



2012 NUSTAR Meeting (02, Mar.)



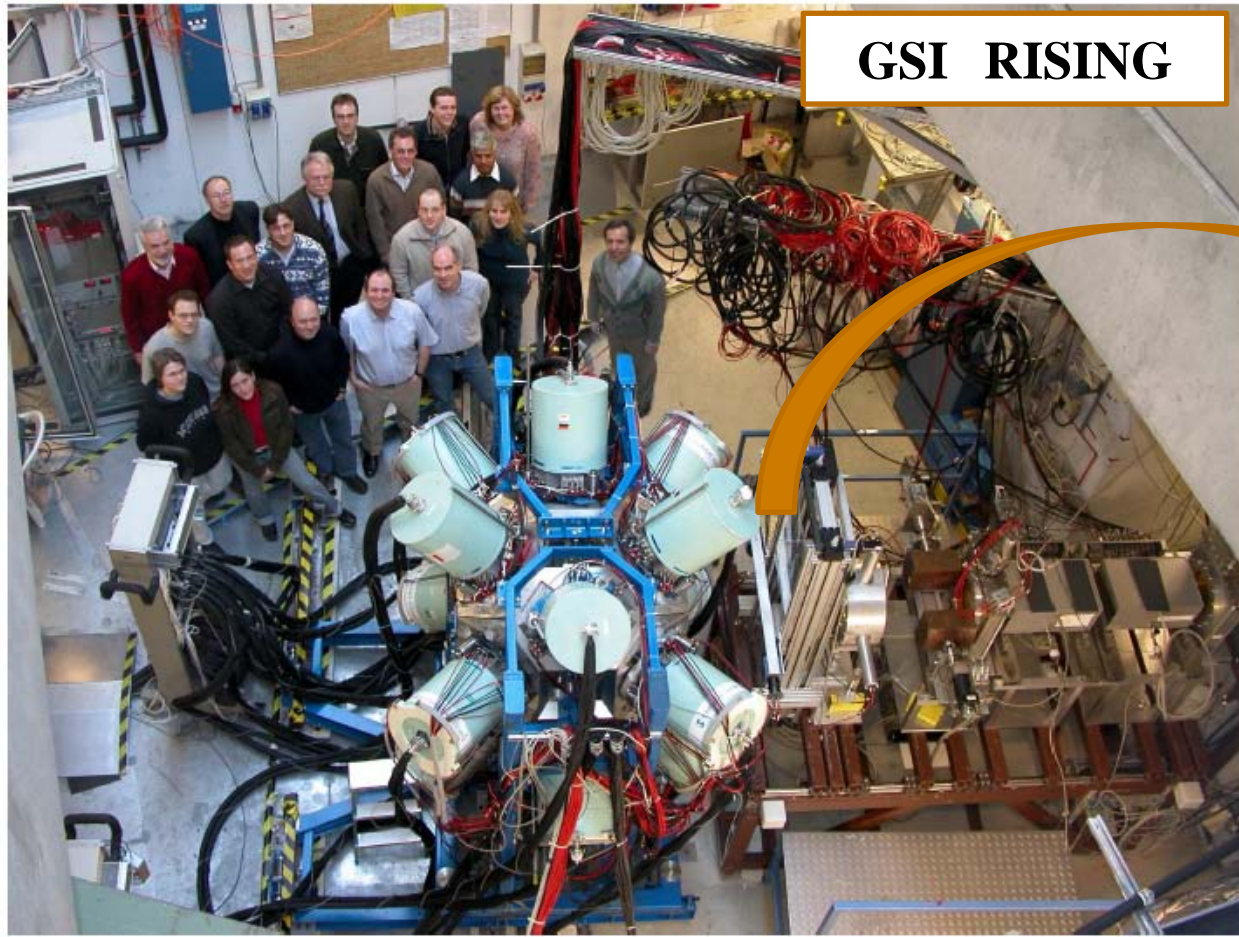
EUROBALL RIKEN Cluster Array

EURICA Project

**Shunji Nishimura
(RIKEN)**

for the EURICA Collaboration

Idea of EURICA Project



GSI RISING

~ 15 months ago,
this plan was just rumor.



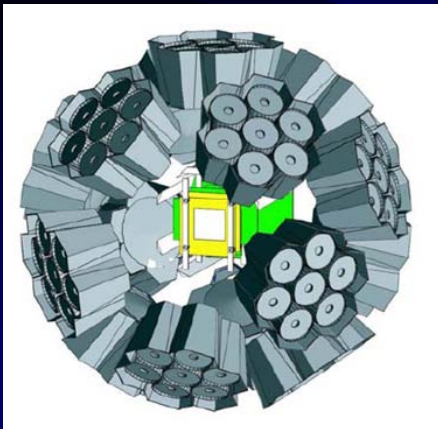
- Euroball Cluster detectors
- Support structure
- Readout electronics



RIKEN RIBF
(Japan)

RISING @ GSI $\leftarrow \rightarrow$ RIKEN

- In-beam γ -ray spectroscopy at relativistic energies about 100MeV/n
- g-factor measurements of isomeric stopped beams
- ➔ • Isomer and β -delayed γ -ray spectroscopy of stopped beam

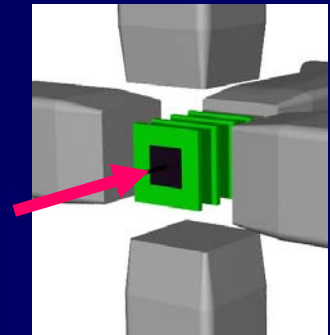


Gamma-detection

1~2 % \rightarrow 15%

**γ - γ : ~ 2 orders
higher effi.**

RIKEN



Decay Spectroscopy

H.Grawe, et al. Eur. Phys. J A 25 (2005) 357
+ E(2+) map

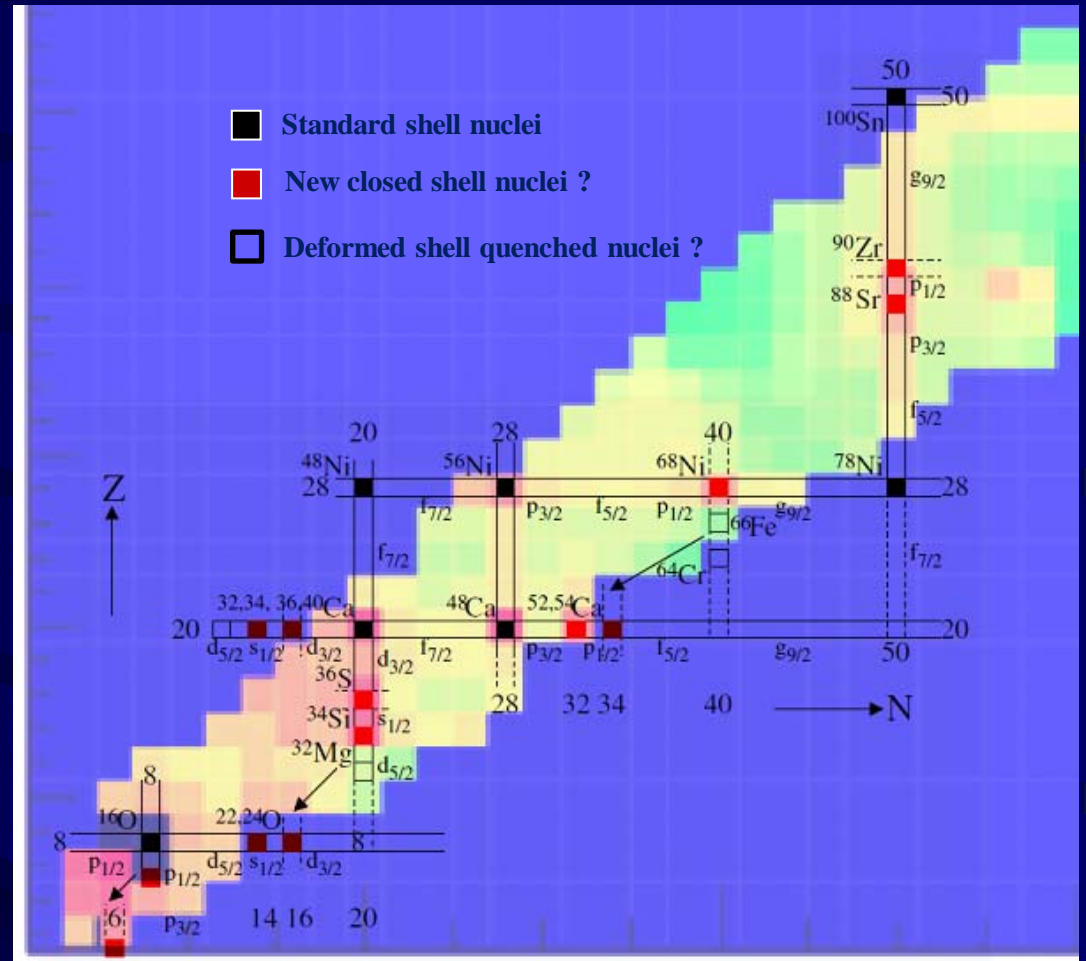
Measurements by decay exp.

- Decay curve : $T_{1/2}$
- Excited states : $E(2^+)$, ..
- Isomeric states
- Q_β
- Neutron emission (P_n)

Systematic Study



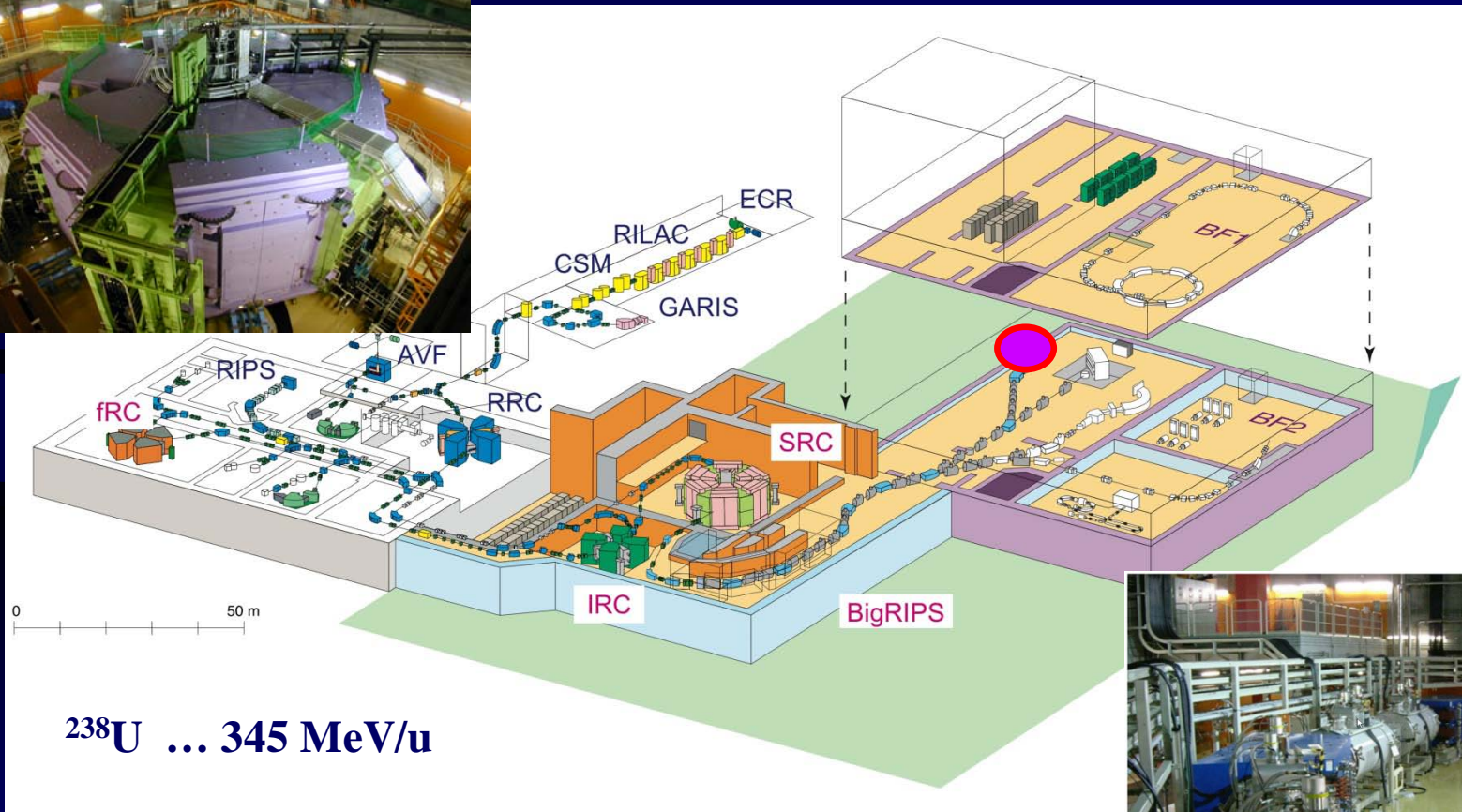
- Nuclear Structure
 - New magic number ?
 - Disappearance?
 - Shell quenching?
 - Deformation?



Feedback to
Nuclear Theory

RIKEN RIBF

Nucleus	Beam Intensity / pnA	
	Achieved	Expected FY 2011/12
^{48}Ca	230	200
^{86}Kr	30	30
$^{124,136}\text{Xe}$	10	10
^{238}U	0.5 3-4	5

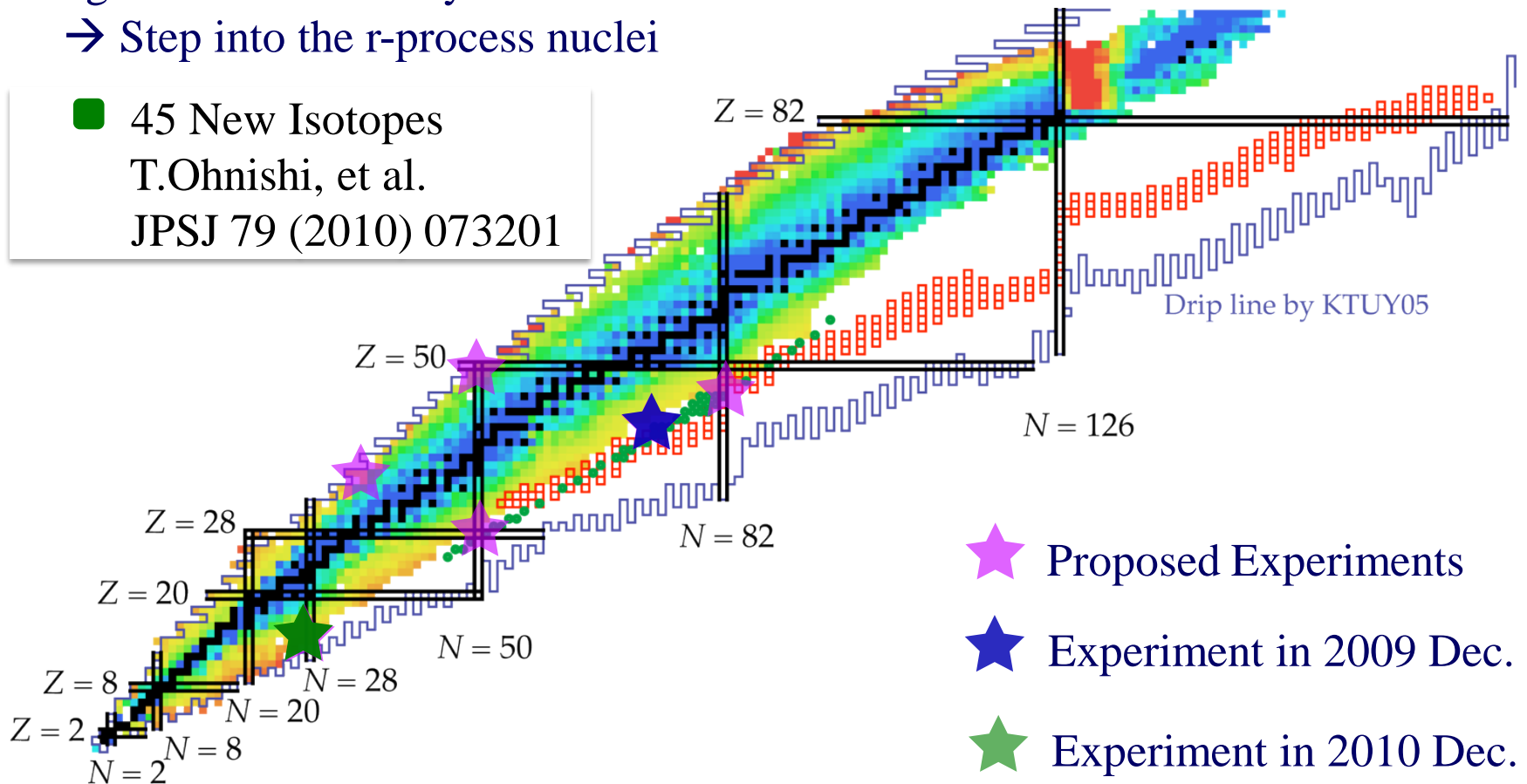


Beta-Decay Experiments at RIBF

Highest beam intensity of ^{238}U -beam

→ Step into the r-process nuclei

■ 45 New Isotopes
T. Ohnishi, et al.
JPSJ 79 (2010) 073201



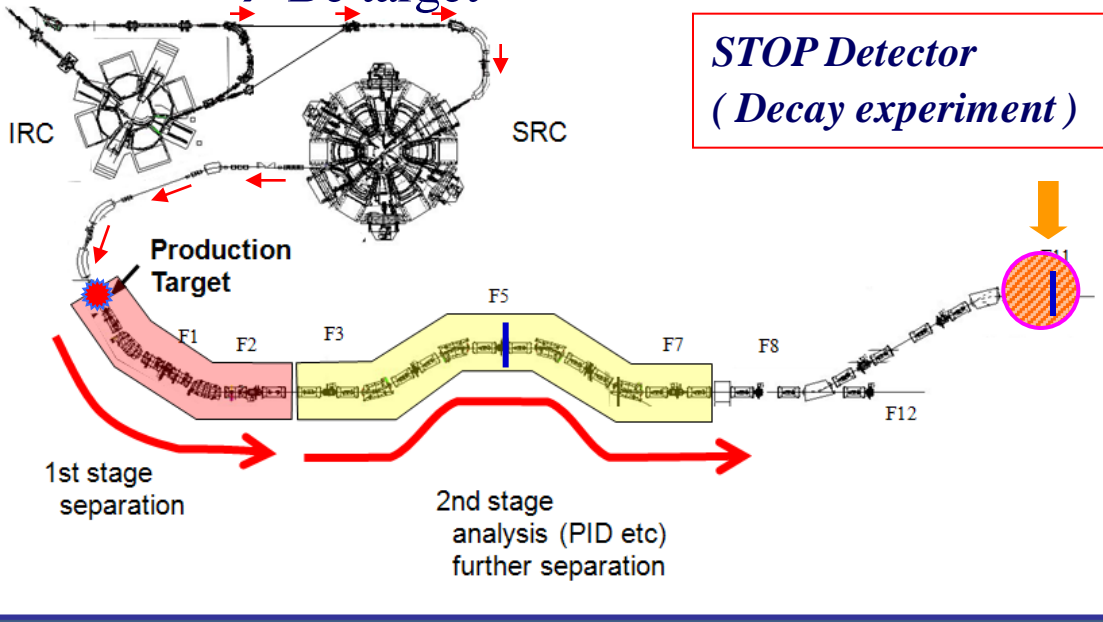
Decay Experiment (2009 Dec.)

- Phys. Rev. Lett. 106, 052502 (2011) ... $T_{1/2}$
- Phys. Rev. Lett. 106, 202501 (2011) ... $^{106,108}\text{Zr}$
- Phys. Lett. B 696, 186 (2011) ... ^{109}Nb
- Phys. Lett. B 704, 270 (2011) ... ^{110}Mo

Beam Production

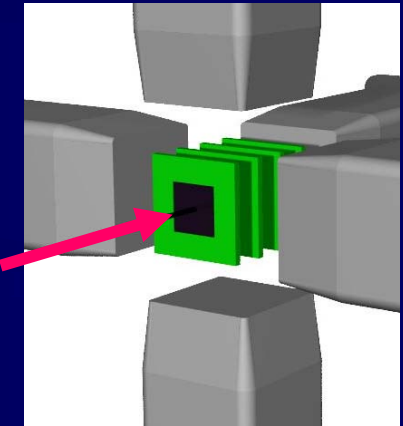
^{238}U @ 345 MeV/u

→ Be target

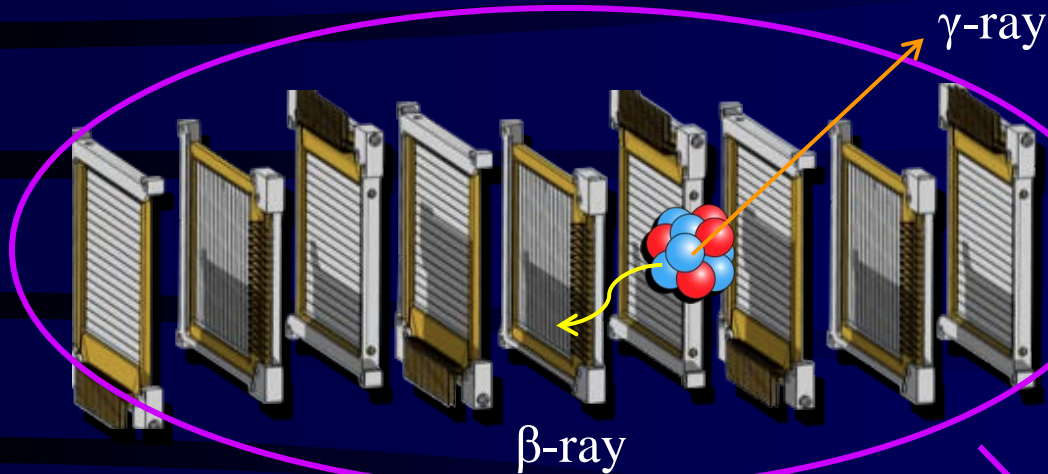


- Charge stripper @ F5
- Degrader @ F11

Silicon strip detector



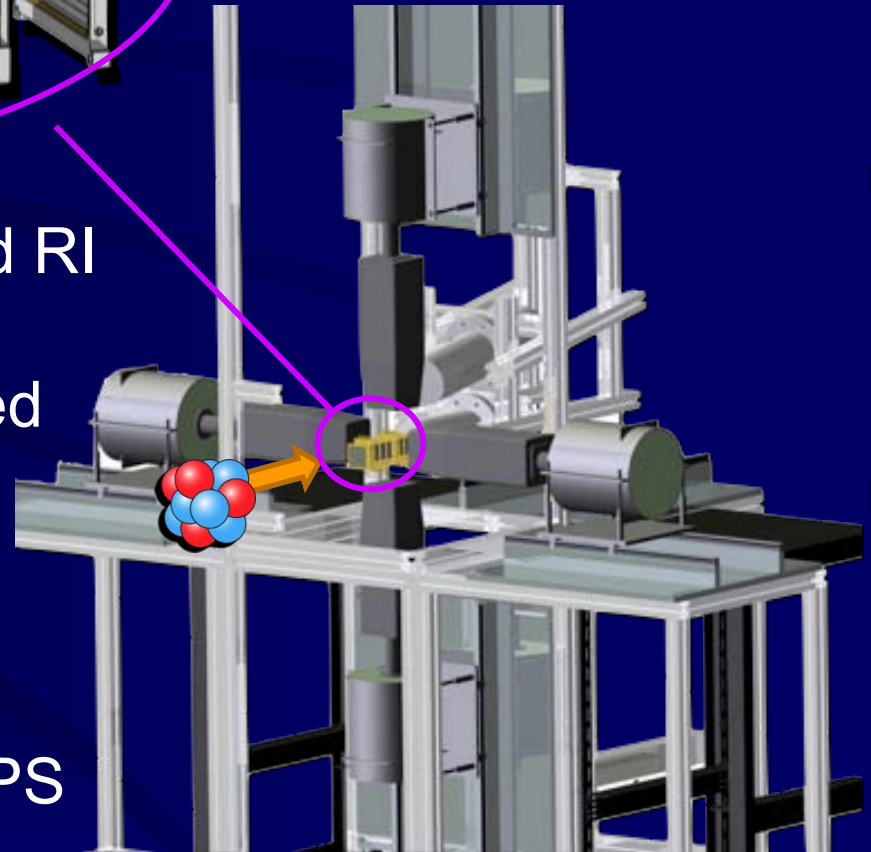
Experimental Setup



- RI & β -ray detection
 - 9 DSSDs ($50 \times 50 \times 1 \text{ mm}^3$)
 - 16 x 16 strips
 - ~ 2000 pixels in total

➤ The implantation of an identified RI is associated with the following β -decay events that are detected in the same DSSSD pixel

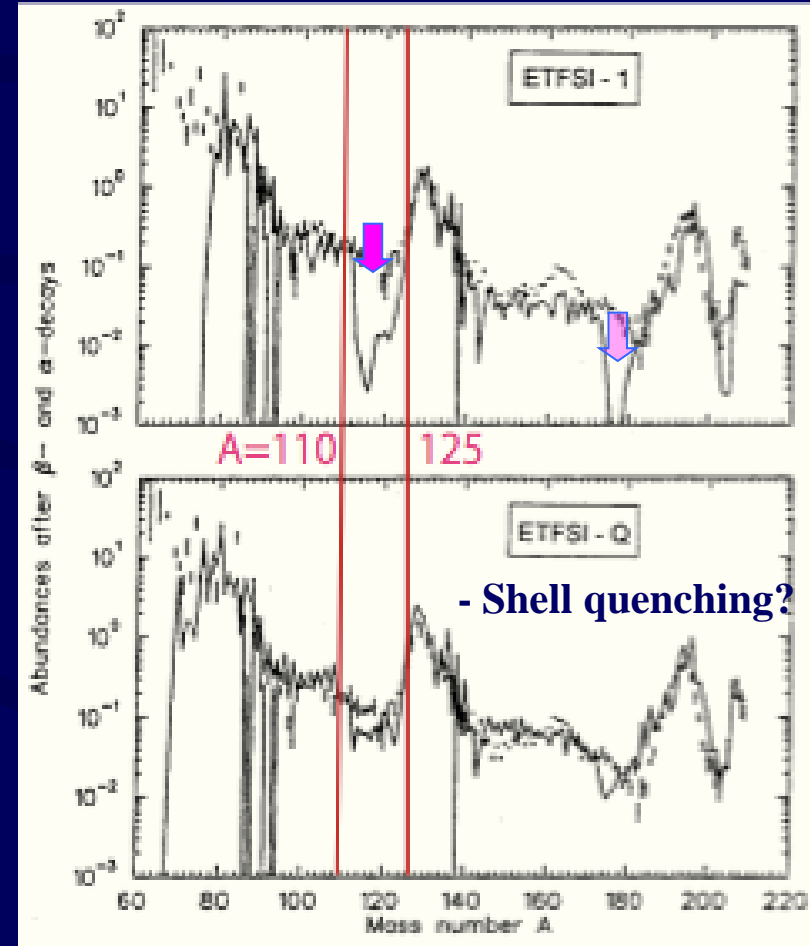
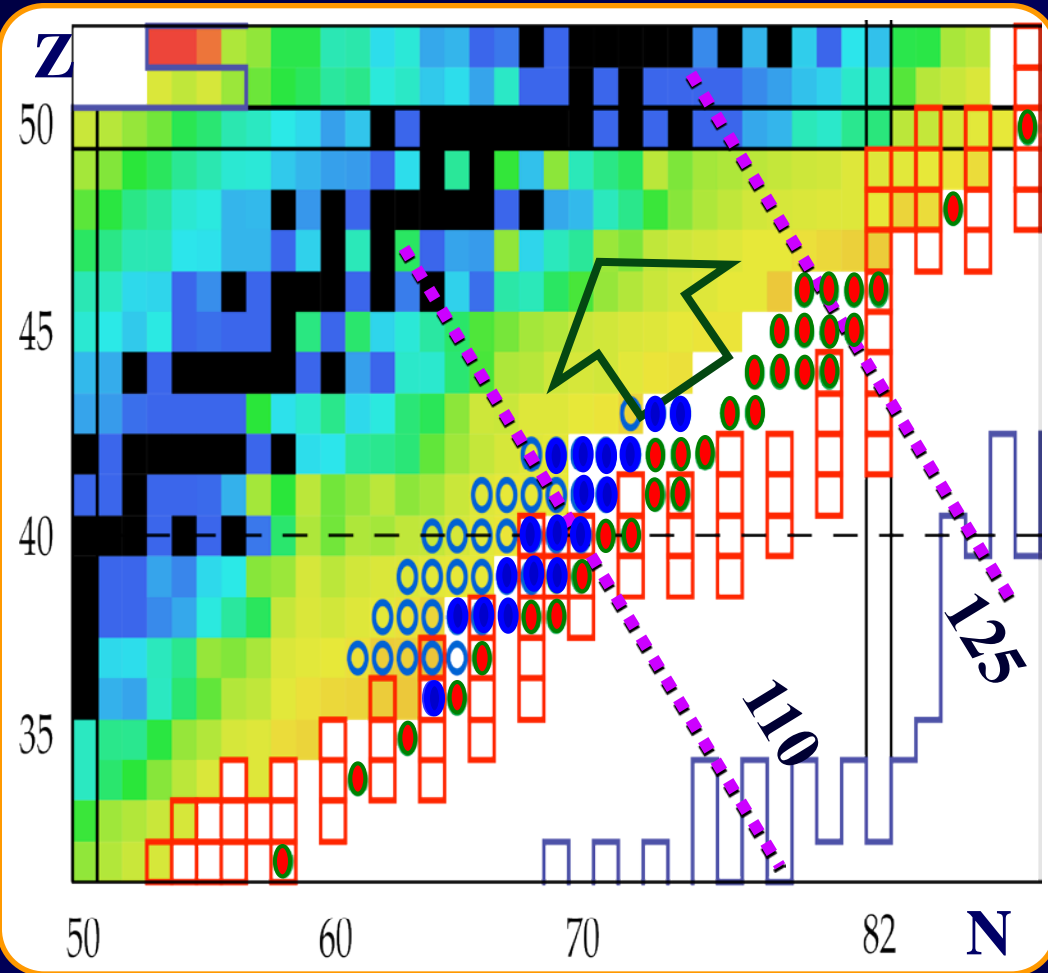
➤ ΔE -TOF-B ρ method using the focal plane detectors in BigRIPS



R-process Abundance around 2nd peak

T. Ohnishi, JPSJ 79 (2010).. 45 new isotopes

B. Pfeiffer et al. Z. Phys. A357 (1997)



$$1/T_{1/2} = \sum_{E_i \geq 0}^{E_i \leq Q_\beta} S_\beta(E_i) \times f(Z, Q_\beta - E_i);$$

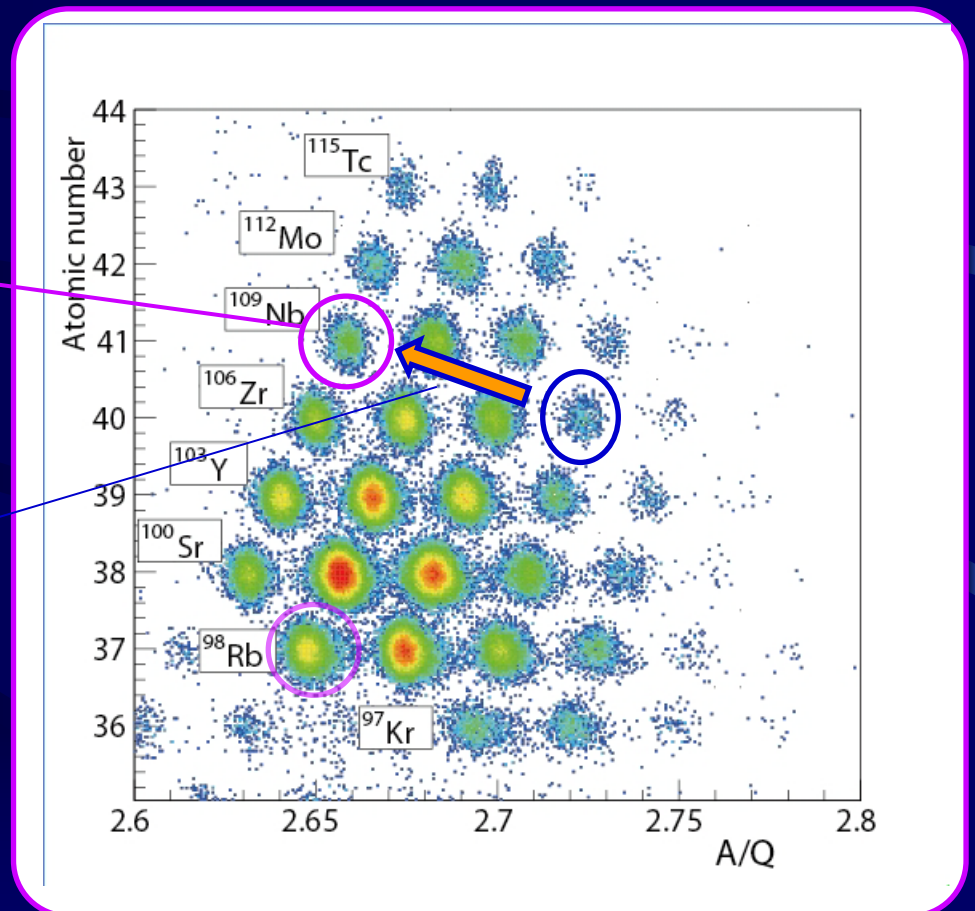
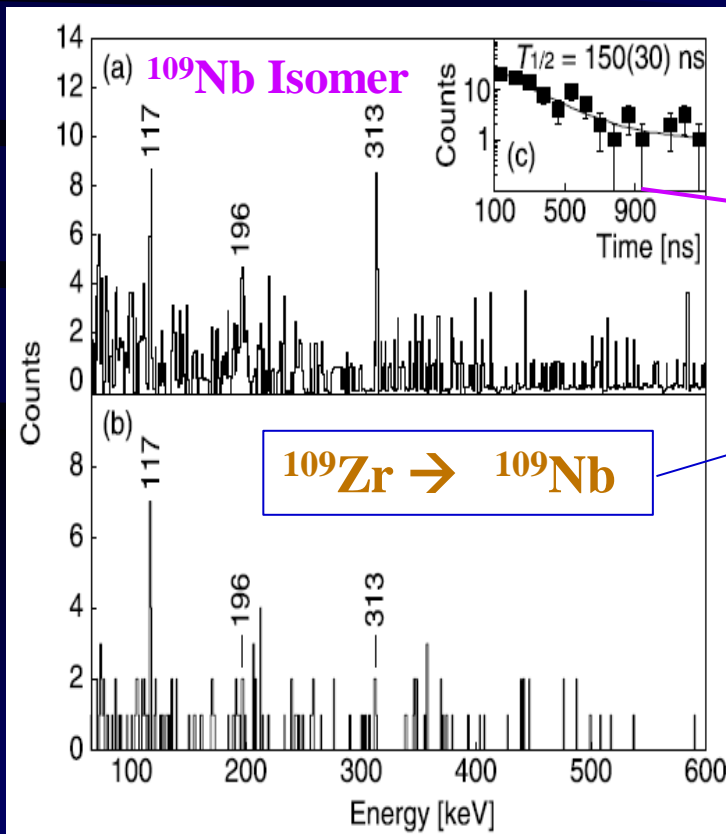
$$f \sim (Q_\beta - E_i)^5$$

Isomers and beta-delayed γ -rays

H. Watanabe, et al.,
PLB 696 (2011) 186.

beam time : 2.5 ~ 3 days

“Low-lying level structure of ^{109}Nb
A possible oblate-shape isomer”

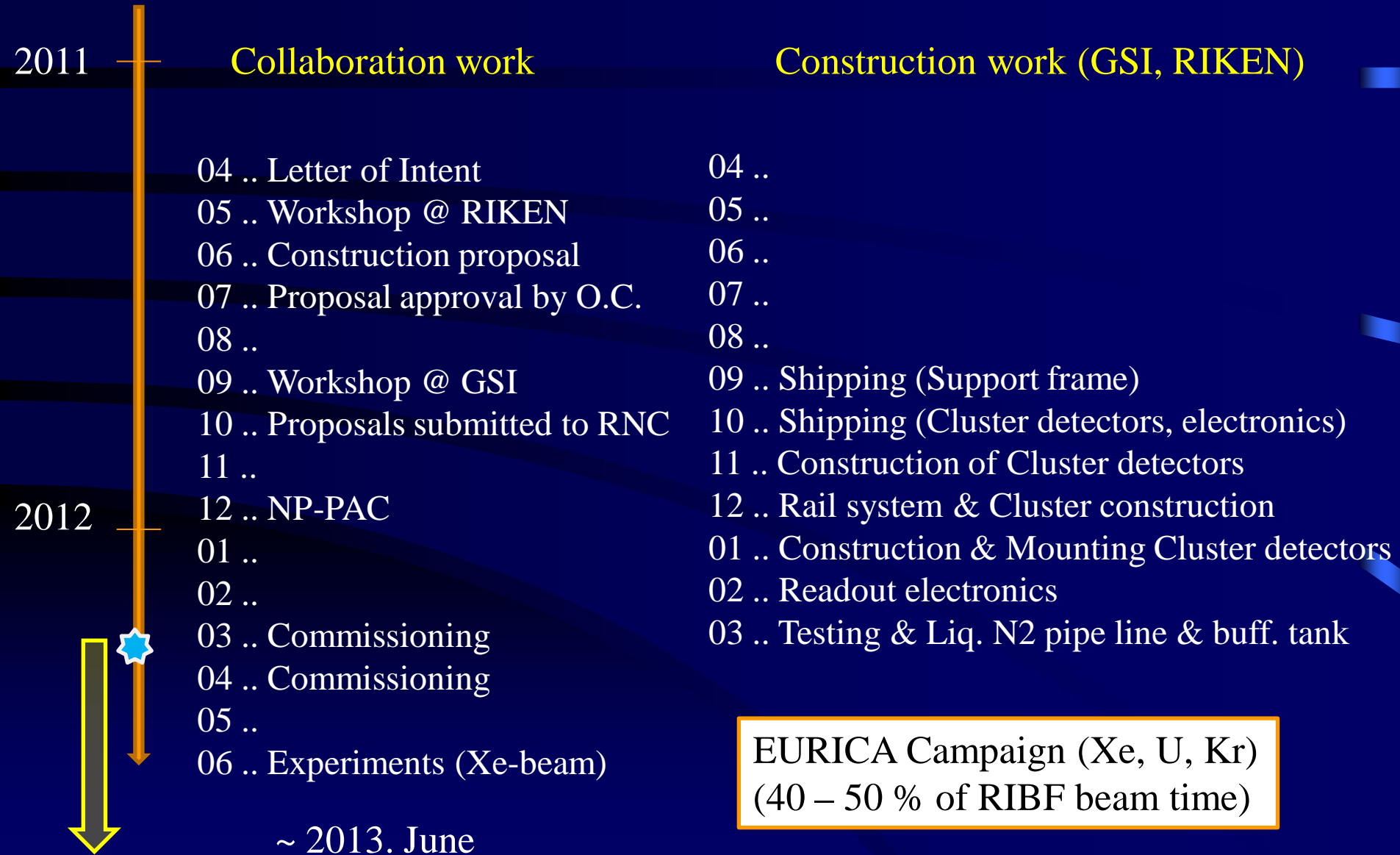


EURICA Project

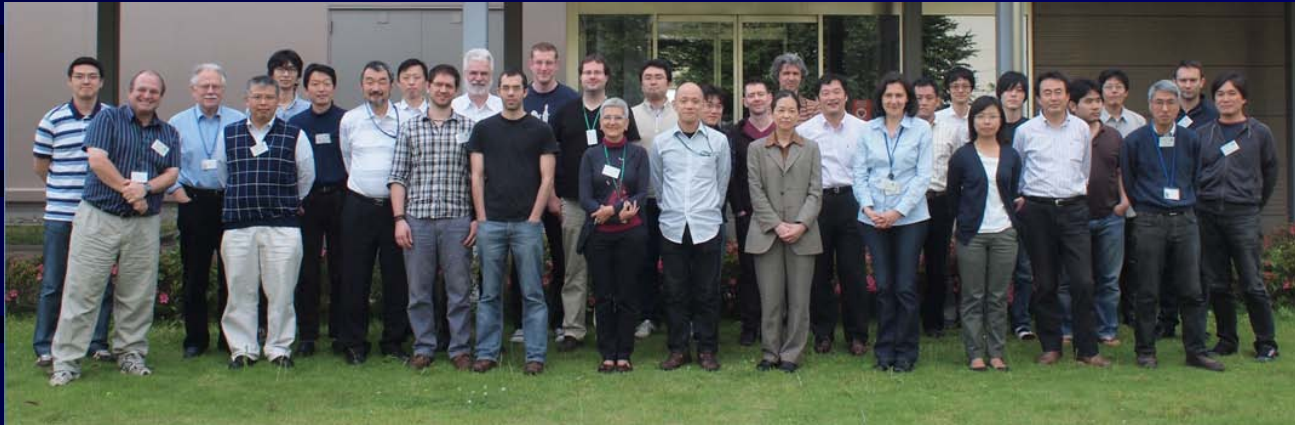
for Stopped Beam Experiment



Time-line (2011 – 2013.06)



EURICA Workshops



2011.05
at RIKEN

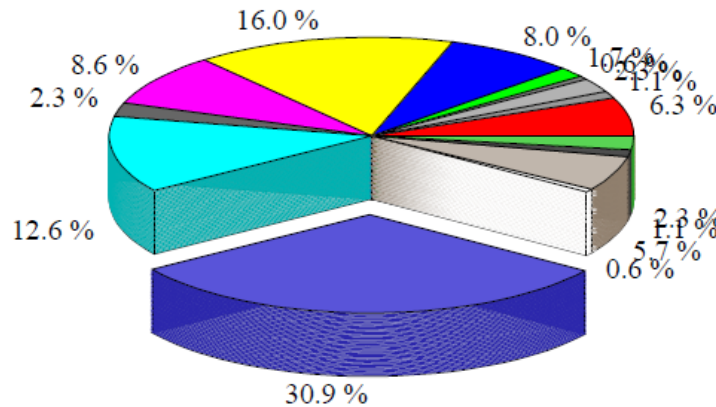


2011.09
at GSI

EURICA Collaboration

(> 170 people, >47 Inst./Univ.)

Origin of Collaboration Members



Bostan⁶, A. Bracco^{5,7}, S. Brambilla⁷, A. Bruce⁴⁴,
 ément⁸, F. Crespi^{5,7}, P.V. Cuong⁴⁵, G. de Angelis^{11,12},
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 Madrid, Spain
 Tsukuba, Japan

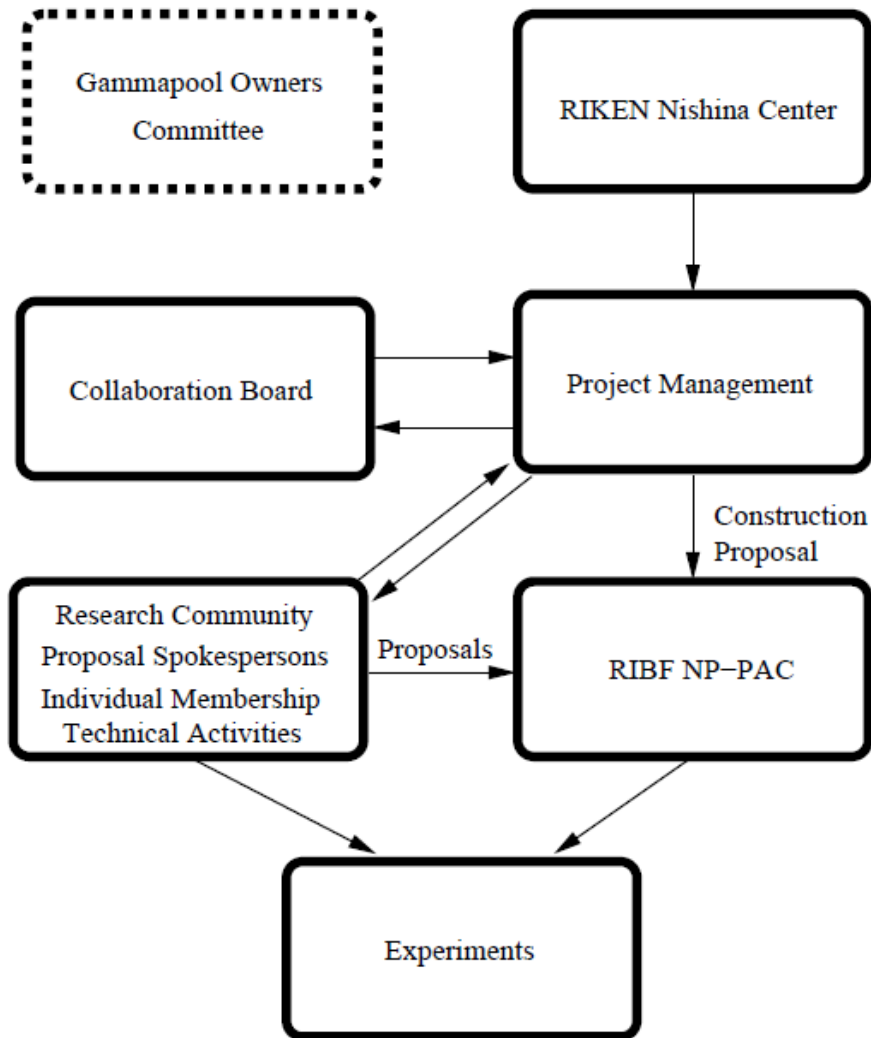
³⁷TU Darmstadt, Germany
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¹³IPN Orsay, France

¹⁴University of Arizona,
 Antalya, Turkey
¹⁷TRIUMF, Vancouver, Canada
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²⁰TU München, Germany
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²²CENBG Bordeaux, France
²³JAEA, Tokai, Japan
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²⁵CEM Orsay, France
²⁸Hoseo University,
 Chun-Nam, Korea
²⁹ICU, Tokyo, Japan
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³²Osaka University, Japan
³³Uppsala University, Sweden
³⁴LPSC Grenoble, France
³⁵Kyoto University, Japan
³⁶University of Tokyo, Hongo,
 Japan

Organization of EURICA



Project Management

- S.Nishimura (Project Manager)
- P.Doornenbal (Technical Co.)

Collaboration Board (CB)

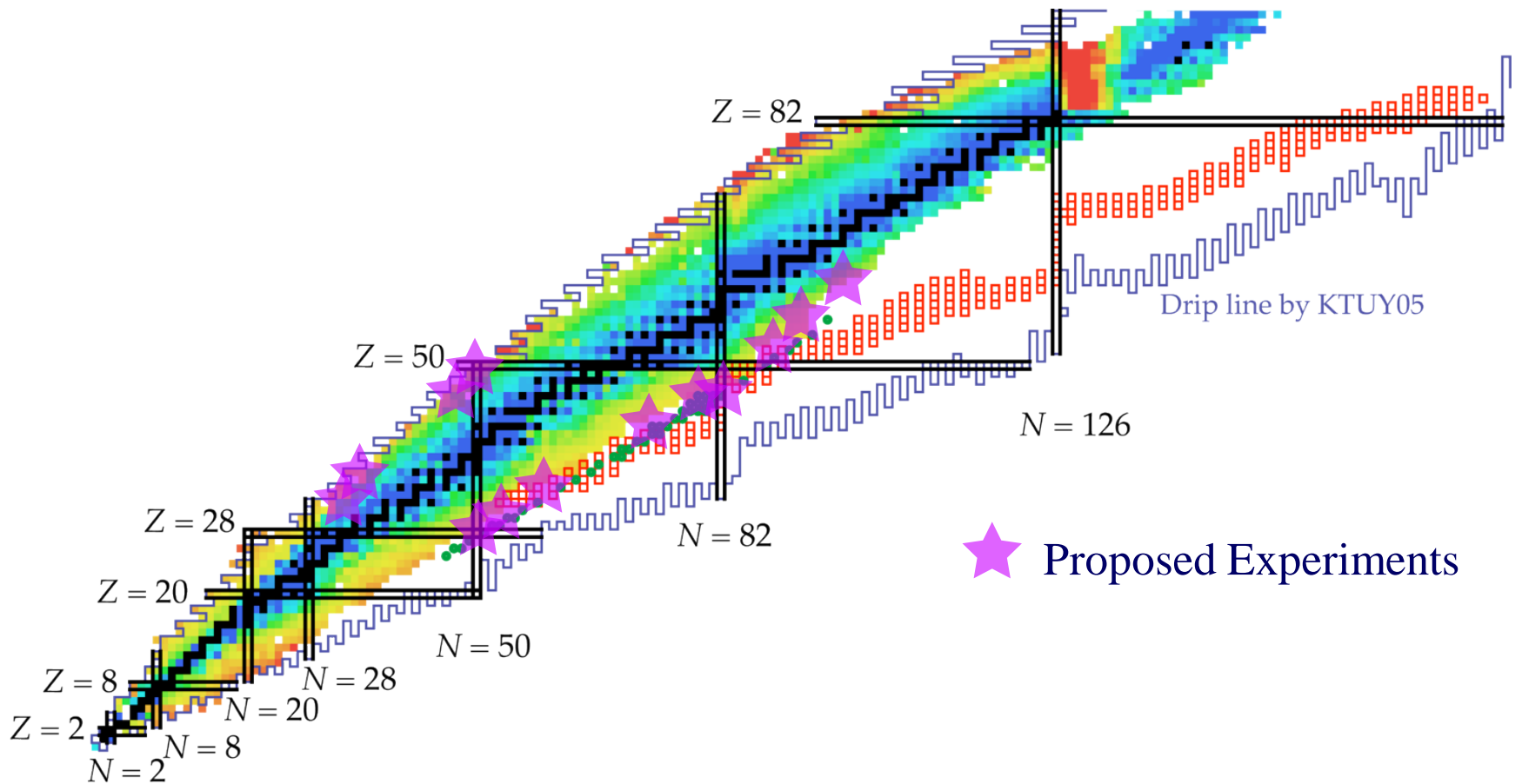
- N. Aoi
- A. Bracco
- E. Ideguchi*
- T.Koike
- R. Krucken
- P. Regan**

Physics Programme (NP-PAC 2011 Dec.)

NP0702-RIBF04R1 (Update Proposal)	B. Blank (S. Grévy)	CENBG Bordeaux	BigRIPS	EURICA	Search for two-proton radioactivity of ^{65}Ge , ^{63}Se , and ^{67}Kr	^{78}Kr	350	30 pA
NP0702-RIBF26R1 (Update Proposal)	T. Sumikama	Tokyo U. of Sci.	BigRIPS+ ZDS	EURICA	Decay spectroscopy of neutron-rich Zr and Mo isotopes	^{238}U	345	5 pA
NP0802- RIBF60&62R1 (Update Proposal)	H. Watanabe & G. Lorusso	RNC	BigRIPS+ ZDS	EURICA	Search for long-lived isomeric states in neutron-rich Cd, Ag, and Pd isotopes / β -decay spectroscopy of the very neutron-rich nuclei Nb-Ag, including the r-process waiting points $^{128}\text{Pd}_{82}$	^{238}U	345	5 pA
NP1012-RIBF49R1 (Update Proposal)	G. de Angelis	INFN Legnaro	BigRIPS+ ZDS	DALIE	Intermediate-energy Coulomb excitation in ^{60}Ni : probing the core polarization around the doubly magic ^{78}Ni	^{238}U	345	5 pA
NP1112-RIBF77	G. Georgiev	CSNSM Orsay	BigRIPS	-	Nuclear structure at the island of inversion around $N=40$. Nuclear moment studies in ^{62}Fe	^{70}Zn	345	270 pA
NP1112-RIBF78	J.-M. Daugas R. Lozeva	CEA/DAM/DIF CNRS IPHC	BigRIPS	-	Exploring the single particle structure of neutron-rich Sn isomers via magnetic moment measurements	^{136}Xe	345	10 pA
NP1112-RIBF79	J. Zenihro	RNC	BigRIPS+ ZDS	-	Nucleon density distributions of ^{132}Sn deduced via ESPRI measurements - Toward precision measurements of scattering lengths of ^{132}Sn	^{238}U	345	> 5 (hopeful 135) pA
NP1112-RIBF80	G. Benzoni	INFN Milano	BigRIPS	EURICA	Structural changes between $N=40$ and $N=50$ next to Ni isotopes: a joint proposal	^{238}U	345	5 pA
NP1112-RIBF81	V. Werner	Yale U.	BigRIPS	EURICA	Role of the $\nu d_{5/2}$ sub-shell in the evolution of Ge and Se isotopes, and evolution of collectivity in adjacent transitional odd- and even- A nuclei	^{238}U	345	5 pA
NP1112-RIBF82	B. Rubio, Y. Fujita, W. Gelletly	IFIC Valencia Osaka U., U. of Surrey	BigRIPS	EURICA	Comparison of $T_z=-2$ beta decays with their mirror process on $T_z=2$ nuclei and search for isospin suppressed gamma and proton transitions	^{78}Kr	350	30 pA
NP1112-RIBF83	P. Boutachkov, R. Wadsworth, A. Blazhev, Z. Liu	TU Darmstadt, U. of York, U. of Cologne, U. of Edinburgh	BigRIPS	EURICA	Study of isomer and proton decays in $N \leq Z$ nuclei below ^{100}Sn	^{124}Xe	345	10 pA
NP1112-RIBF84	A. Gadea, A. Gottardo	IFIC Valencia	BigRIPS+ ZDS	EURICA	Investigation of the proton-neutron $T=0$ condensate through GT decay to the quasi-deuteron 1^+ state in odd-odd $N=Z$ Nuclei	^{124}Xe	345	10 pA
NP1112-RIBF85	G. Simpson, A. Jungclauss, A. Gadea	LPSC Grenoble, CSIC Madrid, IFIC Valencia	BigRIPS+ ZDS	EURICA	Study of the isomeric and β -decays of ^{132}Cd and $^{136,138}\text{Sn}$	^{238}U	345	5 pA
NP1112-RIBF86	E. Ideguchi G. Simpson	CNS, LPSC Grenoble	BigRIPS+ ZDS	EURICA	Search for K-Isomers in Neutron-Rich $Z \approx 60$ Isotopes	^{238}U	345	5 pA
NP1112-RIBF87	A. Odahara, R. Lozeva, C. Moon	Osaka U., CNRS IPHC, Hoseo U.	BigRIPS+ ZDS	EURICA	Shape evolution in neutron-rich $A \sim 140$ nuclei beyond the doubly-magic nucleus ^{132}Sn	^{238}U	345	5 pA
NP1112-RIBF88	H. Watanabe	RNC	BigRIPS+ ZDS	EURICA	Probing neutron-rich isotopes in the vicinity of the doubly mid-shell nucleus ^{170}Dy by β - γ and isomer spectroscopy	^{238}U	345	5 pA
NP1112-RIBF89	A. Garnsworthy	TRIUMF	BigRIPS+ ZDS	EURICA	Decay properties of nuclei along the r-process path around $A=100$	^{238}U	345	5 pA

EURICA

^{238}U -, Xe-, and Kr-beams



Requirements

**High Intensity
Radioactive
Isotope Beam Facility**

RIBF
U beam (~ 5 pnA)

**Large Acceptance
Beam Line
& PID**

BigRIPS (PID : $Z < 70$)



High segmentation (SIMBA)
High efficiency (RIKEN)

Euroball Cluster Detectors
LaBr3 Detectors

**High Efficiency
Beta-Counting System**

**High Efficiency
Gamma-ray Detectors**

Installation : Completed

Jan. 15



Summary



- EURICA :
 - EUROBALL RIKEN Cluster Array (x12)
 - Letter of Intent (2011.April)
 - Proposal (2011.July)
 - Gammapool Owners Committee → 12 Cluster detectors (Approved)
- Collaboration :
 - Free and open access to any researcher interested in joining
 - More than 170 people
 - Scientific supports with a lots of physics cases (13 + 2)
- Experiments (2012.Mar. – 2013.June) :
 - Commissioning (2012. Mar. & April.)
 - First EURICA Experiment in June & U-, Xe, Kr Campaigns
 - 40-50% beam time to be allocated for EURICA
 - ^{238}U beam intensity (x10) from 0.1 ~ 0.3 p nA → 5 p nA
 - Last decay exp. (2009) γ - γ coincidence : 1 week → 10 min.

Let's enjoy and
find something interesting !



- Nuclear Structure
- Nuclear Astrophysics

Acknowledgements

- Gammapool Owners Committee
 - R.Herzberg, ...
- GSI Supports
 - I. Kojouharov, H.Schaffner, N.Kurz, H.J.Wollersheim, J.Gerl, H.Stoker, ...
- PreSPEC Collaboration
 - P.Regan, ..
- RIKEN Supports
 - W.Henning, T.Motobayashi, H.Sakurai, BigRIPS team, Y.Onishi, H.Enyo, ..

and EURICA collaborations

contact : eurica @ riken.jp

Some Photos

Nov.02



Jan.10



Jan.05



Feb.04

