Charles University

Prague

Laser And Beta Source Strip Detector Test Setup in Prague

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Outline

Aims:

- Measurement of collected charge, cluster sizes, noise occupancy, etc. in ATLAS SCT strip detector modules

- Testing of detector quality, front-end electronics parameters, bonding

Possible methods:

1. Test beam
2. Beta source tests
3. Laser tests

Comparison of the results

Simulations in G4

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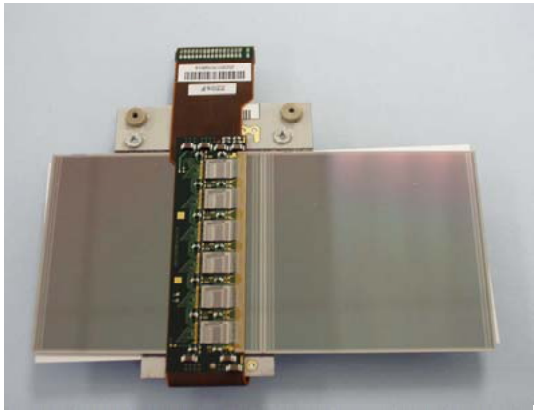
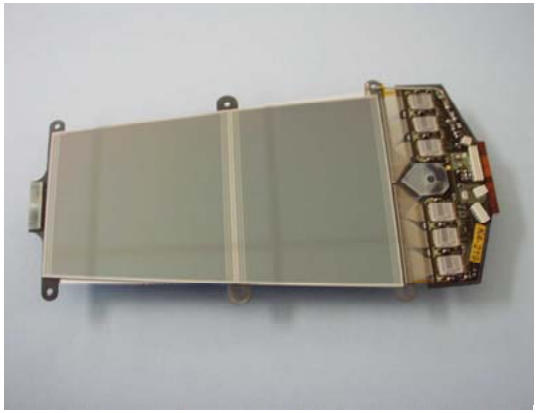
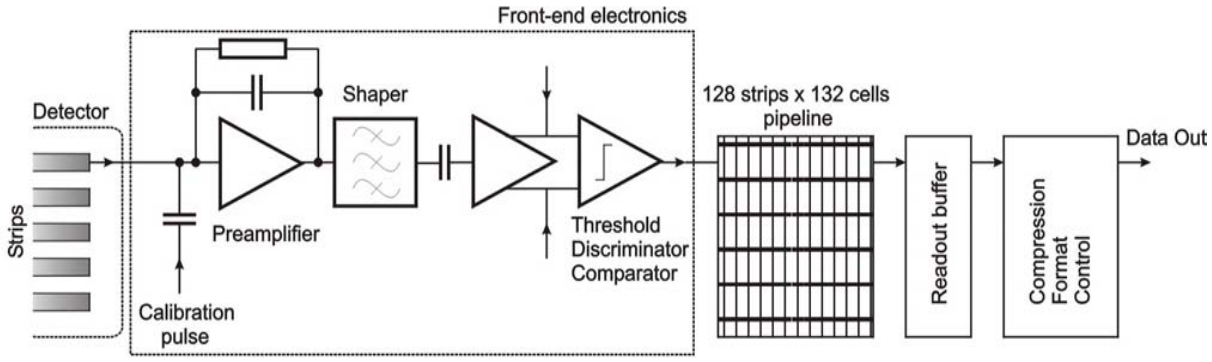
SCT modules

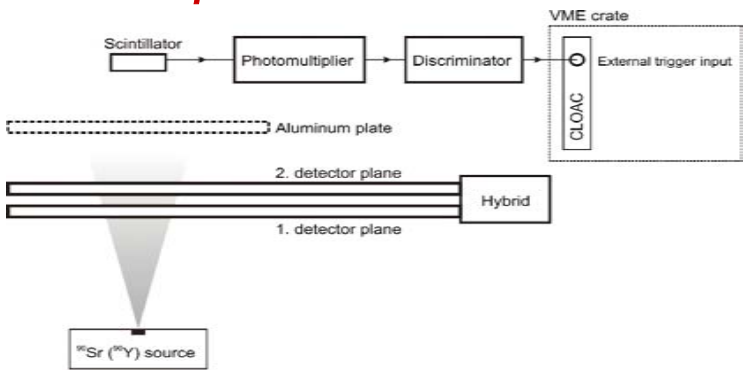
- 2/4 p^+-n-n^+ detectors (~6cm × 6cm × 285μm), hybrid with binary readout electronics, mechanical
- 2 × 768 strips
- Readout:
  - 2 × 6 chips (128 channels)
  - pipeline (128 × 25ns)
  - calibration circuits
  - data compression and optical readout



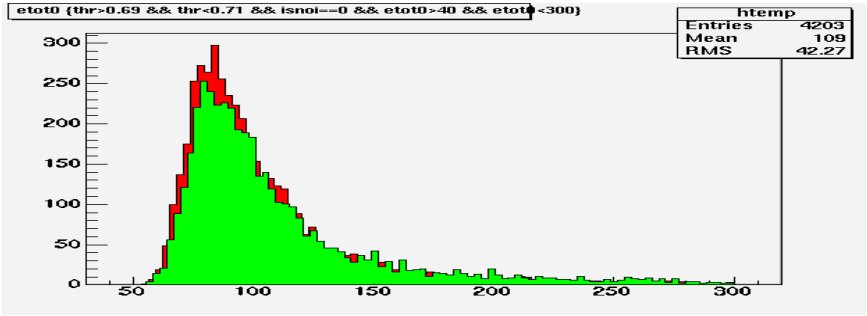




β^- source tests

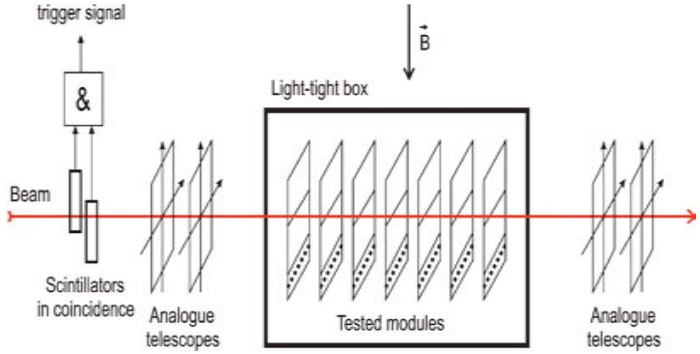


- relativistic electrons (kinetic energy < 2.2 MeV)
- energy loss (Geant4 simulation)

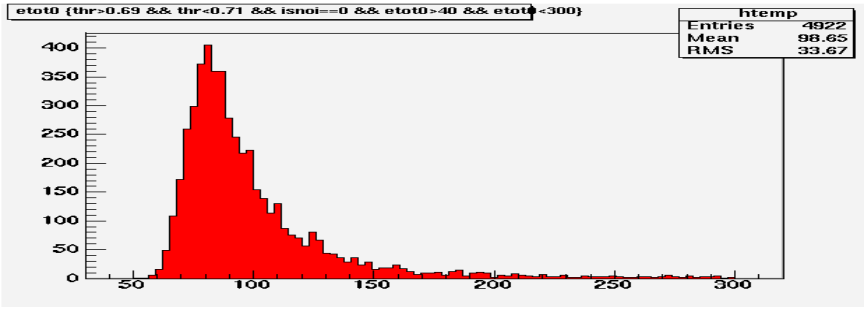


- simple construction, various geometrical settings
- repeated tests (before and after irradiation)
- available at any time
- quick measurement and analysis
- no particle track measurement

Testbeam



- MIP (180 GeV pions)



- expensive
- only few (up to ~ 15) modules can be tested
- available ~ 3x14 days a year
- slower measurement
- analogue telescopes (microstrip detectors)

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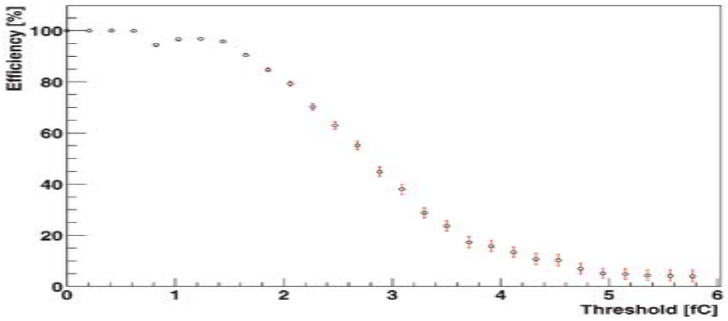
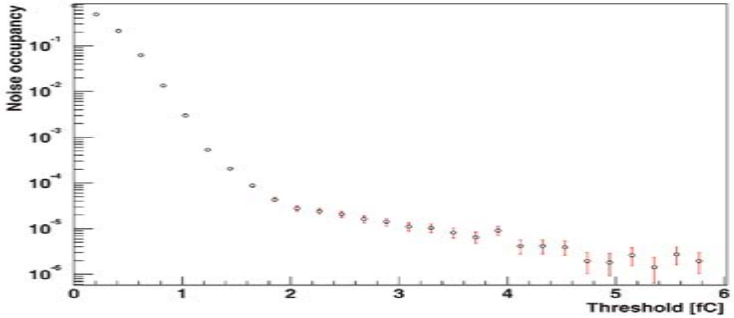
β^- source tests

- Efficiency (not reliable at low thresholds)
- median (threshold of 50% efficiency)

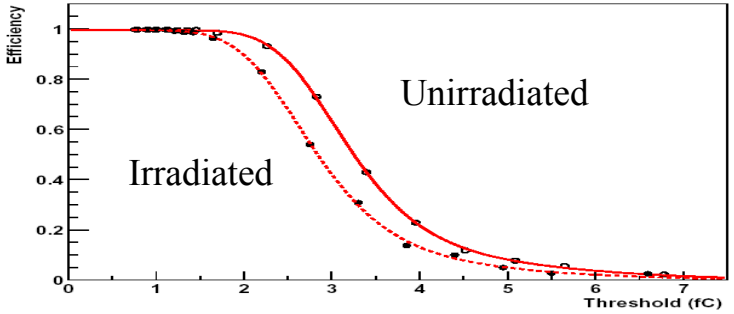


- noise occupancy

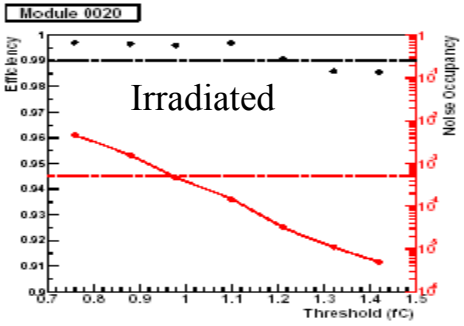


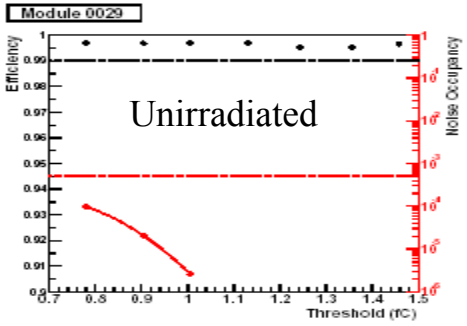
Testbeam

- efficiency (reliable at all thresholds)
- median



- noise occupancy and efficiency (within specifications: 99% eff., $5 \cdot 10^{-4}$ noise occ.)





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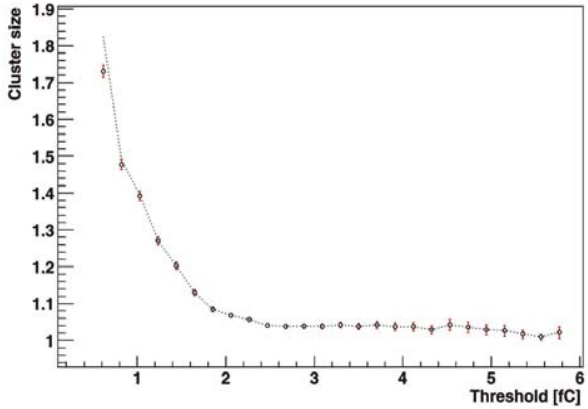
β^- source tests

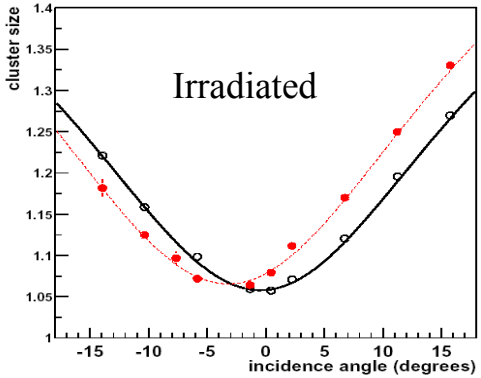
- average width of strips clusters …… charge sharing, δ-electrons, crosstalk

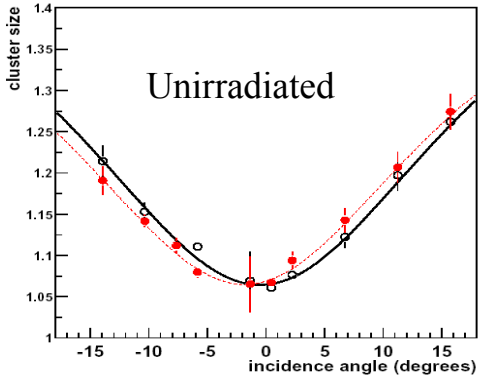
- multiple scattering results in stronger charge sharing and so different results on both detector planes



Testbeam

- angular and magnetic field dependence at 1 fC threshold for (un)irradiated modules





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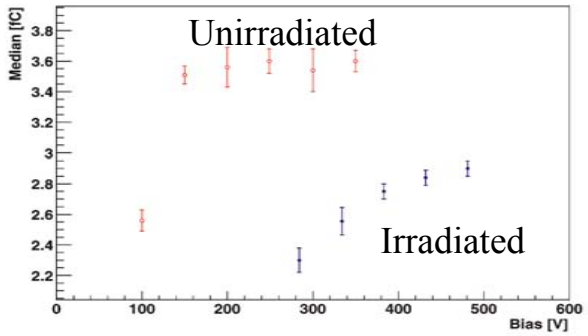
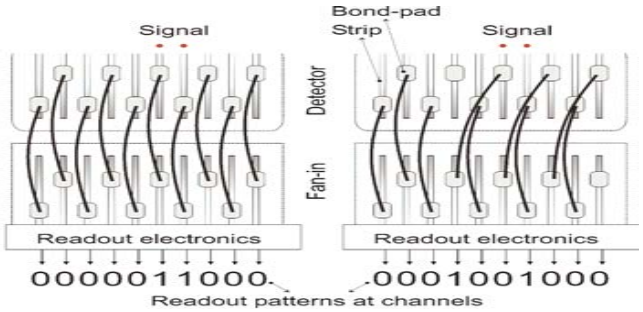
β^- source tests

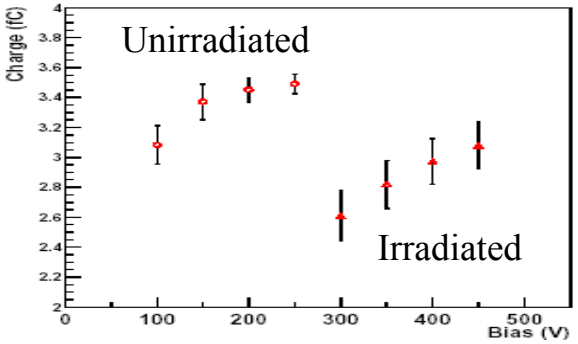
- Median points vs. bias voltage



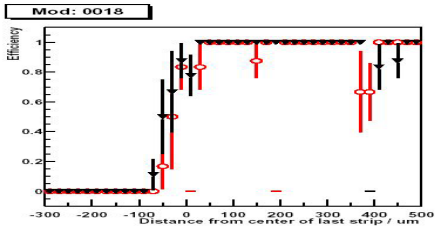
- checking bonding



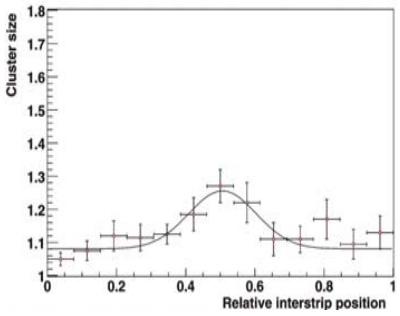
Testbeam

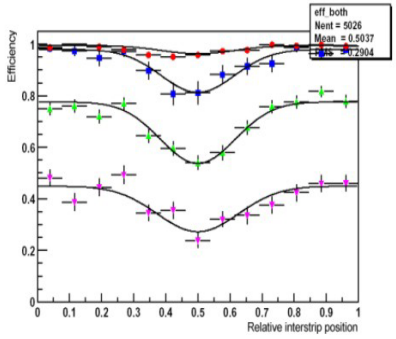


detector behavior at its edges



- interstrip position dependences





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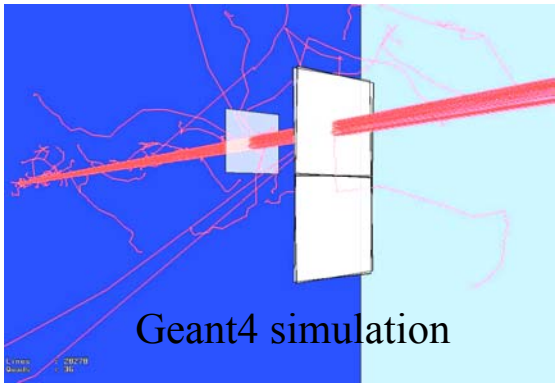
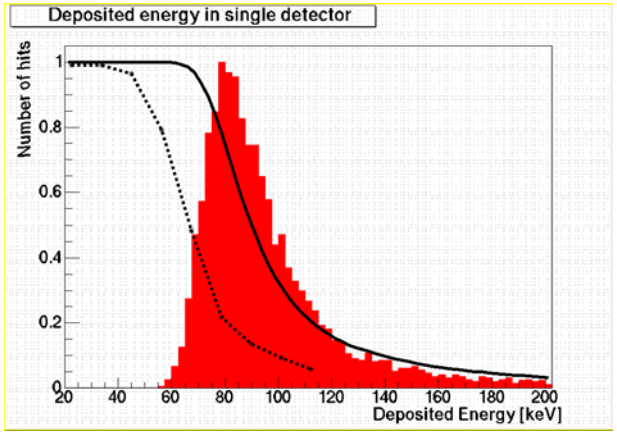
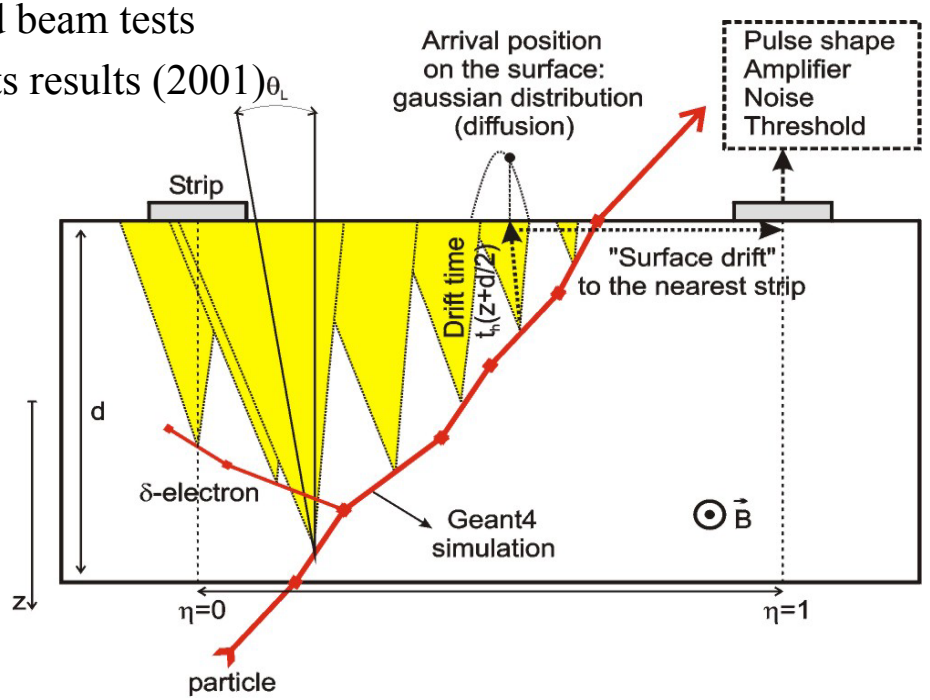
Simulation

- to explain differences between source and beam tests
- to compare simulation to newer beam tests results (2001)







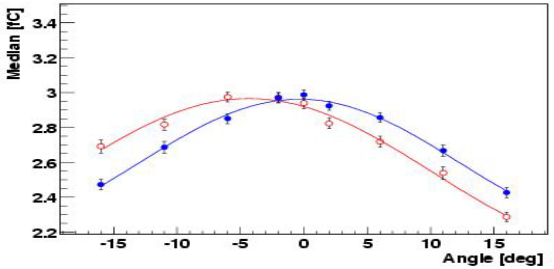
- histogram: deposited energy spectrum of 180 GeV pions from Geant4 simulation

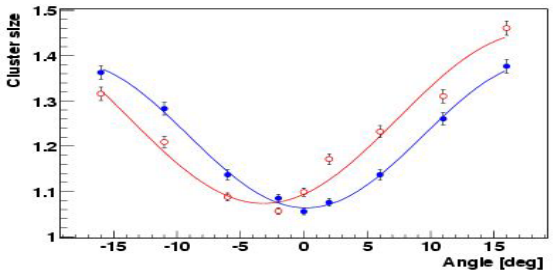
- solid curve: integral of the spectrum

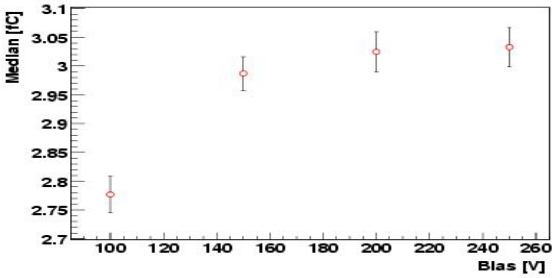
- dashed curve: efficiency threshold scan – result of digitization under Athena

Beam tests simulation – angular and bias dependence with and without magnet

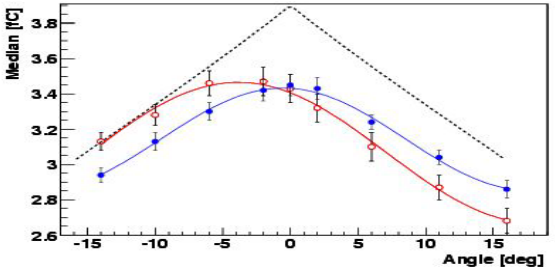
Simulations

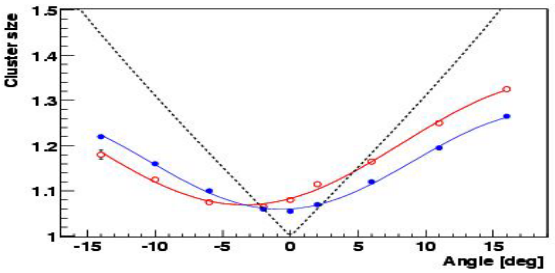


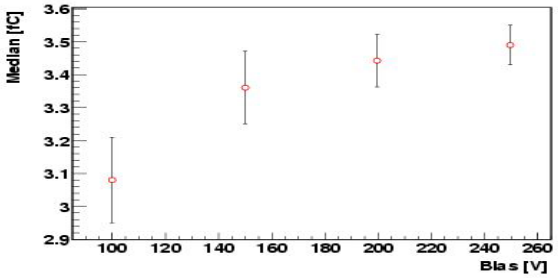




Test beam







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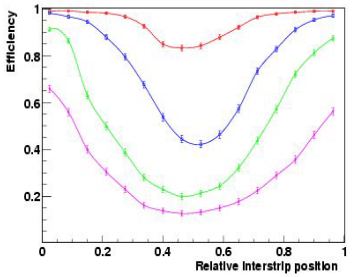
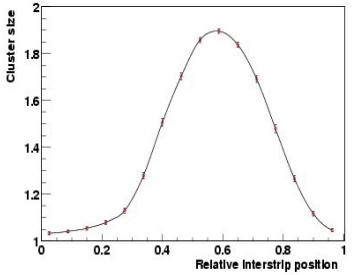
Beam tests simulation – interstrip position dependence

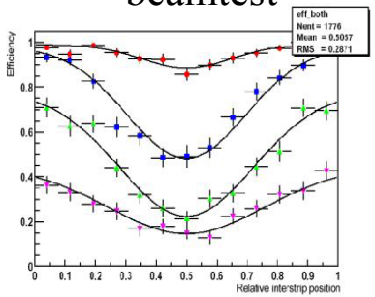
16 degrees incidence angle

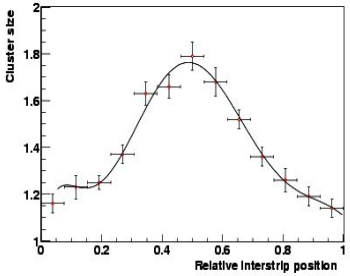
simulation



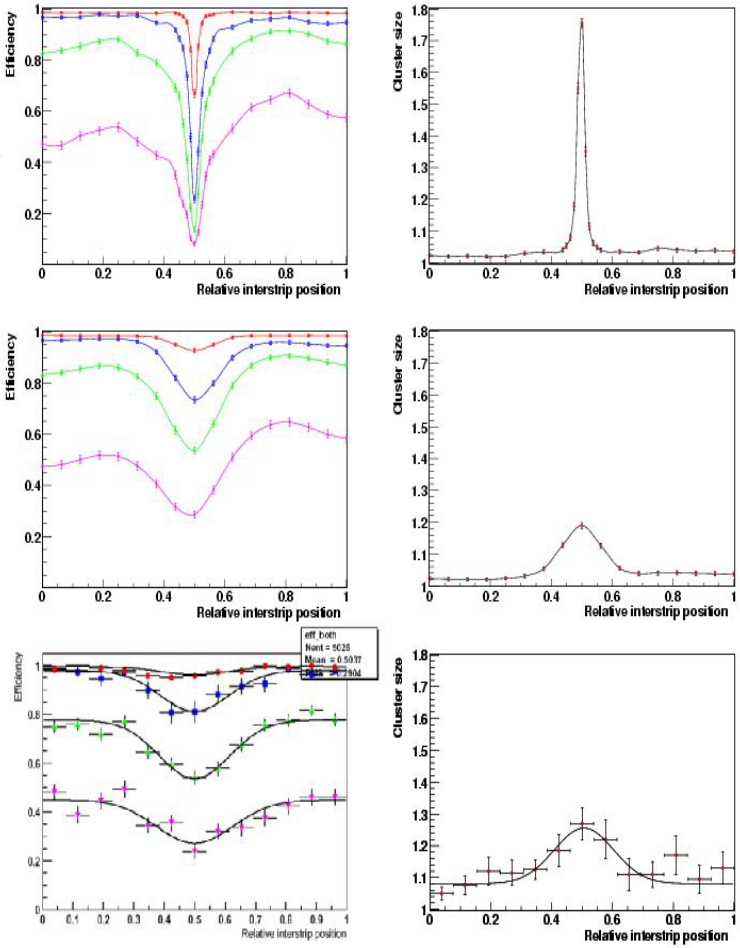


beamtest





perpendicular incidence



- pure simulation
- simulation corrected to particle track determination uncertainties and averaging over 6 μm width interval
- beam tests

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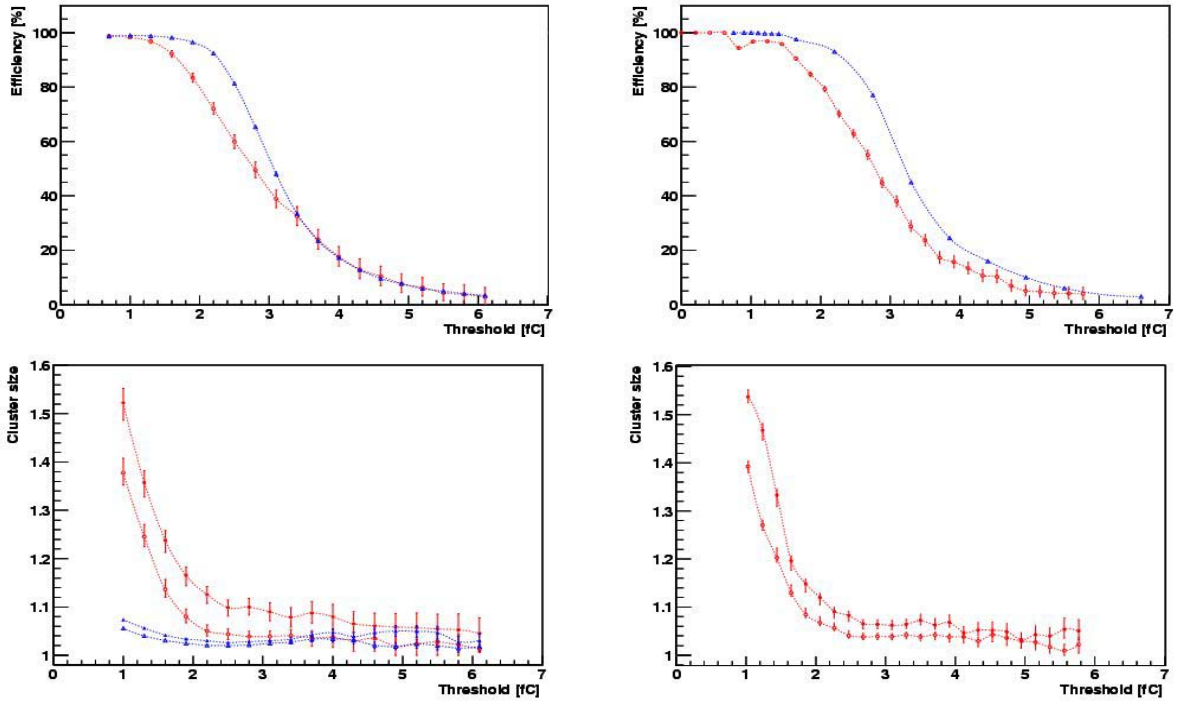
Beam and source tests simulation

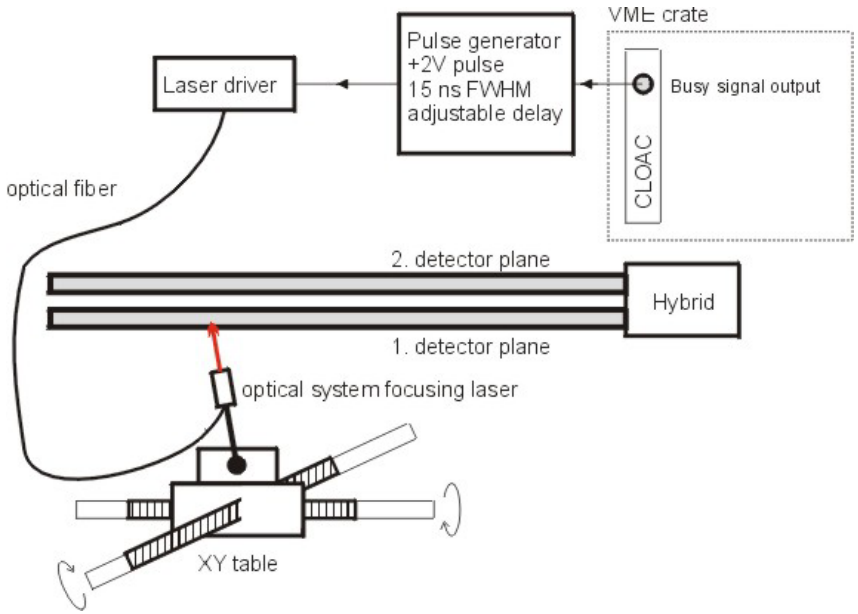
simulation (efficiency, cluster sizes) beam tests (blue) and source test (red)

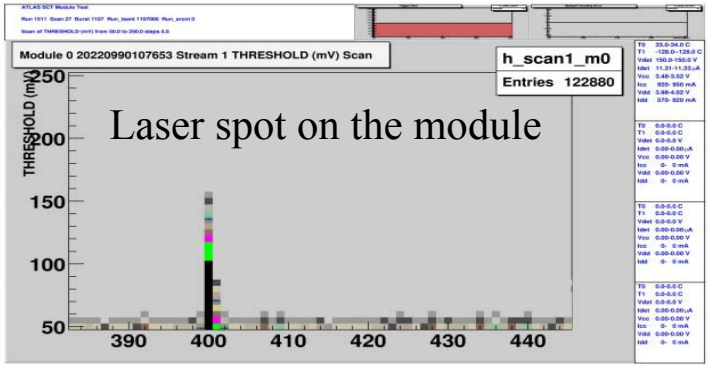


- ratio of medians from beam tests to the ones from source tests ~ 1.1 (both simulation and measurements)

- source tests sensitivity to geometrical settings – low on the detector plane nearer to the radioactive source (both simulation and measurements)

Laser tests





- 600 nm wavelength laser made in CERN and borrowed from CTU Prague

- laser spot size ~ 10 μm < strip pitch

- XY table controlled by a macro under ROOT => automatical position scan over all the strips

Laser tests

- allows to find unbounded or dead channels
- allows to find mixed bonding
- inters strip detail efficiency inspection