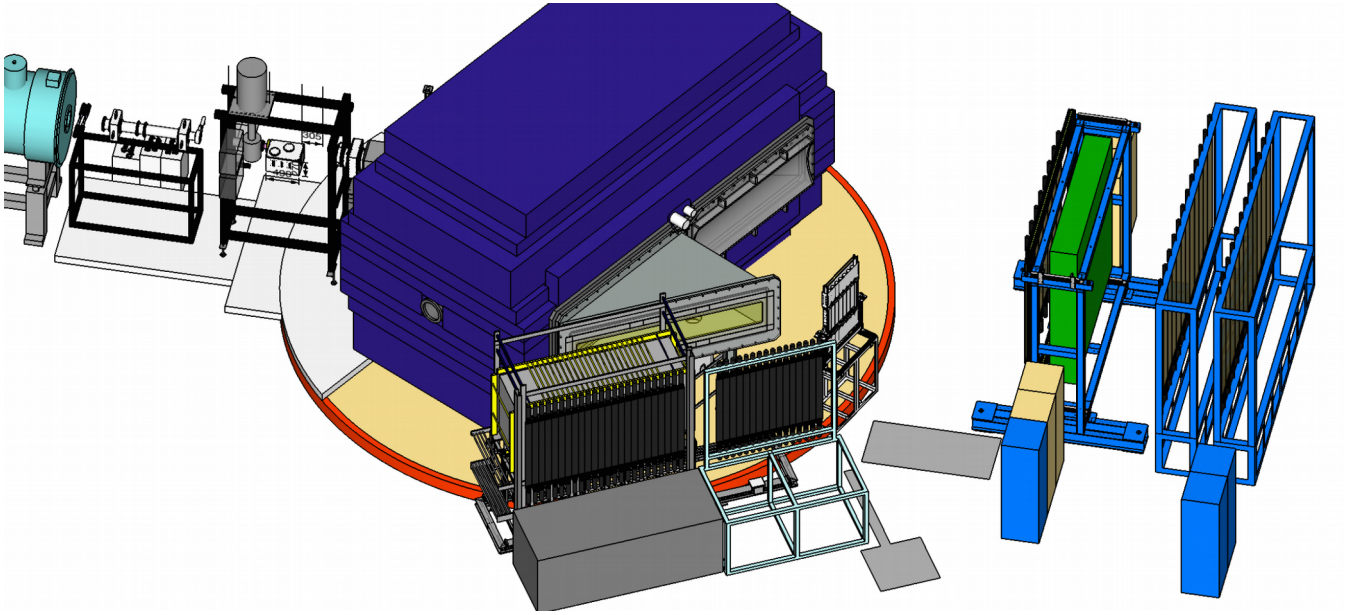
Dipole response of ^{6,8}He and nn correlations

Report A05

TECHNISCHE UNIVERSITÄT DARMSTADT

SFB Workshop, Mainz-Budenheim, 04.07.2018

C. Lehr



Dipole response of ^{6,8}He

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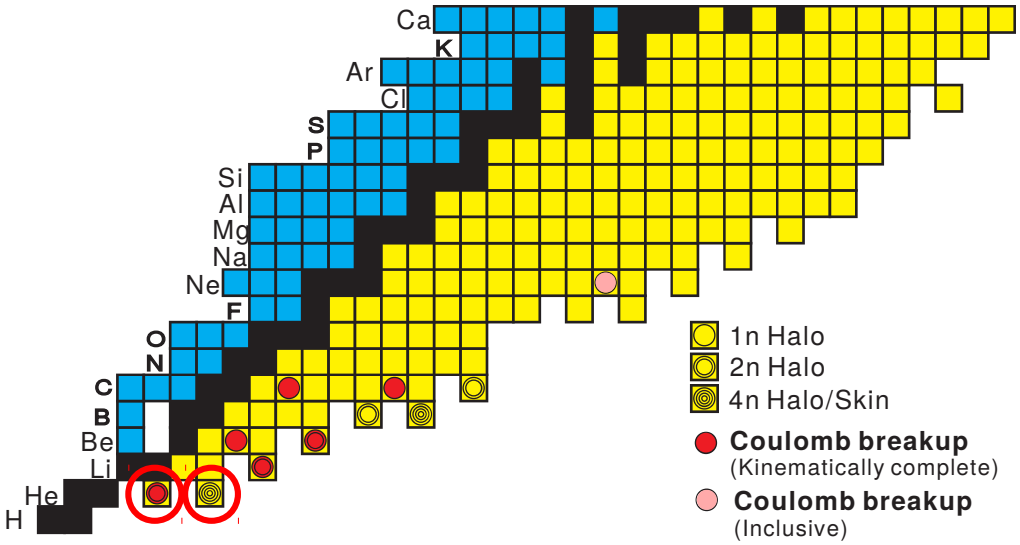
- Enhanced electric dipole response at low excitation energies in halo systems
- Investigate low-energy dipole response of ^{6}He and ^{8}He after Coulomb excitation
- 2- and 4-neutron halo nuclei with alpha plus 2n and 4n structure
- Measure differential cross section via invariant-mass method
- Extract dipole-strength distribution dB(E1)/dE



Picture taken from T. Aumann and T. Nakamura, Phys. Scr. T152 (2013) 014012 (27pp)

Dipole response of ^{6,8}He

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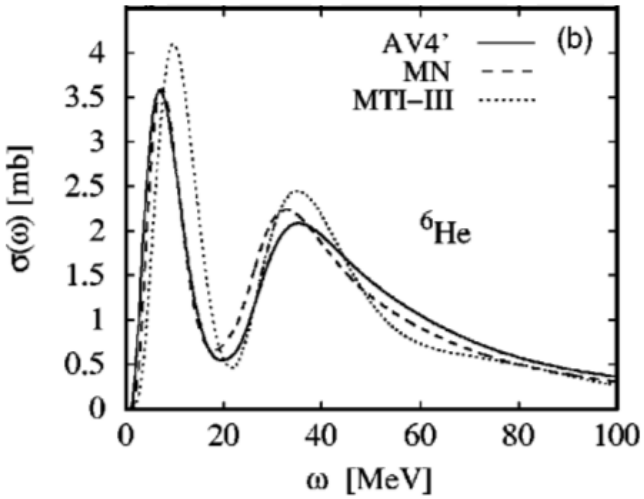
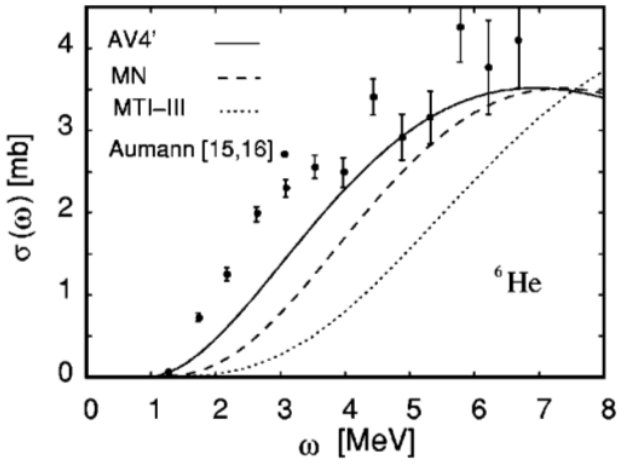
- Decay after electric dipole excitation via two- and four-neutron emission
- Challenging: 4n channel: identification and extraction of individual momentum
- ^{6}He: experimental data only up to 7 MeV (Aumann et al., Phys. Rev. C 59 (1999) 1252)
- ^{8}He: only 2n channel measured by Meister et al., Nucl. Phys. A 700 (2002) 3
- Theory: Sonia Bacca, Ab initio NCSM R.Roth, Halo-EFT H.-W. Hammer
- Good statistics needed up to 15 MeV →only possible at RIKEN with NeuLAND + NEBULA





Pictures taken from S. Bacca et al., Phys. Rev. C 69 (2004) 057001

SAMURAI37 Experiment

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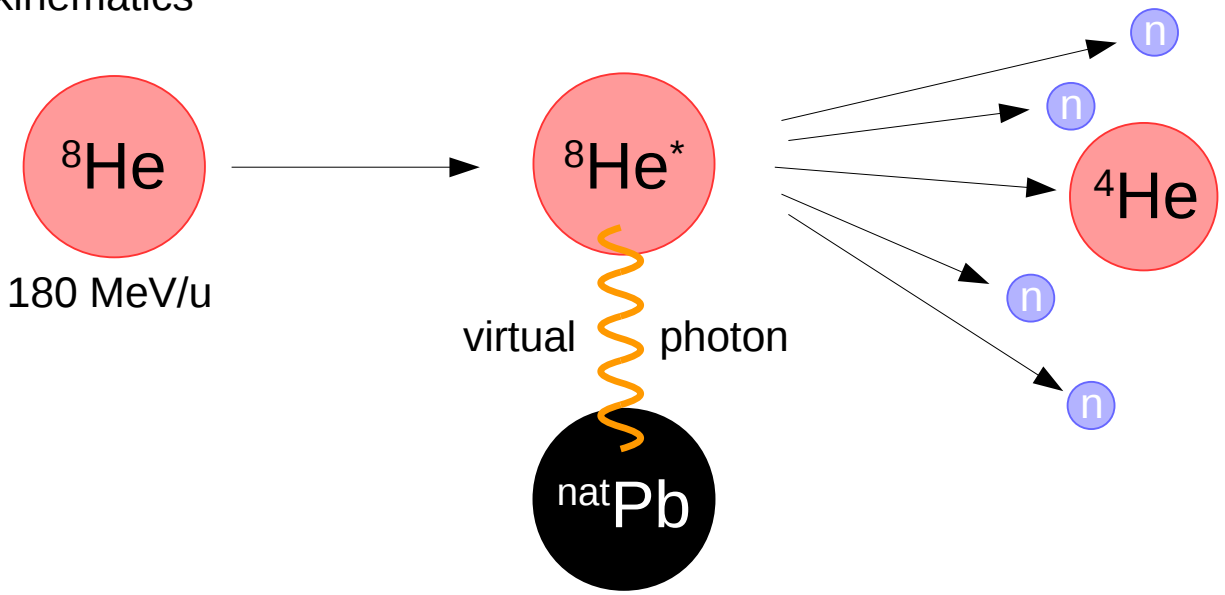
- Experiment performed July 2017 at SAMURAI at RIKEN
- Study dipole response by measuring the multi-neutron decay of ^{6}He and ^{8}He after heavy-ion induced electromagnetic excitation in complete kinematics
- Targets used: Pb, Sn, Ti, C, CH_2
- Inverse kinematics



The SAMURAI setup

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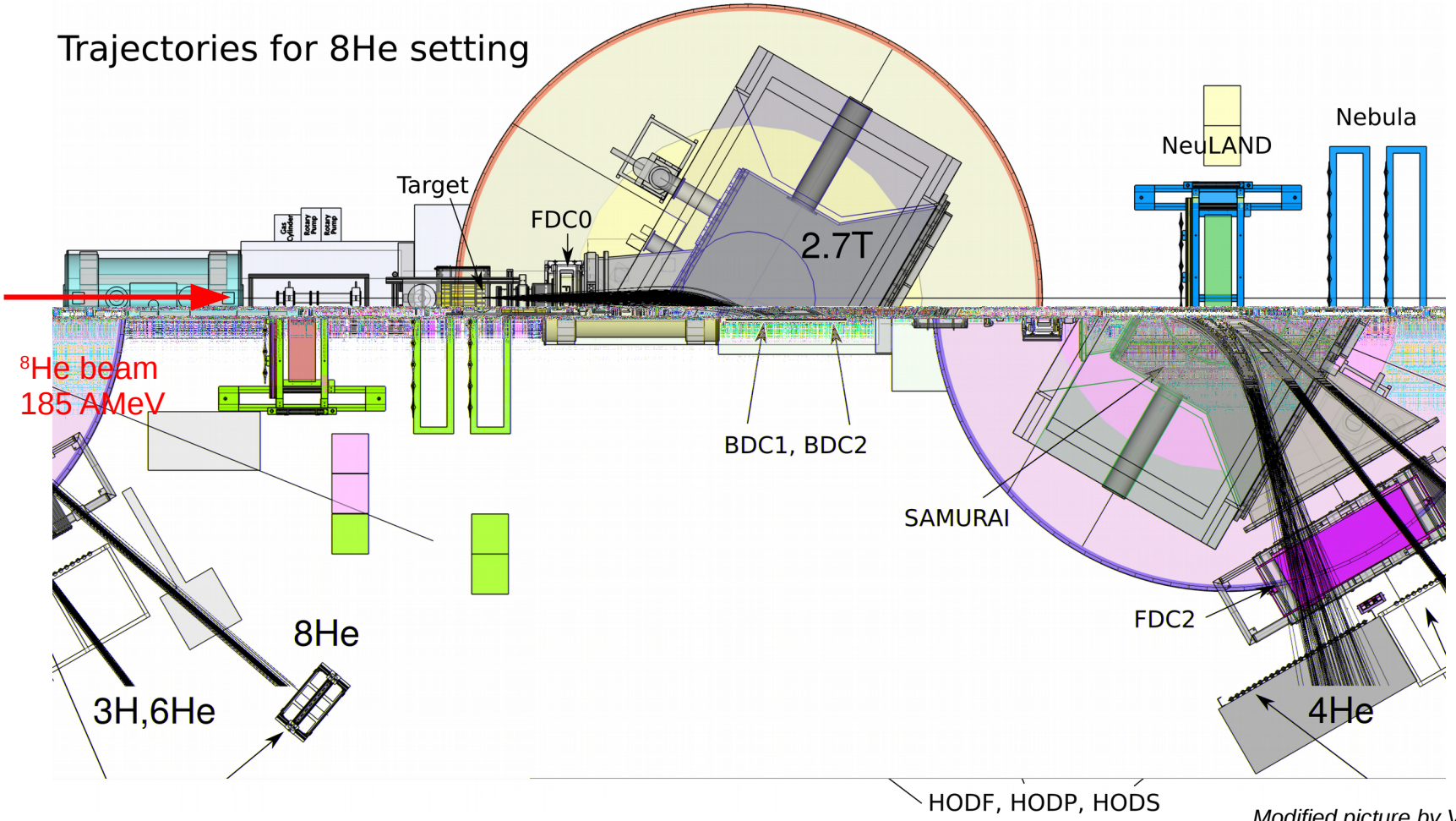

Modified picture by V. Panin

Status

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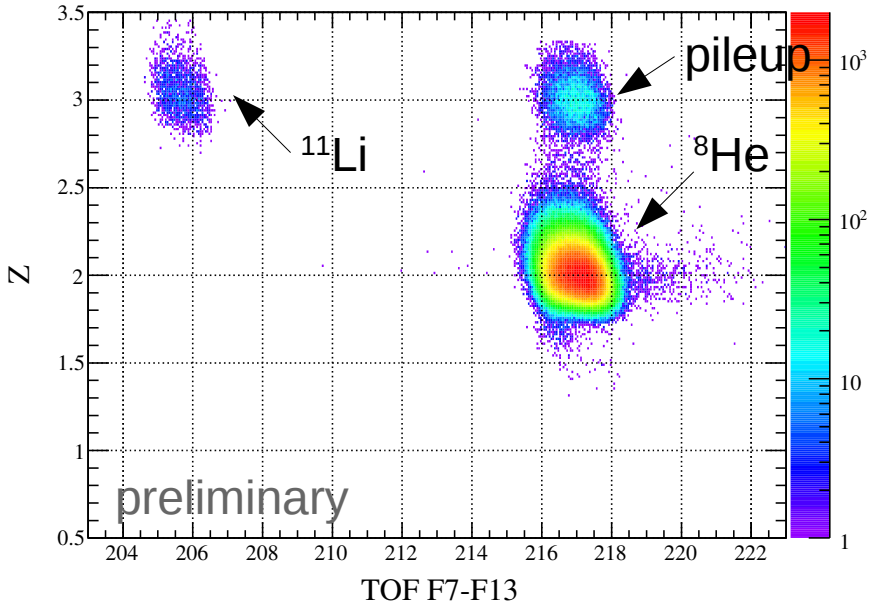
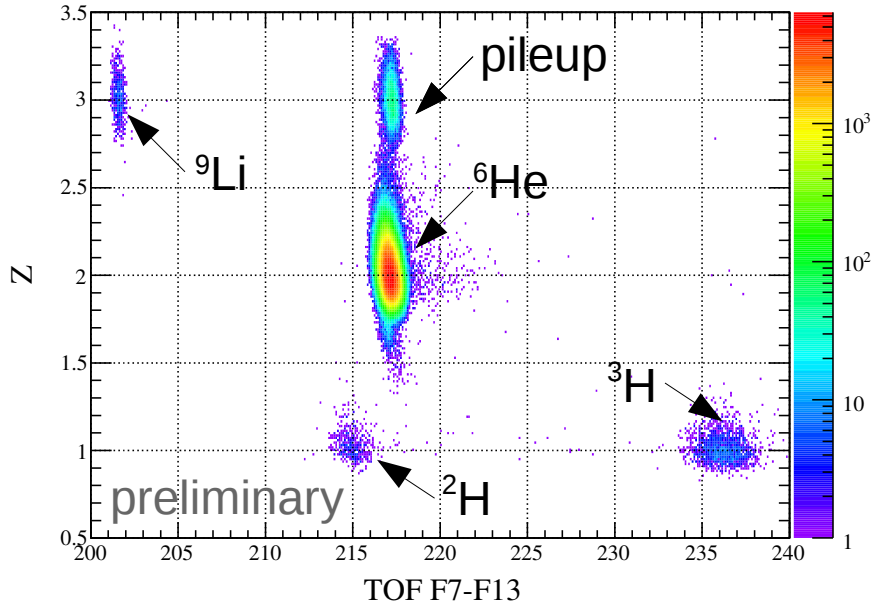
Incoming beam calibration:

- Incoming beam detectors calibrated: ToF, β, ΔE, beam energy
- Incoming ions identified: via Z and ToF

^{8}He setting



^{6}He setting



Status

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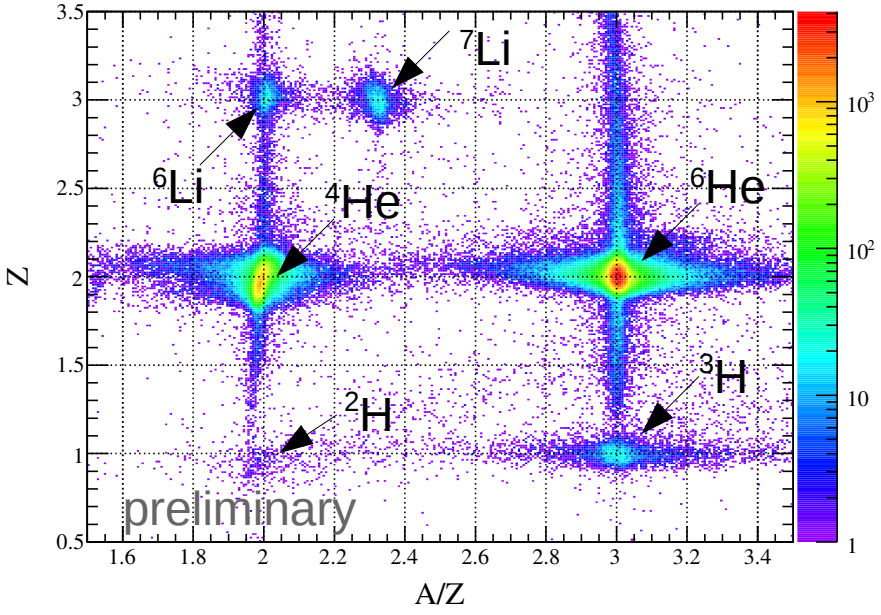
Fragment calibration:

- Fragment Detectors calibrated: ToF, β, Bρ, p
- Reaction fragments identified: via Z and AoZ

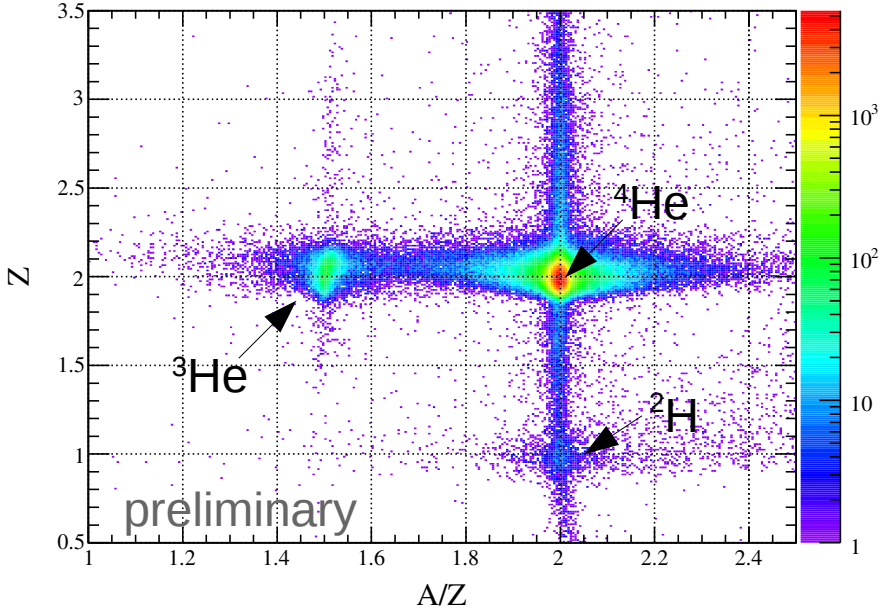
ToF – ΔE – Bρ method

$$B\rho \propto \frac{A}{Z}\beta\gamma$$

^{8}He setting



^{6}He setting



Next steps

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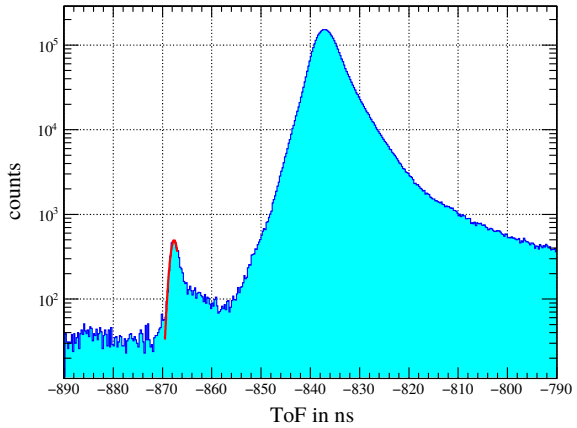
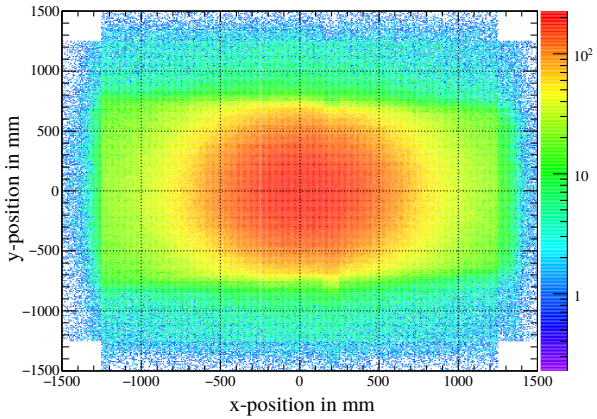
Neutron analysis

- Calibration of the Neutron detectors NeuLAND and NEBULA
- Need to calibrate time, charge, hit position
- ToF calibration with prompt gammas from the target
- Neutron reconstruction:
  identify up to 4 neutrons and reconstruct their momentum
- Cross talk analysis

T. Nakamura, Y. Kondo, NIM B 376 (2016) 156–161





Investigation of the ^{2}n system by quasi-free α-knockout from ^{6}He

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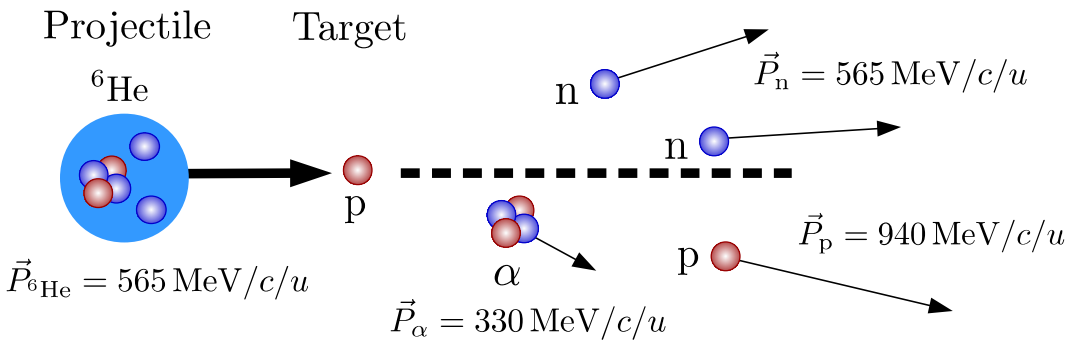
Master thesis project of Marco Alexander Knösel

- Looking at ^{6}He → (p,pα) → 2n from SAMURAI19 data
- Select large centre of mass angle between α and p
- Minimize final-state interaction



Goals:

- Extract n-n scattering length from n-n correlations by comparison with Halo-EFT by Hans Werner Hammer (calculations for ^{6}He as Borromean halo nucleus)
- Analyse calibration measurement for Tetraneutron experiment

Investigation of the ^{2}n system by quasi-free α-knockout from ^{6}He

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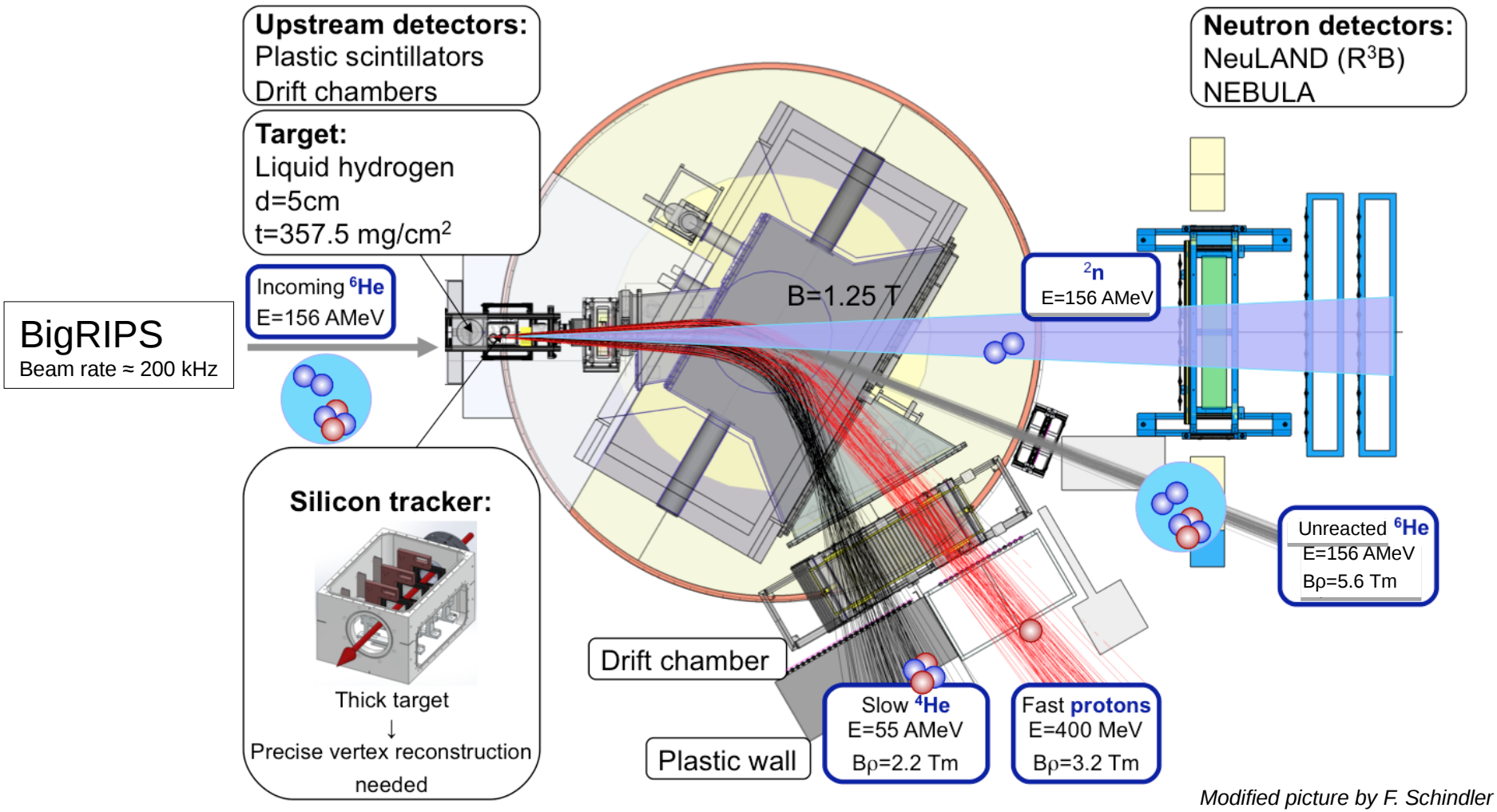

Modified picture by F. Schindler

Investigation of the ^{2}n system by quasi-free α-knockout from ^{6}He

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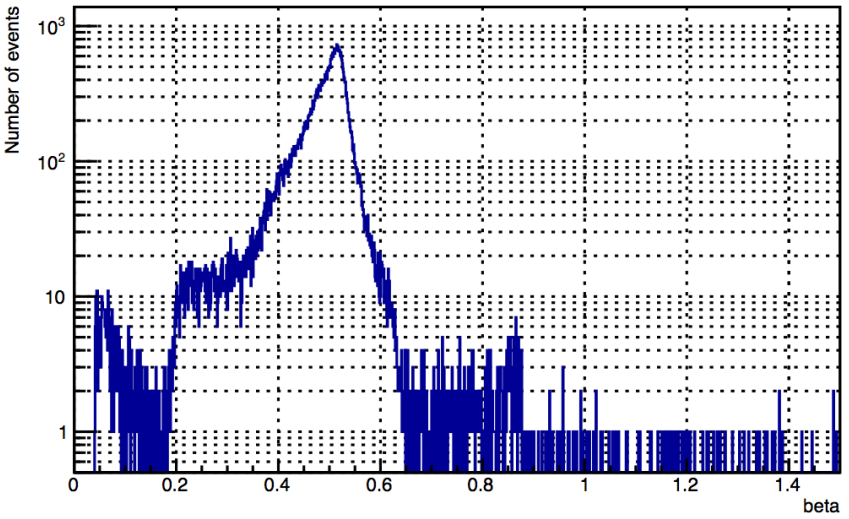
Neutron analysis

- Currently working on neutron detector calibration and neutron reconstruction for 2n case
- Identify background sources in beta-spectrum
- Test different ideas for cluster algorithm
  → When do hits belong to the same cluster?
- Test first ideas for cross talk analysis



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Thank you for your attention!

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