Prototyping of Double Sided Silicon Strip Detectors for the EXL Project at FAIR

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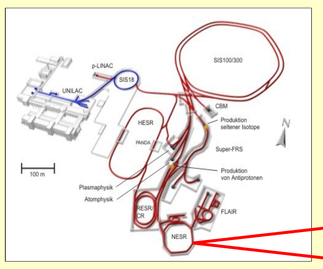
EXL Project

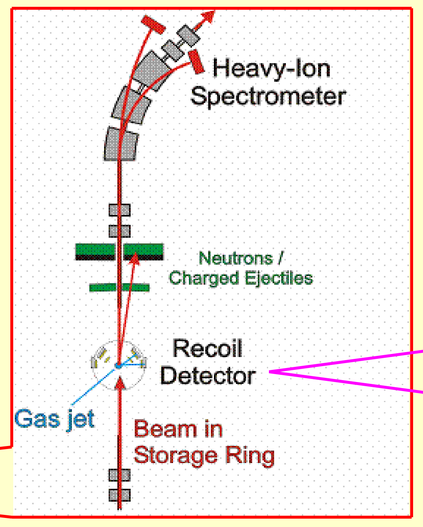
- Reactions with radioactive beams in inverse kinematics
- Recoil detector **ESPA** (**E**XL's **S**ilicon **P**article **A**rray)
- Hundreds of DSSDs planned
- Placement in storage ring environment

FAIR

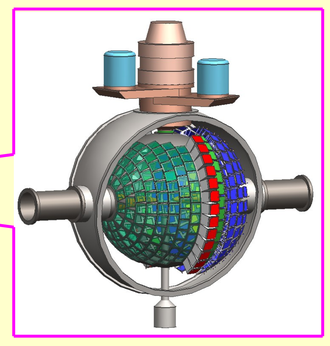
EXL Project scheduled for the second phase of FAIR



EXL

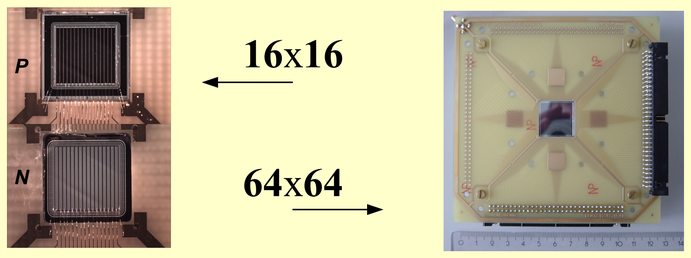


ESPA



DSSSD prototypes

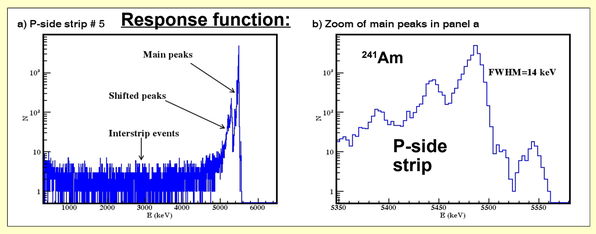
Construction of DSSSD prototypes at GSI from chips manufactured at PTI St. Petersburg



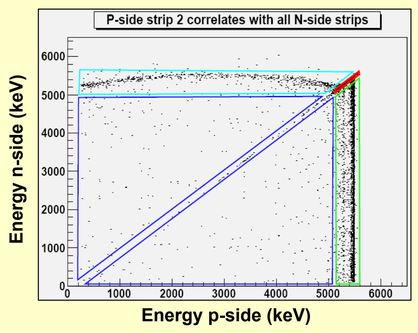
- DSSSDs constructed at GSI (FR-4 PCB with glued DSSSD chip)
- **16x16** - 300µm thickness, 300/300 µm pitch
- **64x64 (64x16)** - 300µm thickness, 300/300 µm pitch (300/1250 µm pitch)

DSSSD Performance Tests

Spectroscopic Properties



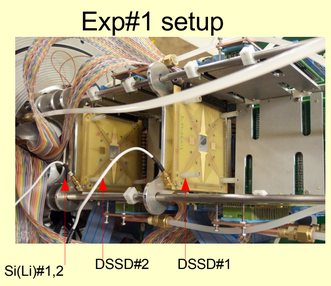
- Energy resolution: For 5. 5 MeV ^{241}Am α's 14 – 20 keV FWHM (both for p- and n- strips)
- Notable interstrip background and satellite peaks

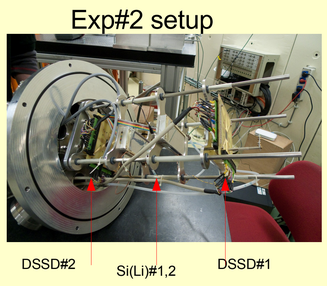


Event type P - N	
Strip – Strip	76.8 %
Strip – Interstrip	18,2 %
Interstrip – Strip	4,1 %
Interstrip – Interstrip	0,9 %

! Probabilities correspond to pitch structure

Proton Energy Reconstruction

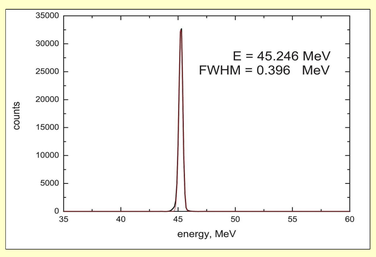




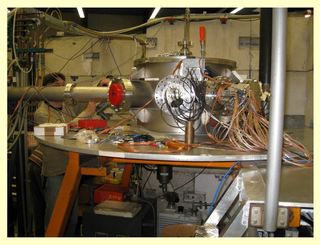
April 2009: KVI Groningen: Protons of 50 MeV
Detectors: DSSD (64x16) - DSSD (64x64) - Si(Li) - Si(Li)

April 2010: KVI Groningen: Protons of 135 MeV
Detectors: DSSD (64x16) -Si(Li) - Si(Li) - DSSD (64x64) - CsI

- Total proton energy reconstruction
- $E_{proton} = 45.2 \pm 0.4$ MeV

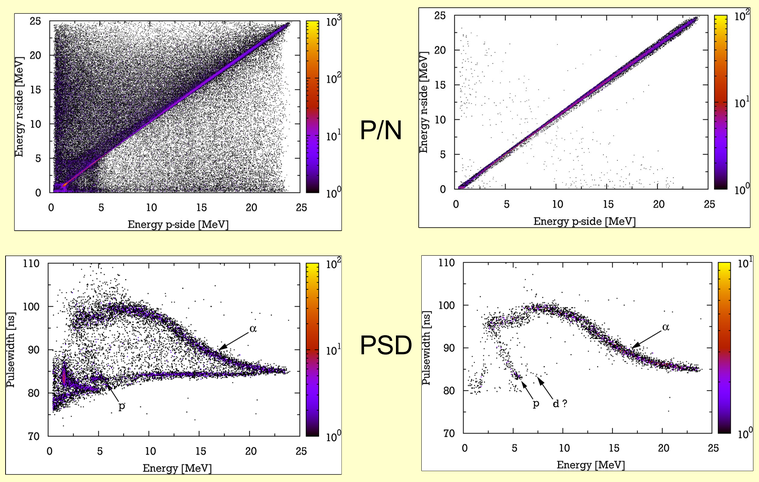


Pulse Shape Discrimination



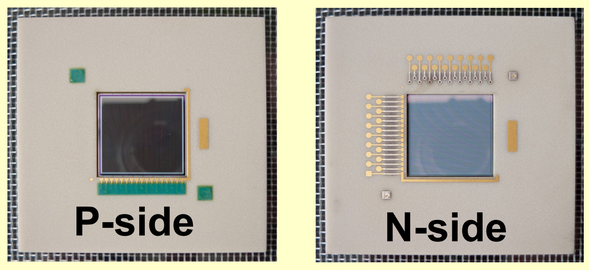
Performed @ TU München:

- α particles E < 30 MeV
- ^{12}C + ^{12}C , 70 MeV
- Separation of protons and alphas



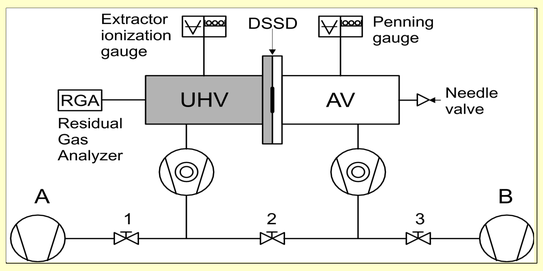
Vacuum Demonstrator

Printed Circuit Board (PCB)



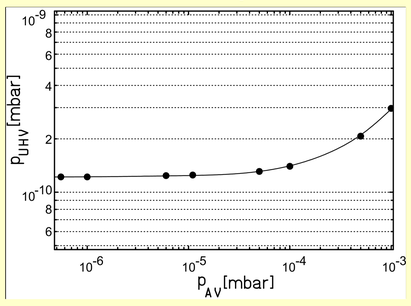
- PCB manufactured from Aluminum Nitride (AlN)
  - Laser drilled holes for routing P-side contacts to N-side
  - Holes filled with gold and covered with glass
  - Ultra low-outgassing + bakeable to ≈ 200°C
  - Expansion coefficient close to Silicon
  - High thermal conductivity
- DSSSD glued with EPO-TEK®H77S low outgassing glue

Demonstrator Test Stand

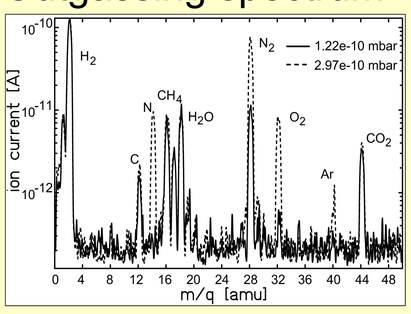


- Test stand with two vacuum chambers with individual pumping circuits
- Interplay between two volumes only through DSSSD-PCB system
- Each part equipped with pressure gage
- UHV side equipped with Residual Gas Analyzer

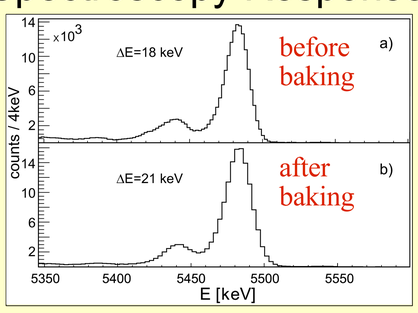
UHV – AV Dependance



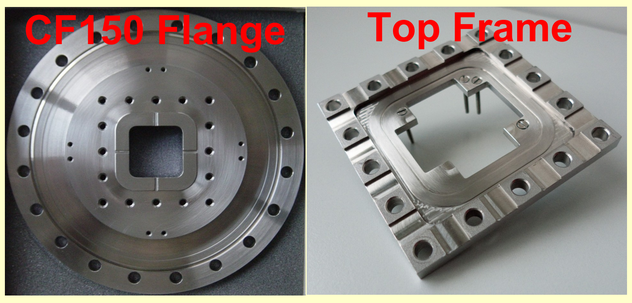
Outgassing spectrum

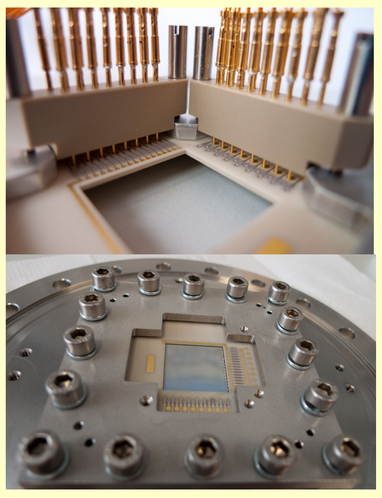


Spectroscopy Response



Mechanical Vacuum Parts and Connectors





Perspectives

- Construction of AlN-PCBs for the new DSSSD chips (64 x 64 mm², 128 x 64 strips, 300 µm) for accepted experiment at ESR
- Study spectroscopic performance and efficiency of prototype DSSSDs in a larger energy range (e.g., α particles from 100 keV to 50 MeV)
- Proper engineering of UHV – AV vacuum window for the new generation of DSSSDs on AlN-PCBs
- How to test the new large DSSSD chips beforehand without gluing and bonding? → probe-like socket using spring-pins