The gas-filled recoil separator RITU at JYFL

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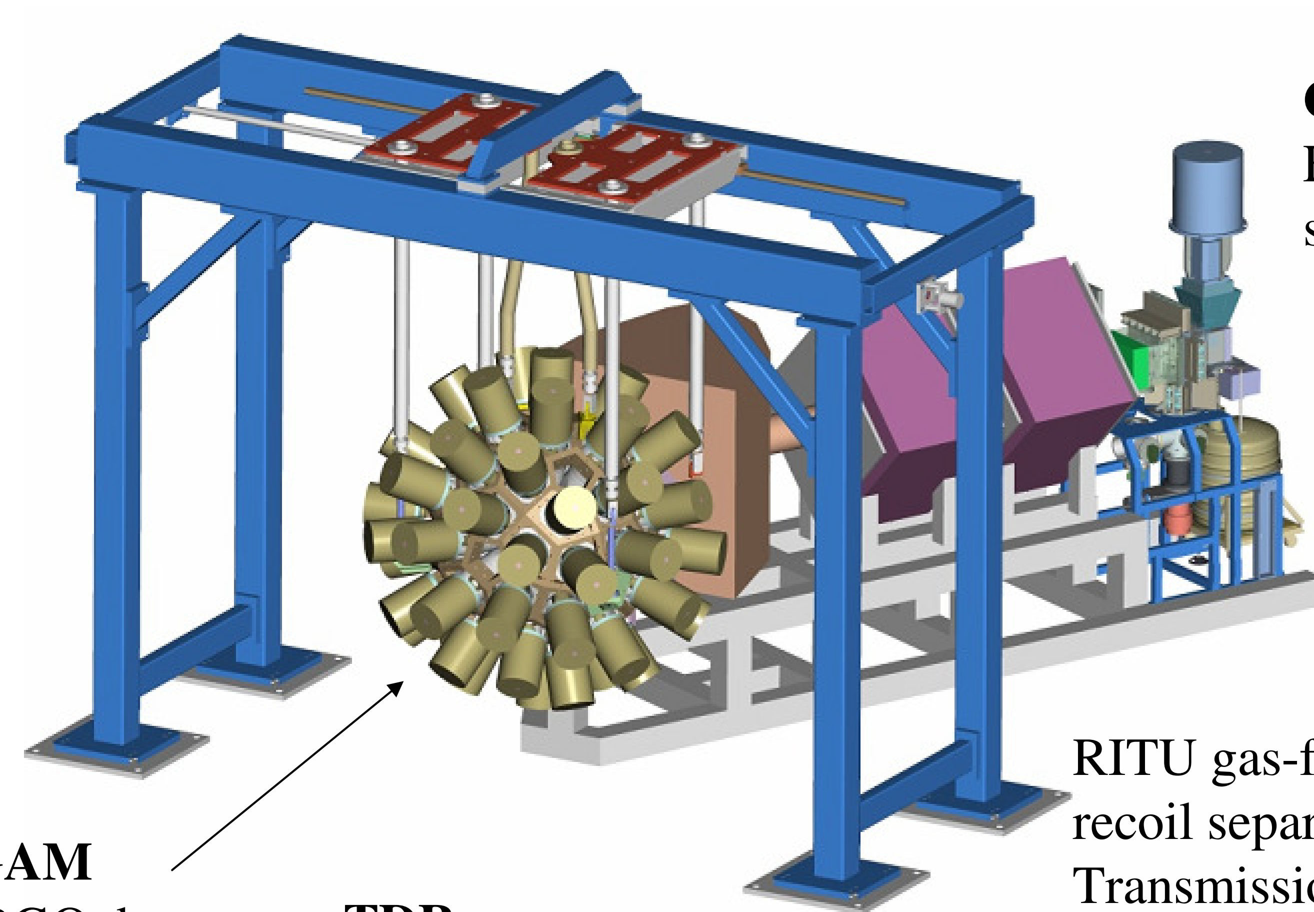
TASCA 07

6th Workshop on Recoil Separator for Superheavy Element Chemistry

September 28, 2007, Davos, Switzerland

RITU + Jurogam at JYFL

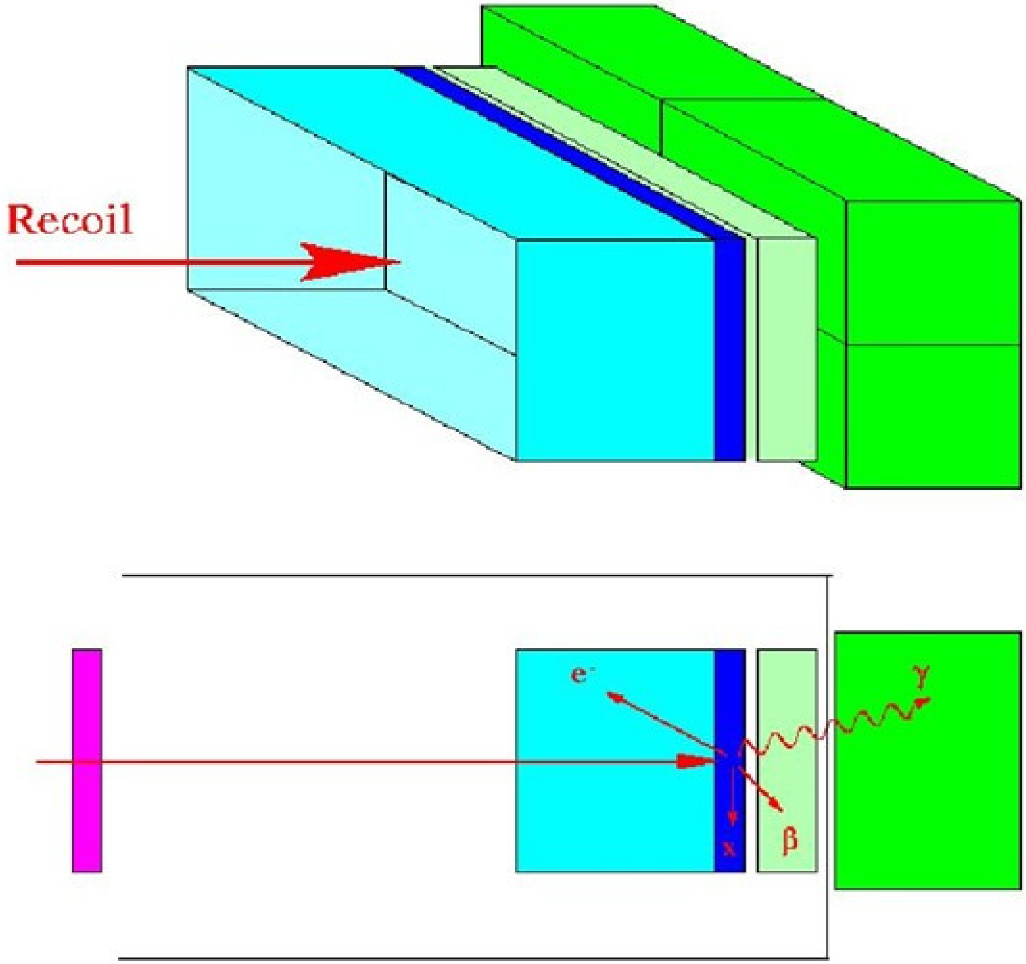


GREAT
Focal plane
spectrometer

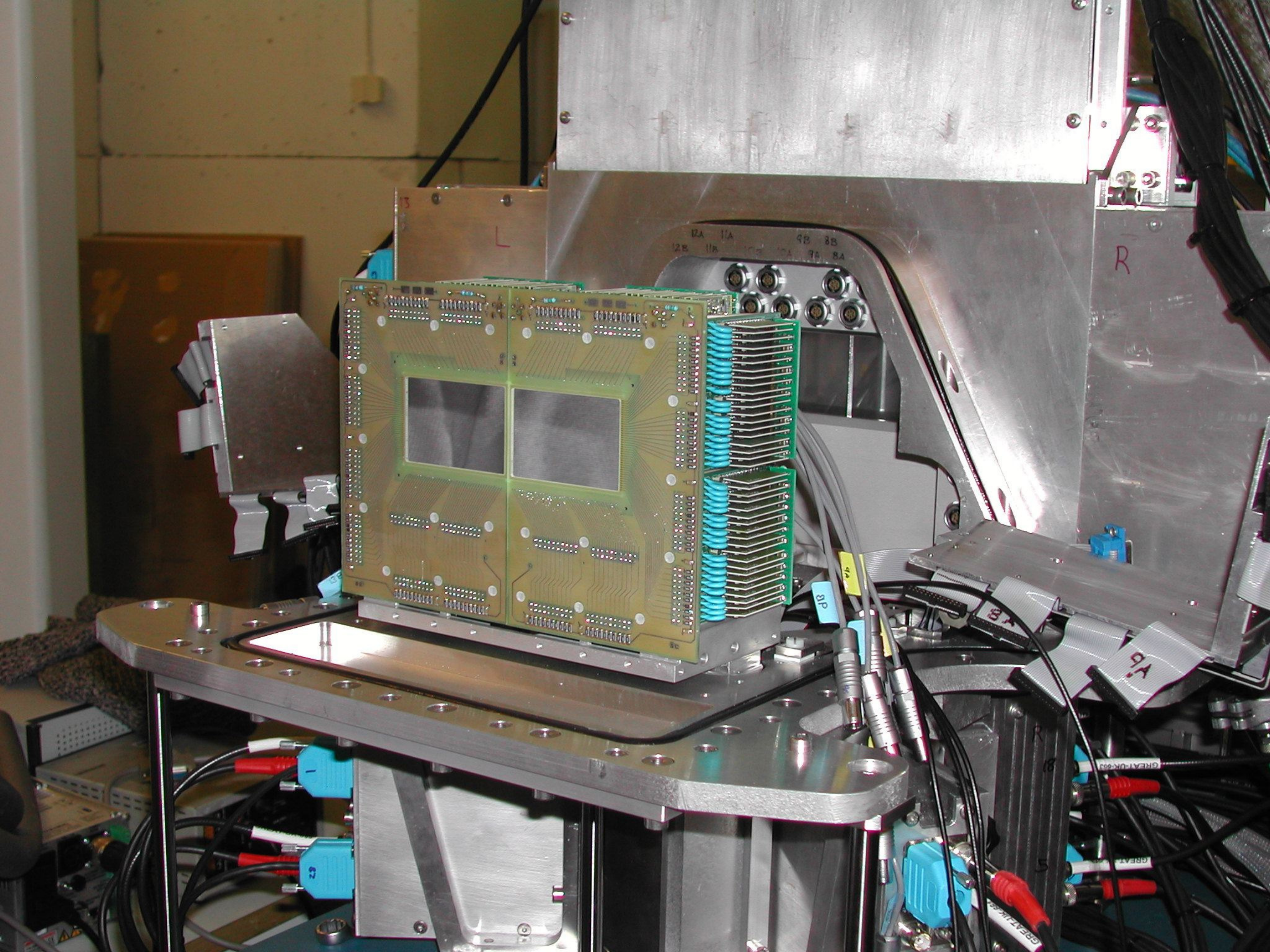
RITU gas-filled
recoil separator
Transmission 20 - 40%
(5 – 70%)

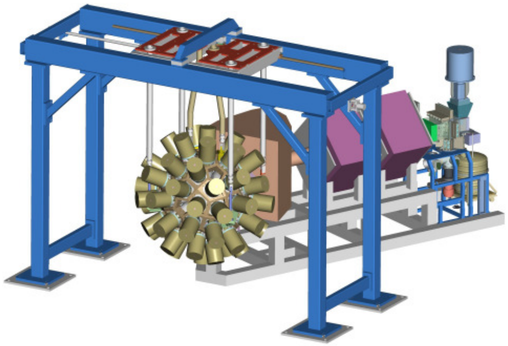
JUROGAM
43 Ge+BGO detectors
Eff. 4%

TDR
Total Data Readout
Triggerless data acquisition system
with 10 ns time stamping



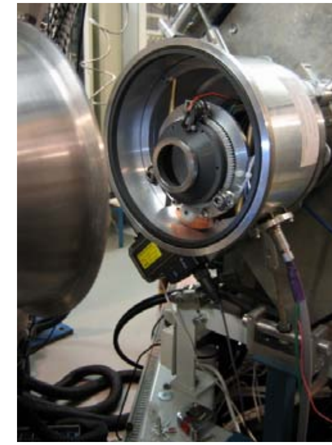
MWPC
PIN-diodes
DSSSD
Planar-Ge
Clover


L
R
12A 11A 9B 8B
12B 11B 9A 8A

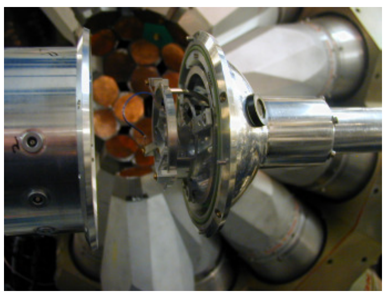


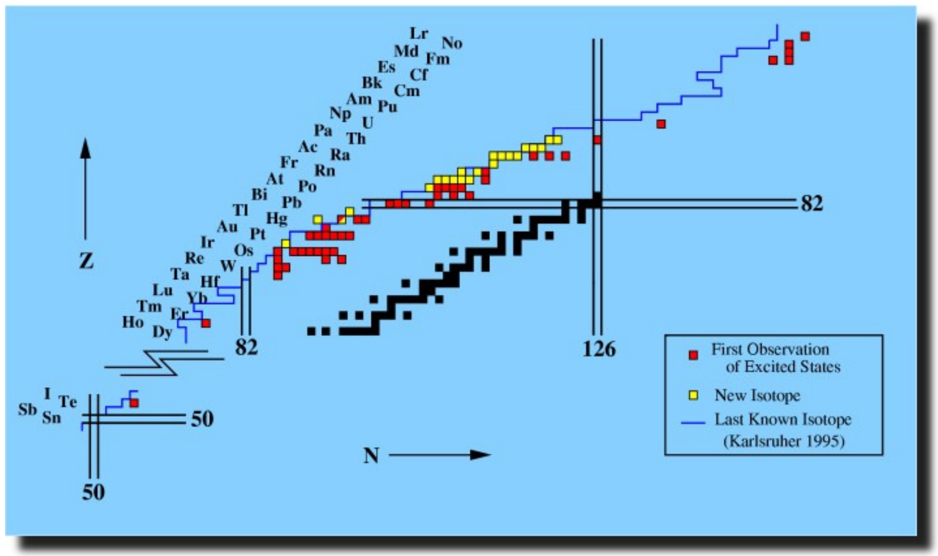
JUROGAM
RITU
GREAT
TDR

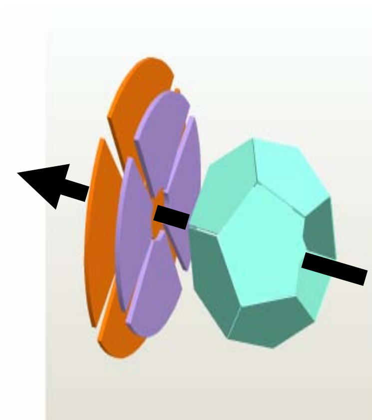
IReS target chamber



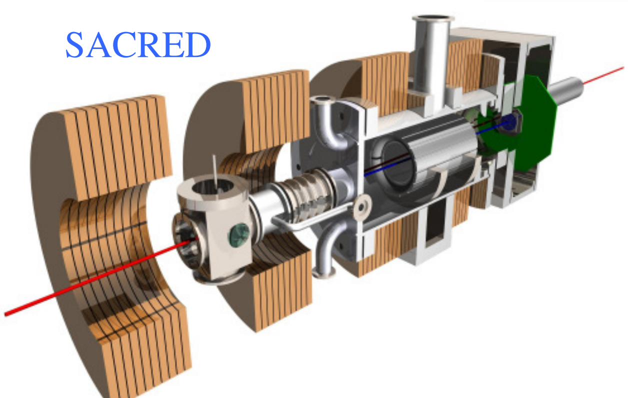
Köln plunger

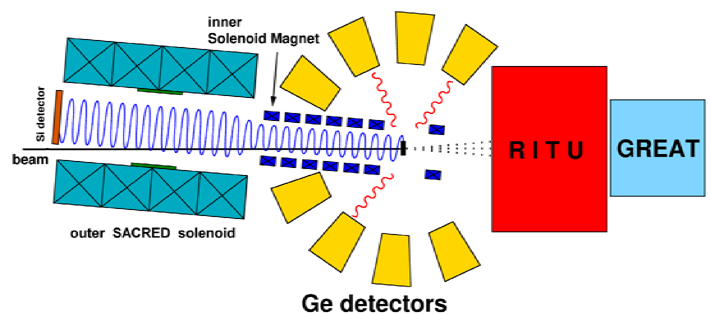






SACRED





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University of Liverpool

SAGE

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LETTERS

Nuclear isomers in superheavy elements as stepping stones towards the island of stability

R.-D. Herzberg[1], P. T. Greenlees[2], P. A. Butler[1], G. D. Jones[1], M. Venhart[3], I. G. Darby[1], S. Eeckhaudt[2], K. Eskola[4], T. Grahn[2], C. Gray-Jones[1], F. P. Hessberger[5], P. Jones[2], R. Julin[2], S. Juutinen[2], S. Ketelhut[2], W. Korten[6], M. Leino[2], A.-P. Leppänen[2], S. Moon[1], M. Nyman[2], R. D. Page[1], J. Pakarinen[1,2], A. Pritchard[1], P. Rahkila[2], J. Sarén[2], C. Scholey[2], A. Steer[2], Y. Sun[7], Ch. Theisen[6] & J. Uusitalo[2]

208Pb(48Ca,2n)254No

Total focal plane rate < 1Hz/10 pnA

In-beam studies around ^{254}No at JYFL

$^{208}Pb(^{48}Ca,2n)^{254}No$	Aug 1998 γ
$^{206}Pb(^{48}Ca,2n)^{252}No$	June 1999 γ
$^{209}Bi(^{48}Ca,2n)^{255}Lr$	Sep 1999 γ
$^{208}Pb(^{48}Ca,2n)^{254}No$	Mar 2001 e^-
$^{207}Pb(^{48}Ca,2n)^{253}No$	Mar 2001 e^-
$^{204}Hg(^{48}Ca,2n)^{250}Fm$	Oct 2001 γ
$^{204}Hg(^{48}Ca,2n)^{250}Fm$	Mar 2002 γ
$^{205}Tl(^{48}Ca,2n)^{251}Md$	Nov 2002 e^-
$^{208}Pb(^{48}Ca,2n)^{254}No$	Apr 2003 γ
$^{205}Tl(^{48}Ca,2n)^{251}Md$	Jun 2003 γ
$^{204}Hg(^{48}Ca,2n)^{250}Fm$	May 2004 γ
$^{207}Pb(^{48}Ca,2n)^{253}No$	Jan 2005 γ
$^{209}Bi(^{48}Ca,2n)^{255}Lr$	Jan 2005 γ

JYFL
- Liverpool (R.-D. Herzberg et al.)
- GSI (F. P. Heßberger et al.)
- DAPNIA/SPhN CEA-Saclay (Y. Le Coz et al.)
- Helsinki (K. Eskola)
- ANL (T. L. Khoo)
- LMU Munich (P. Reiter)
- GANIL (G. de France)
- INP Krakow (J. Styczen)
- Strasbourg (B. Gall et al.)

PHYSICAL REVIEW C 75, 054307 (2007)

α decay studies of the nuclides ^{218}U and ^{219}U

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(Received 9 May 2006; published 4 May 2007)

182W(40Ar,3n)219U
182W(40Ar,4n)218U

PRL 97, 062501 (2006) PHYSICAL REVIEW LETTERS week ending 11 AUGUST 2006

Collectivity and Configuration Mixing in ^{186,188}Pb and ^{194}Po

T. Grahn,[1,*] A. Dewald,[2] O. Möller,[2] R. Julin,[1] C. W. Beausang,[3,†] S. Christen,[2] I. G. Darby,[1,4] S. Eeckhaudt,[1] P. T. Greenlees,[1] A. Görgen,[5] K. Helariutta,[6] J. Jolie,[2] P. Jones,[1] S. Juutinen,[1] H. Kettunen,[1] T. Kröll,[7] R. Krücken,[7] Y. Le Coz,[5] M. Leino,[1] A.-P. Leppänen,[1,‡] P. Maierbeck,[7] D. A. Meyer,[3] B. Melon,[2] P. Nieminen,[1,§] M. Nyman,[1] R. D. Page,[4] J. Pakarinen,[1,4] P. Petkov,[8] P. Rahkila,[1] B. Saha,[2] M. Sandzelius,[1,‖] J. Sarén,[1] C. Scholey,[1] and J. Uusitalo[1]

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(Received 28 March 2006; published 7 August 2006)

106Pd(83Kr,3n)186Pb
108Pd(83Kr,3n)188Pb
114Cd(83Kr,3n)194Po

Symmetric reactions needed for these plunger life-time measurements

Available online at www.sciencedirect.com
ScienceDirect
Physics Letters B 641 (2006) 34–37
PHYSICS LETTERS B
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Probing the limit of nuclear existence: Proton emission from ^{159}Re

D.T. Joss [a,b,*], I.G. Darby [a], R.D. Page [a], J. Uusitalo [c], S. Eeckhaudt [c], T. Grahn [c], P.T. Greenlees [c], P.M. Jones [c], R. Julin [c], S. Juutinen [c], S. Ketelhut [c], M. Leino [c], A.-P. Leppänen [c], M. Nyman [c], J. Pakarinen [a,c], P. Rahkila [c], J. Sarén [c], C. Scholey [c], A. Steer [c,1], A.J. Cannon [d], P.D. Stevenson [d], J.S. Al-Khalili [d], S. Ertürk [e], M. Venhart [c,f], B. Gall [g], B. Hadinia [h], J. Simpson [b]

106Cd(58Ni,p4n)159Re

PRL 99, 022501 (2007) PHYSICAL REVIEW LETTERS week ending 13 JULY 2007

Identification of Excited States in the $T_z = 1$ Nucleus ^{110}Xe: Evidence for Enhanced Collectivity near the $N = Z = 50$ Double Shell Closure

M. Sandzelius,[1] B. Hadinia,[1] B. Cederwall,[1,*] K. Andgren,[1] E. Ganioğlu,[2] I. G. Darby,[3] M. R. Dimmock,[3] S. Eeckhaudt,[4] T. Grahn,[4,†] P. T. Greenlees,[4] E. Ideguchi,[5] P. M. Jones,[4] D. T. Joss,[3] R. Julin,[4] S. Juutinen,[4] A. Khaplanov,[1] M. Leino,[4] L. Nelson,[3] M. Niikura,[5] M. Nyman,[4] R. D. Page,[3] J. Pakarinen,[4,†] E. S. Paul,[3] M. Petri,[3] P. Rahkila,[4] J. Sarén,[4] C. Scholey,[4] J. Sorri,[4] J. Uusitalo,[4] R. Wadsworth,[6] and R. Wyss[1]

58Ni(54Fe,2n)110Xe

Identification based on fast r-α-α chain

Additional beam stopper used to reduce the scattered beam component

Total focal plane rate 1 kHz/1 pnA

PHYSICAL REVIEW C 75, 061301(R) (2007)

Coulomb shifts and shape changes in the mass 70 region

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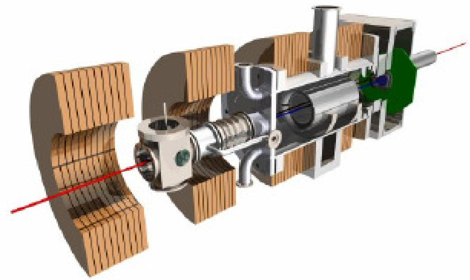
(Received 3 November 2006; published 15 June 2007)

40Ca(36Ar,pn)74Rb
40Ca(40Ca,pn)78Y

Identification based on fast β-decay
These target beam combinations works only at barrier energies
Additional beam stopper used do decrease thescattered beam component



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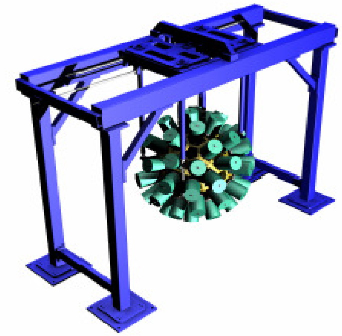


=> SAGE

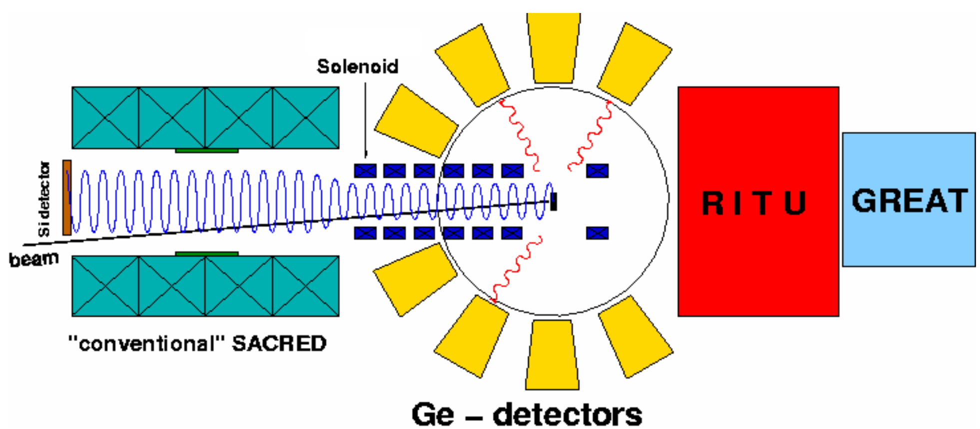
THE UNIVERSITY *of* LIVERPOOL

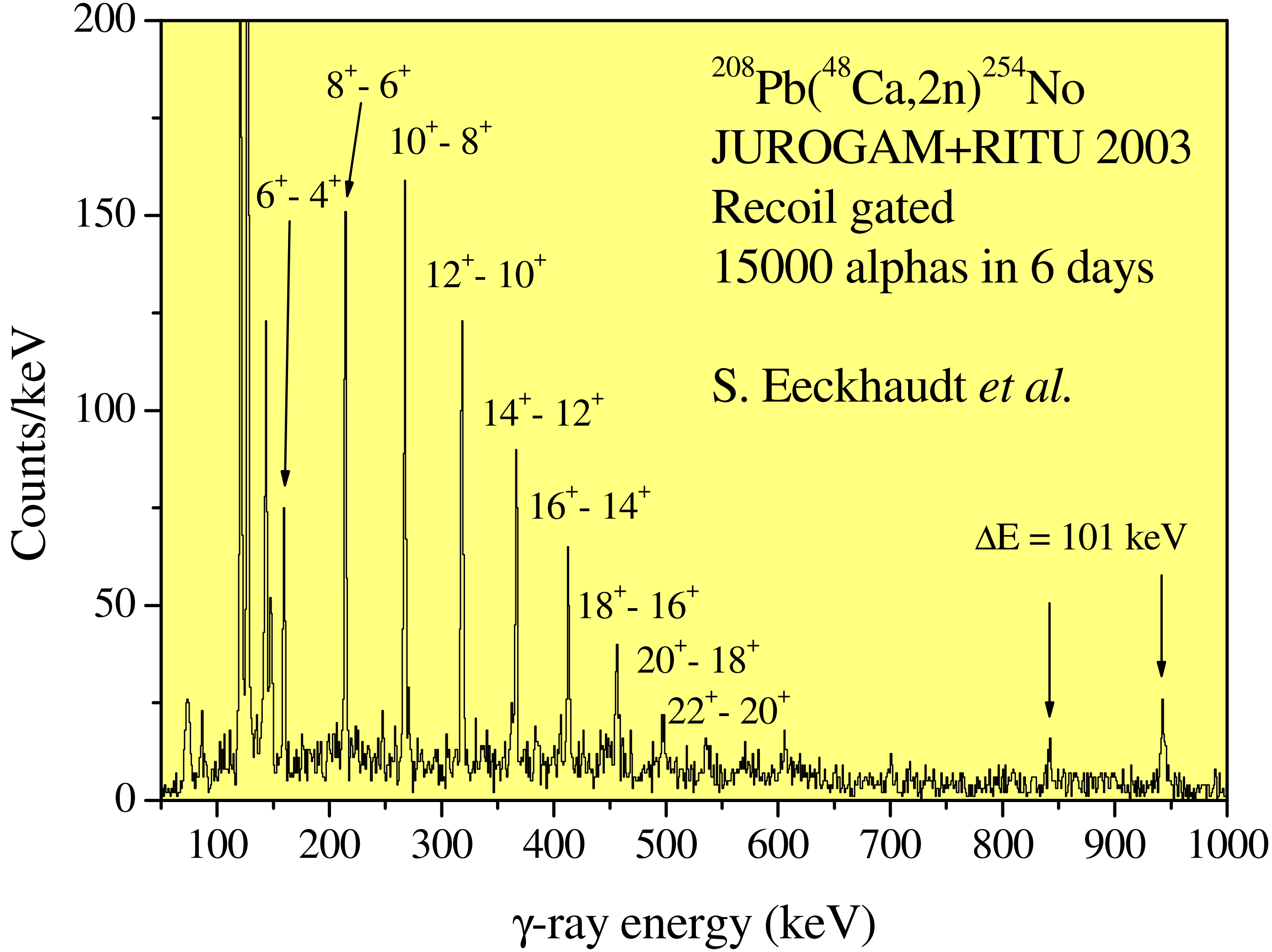
CCLRC

UNIVERSITY OF JYVÄSKYLÄ

- Simultaneous Electron-Gamma Measurements
- Combine Digital Electronics with TDR
- Unique and Powerful Device for Spectroscopy of Heavy Nuclei

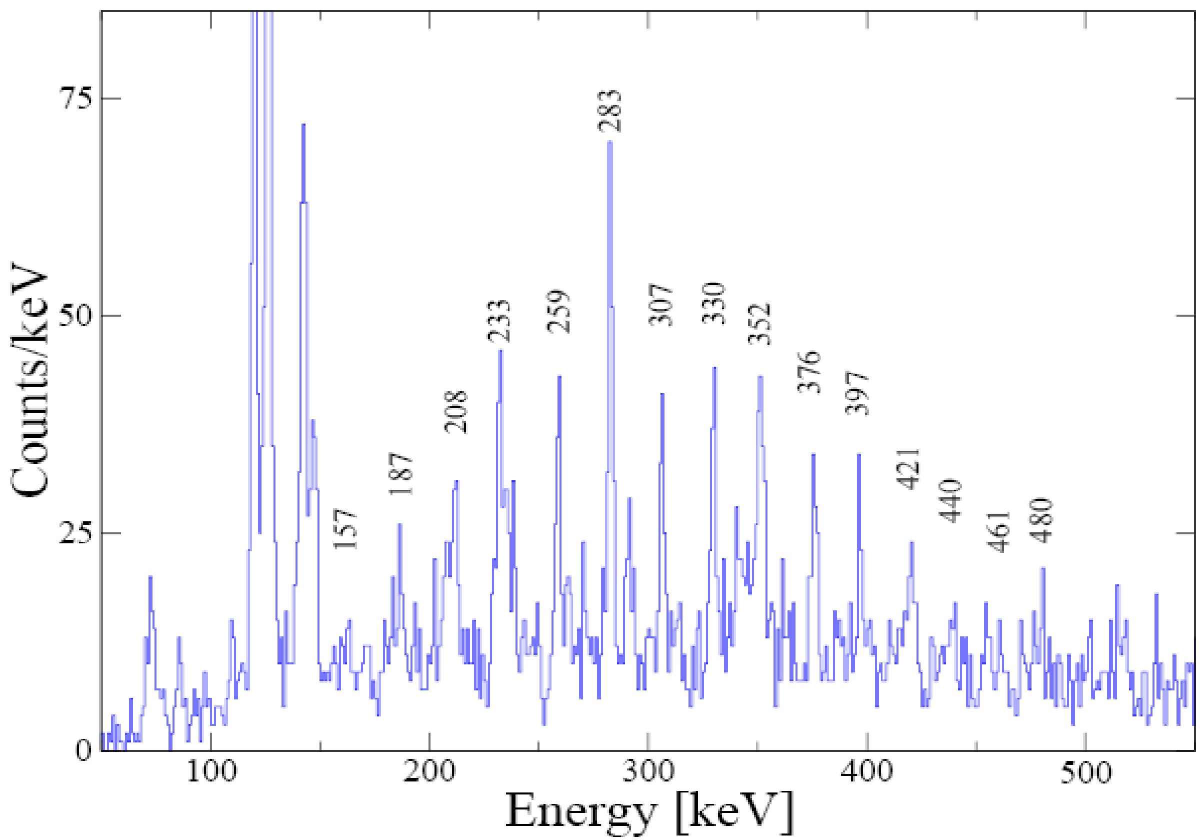
- Progress to Z=104 - ^{256}Rf @ 12 nb!
- Lighter beams / Radioactive Targets e.g. ^{256}No
- Still many cases to be studied e.g. ^{255}No, ^{248}Fm, ^{249}Md

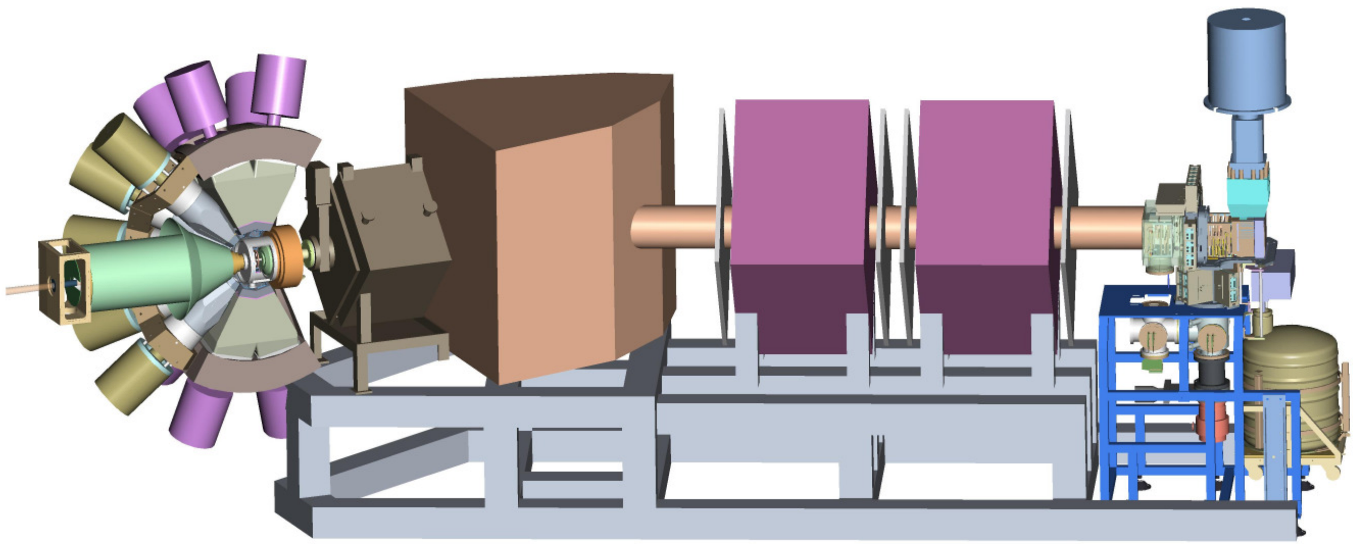




208Pb(48Ca,2n)254No
JUROGAM+RITU 2003
Recoil gated
15000 alphas in 6 days
S. Eeckhaudt et al.
8+- 6+
10+- 8+
6+- 4+
12+- 10+
14+- 12+
16+- 14+
18+- 16+
20+- 18+
22+- 20+
ΔE = 101 keV
Counts/keV
γ-ray energy (keV)
0
50
100
150
200
100
200
300
400
500
600
700
800
900
1000

$^{48}Ca + ^{207}Pb \Rightarrow ^{253}No + 2n$, JUROGAM+RITU+GREAT, R.-D. Herzberg et al.

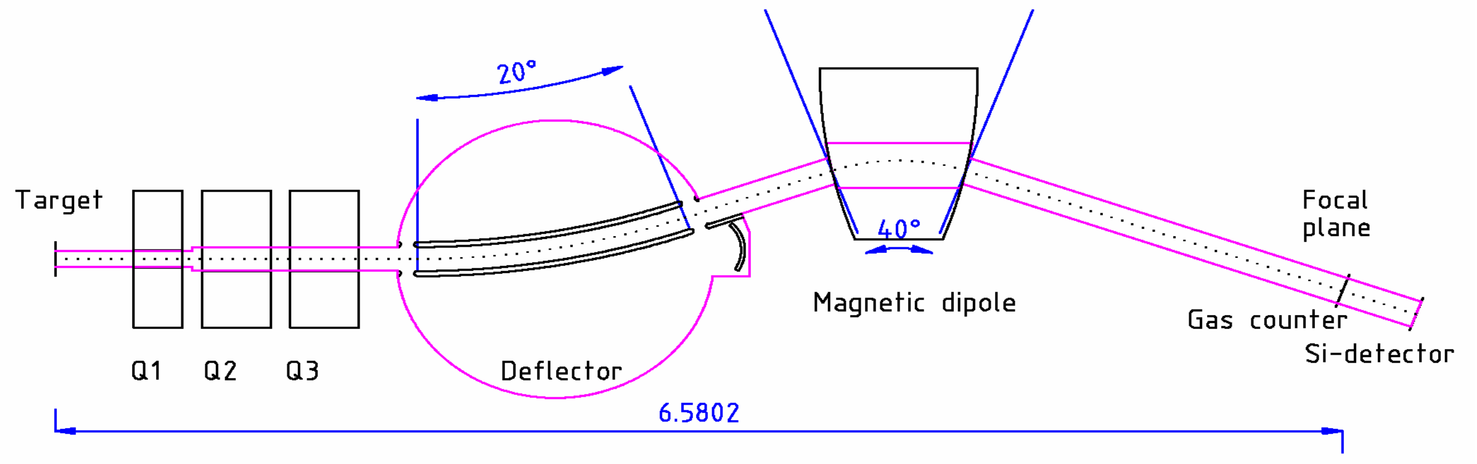




-Digital electronics → higher beam intensities (x 5)
-Longer beam times (x 2)
- New K- 30 cylcotron is dedicated for proton beams

-Now our cross-section limit is 50 – 100 nb for in-beam studies
-In near future the limit should go down by a factor 10 down to 5 – 10 nb level.
-To perform in-beam spectroscopy below 1nb cross-section limit higher γ/e-detection efficiency is needed. ?AGATA?

MARA
Mass Analyzing Recoil Apparatus
Massa-Analysoiva-Rekyyli-Aparaatti



Mara will be used in the mass region 50 < A < 150
For comparison: for the reaction 208Pb(48Ca,2n)254
Mara will have 1/2 off the transmission efficiency of RITU