

Development of detectors for slowed down beams at GSI

P. Boutachkov

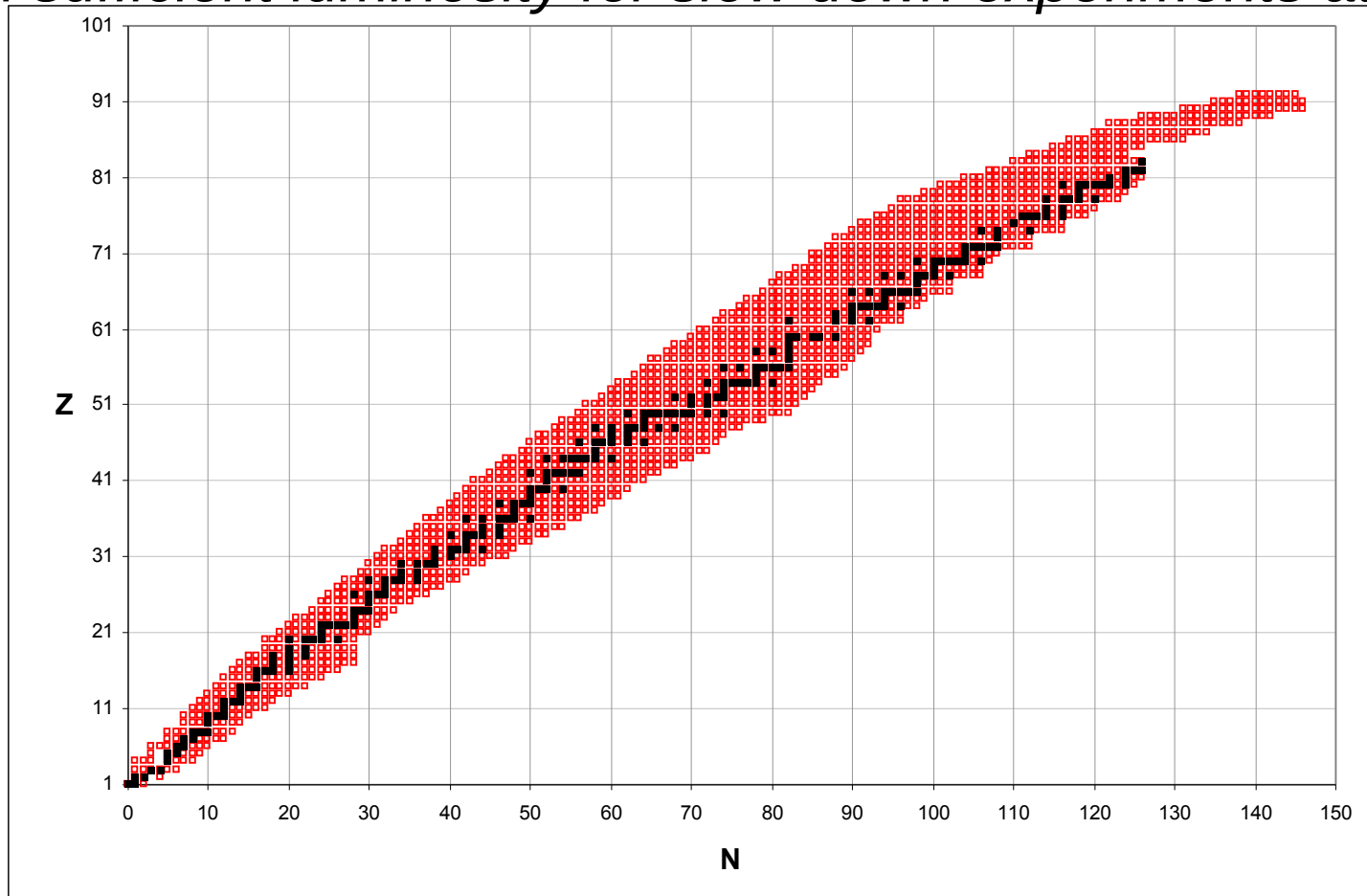
*GSI Helmholtzzentrum,
Helmholtz International Center for FAIR*

- Physics objectives
- Proposed solution
- Test experiments. Detector development
- Future development

Project objective

Obtain *5 MeV/u* to *10 MeV/u* RIB to be used for secondary reaction studies at FRS / Super FRS

RIB with sufficient luminosity for slow down experiments at S-FRS

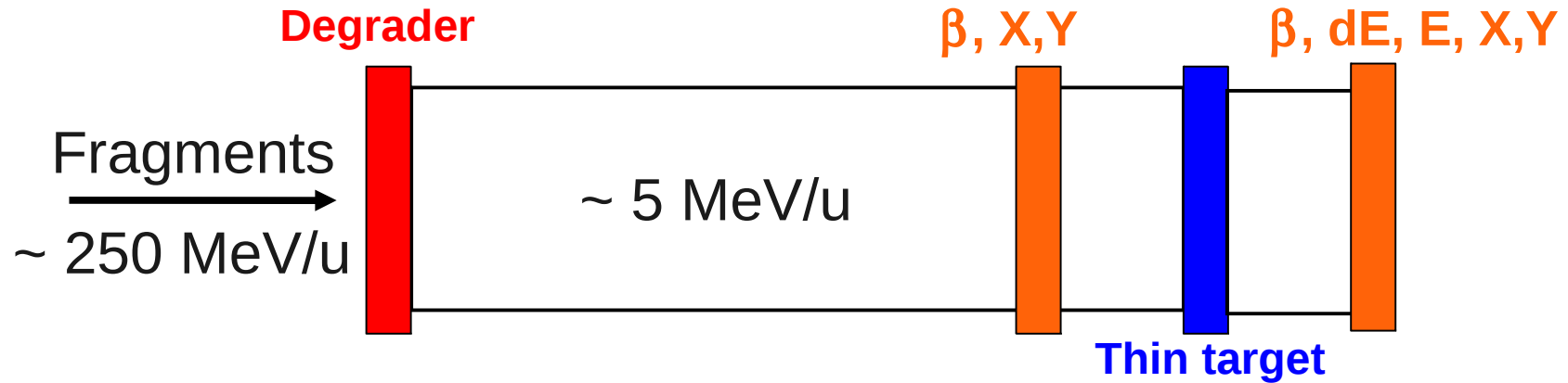


Development of slowed down beams around the world

Fusion enhancement with neutron-rich RIB, $^{32,38}\text{S}+^{181}\text{Ta}$,
slowed from 9 MeV/u to ~ 4 MeV/u
K.E. Zyromski, et al. PRC **55**, R562 (1997)

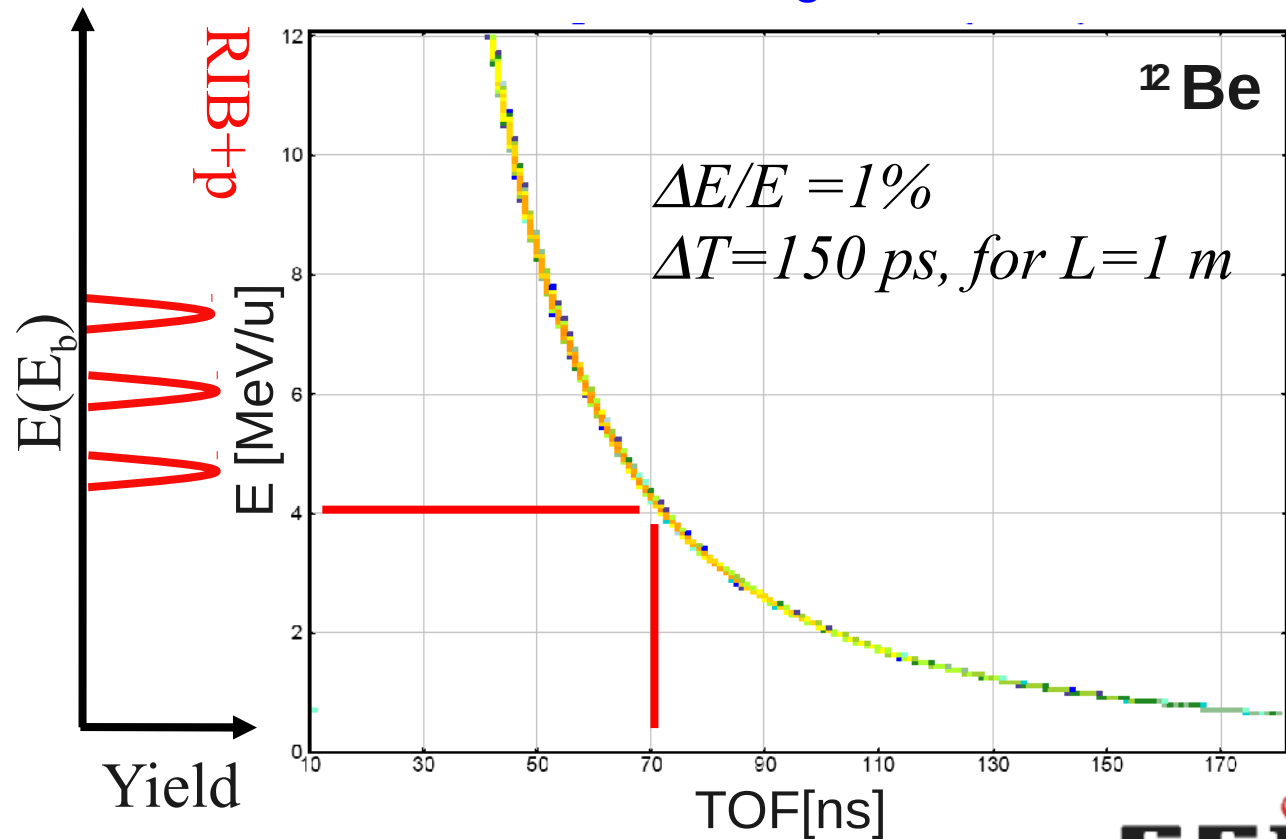
High-spin states in ^{48}Ca , using 5 MeV/u ^{46}Ar beam
slowed from 30 MeV/u to 5 MeV/u
E. Ideguchi, et al. EPJA **25**, 429 (2005)

Simple binary reactions performed with white beam

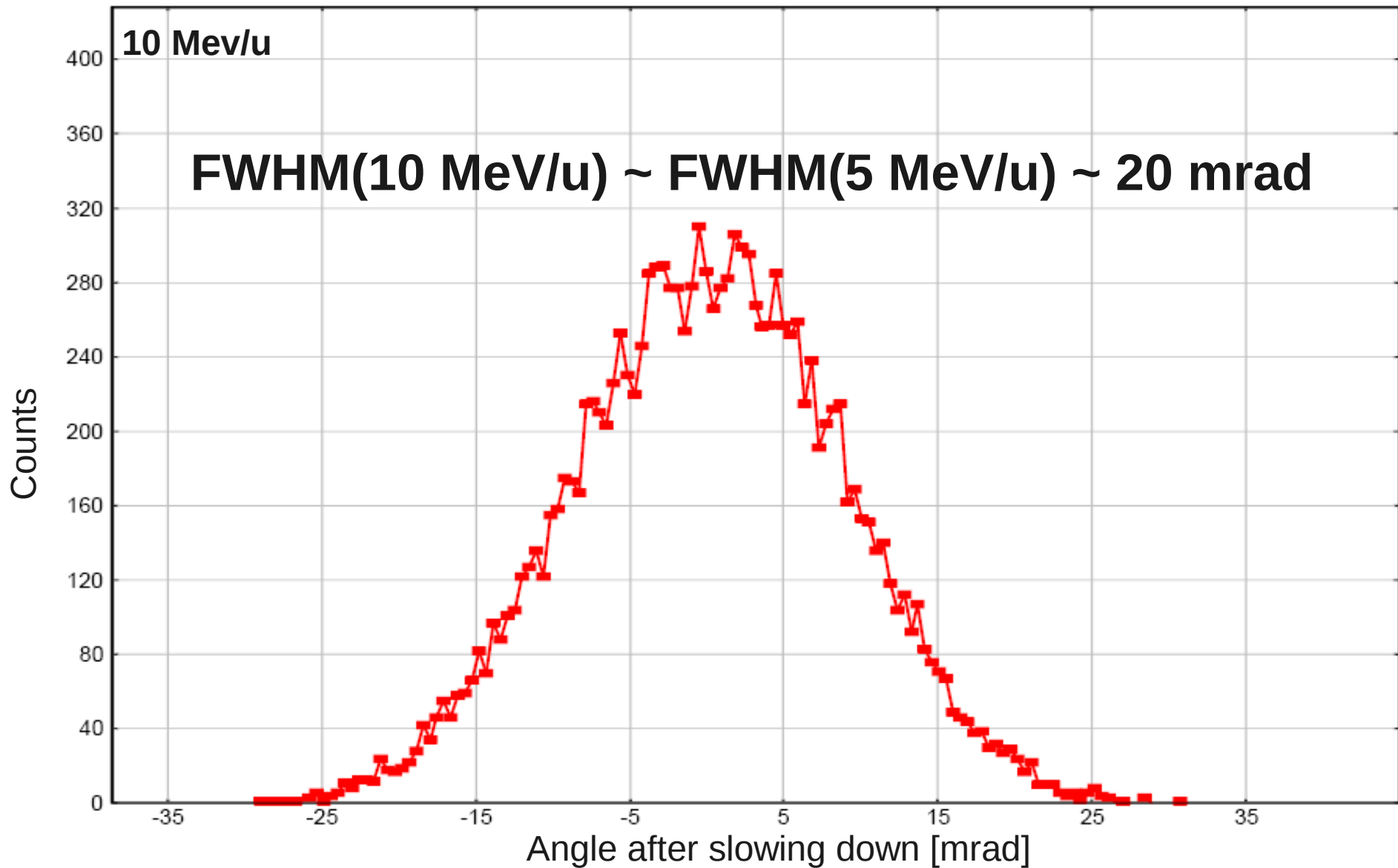


- Energy straggling
- Angular straggling

Event-by-event tracking

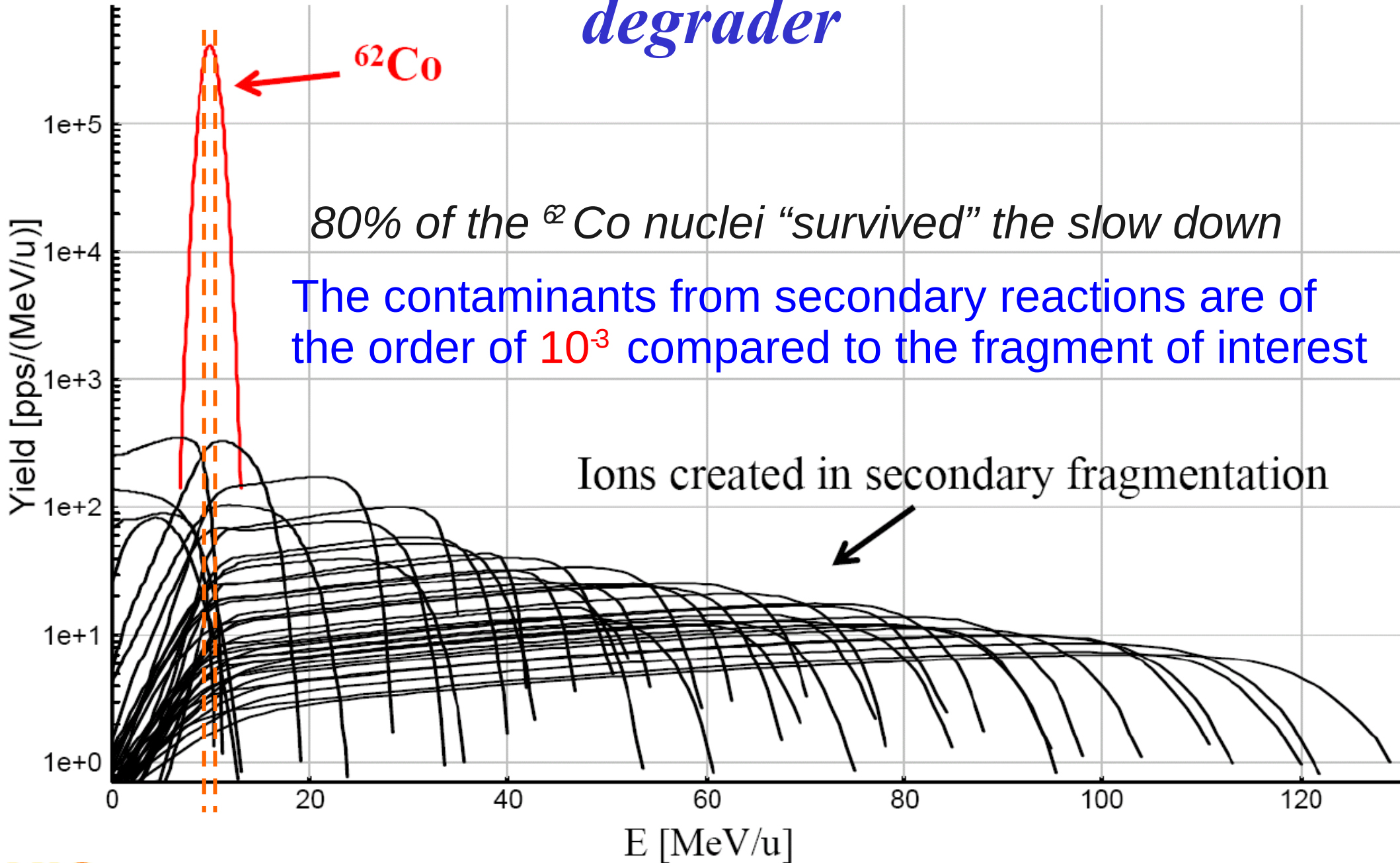


Angular straggling



20 mrad at a distance of 1.5 m \rightarrow 3 cm

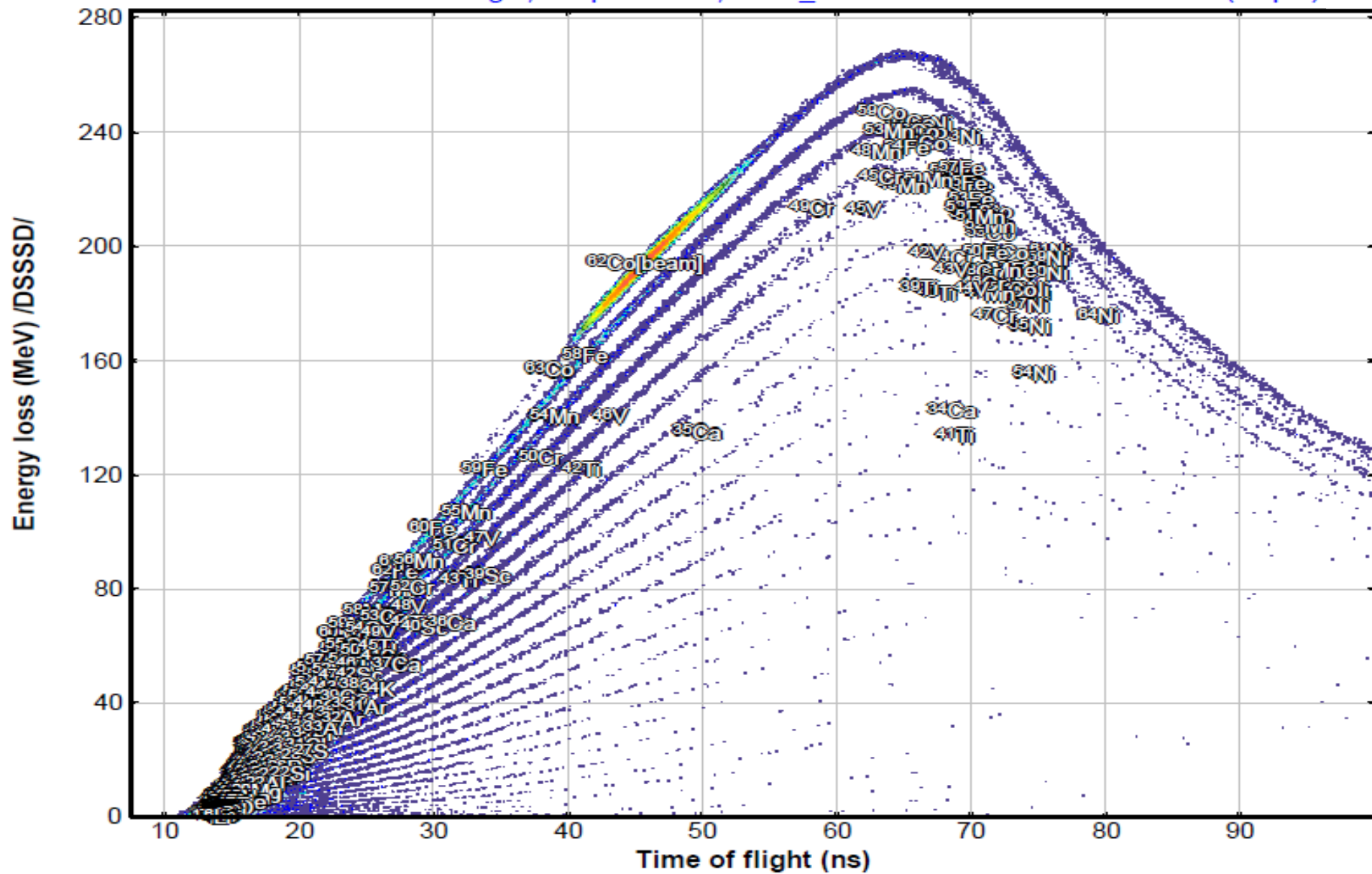
Contaminants from reactions into the degrader



dE-TOF

^{62}Co (220.0 MeV/u) + Al (3.34 g/cm²); Settings on ^{62}Co ; Config: SMA
dp/p=100.00%

Start: Target; Stop: DSSSD; ACQ_start: Detector ** dE: DSSSD - Si (40 μm)



$$\Delta E/E \sim 3\% \quad \Delta T \sim 150 \text{ ps}$$

Projectile:

- Elements p - U
- Energy up to 1.5 GeV/u
- Intensity $10^{12} - 10^{13}$ /s
(depending on element)

Acceptanze

$$\varepsilon_x = \varepsilon_y = 40 \pi \text{ mm mrad}$$

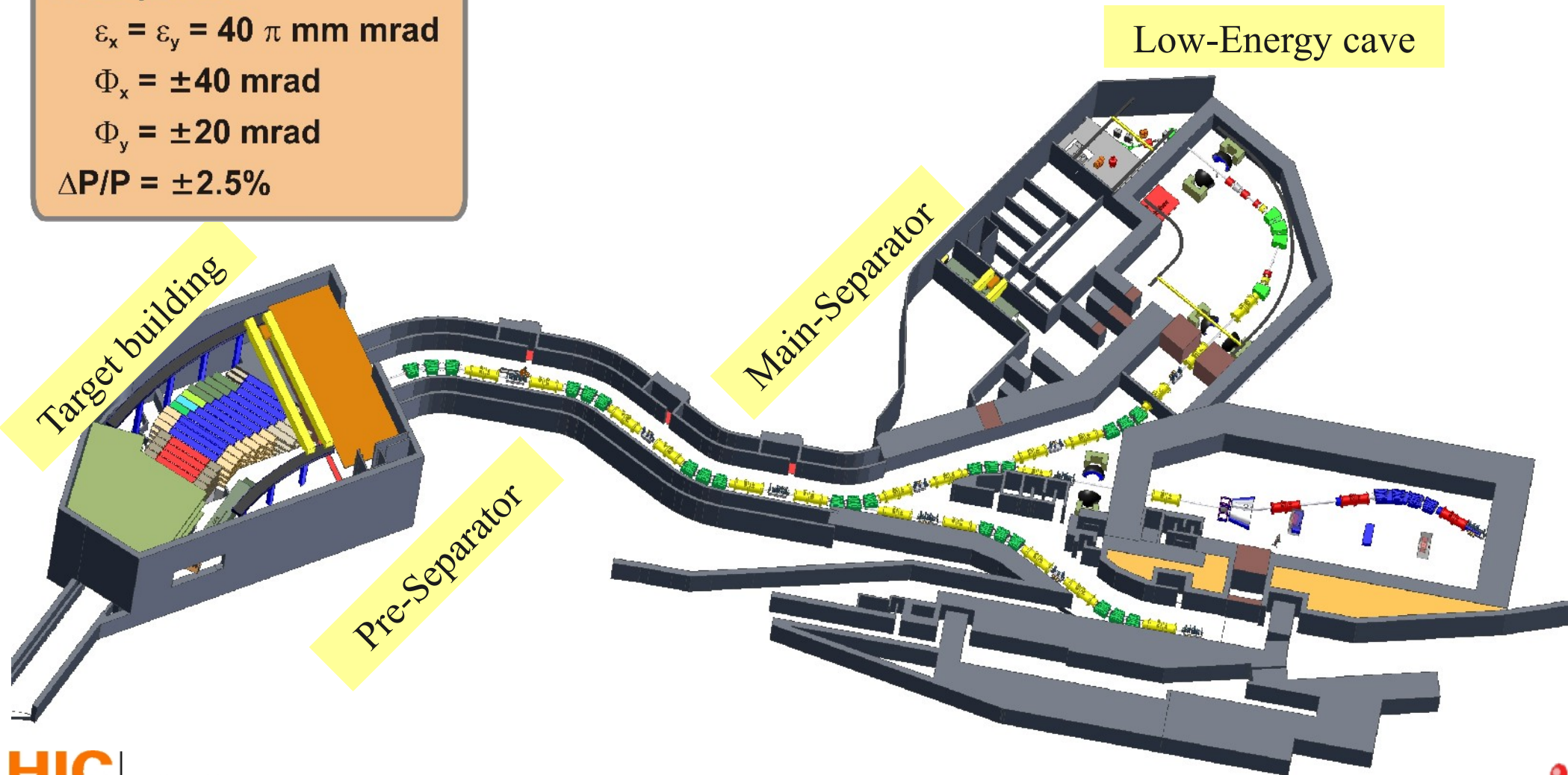
$$\Phi_x = \pm 40 \text{ mrad}$$

$$\Phi_y = \pm 20 \text{ mrad}$$

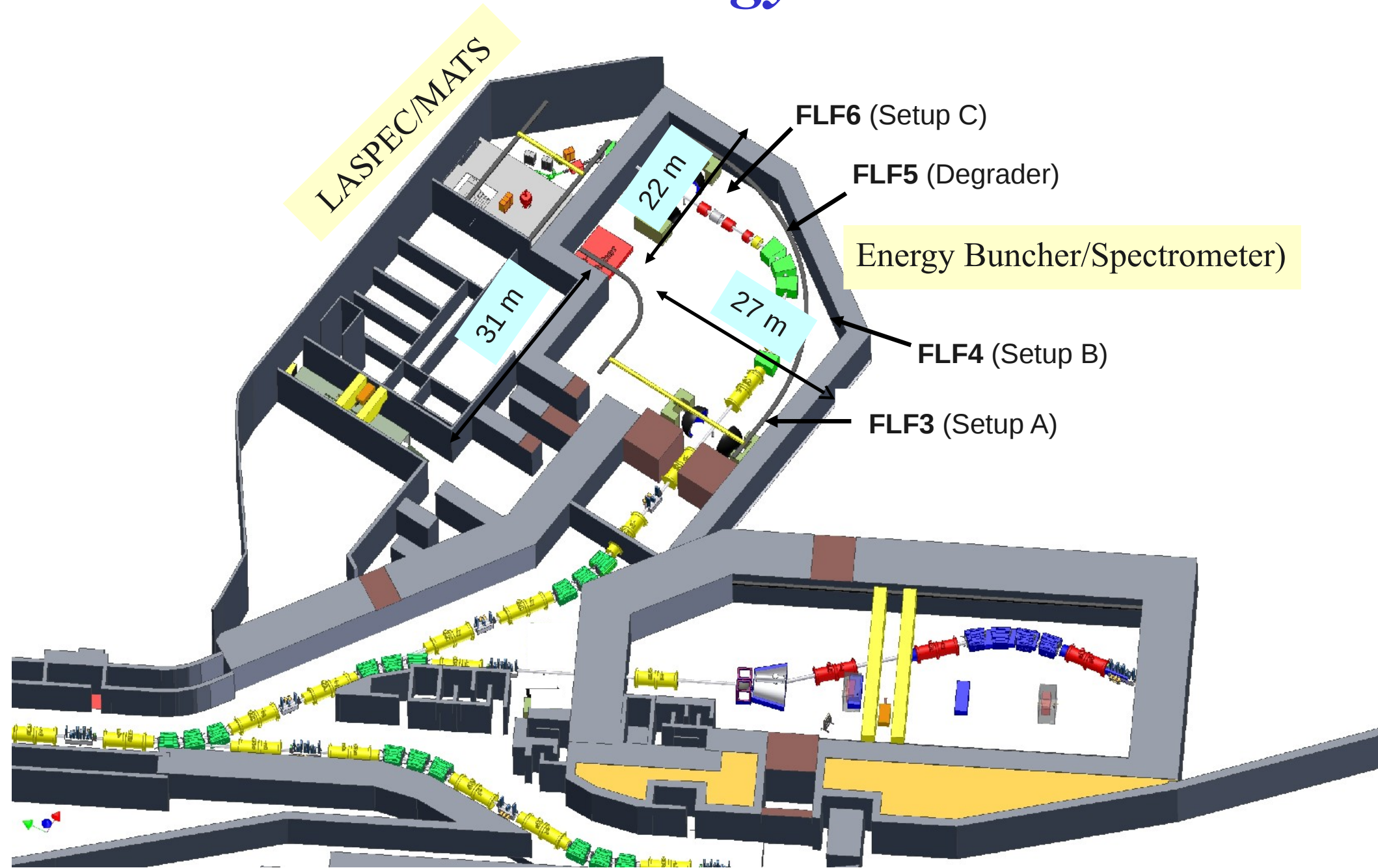
$$\Delta P/P = \pm 2.5\%$$

Super-FRS

$$B\rho_{\max} = 20 \text{ Tm}$$



Low-Energy cave



MCP

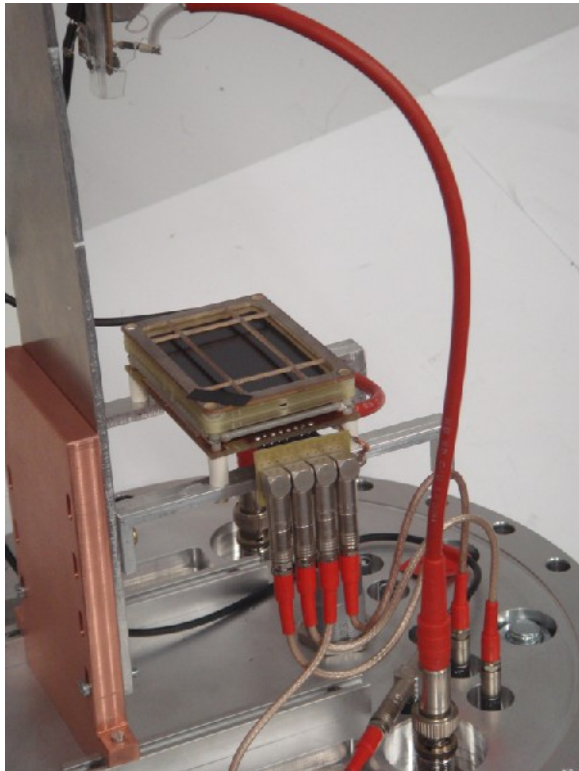
Electronics:

Phillips 715 CFD:

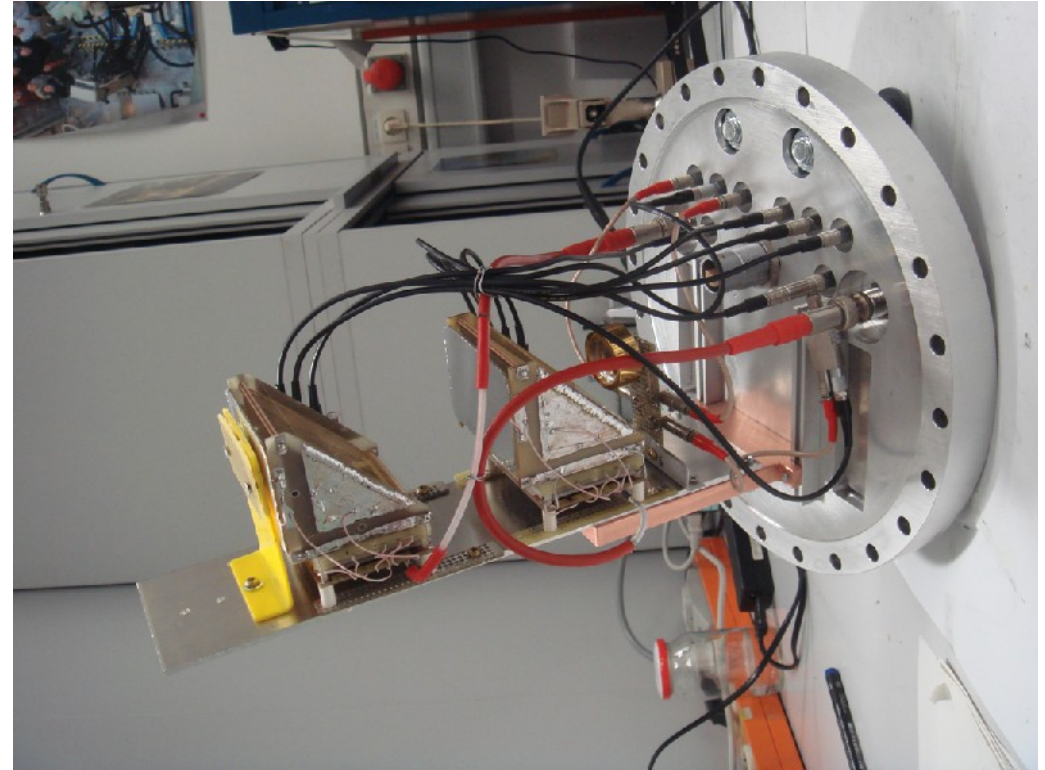
walk +/- 75 ps

CAEN V1290A TDC,

Resolution 25 ps



$\Delta X(\text{FWHM}) \sim 1 \text{ mm}$



4 x 6 cm, 1.5 μm Mylar foil

$\Delta T(\text{FWHM}) \sim \mathbf{140 \text{ ps}}$

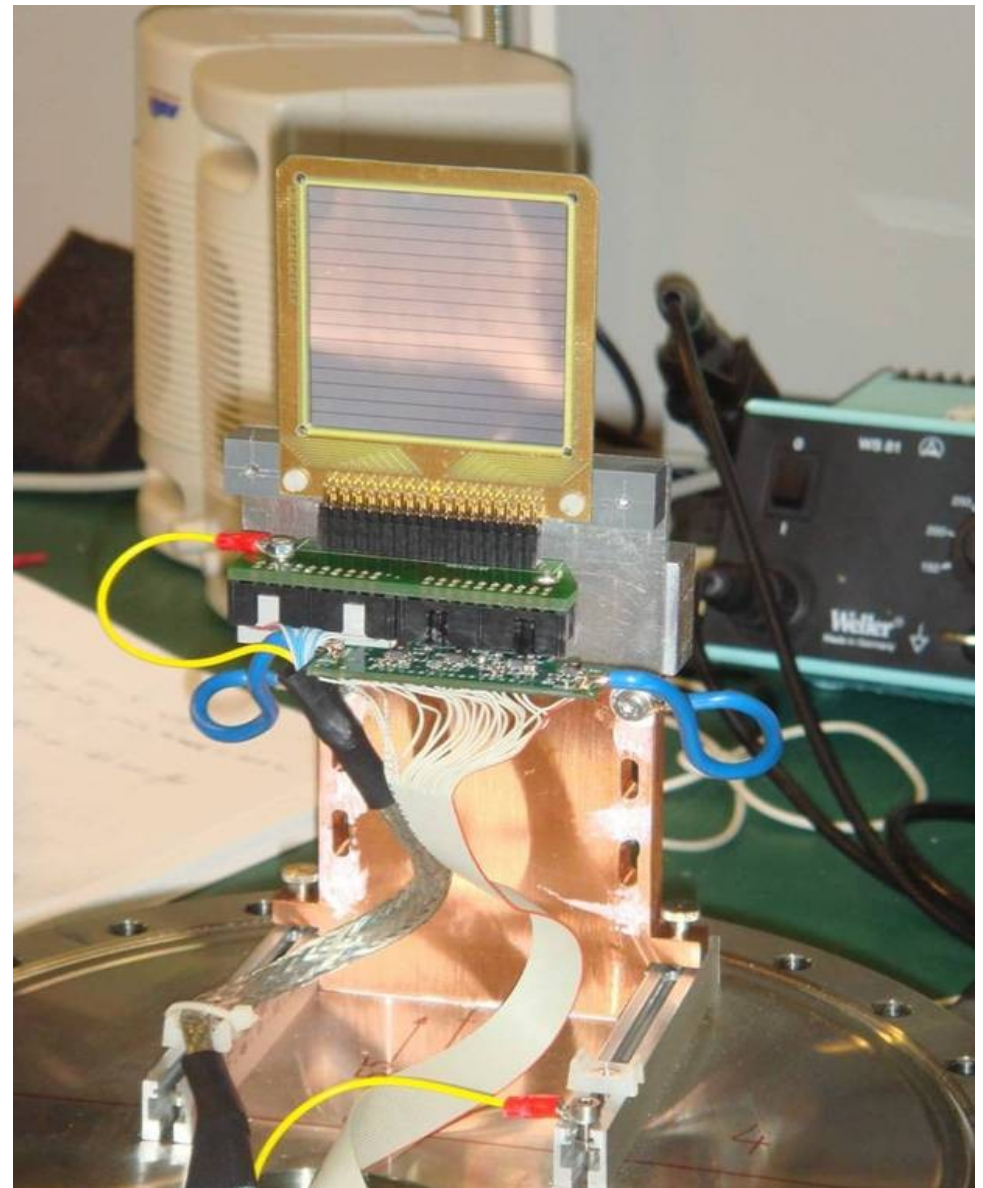
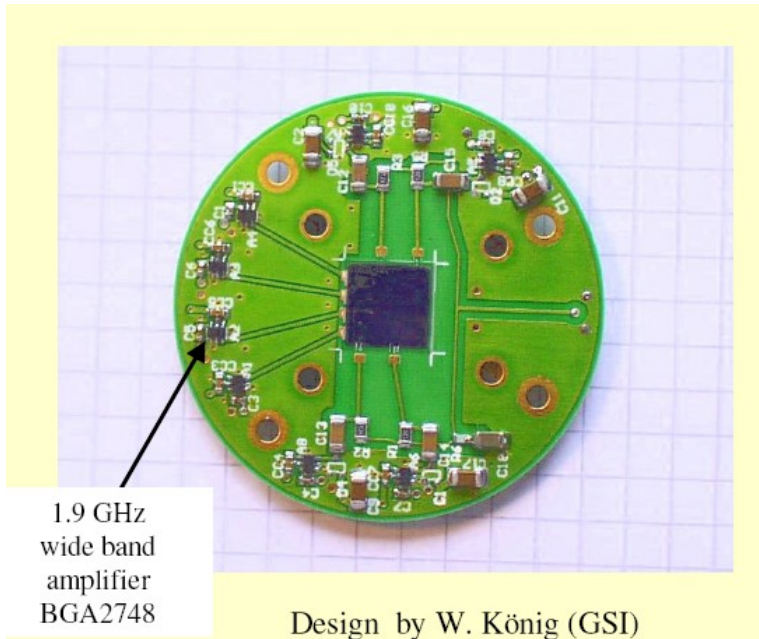
$\Delta X_{\alpha}(\text{FWHM}) \sim 3 \text{ mm}$

$\Delta X_{\text{fr}}(\text{FWHM}) \sim 1.5 \text{ mm}$

$\epsilon_{\alpha} \sim 85 \%$

$\epsilon_{\text{fr}} \sim 100\%$

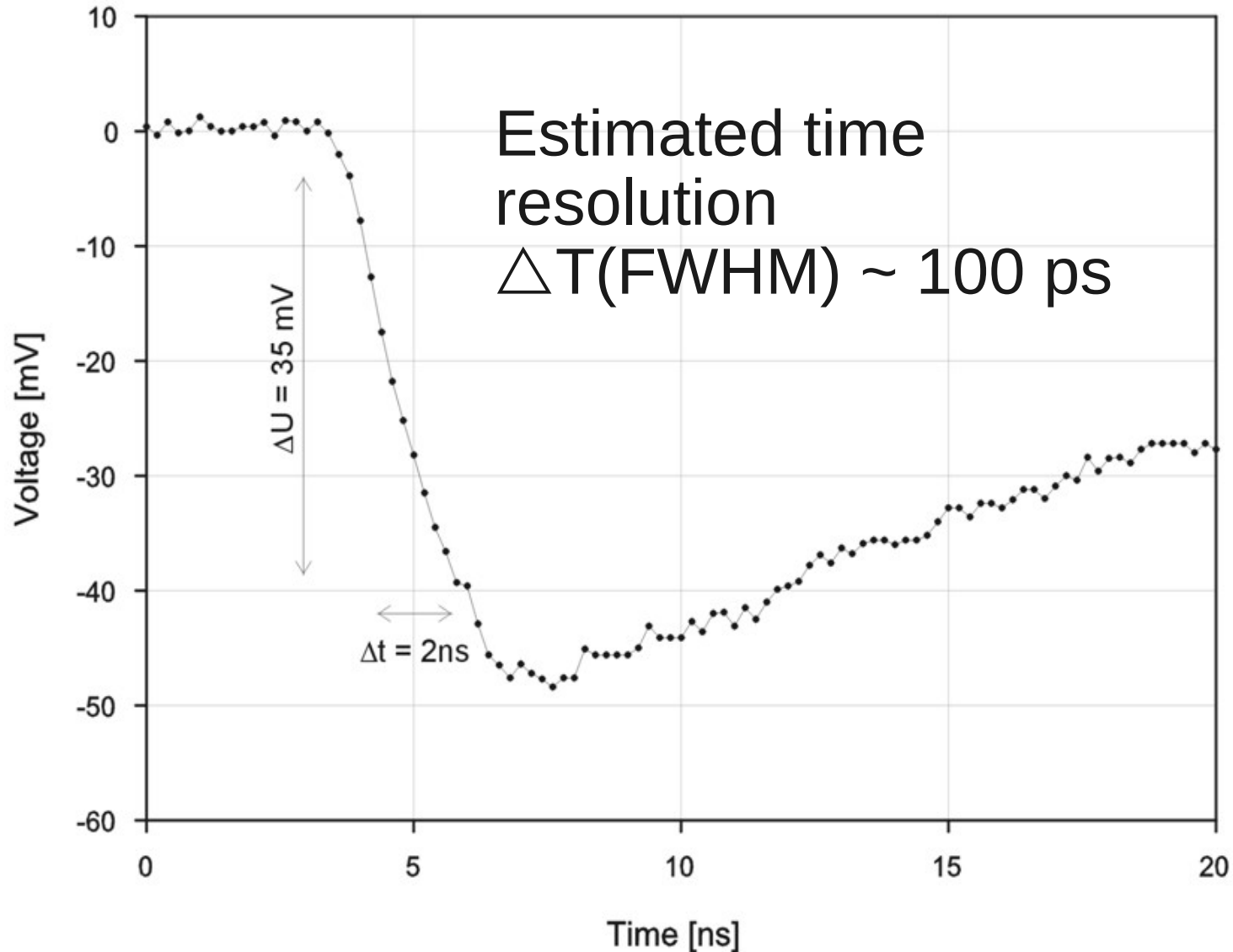
Si fast timing



DSSD: $40 \mu\text{m}$ $5 \times 5 \text{ cm}^2$
16x16 strips

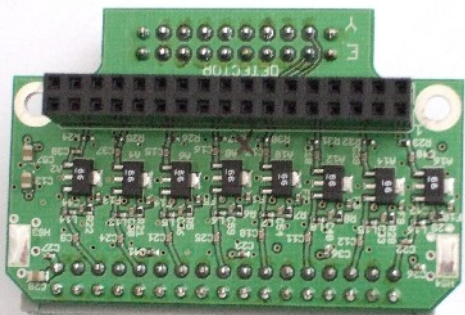
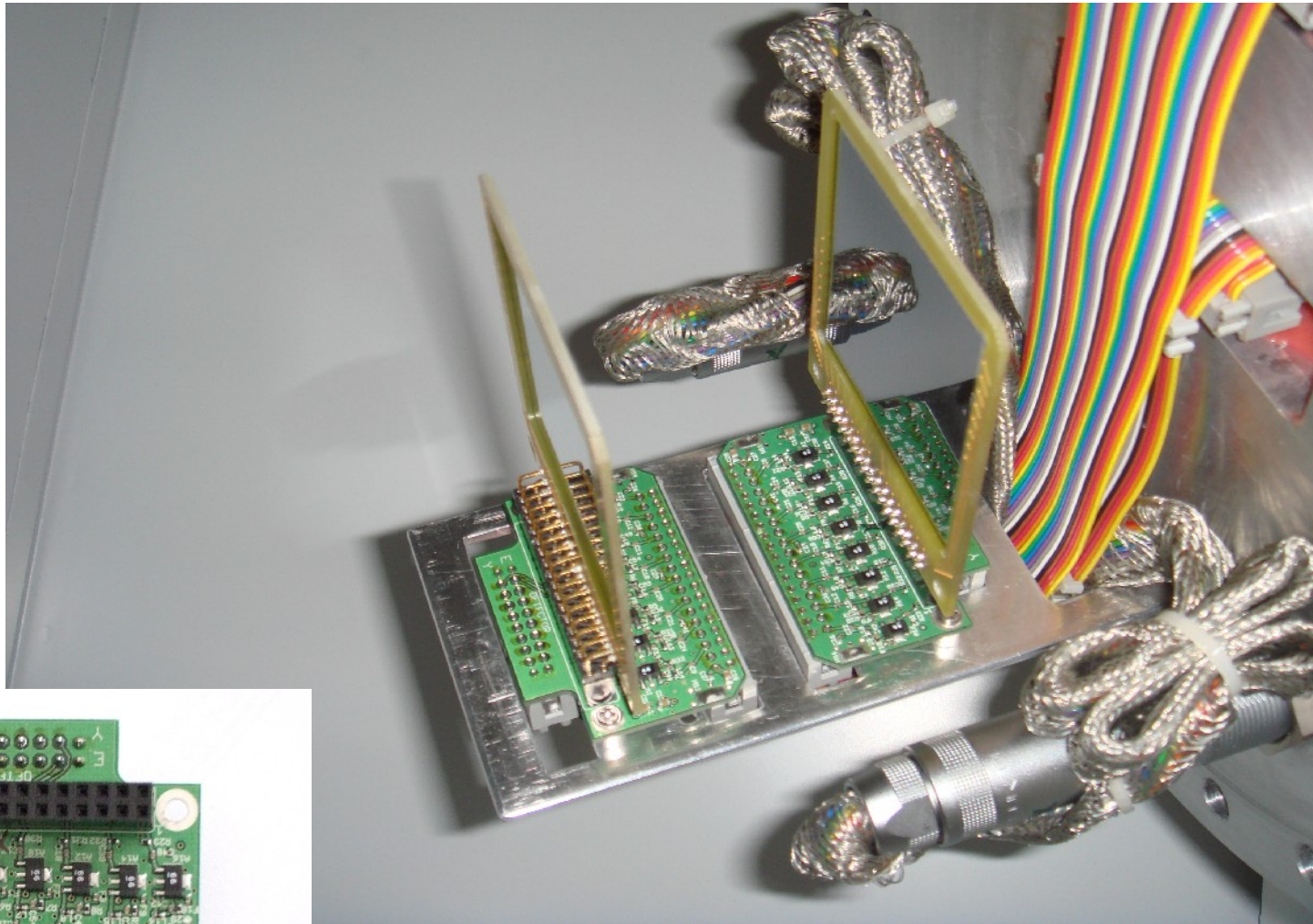
Si fast timing in Aug 2007

Coulomb scattering of ^{48}Ca beam, 12.6 MeV/u at 20°



Development

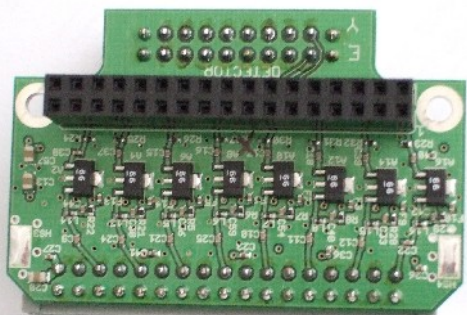
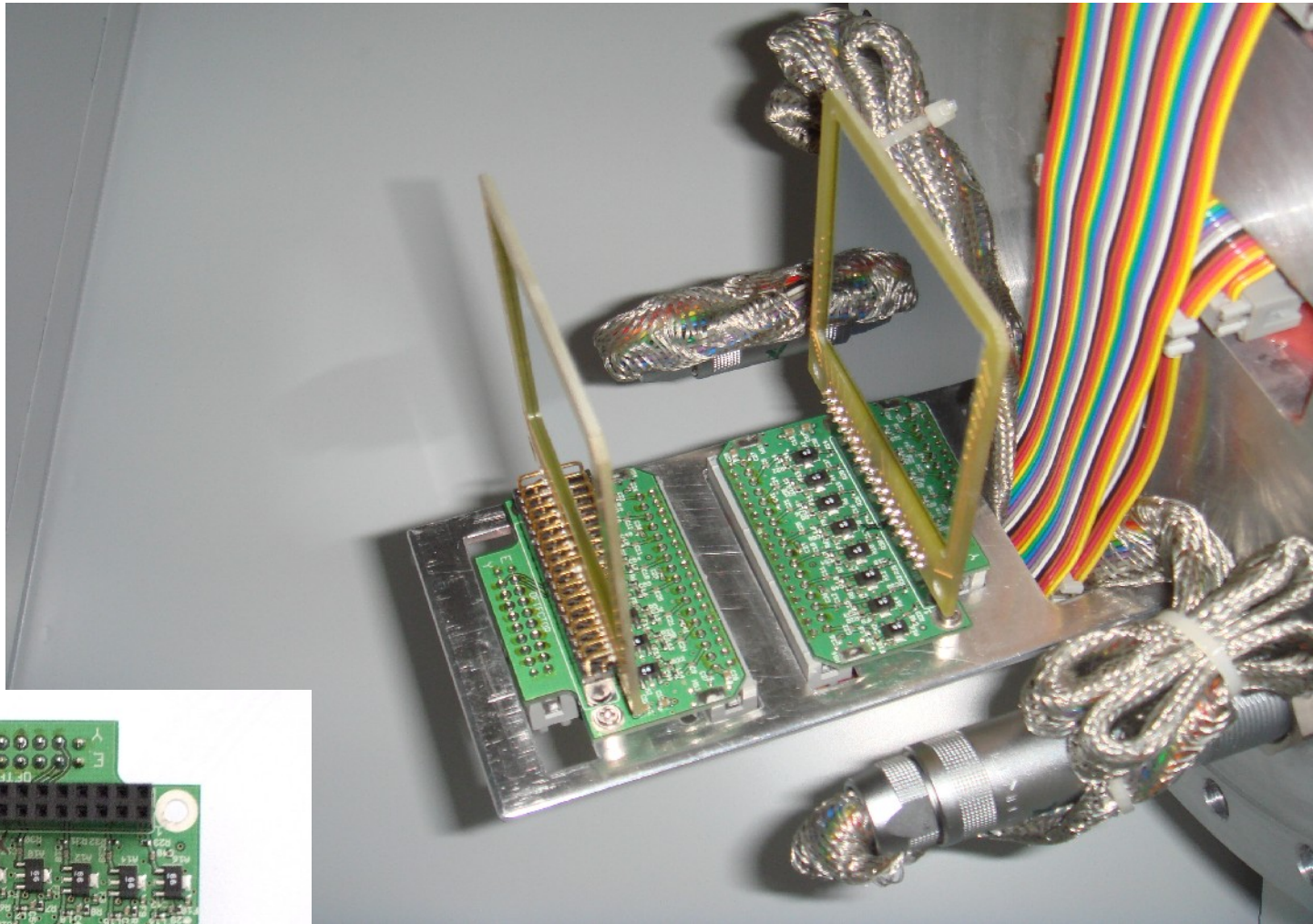
16 ch Fast pre-amp + 16 ch Level discriminators +
16ch ECL converters



Design: W. Koenig(GSI)

Development

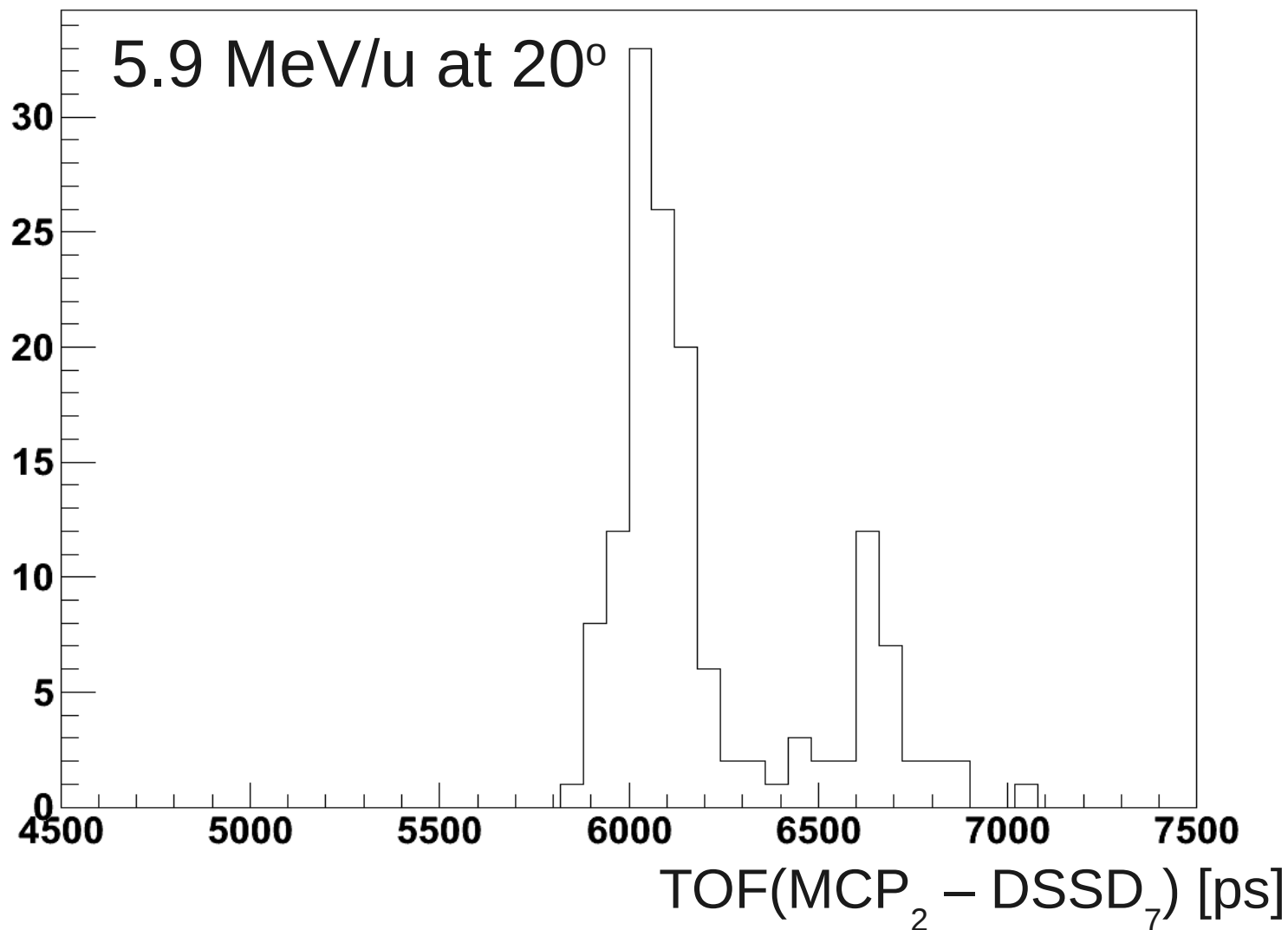
16 ch Fast pre-amp + 16 ch Level discriminators +
16ch ECL converters



Additional electronics: CAEN V1290A TDC

Si fast timing Aug 2009

Coulomb scattering of ^{48}Ca beam,

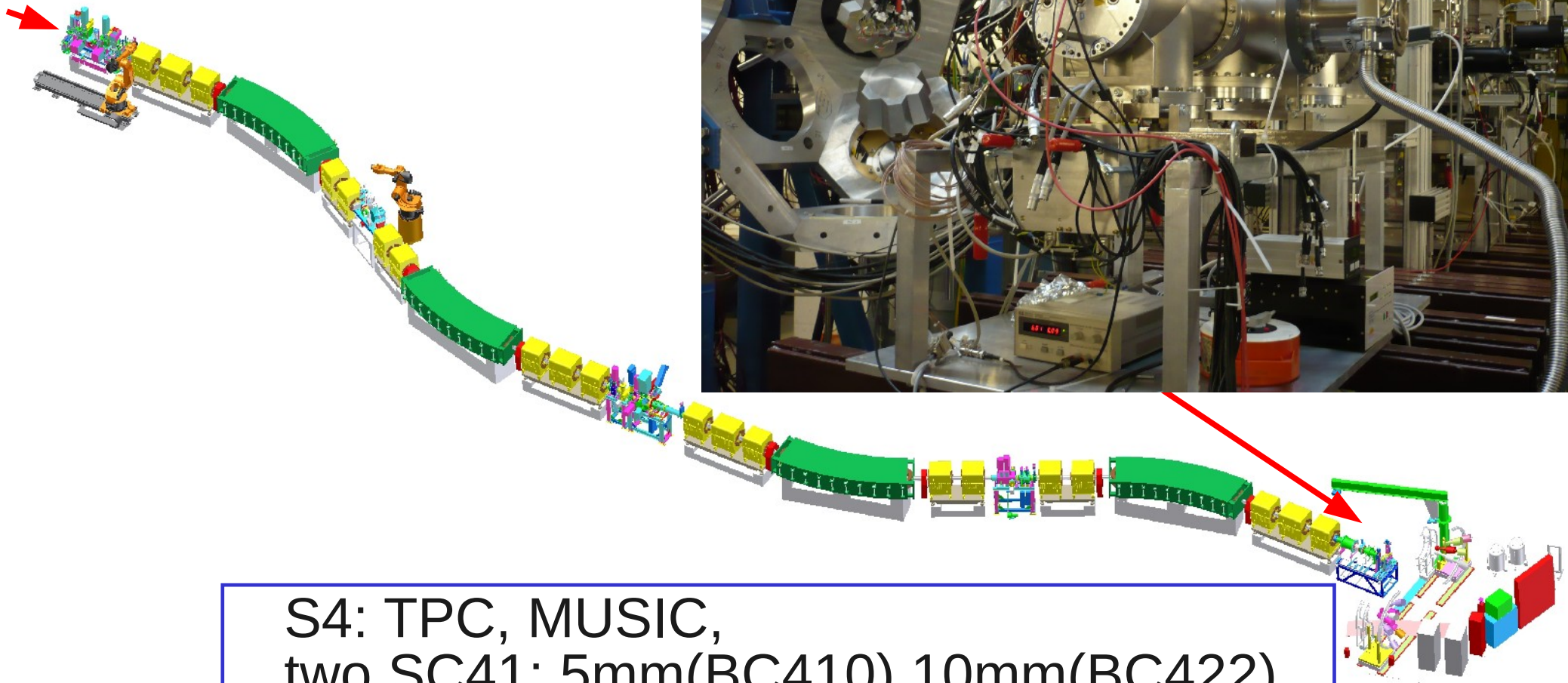


ΔT_{DSSSD} (strip 7) = 200(15) ps $\Delta E/E = 5\%$

Preliminary

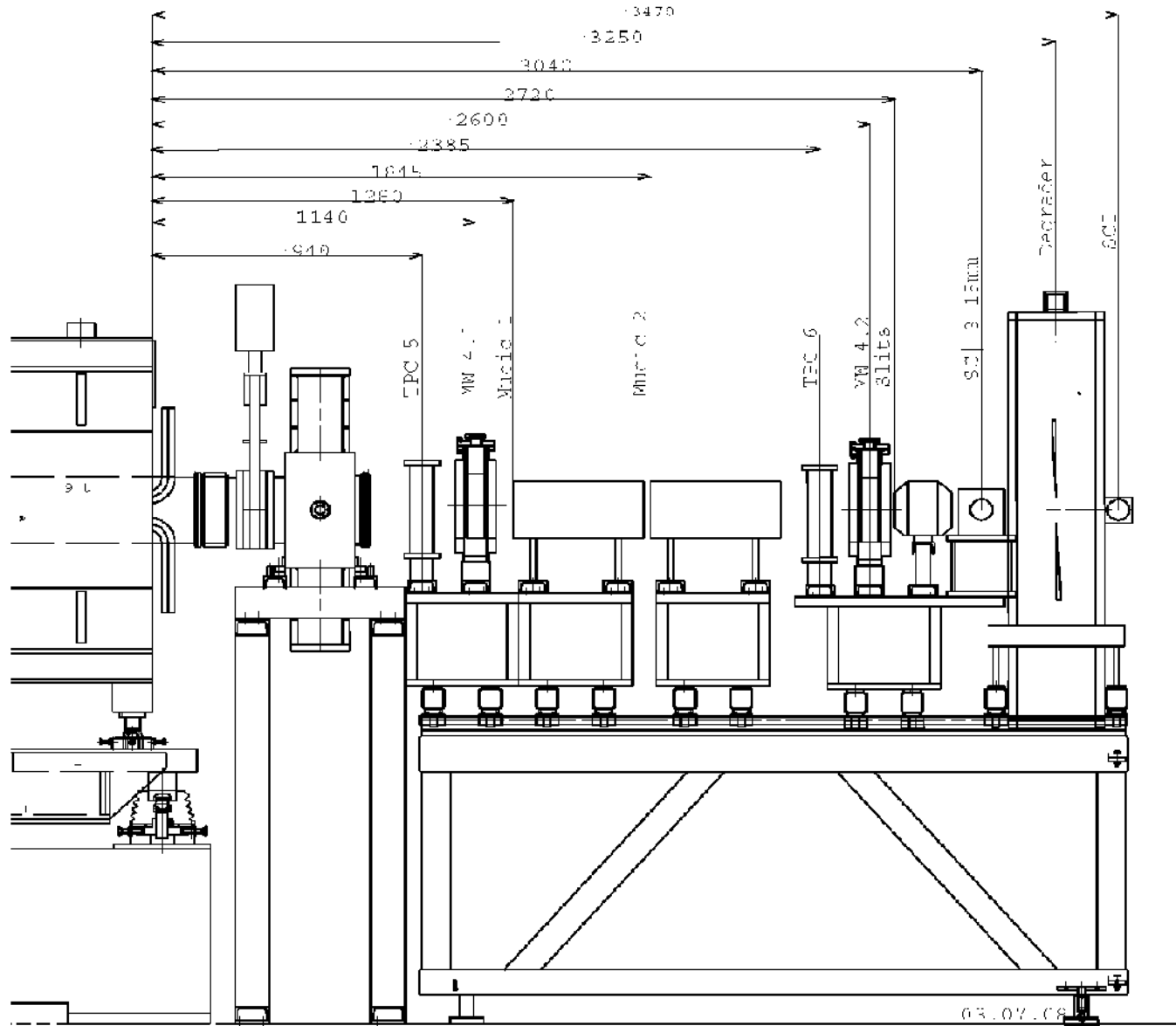
Slowed down beams test at FRS

^{64}Ni



S4: TPC, MUSIC,
two SC41: 5mm(BC410),10mm(BC422)
2xMCP, 2xDSSD

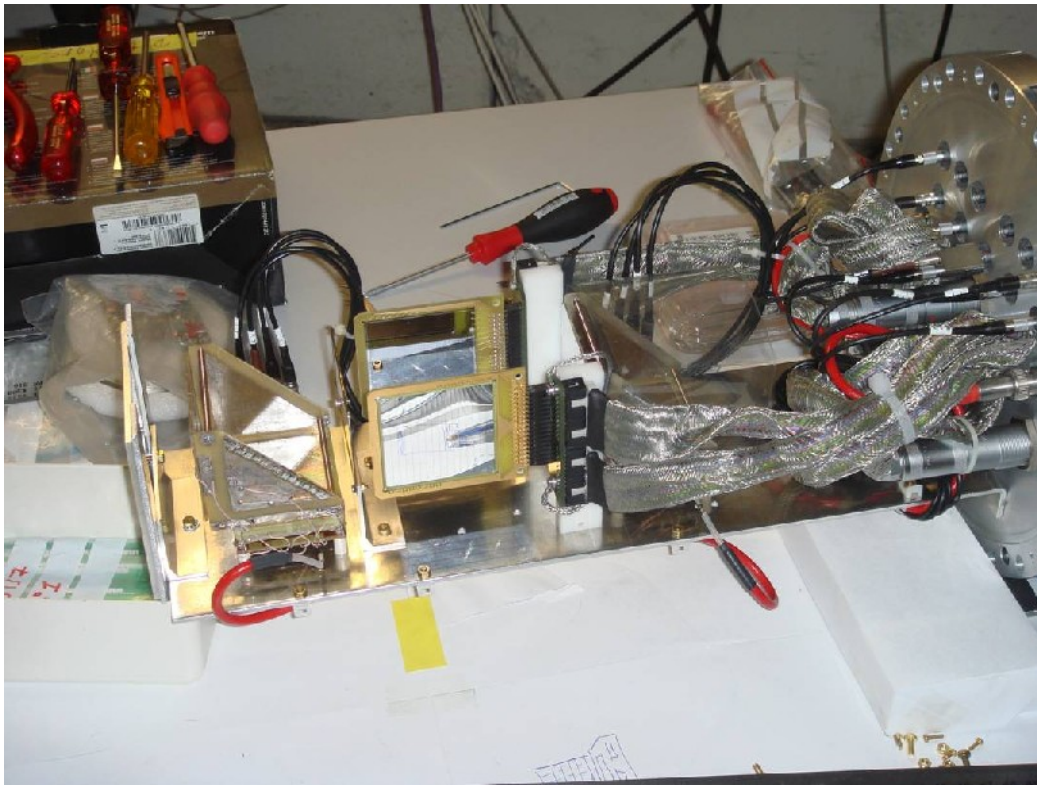
S4-detectors



S4: TPC, MUSIC,
two SC41: 5mm(BC410),10mm(BC422)
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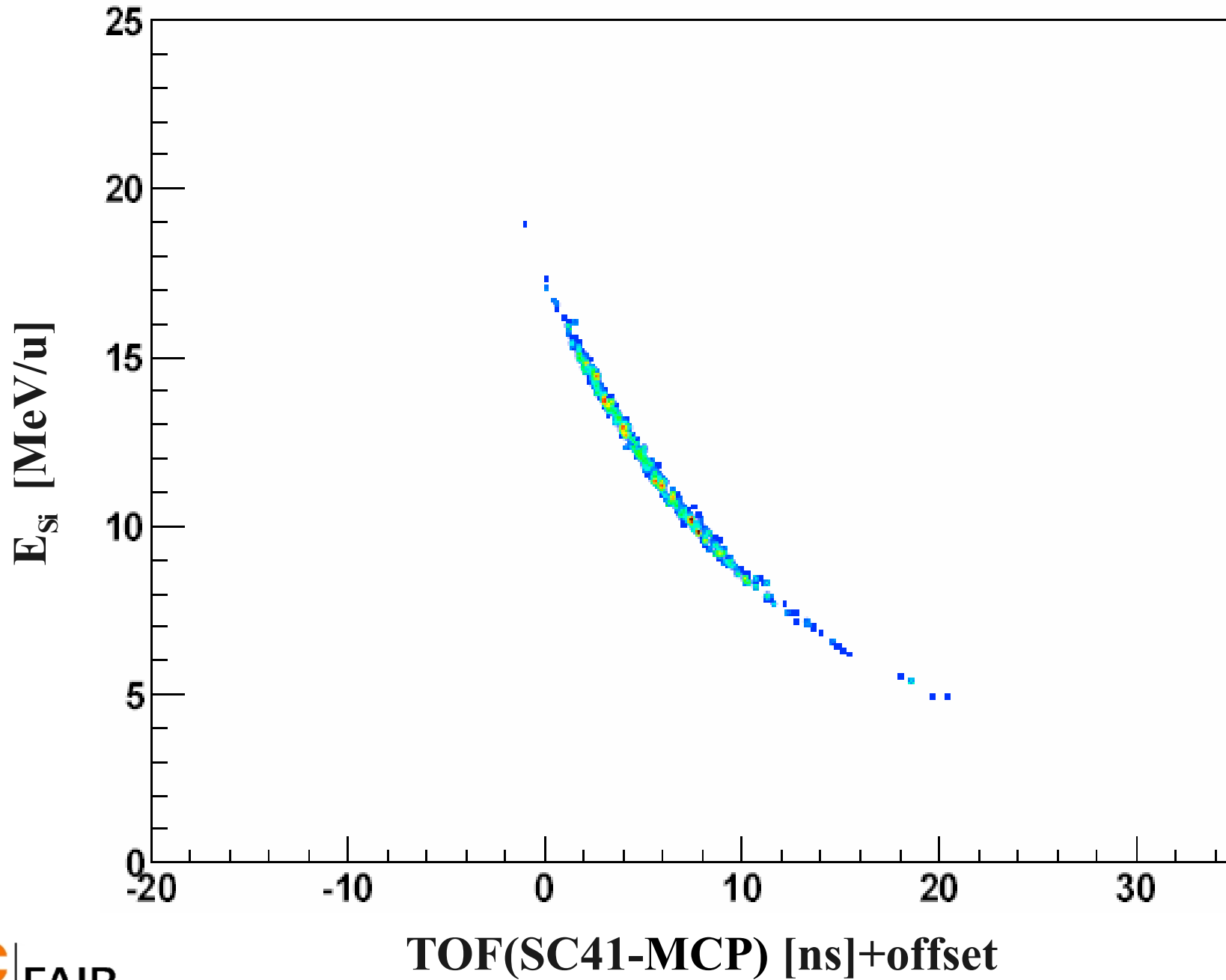
Slowed down beams test at FRS

2xMCP, 2xDSSD



- MUSIC resolution up to 50 kHz
- TOF: at 10^6 p/spill (4s spill)
- Phase space after slowing down
- Beam purity after slowing down
- Coulomb scattering on Au

^{64}Ni



Summary

- MCP detector and fast pre-amplifiers for Si DSSD were built to prove the concept of slowed down beam setup at FRS

Future

- Further development of fast timing with DSSD
- Further analysis

Collaboration

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