Simulations of the high energy beam transport section (HEBT) at FRANZ

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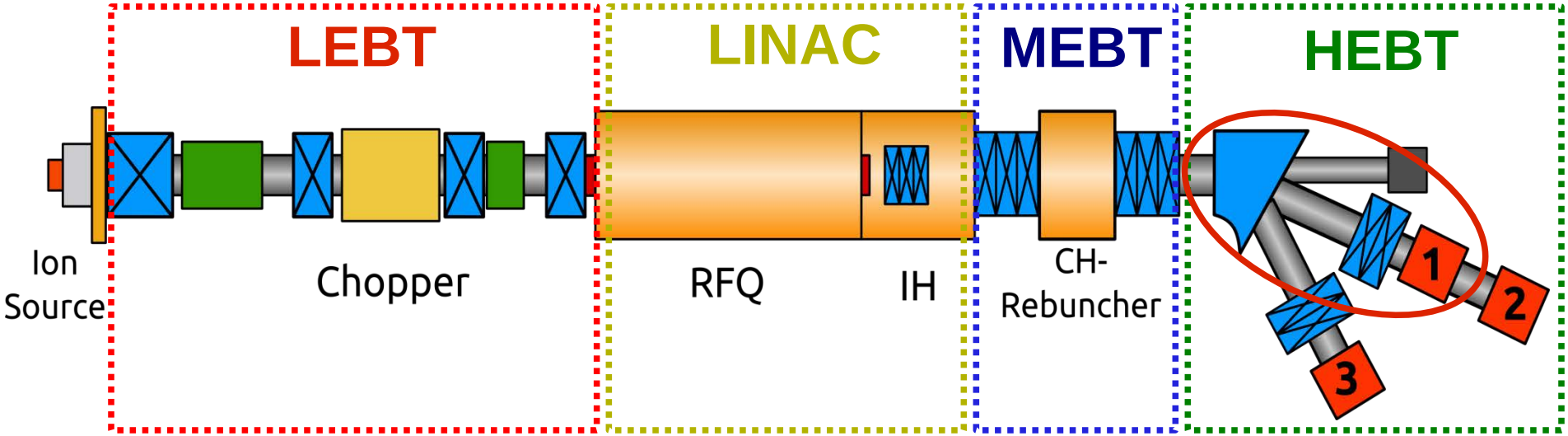
GOETHE UNIVERSITÄT FRANKFURT AM MAIN

FRANZ

Frankfurter **N**eutronenquelle am Stern-Gerlach-**Z**entrum

Sections:



2 mA proton
→ 10^7 n / s / cm^2

In-beam-beamline:
Dipole magnet
Quadrupole doublet
1: Neutron-production target

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2: Target for n- and p-induced reactions
3: Activation target

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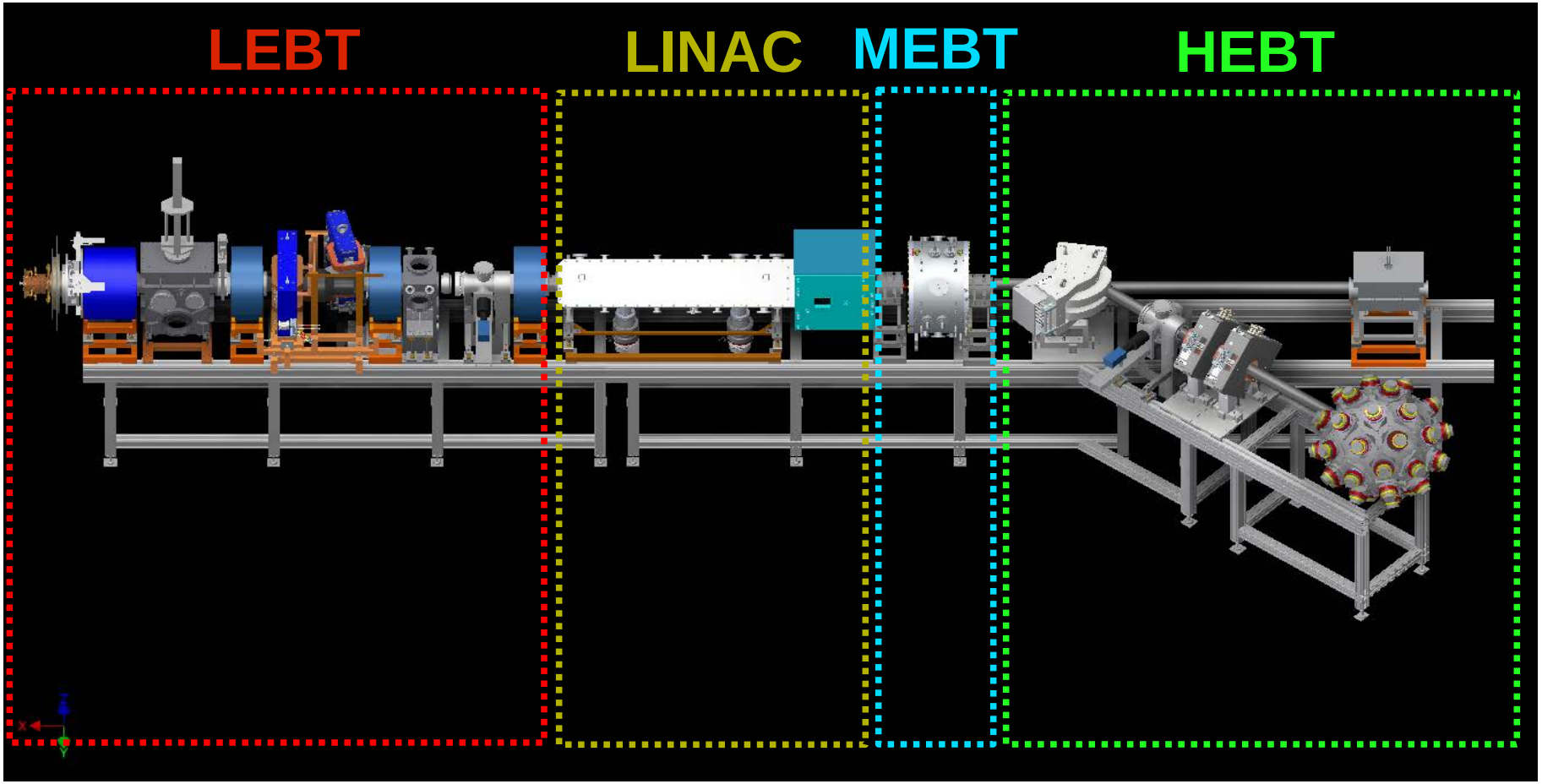


Opportunities at FRANZ

- Highest proton beam current at an energy of 2 MeV worldwide
- Studying production of p-nuclei via proton-induced reactions
- Measuring neutron capture reactions for neutron induced synthesis

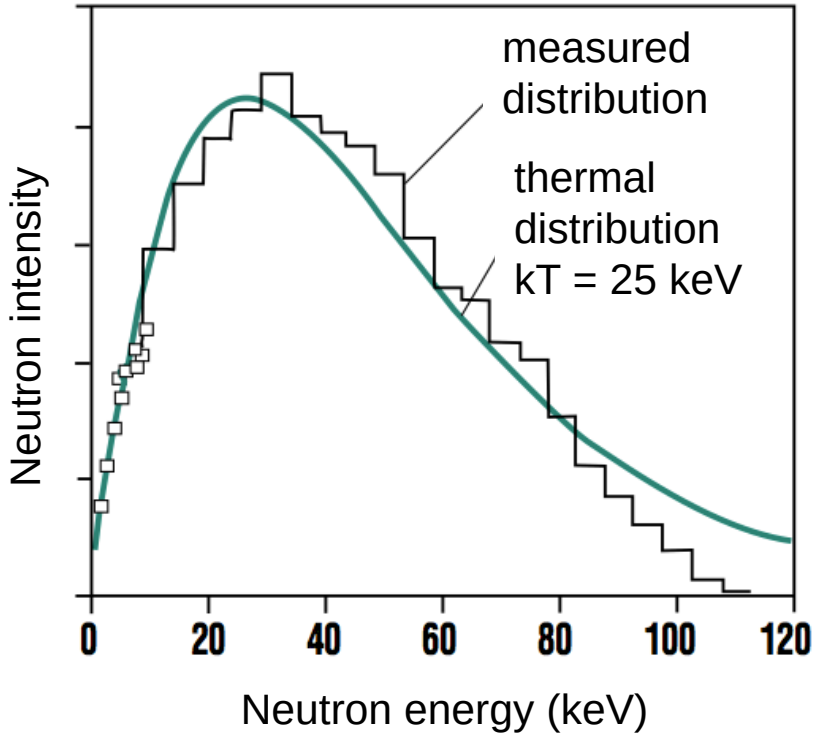
Neutron production

Reaction: $^{7}Li + p \rightarrow {}^{7}Be + n$

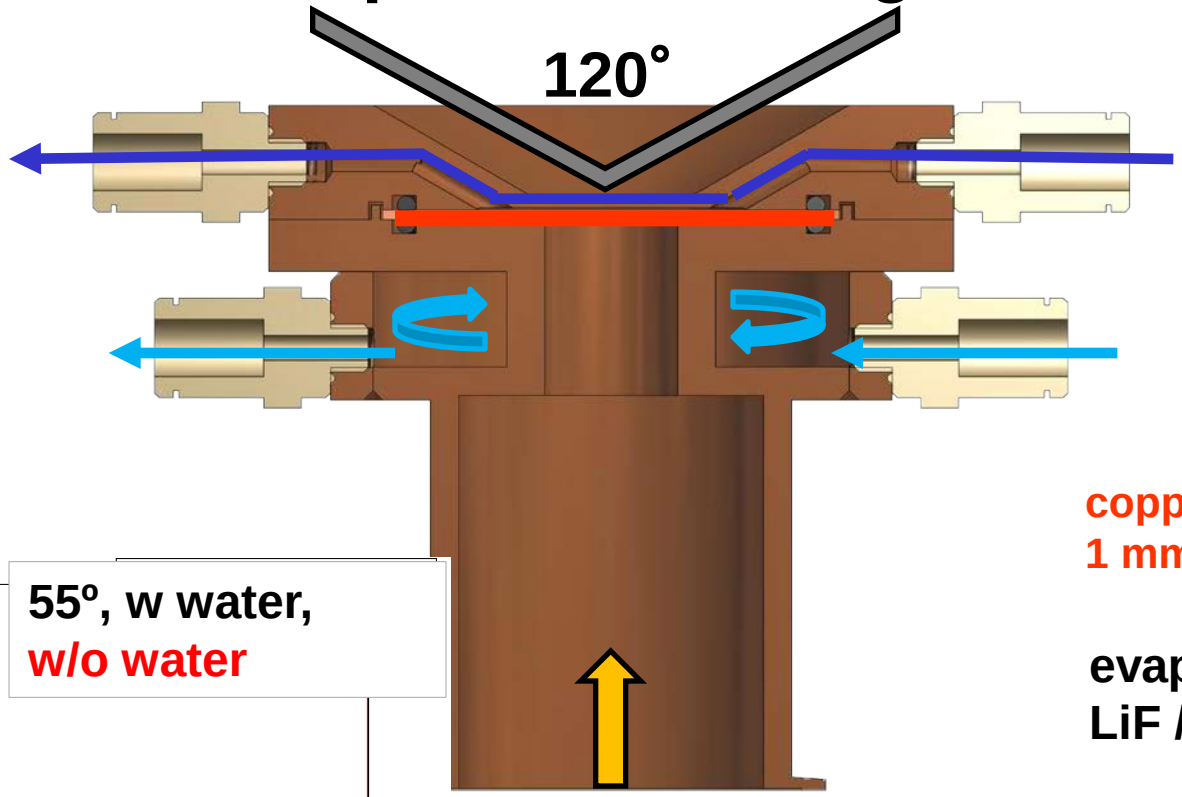
For E_p = 1.912 MeV:

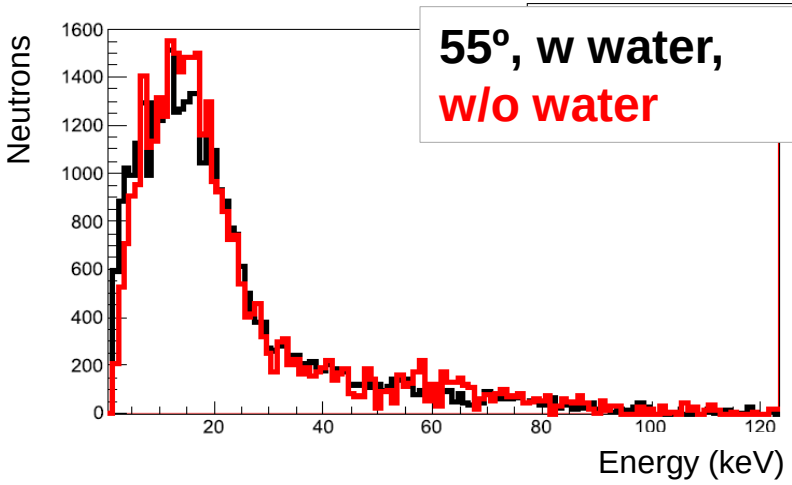
- thermal neutron distribution in the right energy range
- neutrons kinematically collimated

$\longrightarrow$ convenient for the s-process



Neutron production target



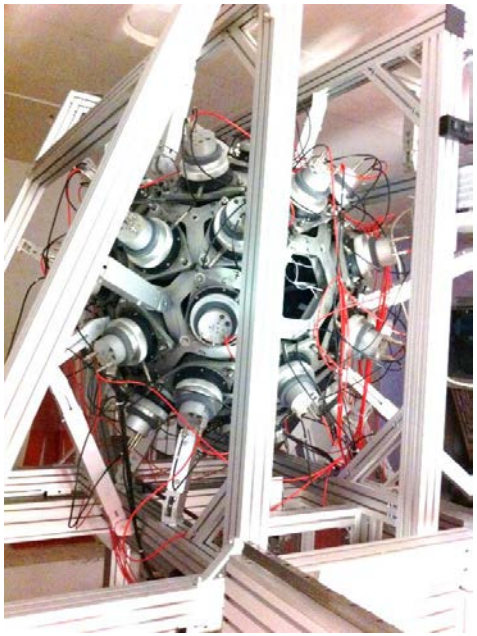


Photon calorimeter and DAQ

41 BaF_2 crystals

≈90% total efficiency

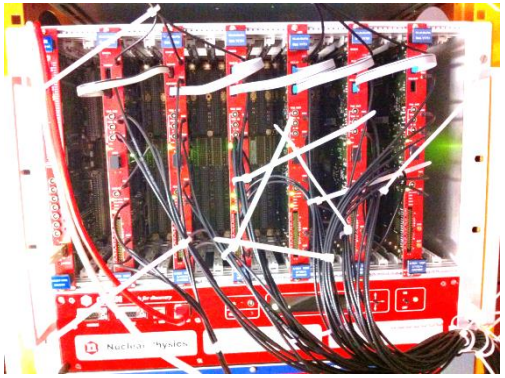
≈50% FE peak efficiency



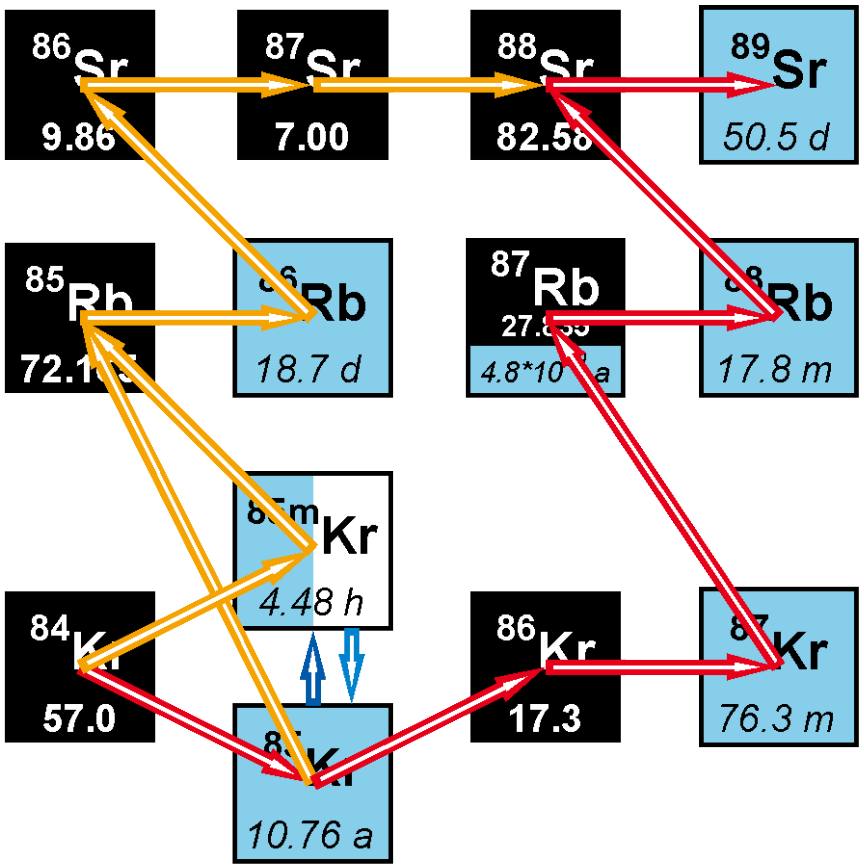
digital DAQ system:

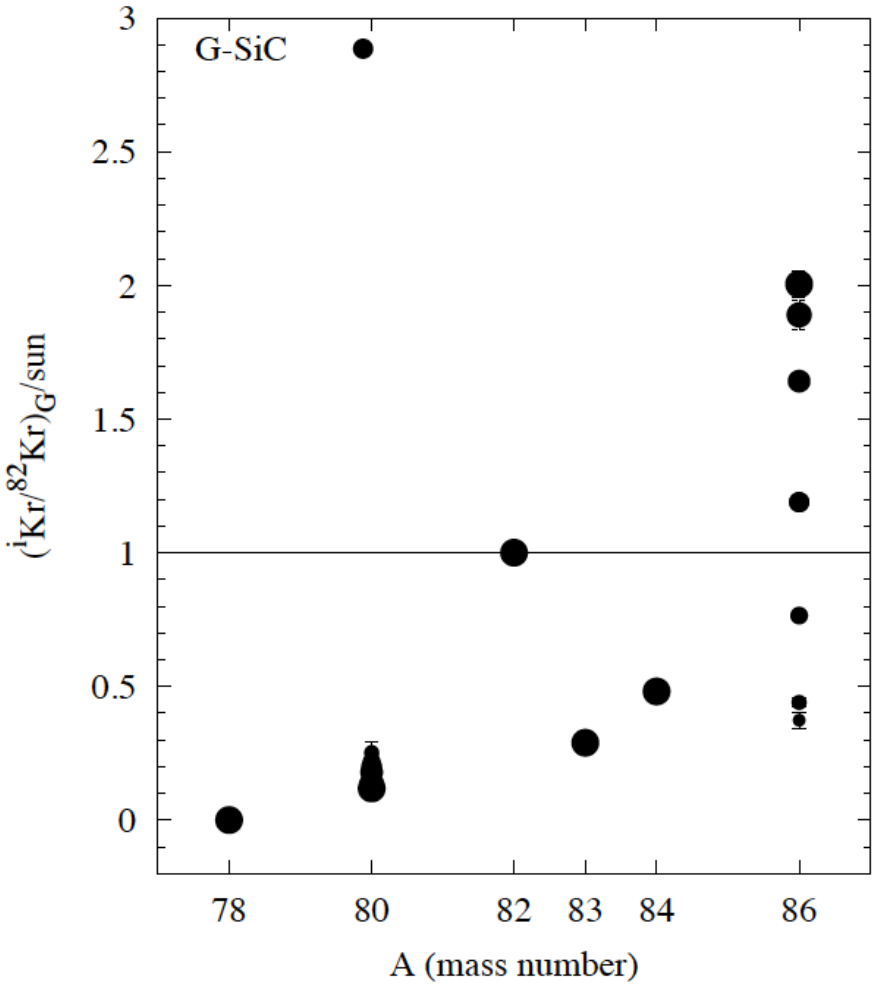
6x CAEN V1751 digitizer:

8 channels, 10 bit, 1 GS/s



The s-process branching at ^{85}Kr



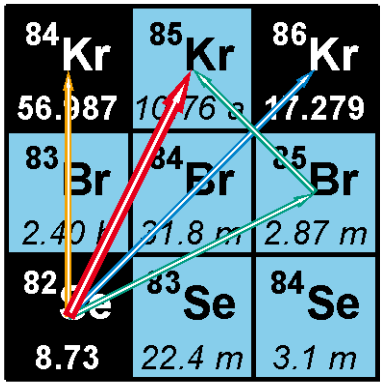


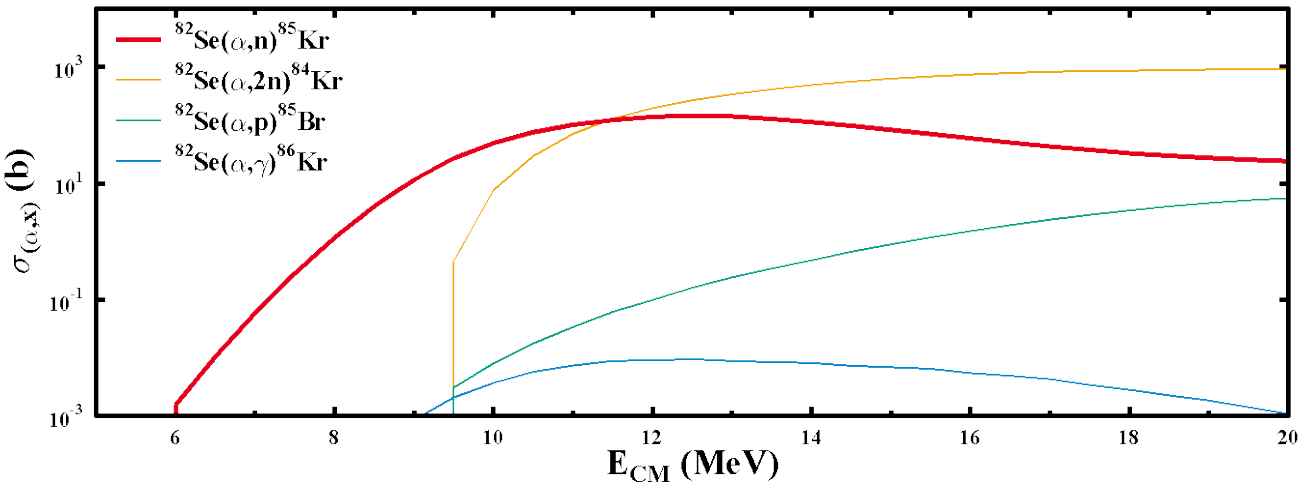
M. Pignatari et al., Memorie della Società Astronomica Italiana **77** (2006) 897

The s-process branching at ^{85}Kr

large spread of ^{82}Kr/^{86}Kr observed in SiC grains:
→ determine $t_{1/2}$(T) for ^{85}Kr

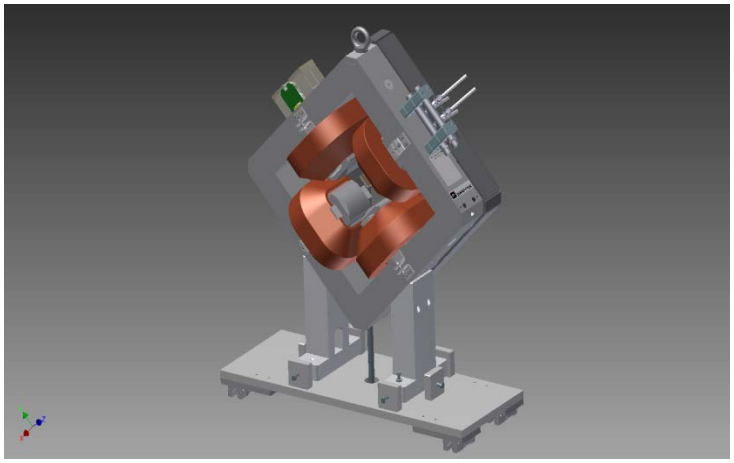
absolute amount of ^{86}Kr:
→ measure ^{85}Kr(n, γ)
Production of sample of ^{85}Kr



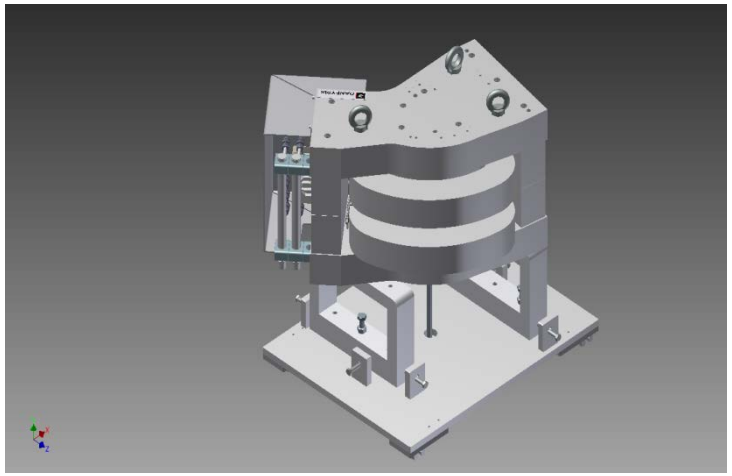


Simulation framework

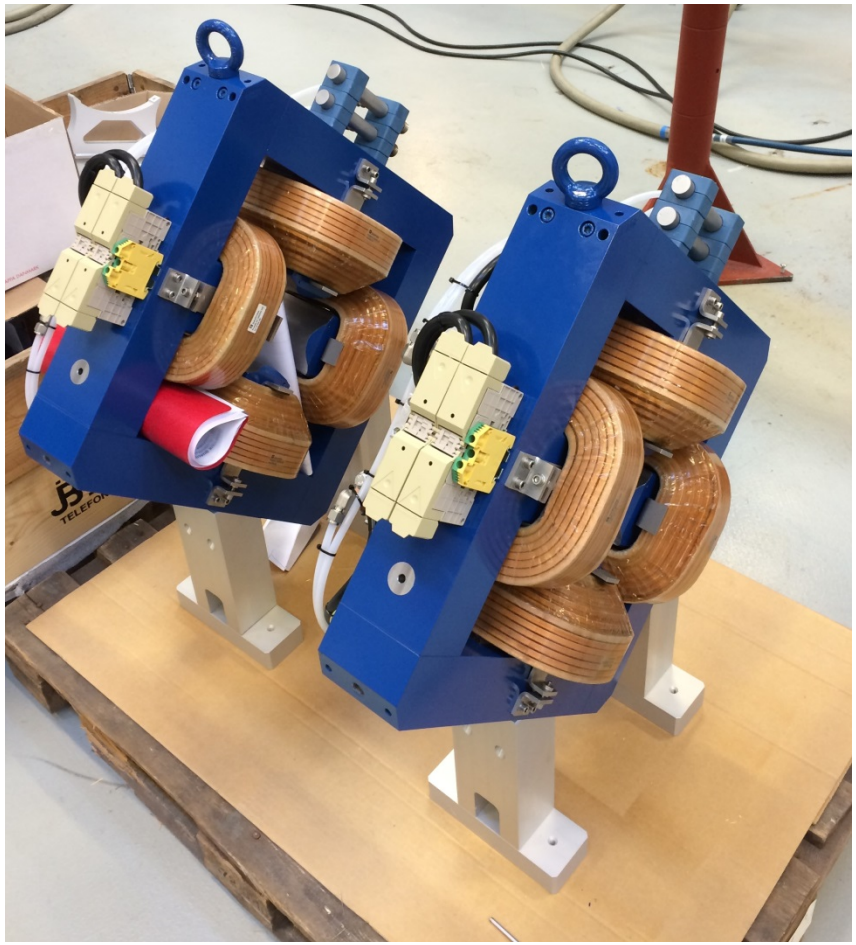
- Beam dynamics simulations with hard edge models performed for magnetic parameters



- 3D CAD Models of magnets developed



Simulation framework



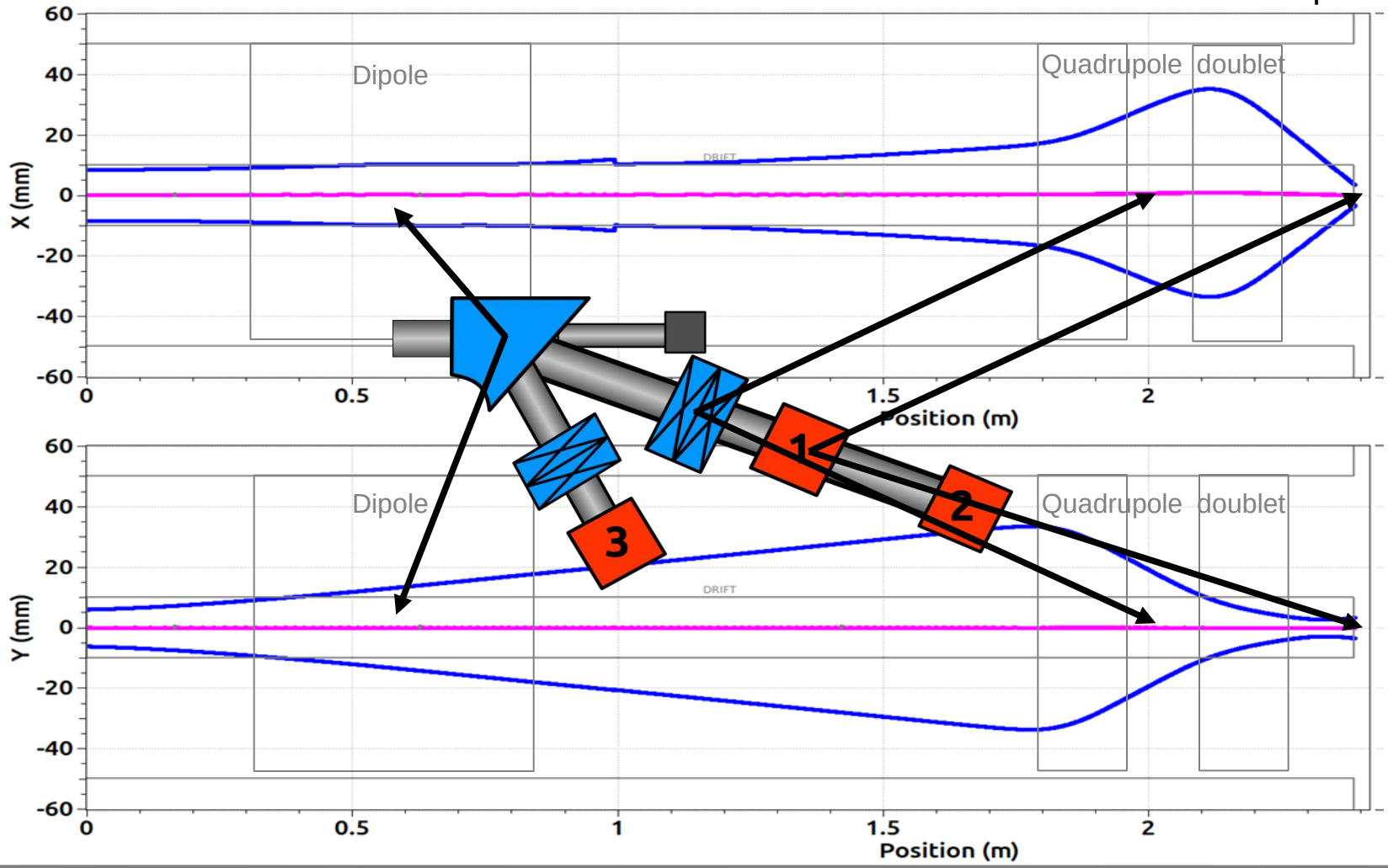
- 3D magnetic field of models simulated via CST EM Studio
- Extracted fields used for more precise beam dynamics simulations
- Magnets in production at Danfysik

Beam dynamics simulation

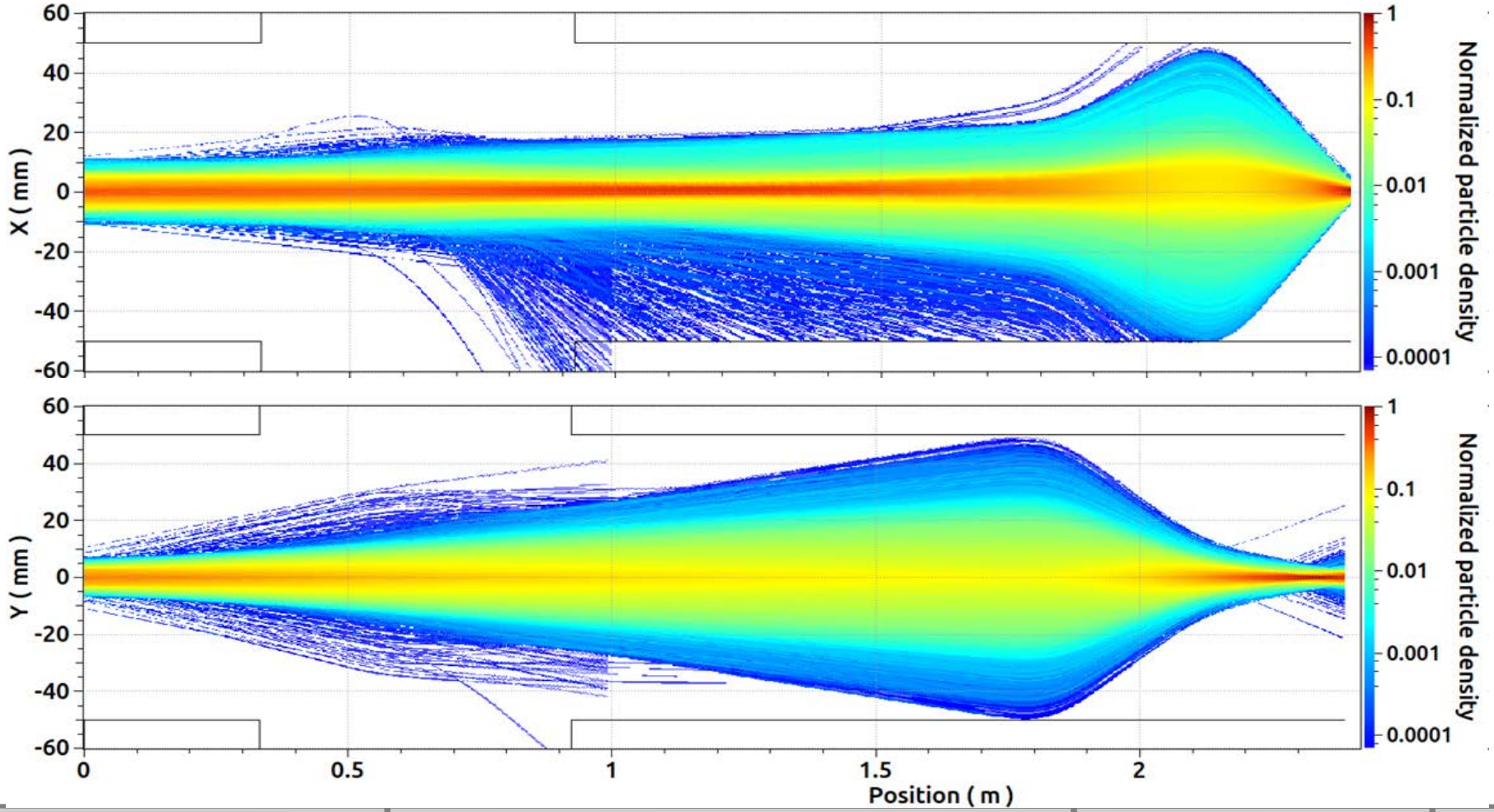
- Code used: TraceWin
- Multi-particle simulations in space charge regime
- Input distribution from previous MEBT simulations
- Number of particles: ~100,000
- Beam current: 2 mA
- Energy: 2.0 MeV
- Bunch Frequency: 175 MHz

Envelopes

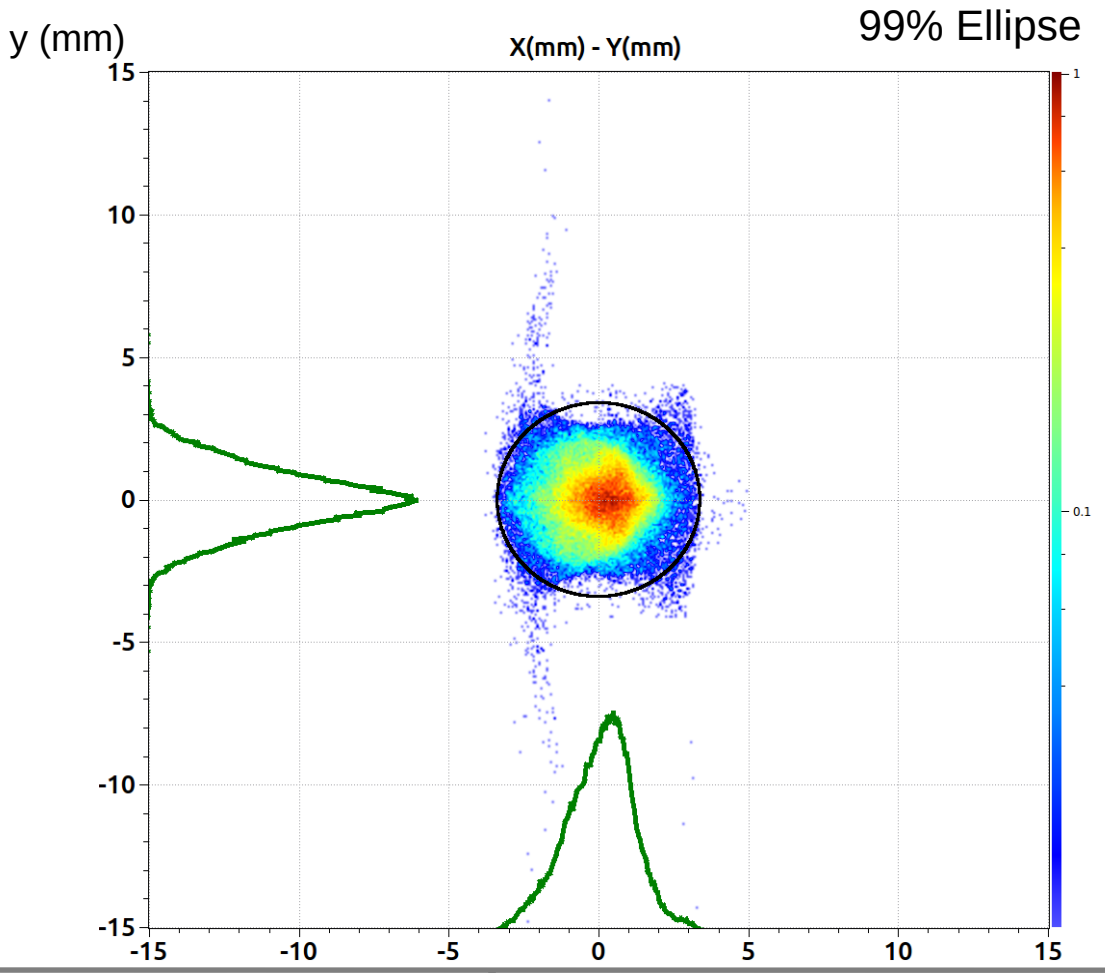
99% Envelopes



Beam density distribution



Output distribution



- Nearly circular beam spot
- Homogeneous particle distribution
- Beam radius: 3.5 mm

Summary and Outlook

- Beam requirements at the can be reached
- Magnet system can be adjusted to illuminate the target completly
- Construction of magnets is ongoing
- Delivery expected in May 2015
- Next step: setup of beamline