Present and future of JURO-spectroscopy at JYFL

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on behalf of the JUROGAM collaboration

JURO history

1996 DORIS - 0.8 %
12 TESSA units

1997 JUROSPHERE - 1.7 %
15 EUROGAM Phase 1 + 10 TESSA units

2003 JUROGAM - 4.2 %
43 EUROGAM Phase 1 +GASP units

2008 JUROGAM II - 6.1 %
15 EUROGAM Phase 1+ 24 EUROBALL Clover units

combined with RITU

140 peer reviewed articles
-including 16 letters
- 60 since 2005

nature LETTERS

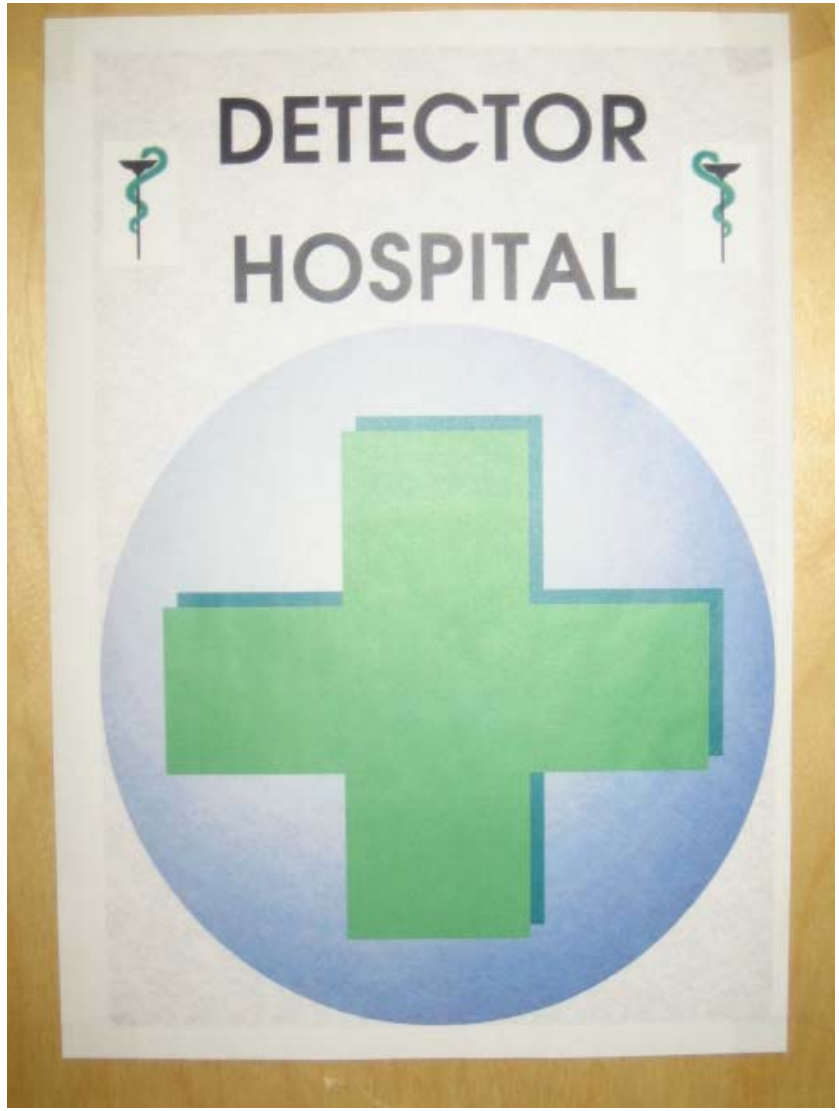
Nuclear isomers in superheavy elements as stepping stones towards the island of stability

JURO hospital

for JUROGAM II (since 2009)

46 annealing processes
24 FET changes
31 PA/HV repairs
4 (to be) sent to the factory

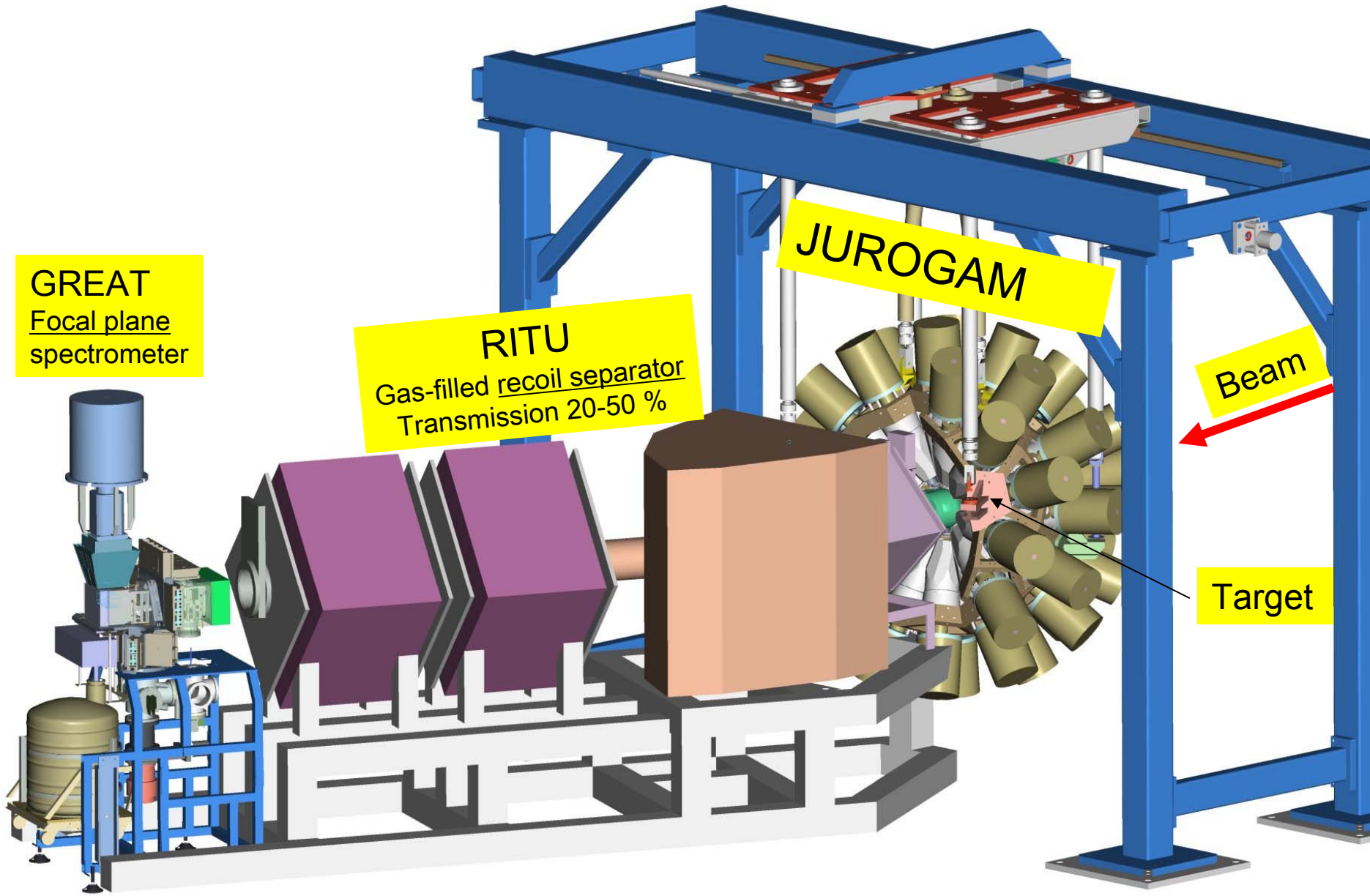
repair course given by
Ivan Hietter (Canberra)



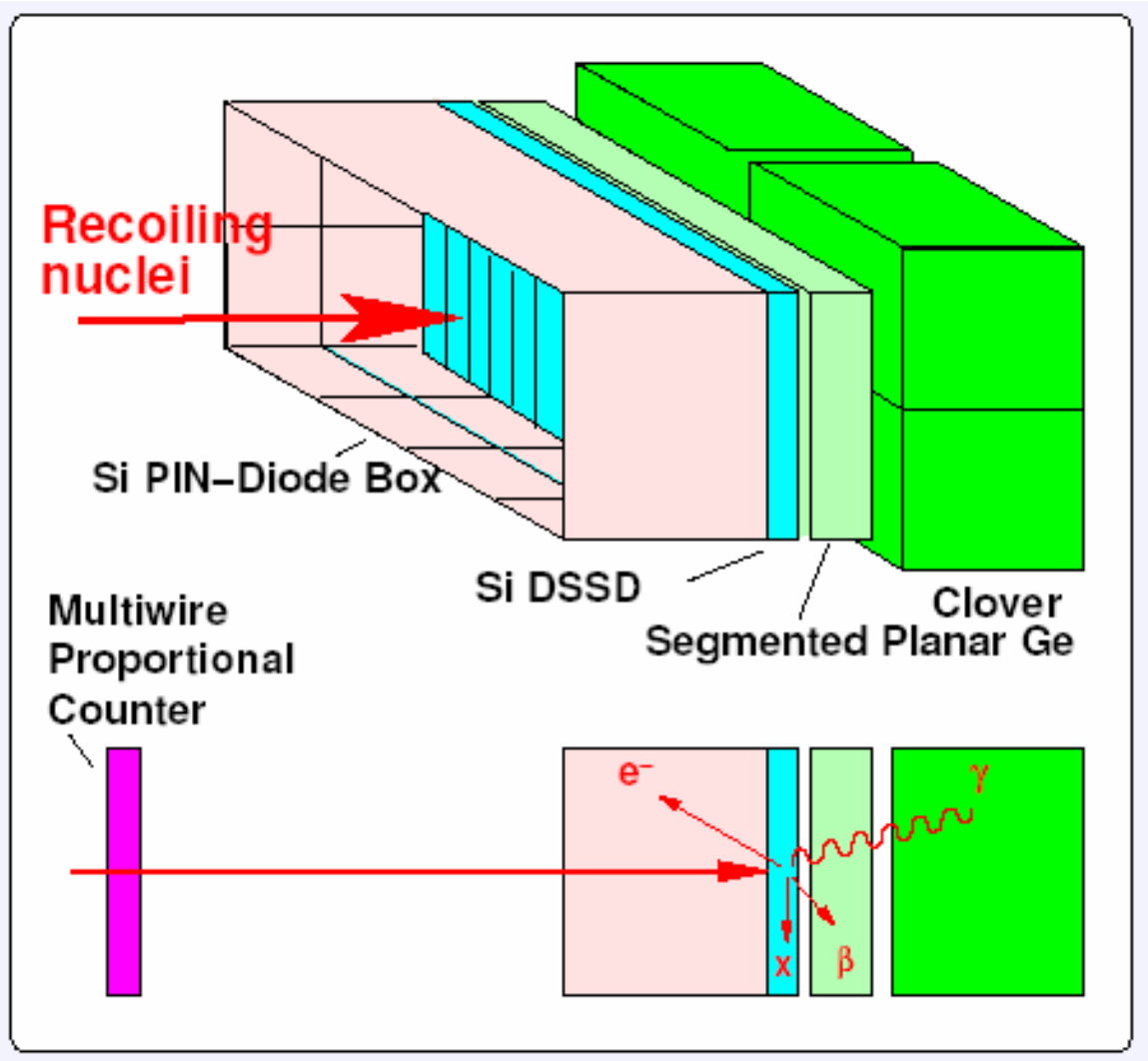
JYFL accelerator laboratory

- 2000-3000 hours per year for JURO experiments
- large variety of stable-ion beams
- ENSAR - Access Laboratory
- Centre of Excellence in Finland → 2017
- UK investments in instrumentation

Recoil-Decay-Tagging (RDT) at JYFL



GREAT spectrometer at the RITU focal plane



UK – JYFL investment

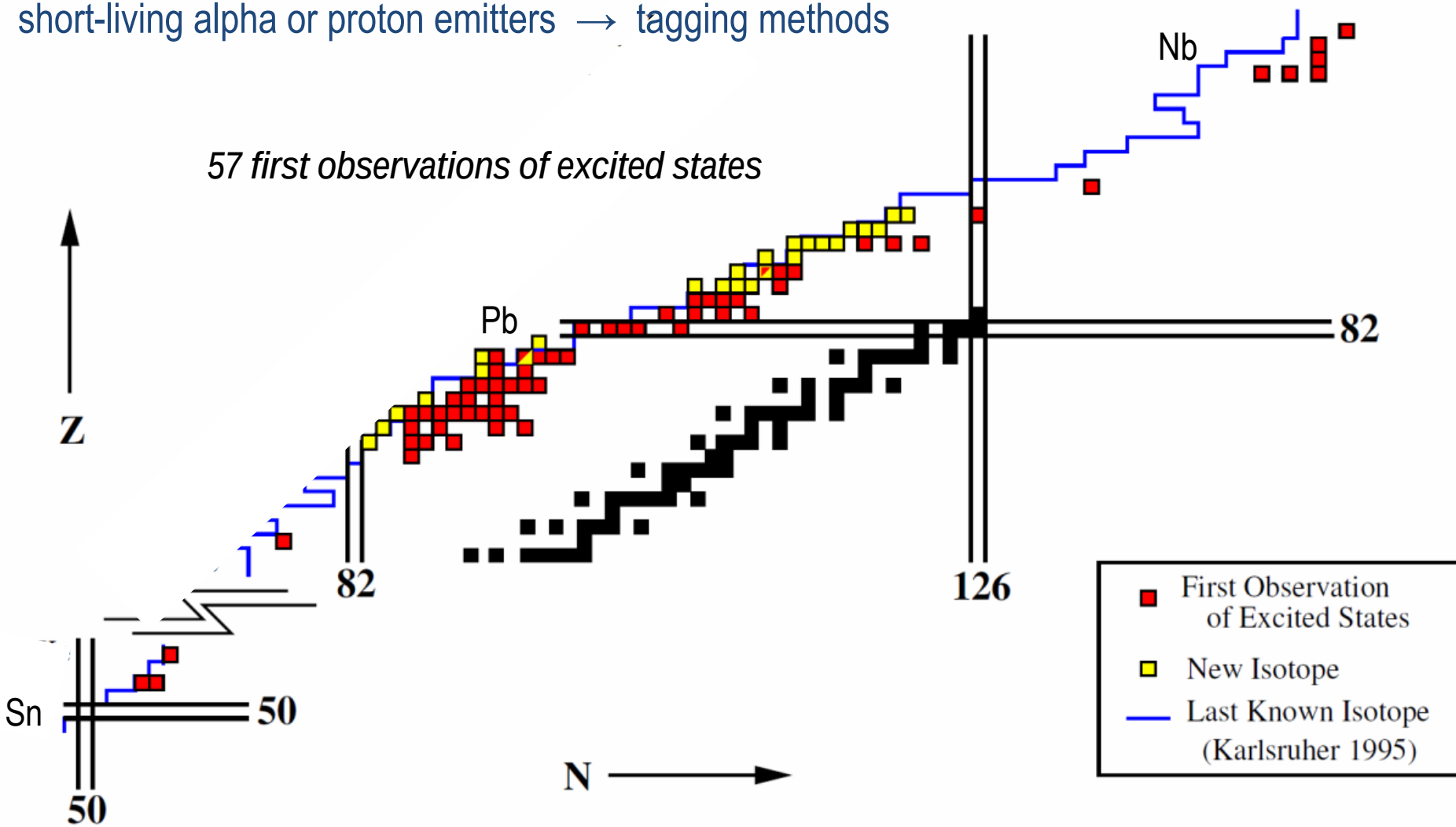
digital electronics and Total Data Readout for data acquisition

- 10 ns stamping with a 100 MHz clock
- 250 Lyrtech digital channels
- free running mode
- enables to correlate prompt and delayed events
- event reconstruction and analysis software package GRAIN

UK – JYFL investment
Daresbury design

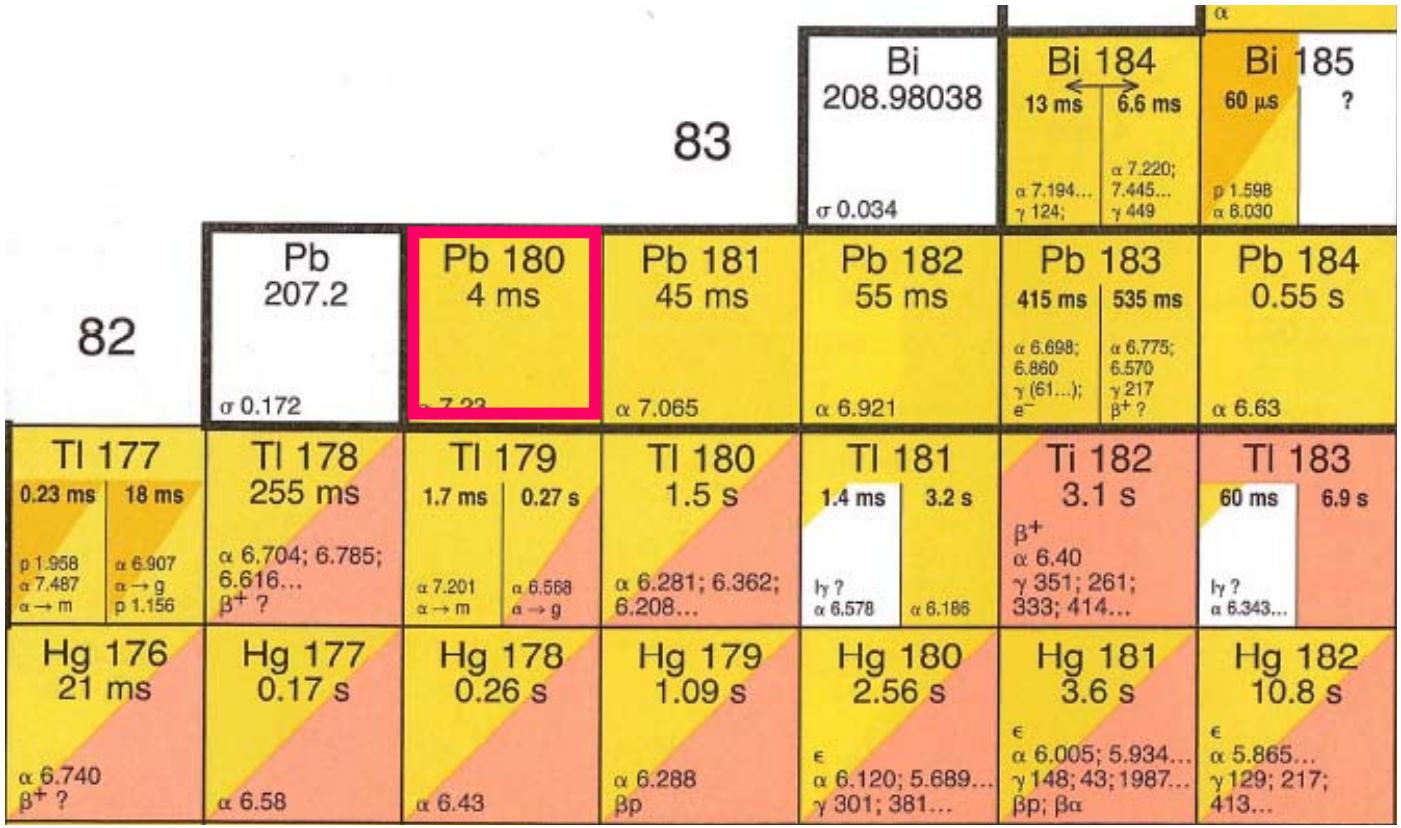
very neutron deficient heavy and SHE nuclei

- ☺ can be produced via fusion evaporation with stable-ion beams and stable targets
- ☹ cross-sections down to 1 nb
- ☺ short-living alpha or proton emitters → tagging methods



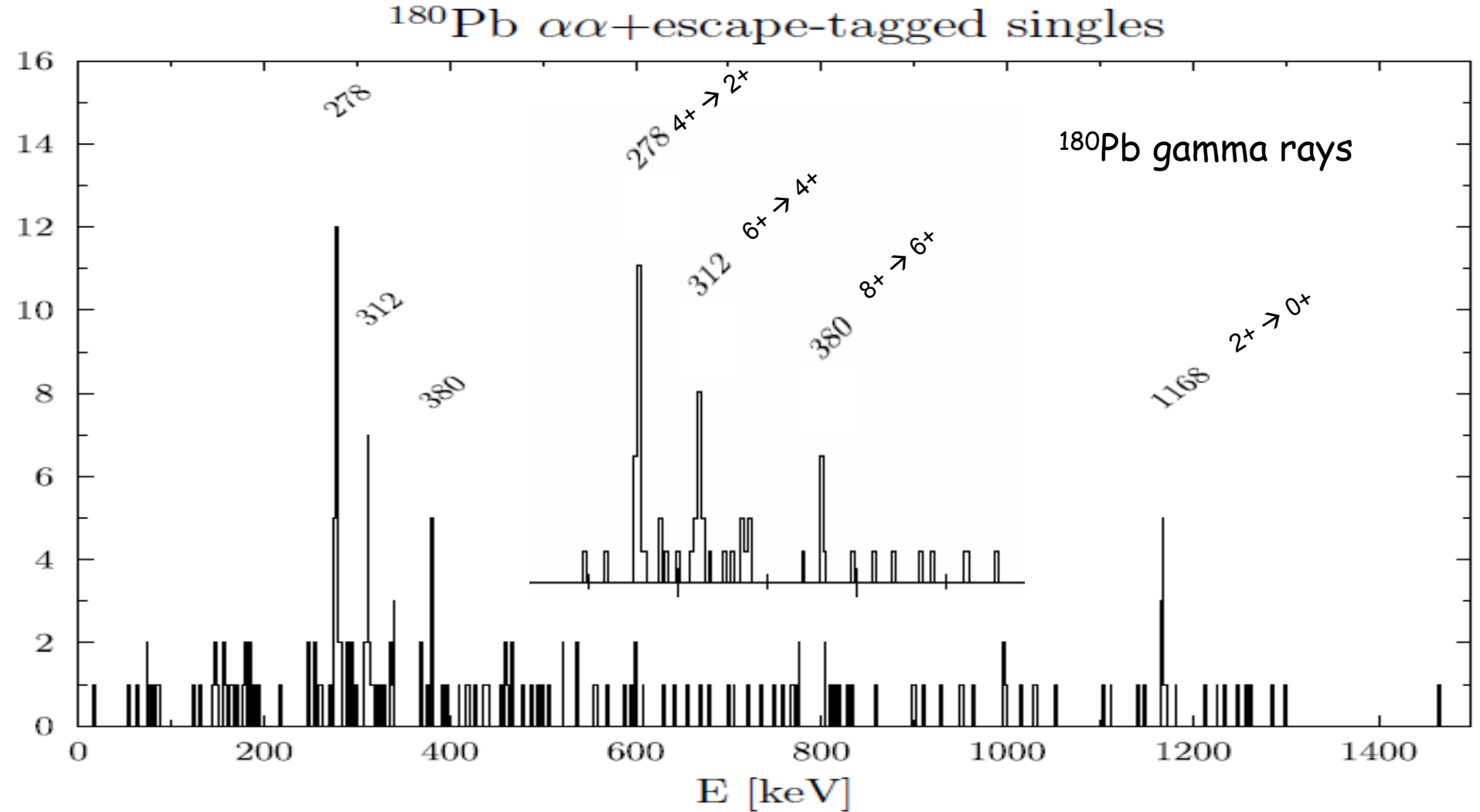
^{90}Zr + ^{92}Mo → ^{180}Pb + 2n (10 nanobarn)

JYFL-York-Liverpool collaboration

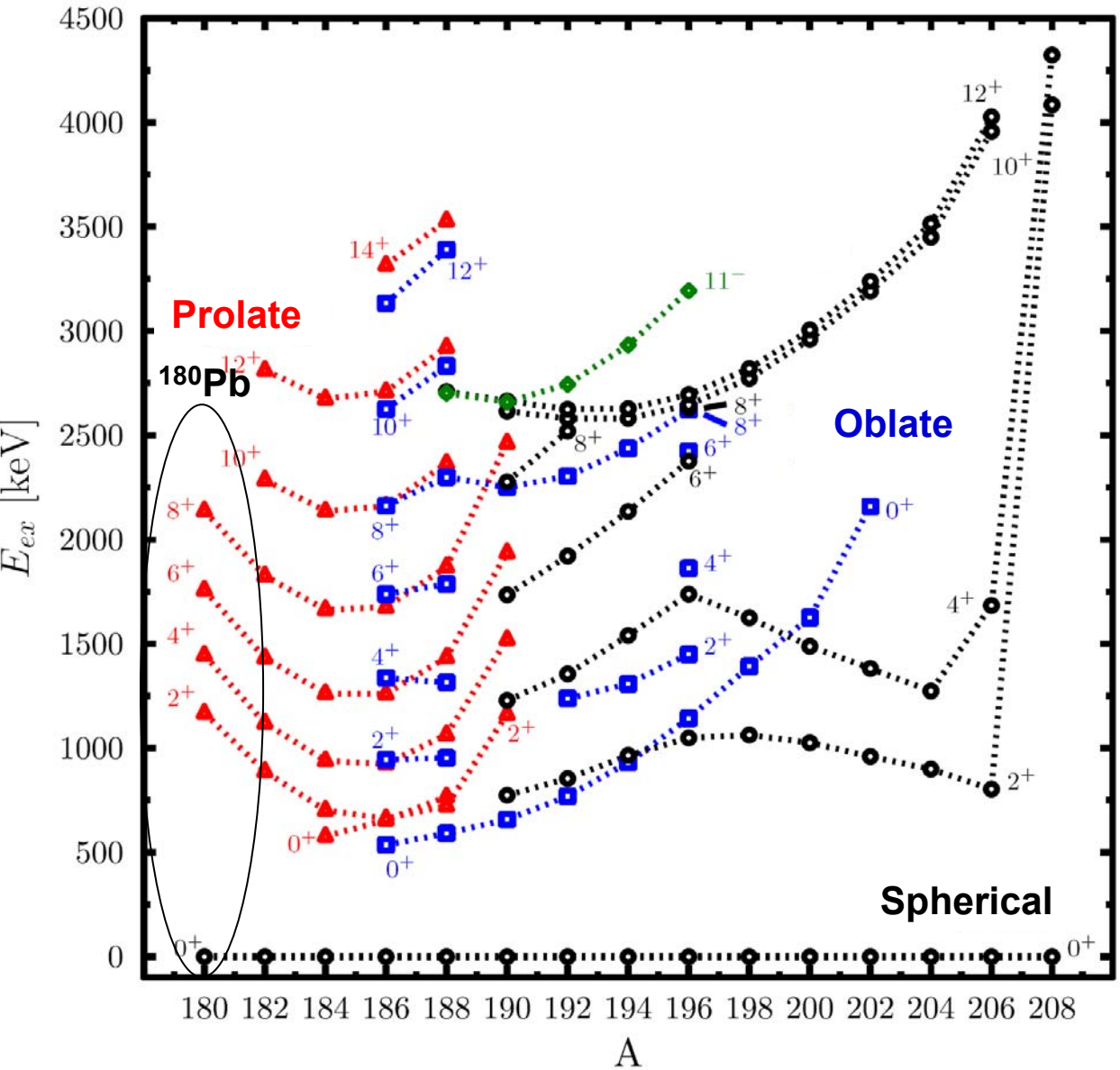


Recoil Decay Tagging with ^{180}Pb and ^{176}Hg alpha decays

^{92}Mo(^{90}Zr,2n)^{180}Pb - 10 nanobarn – WR



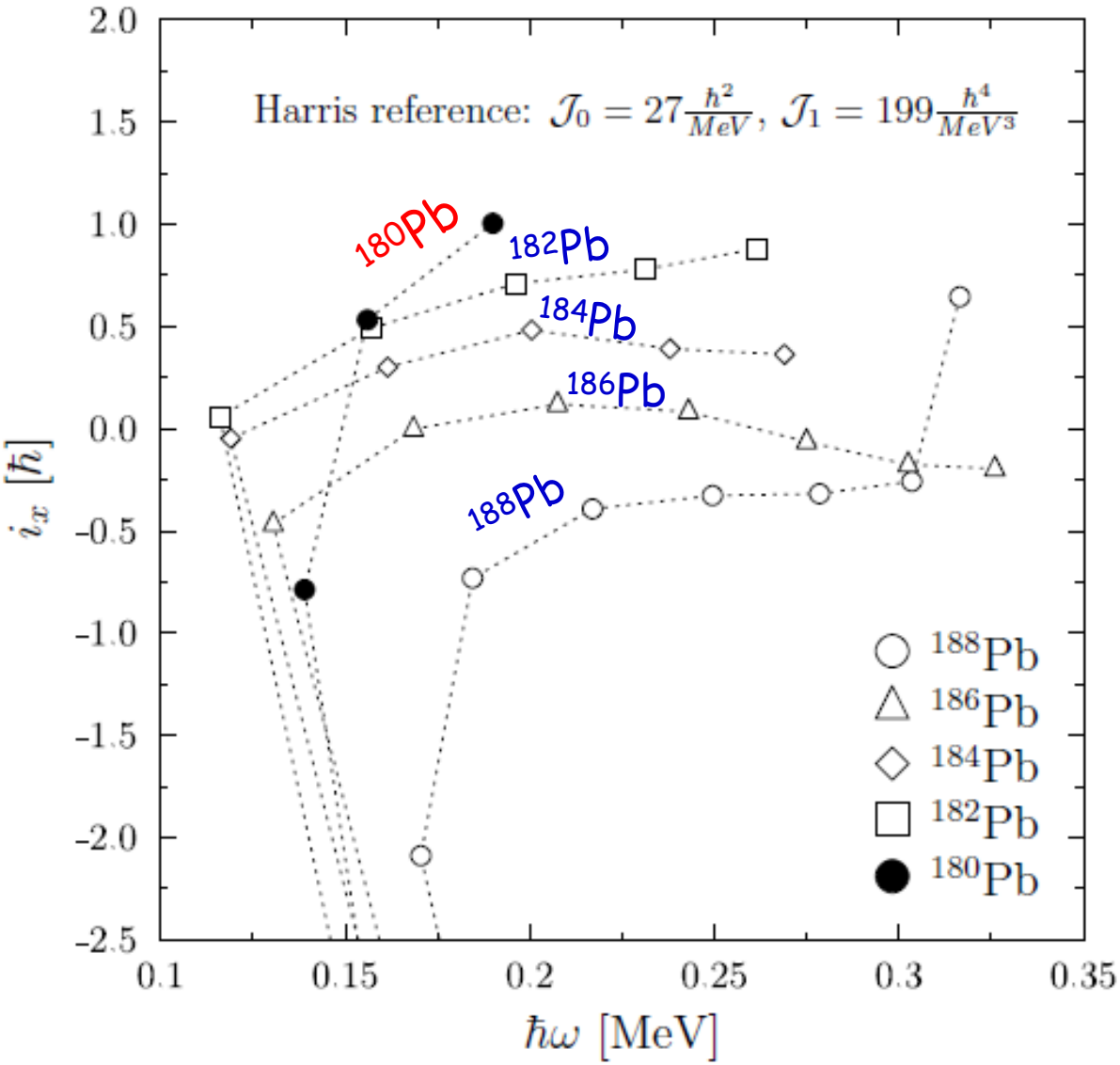
Level systematics of even-A Pb nuclei



in ^{180}Pb still
a prolate minimum
at about 1 MeV above
the spherical one

Obs !
S(p) = 930 (50) keV,
S(2p) = 200 (25) keV

in-beam spectroscopy at the extreme - ^{180}Pb



Alignments:

^{180}Pb behaves like ^{188}Pb

→

???

Reminder:

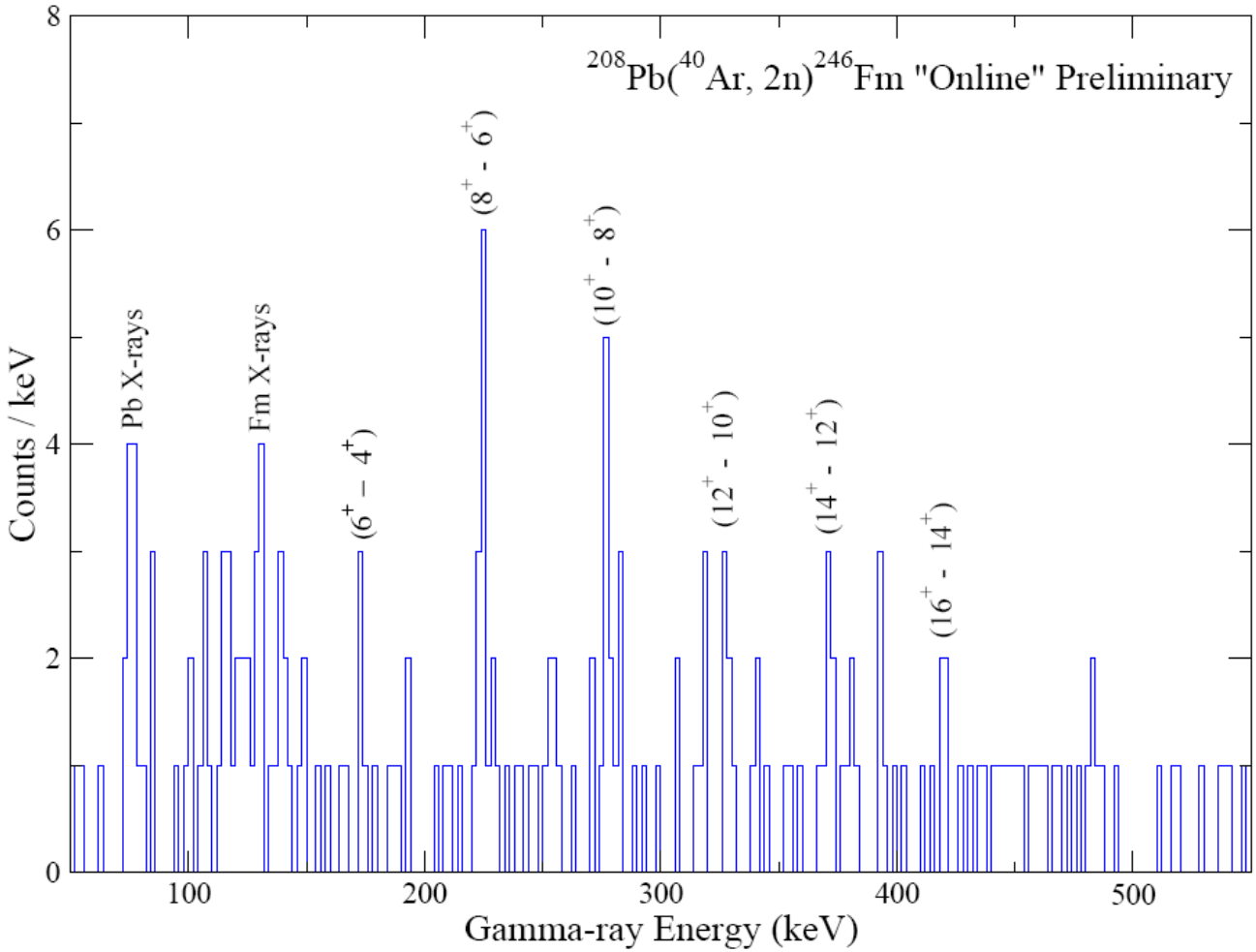
in-beam gamma-ray experiment
→ 10 pnA on a 0,5 mg/cm^2 target

10 nanobarn
→ 1 reactions per hour !!

in-beam spectroscopy at the extreme ^{246}Fm

40 pnA – 35 kHz per Ge detector – digital electronics

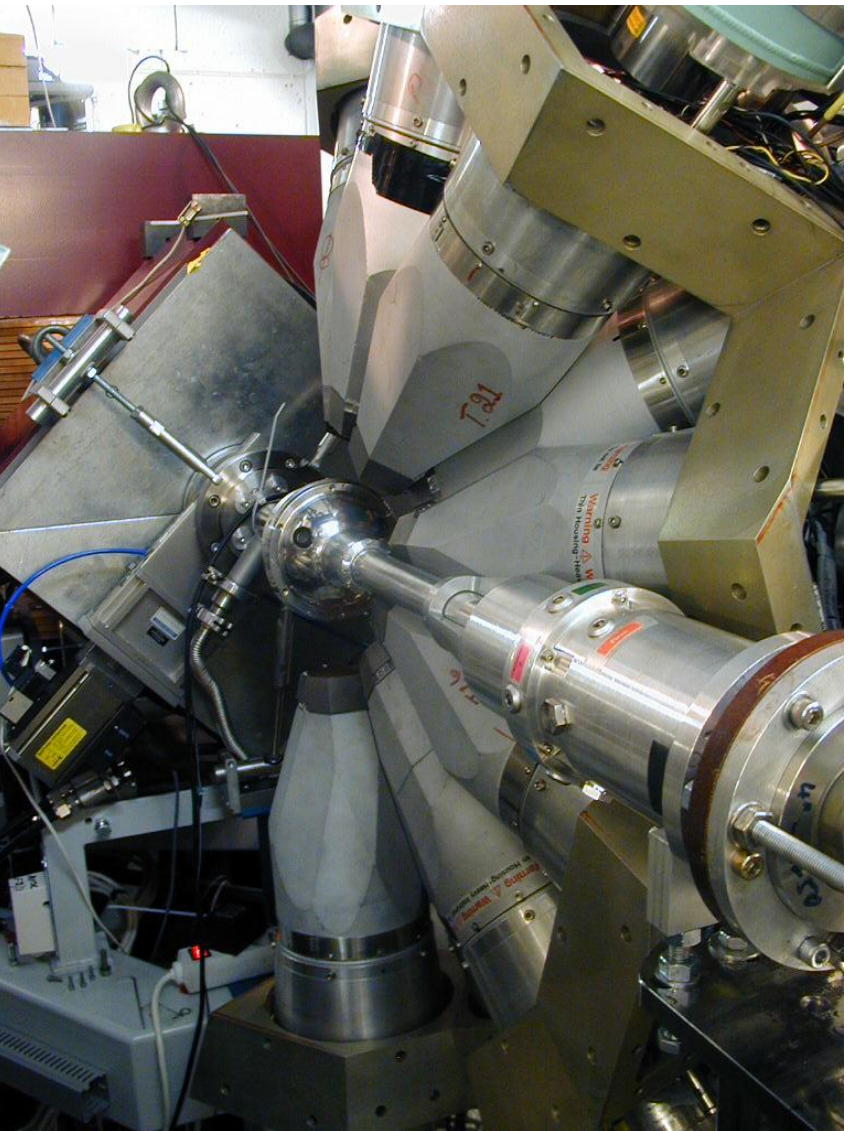
→ 15 nanobarn in SHE studies

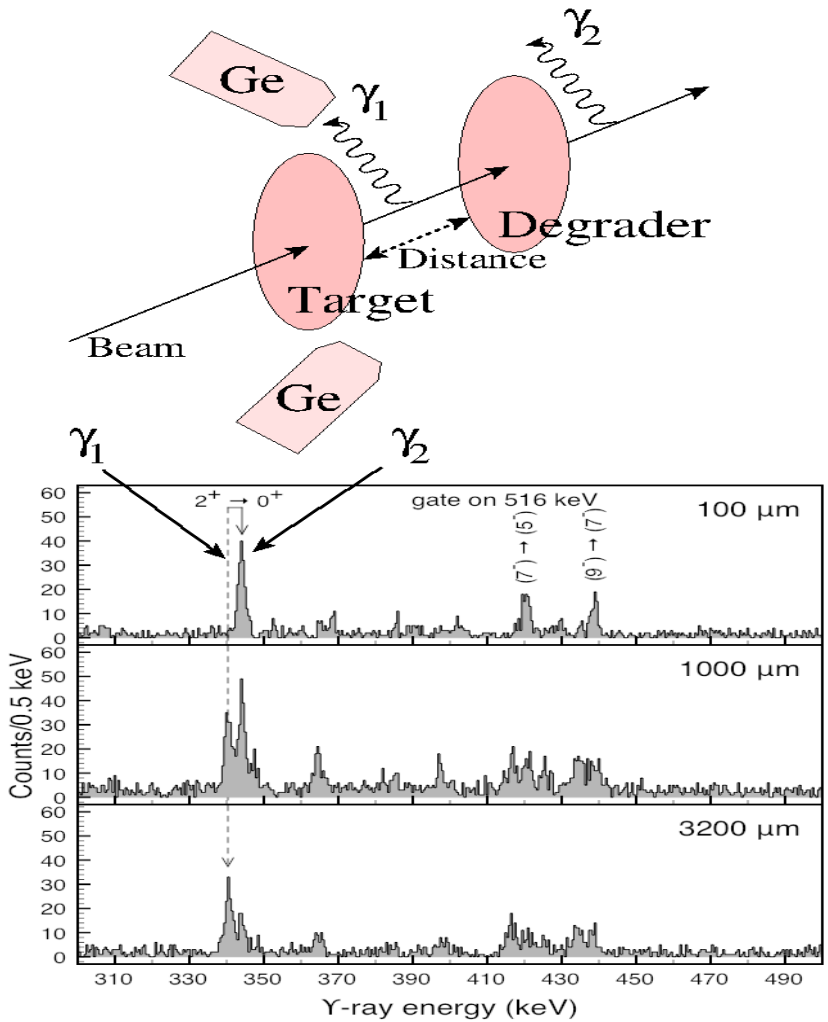


more in Steffen Ketelhut's talk

RDT-Plunger-lifetime measurements

plunger inside JUROGAM at RITU





- RDT enables very clean spectra
  - more in Tuomas Grahn's talk
    - *new plunger DPUNS (D. Cullen et al.)*

JURO proposals

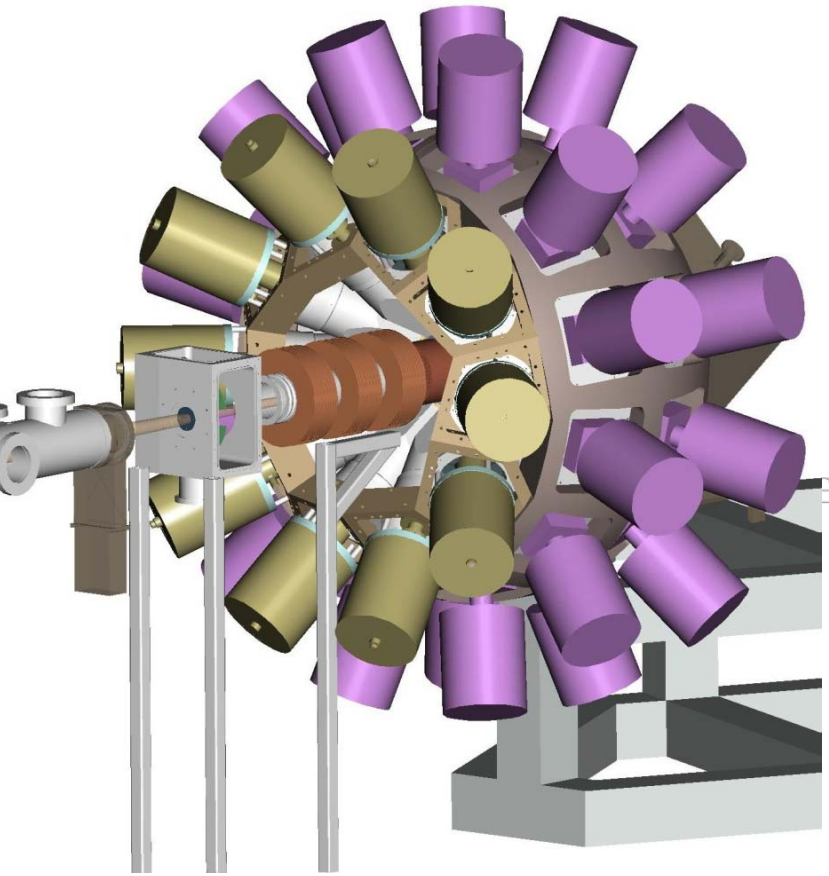
24 pending JURO-proposals (230 days)

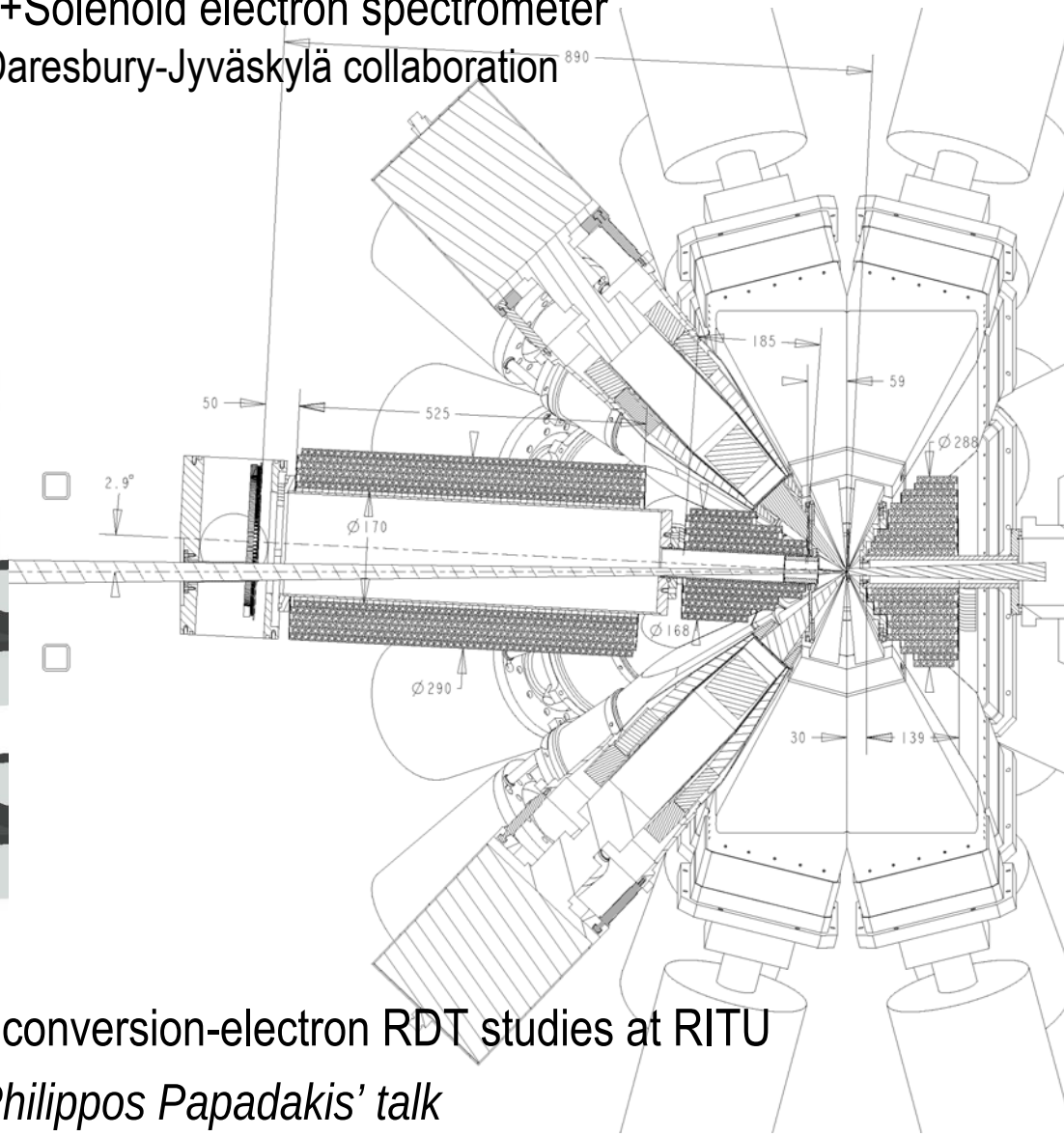
Expt. No	Title	Spokeperson(s)	Days Remaining (S) = Scheduled
JR98	Decay study of ^{113}Ba	T. Bäck	14
R45	Pushing nuclear structure studies to the extremes for the proton drip line around A=70	D. Jenkins	4 (S)
JR103	Magnetic rotation and shape co-existence in ^{144}Dy	D. Cullen	7
JR104	Proof-of-principle of double-beta tagging	D. Jenkins A. Obertelli	7 (S3)
JR106	Neutron single-particle orbitals and resultant shapes in neutron-deficient A=173 nuclei	D. O'Donnell C. Scholey	12 (S)
JR107	Configurations and competing structures in ^{195,194}Bi	P. Nieminen	8
JR108	In-beam gamma-ray spectroscopy of N=Z+3 ^{111}Xe	B. Hadinia	14
L01	Decay spectroscopy of ^{159}Re using LISA and GREAT	R. Page	14
S06	Exploring nuclear shapes in the transitional region of N~90: Coulomb excitation of ^{152,154}Sm to study E0 transitions with SAGE	P. Davies	3
S07	Probing E0 transitions in ^{188}Pb using the SAGE spectrometer	J. Pakarinen	7
JR109	Search for non-collective transitions in ^{166}Os	T.Grahn D.O'Donnell	10
JR110	Prompt and delayed spectroscopy of ^{199}At and ^{201}At	U.Jakobsson J.Uusitalo	10
JR111	In-beam gamma-ray spectroscopy of heavy elements: ^{256}Rf	P.T.Greenlees B.Gall R.-D.Herzberg Ch.Theisen	21 (17S)
JR112	Oblate-prolate shape competition and isomeric states in ^{185}Tl	P.Nieminen G.J.Lane	7
R46	Alpha-decay study of the proton unbound $^{211-213}$Pa	J.Uusitalo	14
S08	Simultaneous conversion-electron and gamma-ray spectroscopy using SAGE; an in-beam study of ^{253}No	R.-D. Herzberg	10
S09	Complete spectroscopy of the transfermium nucleus ^{255}Lr	M.Sandzelius K.Hauschild A.Lopez-Martens	4
S10	Spectroscopy of the odd-proton ^{249,251}Md	Ch.Theisen	11
L02	Using the (p,p'gamma) reaction to investigate low-spin states in ^{154}Gd	L. Bianco	5
L03	Search for fast alpha decays in ^{218}Th and ^{216}Ra	T. Grahn D. O'Donnell	7
JR113	DPUNS Commissioning: Investigation into the low-energy yrast structure of ^{98}Ru via lifetime measurements	M. J. Taylor	5
JR114	DPUNS: Lifetime measurements of proton-unbound states in ^{151}Lu; proton emission from a spherical or deformed system?	D. M. Cullen	14
JR115	Shape co-existence in odd-A isotopes: In-beam spectroscopy of ^{177,179}Au	D. T. Joss M. Venhart	10
R47	Isomeric and decay spectroscopy of ^{179}Pb	C. Scholey P. Ruotsalainen	14
		TOTAL	232 - (S) 36

SAGE

JUROGAM2+Solenoid electron spectrometer

Liverpool-Daresbury-Jyväskylä collaboration





simultaneous gamma- and conversion-electron RDT studies at RITU

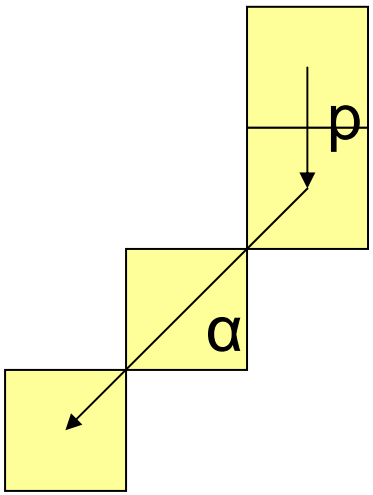
more in Philippos Papadakis' talk

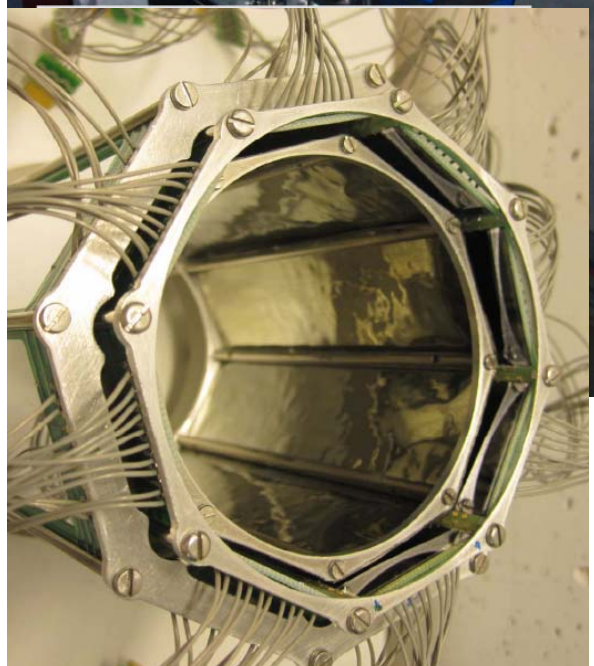
LISA

detector array for detection
of prompt light ions at RITU and MARA

–

tagging of very fast proton emitters



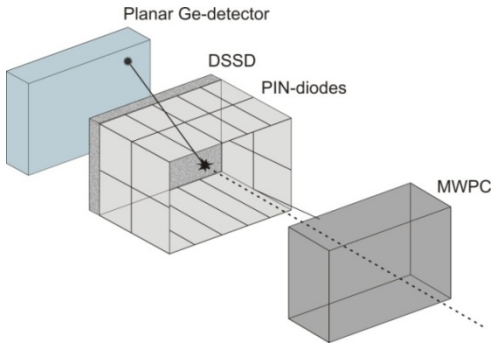


Liverpool-Daresbury
investment

new methods

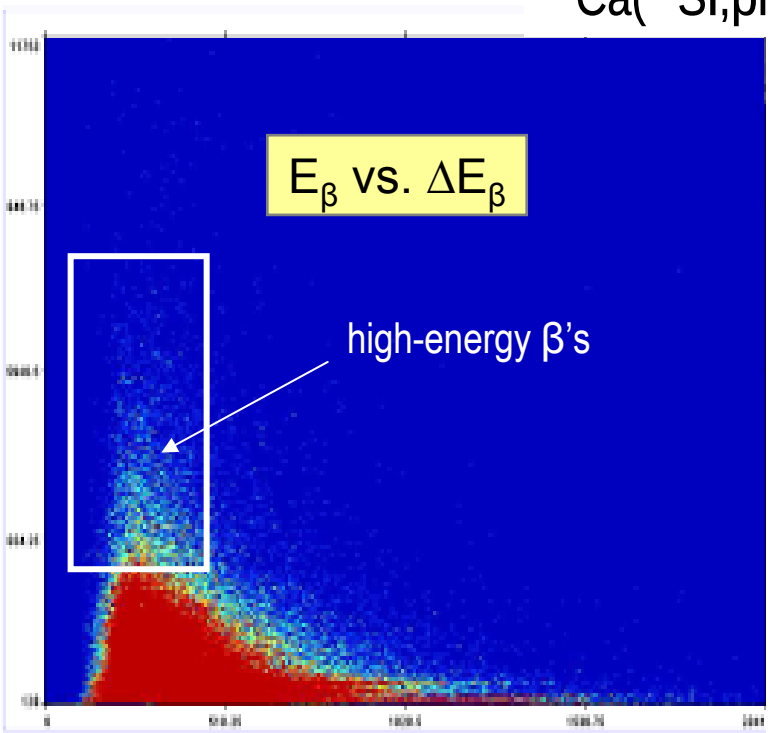
Recoil – β – Tagging for N = Z nuclei

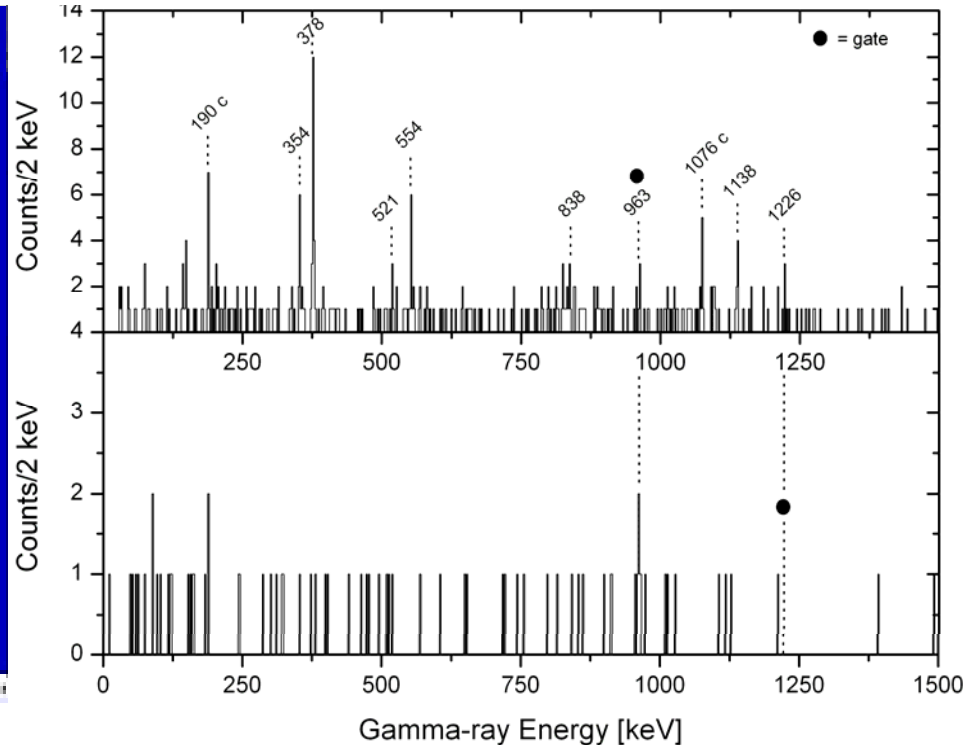
York contribution



access to excited state structure of N=Z
superallowed β –emitters
T = 1 and T = 0 states

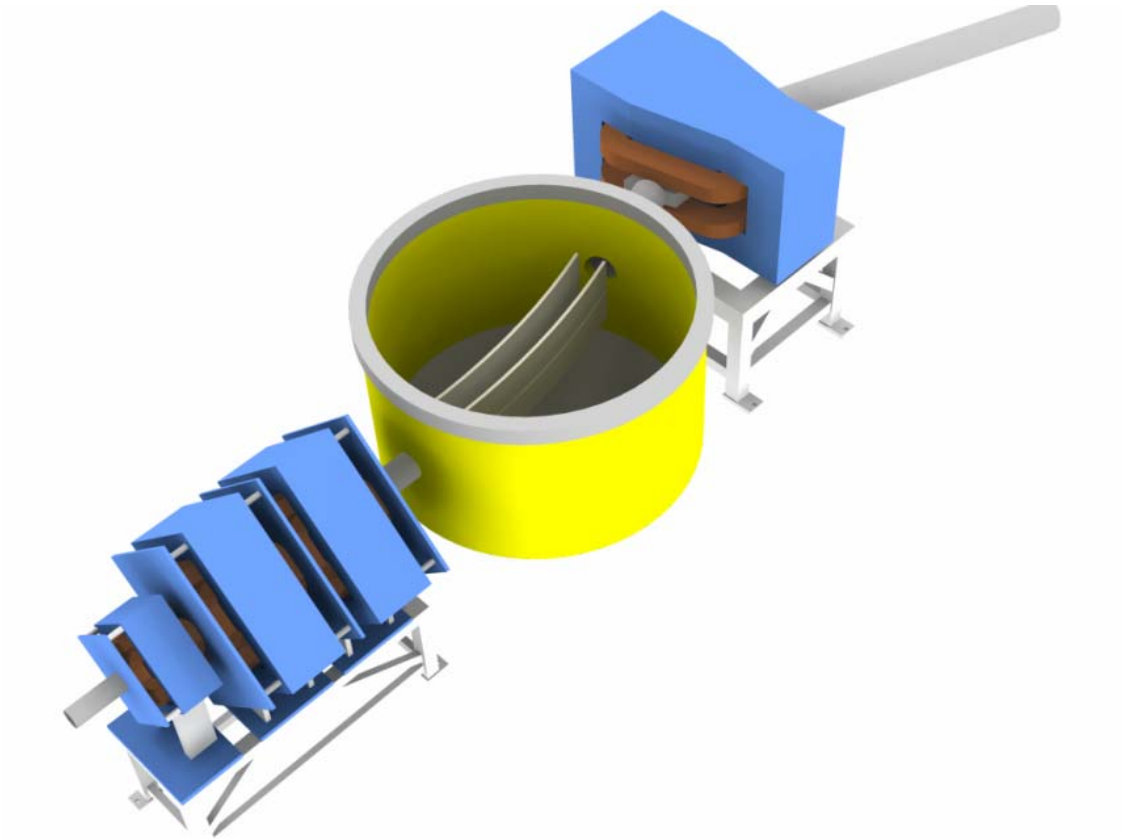
$^{40}Ca(^{28}Si,pn)\ ^{66}As$ Z=N=33





new instrumentation

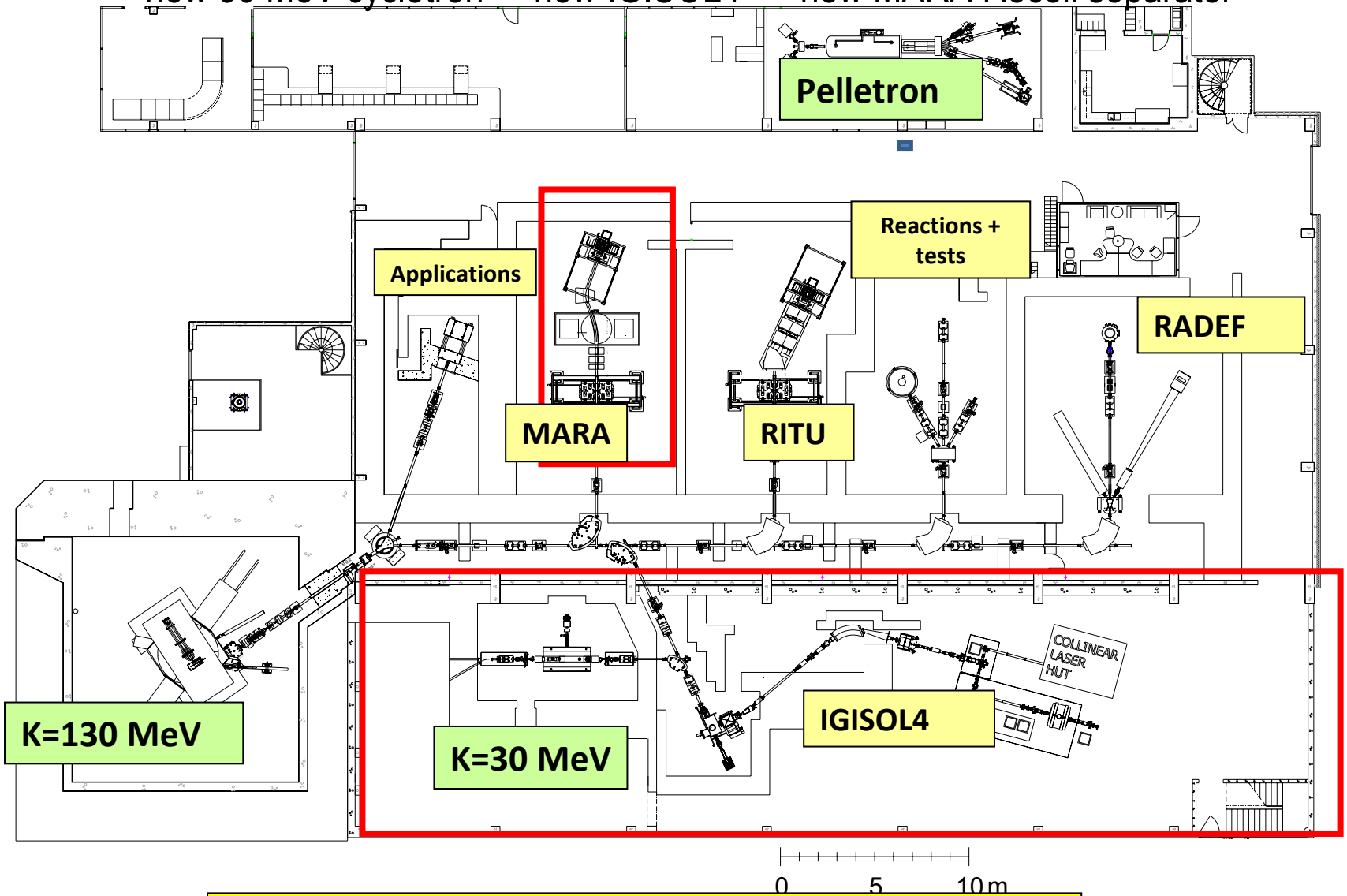
MARA (vacuum) recoil separator from 2012
for extending tagging measurements towards
lighter neutron deficient nuclei



more beam time

upgrade of the JYFL Accelerator Laboratory

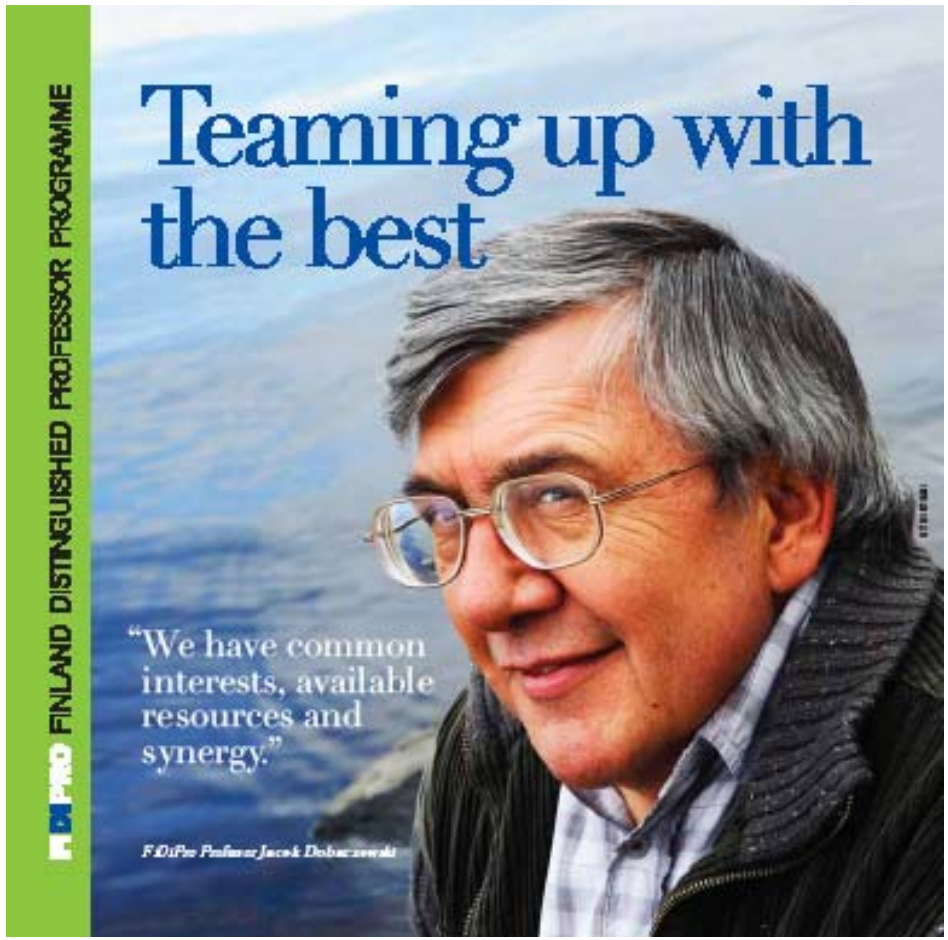
new 30 MeV cyclotron - new IGISOL4 - new MARA Recoil separator



→ more beam time for difficult experiments and testing

FiDiPro team of Jacek Dobaczewski

EuTINP




Thank you!