# Introduction to the State Key Laboratory of Nuclear Physics and Technology at Peking University

Yanlin Ye
School of Physics, Peking University

2010.10.14 at Beihang U

# Contents

# I. An overview

- At the beginning of $50^{th}$ in last century, Prof. Hu Ning、Yang Liming et al., Started Theoretical Nuclear and particle Physics in PKU.
- In 1955, the first higher education base on nuclear science in China was created in PKU. About 2000 students were graduated before the cultural revolution (1966).


**2006.10.13.**

- After the cultural revolution, there had been a new phase for developing facilities and research base in PKU. Three low energy accelerators were built and installed in the Department of Technical Physics and the Institute of Heavy Ion Physics in 1980s
- Gradually join the big science research cooperation in the world since 1990’s

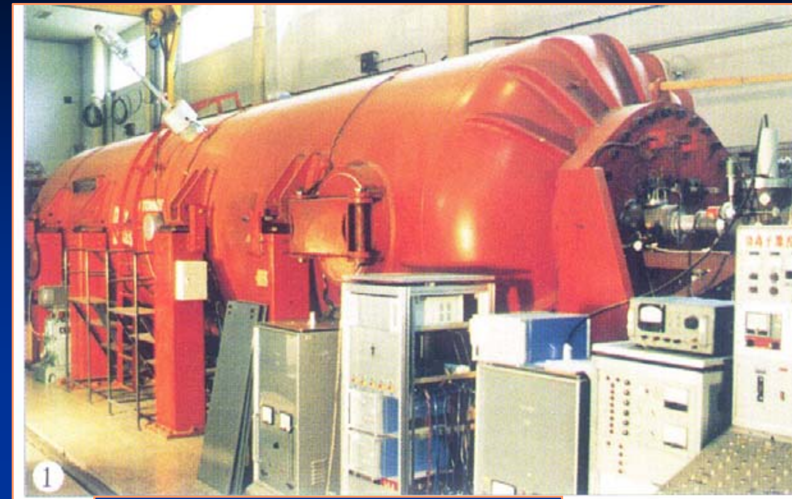
# Organizations

- Department of Technical Physics
- Institute of Theoretical Physics
- Institute of Heavy Ion Physics

Forming a State Key Laboratory of Nuclear Physics and Technology since 2007, with about 60 faculty members.

Accelerator building

4.5MV VDG



2x6MV tandem

2x1.7MV tandem


a new AMS

# RF supercontacting accelerator Lab.

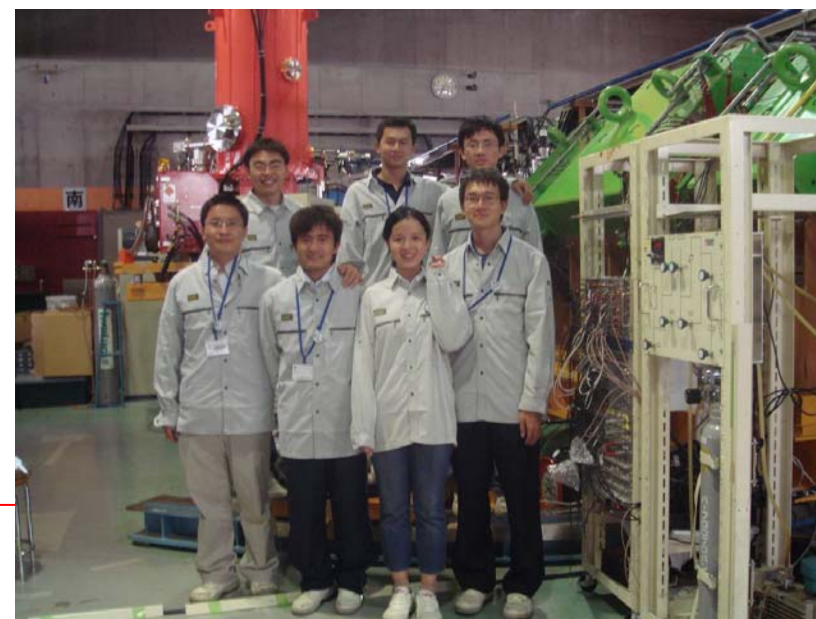
2K LHe
system

# Particle detection Lab.

# Nucl. Phys. education base

# Nishina School





# Contribution to the community


Establishment of the “Council for China-Japan Cooperation on Nuclear Physics” in 2006.

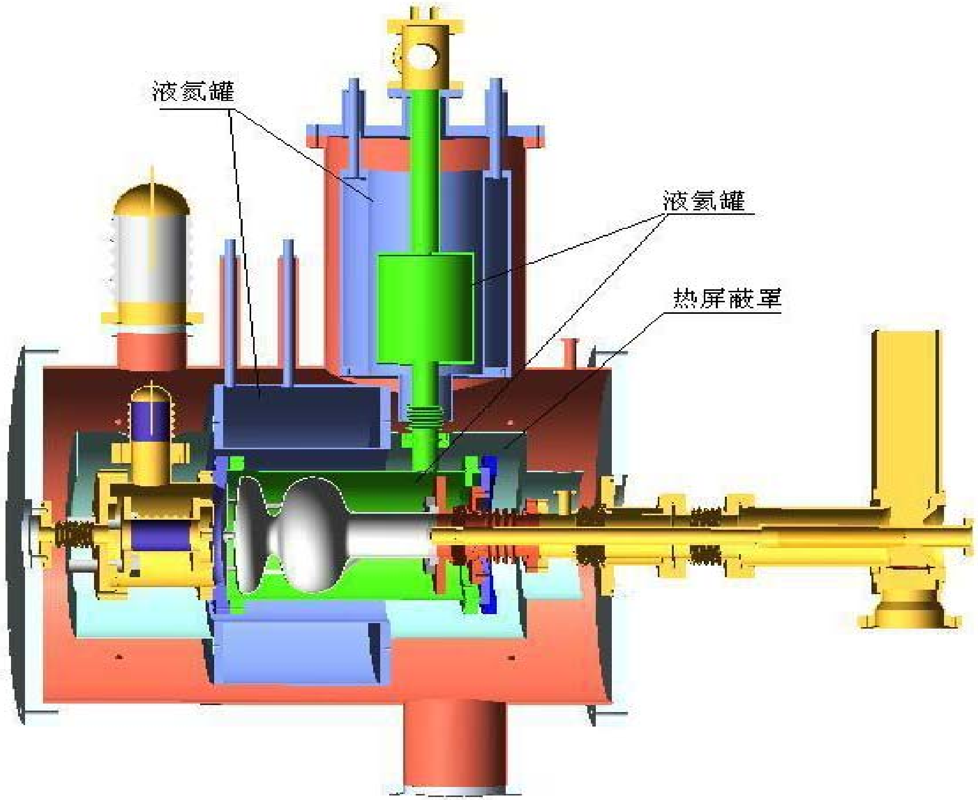

Establishment of the ANPhA（Acian Nuclear Physics Association” in 2009

# II. Main Research Fields

- Accelerator Physics and Techniques
- RIB nuclear Physics
- Hadron Physics
- Applications

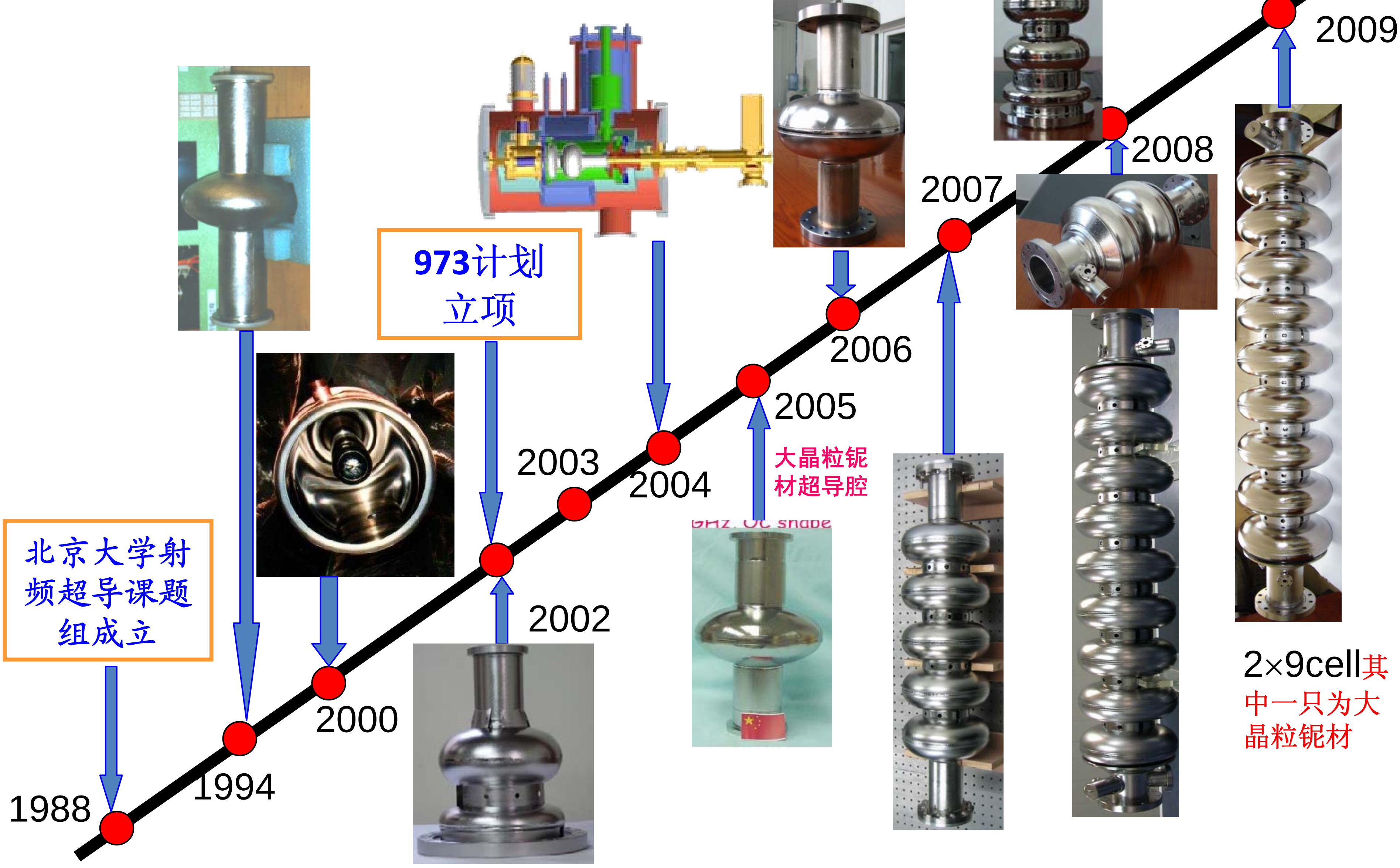
**DC-SC光阴极注入器的核心部件：**

皮尔斯枪、1＋1/2超导腔、2K恒温器与主耦合器

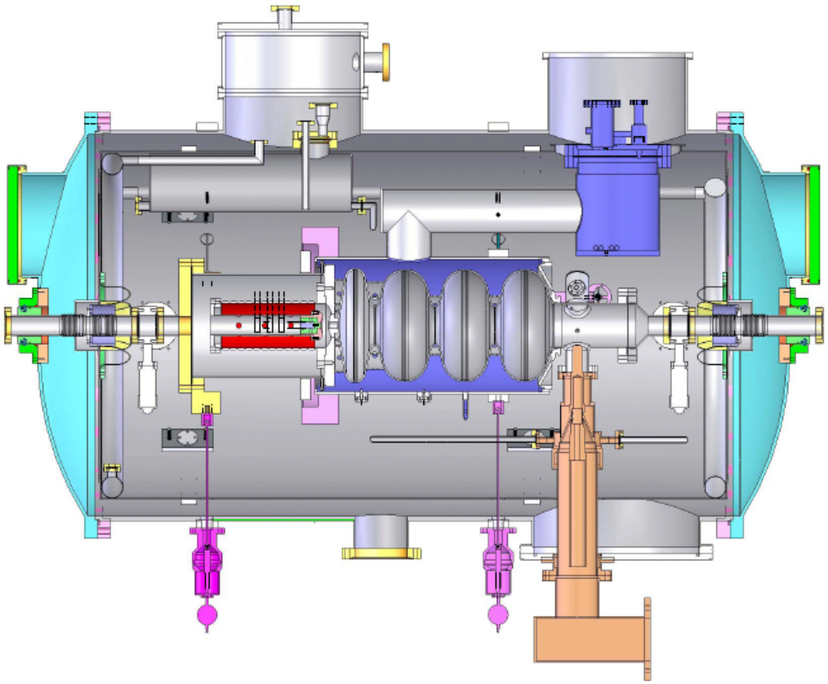


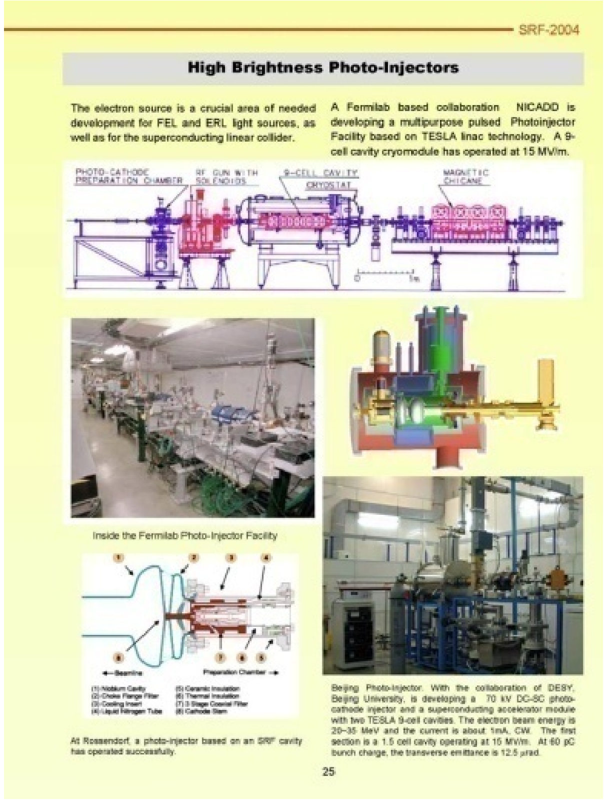

- 解决了光阴极与超导腔相容问题
- 结构紧凑
- 能工作在CW模式
- 具有提供高平均流强的能力（mA量级）
- 采用激光驱动光阴极，可以获得高品质电子束
- 电子束和超导腔之间的相位可以精确控制，时间抖动<1ps

# Milestone of Superconducting Accelerator Lab



# DC-SC injector





SRF-2004

**High Brightness Photo-Injectors**

The electron source is a crucial area of needed development for FEL and ERL light sources, as well as for the superconducting linear collider.

A Fermilab based collaboration NICADD is developing a multipurpose pulsed Photoinjector Facility based on TESLA linac technology. A 9-cell cavity cryomodule has operated at 15 MV/m.

PHOTO-CATHODE PREPARATION CHAMBER
RF GUN WITH SOLENOIDS
9-CELL CAVITY CRYOSTAT
MAGNETIC CHICANE

Inside the Fermilab Photo-Injector Facility

←Beamline
Preparation Chamber →
(1) Niobium Cavity
(2) Choke Flange Filter
(3) Cooling Insert
(4) Liquid Nitrogen Tube
(5) Ceramic Insulation
(6) Thermal Insulation
(7) 3 Stage Coaxial Filter
(8) Cathode Stem

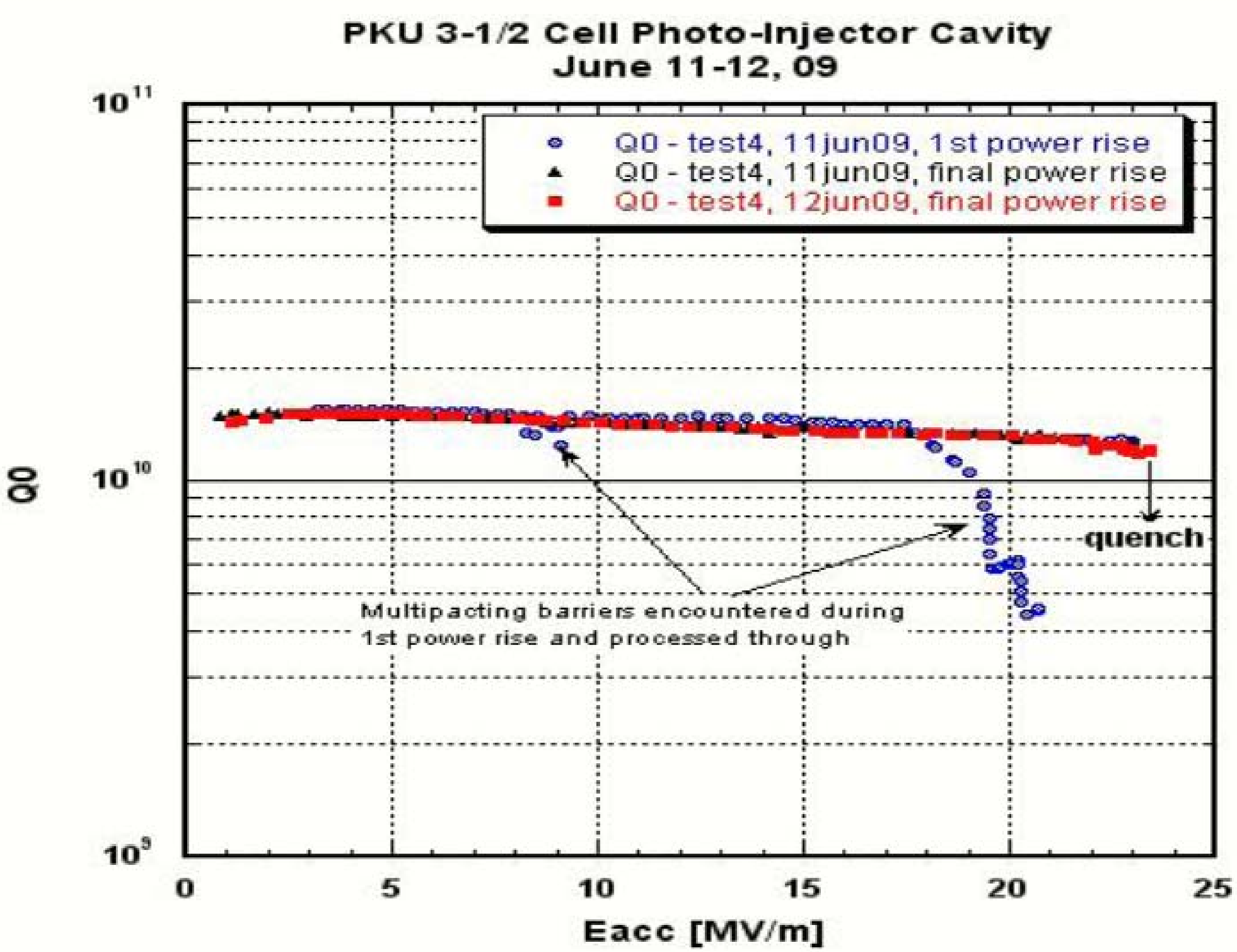
At Rossendorf, a photo-injector based on an SRF cavity has operated successfully.

Beijing Photo-injector. With the collaboration of DESY, Beijing University, is developing a 70 kV DC-SC photo-cathode injector and a superconducting accelerator module with two TESLA 9-cell cavities. The electron beam energy is 20~35 MeV and the current is about 1mA, CW. The first section is a 1.5 cell cavity operating at 15 MV/m. At 60 pC bunch charge, the transverse emittance is 12.5 μrad.

25

- 100 KV Pierce DC gun with $Cs_2Te$ cathode matched with SRF cavity
- Operating at 2K with tuner and screened LN
- Providing ~5 MeV ~70 pc superfast pulse beam with low emmittance

# PKU 3+1/2-cell tested at J-Lab

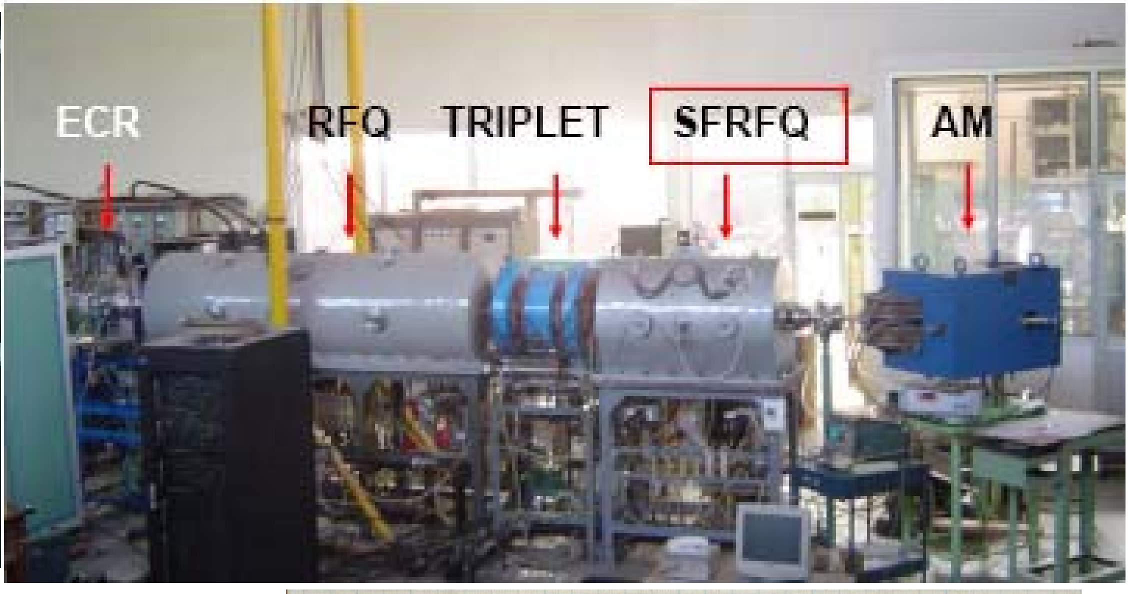



**DC-SC 关键部件大晶粒3.5-cell 腔（23.5 MV/m)**

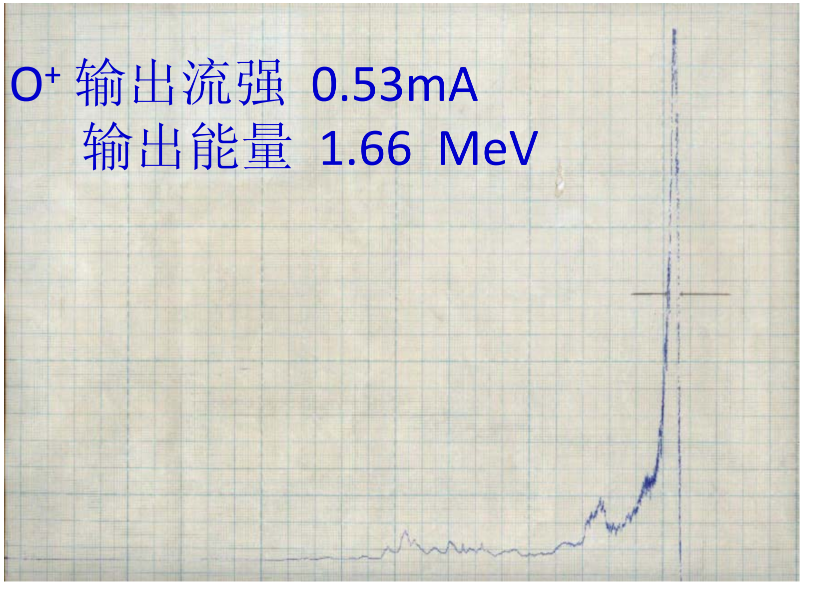
# Lab. upgrading

2K LHe system

# Separated sector RFQ




SFRFQ 是新型 RFQ 结构，加速效率比常规 RFQ 高出 60%-80.




**SFRFQ 载束试验结果**

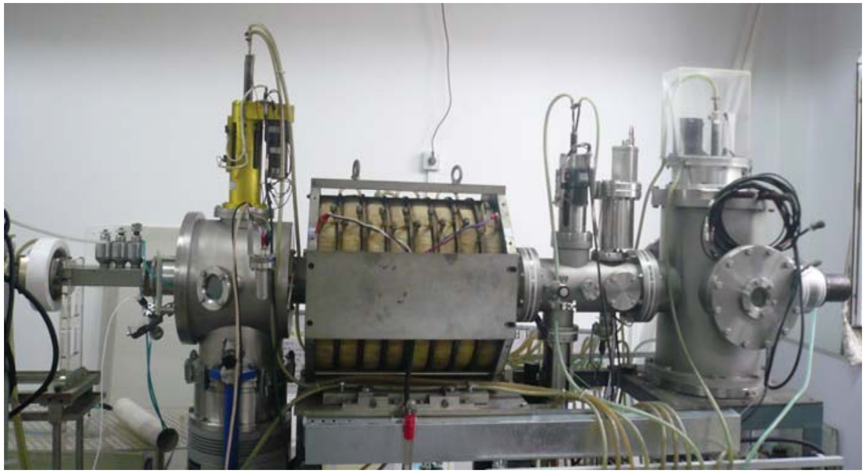
# High intensity RFQ for (d,n)

- 加工中的2MeV/40mA氘离子RFQ加速器

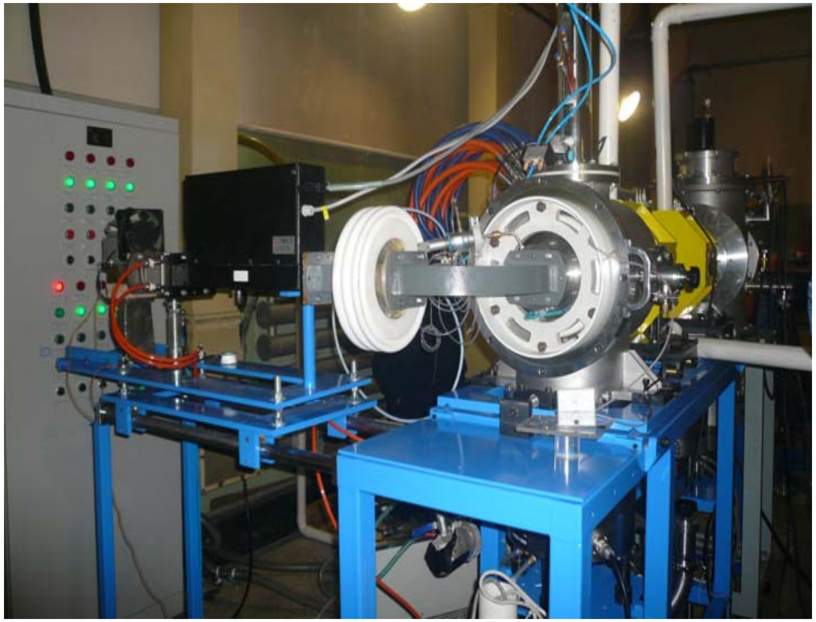
组装中的加速器电极结构

加速器腔筒

# High intensity ion source

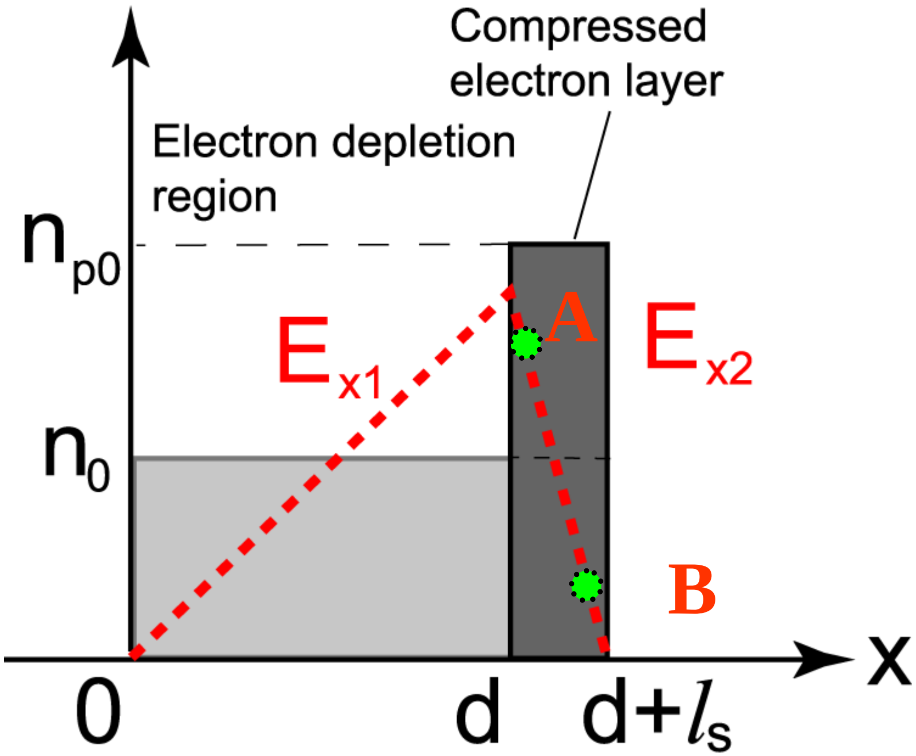


ECR质子源在微波源功率仅为320 W，引出电压为50kV的情况下得到了总流强100mA的束流。

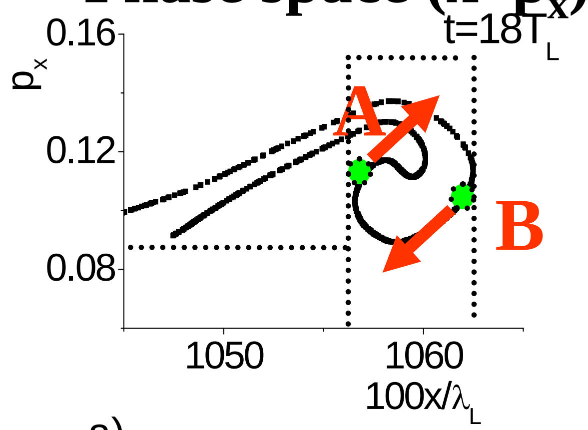


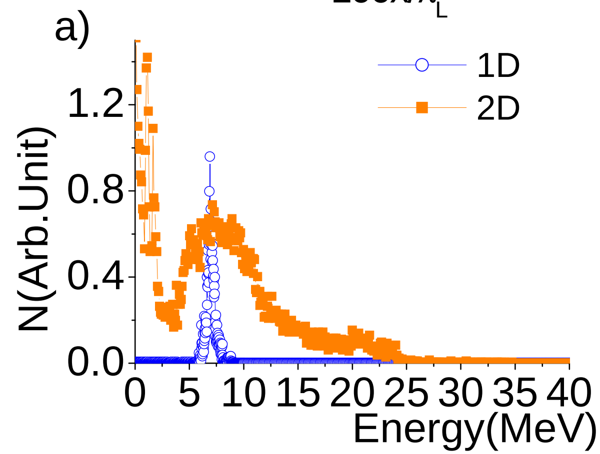
用于RFQ加速器中子照相装置的50 keV/50mA氘离子注入器研制成功，束流发射度小于0.2pi.mm.mrad。

**X.Q.Yan et al, PRL 100, 135003 (2008)**




**Phase space (x~p_x)**

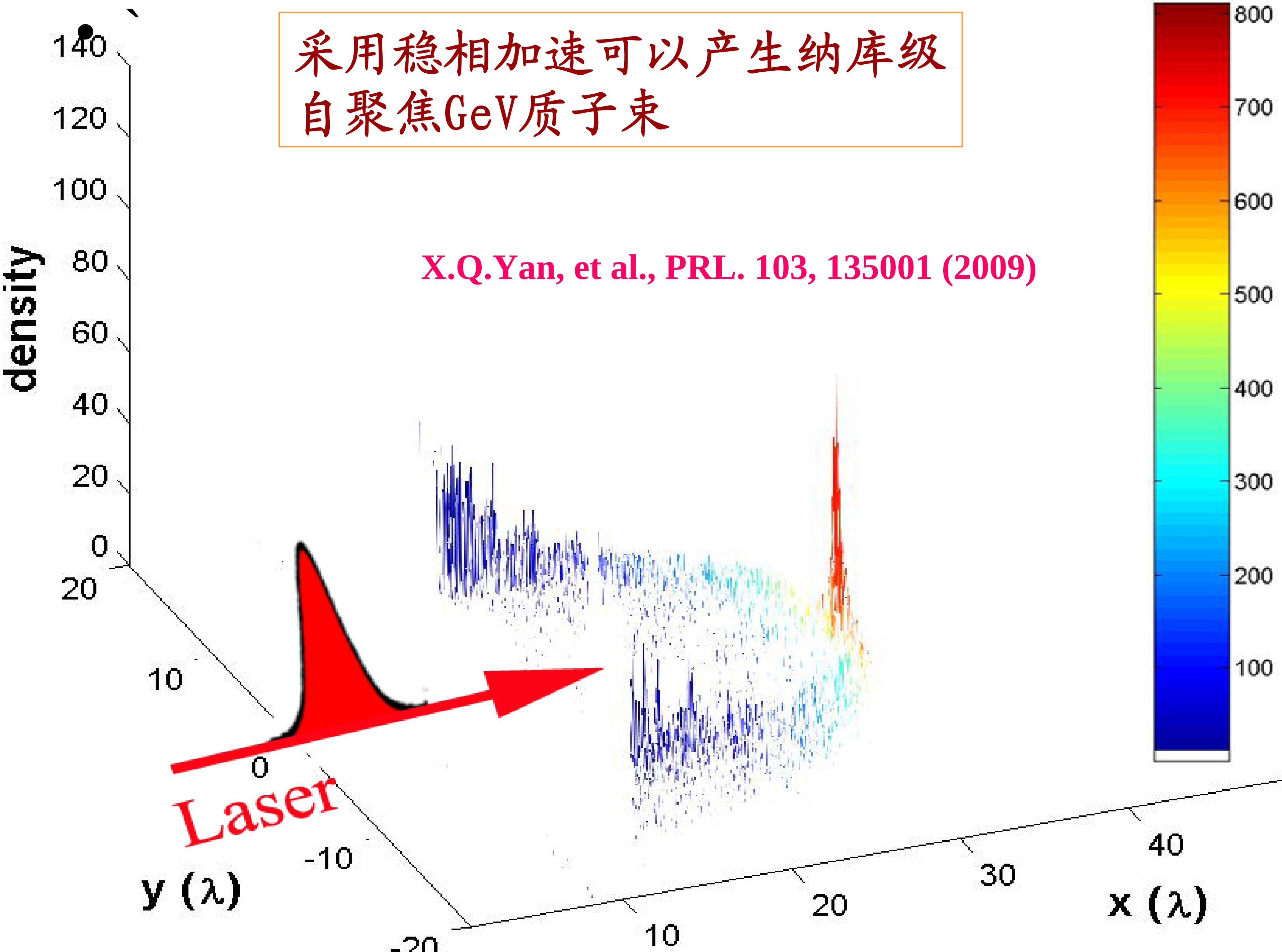



激光等离子体加速使加速梯度提高了1000 倍，可能提前30年达到 PeV， 为人类探索物质更深层次的构成与运动规律提供有效手段

# 采用稳相加速可以产生纳库级自聚焦GeV质子束

X.Q.Yan, et al., PRL. 103, 135001 (2009)



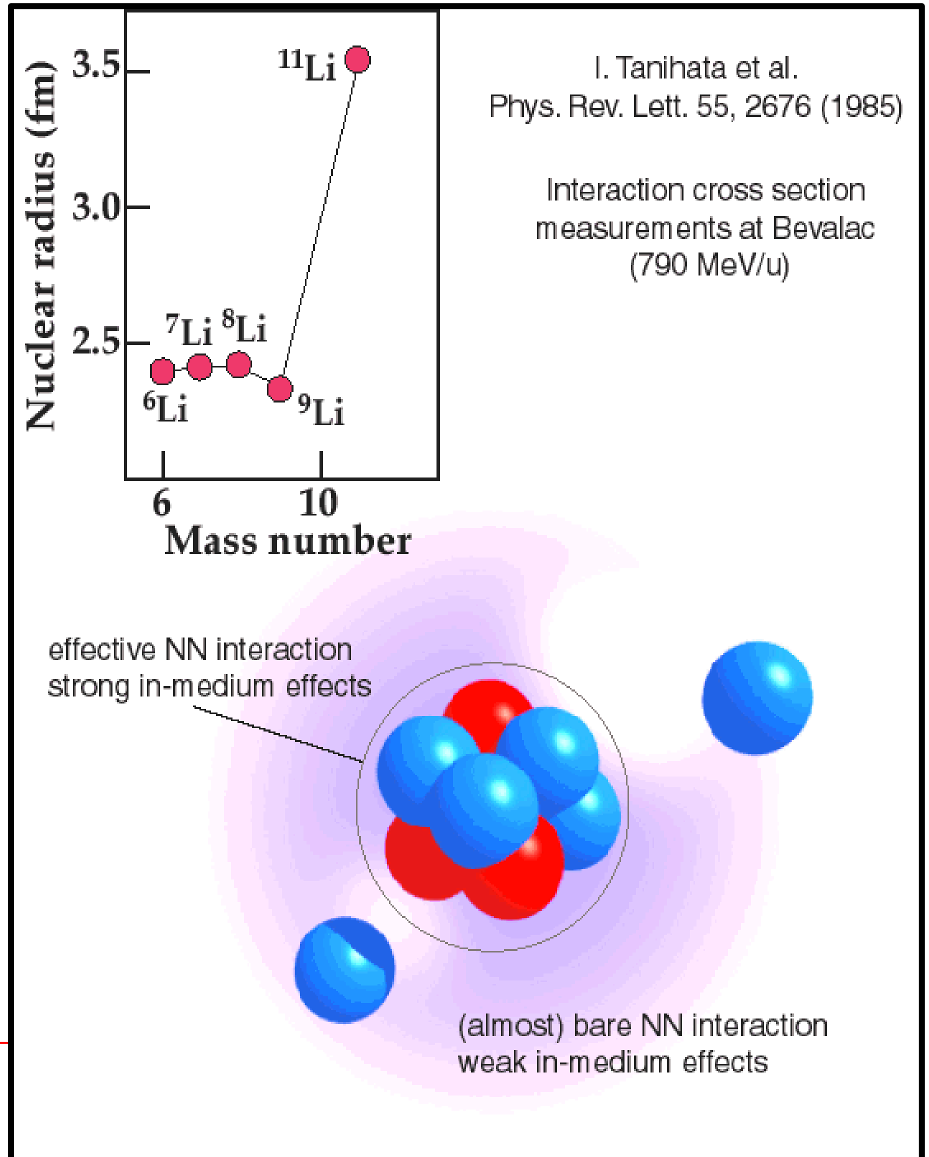
# II.2 RIB Nucl. Phys.

- ☐ Theory
  (Prof. Xu; Meng; Liu)
- ☐ decay experiment
- ☐ reaction experiment

# Theory

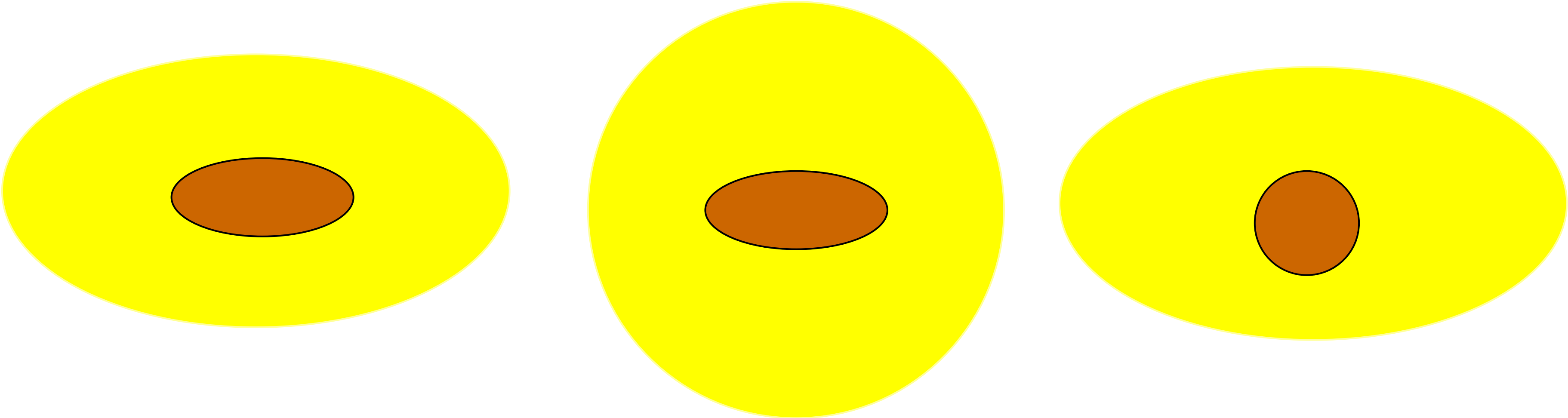
**J. Meng et al.,**

**PRL,77(1996)3963**
**PRL,80(1998)460**
**Halo and Giant Halo**
**PRL,101(2008)122502**
**Spin-isospin res.**



# Deformed Halo? Deformed core?

Decoupling of the core and halo in deformed nuclei？



$^{11,14}$Be

Ne isotopes

…

Misu, Nazarewicz, Aberg, NPA614(97)44

Bennaceur et al., PLB296(00)154

Hamamoto & Mottelson, PRC68(03)034312

Hamamoto & Mottelson, PRC69(04)064302

Poschl et al., PRL79(97)3841

Nunes, NPA757(05)349

Pei, Xu & Stevenson, NPA765(06)29

# DDRHFB theory

- Hamiltonian Density

$$\mathscr{H} = \bar{\psi}\left(-i\gamma\cdot\nabla + M\right)\psi + \frac{1}{2}\int d^4x' \sum_{\phi} \bar{\psi}(x)\bar{\psi}(x')\left(\Gamma_{\phi}D_{\phi}\right)_{x,x'}\psi(x')\psi(x),$$

- System Degrees of Freedom

$$\Gamma_{\sigma} \equiv -g_{\sigma}(x)g_{\sigma}(x') \qquad \Gamma_{\pi} \equiv \frac{-1}{m_{\pi}^2}\left(f_{\pi}\vec{\tau}\gamma_5\gamma_{\mu}\partial^{\mu}\right)_x\cdot\left(f_{\pi}\vec{\tau}\gamma_5\gamma_{\nu}\partial^{\nu}\right)_{x'}$$

$$\Gamma_{\omega} \equiv \left(g_{\omega}\gamma_{\mu}\right)_x\left(g_{\omega}\gamma^{\mu}\right)_{x'} \qquad \Gamma_A \equiv \frac{e^2}{4}\left(\gamma_{\mu}(1-\tau_3)\right)_x\left(\gamma^{\mu}(1-\tau_3)\right)_{x'}$$

$$\Gamma_{\rho}^{\mathrm{V}} \equiv \left(g_{\rho}\gamma_{\mu}\vec{\tau}\right)_x\cdot\left(g_{\rho}\gamma^{\mu}\vec{\tau}\right)_{x'} \qquad \Gamma_{\rho}^{\mathrm{T}} \equiv \frac{1}{4M^2}\left(f_{\rho}\sigma_{\nu k}\vec{\tau}\partial^{k}\right)_x\cdot\left(f_{\rho}\sigma^{\nu l}\vec{\tau}\partial_{l}\right)_{x'}$$

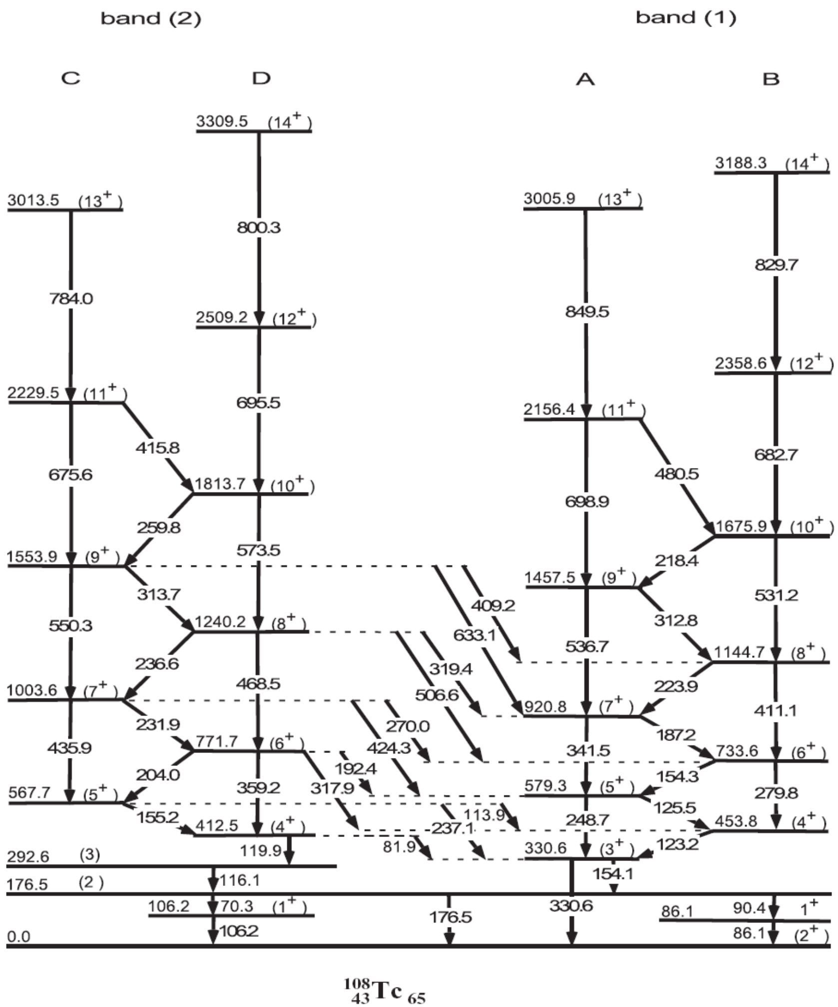
$$\Gamma_{\rho}^{\mathrm{VT}} \equiv \frac{1}{2M}\left(f_{\rho}\sigma^{k\nu}\vec{\tau}\partial_k\right)_x\cdot\left(g_{\rho}\gamma_{\nu}\vec{\tau}\right)_{x'} + \left(g_{\rho}\gamma_{\nu}\vec{\tau}\right)_x\cdot\frac{1}{2M}\left(f_{\rho}\sigma^{k\nu}\vec{\tau}\partial_k\right)_{x'}$$

- In-medium Effects

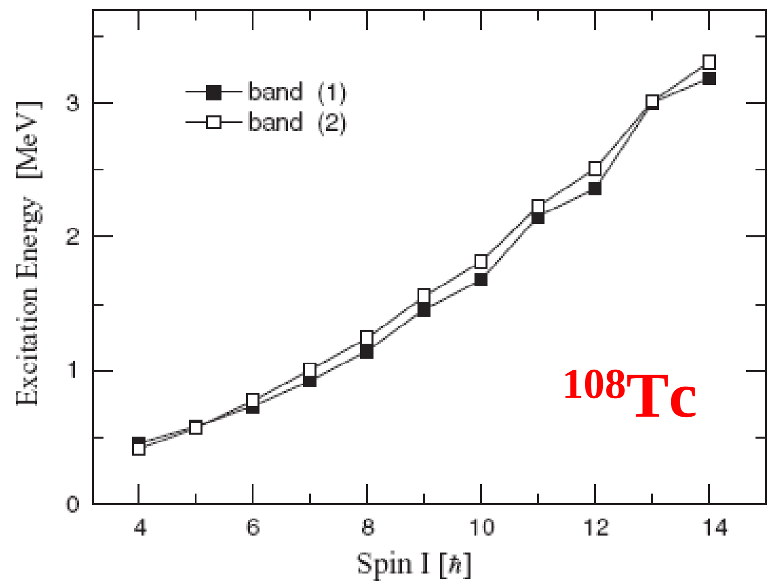
Density dependent meson-nucleon couplings

# Pseudospin partner bands

$^{108}$Tc实验能级纲图




近简并的双带能谱




形成机制?

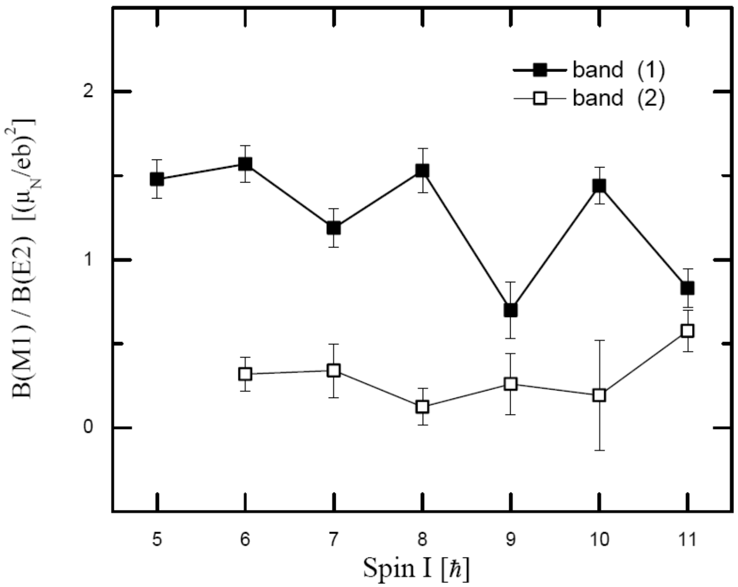
清华&美国实验组 (2005年)

# Pseudospin partner bands

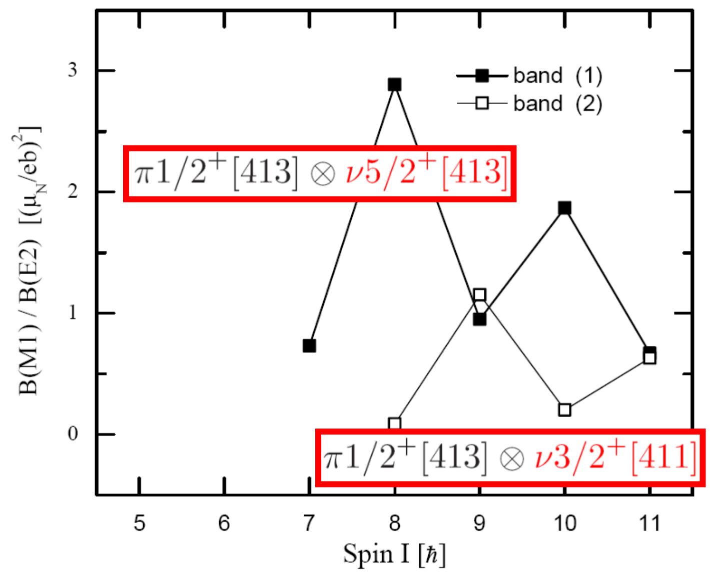
◆ 双带虽然有近简并的能谱， 但电磁跃迁性质差异很大：
带1和带2 B(M1)/B(E2) 幅度差异很大；staggering相位相反.

◆用赝自旋伙伴带的概念能很好理解能谱尤其是电磁跃迁的特征。

实验




理论

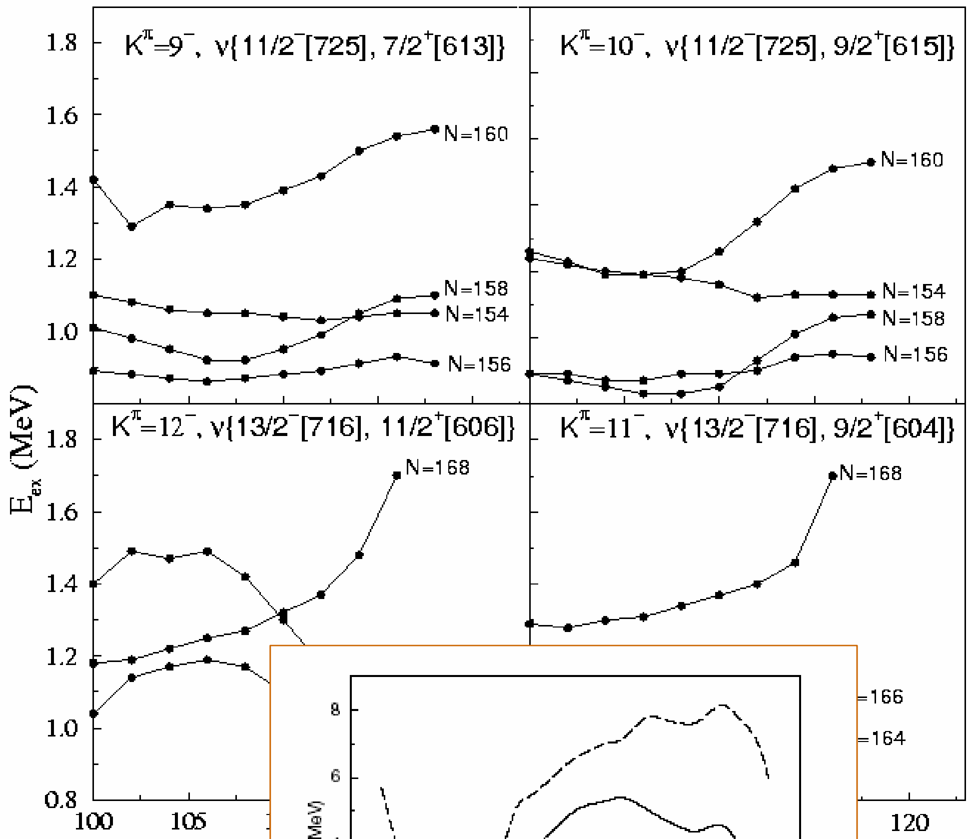


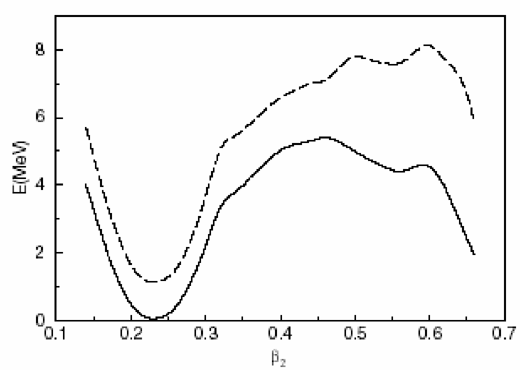

**第一例A~100区的奇奇核中的赝自旋伙伴带！**

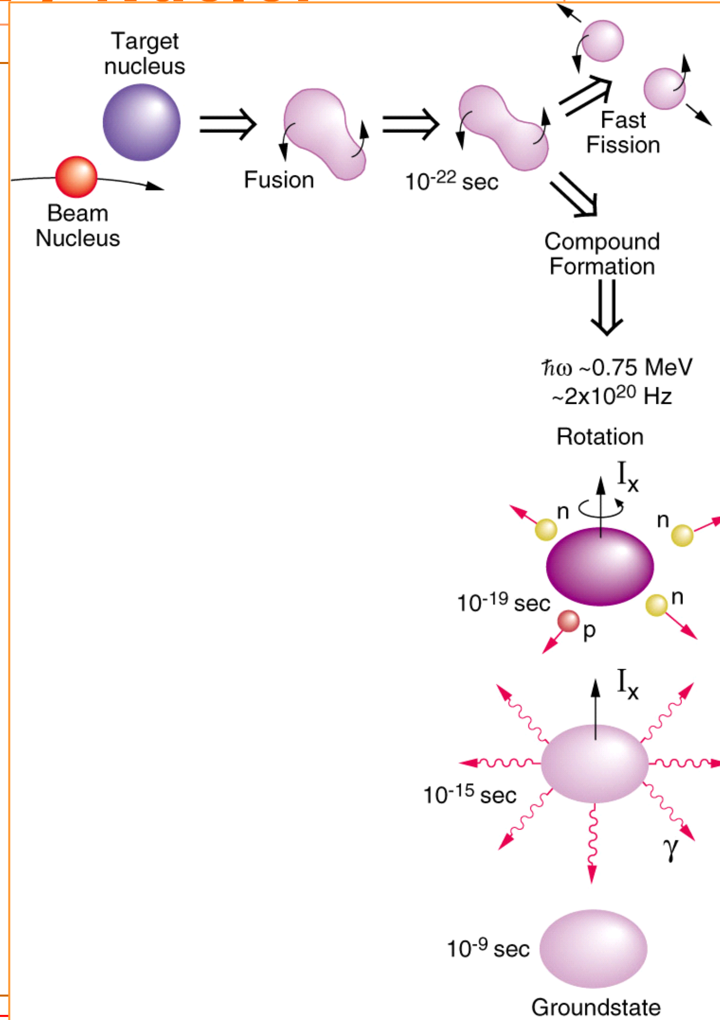
***Identification of pseudospin partner bands in $^{108}$Tc, Phys. Rev. C 78, 064301 (2008).***

# F.R. Xu, *et al.*: PRL,92(2004)252501

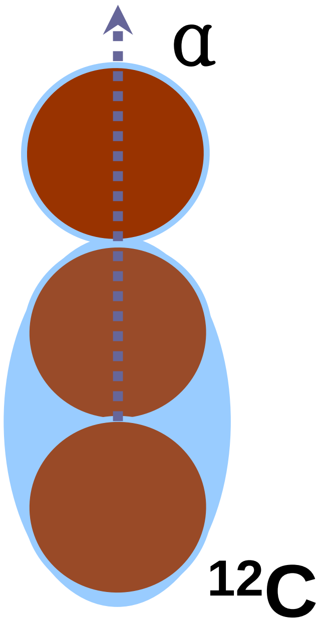
## Isomer and super heavy Nuclei

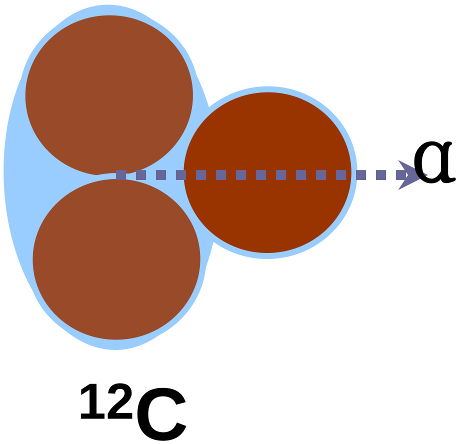


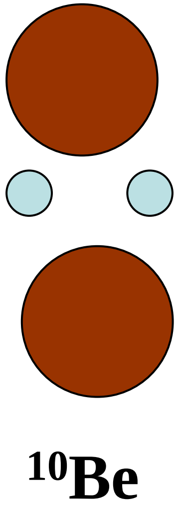



# Prof. Xu et al.,Cluster structure and decay




**Linear structure** **Triangular structure** **Molecular structure**

- F.R. Xu, J.C. Pei, PLB 642 (2006) 322
- J.C. Pei, F.R. Xu, PLB 650 (2007) 242
- Pei, Xu, Lin, Zhao, PRC 76 (2007) 044326
- C. Qi, F.R. Xu et al., PRL 103 (2009) 072501
- C. Qi, F.R. Xu et al., PRC 80 (2009) 044326

PRL 103, 072501 (2009) PHYSICAL REVIEW LETTERS week ending 14 AUGUST 2009

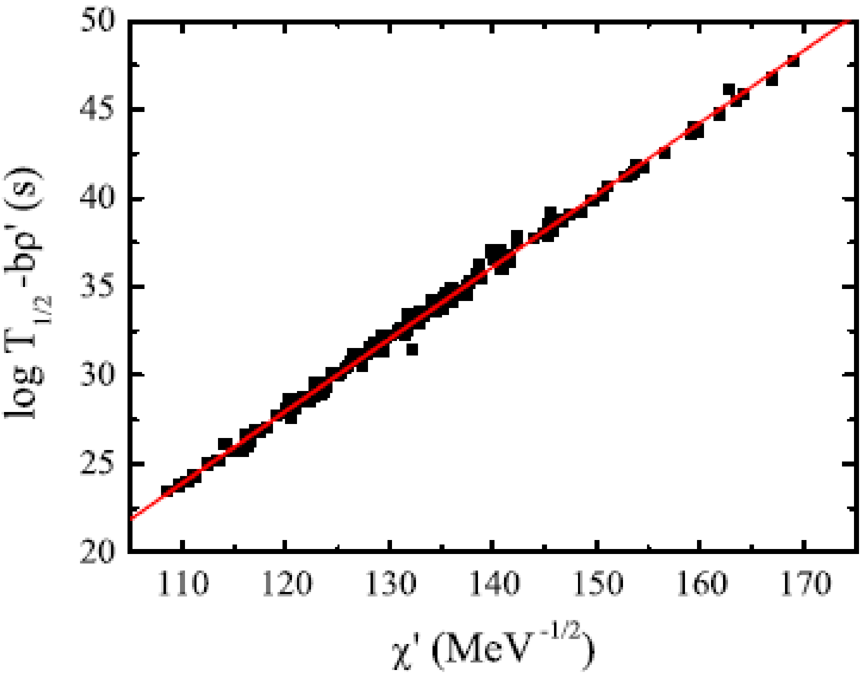
# Universal Decay Law in Charged-Particle Emission and Exotic Cluster Radioactivity

C. Qi,[1] F. R. Xu,[1] R. J. Liotta,[2] and R. Wyss[2]
[1]School of Physics, and State Key Laboratory of Nuclear Physics and Technology, Peking University, Beijing 100871, China

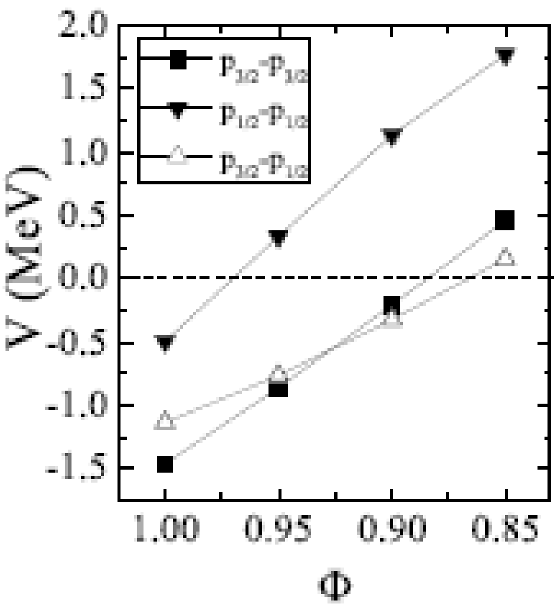
从R矩阵理论出发，研究了cluster衰变的微观机制，同时得到了一个有关cluster衰变寿命的线性关系，能同时预言各种各样的cluster衰变性质。

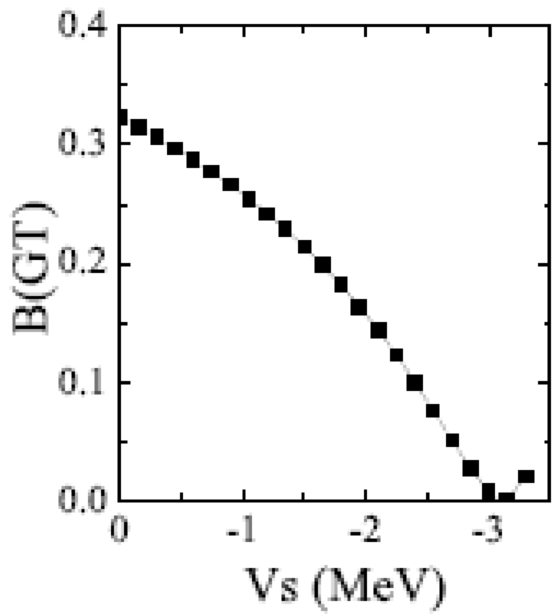
$$T_{1/2} = \frac{\hbar \ln 2}{\Gamma_c} \approx \frac{\ln 2}{\nu} \left| \frac{H_l^+(\chi, \rho)}{RF_c(R)} \right|^2,$$

$$\log T_{1/2} = a\chi' + b\rho' + c.$$



# CD-Bonn SM




$^{14}$C的β衰变计算

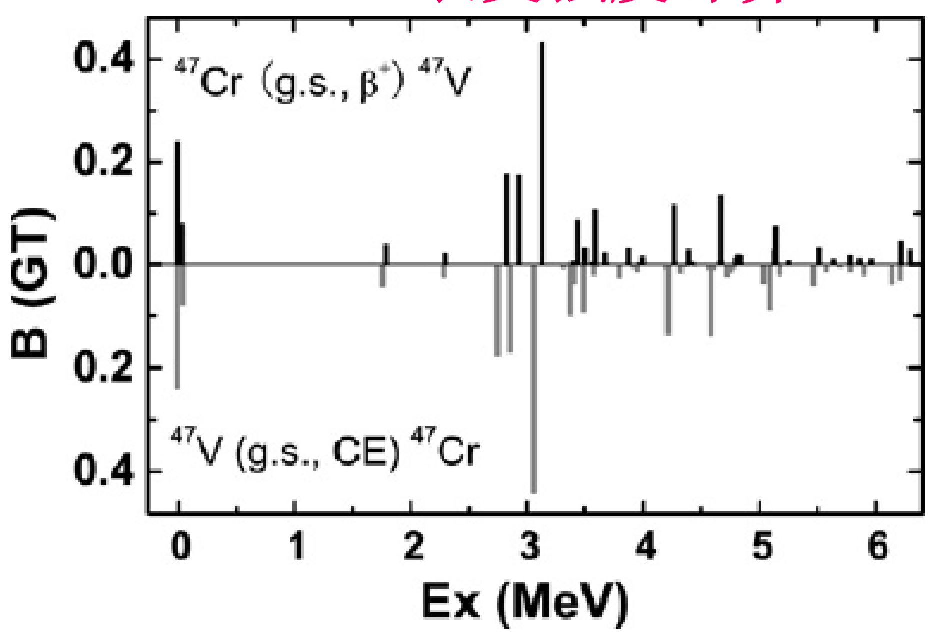
**Why $^{14}$C T1/2=5730 year?**

而其他丰中子碳同位素只有秒或毫秒量级！

$$G = V_{NN} + V_{NN} \frac{Q}{\omega - QH_0Q} G,$$

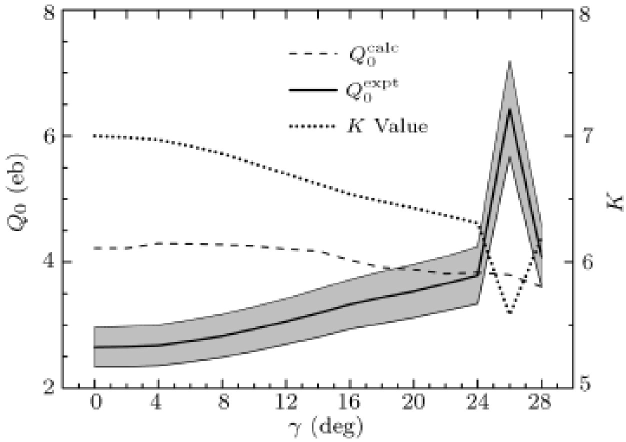
$$\langle \psi_f || \sigma \tau || \psi_i \rangle = \sqrt{\frac{2}{3}} \left[ \kappa(a + 2b) + \eta(\sqrt{2}b - \sqrt{5}c) \right]$$

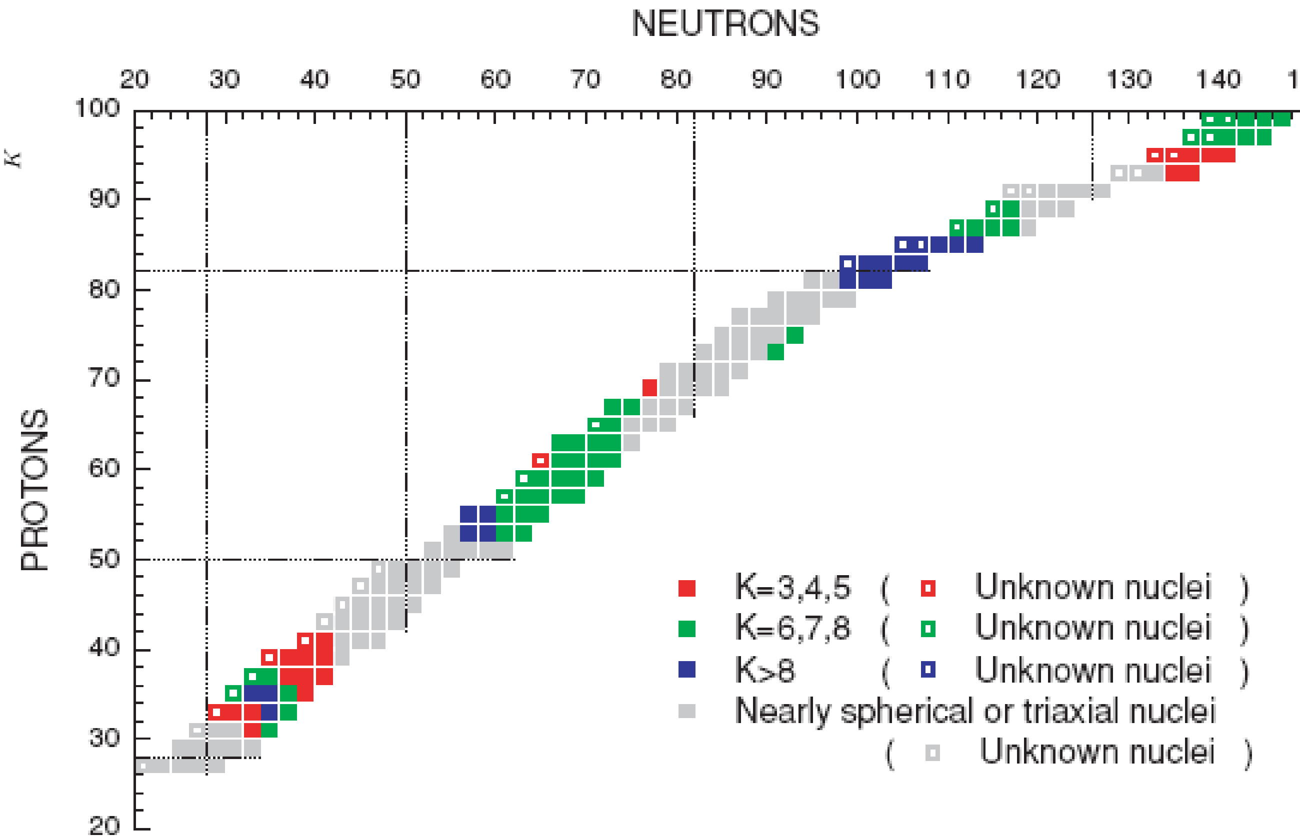
β衰变强度计算




1. C. Qi, F.R. Xu, NPA 800 (2008) 47
2. C. Qi, F.R. Xu, NPA 814 (2008) 48
3. Qi, Xu, Jiang, PRL (submitted)

# High-K Isomers at drip-line



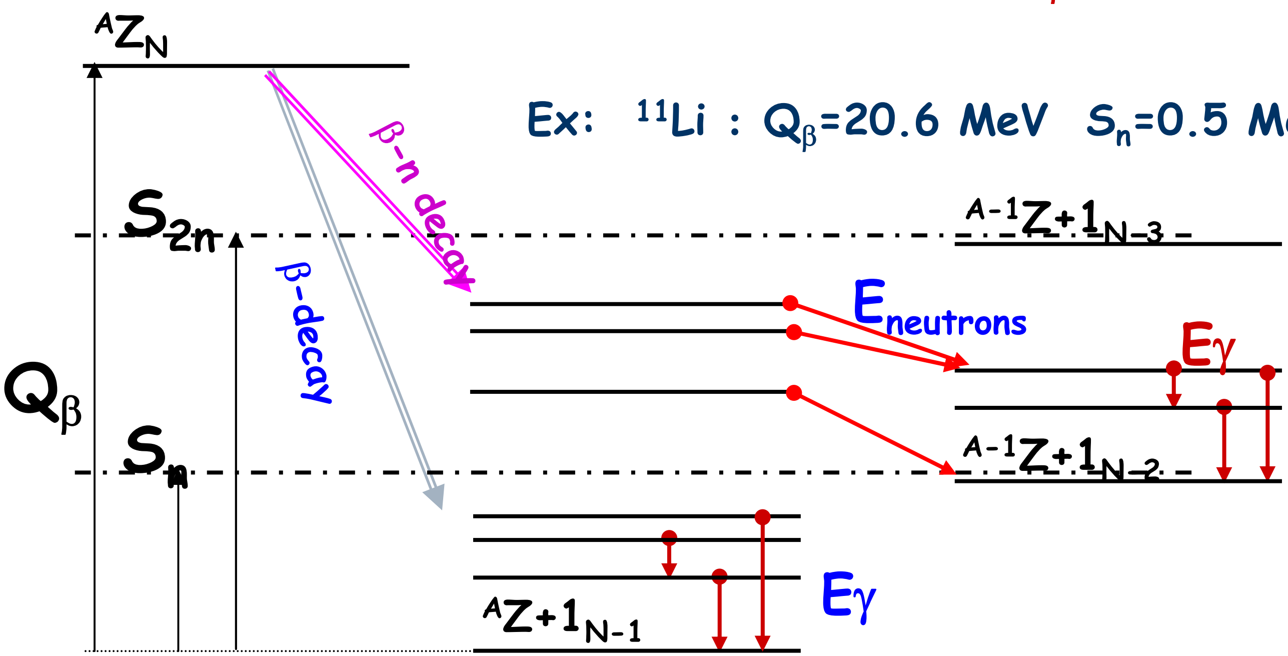
# Exp. Nucl. Phys. Group

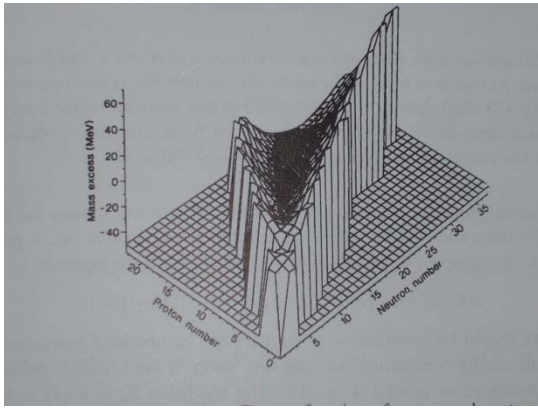
# Decay experiment

- β -delayed particle emission for unstable nuclei

⇒ for N>>Z : $Q_\beta$ ↗ , $S_n$ ↘

Ex: $^{11}$Li : $Q_\beta$=20.6 MeV  $S_n$=0.5 MeV ⇒ $P_n$~92%

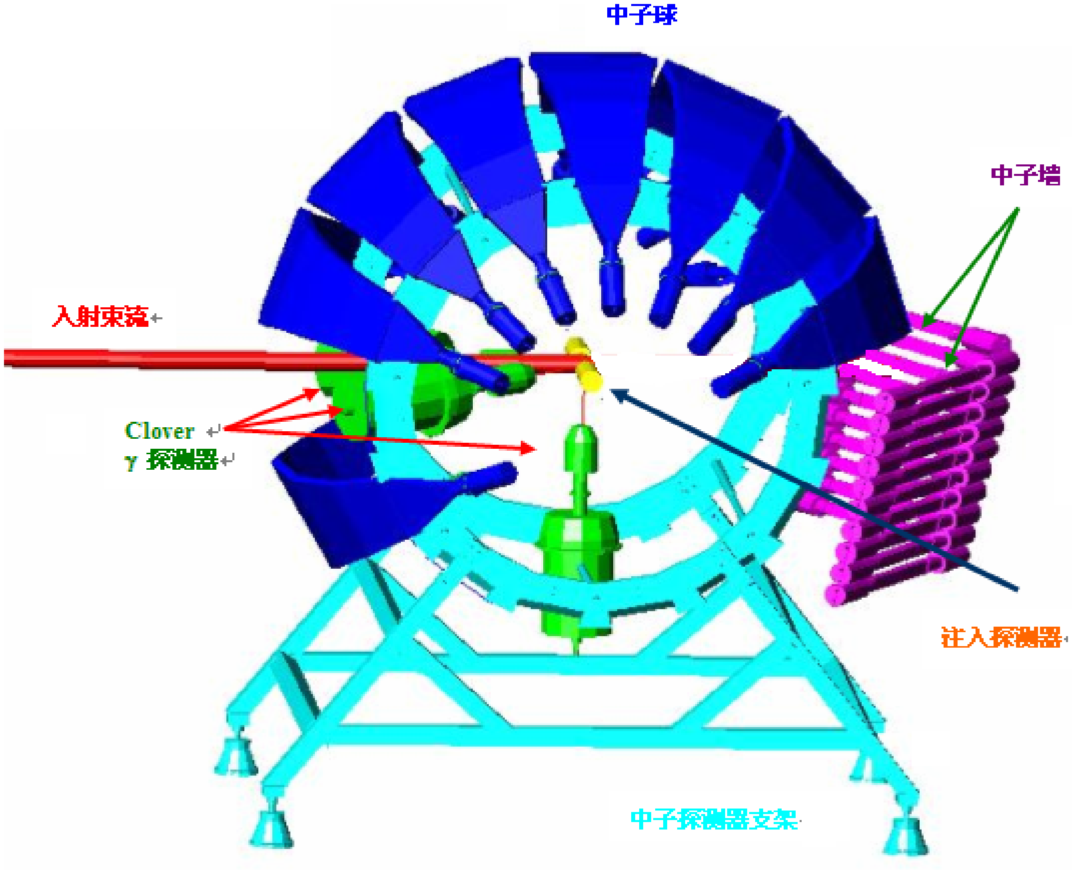


# at Peking University

## ➤Previous facility in 2004

- Neutron Sphere：8 pieces of BC408 ,157cm x 40(20)cm x 2.5cm, covering 30％ of 4π。
- Neutron Wall：20 pieces of BC408, 40cm × 5cm × 2.5cm。Covering 2.2％ of 4π。
- A set of implantation and β detector




- 3 sets of Clover γ detectors (IMP-Lanzhou）。

## ➢Upgrade 2006

- Neutron sphere: Change the refletion layer (TYVEK1056D), coupling layer and the PMTs (XP2020)

- Neutron wall: Change the refletion layer, coupling layer and the PMTs. Placed inside the sphere.

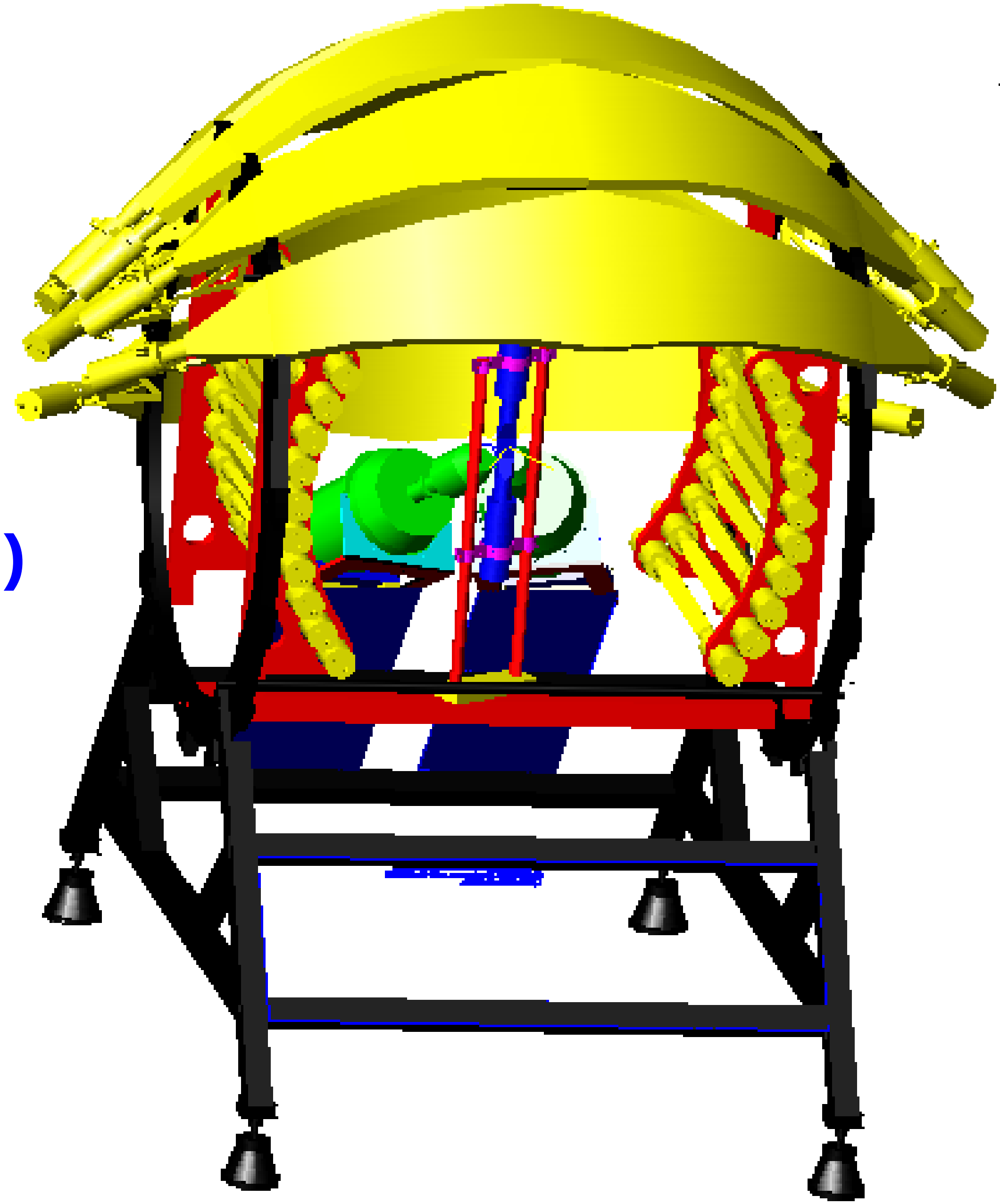
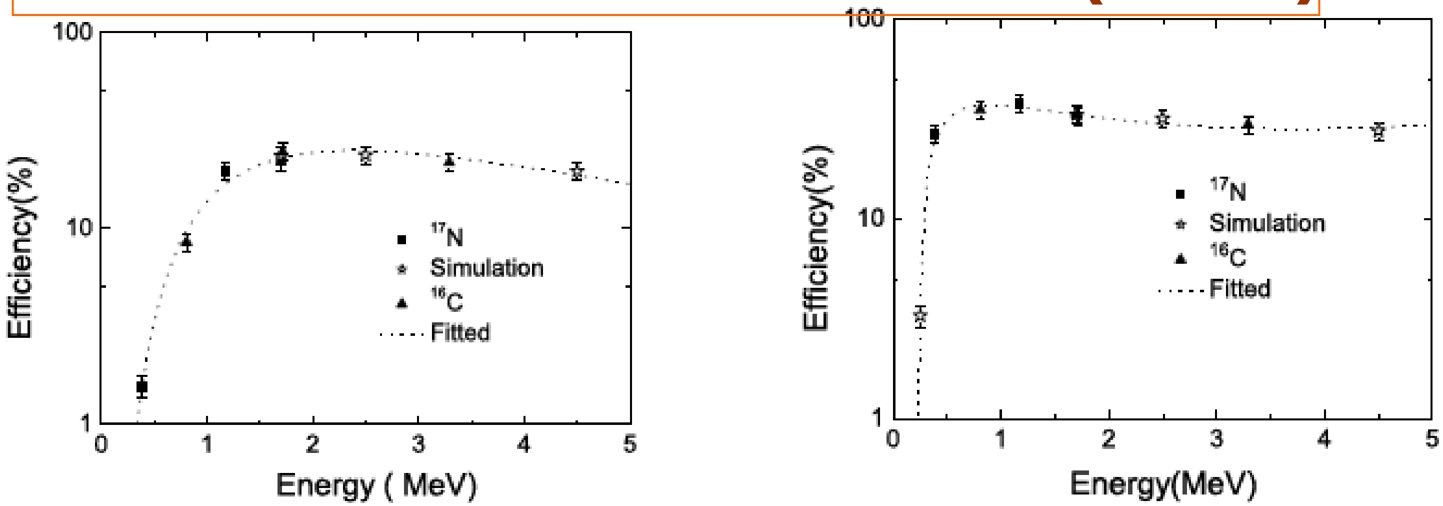


Table 1

$\beta$-delayed neutron peak shape parameters of neutron sphere and neutron wall.

| Nucleus | Energy(MeV) | BR(%) | neutron sphere $x_0$(ns) | neutron sphere $\Gamma$(ns) | neutron sphere $S$ | neutron wall $x_0$(ns) | neutron wall $\Gamma$(ns) | neutron wall $S$ |
|---|---|---|---|---|---|---|---|---|
| $^{17}$N | 0.383 | 38 | 118.4 | 11.0 | 0.8 | 116.9 | 10.7 | 0.23 |
| | 1.170 | 50.1 | 66.8 | 3.9 | 0.6 | 66.5 | 5.1 | 0.28 |
| | 1.700 | 6.9 | 55.3 | 3.2 | 0.4 | 55.6 | 3.9 | 0.29 |
| $^{16}$C | 3.29 | 84.4 | 40.2 | 2.7 | 0.2 | 40.2 | 2.0 | 0.2 |
| | 1.715 | 15.6 | 55.2 | 2.9 | 0.4 | 55.6 | 3.4 | 0.28 |
| | 0.808 | 1.0 | 80.6 | 4.1 | 0.6 | 80.2 | 5.6 | 0.23 |

**Nucl. Instr. Meth.A 606, 645(2009)**

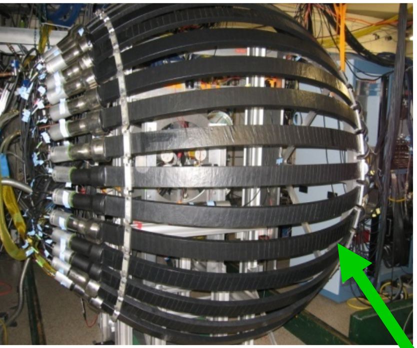


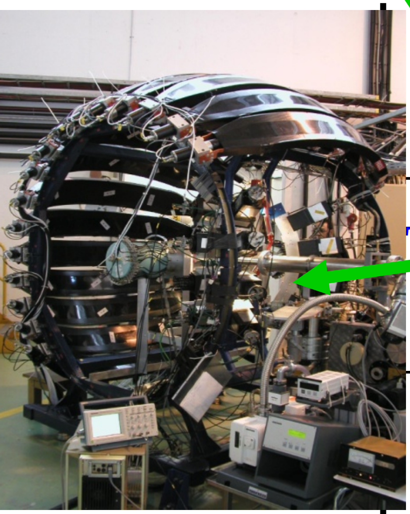

(a) neutron sphere

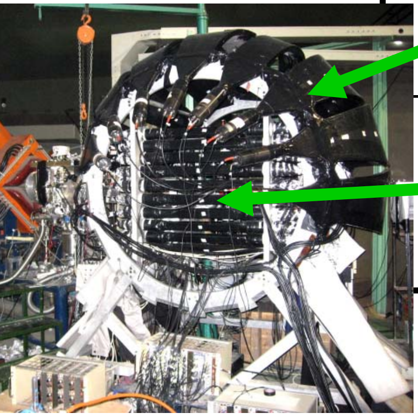
(b) neutron wall

Figure 7. Experimentally determined intrinsic efficiency curves of neutron sphere and neutron walls obtained from in-beam test. The solid curves are fitted results.

# ➢ 世界上主要实验探测设备的比较

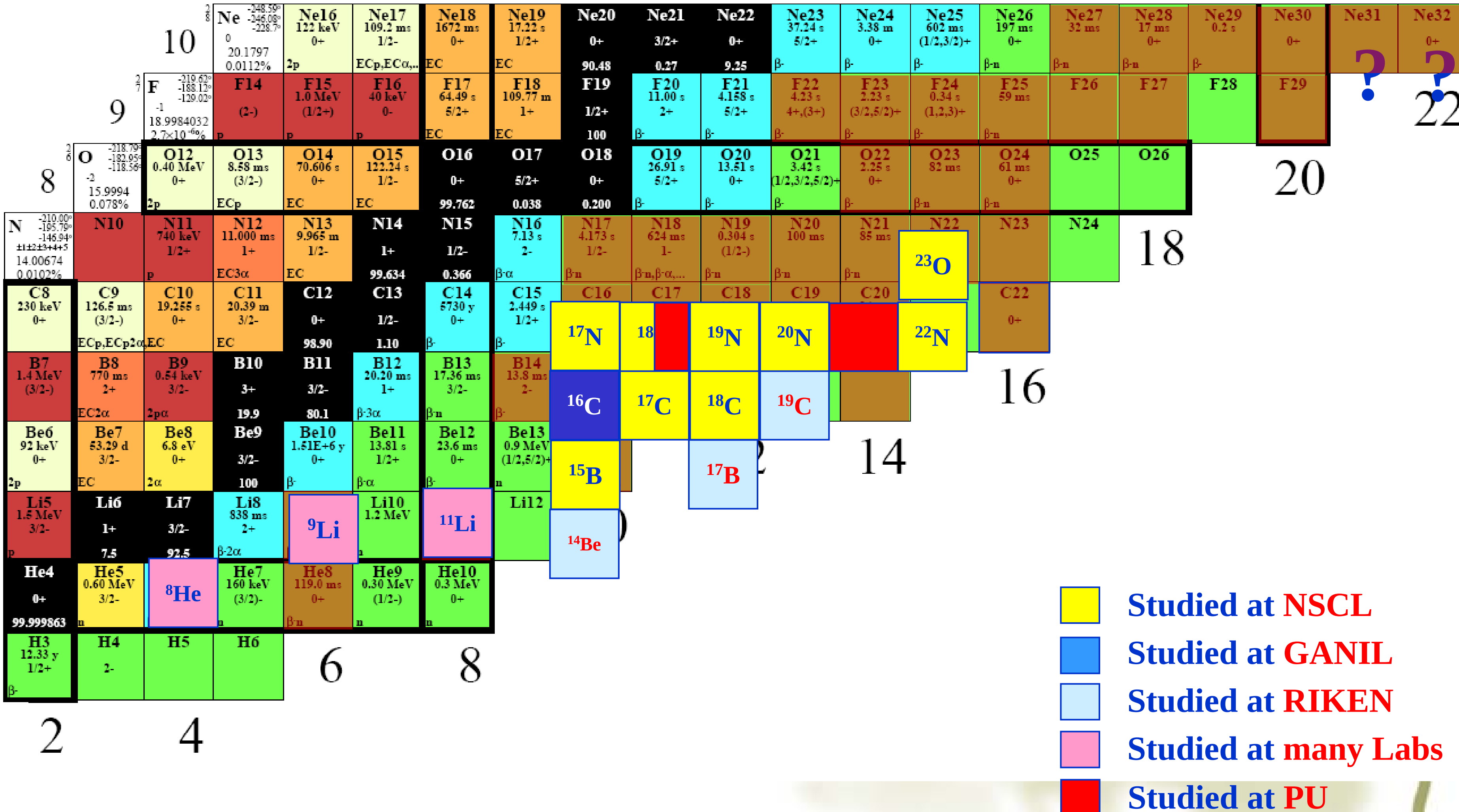






| Array | 材料 | 几何尺寸 | 片数 | R(m) | 立体角(%) | 本征效率(%)@1MeV | 中子测量阈(keV) |
|---|---|---|---|---|---|---|---|
| NSCL(Ball) | BC412 | 长：157cm<br>宽：7.6 cm<br>厚：2.54 cm | 16 | 1 | 15 | 12 | 800 |
| TONNERRE (Ball) | BC400 | 长：160cm<br>宽：20<br>厚：4 $cm^3$ | 32 | 1.2 | 45 | 12 | 200 |
| 北京大学中子球 | BC408 | 长：157cm<br>中间宽：40cm<br>两头宽：20cm<br>厚：2.5cm | 8 | 1 | 30 | 14.1 | ~350 |
| 北京大学中子墙 | BC408 | 长：40m,<br>宽：5cm<br>厚：2.5cm | 8 | 0.6 | 8.8 | 36.5 | ~200 |

Nucl. Instr. Meth. A 505(2009)645



10
9
8
2
4
6
8
14
16
18
20
22
?
?
$^{23}$O
$^{17}$N
18
$^{19}$N
$^{20}$N
$^{22}$N
$^{16}$C
$^{17}$C
$^{18}$C
$^{19}$C
$^{15}$B
$^{17}$B
$^{14}$Be
$^{9}$Li
$^{11}$Li
$^{8}$He
Studied at NSCL
Studied at GANIL
Studied at RIKEN
Studied at many Labs
Studied at PU

# Systematical work

IEEE TRANSACTIONS ON NUCLEAR SCIENCE, VOL. 52, NO. 1, FEBRUARY 2005 473

## Efficiency Calibration of a Large-Area Neutron Detector by Using Am/Be Neutron Source

Q. Y. Hu, Y. L. Ye, Z. H. Li, X. Q. Li, D. X. Jiang, T. Zheng, Q. J. Wang, H. Hua, C. E. Wu, Z. Q. Chen, J. Ying,

Nuclear Instruments and Methods in Physics Research A 606 (2009) 645–650

## Performances of a β-delayed neutron detection array at Peking University

Jianling Lou [1], Zhihuan Li *, Yanlin Ye **, Hui Hua, Q.J. Faisal, Dongxing Jiang, Xiangqing Li,

PHYSICAL REVIEW C **72**, 064327 (2005)

## $\beta$-decay of the neutron-rich nucleus $^{18}$N

Z. H. Li, Y. L. Ye, H. Hua,* D. X. Jiang, Y. M. Zhang, F. R. Xu, Q. Y. Hu, G. L. Zhang,

PHYSICAL REVIEW C **75**, 057302 (2007)

## Observation of a new transition in the $\beta$-delayed neutron decay of $^{18}$N

J. L. Lou,[1] Z. H. Li,[1,*] Y. L. Ye,[1] H. Hua,[1] D. X. Jiang,[1] L. H. Lv,[1] Z. Kong,[1] Y. M. Zhang,[1] F. R. Xu,[1] T. Zheng,[1] X. Q. Li,[1]

PHYSICAL REVIEW C **80**, 054315 (2009)

## Experimental study of the $\beta$-delayed neutron decay of $^{21}$N

Z. H. Li, J. L. Lou, Y. L. Ye,* H. Hua, D. X. Jiang, X. Q. Li, S. Q. Zhang, T. Zheng, Y. C. Ge, Z. Kong, L. H. Lv,

# Neutron & γ spectra for $^{21}$N β-n- γ

**Phys.Rev.C 80, 054315(2009)**

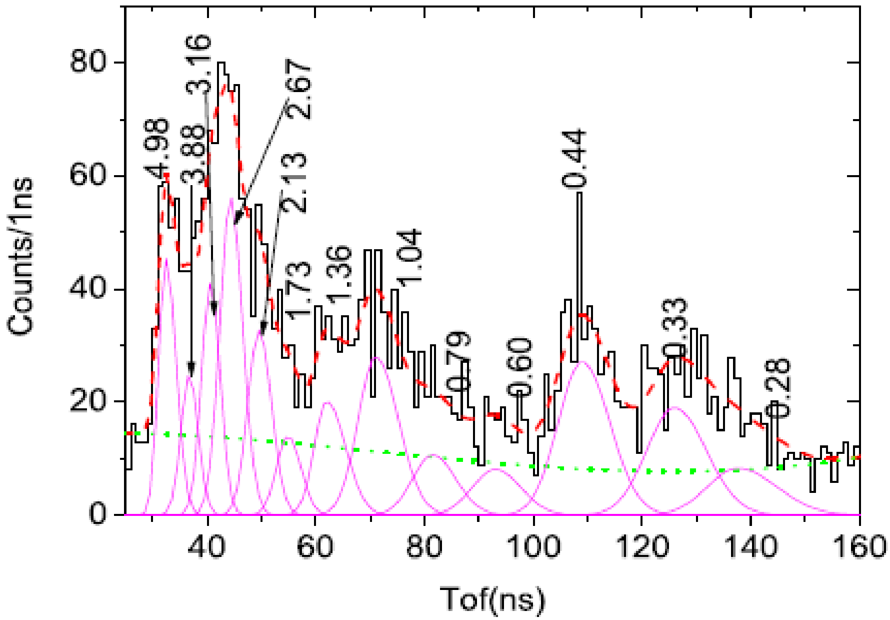



Fig.3 The time-of-flight spectrum measured by neutron neutron wall. The flight path of all neutron detectors were unified to 1 meter. The step vert solid line, the dash line, the dot line, and the solid line stand for original data, fitted data, background and fitted neutron peaks, respectively.

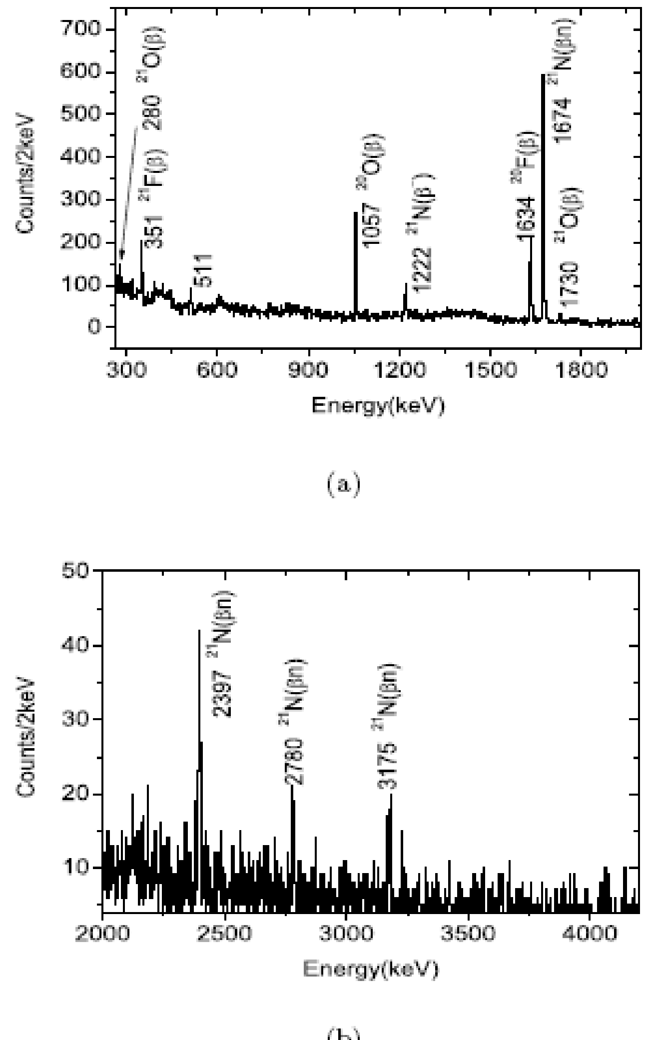


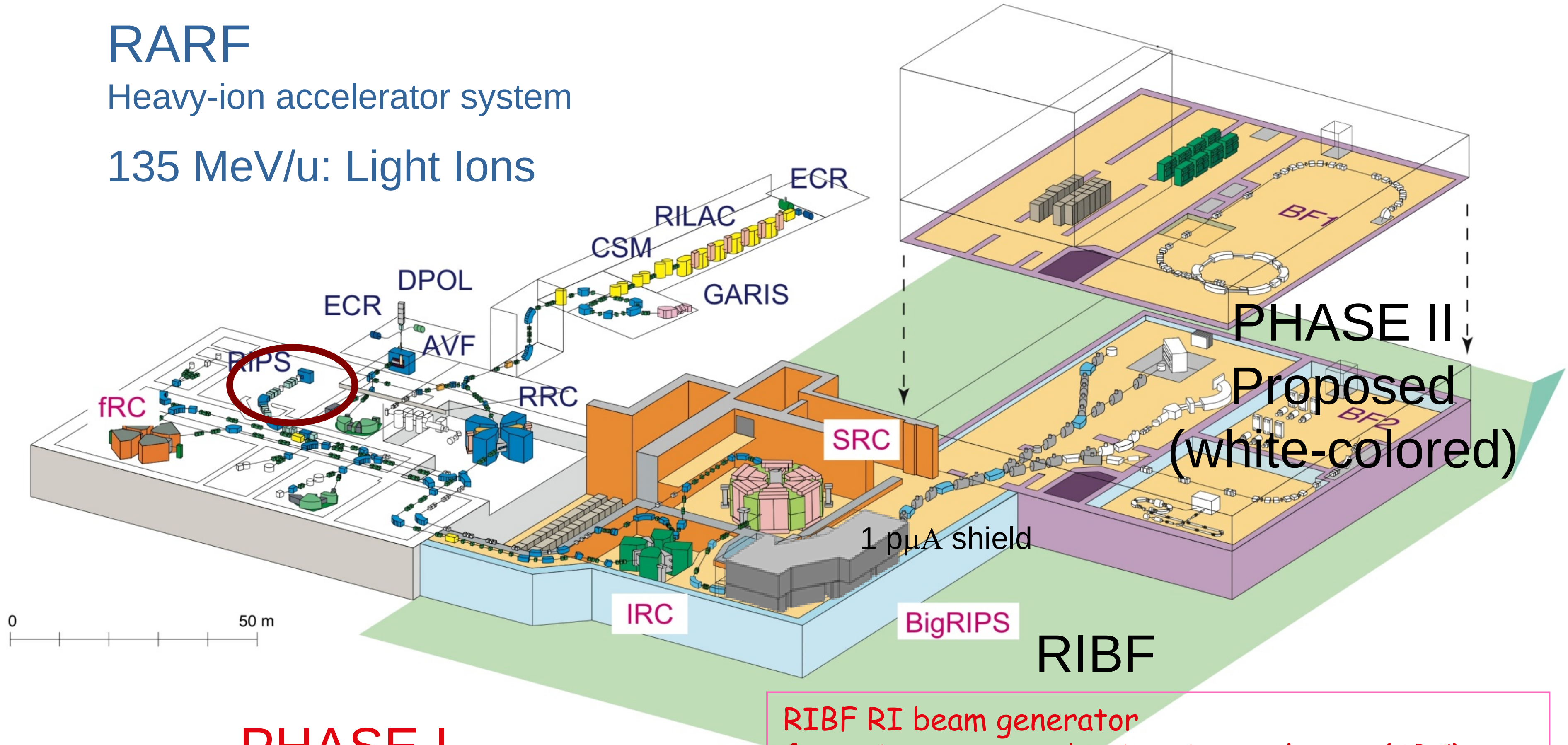

Fig.4 β-γ coincidence spectrum from the β-decay of $^{21}$N, (a) is the low energy part and (b) is the high energy part, and all the energies are given in keV.

# reacrion experiments

- $^{17}$Ne, $^{16}$C experiments in Lanzhou
- $^{6}$He, $^{8}$He experiemnts in RIKEN

# $^{6}$He,$^{8}$He experiments at RIKEN

RARF
Heavy-ion accelerator system
135 MeV/u: Light Ions

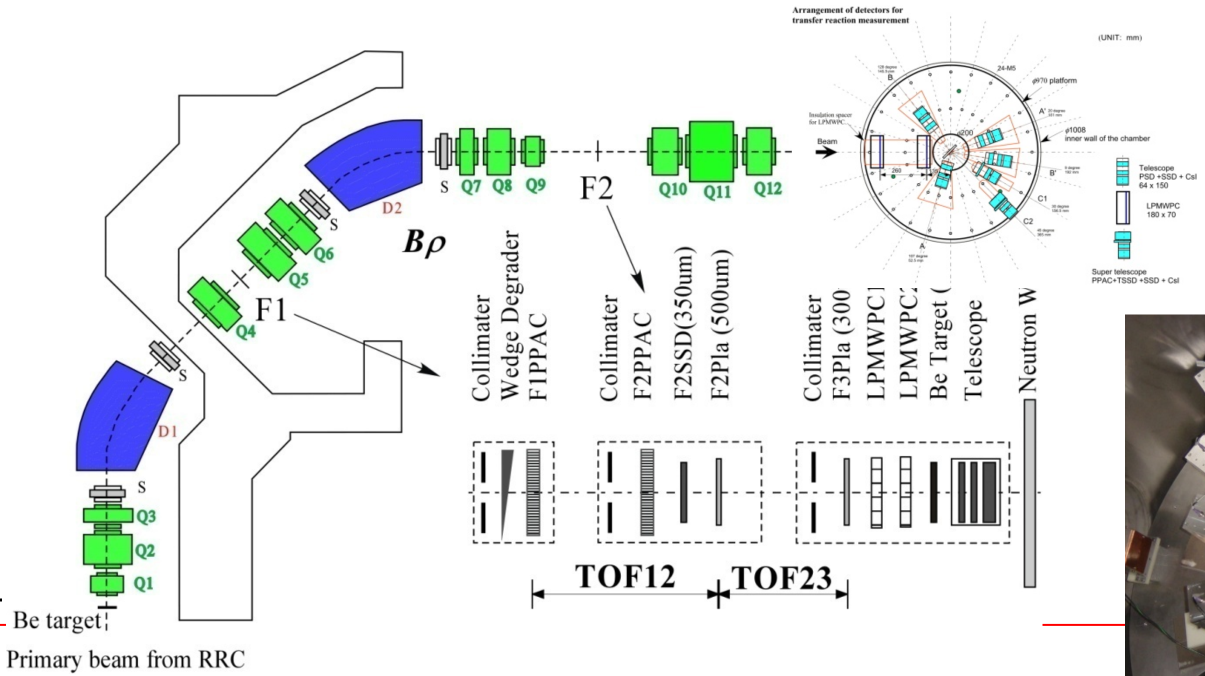



PHASE I
350 MeV/u: All Ions

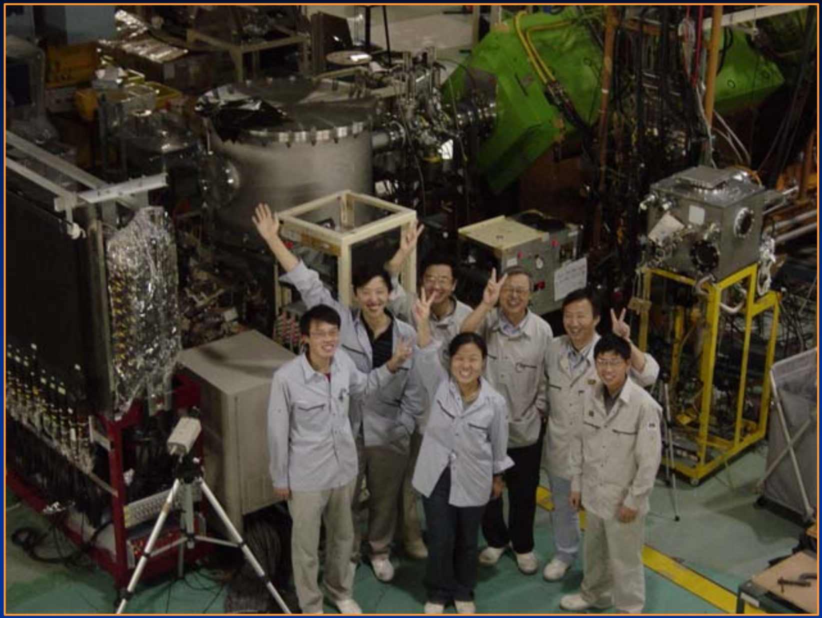
RIBF RI beam generator featuring superconducting ring cyclotron (SRC) and superconducting projectile fragment separator (BigRIPS) will be commissioned in 2006.

# Experiment at RIPS in 2002: R347n(2A)

## 25 MeV/u $^{6}$He + $^{9}$Be

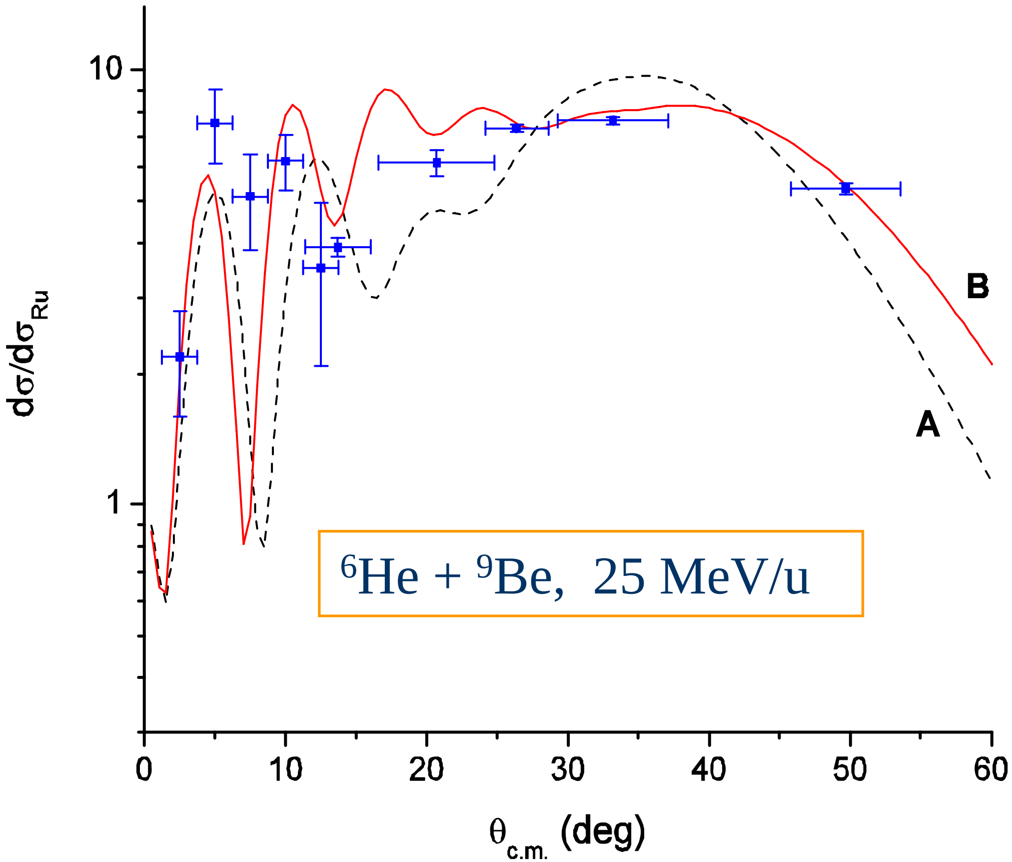






# Quasi-Elastic scattering

**Y.Ye et al., PRC71（2005）014604**



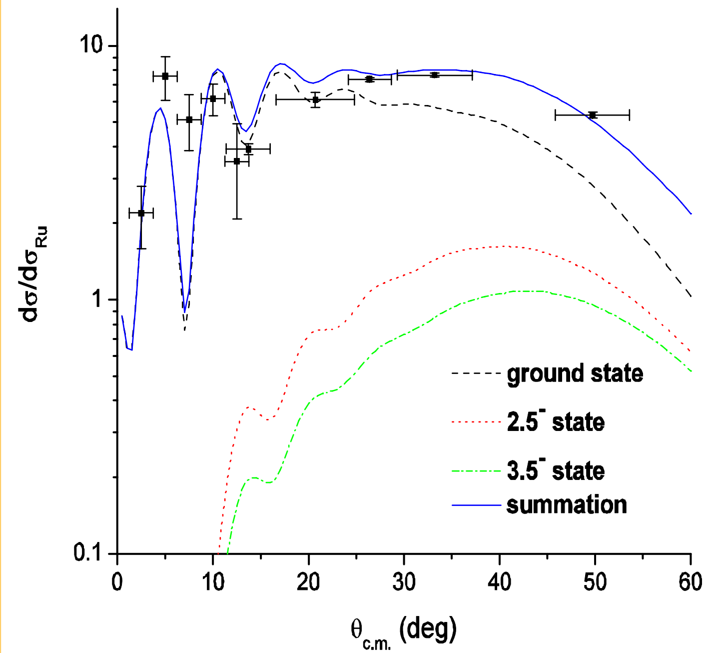



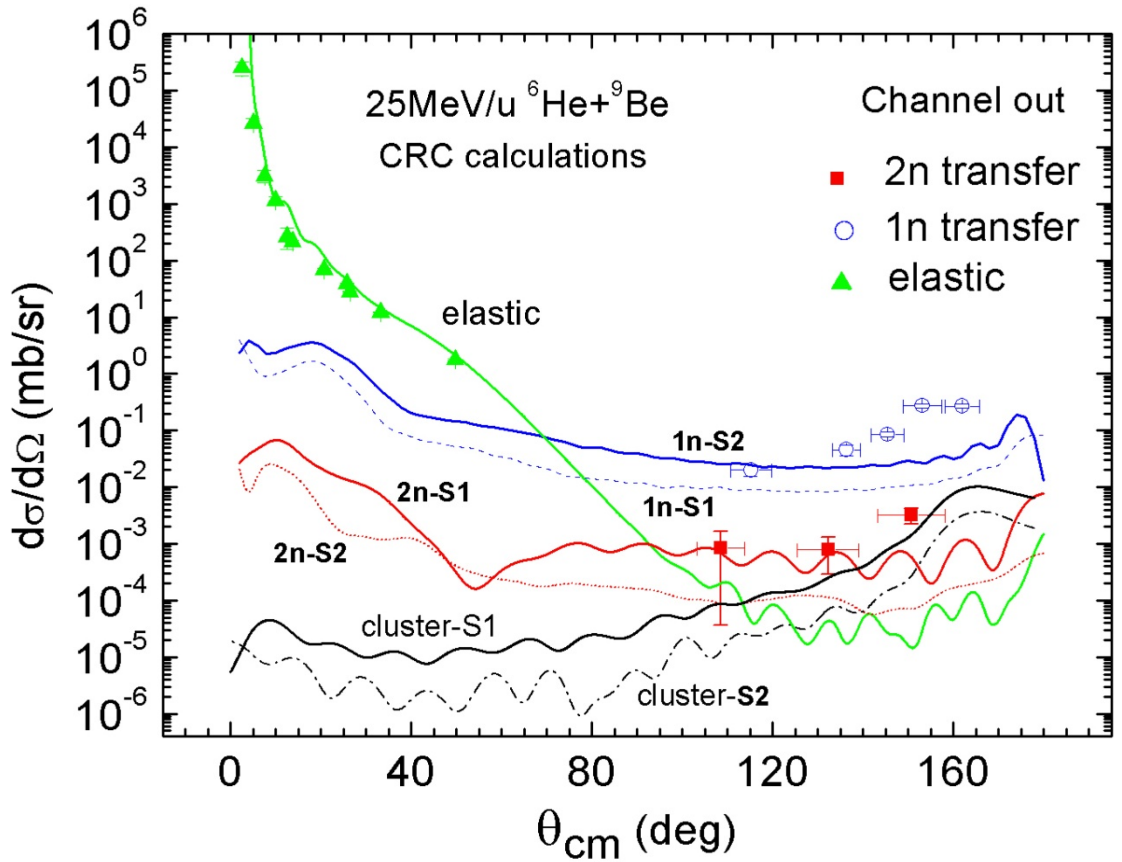

FIG. 7: Differential cross sections of the elastic scattering of 25 MeV/nucleon $^6$He from $^9$Be target. The solid points represent the experimental data, the dashed line corresponds to the optical model calculation with the parameter set A in Tab.II and the solid line with the parameter set B.

TABLE II: Optical potential parameters for $^6$He+$^9$Be at 25 MeV/nucleon.

| Sets | $V$ (MeV) | $r_v$ (fm) | $a_v$ (fm) | $W$ (MeV) | $r_w$ (fm) | $a_w$ (fm) | $\sigma_r$ (mb) |
|---|---|---|---|---|---|---|---|
| A | 133.1 | 0.646 | 1.05 | 19.7 | 0.97 | 1.31 | 1663.4 |
| B | 114.8 | 0.97 | 1.05 | 36.4 | 0.97 | 1.27 | 2061.4 |
| C | 114.8 | 0.97 | 1.05 | 37.0 | 0.97 | 1.27 | 2102.9 |

# 1n and 2n transfer

Y.Ye et al., J.Phys.G31（2005）S1647



# Recoiled Proton Tagged Knockout Reaction for $^{8}He$

Y.Ye[1], Z.Cao[1] , J.Xiao[1], D.Jiang[1], T.Zheng[1], H.Hua[1], Y.Ge[1], X. Li[1], J.Lou[1],, Q.Li[1], L.Lv[1], R.Qiao[1], H.You[1], R.Chen[1], H.Sakurai[2], H.Otsu[2], Z.Li[2], M.Nishimura[2], S.Sakaguchi[2], H.Baba[2], Y. Togano[2], K.Yoneda[2], C.Li[2], S.Wang[2,1], H.Wang[2,1], K.Li[2,1], T. Nakamura[3], Y.Nakayama[3], Y.Kondo[3], S.Deguchi[3], Y.Sato[4], K.Tshoo[4]

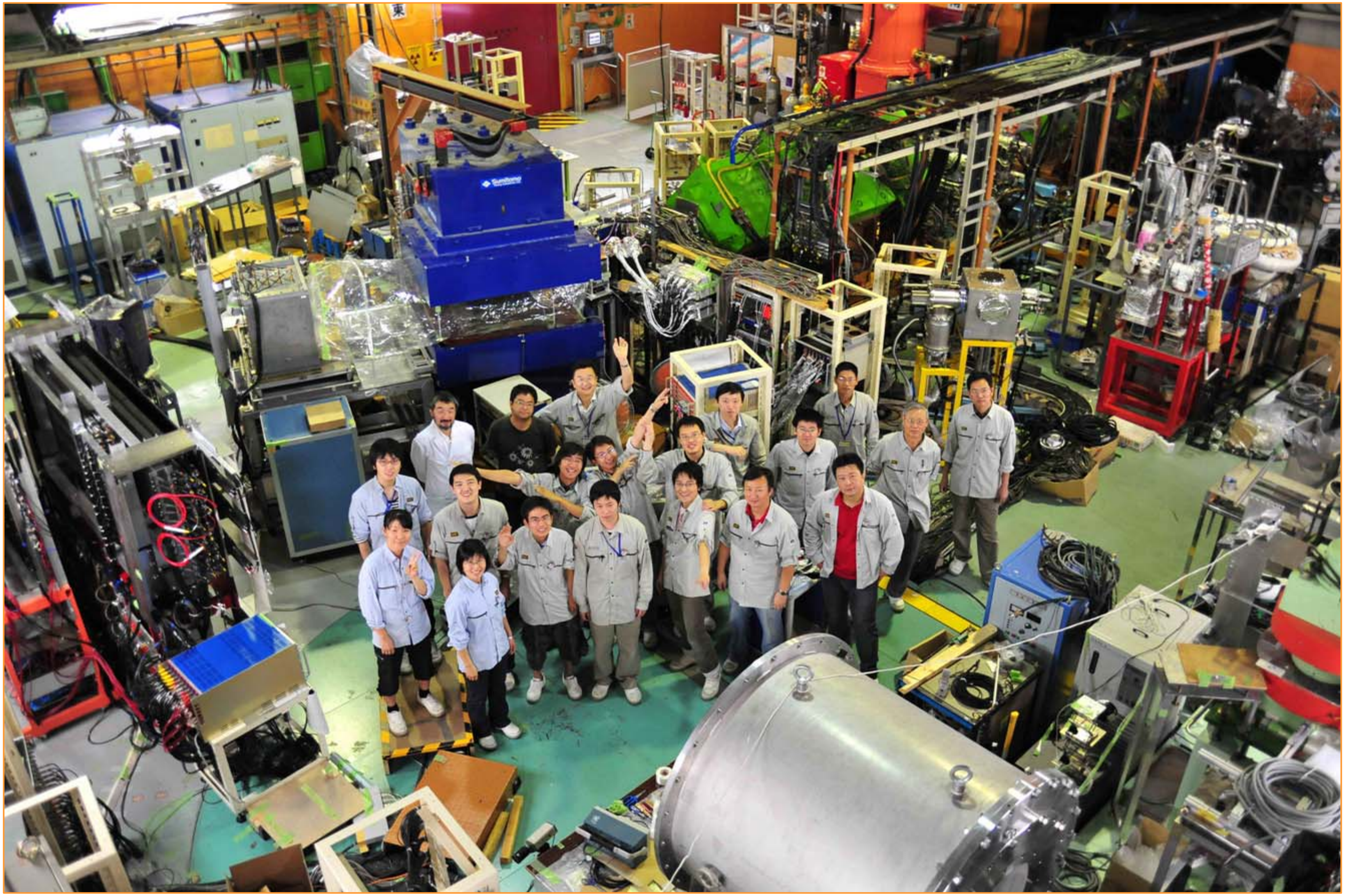
1 School of Physics and State Key Laboratory of Nuclear Physics and Technology, Peking University, Beijing 100871, China

2 RIKEN, 2-1 Hirosawa, Wako, Saitama, 351-0198, Japan

3 Department of Physics, Tokyo Institute of Technology, Japan.

4 School of Physics, Seoul National University, Korea

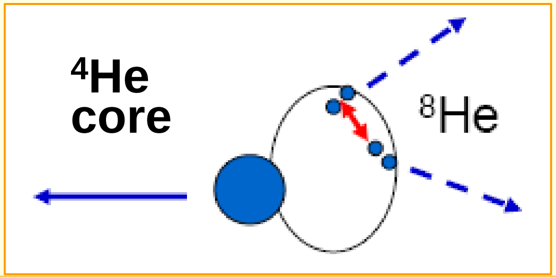

**2009.08.06.**

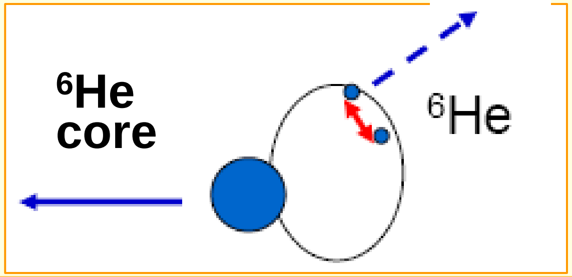


**2009.08.05.**

# The experiment

## Motivation



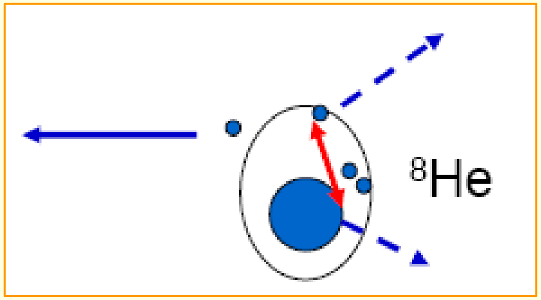

- **with core knockout**

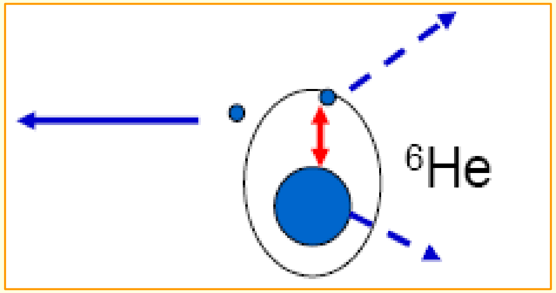
  **establish the core knockout mechanism**

  **(new method)**

  **measuring the momentum correlation among the valence neutrons**

  **(new information for 2n and 4n correlation)**




- **with valence neutron knockout**

  **check the low lying $p_{1/2}$ resonance in $^7$He with more exclusive way;**

  **(clarification)**

  **better interpretation of the SF for $^6$He$(2^+)$+2n**

  **(new interpretation)**

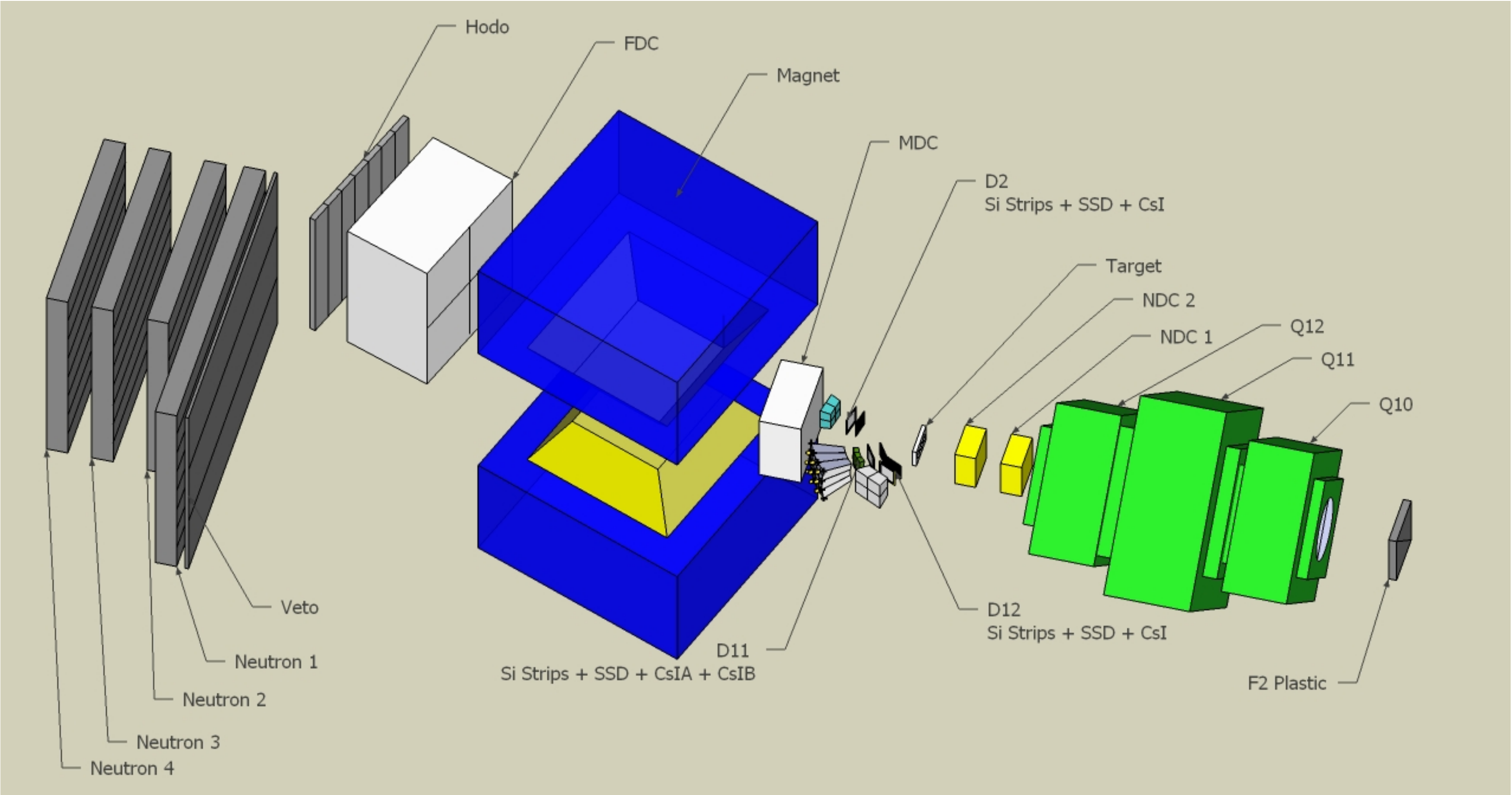
(p, 2p)

↓

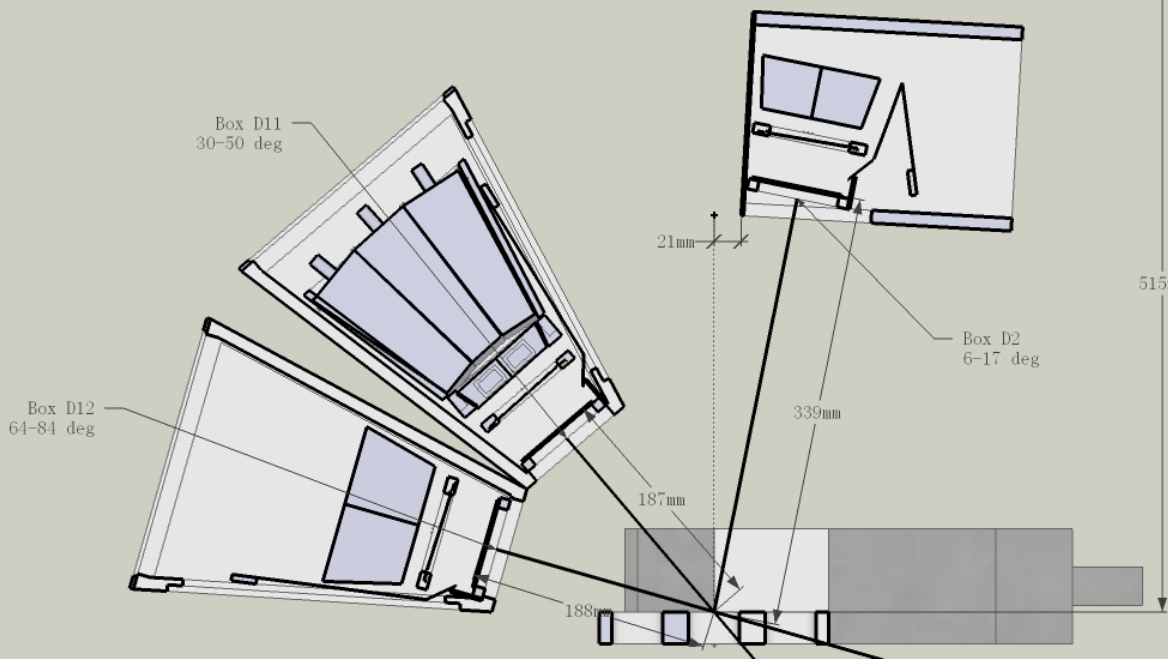
(p, p+Core)

# Setup @RIPS-RIKEN

- Primary Beam: $^{13}C$, 115MeV/A, 470enA
- Primary Target: Be(12mm), F1 Wedge: Al($962 mg/cm^2$)
- Second Beam **$^{8}He$, 82MeV/A ~$3*10^5$pps**
- Second Target: $CH_2$($0.0830 mg/cm^2$), C($0.1339 mg/cm^2$), Empty



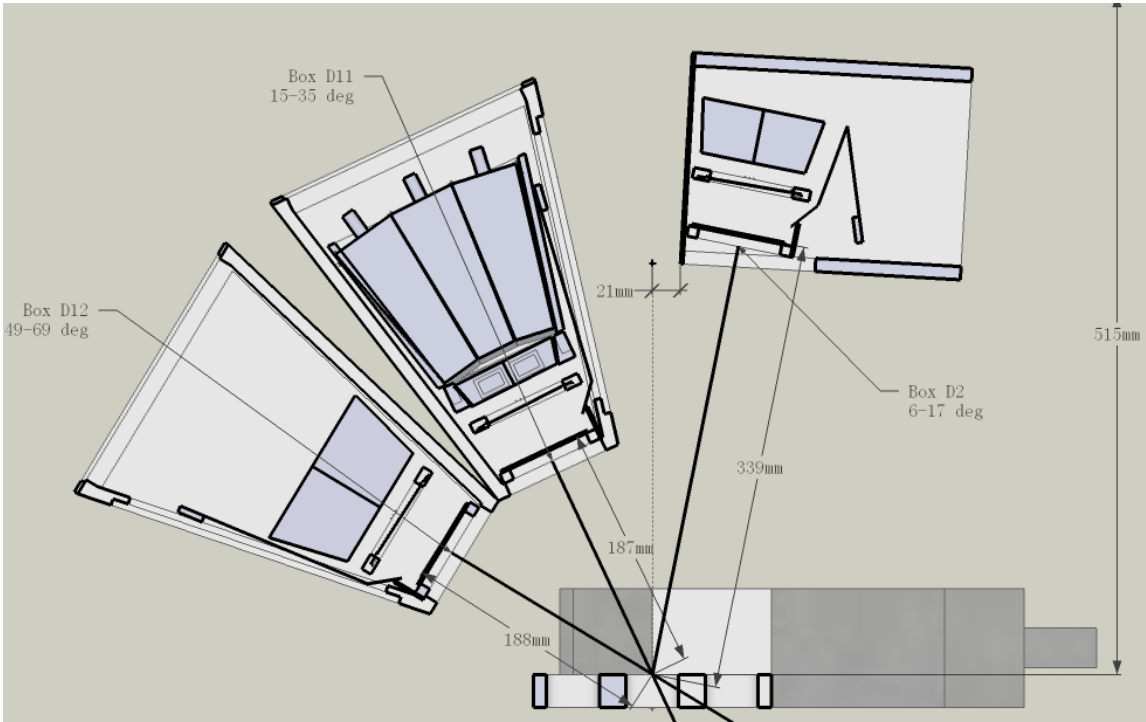
# Telescope Setup




**SetupI**

D1: 30→84 Degree

D2: 8 →19 Degree

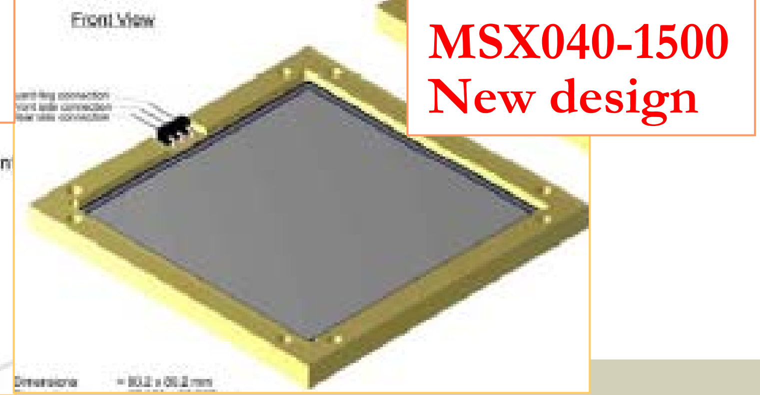


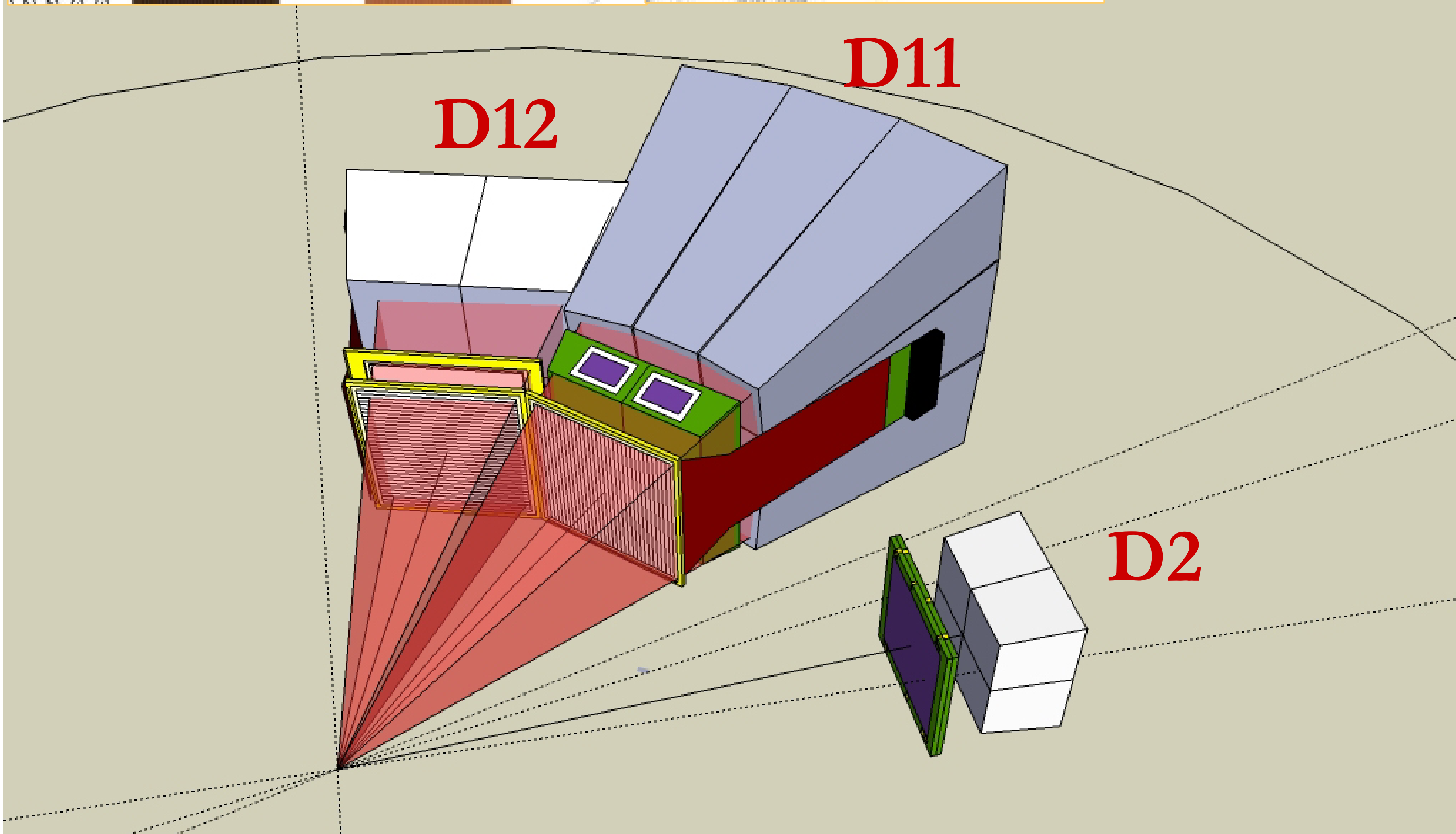

**SetupII**

D1: 15→69 Degree

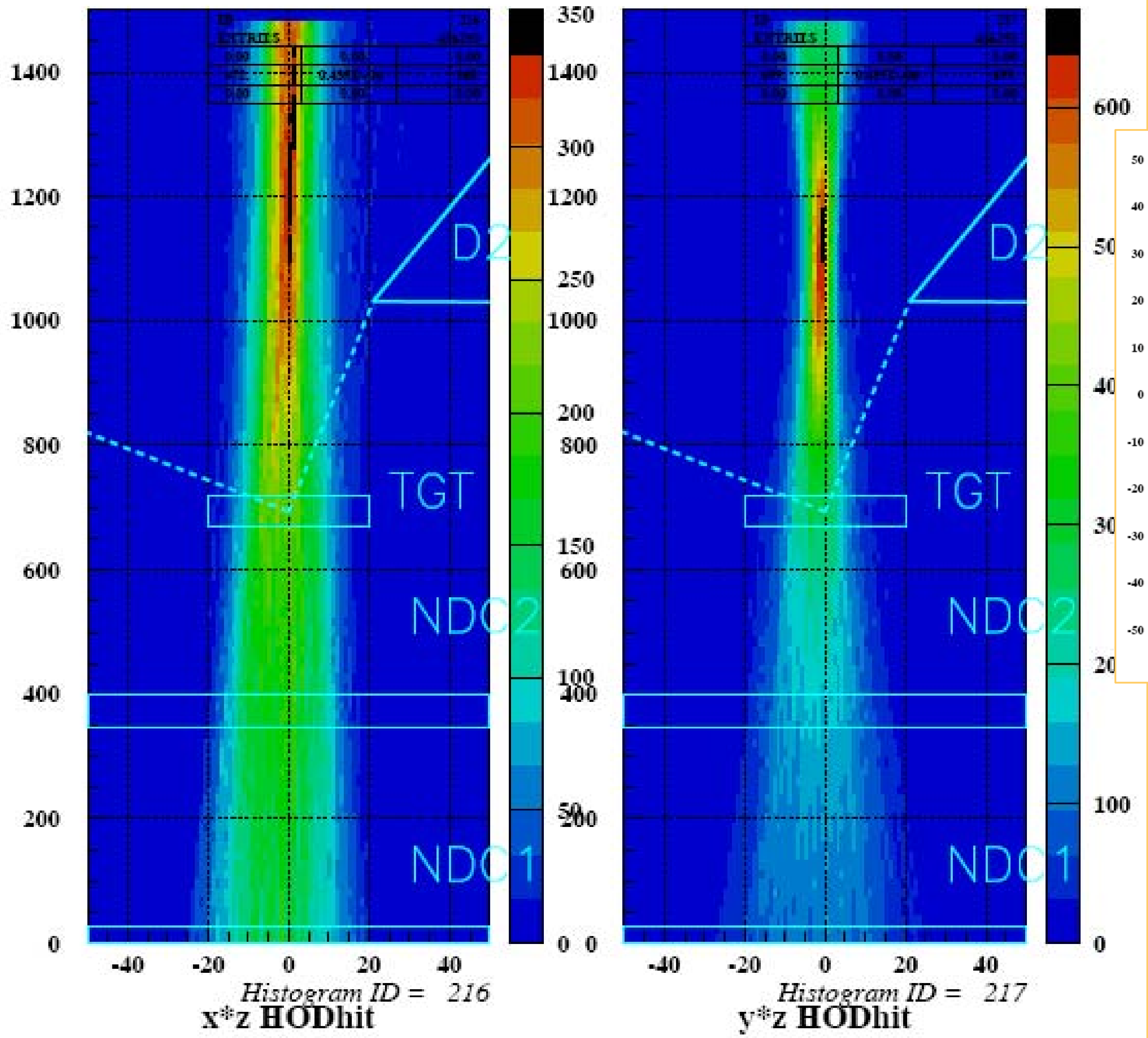
D2: 6 →17 Degree

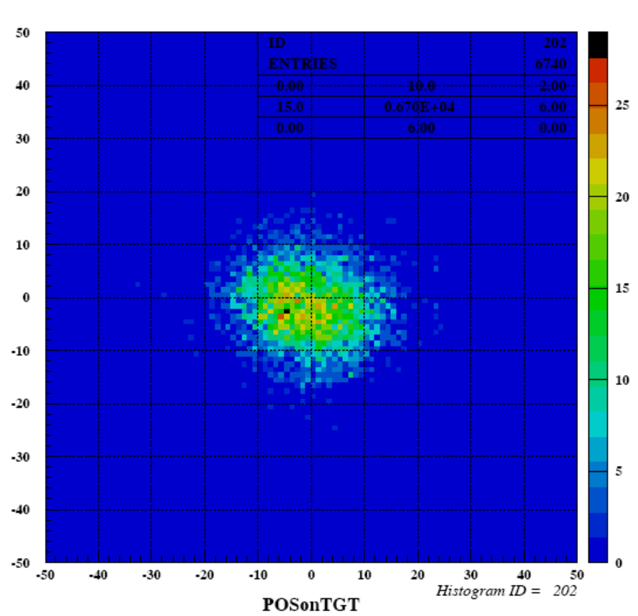

Rear Strip 1
BB7-1000-
new design


Front View
MSX040-1500
New design


D11
D12
D2

# Beam profile



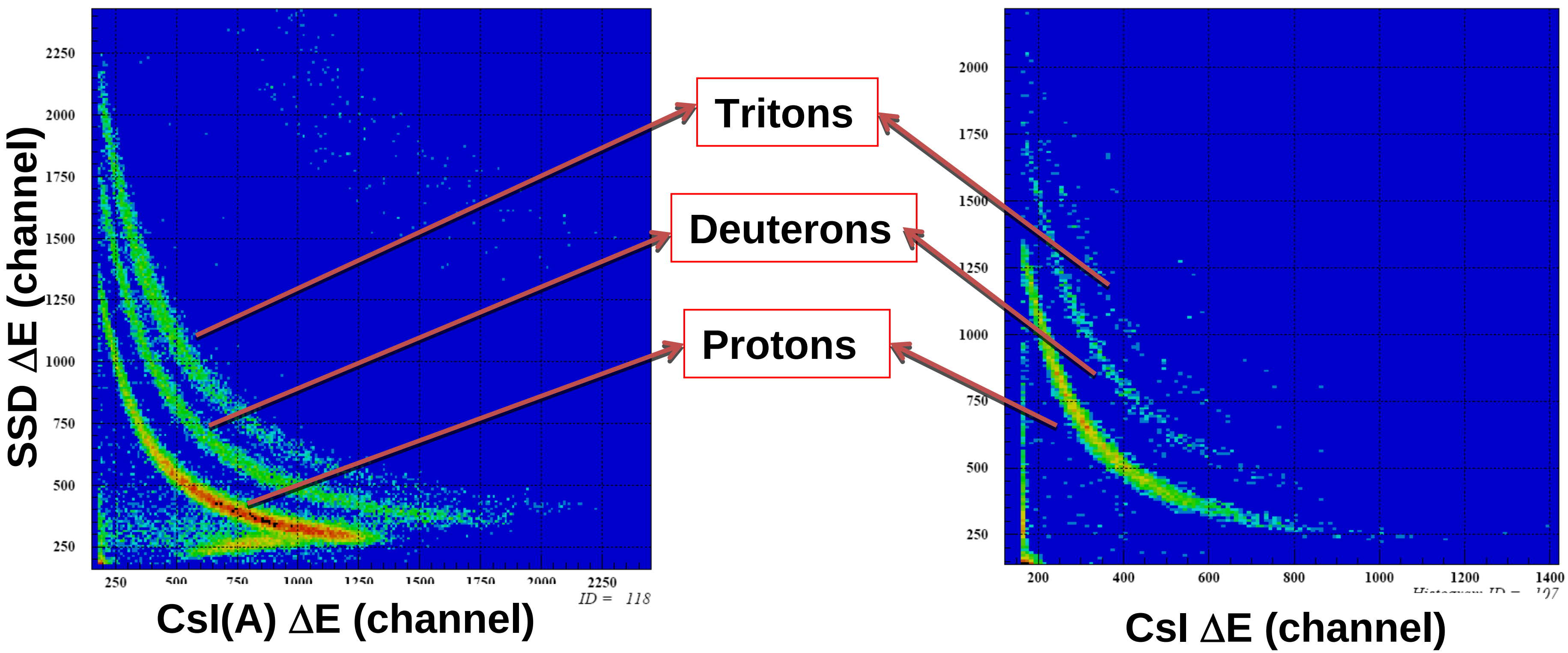



# Ability to identify the two knockout mechanism: knockout Nucleon or Core

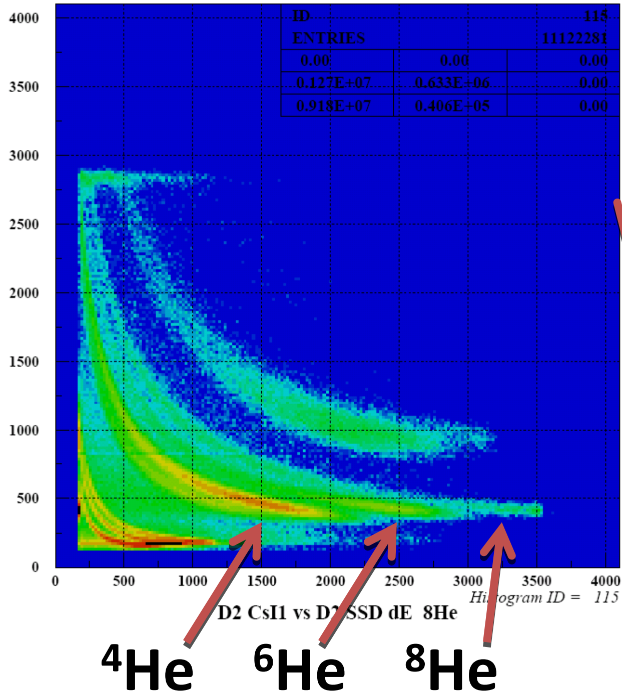
- $^{8}$He selected as incident particle

**Telescope D11 at smaller angles**

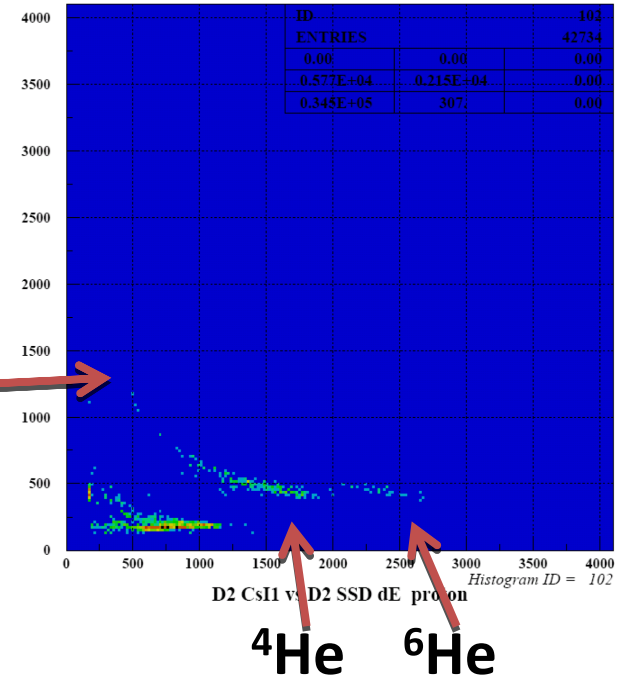
**Telescope D12 at larger angles**



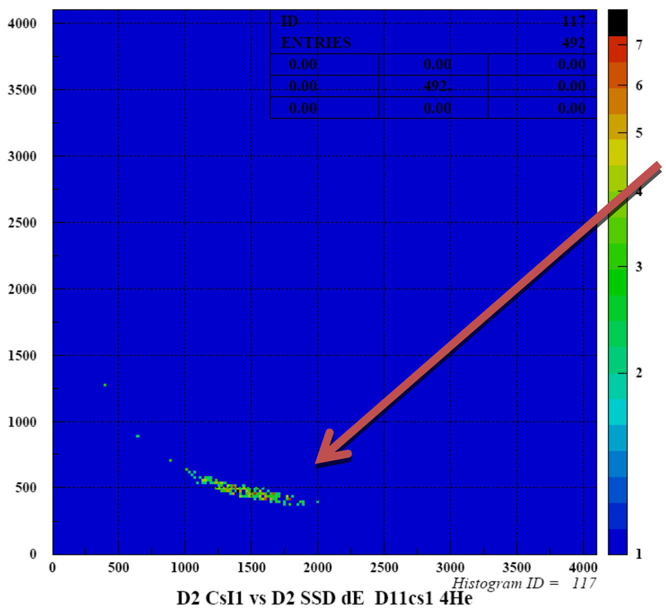
$\Delta$E-E plot for Telescope D2



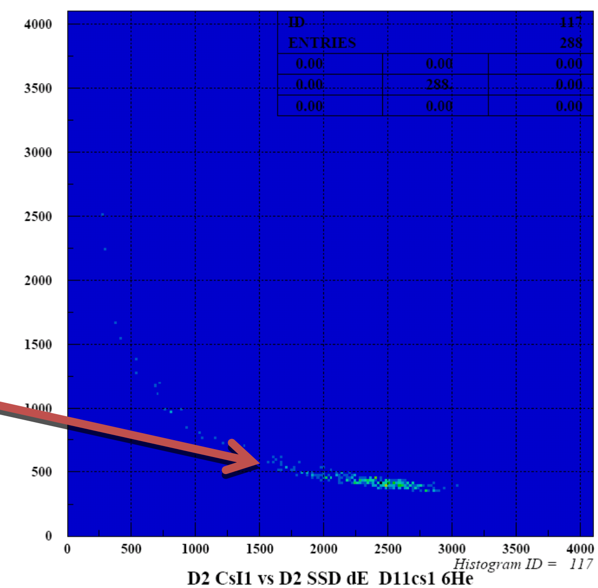

He isotope identify with proton tagging




$^4$He in coincidence with proton in D1/ CsI#1

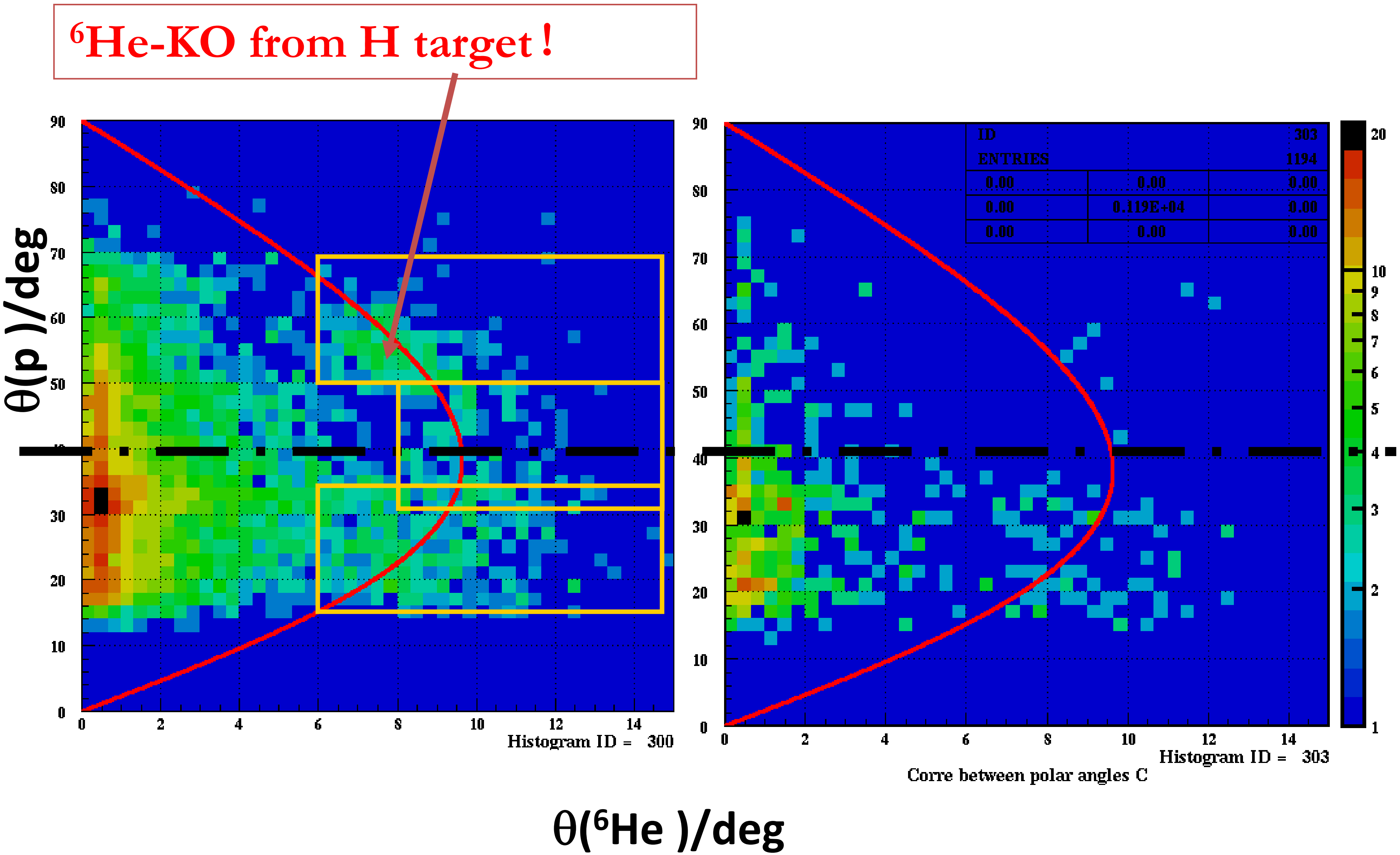


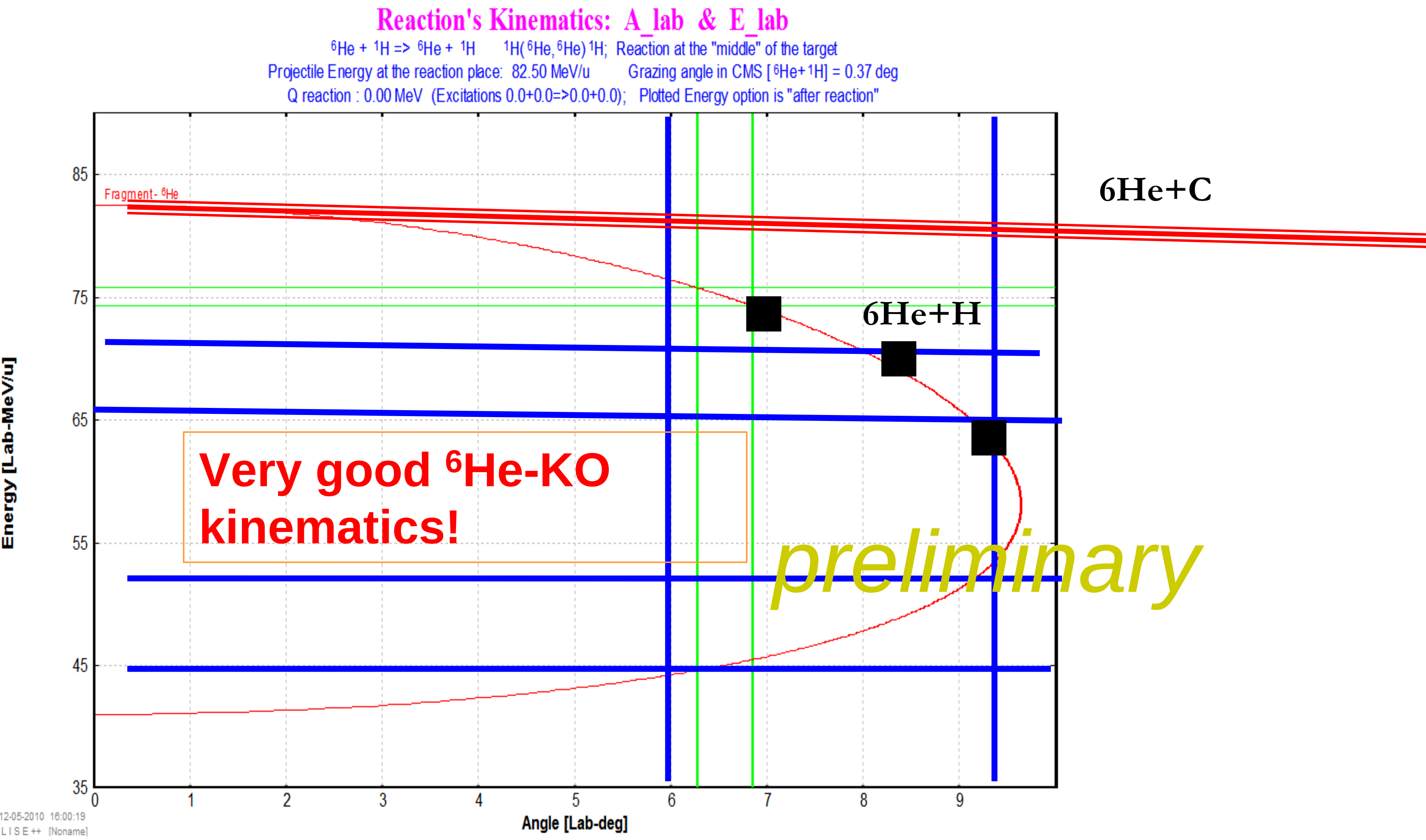

$^6$He in coincidence with proton in D1/ CsI#1

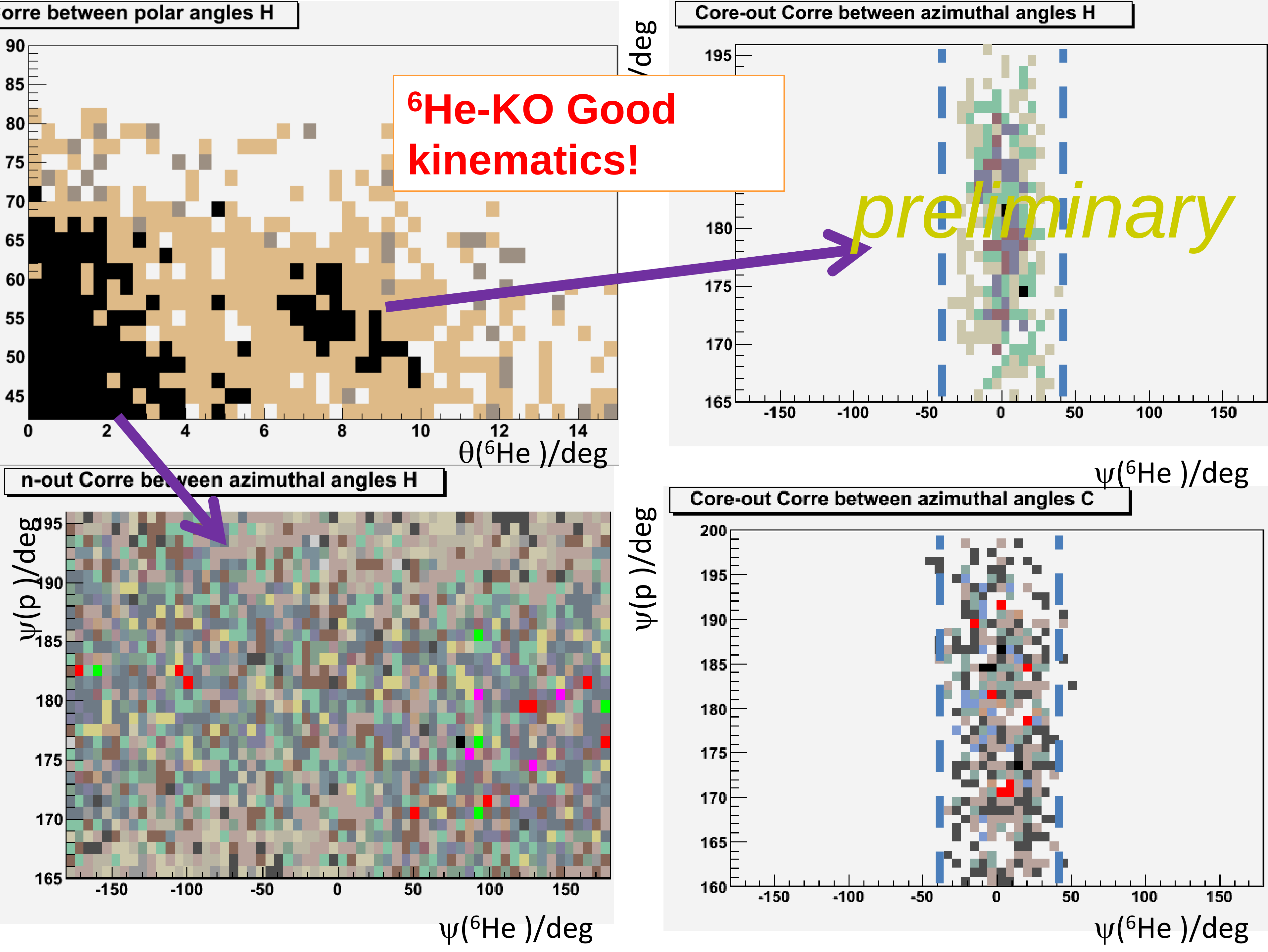


# $^{6}$He-core knockout and N-knockout

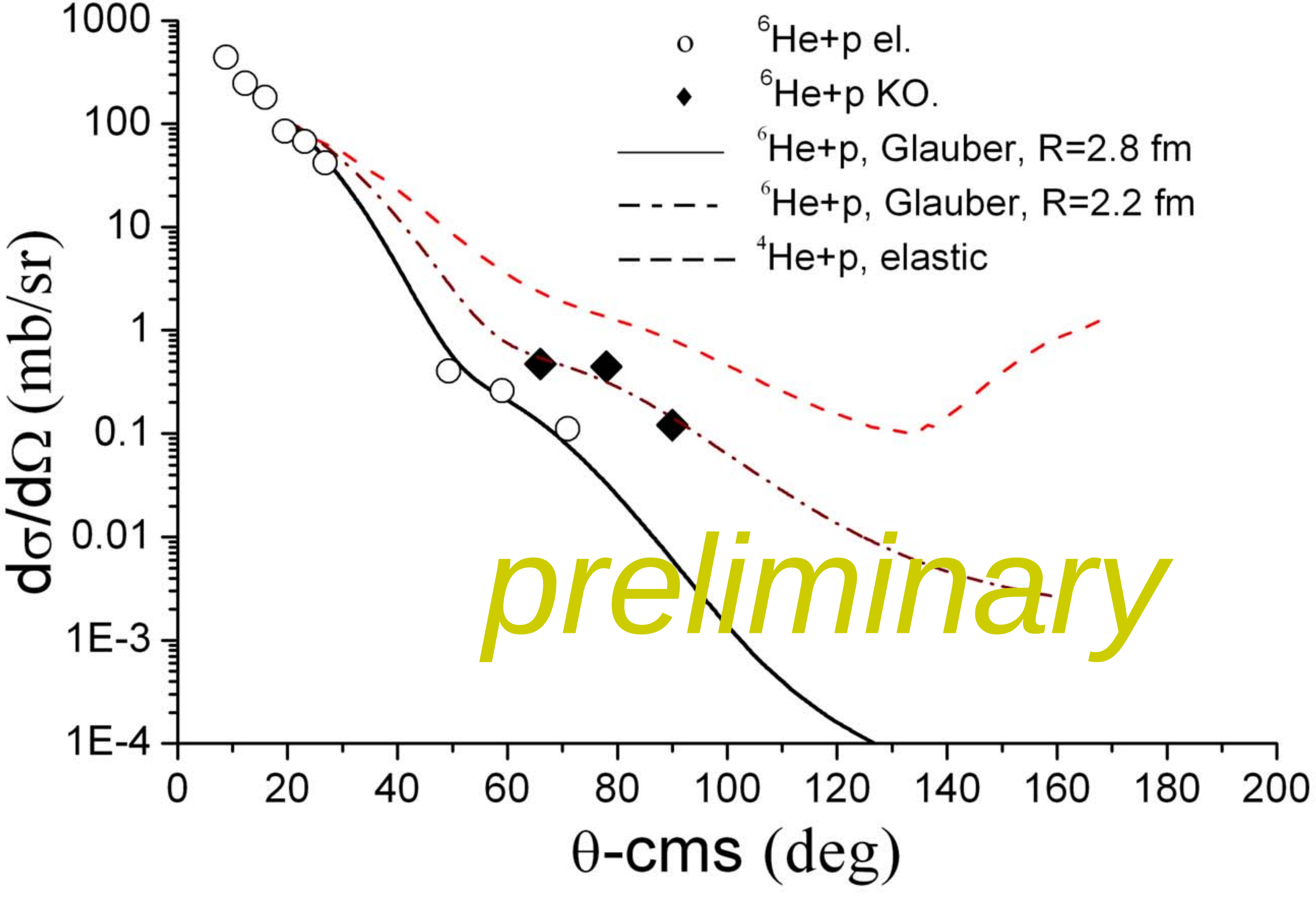
左图为CH靶，右图为C靶。




Reaction's Kinematics: A_lab & E_lab
6He + 1H => 6He + 1H 1H(6He,6He)1H; Reaction at the "middle" of the target
Projectile Energy at the reaction place: 82.50 MeV/u Grazing angle in CMS [6He+1H] = 0.37 deg
Q reaction : 0.00 MeV (Excitations 0.0+0.0=>0.0+0.0); Plotted Energy option is "after reaction"
Fragment- 6He
6He+C
6He+H
Very good 6He-KO kinematics!
preliminary
Energy [Lab-MeV/u]
Angle [Lab-deg]
85
75
65
55
45
35
0
1
2
3
4
5
6
7
8
9
12-05-2010 16:00:19
L I S E ++ [Noname]



orre between polar angles H
θ(6He )/deg
6He-KO Good kinematics!
Core-out Corre between azimuthal angles H
preliminary
ψ(6He )/deg
/deg
n-out Corre between azimuthal angles H
ψ(p )/deg
ψ(6He )/deg
Core-out Corre between azimuthal angles C
ψ(p )/deg
ψ(6He )/deg



dσ/dΩ (mb/sr)
1000
100
10
1
0.1
0.01
1E-3
1E-4
0
20
40
60
80
100
120
140
160
180
200
θ-cms (deg)
o
6He+p el.
6He+p KO.
6He+p, Glauber, R=2.8 fm
6He+p, Glauber, R=2.2 fm
4He+p, elastic
preliminary

# II.3 Hadron Physics

- Strong theoretical research let by Academician Guangda Zhao, covering wide area of basic subjects.
- Joining the international experimental HEP projects, such as LHC-CMS ;BEPC-BES; KEK-belle; DESY-Hermes; RHIC-Phenix etc.

# 例1：K.T.Zhao—重夸克偶素的系列研究

PRL 102, 162002 (2009) PHYSICAL REVIEW LETTERS week ending 24 APRIL 2009

**QCD Corrections to $e^+e^- \to J/\psi + gg$ at $B$ Factories**

Yan-Qing Ma,[1] Yu-Jie Zhang,[1] and Kuang-Ta Chao[1,2]
[1]*Department of Physics and State Key Laboratory of Nuclear Physics and Technology, Peking University, Beijing 100871, China*

PRL 101, 112001 (2008) PHYSICAL REVIEW LETTERS week ending 12 SEPTEMBER 2008

**QCD Prediction for the Non-$D\bar{D}$ Annihilation Decay of $\psi(3770)$**

Zhi-Guo He, Ying Fan, and Kuang-Ta Chao

PRL 98, 092003 (2007) PHYSICAL REVIEW LETTERS week ending 2 MARCH 2007

**Double-Charm Production $e^+e^- \to J/\psi + c\bar{c}$ at $B$ Factories with Next-to-Leading-Order QCD Corrections**

Yu-Jie Zhang[1] and Kuang-Ta Chao[1,2]

PRL 96, 092001 (2006) PHYSICAL REVIEW LETTERS week ending 10 MARCH 2006

**Next-to-Leading-Order QCD Correction to $e^+e^- \to J/\psi + \eta_c$ at $\sqrt{s} = 10.6$ GeV**

Yu-Jie Zhang,[1] Ying-Jia Gao,[1] and Kuang-Ta Chao[2,1]

## ♠ 新生奇异夸克星和中子星的区分

中子星：相对论平均场，　　夸克星：袋模型

⟶ 引力波g-模 振荡频率

-----------------------------------------------------

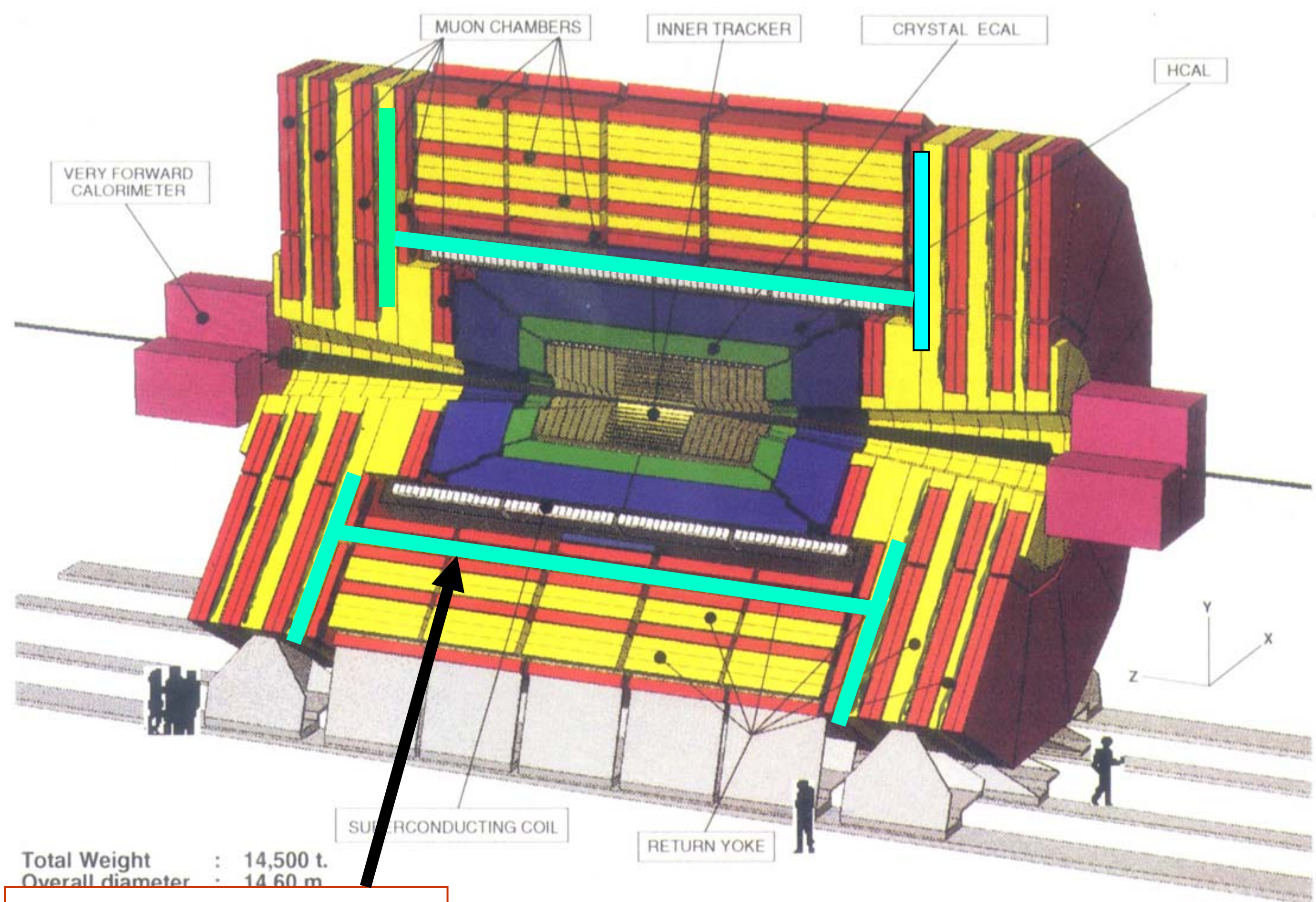
Referee C’s Report:

-----------------------------------------------------

I have formed the view that this paper is acceptable for publication in PRL. My reasons in favor are that the result is of general interest in gravitational-wave physics, supernova physics and nuclear/quark physics. The suggestion that the g-mode signature will be rather different in a neutron star and a strange star following a core collapse supernova is, I think, new. As there is considerable interest in the observational distinction between the two classes of compact stars, the paper is relevant. One would hope that publication in PRL would stimulate the authors and others to more detailed studies.

**W.J. Fu, H.Q. Wei, and Y.X. Liu, arXiv: 0810.1084, Phys. Rev. Lett. 101, 181102 (2008)**

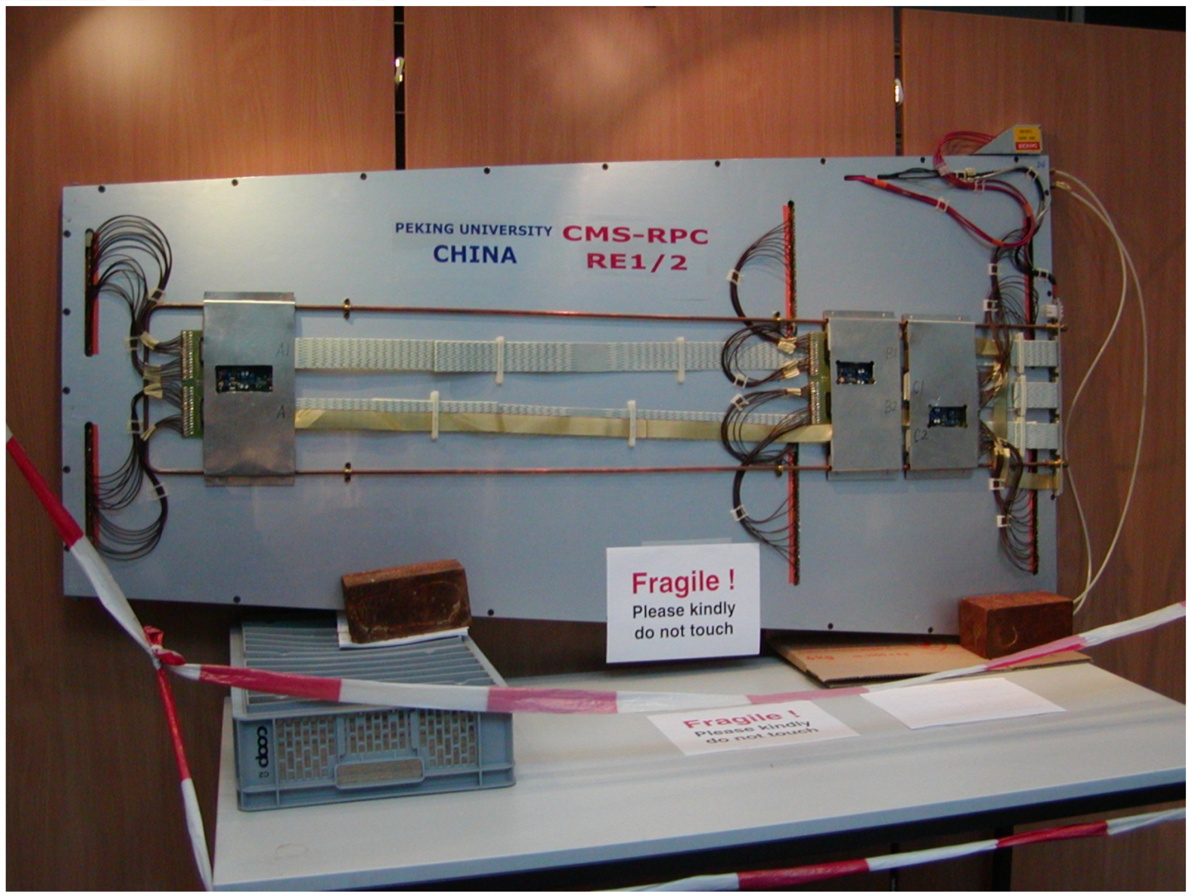
# CMS muon trigger RPC




**PU Task**

Fig. 1.1: Three-dimensional view of the CMS detector.

**In 2002, the full size RE1/2 prototype made by PU was tested at CERN and exhibited at the CMS hall.**


The Compact Muon Solenoid Experiment

CMS Bulletin

CERN, CH-1211 GENEVA 23, Switzerland

Bulletins are available on CMS internal information server: http://cmsdoc.cern.ch/cms.html

Number 06-01
13 March 2006

Moving Forward !

YE+1 yoke equipped with CSC/RPC packages (inner ring) and RE1/3 RPC's (outer ring).

The ME1/3 CSC's now cover the RPC outer ring and hence complete the first Muon station on YE+1.

2006年12月CMS季刊在封面报道北大负责研制的RPC探测器完成在总体结构上的安装。

## The Peking University (China) in CMS

2009年11月26日的CMS times双周刊报道


Representatives of PKU CMS at CERN

The Peking University (PKU) group has been a member of the CMS collaboration since 1996. Currently consisting of 3 professors, 3 engineers and technicians and about 10 PhD students, the group has been heavily involved in both hardware and physics analysis. As part of the RPC project, the group shares the work on the R&D, assembly and testing, installation and commissioning of the RPC detector for the CMS Muon Trigger System.

The RPC performance has been studied with cosmic ray data and the RPC seed reconstruction has also been developed by the group. In the CMS physics programme, the group's interests include the study of the production mechanism and polarization of heavy flavor quarkonium J/ψ and Upsilon in the high-pT region, a feasibility study on the search for a SM Higgs Bosons in a close collaboration with the Fermi Lab and INFN, as well as Top Physics, forward Physics and b Physics.

# CMS-NRQCD

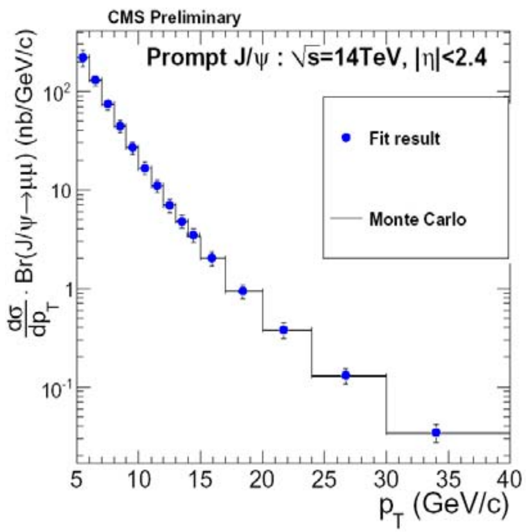
- **CMS J/Ψ重建及触发效率研究**

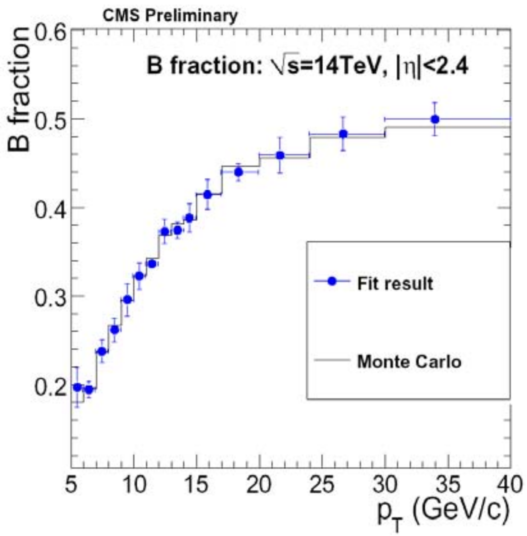
  *该项研究工作已被总结成**CMS Analysis Note（AN-094）***
  *去年改进后升级成 **CMS Note 2007/017，**杨宗长*

- **大横动量区J/ψ、ϒ极化的测量**

  *以上工作总结成**CMS Analysis Note (AN-023)***
  *后升级成**CMS PAS BPH-07-002***

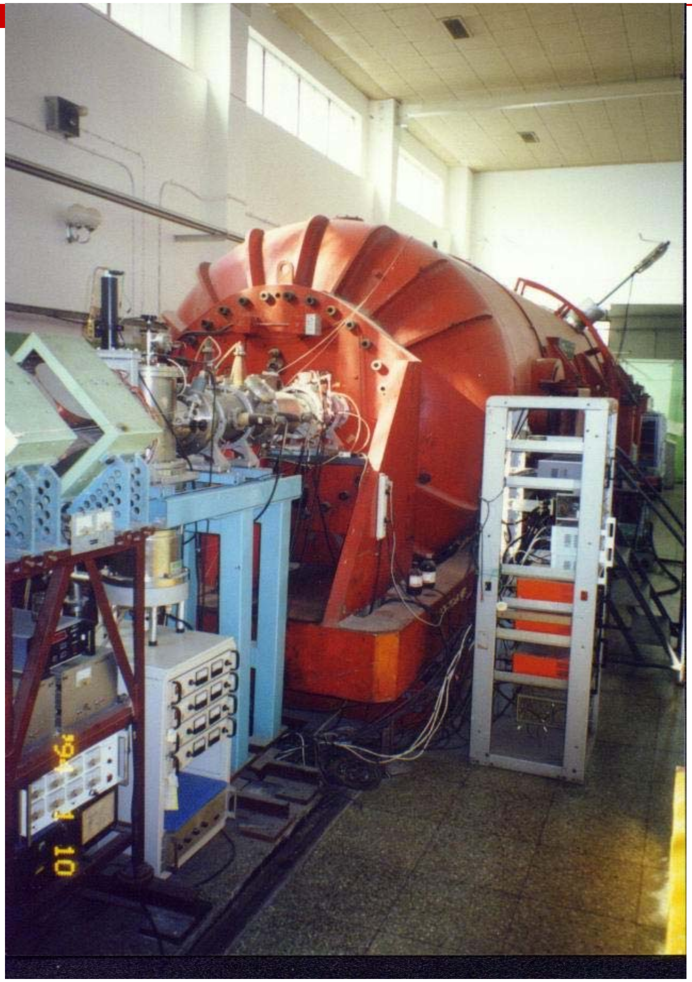
- **利用$\chi_{cJ}$检测NRQCD的研究**　　*在**CMS**组内报告*




**$3fb^{-1}$,误差包含统计与系统误差**

# II.4 Nuclear technique applications

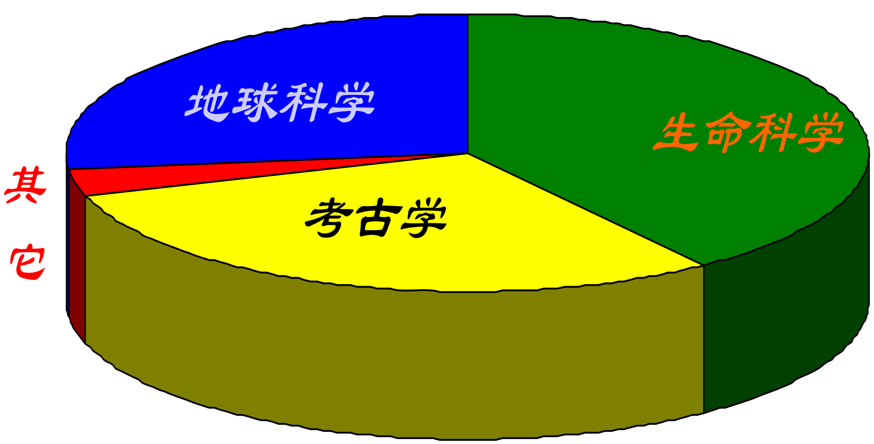


**PKUAMS:**

1988开始，1993年建成，测量$^{14}C$、$^{10}Be$、 $^{26}Al$，$^{14}C$测量精度0.5%，

| Dynasties | 过去 | 新结果 |
|---|---|---|
| 夏 | ? BC - ? BC | ca. 2070 BC - 1600 BC |
| 商 | ? BC - ? BC | ca. 1600 BC - 1046 BC |
| 西周 | ? BC - 771 BC | ca. 1046 BC - 771 BC |

Oracle bones from Yinxu site of Shang Dynasty

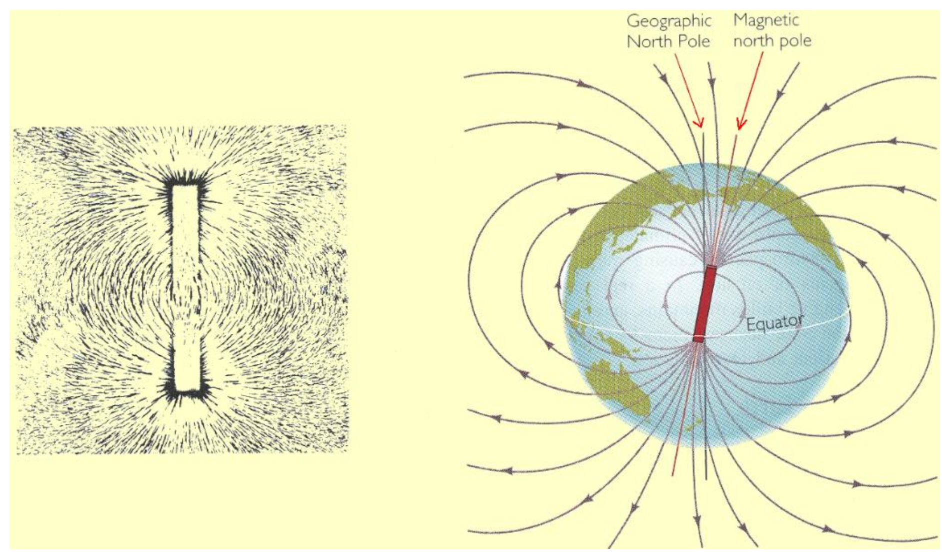


# Inversion of the earth magnetic fied

- 地磁反转期间地磁场变弱，宇宙射线增强，大气中$^{10}$**Be**产率增加。

- 通过测量陕西洛川黄土剖面近**200**个样品中的$^{10}$**Be**含量，发现了与**Matuyama-Brunhes** 地磁反转事件（约**78**万年前）相对应的$^{10}$**Be**含量峰位。

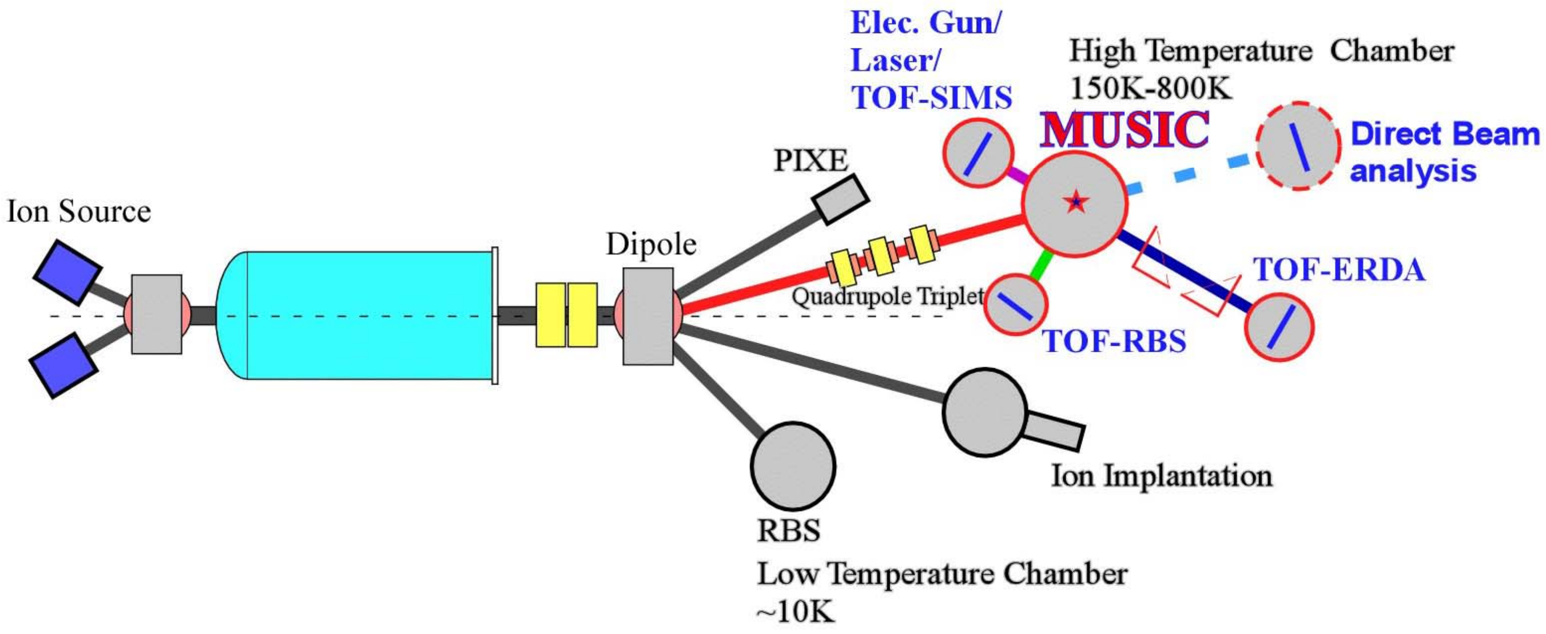
- 对确定黄土剖面准确时标具有重要意义。



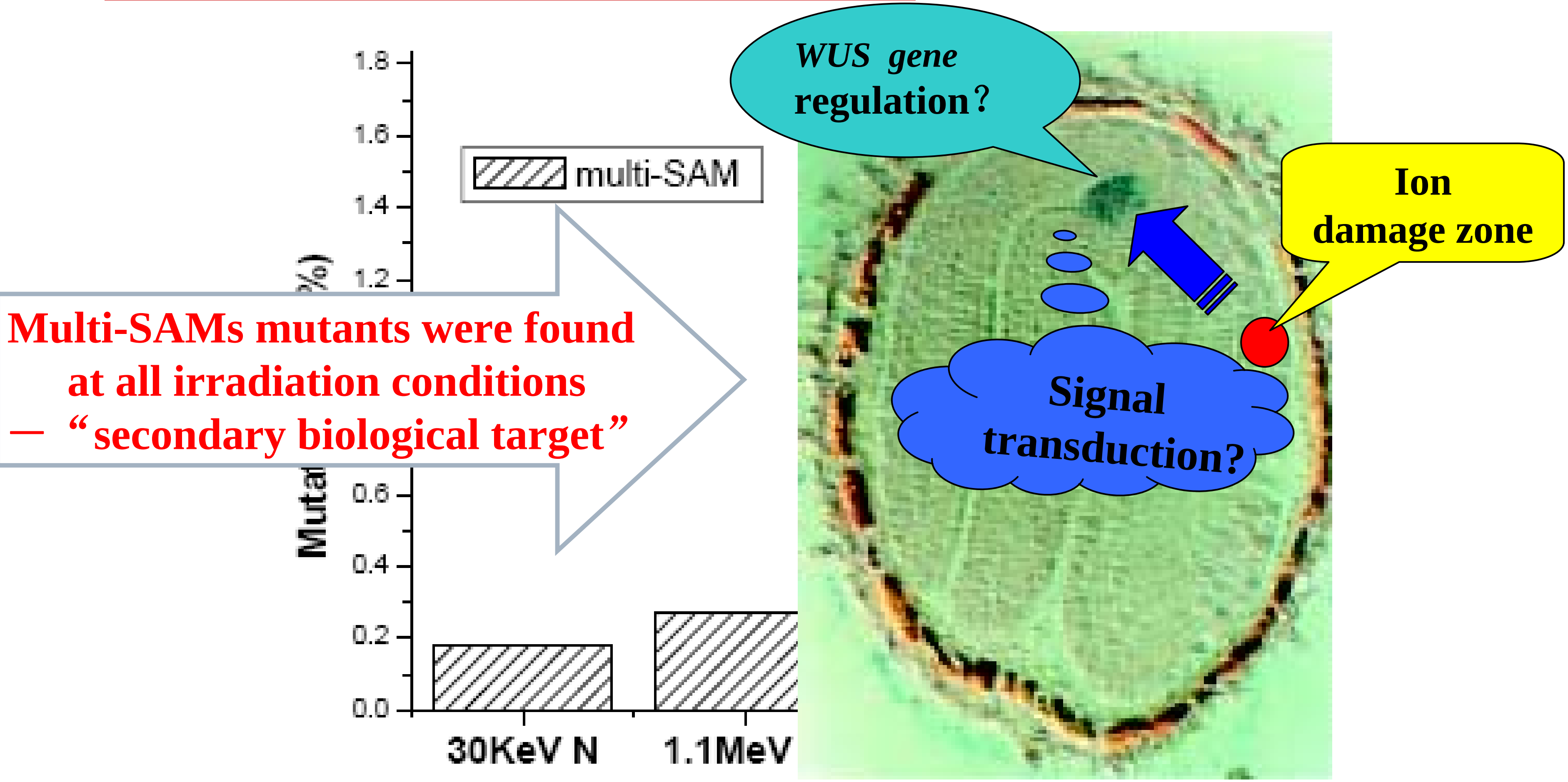
# Upgrade of the 2 x 1.7 MV tandem system

Schematic drawing of the upgrading plan of 2x1.7MV tandem accelerator

**MUSIC: MUlti-uSage Ion Chamber**

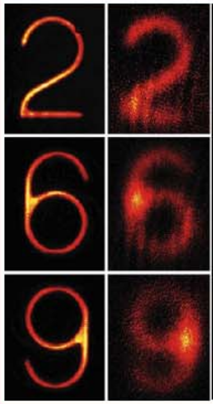


# Mutants induced by Ion Irradiation




**The multi-SAMs mutation rates after irradiation with 30 keV $N^+$, 1.1 MeV protons, 2.6 MeV protons and 6.5 MeV protons, respectively**

# RESEARCH HIGHLIGHTS



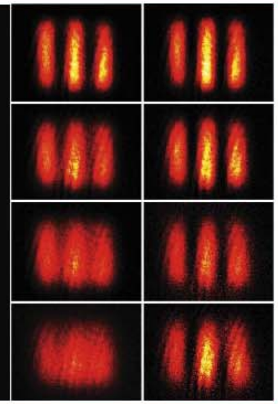
## Fuzzy figures

*Phys. Rev. Lett.* **100,** 223601 (2008)

Capture the complex patterns of photons that make up several numerals in a vapour of rubidium atoms at 52 °C, and those images will degrade as the atoms diffuse (pictured left). But Moshe Shuker of the Technion-Israel Institute of Technology and his colleagues have found a way to store such images and then regenerate the original light beam. The numbers were created by projecting a laser beam through a stencil and exciting the atoms.

Shuker's team stored images comprising sets of three parallel lines for 2, 10, 20 or 30 microseconds (pictured far right and in descending order) using a 'phase shift' technique to counteract the effect of diffusion (shown near right). The technique involves manipulating the phase of the input image, which controls the quantum phases of the atoms. The phases of the atoms that diffuse away from an image's lines are at 180° to one another, and so cancel each other out in the restored image.

Thirty microseconds is a thousand-fold increase over the previous record for delaying an image. The work has potential applications in many fields, including quantum information processing.



M. SHUKER ET AL.

CHEMICAL NANOTECHNOLOGY

## Close the gate

*J. Am. Chem. Soc.* doi:10.1021/ja800266p (2008)

Nanoscale synthetic channels that are opened and closed by a DNA 'switch' have been constructed by a team in China. Such channels could form part of a selective membrane for filtering and purifying water or for mimicking the changeable permeability of biological ion channels.

Yugang Wang of Peking University and his colleagues etched funnel-shaped holes, 5–44 nanometres wide at the narrowest point, into polymer membranes and lined the pores' mouths with single strands of DNA. The DNA in the pore is tightly folded in acidic conditions but unravels into loose chains at pH 8.5. This alters the diameter of the hole and therefore the flux of ions through it.

MOLECULAR BIOLOGY

## Sod it

*Genes Dev.* **22,** 1451–1464 (2008)

Mutations in the *SOD1* gene cause motor neurons to die in amyotrophic lateral sclerosis, also known as Lou Gehrig's disease. Hidenori Ichijo of the University of Tokyo and his co-workers have pinned down why.

The key lies in the system of intracellular membranes called the endoplasmic reticulum (ER). Mutations in *SOD1* seem to affect the system that degrades worn-out pieces of ER, and a surfeit of ER containing misfolded proteins activates a genetic programme that kills the cell.

Ichijo's team found that they could mitigate motor-neuron death and extend the lifespan of *SOD1*-mutant mice by deleting a gene (*ASK1*) that turns on the cell-death programme.

ANIMAL BEHAVIOUR

## Token symbolism

*PLoS ONE* [illegible] (2008)

Apes use and [illegible] symbols but they are not unique in this [illegible] capuchin monkeys (*Cebus apella*; below) can [illegible] tokens that represent different items [illegible]

Elsa Addessi of the CNR, Italy's nation[illegible] research council, and her colleagues trained five monkeys to associate a particular token — such as a green chip, black plastic tube or a brass hook — with one of three specific types of food. They then gave the monkeys a series of choices, each time between different amounts of two food items or between two types of token.

The value the monkeys assigned to a token was very similar to the value they gave to the food it represented, which suggests that the animals weighed up both real and symbolic options in an equivalent manner.

E. VISALBERGHI

ASTROPHYSICS

## Cosmic tiara

*Astrophys. J.* **680,** 295–311 (2008)

A halo of stars surrounds the Milky Way, but researchers disagree how it got there. One theory proposes that it formed from the same cloud of gas as the galaxy itself; the other says the halo is the remains of several 'dwarf galaxies' that were originally separate from but close to the Milky Way proper. A survey of about three million halo stars weighs [illegible] in favour of the latter hypothesis. [illegible] the Max Planck Institute for Astrono[illegible] [illegible]erg, Germany, and his colleagues com[illegible] the Sloan Digital Sky Survey wi[illegible] The halo's structure, they say, sug[illegible] remains of several smaller galaxies [illegible] subsumed into the Milky Way after it form[illegible]

ECOLOGY

## Dotty diets

*Nature Nanotech.* doi:10.1038/nnano.2008.110 (2008)

Those who worry about nanotechnology do so partly because of its potential environmental impact. So David Holbrook and a team from the US National Institute of Standards and Technology, in Gaithersburg, Maryland, have tested whether quantum dots (tiny blobs of semiconducting material) accumulate in a simple invertebrate food web.

Over a series of experiments, they put bacteria (*Escherichia coli*), rotifers (*Brachionus calyciflorus*) and ciliates (*Tetrahymena pyriformis*) in flasks with carboxylated and biotinylated quantum dots, which may find a use in computing and solar cells.



© 2008 Macmillan Publishers Limited. All rights reserved

CHEMICAL NANOTECHNOLOGY

# Close the gate

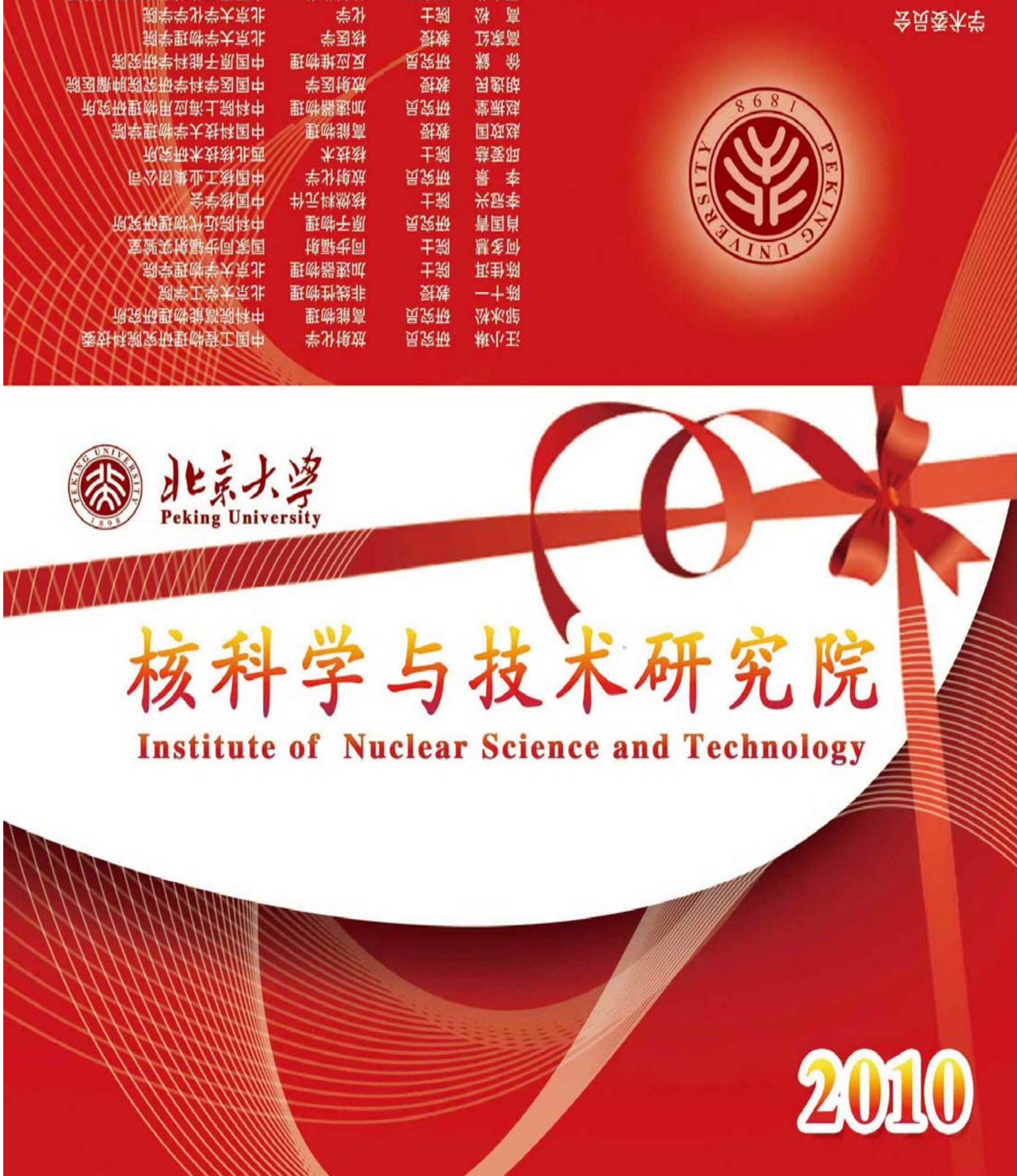
*J. Am. Chem. Soc.* doi:10.1021/ja800266p (2008)

Nanoscale synthetic channels that are opened and closed by a DNA 'switch' have been constructed by a team in China. Such channels could form part of a selective membrane for filtering and purifying water or for mimicking the changeable permeability of biological ion channels.

Yugang Wang of Peking University and his colleagues etched funnel-shaped holes, 5–44 nanometres wide at the narrowest point, into polymer membranes and lined the pores' mouths with single strands of DNA. The DNA in the pore is tightly folded in acidic conditions but unravels into loose chains at pH 8.5. This alters the diameter of the hole and therefore the flux of ions through it.

《Nature》 highlight

# III. Some consideration for the future



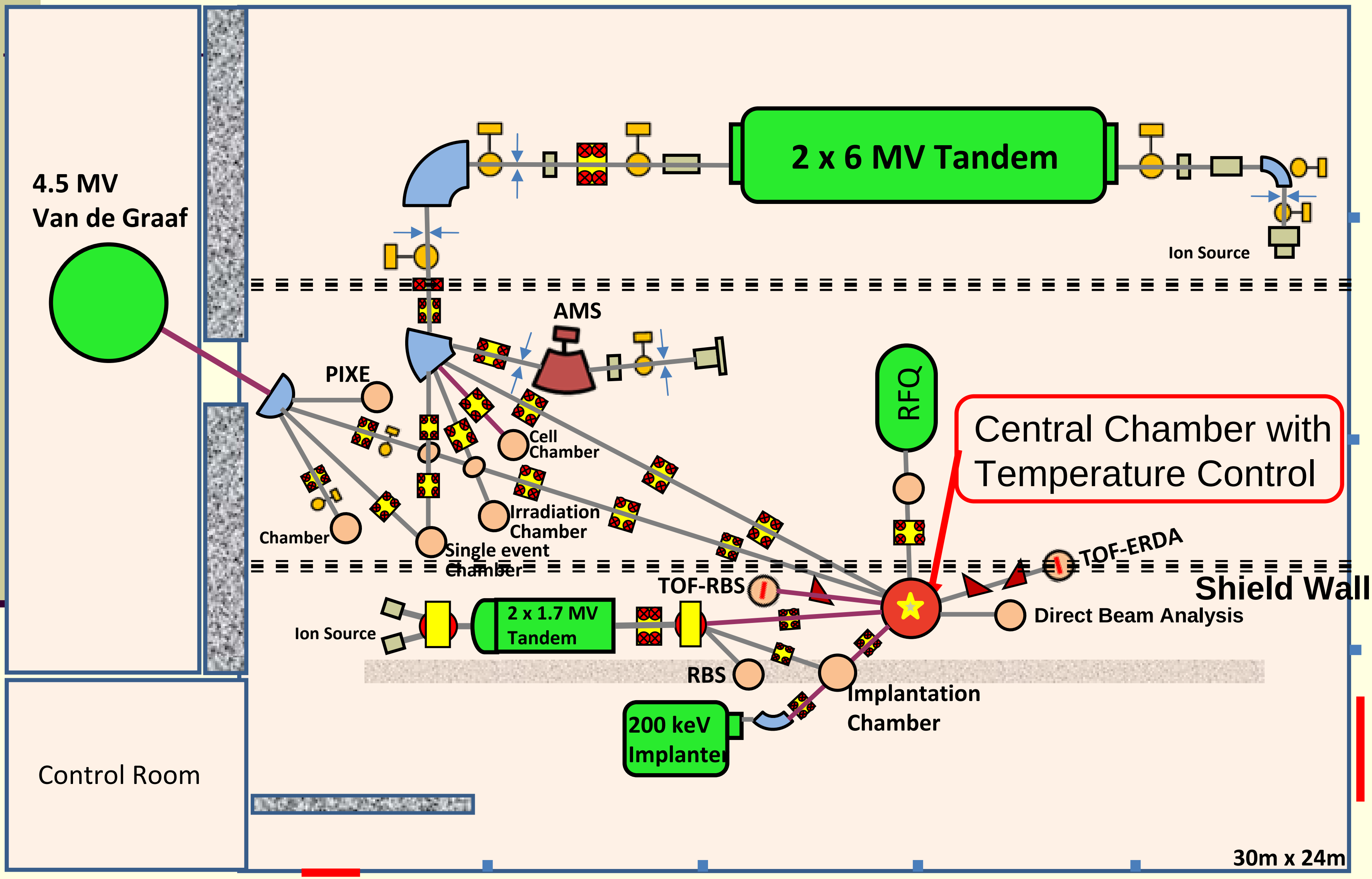
# Planned Program For facilities

- Domestic superconducting cavity
- FEL with high average power。
- 2MeV high intensity d RFQ accelerator for neutron applications。
- triple beam system for nuclear material study
- for long range, a mid-scale multi-purpose facility for basic research as well as for applications (under investigation)

# Super conducting e_accelerator


1. PKU-ERL-FEL装置　2. 低温液氦系统　3. 功率源　4. 控制室　5. 超净室及垂直测试平台

# Proposed triple beam system for nuclear material study



Thanks for your attention!

谢谢！