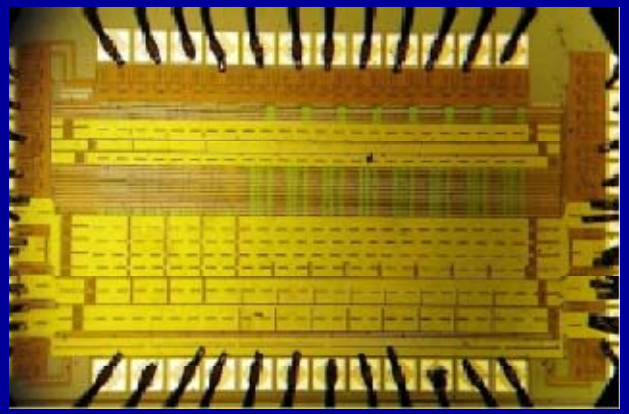
- One FE ASIC will contain 32 - 64 channels, 10 bit
- One ADC will serve several channel (MC simulations Still not finished)
- AMS 0.35 μm technology
- prototypes of the FE ASIC and ADC ASIC available,

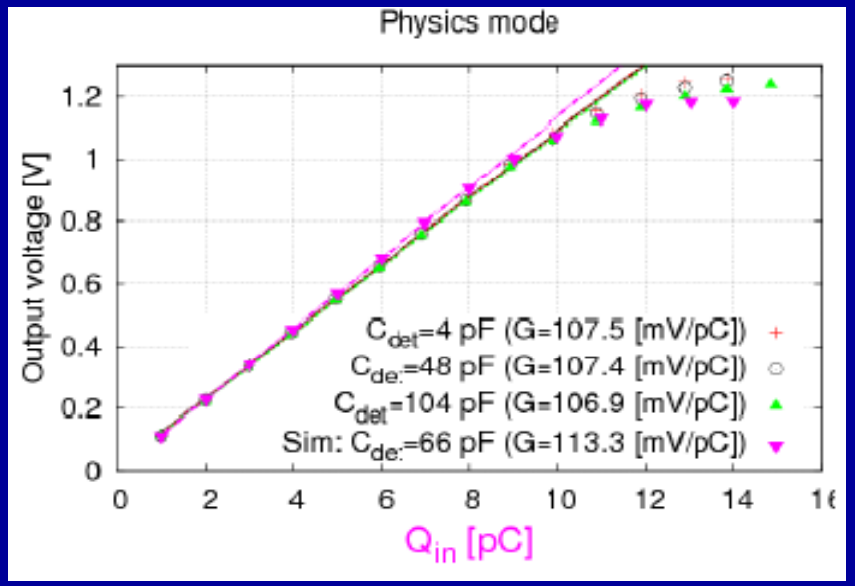
Tests of the FE ASICS so far promising.



FE Electronics

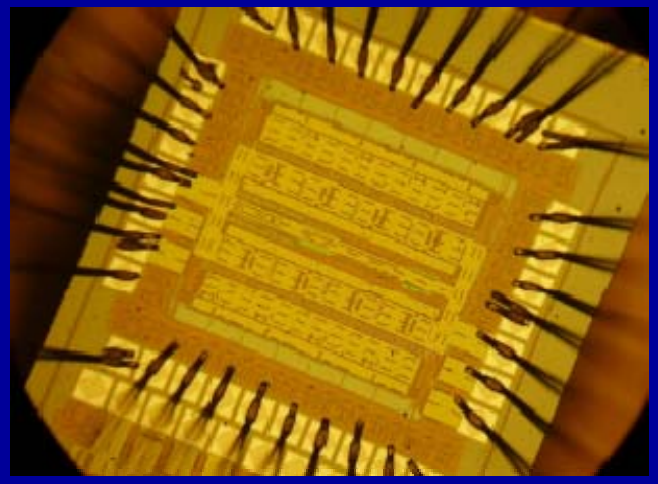
FE Asic:
8 channles per chip, 4 with MOS feedback resistance,
4 with passive Rf feedback





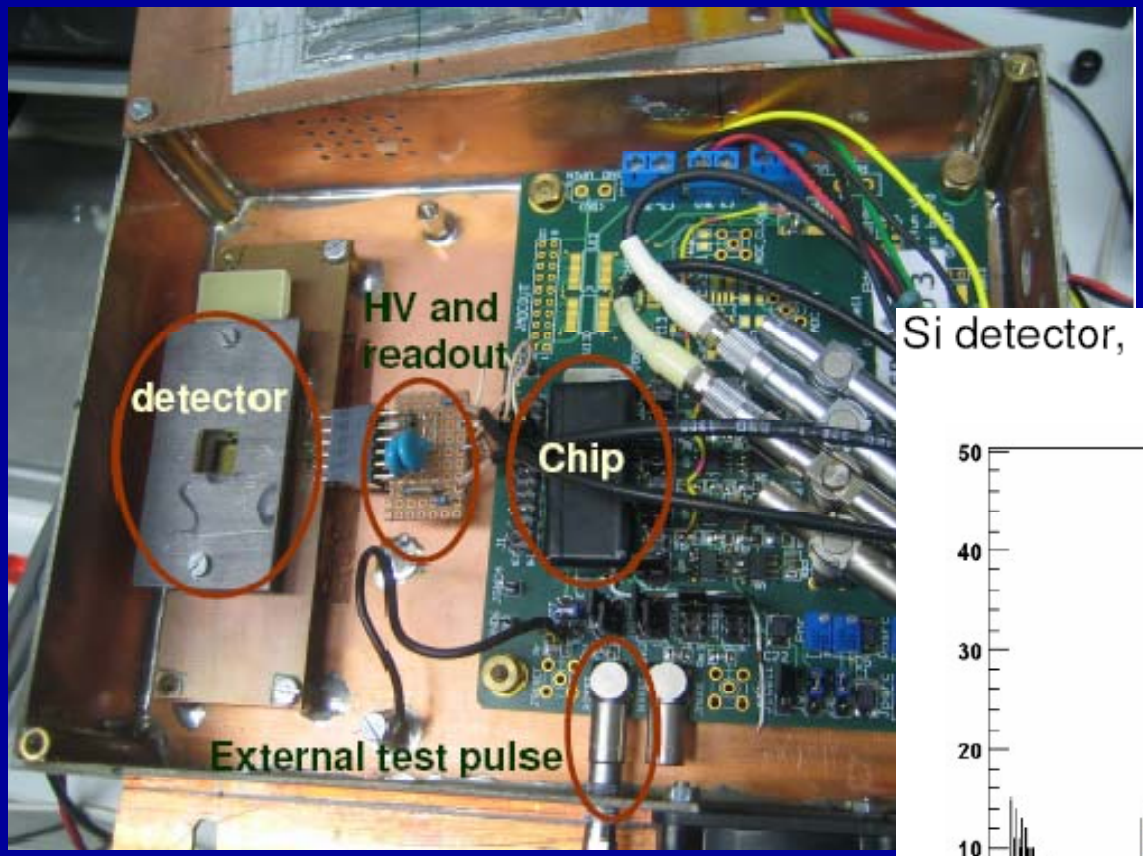
ADC Asic:
Pipeline architecture
10 bit resolution
Maximum sampling rate 35 MHz

First prototypes needed improvement,
Submission ADC and DAC Sept. 2008
Prototypes expected Nov. 2008

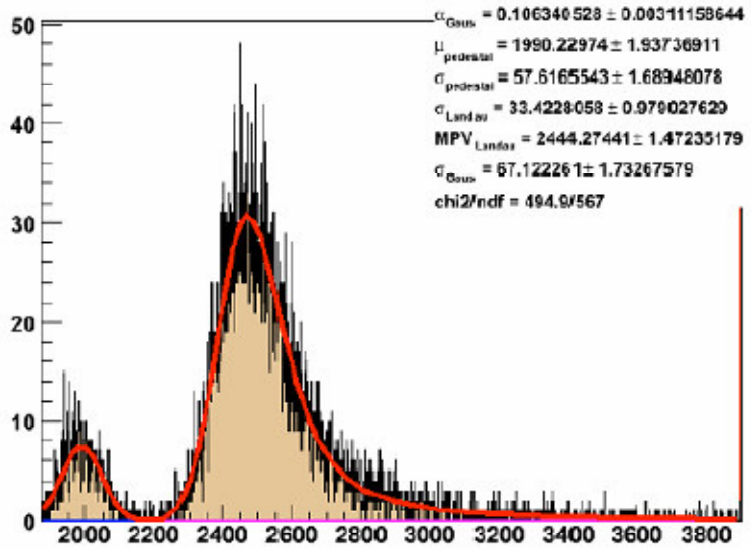


FE Electronics

First successful tests of the analog part with a single pad sensor



Si detector, MOS preamp.

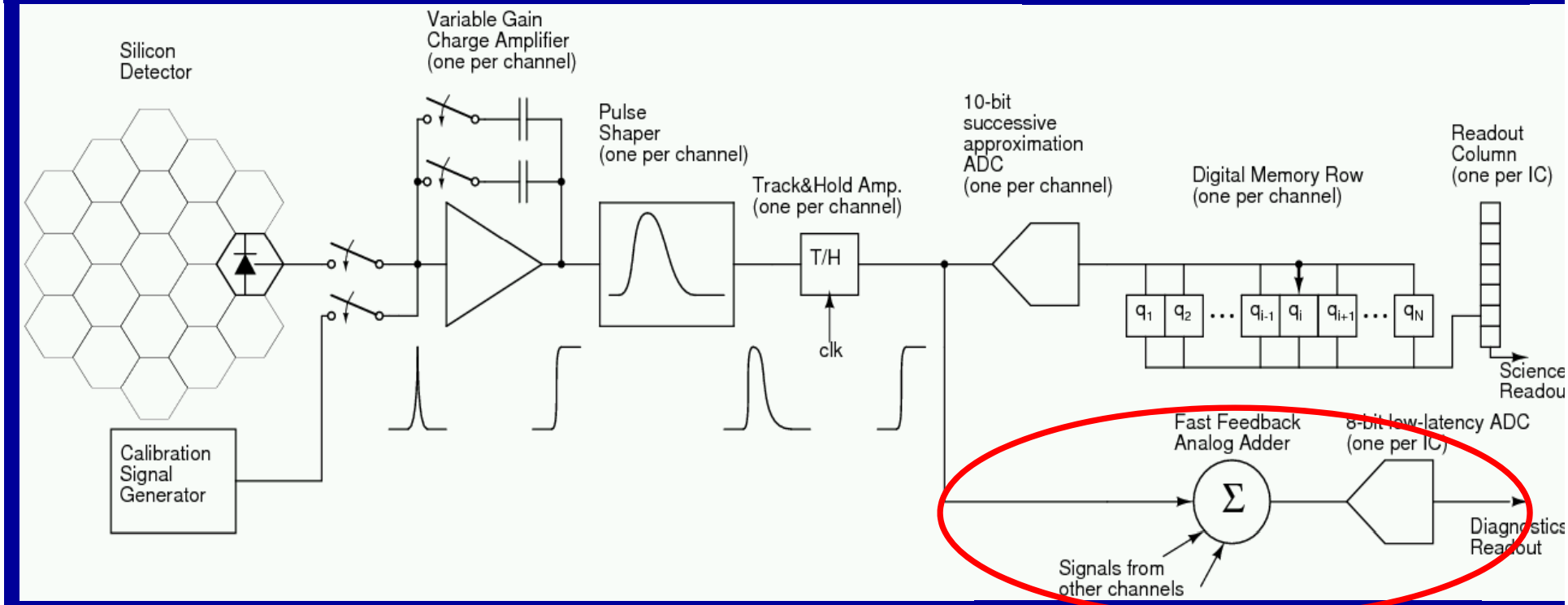


FE electronics

SLAC-Stanford

Dedicated FE electronics for BeamCal, based on KPiX (see talk by Herbst in the DAQ session)

Digital Buffering during bunch train, readout in between trains



Fast analog adder for groups of pads used for fast feedback

BeamCal Mechanics

BeamCal Mechanics

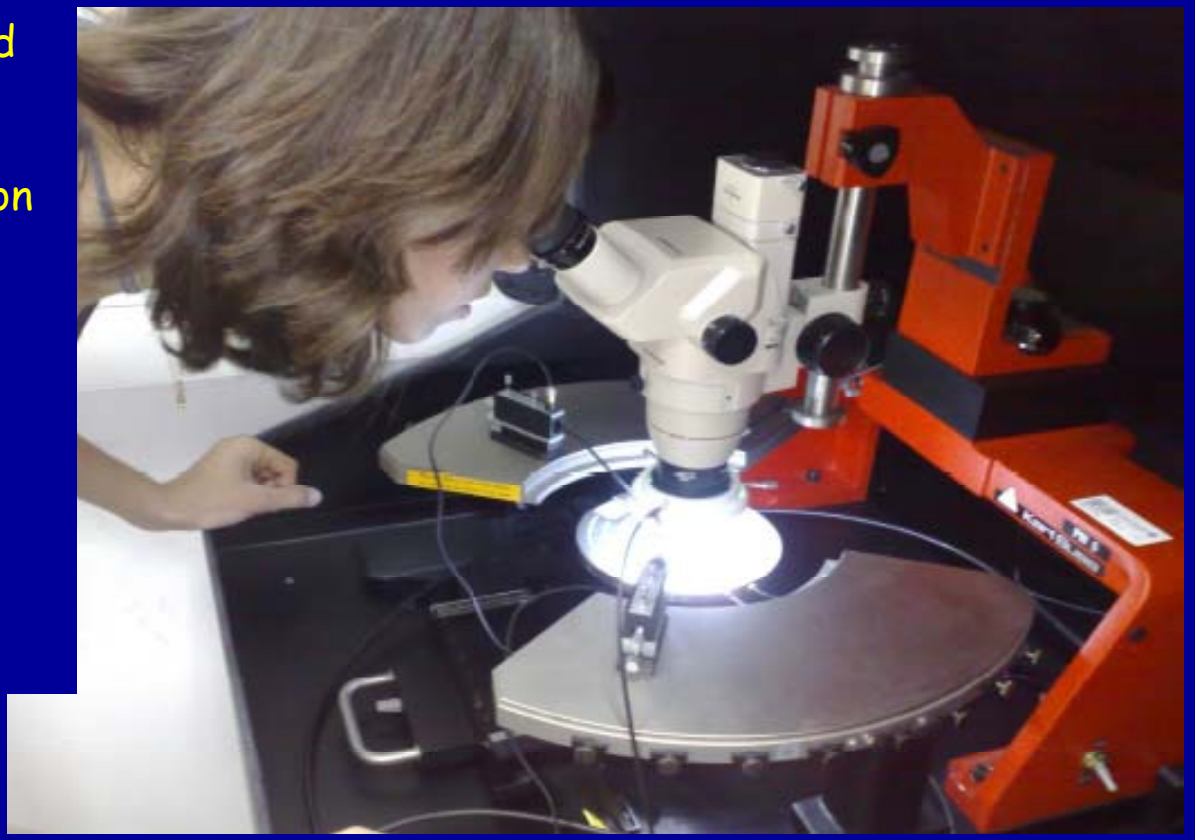
Silicon lab in Tel Aviv

A dedicated silicon lab is created in Tel Aviv:

- Computer monitored prob station
- Computer supported I(V), C(V) measurements

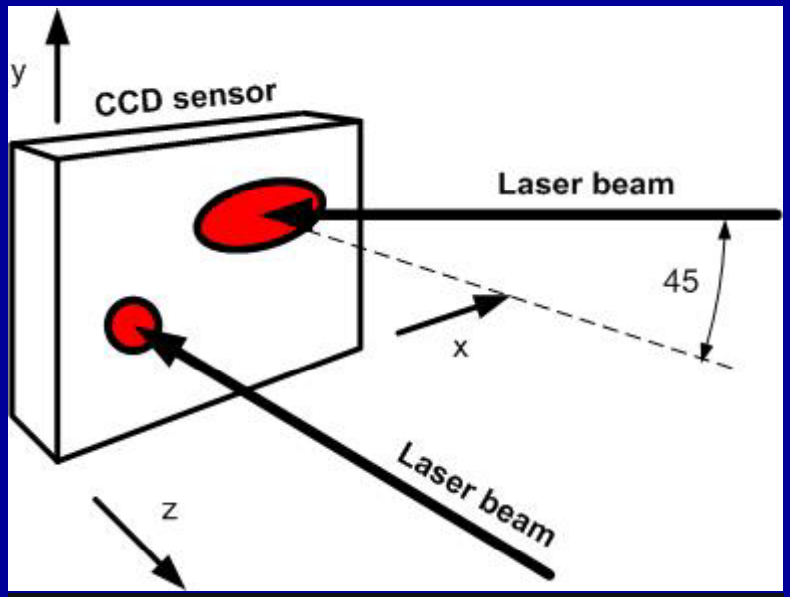
in preparation:

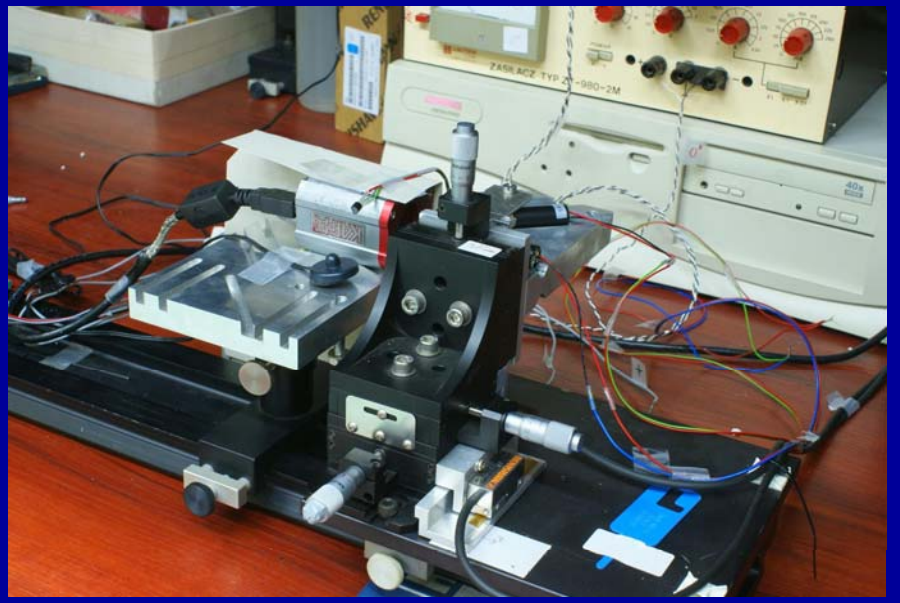
- clean room
- spectroscopic set-up

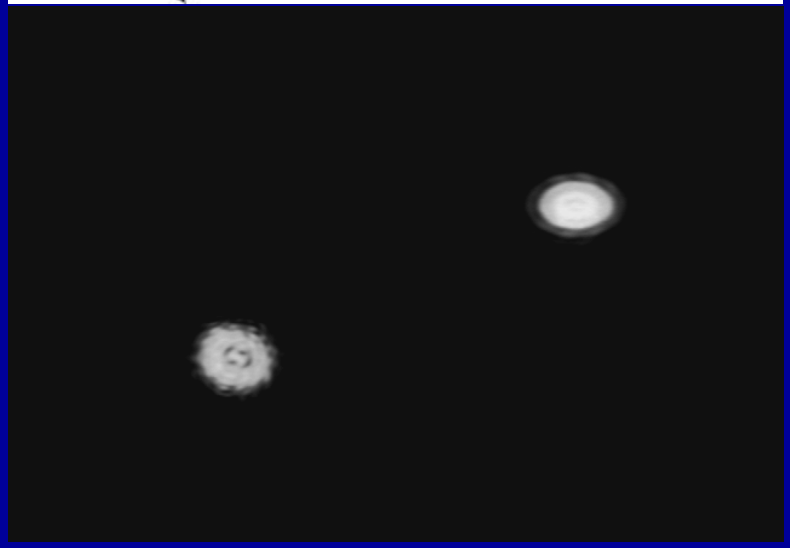


A dedicated HEP lab building is designed for detector R&D, planned to be ready mid 2009

Laser Position Monitoring







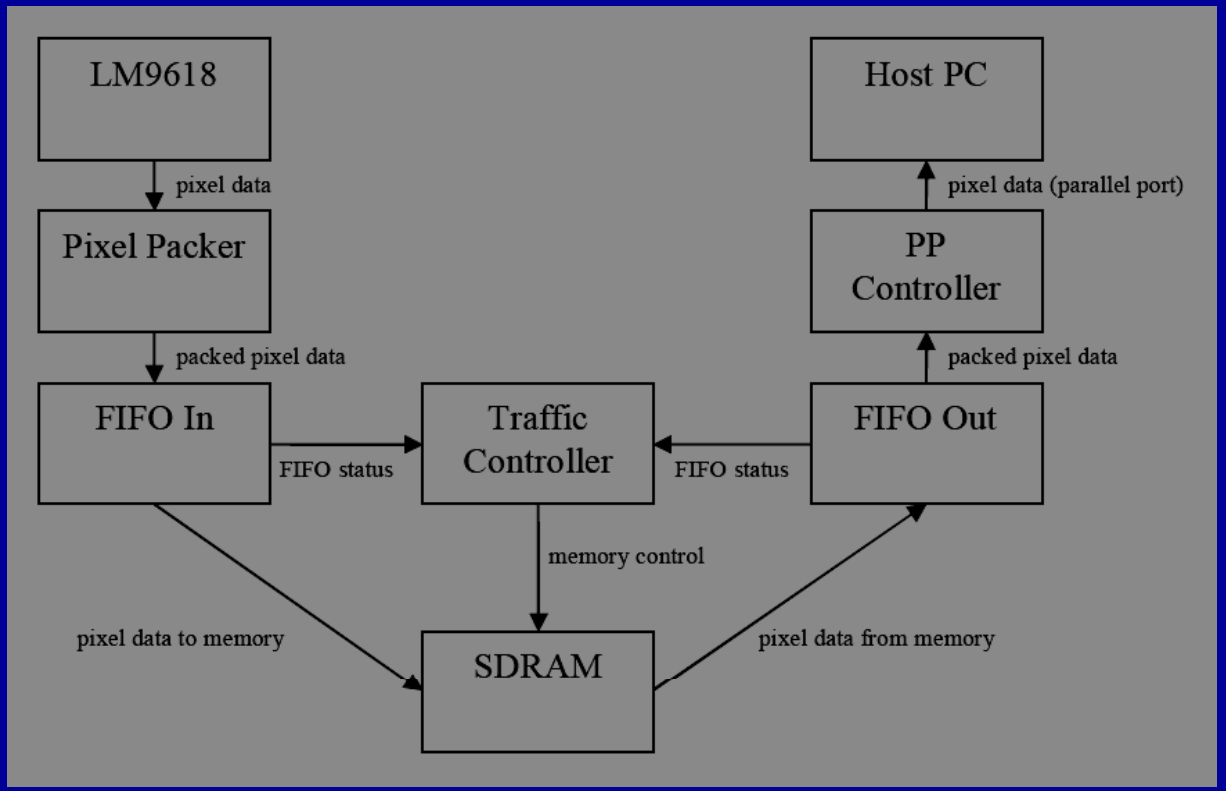
Over short distances accuracies reached:
Displacements in the x-y plane: +-0.5 µm
Displacements in z direction: +- 1.5 µm

Laser Position Monitoring

Scheme of the readout and monitoring electronics

Dedicated
CMOS sensor

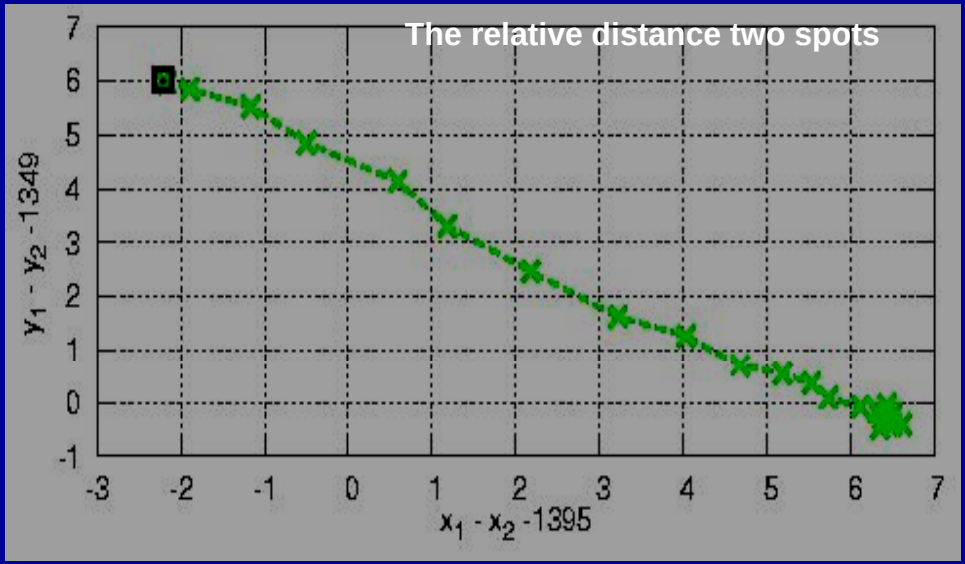
Displacement calculations

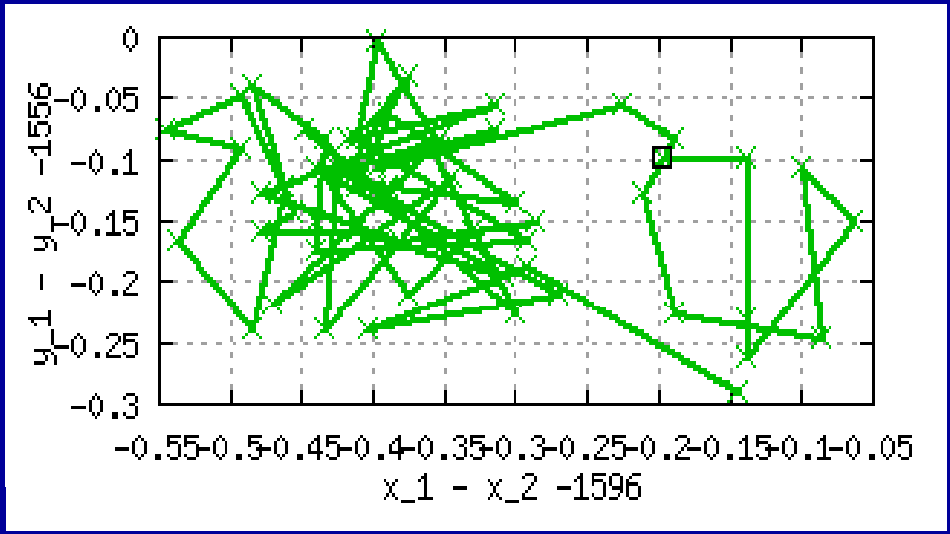


Laser Position Monitoring

Impact of temperature changes

Gradient: 1 µm/^{0}C





Long term tests (> 24 hours)
Relative distance between the two laser beams

Stable within +- 0.5 µm

Summary

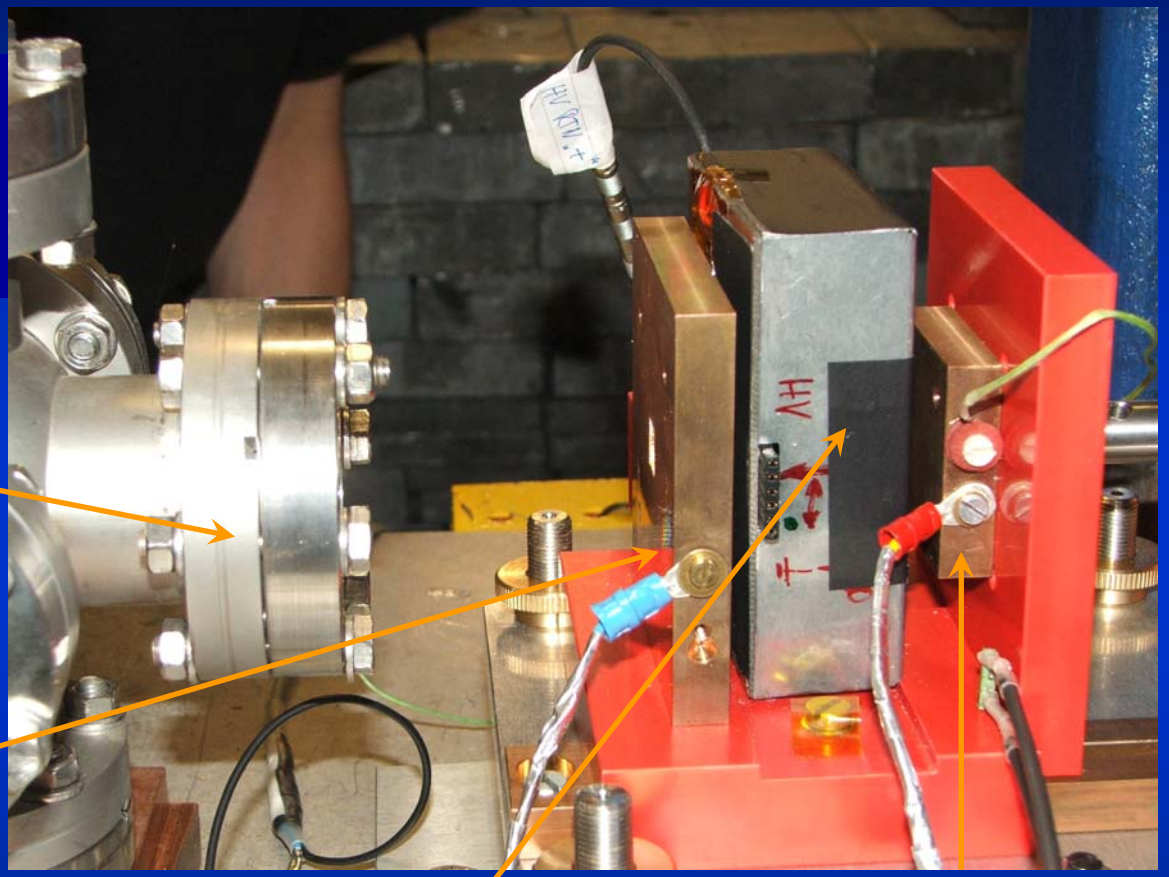
- Laboratory and beam-test infrastructure is created/improved/completed
  EUDET memo before end of the year
  will be used intensively in future
- First FE ASICS are produced, tests almost completed, second submission of the ADC done
  EUDET memo before end of the year
  EUDET extension will be used for updates/higher complexity
- Prototype of a laser positioning monitoring system is built, matches the accuracy requirements on small distances
  EUDET memo before end of the year

VFCAL is 'on schedule'

Test Beam Equipment and sensor tests

Setup used for radiation hardness tests at the SDALINAC accelerator

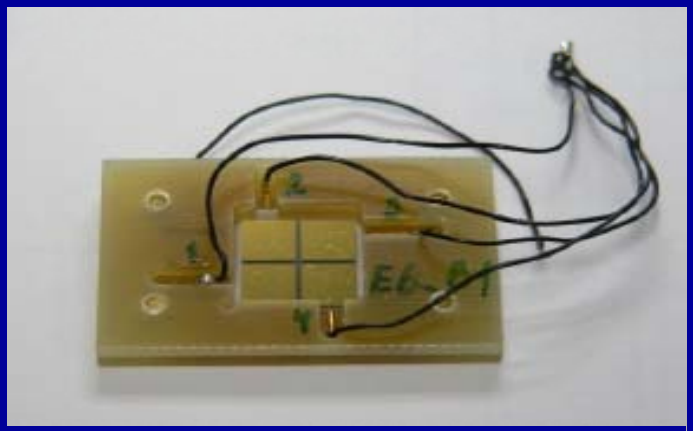
TU Darmstadt



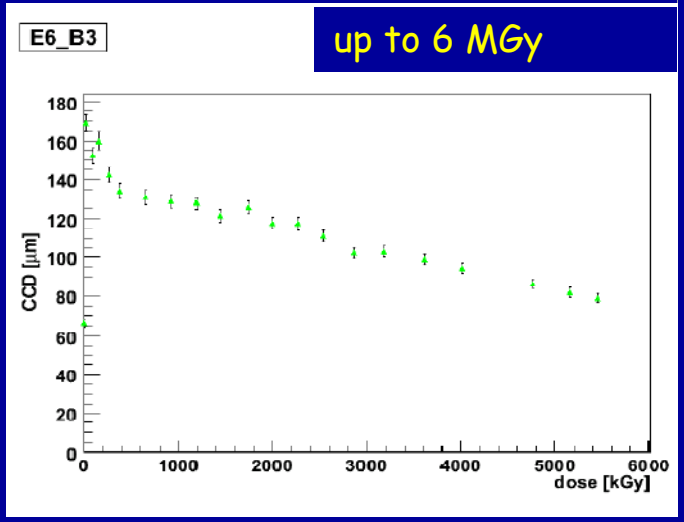
Completed and more comfortable: more efficient use of the beam

Test Beam 2007

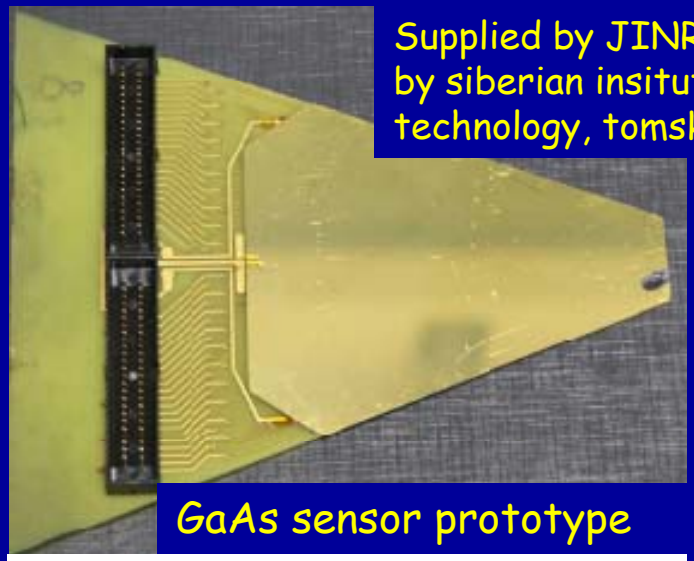
- Completion of Diamond sensor tests
- Test of GaAs sensors
- Test of rad. Hard Si sensors, delivered by BNL and Prague



diamond sensor prototype

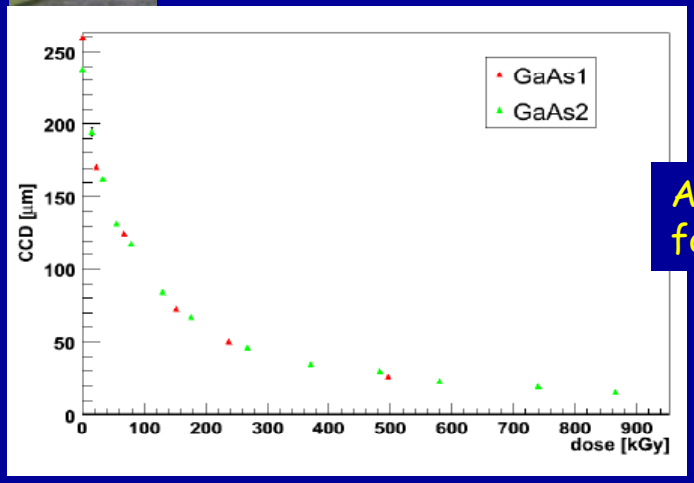


up to 6 MGy



Supplied by JINR, produced by siberian insitute of technology, tomsk

GaAs sensor prototype



About factor 10