Overview of SAMURAI

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RIKEN Nishina Center

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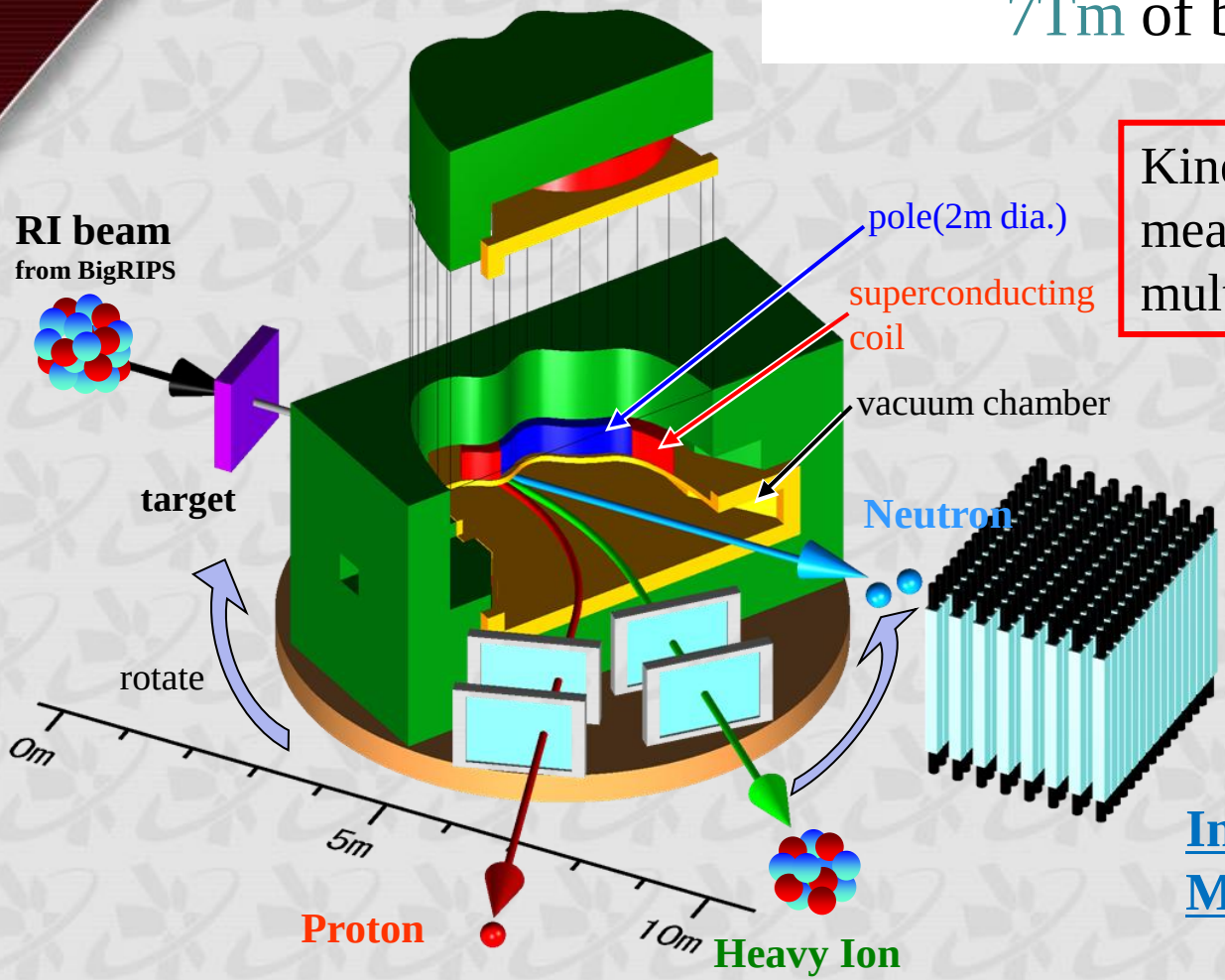
SAMURAI

Superconducting **A**nalyzer for **MU**lti-particle from **RA**dio **I**sotope Beam with 7Tm of bending power

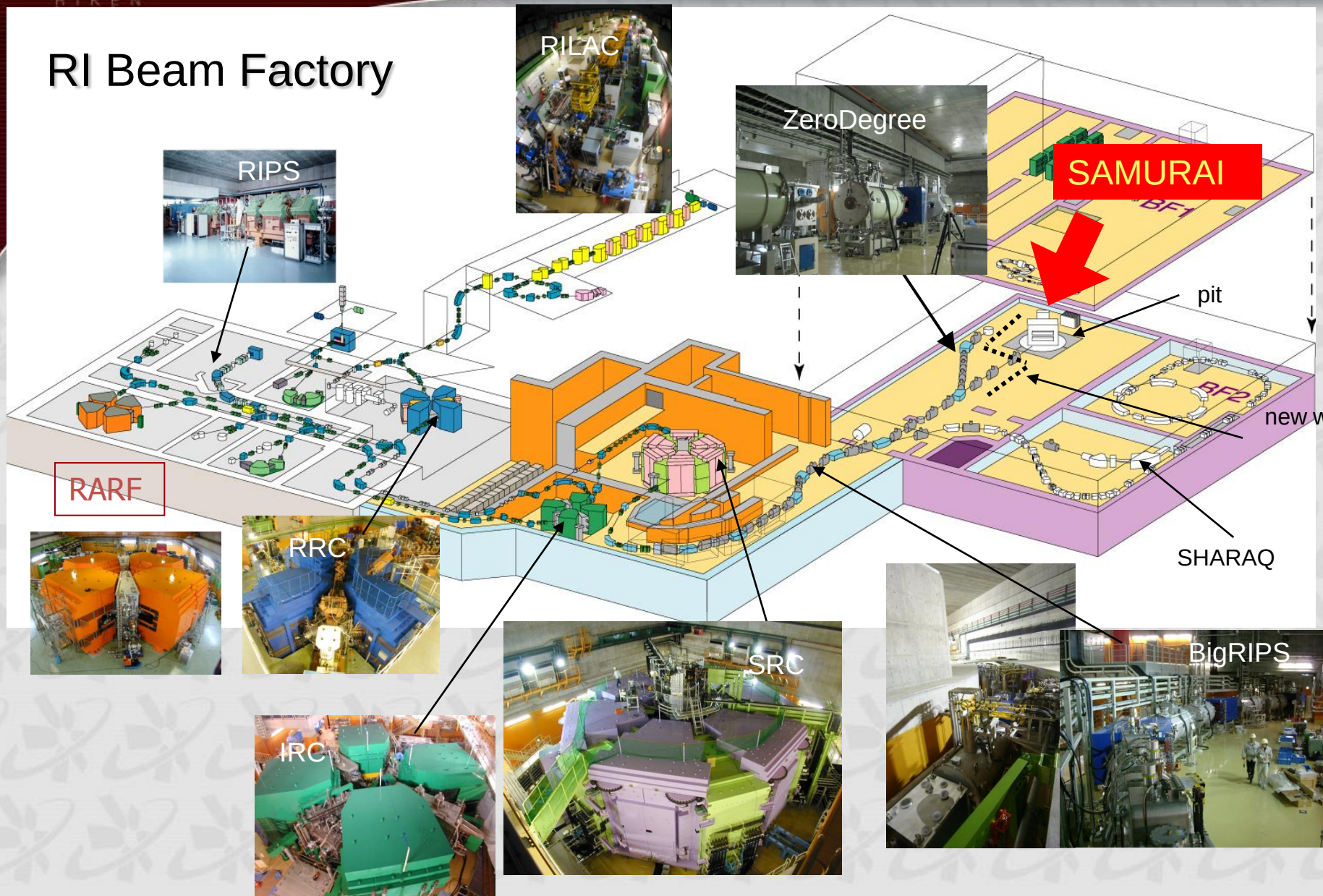
Kinematically complete measurements by detecting multiple particles in coincidence



- Superconducting Magnet
- Heavy Ion Detectors
- Proton Detectors
- Neutron Detectors
- Large Vacuum Chamber
- Rotational Stage

Invariant Mass Measurement
Missing Mass Measurement

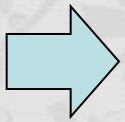
Where is “SAMURAI” ?



Magnet design

>> H. Sato, pm 9-Mar

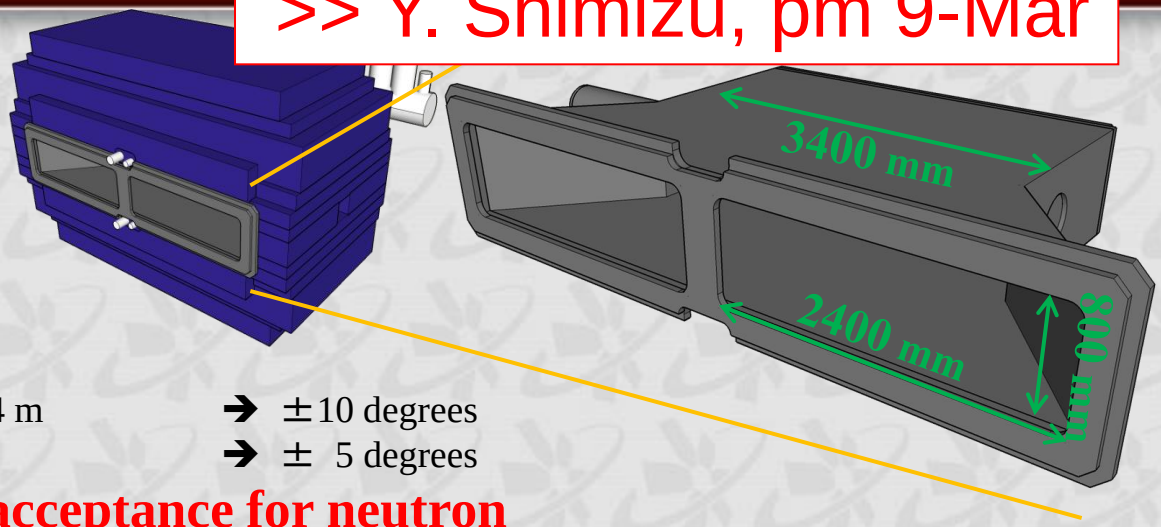
- **Requirements**
  - **Large field integral --> for high precision momentum analysis**
  - **Large pole gap --> for large vertical acceptance for neutrons**
  - **No coil link --> for large acceptance in the horizontal direction**
  - **Small fringing field --> for detectors around the target region and tracking detectors**
  - **Flexibility --> for various experimental conditions**
  - **Large momentum acceptance --> for heavy fragments and protons in coincidence**
  - **High momentum resolution --> for deuteron-induced reactions**



- ✓ Field Integral 7 Tm (dR/R ~ 1/700 @ 2.3 GeV/c for A/Z=3)
  → mass separation σ_A=0.2 for A=100
- ✓ Large Gap (0.8 m --> vertical ±5 degrees)
- ✓ Large opening (3.4 m --> horizontal ±10 degrees)
- ✓ Small Fringing Field (< 50 gauss @ 50cm from magnet)
- ✓ H-type magnet with cylinder poles (2m in diameter)
- ✓ Close coiling, wet winding, non-stabilized SC wire
- ✓ Magnetic field … about 3T at center by ~1.9MAT
- ✓ Field clamp
- ✓ Build-in vacuum chamber
- ✓ Rotatable base (from -5 to 95 deg, 0.1deg/sec)

Vacuum Chamber

>> Y. Shimizu, pm 9-Mar



- **Requirements**
  - Large acceptance
    - Horizontal space: 3.4 m ➔ ±10 degrees
    - Vertical gap: 0.8 m ➔ ± 5 degrees

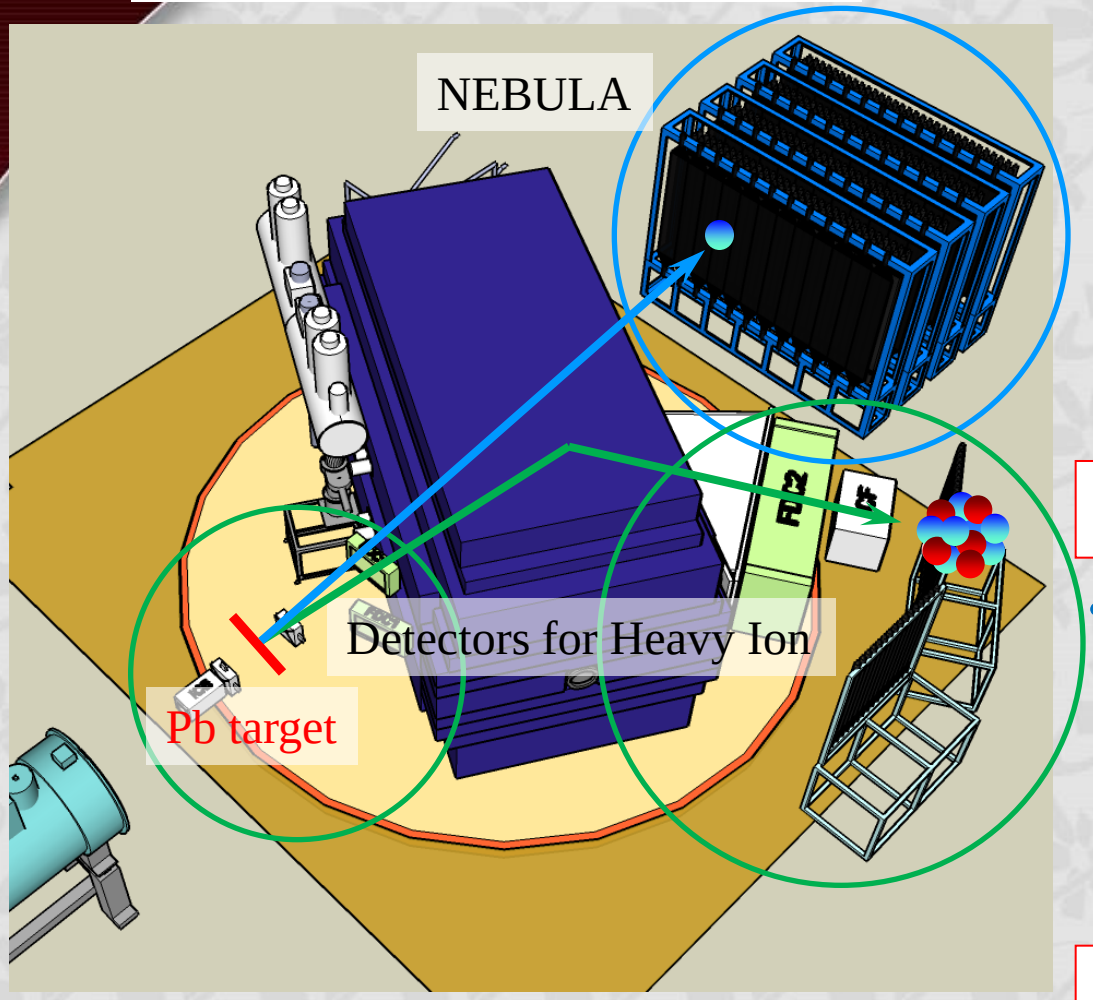
    Large angular acceptance for neutron

    Enable to install the detector in the vacuum chamber
- **Design**
  - Very large window (H: 2.4 m, V: 0.8 m)
  - Vacuum partition (~ 10^{-4} Pa)
    - Mylar + Kevlar (300 μm)
    - ✓ **Vacuum test for endurance**
    - ✓ **Destructive test**

vacuum test for endurance

Detector System – (γ, *n*) measurement mode

(γ, *n*) reaction: neutron-rich side



- **Detectors for Heavy Ion**
  - Position measurement
    - Drift Chambers
      Beam / Fragments
  - Charge measurement
    - Ion Chambers
      Beam / Fragments
  - Velocity measurement
    - Plastic hodoscope
    - Cherenkov counter
  - Total E measurement
    - Pure CsI detector

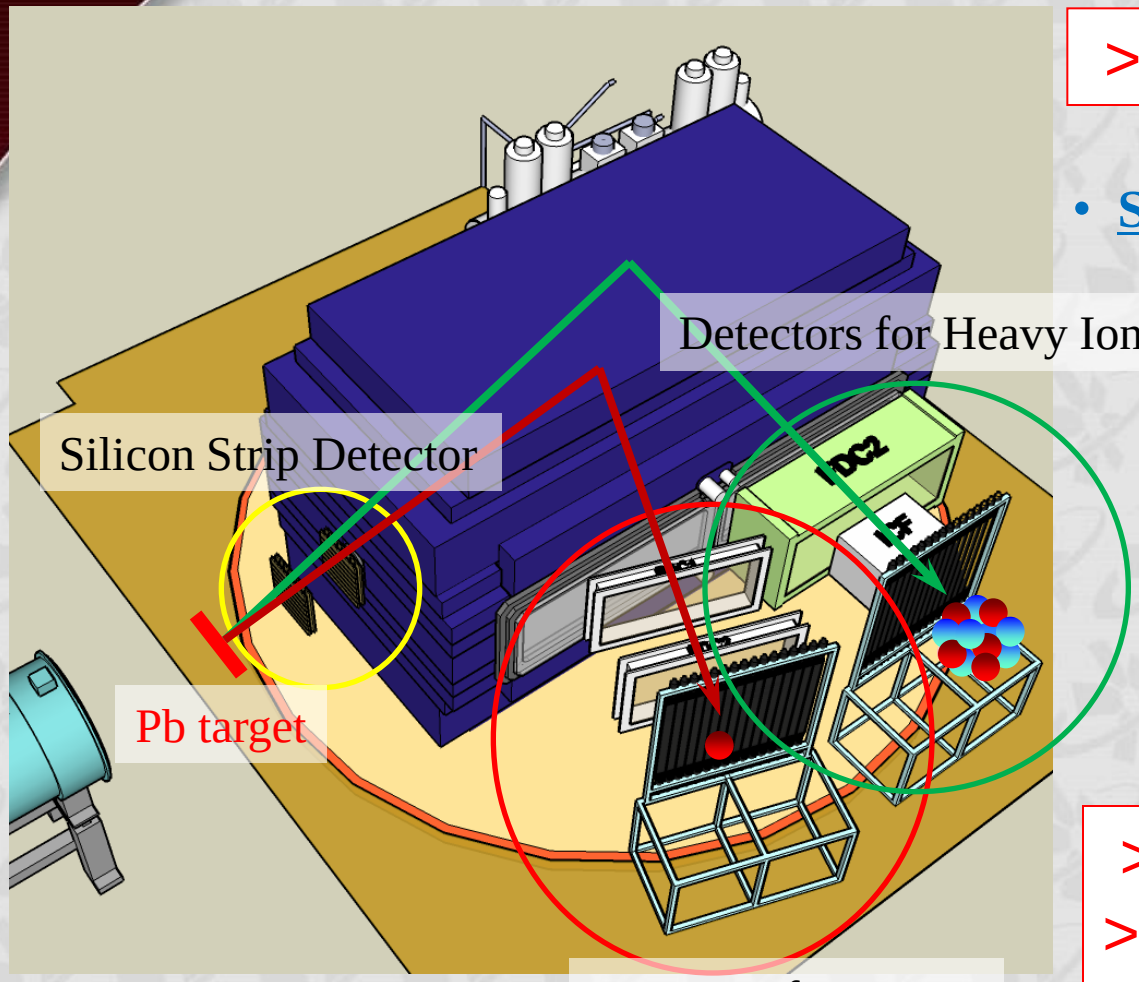
>> T. Kobayashi, pm 9-Mar

- **NEBULA**
  - Plastic scintillator
    - 240 modules
    - Effective Area: 3.6 m (H) × 1.8 m (V)
      ~ 100 % coverage @ E_{rel} < 3 MeV
      ~ 40 % coverage @ E_{rel} ~ 10 MeV
    - Efficiency ~ 66 % (Harf: ~40 %)

>> Y. Kondo, pm 9-Mar

Detector System – (γ, *p*) measurement mode

(γ, *p*) reaction: proton-rich side



- **Detectors for Proton**
  - Proton Drift Chamber
  - Plastic Hodoscope

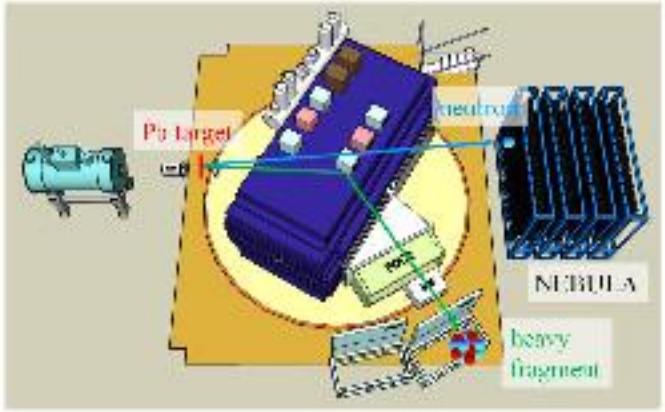
>> T. Kobayashi, pm 9-Mar

- **Silicon Strip Detector**
  - Broad dynamic range
    Both proton & heavy ion (Z < 50) hit the detector
  - Capability of high density signal processing
    Signals of about 2500ch in total
    Modify integrated ASD circuit HINP16C in collaboration with Texas A&M and Washington Univ.
    HINP16C --- 16ch processing in 1 chip two output for energy and timing

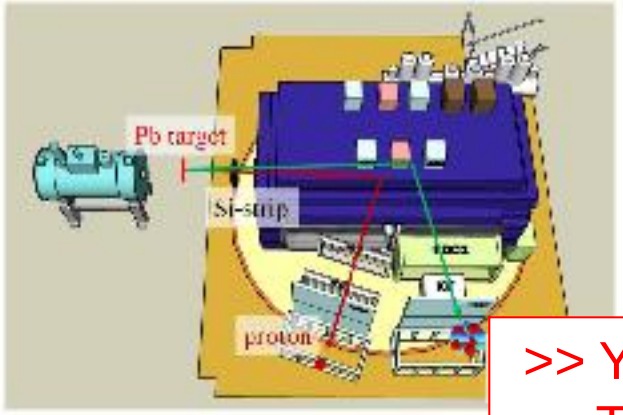
>> Y. Togano
>> B. Roeder, R. Shane
pm 9-Mar

Various Configuration

(γ, *n*) reaction: neutron-rich side



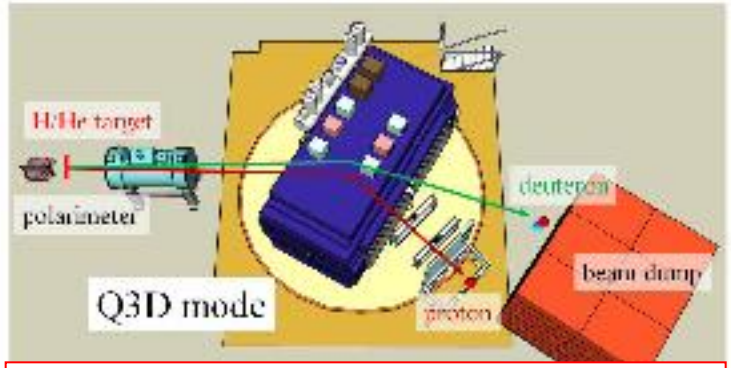
(γ, *p*) reaction: proton-rich side



(*p*,*p*′), (*p*,2*p*), (*p*,*pn*), …

>> Y. Matsuda, A. Obertelli, T. Hashimoto, pm 10-Mar

pol. *d*-induced reaction



>> K. Sekiguchi, pm 10-Mar

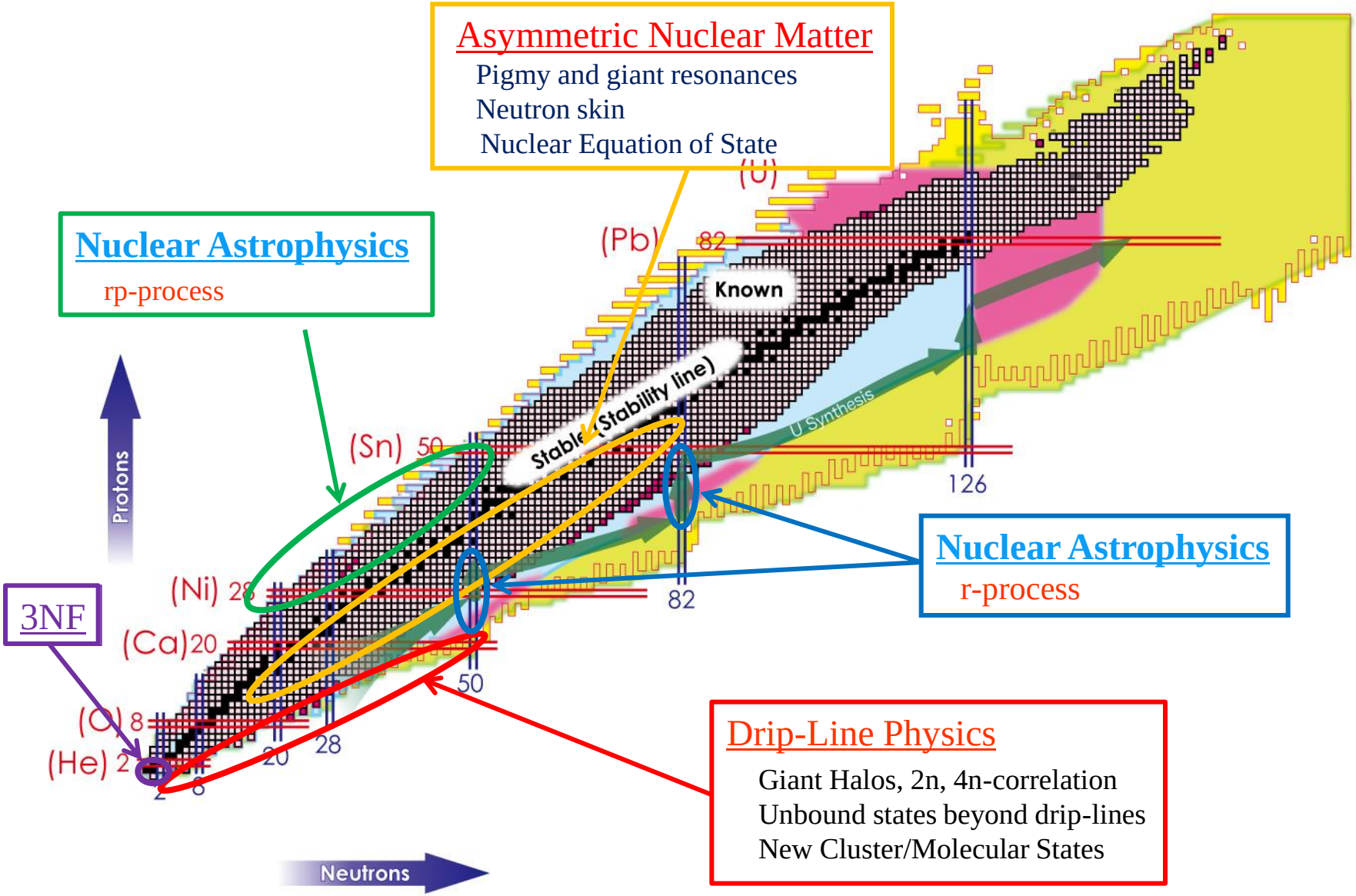
EOS measurement

>> W. Lynch, T. Murakami, pm 10-Mar

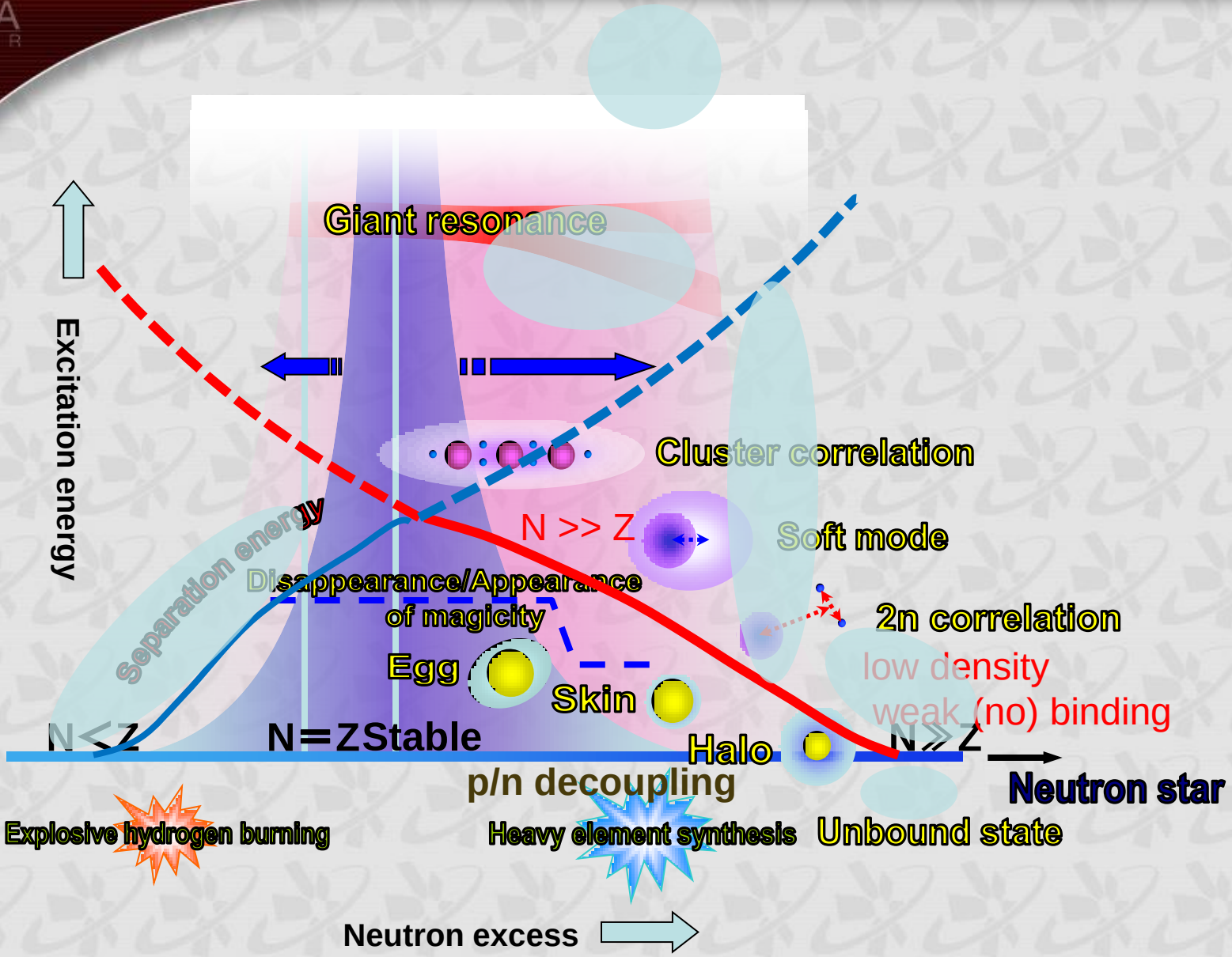
Flexibility of settings is one of the good properties of SAMURAI.

Physics Subjects in Nuclear Chart

>>10-Mar



Regions of interest in asymmetry – excitation plain



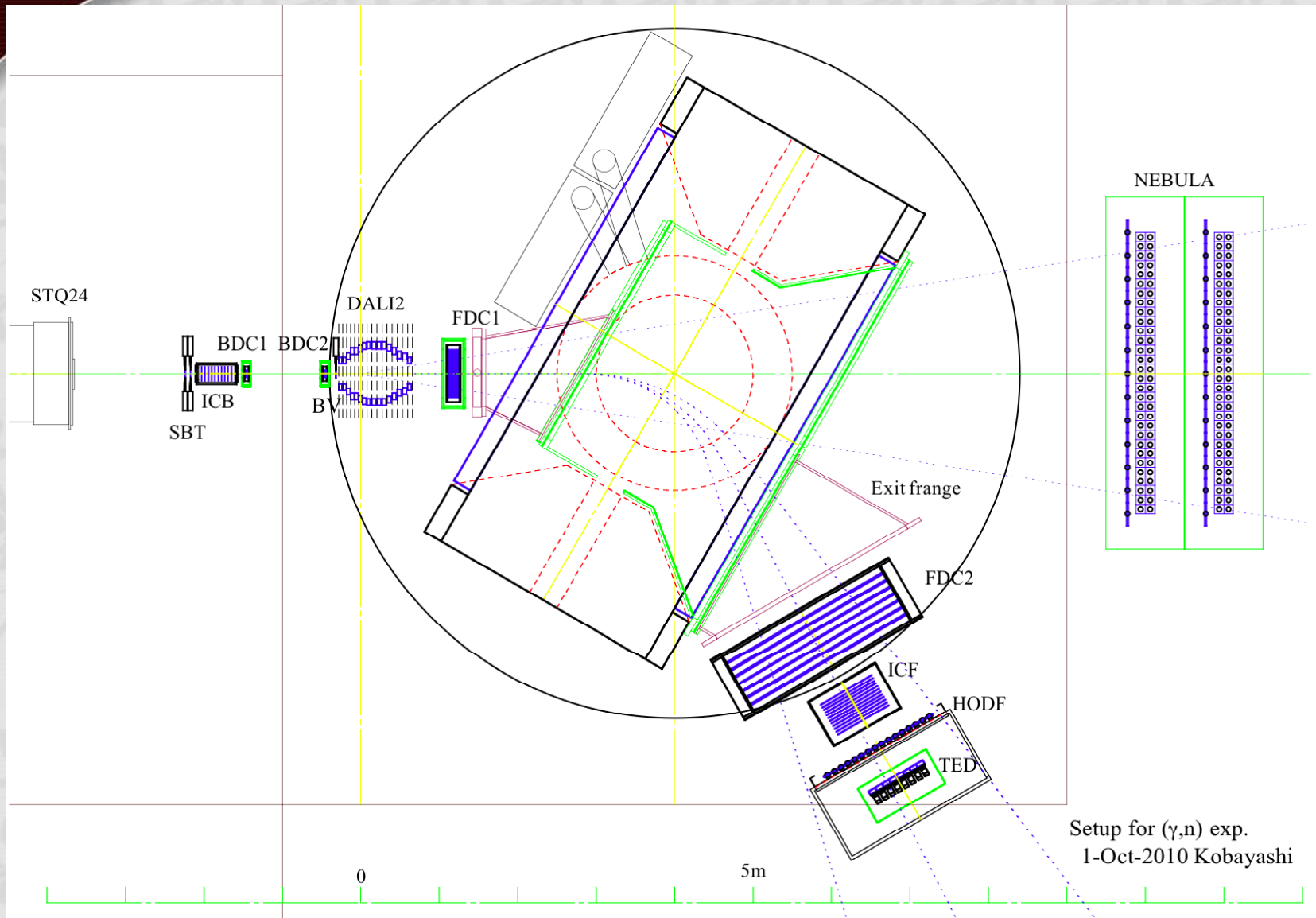
Schedule of SAMURAI

- 1st experiment – Early 2012
  - Magnet construction completed in May 2011
  - Followed by preparation of detectors, infrastructure
  - Beam line available in early 2012

First, neutron breakup setup will be ready

Proton breakup – prepared in 2012
to be ready in early 2013

Experiment Setup in early 2012



Construction Members

T. Kobayashi (Tohoku) ・Spokesperson
T. Motobayashi (RIKEN)・Co-spokesperson
K. Yoneda (RIKEN) ・Project manager

Construction Team Member (*Leader)

Magnet and Infrastructure:	H. Sato*, K. Kusaka, J. Ohnishi, H. Okuno, T. Kubo (RIKEN)
Vacuum system and Utilities:	H. Otsu*, Y. Shimizu (RIKEN)
Heavy ion detectors:	Y. Matsuda, K. Sekiguchi, N. Chiga, graduate students, T. Kobayashi* (Tohoku), H. Otsu (RIKEN)
Neutron detectors (NEBULA):	T. Nakamura*, Y. Kondo, Y. Kawada, T. Sako, R. Tanaka (Tokyo Tech), Y. Satou (Seoul National Univ.)
Proton detectors:	K. Yoneda*, Y. Togano, M. Kurokawa, A. Taketani, H. Murakami, T. Motobayashi (RIKEN), K. Kurita (Rikkyo), T. Kobayashi (Tohoku), L. Trache (Texas A&M) and the TWL collaboration
Polarized deuteron induced reaction experiment devices:	
Time projection chamber:	K. Sekiguchi*, T. Kobayashi, Y. Matsuda, graduate students (Tohoku) T. Murakami* (Kyoto), T. Isobe, A. Taketani, S. Nishimura, Y. Nakai, H. Sakurai (RIKEN), W.G. Lynch (Michigan State) and SAMURAI TPC collaboration

In-House Work Force:

Research Instruments Group (T. Kubo - Group Leader)
SAMURAI Team (T. Motobayashi*, H. Sato, Y. Shimizu, K. Yoneda)

Thank you for your attention !