Silicon Micro-Strip Detectors :

Explore the Limits of a Detection & Tracking Technology

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Outlook of the Presentation

Introduction : tracking and detection requirements

I. Presentation of the Double Sided Silicon Strip Detector (DSSSD)

II. Measurement of the time, position & Energy Resolution

Test/Experiment 'U218' at GSI "Coulomb scattering of ^{48}Ca beam on Au target at UNILAC"

i. Experimental setup : *Beam Tracking Measurement*

ii. Some Results

III. Measurement of the Angular & Energy Resolution

Experiment at ITN- Lisbon *"Elastic and Inelastic Proton Scattering on Heavy Ions around the Coulomb Barrier – ^{197}Au, ^{58}Ni, ^{40}Ca & ^{12}C"*

i. Experimental setup : *Tracking of Reaction Fragments*

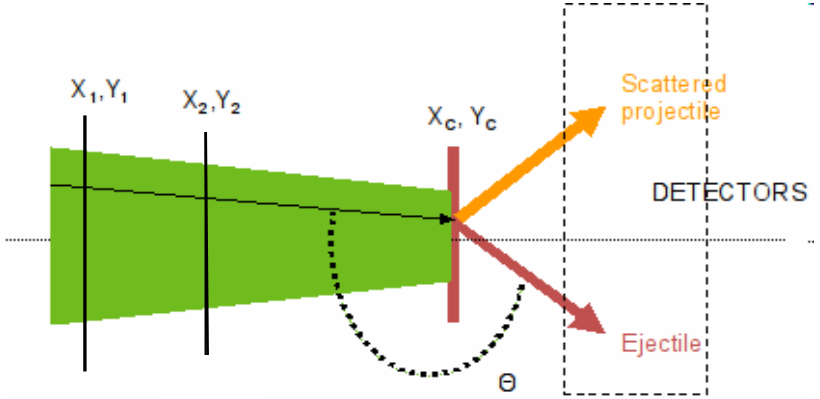
ii. Preliminary Results

Conclusion & Outlooks

Intro : Tracking and Detection Requirements

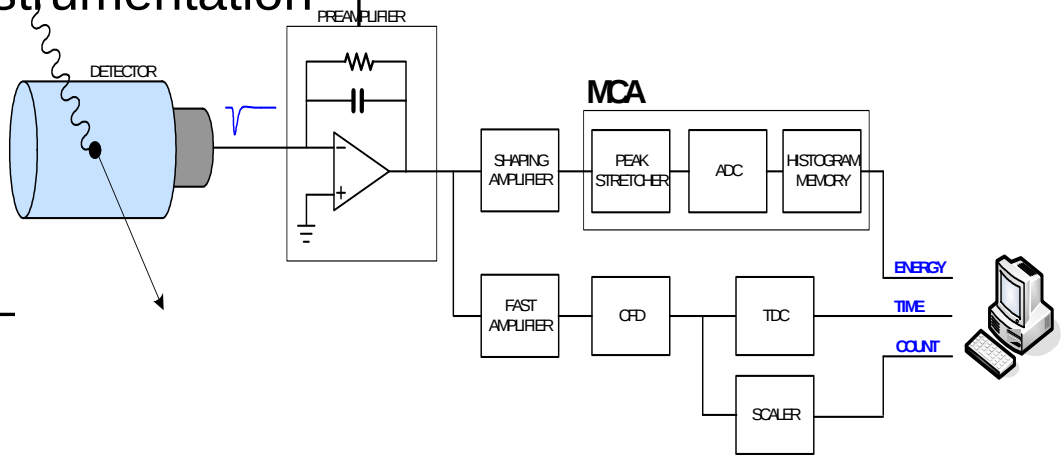
Trajectory Reconstruction

- Time Resolution
- Position/Angular Resolution
- Energy Resolution



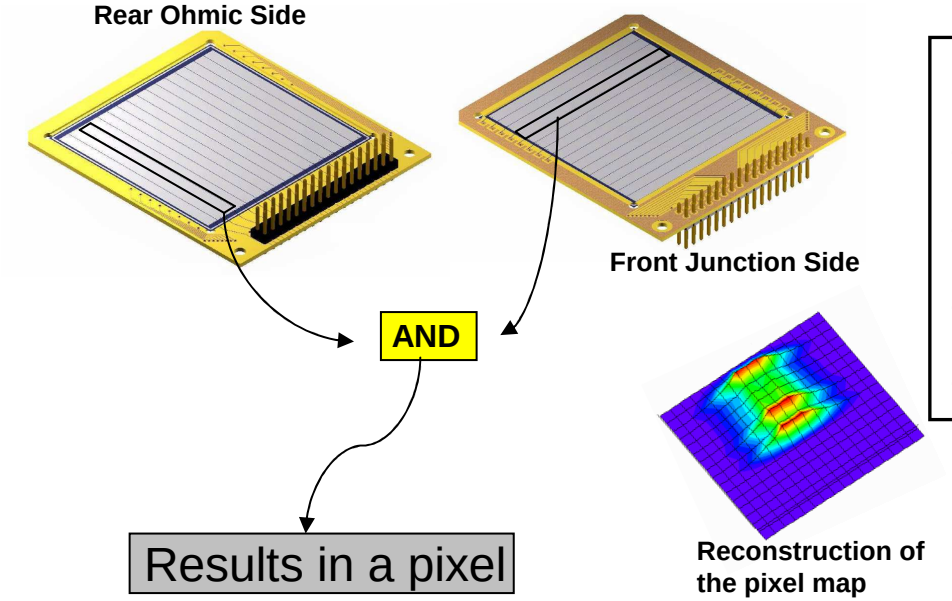
Read-out Systems & Related Instrumentation

- Detector
- Dedicated Electronics
- Data Acquisition



I. Presentation of the DSSSD

- DSSSD : Double Sided Silicon Strip Detector
- X strips on the front side / Y strips on the back side
- Front vs Back can be used in several ways:
  - Front and back connected to a charge sensitive pre-amp to measure the deposited energy and pixelize the detector
  - one side connected to a charge sensitive pre-amp (energy measurement) and the other to fast pre-amp for timing measurement

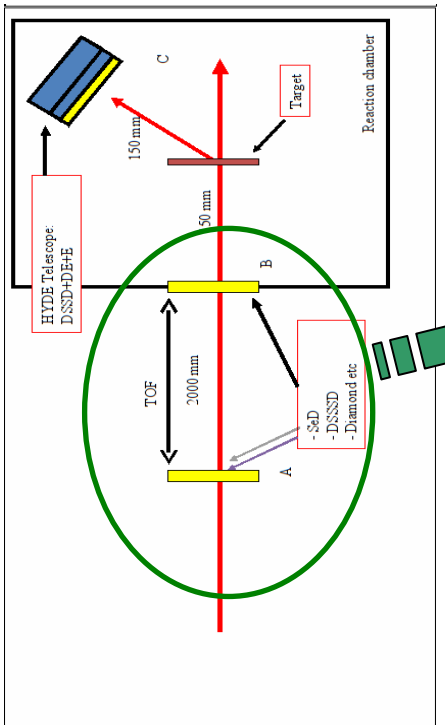


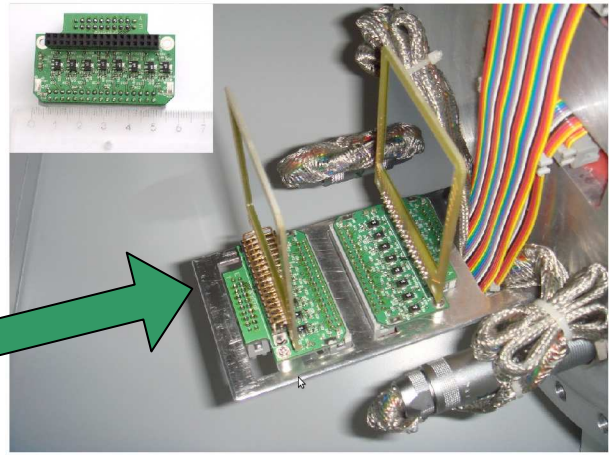
Facts about DSSSDs

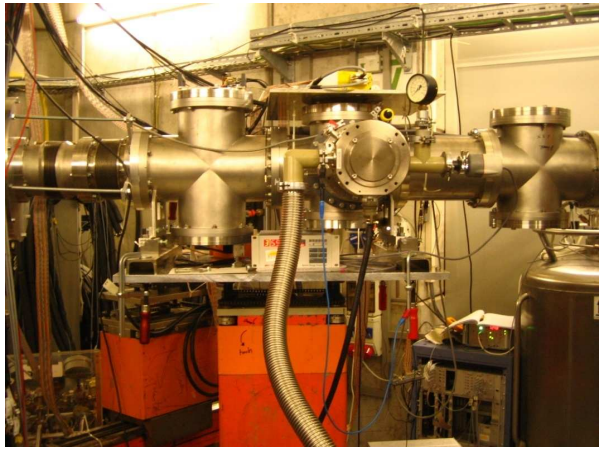
- Commercial detectors
- Can be coupled to commercial electronics
- Fairly cheap (around 5000 € for a DSSSD)
- Plug and Play

II. Time, Position & Energy Resolution (1/2)

GSI - Germany: **Aug 2009**. Test/Experiment U218: *"Coulomb scattering of ^{48}Ca beam on Au target at UNILAC"*







Experimental Setup

- The Setup consisted of 2 transmission MCP Detectors followed by 2 DSSSDs of 40µm
- The DSSSDs were mounted on a 16ch low voltage pre-amplifier developed and built at GSI
- Timing measurements : fast preamplifiers connected to one of the DSSSD sides
- Deposited energy : the other side of the DSSSDs was read out with a commercial charge sensitive preamplifier

Contribution to the **GSI Annual Report 2009**: "***Fast timing with DSSSD Detectors***", *P. Boutachkov et al.*

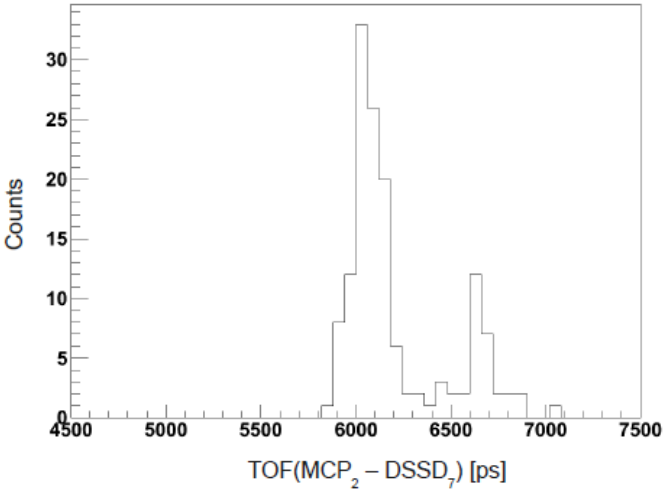
II. Time, Position & Energy Resolution (2/2)

GSI - Germany: **Aug 2009**. Test/Experiment U218: *"Coulomb scattering of ^{48}Ca beam on Au target at UNILAC"*

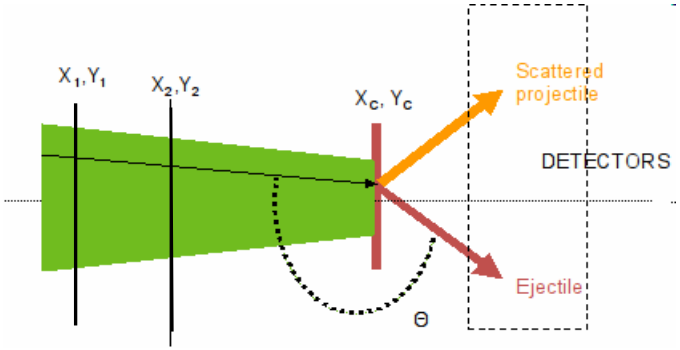
Some Results

- DSSSD1 : 2 ns rise time measured
- FWHM : ≈ 100 ps for a set of pixel
- Energy Resolution : ≈ 5%
- Energy Identification of a Particle (v<<c)

$$E = \frac{1}{2} m.V^2 = \frac{1}{2} \mathrm{m} \left(\frac{\Delta P}{\Delta t} \right)^2 = \frac{1}{2} m \left(\frac{P_2 - P_1}{t_2 - t_1} \right)^2$$



TOF between the first MCP detector and a pixel from the DSSSD



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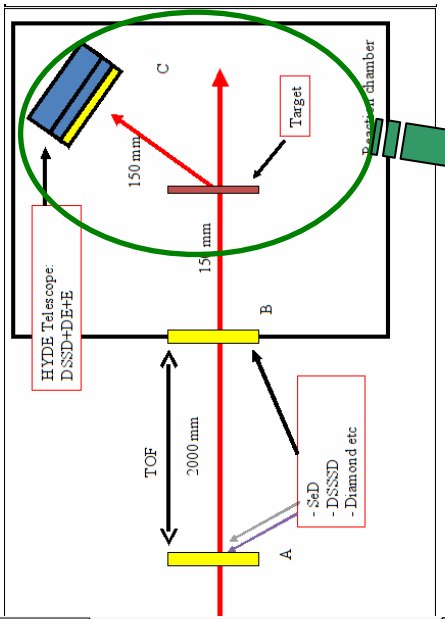
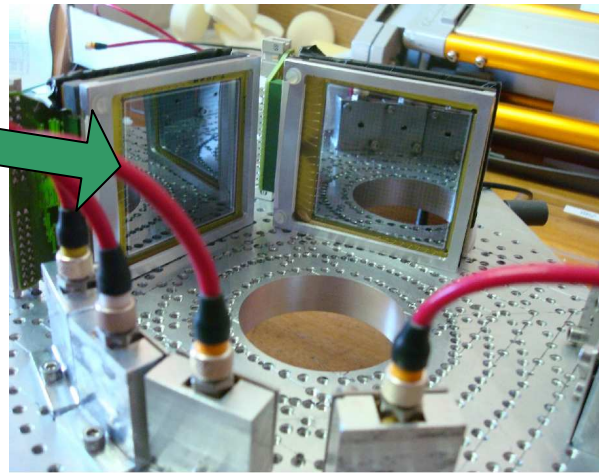
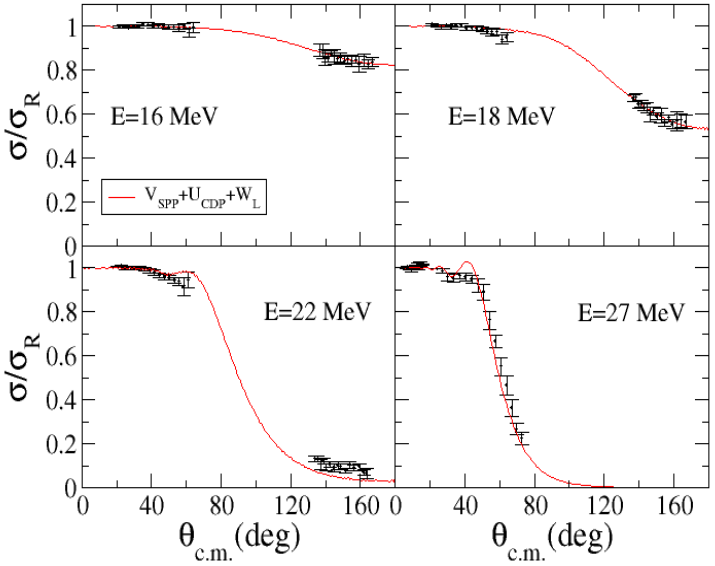
III. Angular & Energy Resolution

ITN - Lisbon: **Oct 2009**. Experiment: *"Elastic and Inelastic Proton Scattering on Heavy Ions around the Coulomb Barrier – ^{197}Au, ^{58}Ni, ^{40}Ca & ^{12}C"*

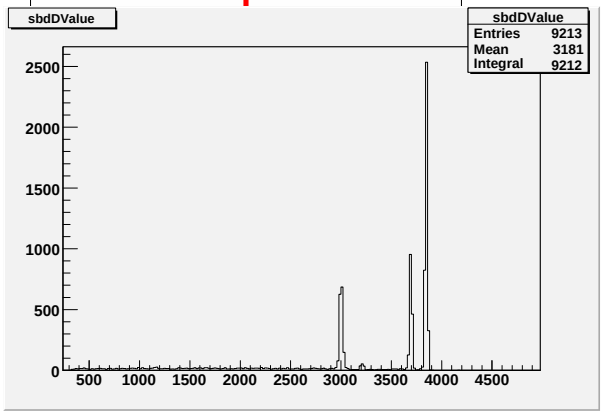




Experimental Setup



Just an Example



Separation of the peaks ^{12}C, ^{58}Ni, $^{197}Au

$$\frac{-h^2}{2\mu}\nabla^2\Psi(R)+U(R,E).\Psi(R)=E.\Psi(R) \qquad U(R,E)\rightarrow\Psi(R)\rightarrow|f(\theta)|^2\rightarrow\sigma_{Th}$$

- Using a model for the interaction potential U(R,E) we solve the equation and we obtain the wave function Ψ(R) which will give us the theoritical cross section (σ_{th}) as a function of angle and energy
- The experimental cross section obtained from the number of counts (σ_{exp} as a function of angle and energy) will be compared to the σ_{th}

Conclusion & Outlooks

DSSSD a good candidate for tracking

- Good timing and position resolution
- Good energy resolution
- 5 x 5 cm^2 active area
- Fairly cheap
- Easy to mount
- Radiation Hardness (GSI :10^4 pps / ITN Lisbon : Beam current on target : 5 nA)

Outlook

- Continue the data analysis of the experiment of ITN-Lisbon
- Perform more tests
- Continue with training
    - Detectors and related electronics
    - Programming and data analysis