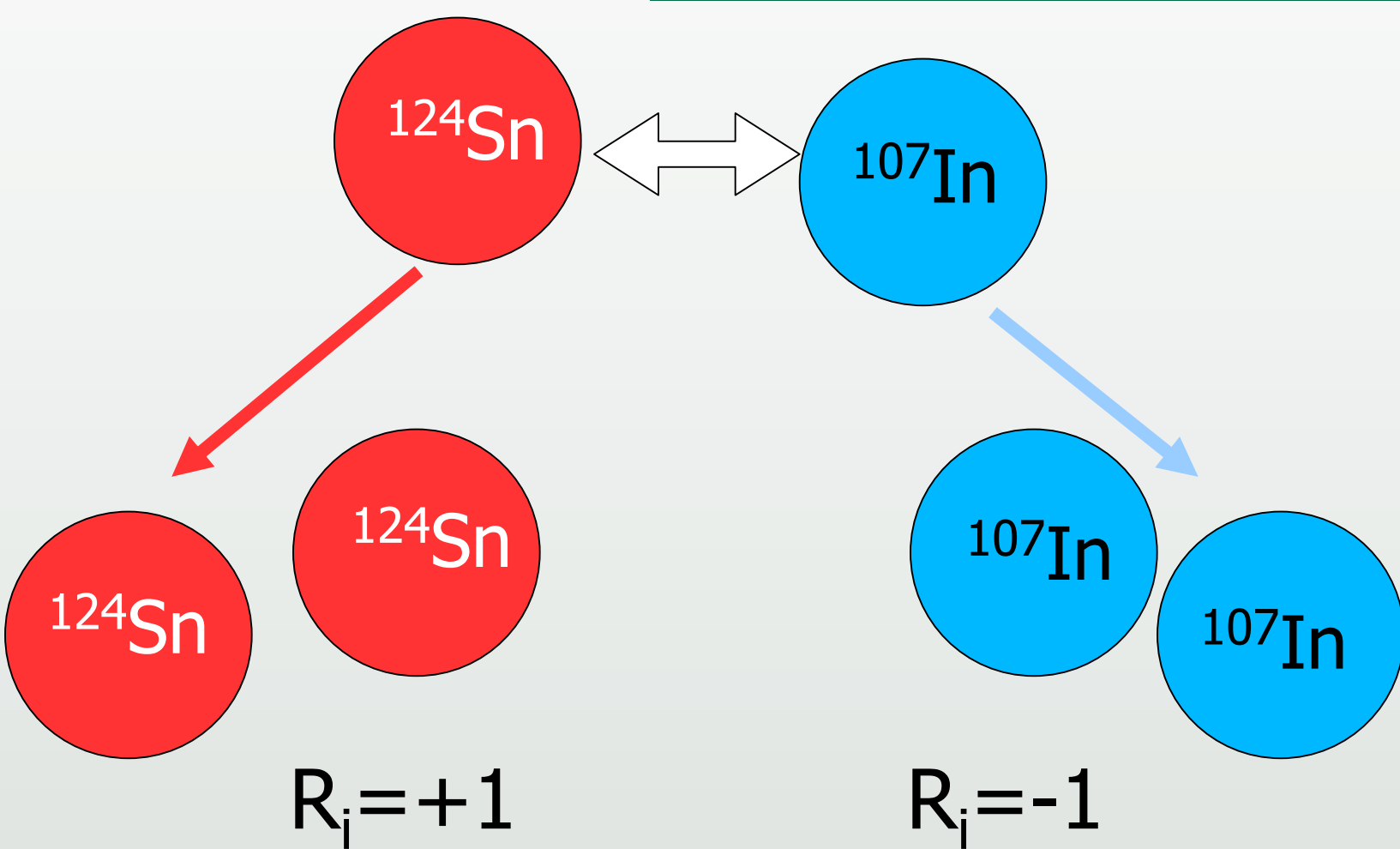


Measuring Isospin Diffusion with the ZeroDegree Spectrometer

Rachel Hodges Showalter, Noritsugu Nakatsuka, Tadaaki Isobe, Jack Winkelbauer

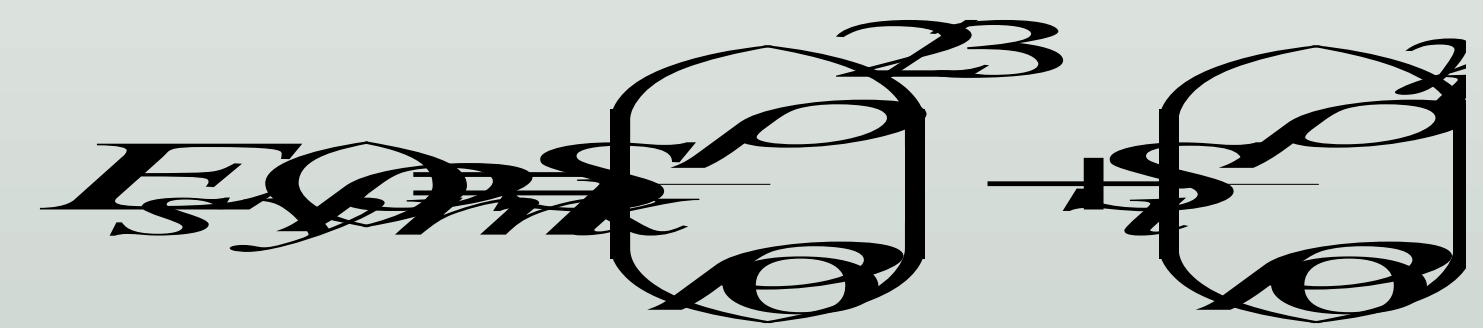
Tetsuya Murakami, Bill Lynch, Betty Tsang, Hiroyoshi Sakurai, Jenny Lee, Mizuki Nishimura, Shunji Nishimura, Yoichi Nakai, Naoki Fukuda, Naohito Inabe, Daisuke Kameda, Toshiyuki Kubo, Hiroshi Suzuki, Hiroyuki Takeda, Yoshiyuki Yanagisawa, Sherry Yennello, Alan McIntosh, Lauren Heilborn, Andrew Zarrella, Will Powell, Janet Sampson, Justin Estee, Lu Fei, Guojiang Zhang, Abdou Chbihi, Alfredo Galindo-Uribarri, Elizabeth Padilla Rodal, Byungsik Hong, Genie Jhang, Walter Reviol, Demetrios G. Sarantites, Lee G. Sobotka

Isospin Diffusion

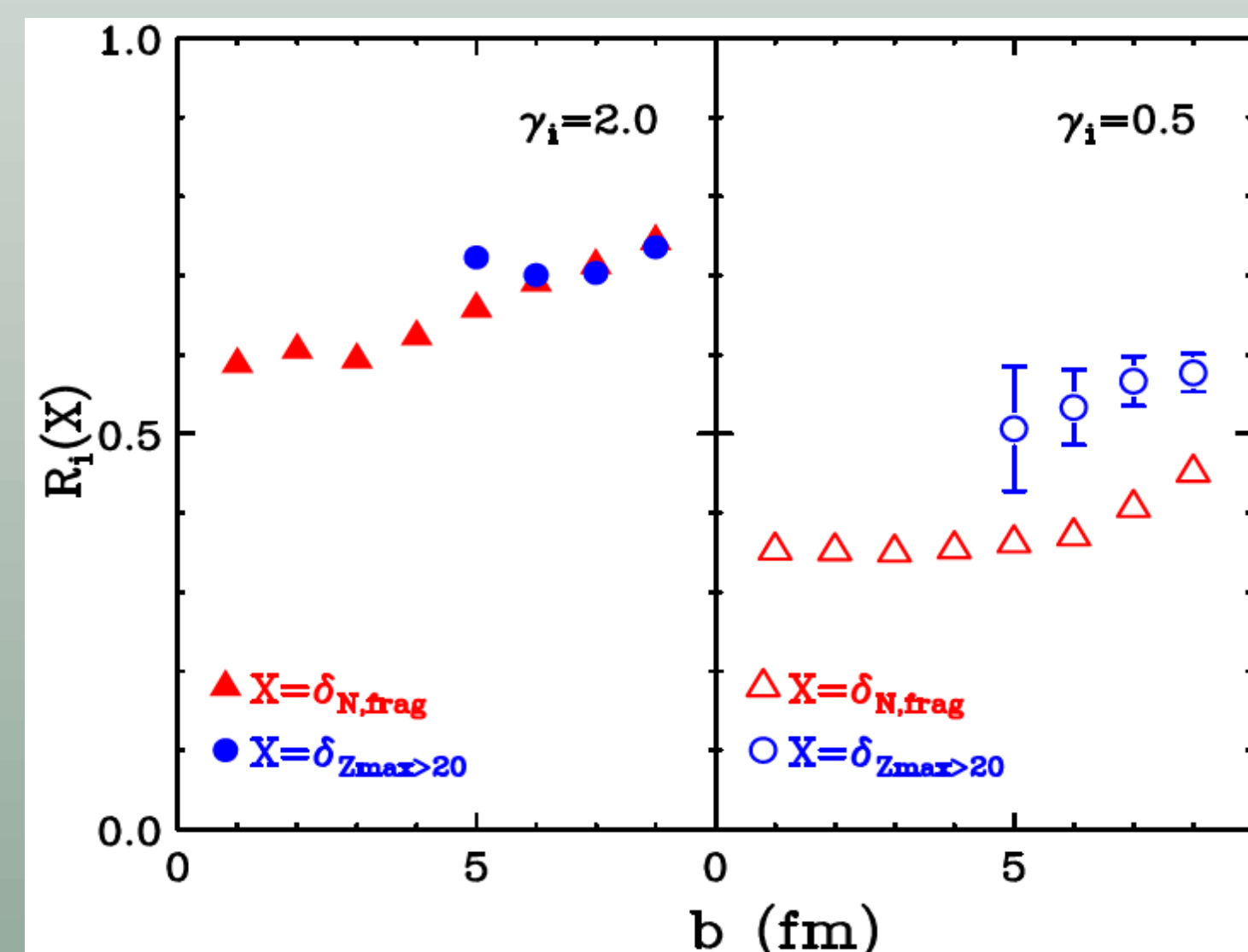


What is Isospin Diffusion?

- Asymmetric systems ($A+B$) move towards isospin equilibrium under the influence of symmetry energy.
- Symmetric systems ($A+A$; $B+B$) provide reference values, do not have isospin diffusion
- To measure extent of isospin diffusion: construct isospin transport ratio $R_i(X)$



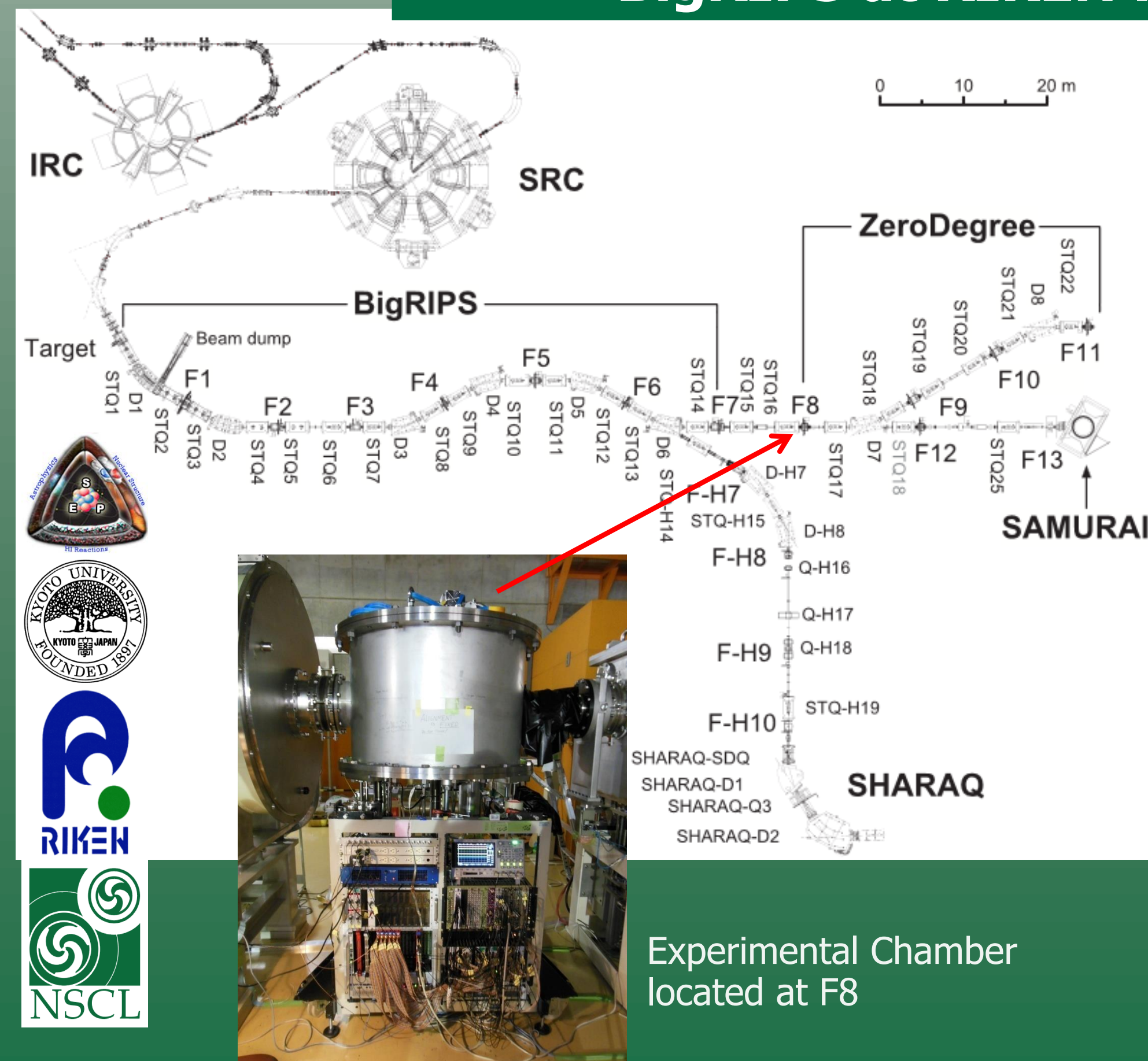
$$R_i = \frac{X - (X_A + X_B)}{X_A - X_B}$$



Heavy Residues

- Different amount of isospin diffusion for heavy residues, provide another observable sensitive to symmetry energy
- Residues have larger production cross-section values
 - can use unstable beams at lower intensity
 - allow us to probe larger asymmetry difference

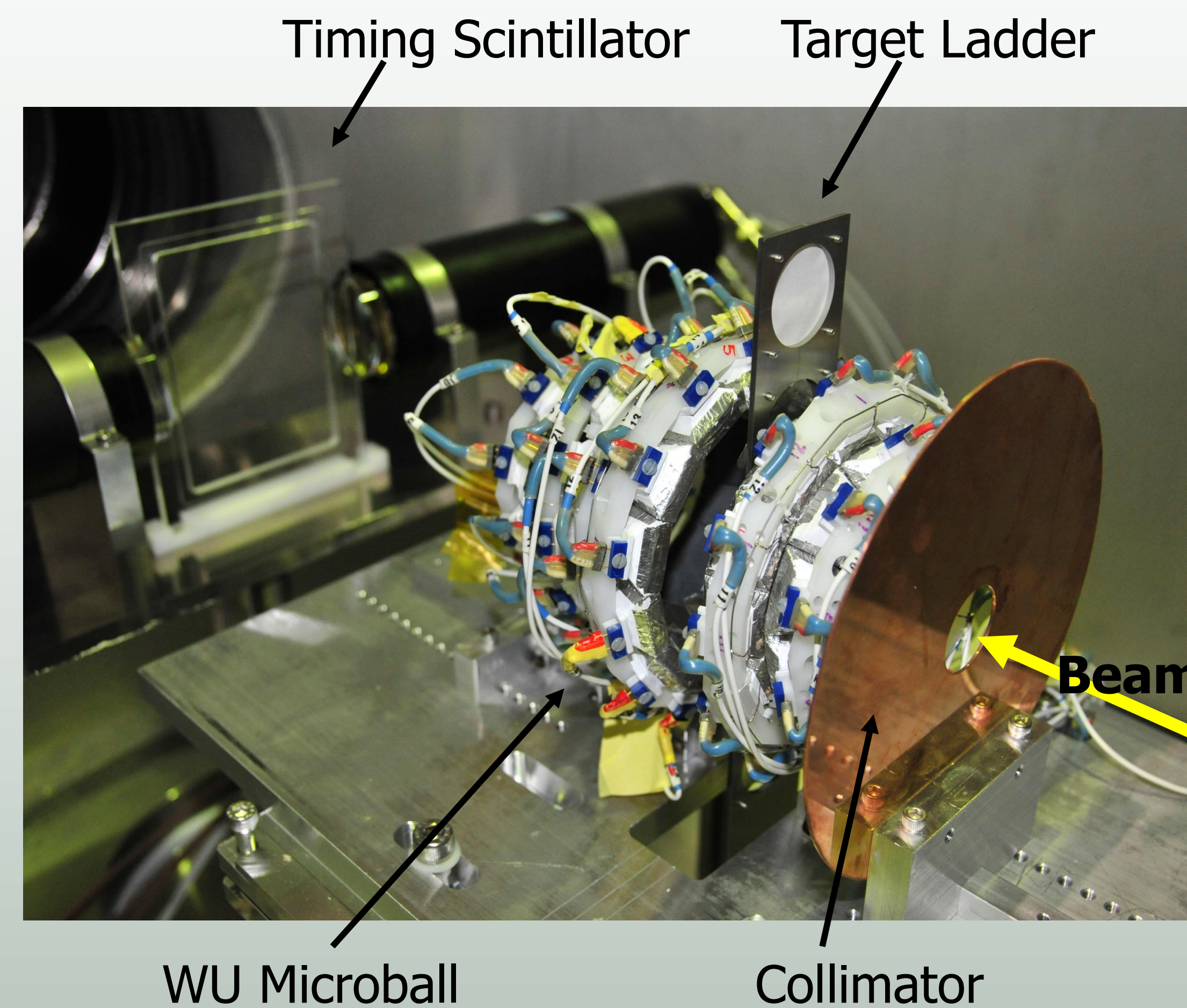
BigRIPS at RIKEN RIBF



Beam Production

- Used ^{124}Xe primary beam to produce ^{112}Sn , ^{107}In secondary beams at 70 AMeV
- Chose ^{107}In due to problems with ^{108}Sn purity
- Intensity $\sim 10^5$ on target
- ^{86}Zr calibration beam for ZDS, target thickness measurements
- BigRIPS: separator
- ZeroDegree: spectrometer

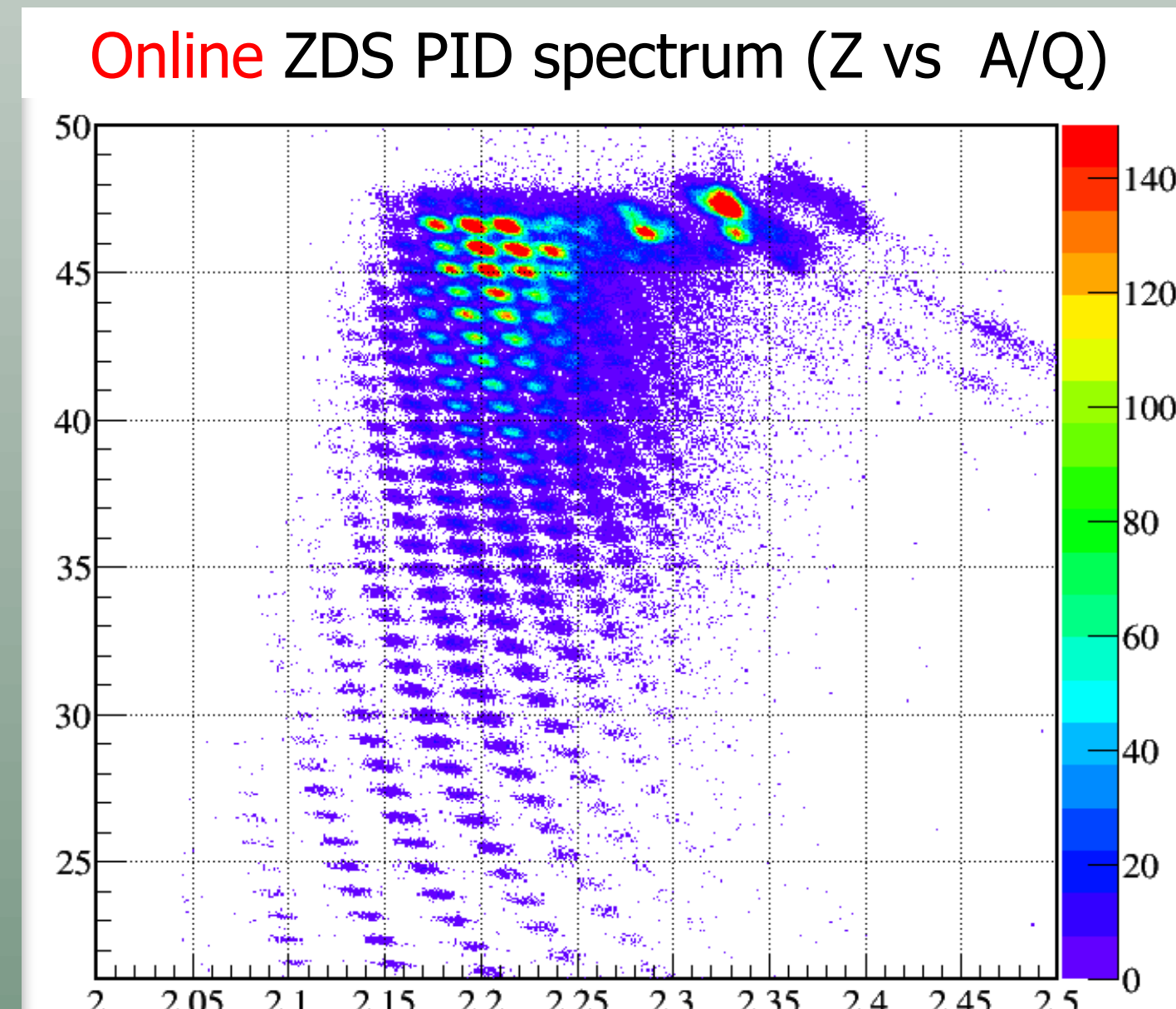
Experimental Setup



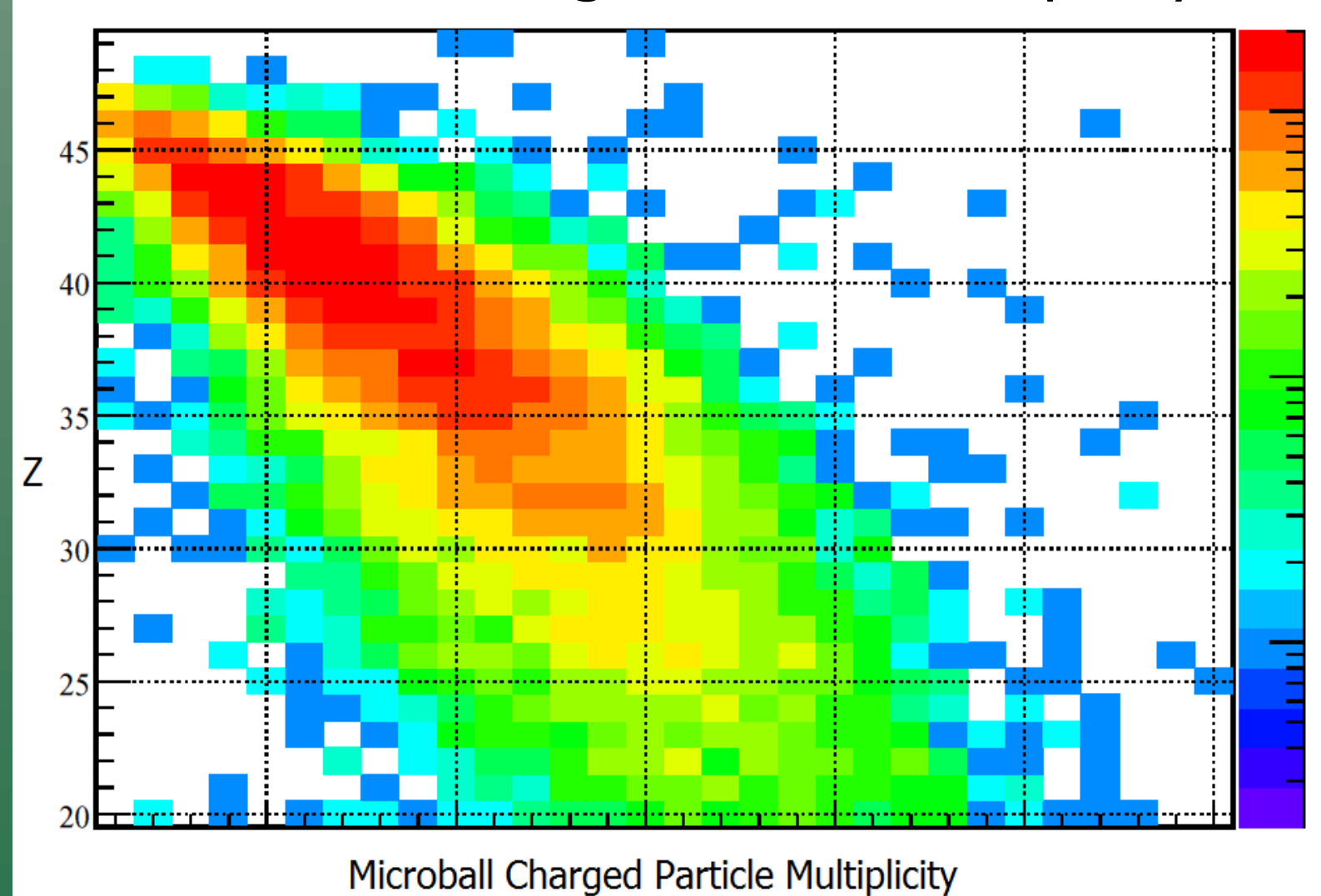
- Experimental goal to measure extent of isospin diffusion in $^{112}\text{Sn}+^{112}\text{Sn}$, $^{107}\text{In}+^{124}\text{Sn}$ reactions
 - construct $R_i(X)$ from heavy fragments
- Detected heavy residues in the ZeroDegree Spectrometer
- Detected light charged particles in the Washington University Microball
- Map data from $^{112}\text{Sn}+^{112}\text{Sn}$ reaction to previous experiment at NSCL

ZDS: ZeroDegree Spectrometer

- Measure 2.5° acceptance
- Selected $B_p=2.45, 2.52$ to avoid beam charge states and to map back to NSCL Sn+Sn experiment
- Track reconstruction through BigRIPS from precise TOF measurement
 - Include timing scintillator at F8
- Measure yields of select isotopes with $Z\sim 30-40$ and compare across reactions



Online ZeroDegree Spectrometer Z vs Microball Charged Particle Multiplicity



Microball (WU)

- Array of 70 CsI(Tl)-photodiode detectors
- Together, they provide coverage from $14^\circ \leq \theta_{lab} \leq 147^\circ$
- The forward-most and backward-most rings were removed to allow for a large beamspot
- Used to determine impact parameter of events
- In offline analysis: will select data in ZDS from peripheral events

MICHIGAN STATE UNIVERSITY

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