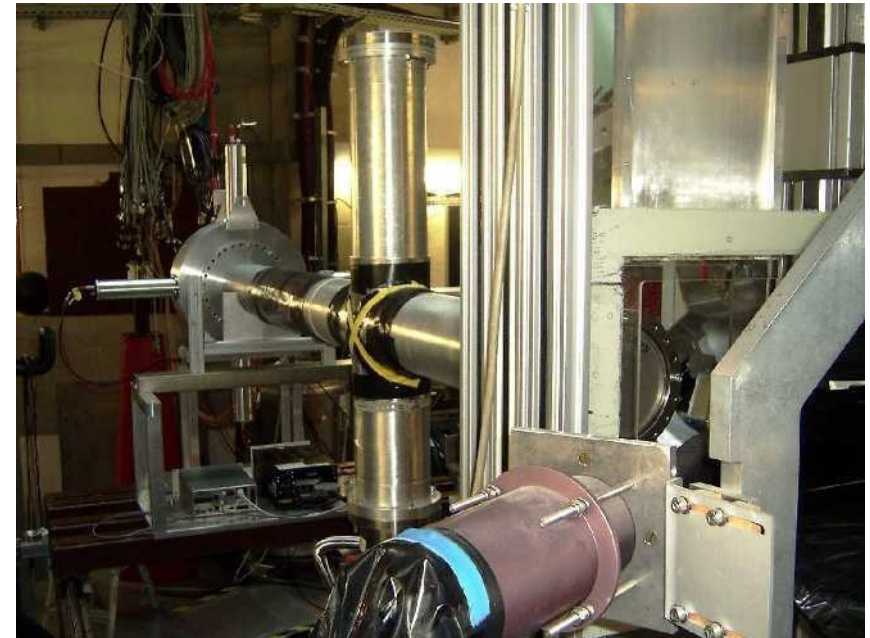


Results from the slowed down beams projects at GSI

P. Boutachkov
GSI

- Physics objectives
- Proposed solution
- Test experiments

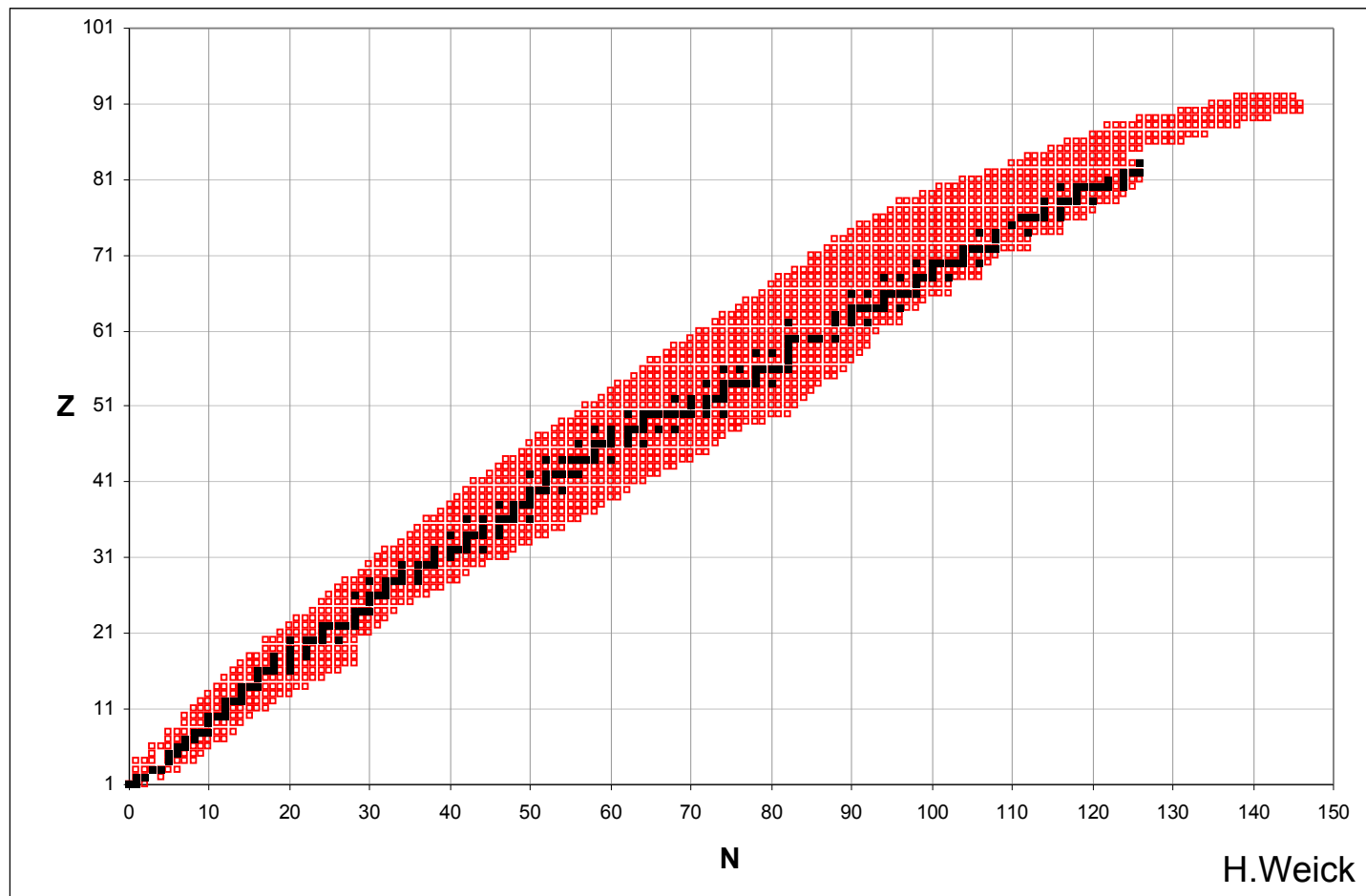


Test setup for slowed down beams at FRS

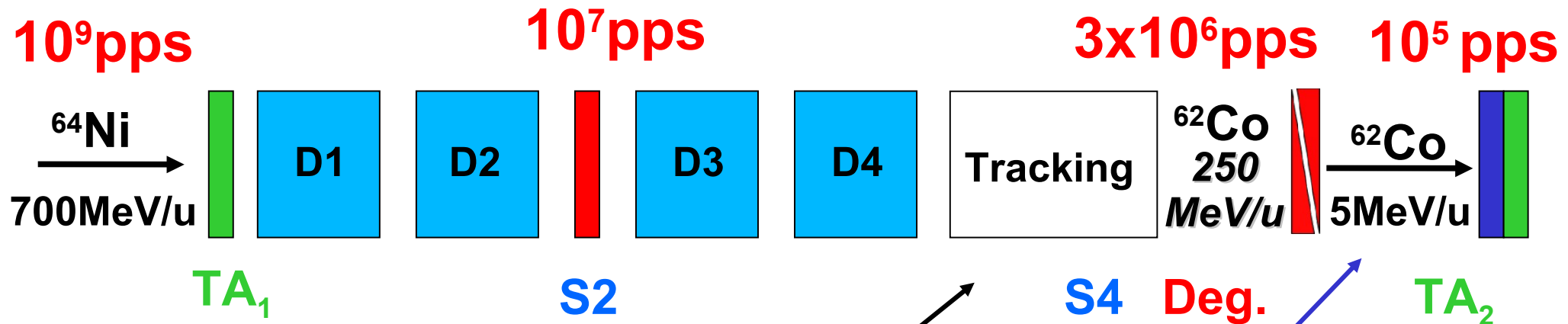
Objective of the slowed down beams projects at GSI

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

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



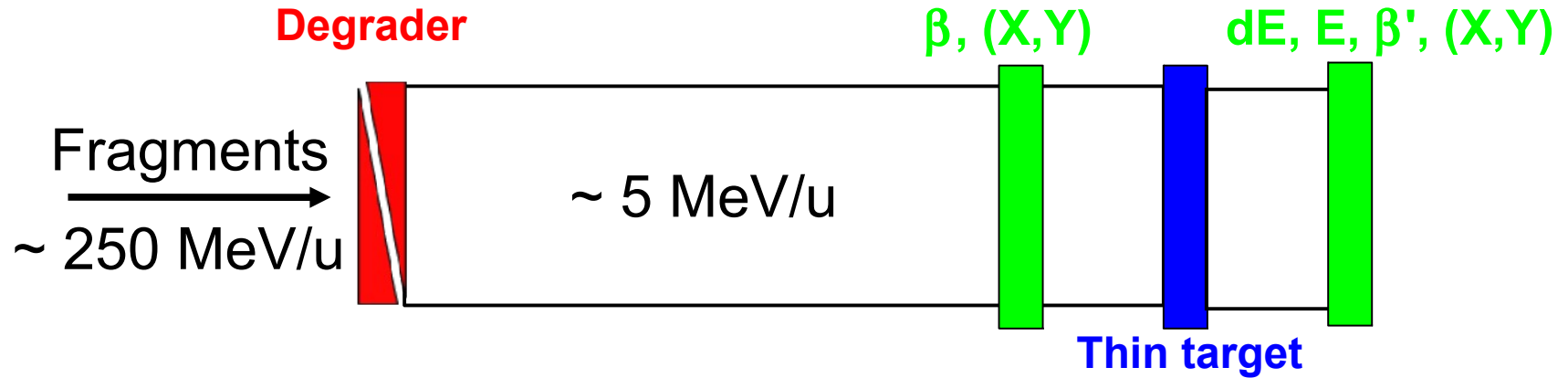
Slowed down beams projects and FRS



Track the trajectory of each particle before slowing down

- Track the trajectory of each particle after slowing down
- Identify the energy of each particle before the secondary target

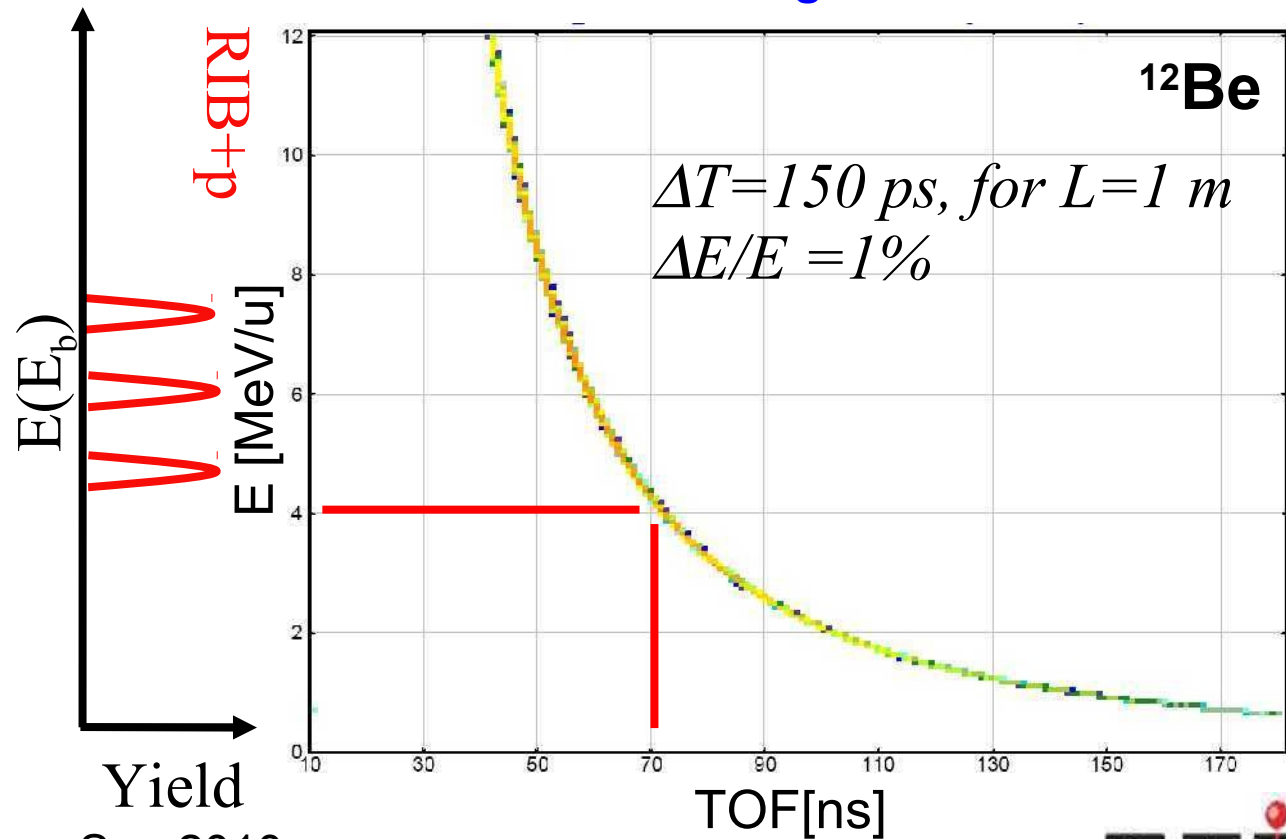
Simple binary reactions performed with White Beam



- Energy straggling
- Angular straggling

Event-by-event tracking

- Contaminants from reactions into the degrader

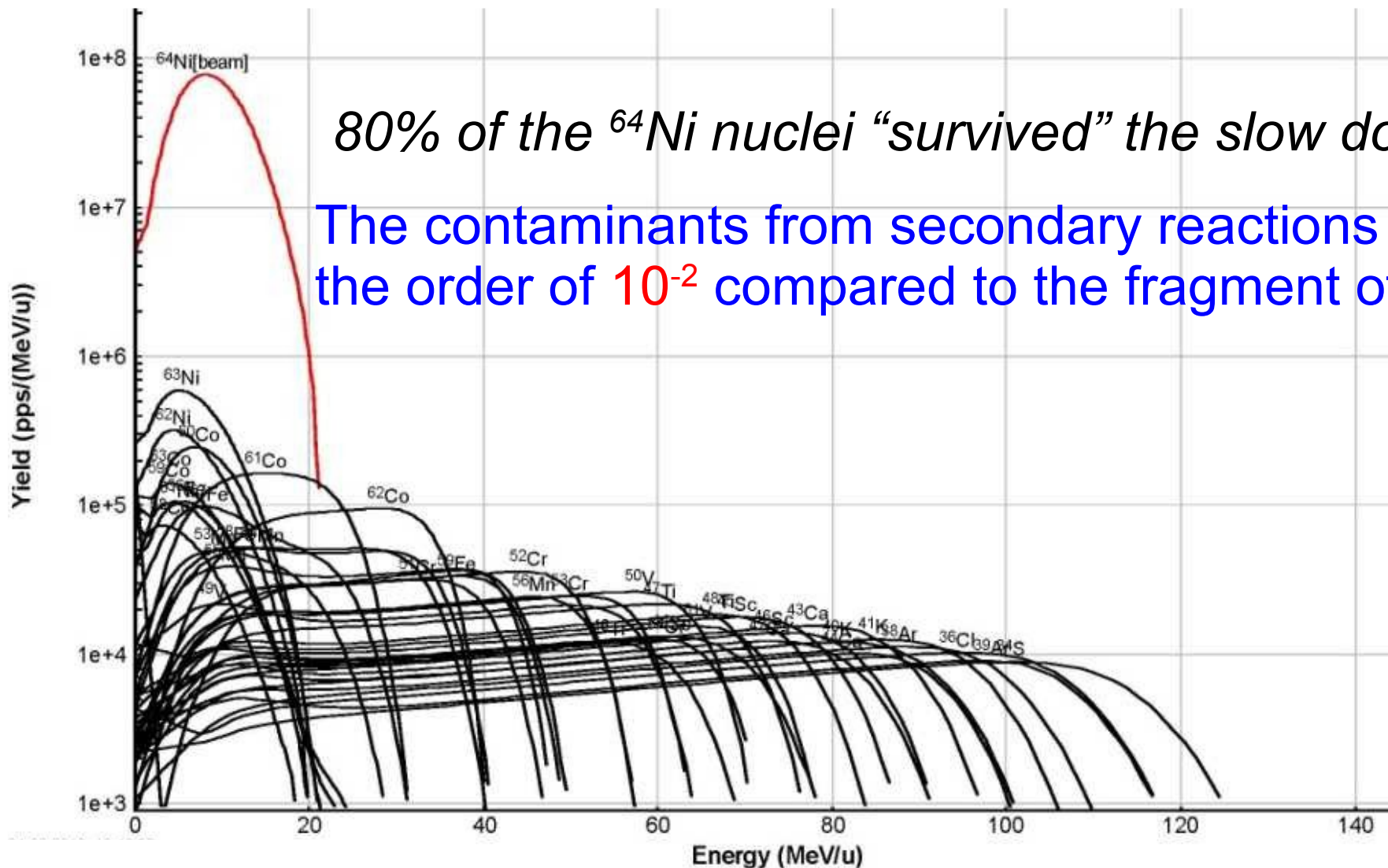


Sep 2010

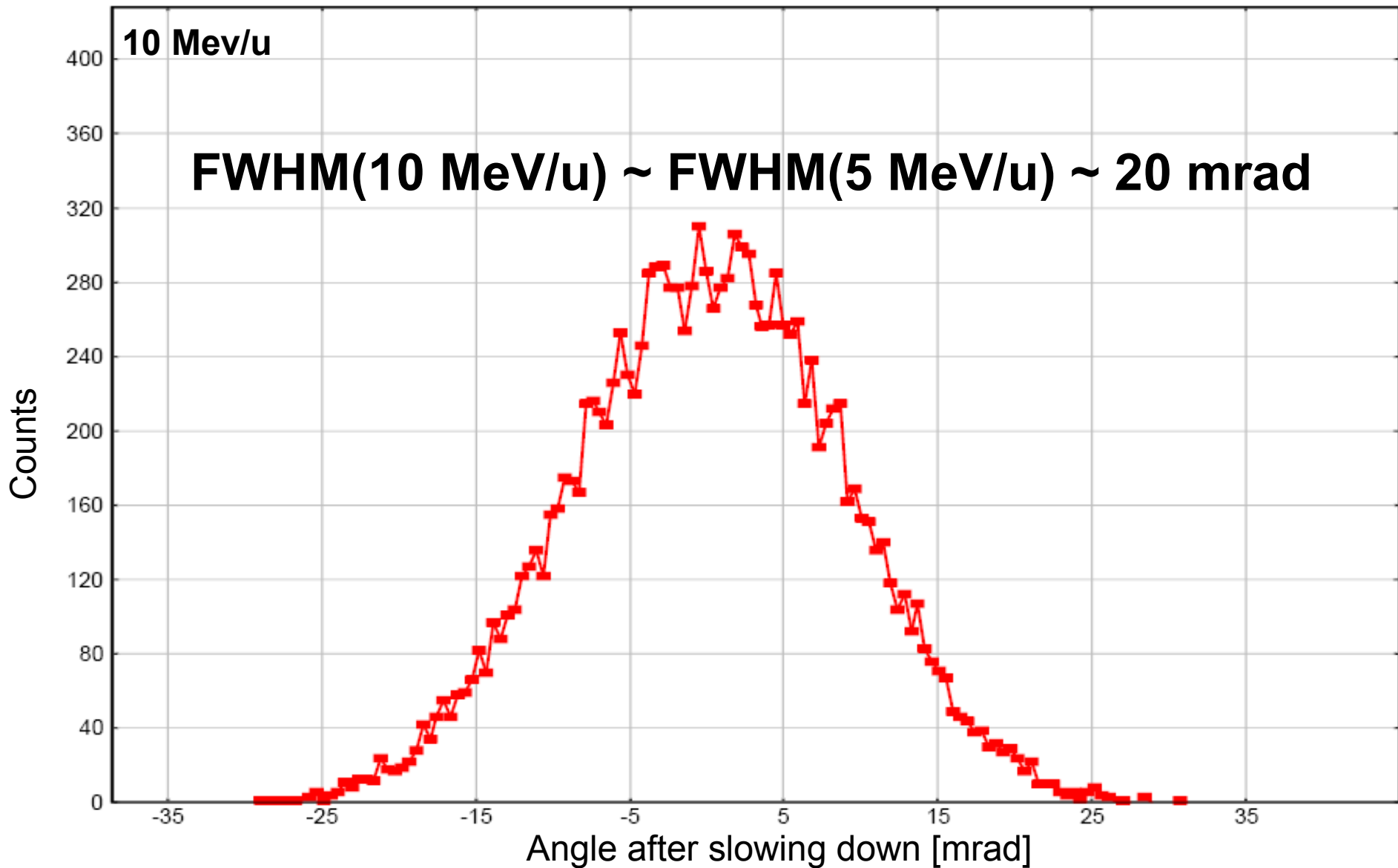
Contaminants from reactions into the degrader

80% of the ^{64}Ni nuclei “survived” the slow down

The contaminants from secondary reactions are of the order of 10^{-2} compared to the fragment of interest



Angular straggling



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

Estimated upper limit for the Doppler shift due to energy+angular straggling

$$E=10 \text{ MeV/u } L=1.5 \text{ m}$$

- ❖ Scintillator, 100 micron

$$dE_{\gamma} / E_{\gamma} = 0.02$$

- ❖ Diamond, 40 micron, no energy loss information

$$dE_{\gamma} / E_{\gamma} = 0.05$$

- ❖ Secondary Electron Detectors, 150 ps time resolution

$$dE_{\gamma} / E_{\gamma} = 0.0075$$

- ❖ Si, 40 micron, 100ps time resolution, energy loss added back

$$dE_{\gamma} / E_{\gamma} = 0.007$$

MCP

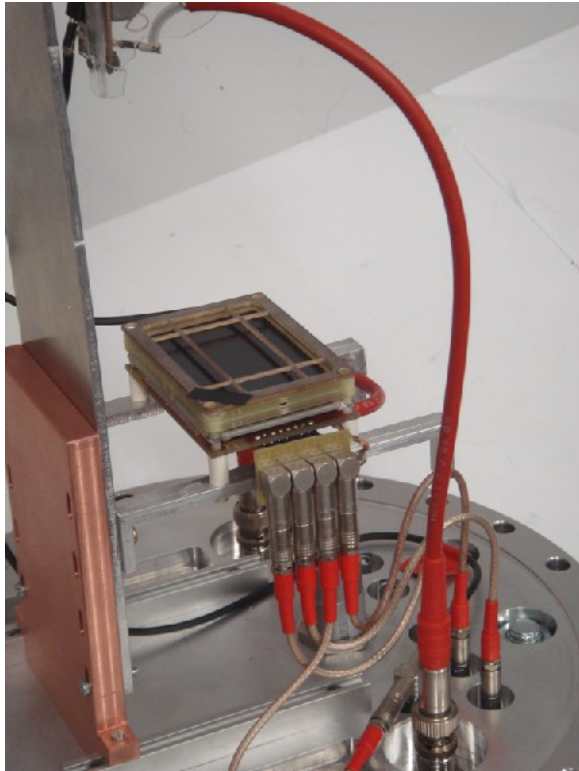
Electronics:

Phillips 715 CFD:

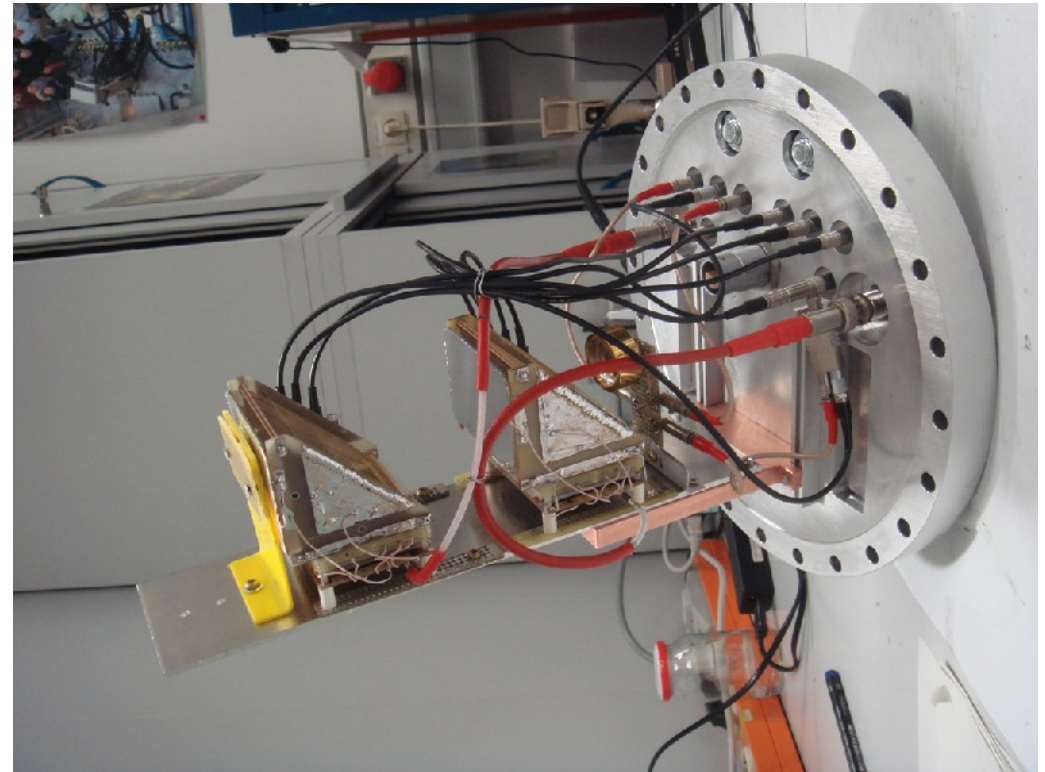
walk +/- 75 ps

CAEN V1290A TDC,

Resolution 25 ps



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



4 x 6 cm, 1.5 μm Mylar foil

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

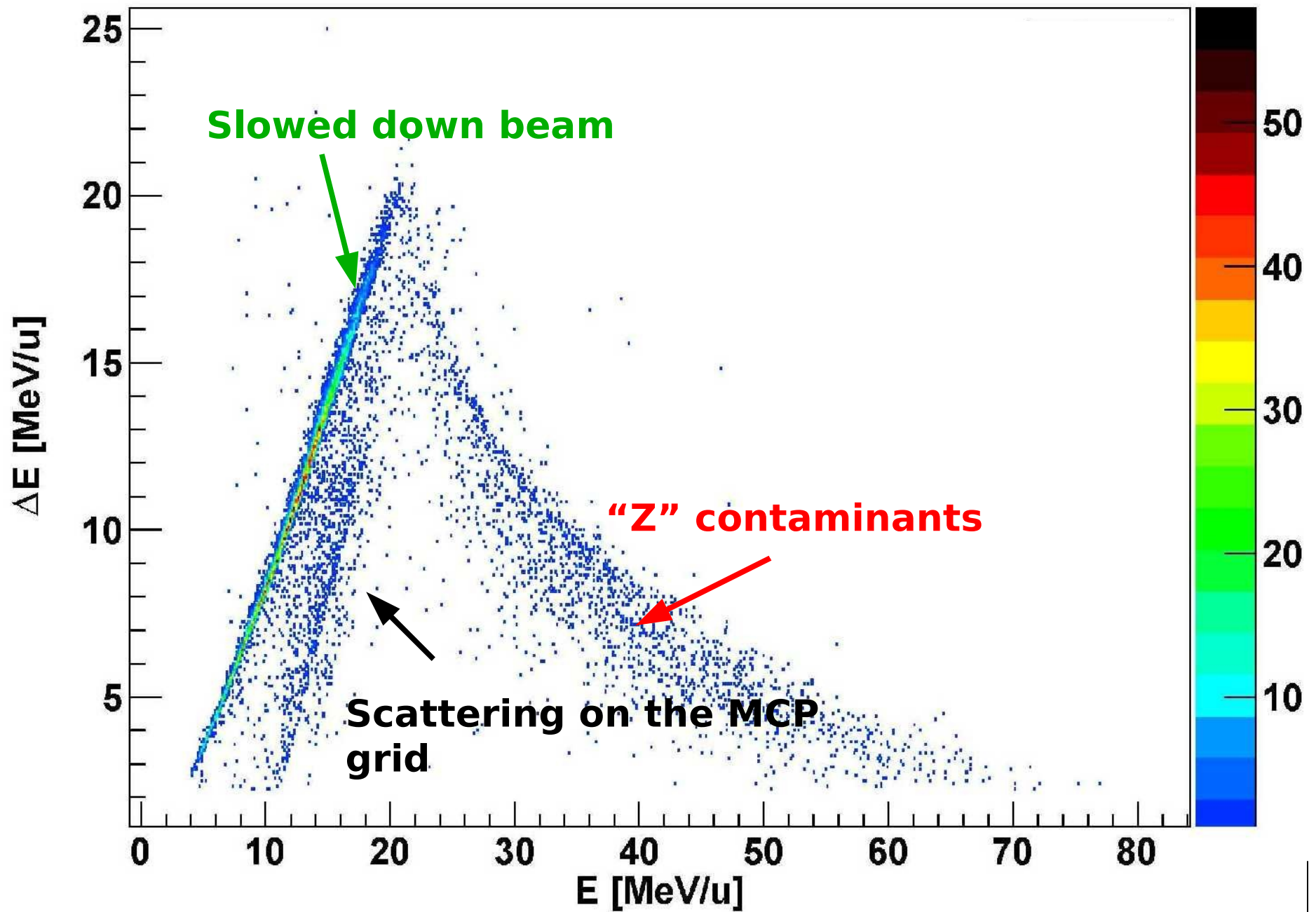
$\Delta X_{\alpha}(\text{FWHM}) \sim 3 \text{ mm}$

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

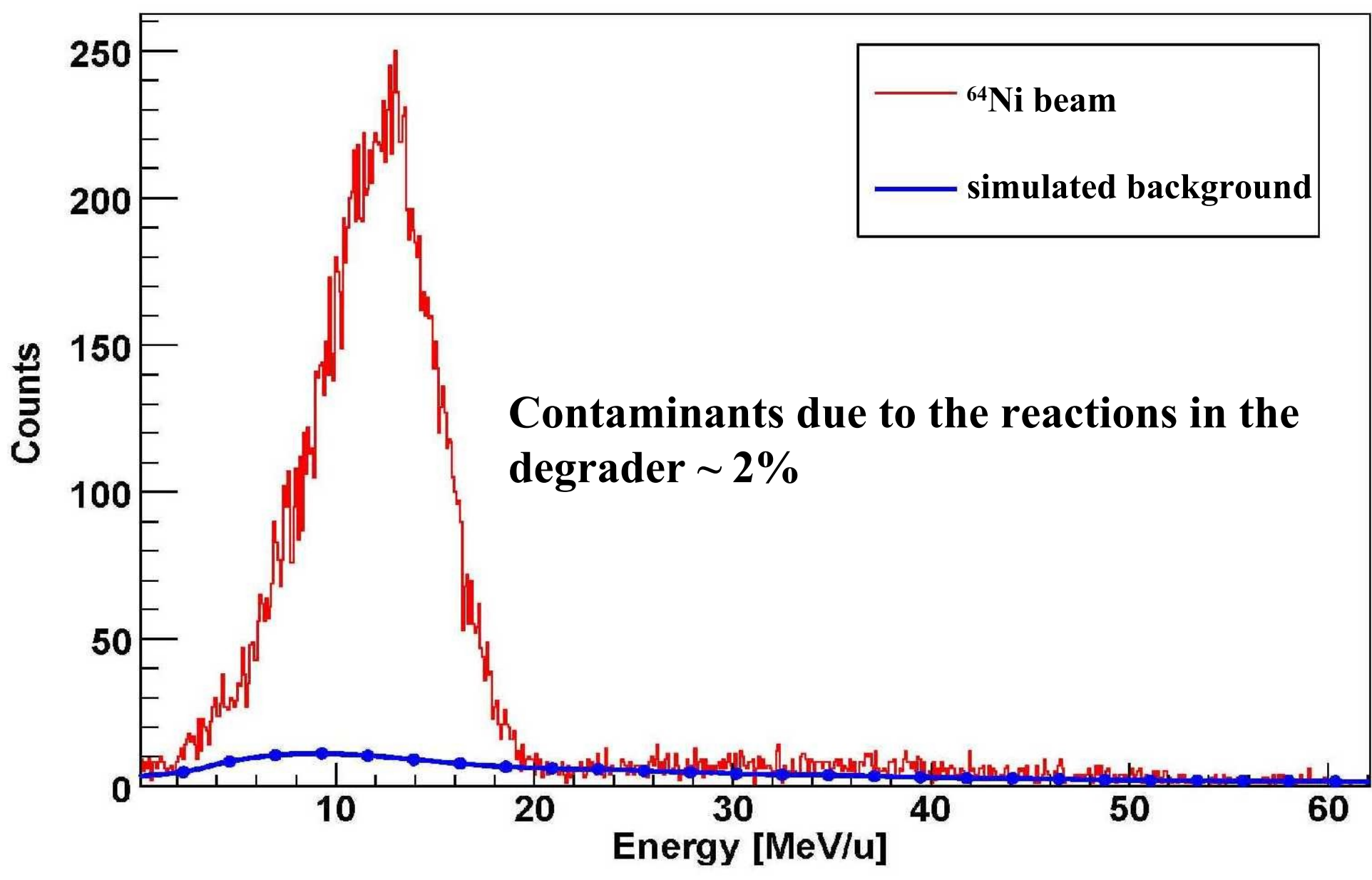
$\epsilon_{\alpha} \sim 85 \%$

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

^{64}Ni



Energy after slowing down



Conclusions

Slowed beam down experiment can be performed at FRS

- 80 % of the beam particles survived slowing down.
- Energy spread after slowing down to 10 MeV/u is 8 MeV/u.
The predicted energy spread is 9 MeV/u.
- Contaminants due to the reactions in the degrader are of the order of 2%

Collaboration

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