東京大学
THE UNIVERSITY OF TOKYO

東京大学 大学院
理学系研究科・理学部
SCHOOL OF SCIENCE, THE UNIVERSITY OF TOKYO

CNS

RIKEN
NISHINA
CENTER

NP-PAC
Feb 18-19, 2008

Report from CNS

(Overview of Nuclear Physics programs with CRIB and SHARAQ)

Part 1 CRIB experiments

Part 2 SHARAQ construction

CRIB Activities during 2007.9 ~ 2008.1

Programs performed during 2007.9 ~2007.12 at CRIB [I]

- Production Test of ^{17}N of Polarized RI beam (Asahi)
  October ’07 ; 2 days
  December ’07; 2 days

- ^{17}F elastic scattering (Zhang)
  October ’07; 10 days
  strong collaboration with CAEA

- ^{46}Cr beam production test (Wakabayashi)
  Nov.’07; 2 days

Recent publications (refereed)

1) **Single-Particle Resonance Levels in ^{14}O Examined by ^{13}N+ *p* Elastic Resonance Scattering**
   : Phys. Lett. B 650 (2007) 129 – 134
   T. Teranishi, et al.

2) **Investigation of Structure in ^{23}Al via Resonant Proton Scattering of ^{22}Mg+p and the ^{22}Mg(p,γ)^{23}Al Astrophysical Reaction Rate**
   : Phys. Rev. C76 (2007) 055802
   J.J. He, et al.

3) **Elastic Scattering of 120-MeV Alpha Particles by ^{28}Si**
   : Jour. Korean Phys. Soc., 51 (2007) 1635 – 1639
   Y.K. Kwon, et al.

CRIB Programs Scheduled
(January ~ March, 2008)

- Acceleration of ^{16}O at 10.5 MeV/u and ^{17}Ne production (Teranishi) : Jan. '08; 1 day
- $^{18}F(p,\alpha)^{15}O$ stellar reaction (Cherubini/Catania) : March '08; 7 days
- Test of P30 beam production (He/Edinburgh) : March '08; 1.5 days

Back Logs – 1 (14 days)

CRIB Programs planned for the period of April ~ July, 2008

Programs approved (not scheduled) ;

- Study of $^{30}S(\alpha,p)$ stellar reaction (Chen/McMaster)
  : May '08, 2 days
  : July '08, 2 days
- $^{14}O + \alpha$ resonant elastic scattering (K.I.Hahn/ Korea)
  : June '08, 6 days
- Detector test- Ionization chamber for high PI capability (Wakabayashi/CNS) : April '08, 2 days

Back Logs – 2 (22.5 days)

CRIB Approved Programs not scheduled as of February 2008

- Study of ^{21}Na(α,p) stellar reaction (Le/Vietnam)
  : 9 days
  → Being planned for 2008 fall.

- Study of ^{30}S(α,p) stellar reaction (Chen/McMaster)
  : 9 days
  → Being planned for '08 fall or '09 winter.

- Study of Quasi-fission process (Das Gupta/Australia)
  : 4.5 days
  → Not decided.

– Total Back Logs –
(to be carried out after April 2008)

14 + 22.5 + 2 + 2= 40.5 days (incl. detector tests)

2 days : Teranishi
2 days : He

incl. 4.5 days by Gupta which might be shifted to a later time

~ 1 year performance

Guideline for experiment scheduling since June, 2007

(Machine Time Committee agreement)

One experiment per a month

Sufficient interval is needed for preparation

maintenance and tuning needed

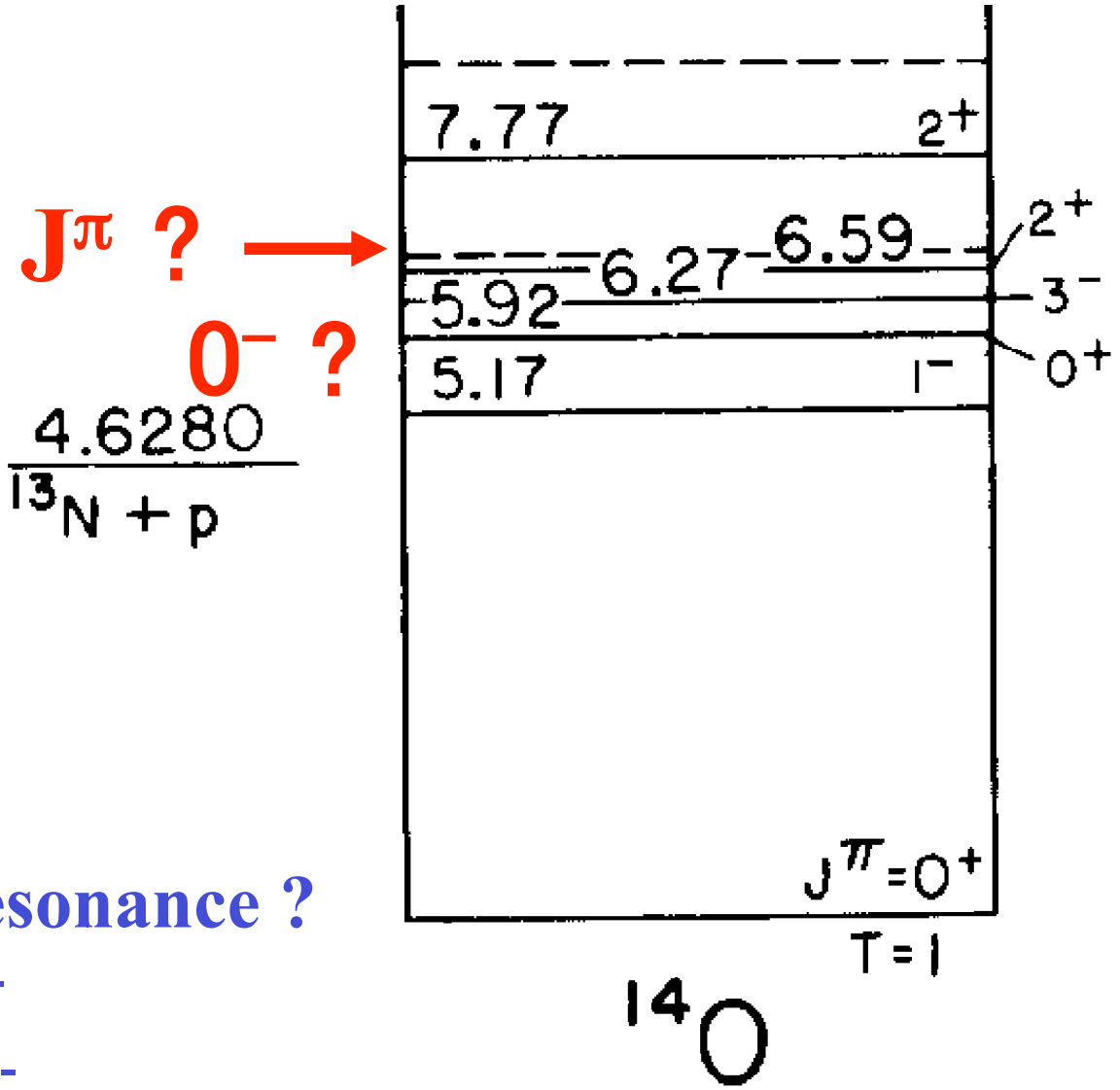
This is due to limited human resources for running CRIB, and is in accordance with the recommendation by the Advisory Committee of CNS (Feb. 2007).

Recent Result;
Resonance Search of ^{13}N+p for rp-process

by T. Teranishi (Kyushu U.)

^{13}N+p experiment (^{14}O resonances)

- Search for unknown resonances
  Astrophysical ^{13}N(p,γ)^{14}O reaction rates
- Spectroscopic factors for single-particle proton orbitals



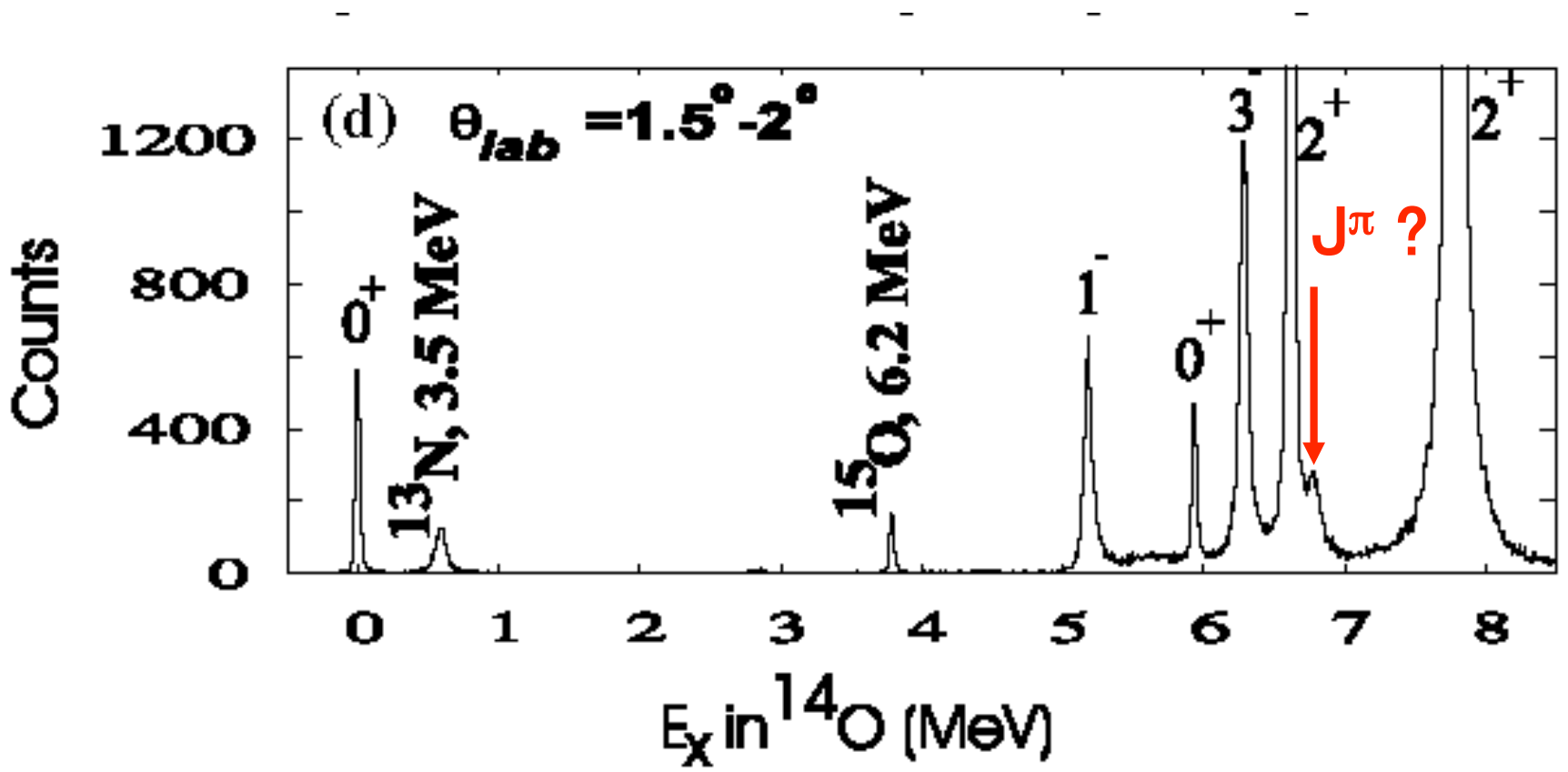
single particle resonance ?

$(p_{1/2} \cdot s_{1/2})$ $J=0^-, 1^-$

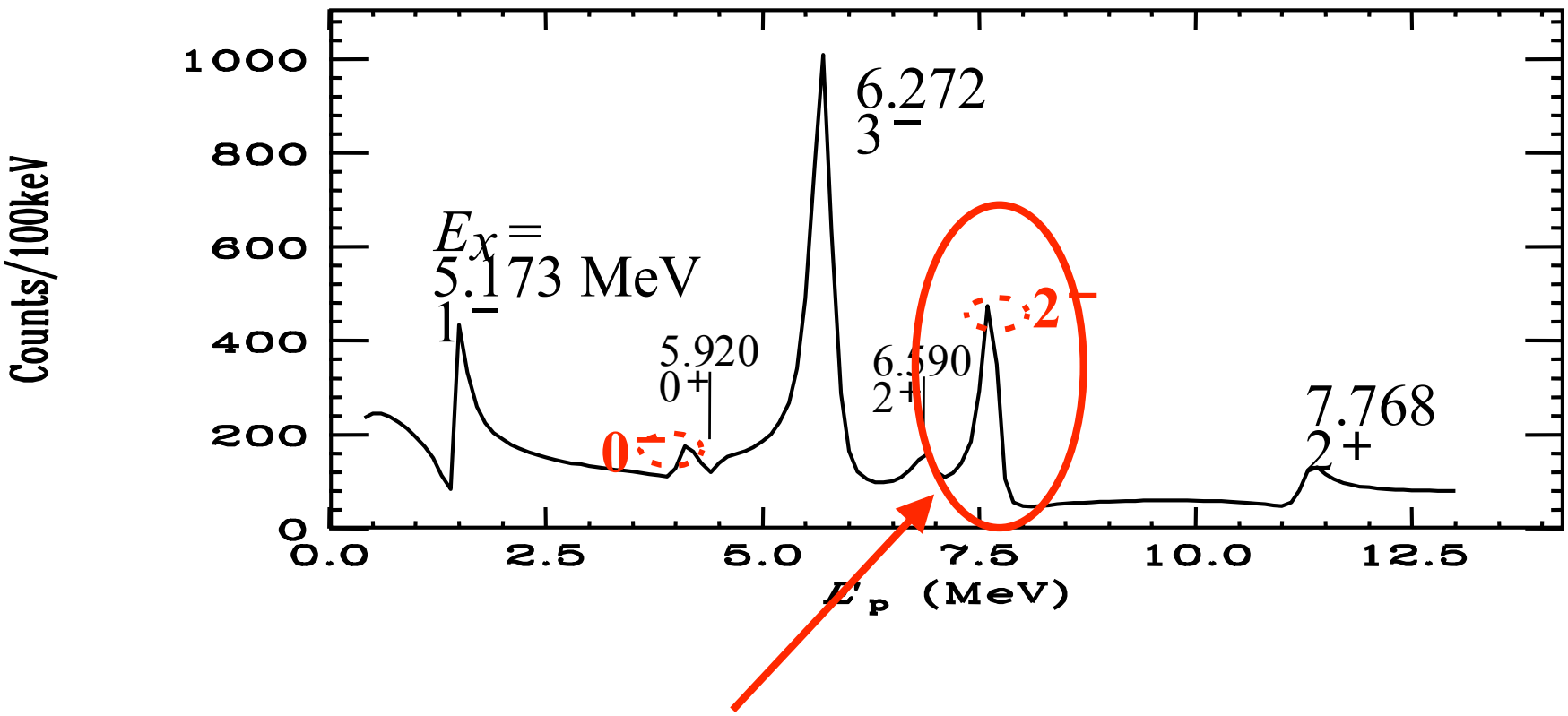
$(p_{1/2} \cdot d_{5/2})$ $J=2^-, 3^-$

$^{14}N(^{3}He,t)^{14}O$ E_L=420 MeV

(RCNP / Negret 05)



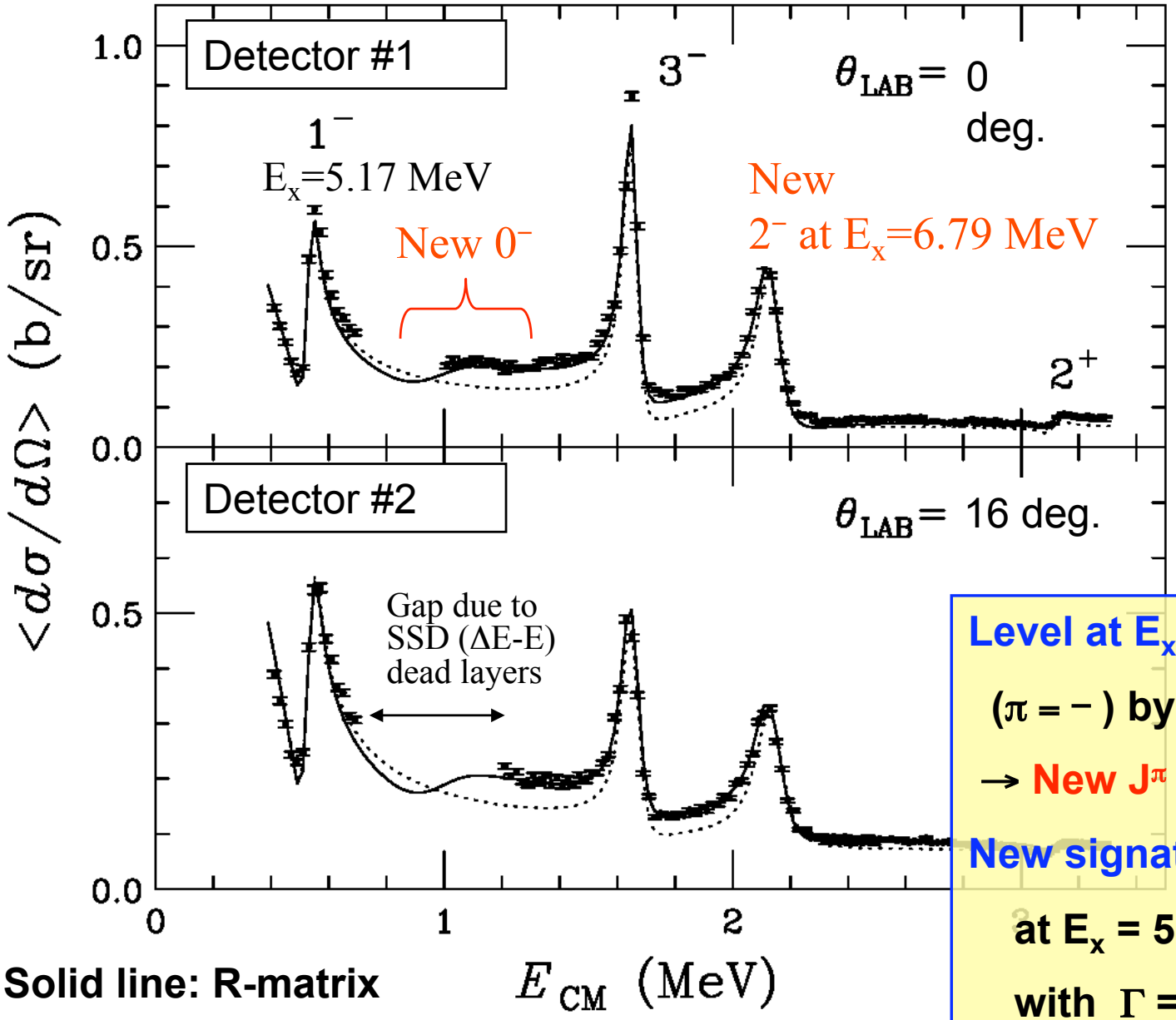
Prediction : ^{13}N+p Resonance



If it is a good single particle state

(Collaboration with Kyushu U.)

^{13}N+p result (^{14}O resonances)



Solid line: R-matrix

Energy resolution ~20 keV (FWHM)

Level at E_x = 6.79 MeV

($\pi = -$) by ^{14}N(^{3}He,t) reaction

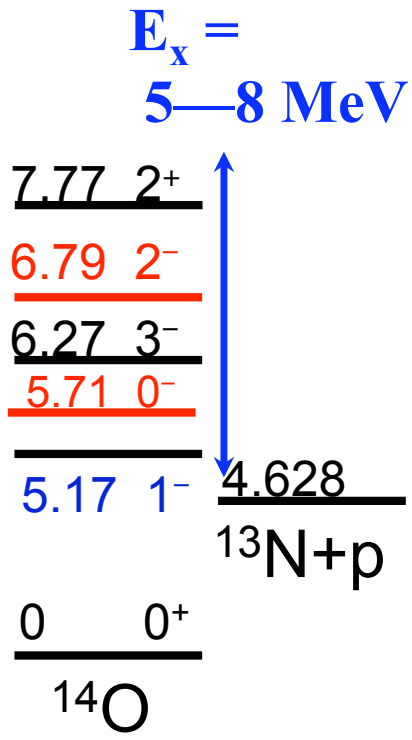
→ New J^π assignment $J^\pi = 2^-$

New signature of 0^- level

at E_x = 5.71(2) MeV

with Γ = 400(100) keV

Summary of ^{13}N+p

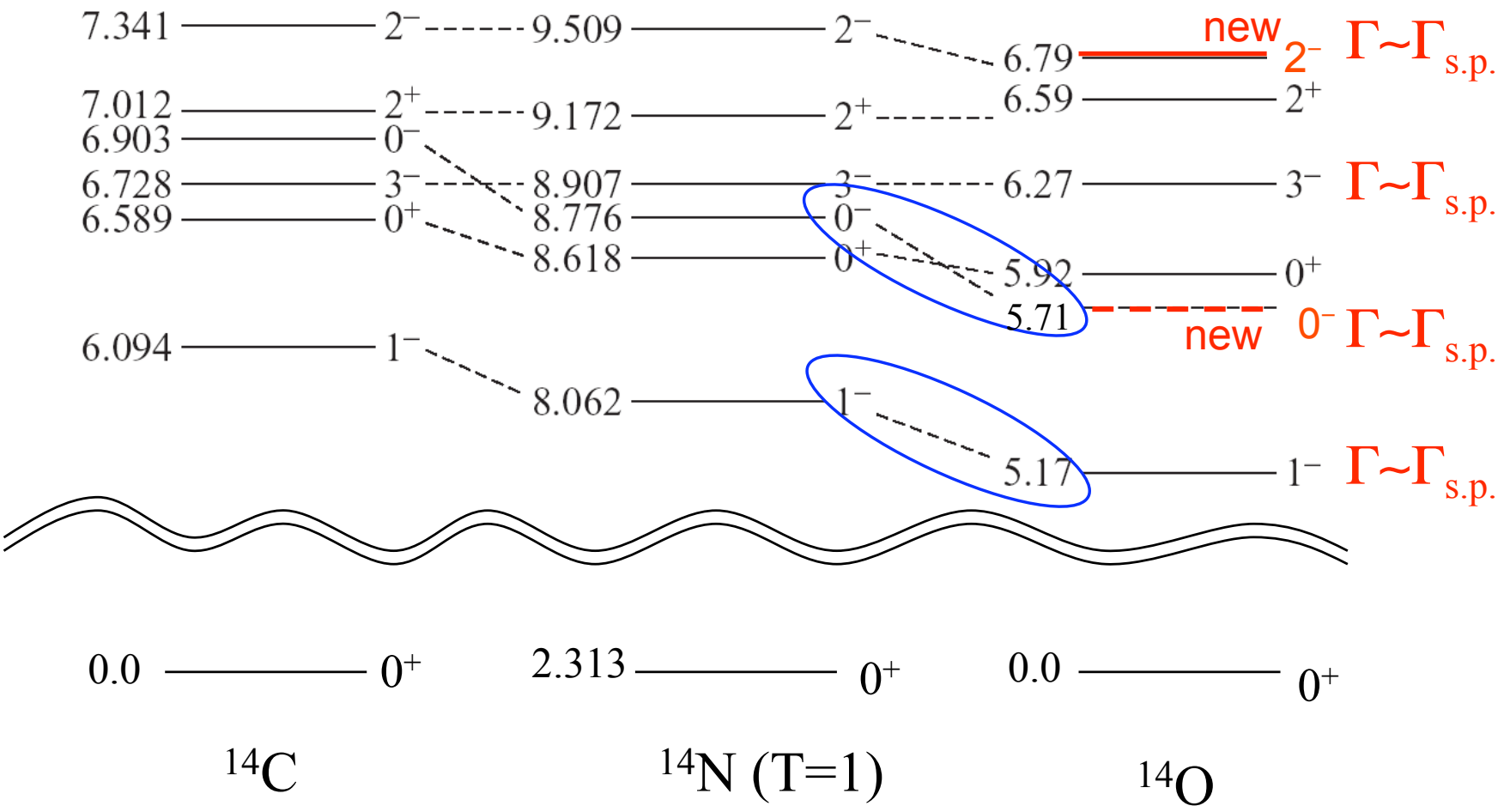


J^π	l_j	Γ_{exp} (keV)	$\Gamma_{s.p.}$ (keV)
1^-	$s_{1/2}$	42(3)	45
0^-	$s_{1/2}$	400(100)	550
3^-	$d_{5/2}$	42(3)	53
2^-	$d_{5/2}$	96(4)	130

- The first experimental signature of the 0^- levels in ^{14}O.
- $J^\pi = 2^-$ has been clearly established for the 6.8 MeV level.
- The **Γ** of 1^-, 0^-, 3^- & 2^- levels are comparable to the single-particle values (Γs.p.).
  $\Gamma_{s.p.}$ values were estimated using phase shifts in a Woods-Saxon potential model.

1^- & 0^- levels: ^{13}N+p ($2s_{1/2}$) resonance
3^- & 2^- levels: ^{13}N+p ($1d_{5/2}$) resonance

T=1 triplets in A=14 nuclei



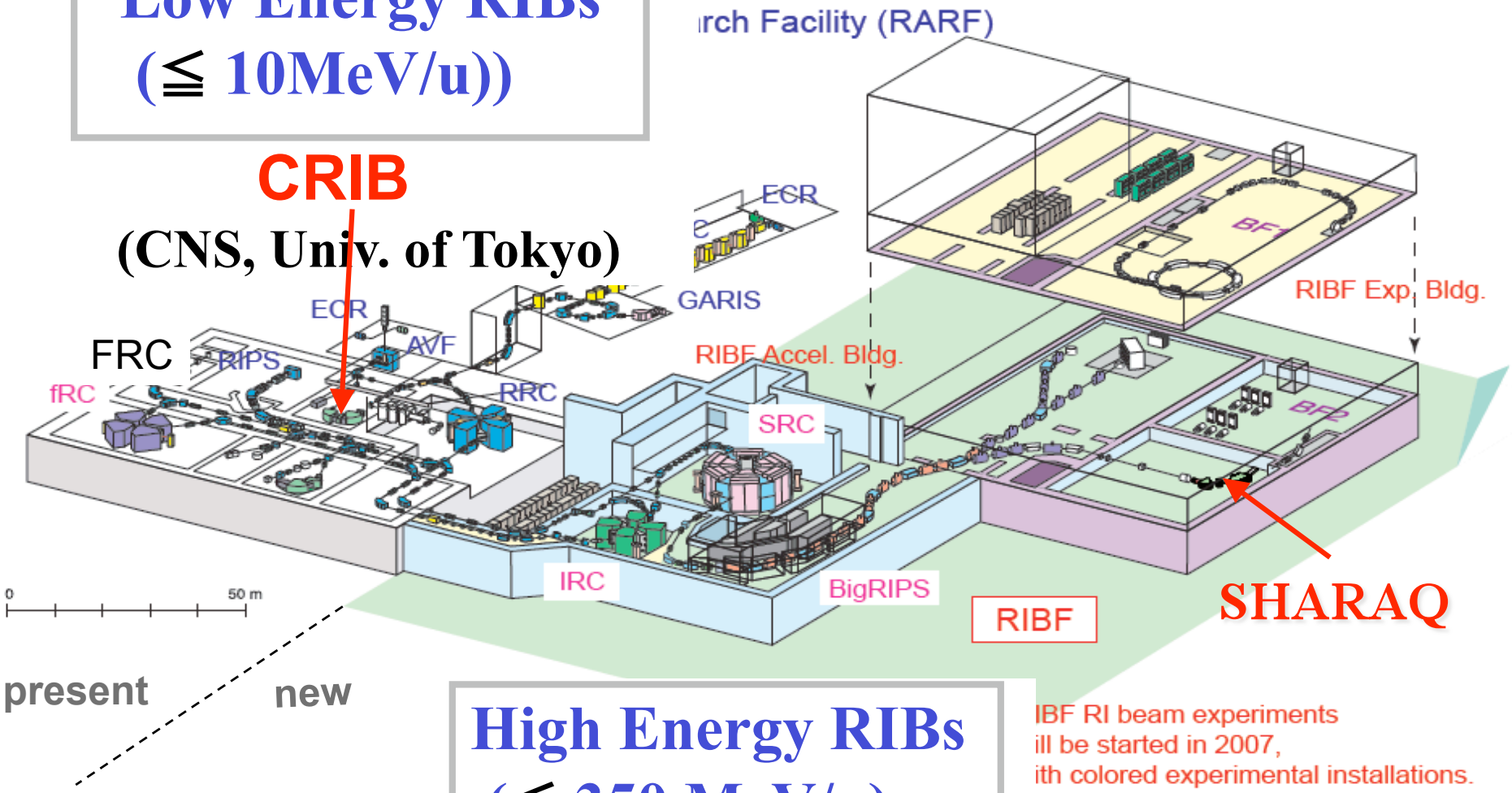
Very large Thomas-Ehrman shifts for s-wave resonances !

SHARAQ construction

RIKEN RIBF Facility

Low Energy RIBs
(≦ 10MeV/u))

CRIB
(CNS, Univ. of Tokyo)



High Energy RIBs
(≦ 350 MeV/u)

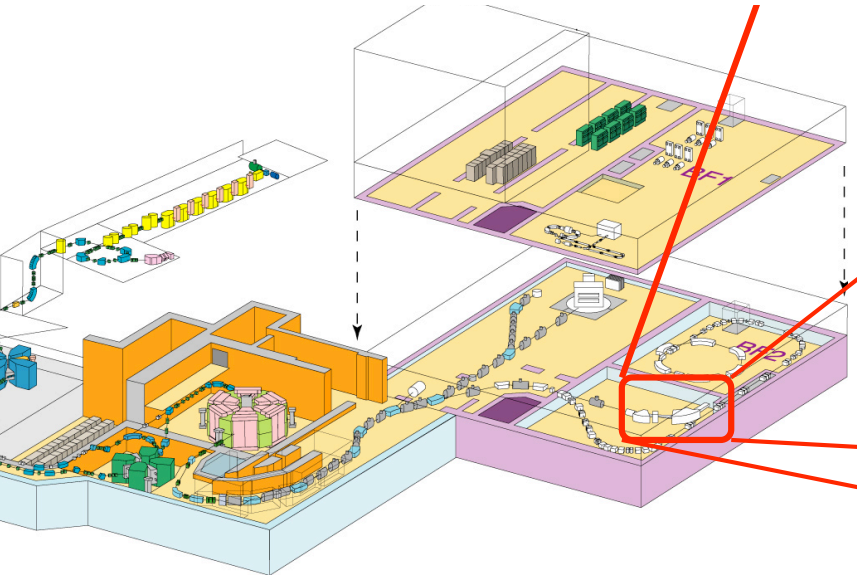
IBF RI beam experiments
ill be started in 2007,
ith colored experimental installations.

Spectroscopy with High-resolution Analyzer and Radio Active Quantum beams

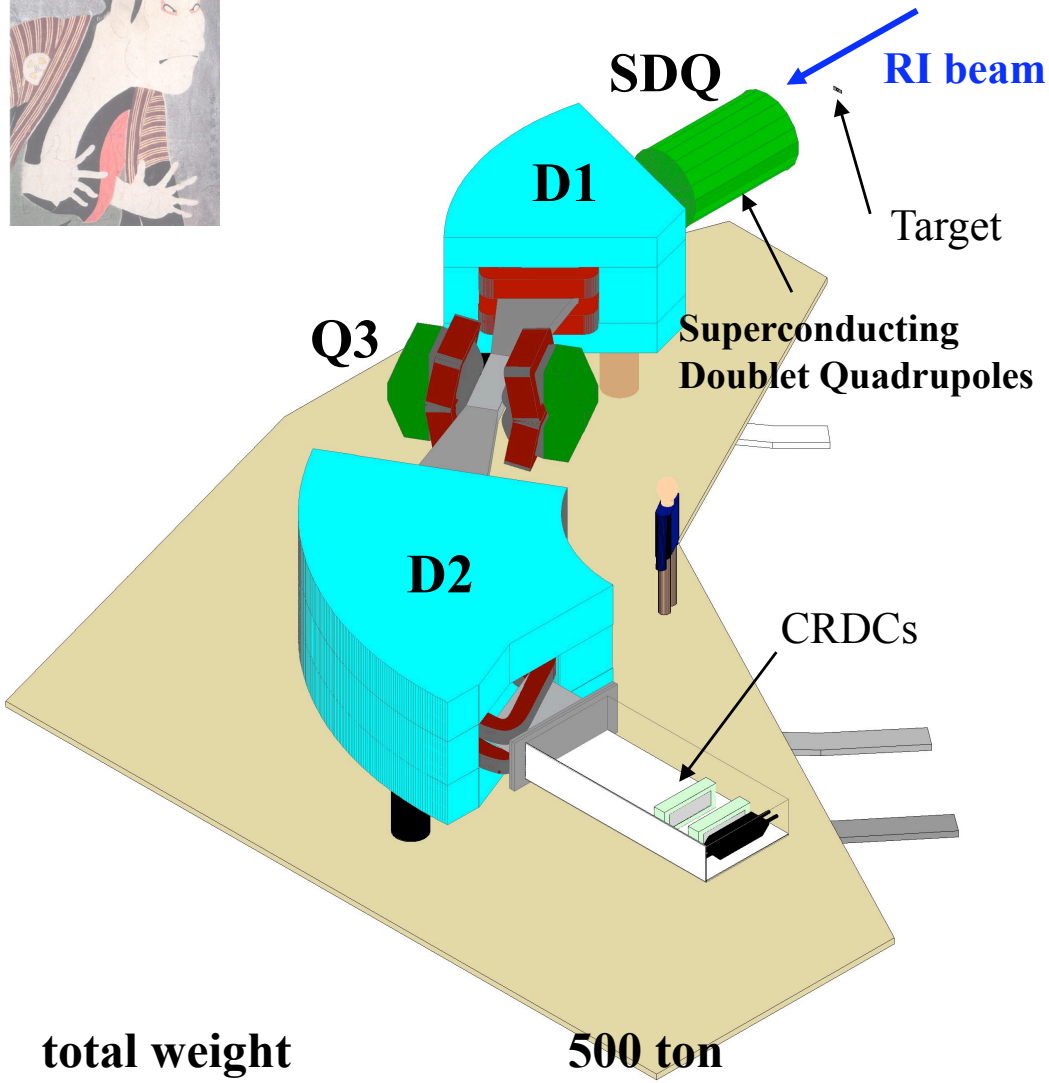
SHARAQ Project

High resolution SHARAQ spectrometer (CNS+Sakai-g) + High-quality RI beam (RIKEN)

mag. rigidity	$B\rho_{(max)} = 6.8$ Tm
momentum res.	$\delta p/p = 1/15000$
angular res.	$\delta\theta = 1$ mrad
acceptance	$\Delta\Omega = 4.8$ msr
mom. accep.	±1%



SHARAQ Spectrometer



total weight **500 ton**

Present Status

Spectrometer:

all the magnets have been installed.

focal plane detectors (cathode read-out drift chamber)

in collaboration with GANIL

Beamline:

to be constructed by RIKEN in FY2008.

beam-line detectors

low-pressure drift-chambers are under development.

beam irradiation test is scheduled in March 2008.

Commissioning :

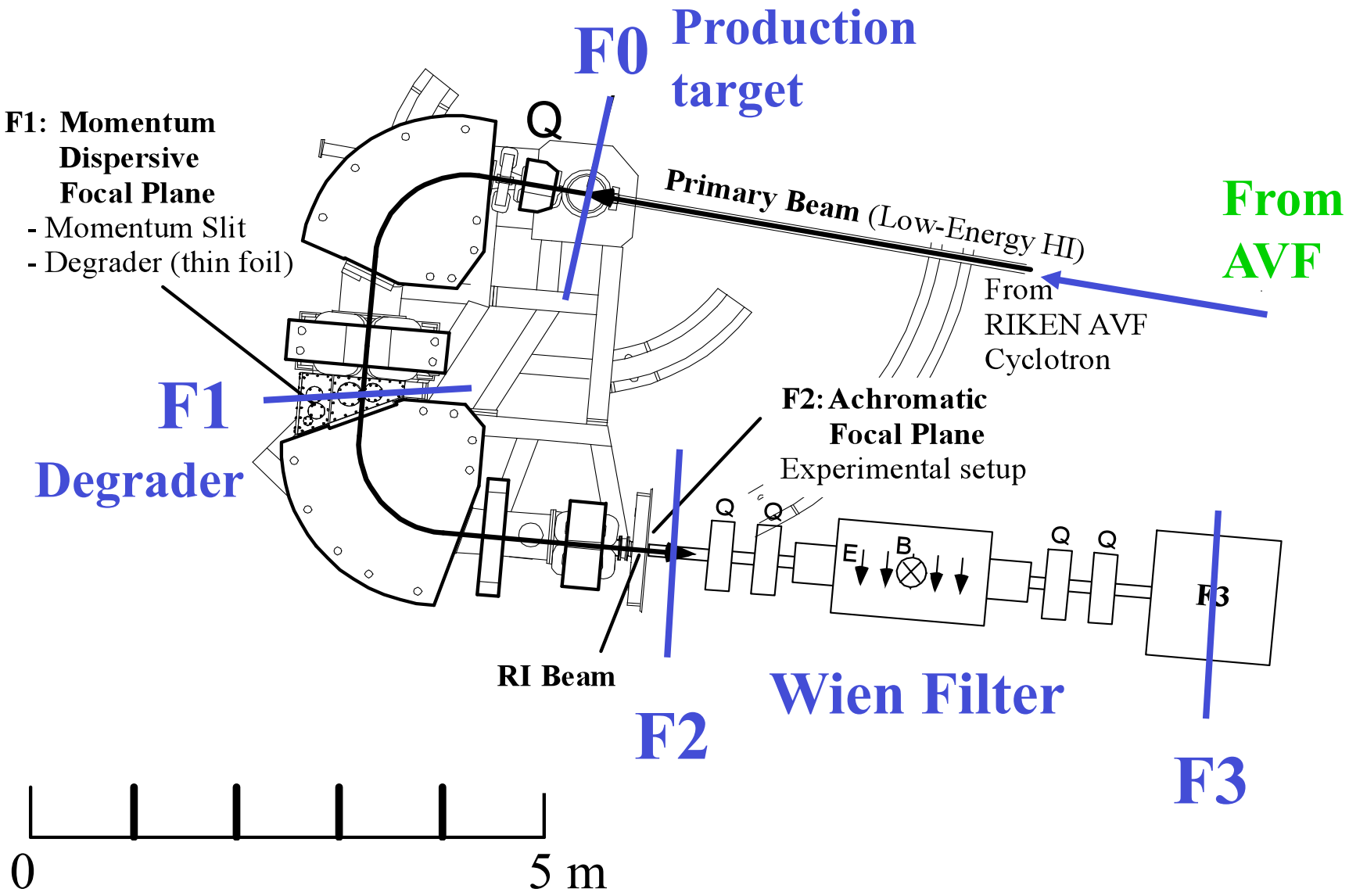
scheduled in March 2009

→ Sakai's presentation : 2/19 afternoon

E N D

以下、参考のために

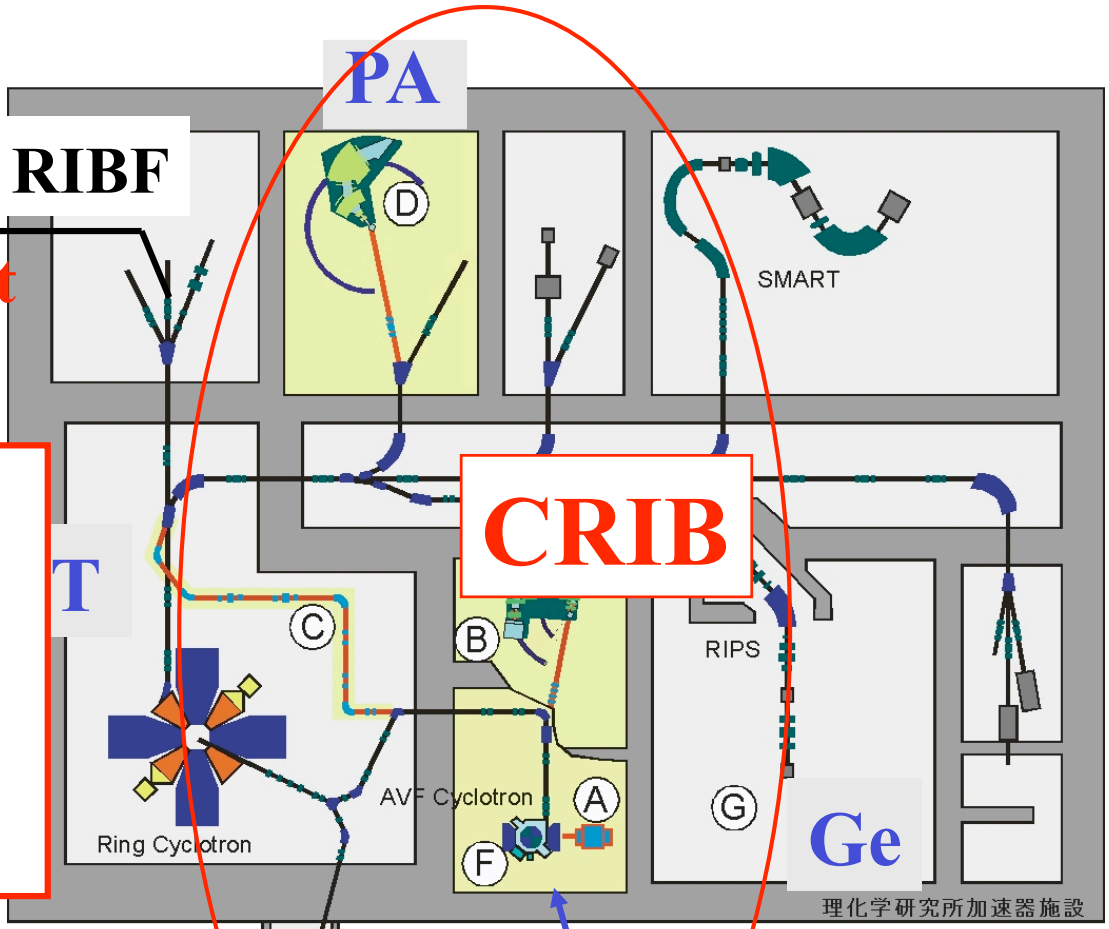
Low-energy in-flight RI beam separator CRIB



CNS Facilities at RIKEN

(Under CNS-RIKEN joint venture(2000~))

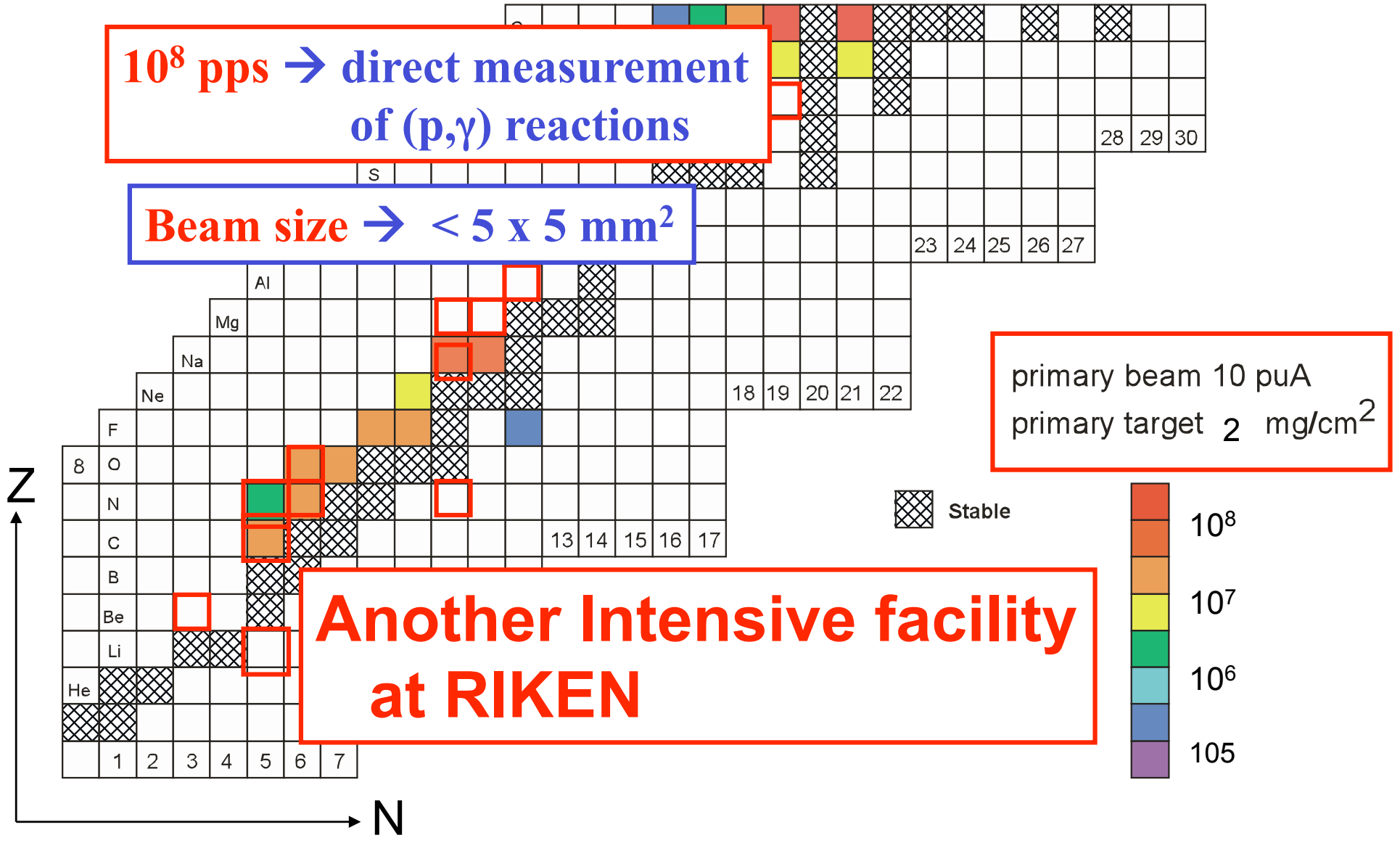
AVF Upgrade Project (CNS-RIKEN Joint Project)



Parallel p
system (T

- **Major part of AVF operation is now available for CRIB.**

Low-Energy RIB intensity to be reached at CRIB



Specification

dispersion (D)	**5.86 m**
horizontal magnification (M_x)	**0.40**
D/M_x	**14.7 m**
momentum resolution (image size 1mm)	**1/14700**
vertical magnification (M_y)	**0.0**
angular resolution	**< 1 mrad**
vertical acceptance	**± 3.0deg**

for spot size 60mm×10mm (in dispersion matching operation)

horizontal acceptance	**± 1deg**
solid angle	**2 msr**

for spot size of 10mm×10mm

solid angle	**4.8 msr**

When should SHARAQ “appear” in PAC ?