Physics with R³B-NeuLAND at RIBF/RIKEN

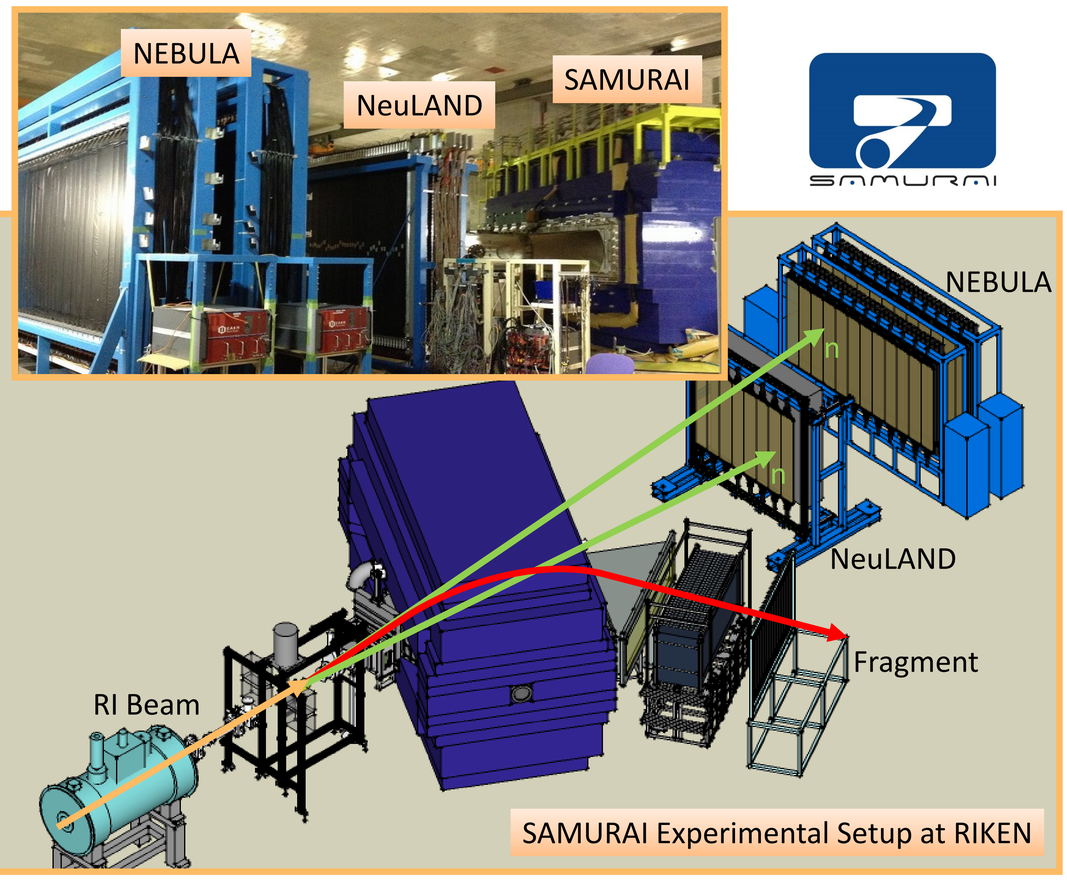
J. Kahlbow (TU Darmstadt) & the R³B-NeuLAND-SAMURAI Collaboration

NeuLAND Demonstrator at SAMURAI

- **NeuLAND = high-resolution neutron ToF-spectrometer**
- First 4 double planes (250x250x40cm³, 400 plastic-scintillator bars) shipped to Japan in Jan. 2015
- Added to SAMURAI setup and NEBULA for reaction measurements in inverse kinematics at RIBF/RIKEN
- SAMURAI = RI beam exp. with large-acceptance spectrometer and coincident fast-neutron detection
- Significant increase of multi-neutron detection efficiency with NeuLAND Demonstrator

  → 4*n* detection possible for the first time
- Improved invariant-mass resolution
- Exp. campaign: autumn 2015 – summer 2017, 12 experiments in 71 days of beam

  [J. Kahlbow, K. Boretzky *et al.*, GSI-FAIR Scientific Report 2017]



SAMURAI Experimental Setup at RIKEN

Key Detector in SAMURAI Physics Program

Structure of *n*-rich nuclei

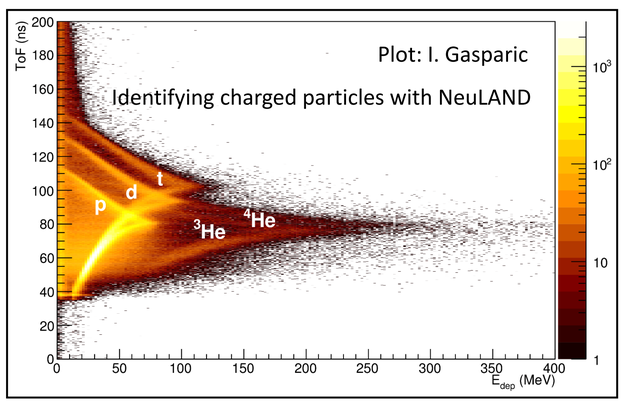
- "Soft" dipole excitation of ^{6,8}He

  → **2*n*** & **4*n*** decay

  → Test of *ab initio* theory:

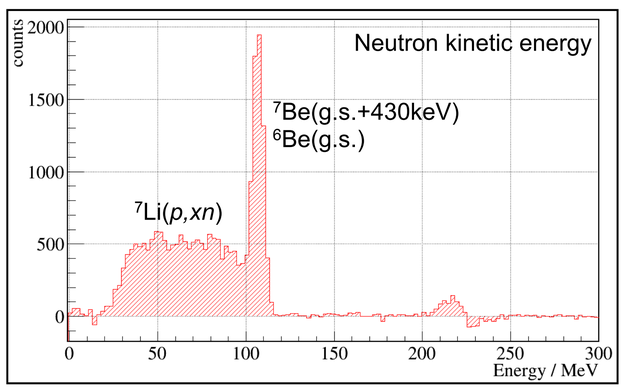
  S. Bacca *et al.*: Lorentz Integral Transforms

  R. Roth *et al.*: No-Core Shell Model
- Dipole response of *n*-rich Ca isotopes
- Spectroscopy of *n*-rich nuclei in K-V region (SEASTAR3 campaign)
- Coulomb break-up and knockout on deformed halo nucleus ^{31}Ne
- Search for ^{22}C(2⁺) and ^{21}B: Structure at and beyond the *N*=16 subshell closure
- EoS: Heavy-ion collision in Sπrit TPC at $\rho=2\rho_0$ with $^{108\text{-}124}$Sn



- Calibration measurement for 1*n* detection efficiency:

  ^{7}Li(*p*,*n*) at 110MeV & 250MeV

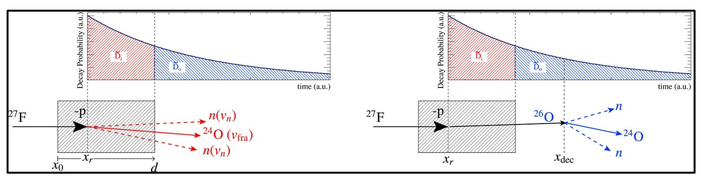


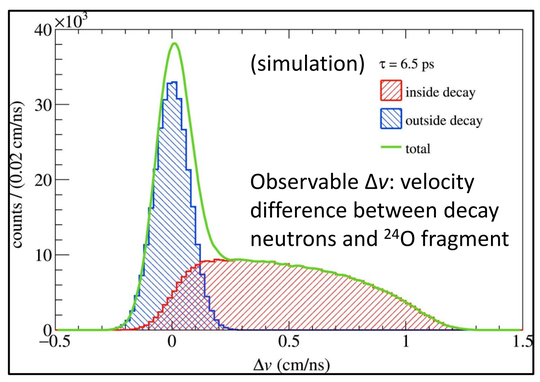
Multi-neutron decays beyond the dripline

Lifetime τ of ^{26}O(g.s.)

- Low ^{26}O(g.s.) decay-energy and ν($d_{3/2}$) centrifugal barrier hinder the 2*n* emission → *n*-radioactive decay?

  [L.V. Grigorenko *et al.*, Phys. Rev. Lett. 111, 042501 (2013)]
  [Z. Kohley *et al.*, Phys. Rev. Lett. 110, 152501 (2013)]
- New and precise method: sub-picosecond sensitivity
- Determine τ from decays in- & outside the target



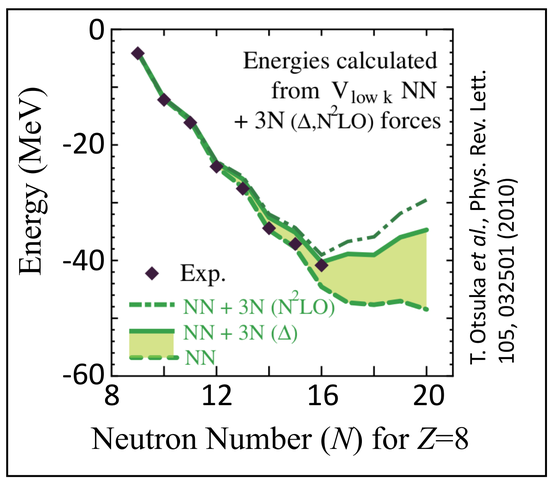


- Thick (W & Pt) and multiple targets increased the sensitivity in experiment

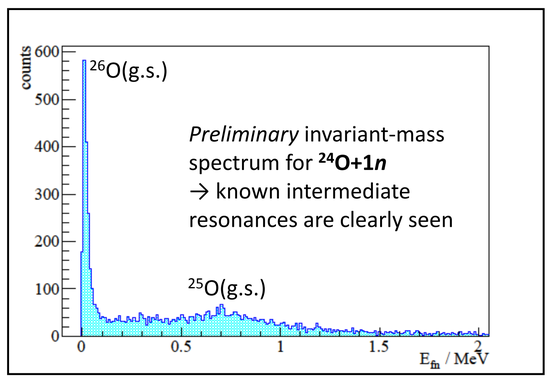
J. Kahlbow, C. Caesar *et al.*, Nucl. Instr. Meth. Phys. Res. A, 866 (2017)

Spectroscopy of ^{28}O & ^{27}O

- Solving the "oxygen anomaly"



- ^{29}F(*p*,2*p*)^{28}O → ^{24}O + **4*n***

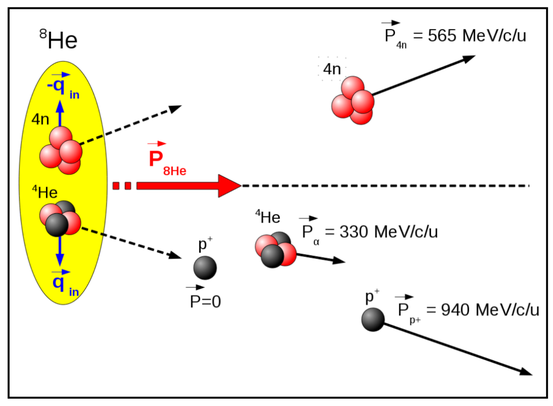


- ^{29}Ne(*p*,3*p*)^{27}O → ^{24}O + **3*n***
- Only feasible together with NeuLAND, $\varepsilon \approx 1\%$

Search for a resonant tetraneutron system

- **^{8}He(*p*,*pα*)4*n*** ; ^{8}He(*p*,2*p*)^{7}H
- Quasi-elastic scattering of *α* particle
- Knockout reaction at large momentum transfer at around 180° center-of-mass scattering angle

  → minimizes final-state interaction with charged particles



- Missing- & invariant-mass technique
- Study of neutron correlations

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