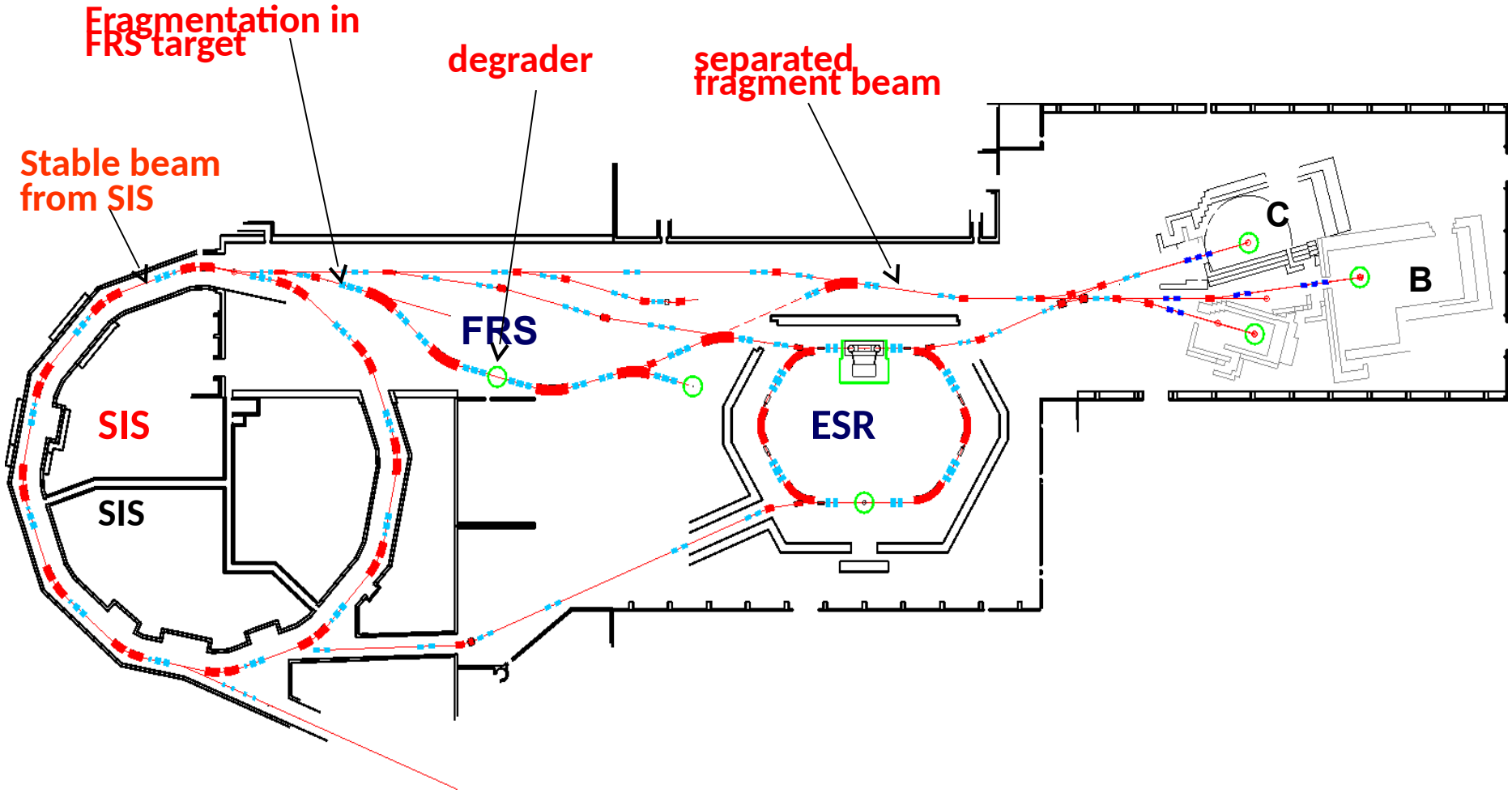
NuSTAR

NUclear STructure, Astrophysics and Reactions

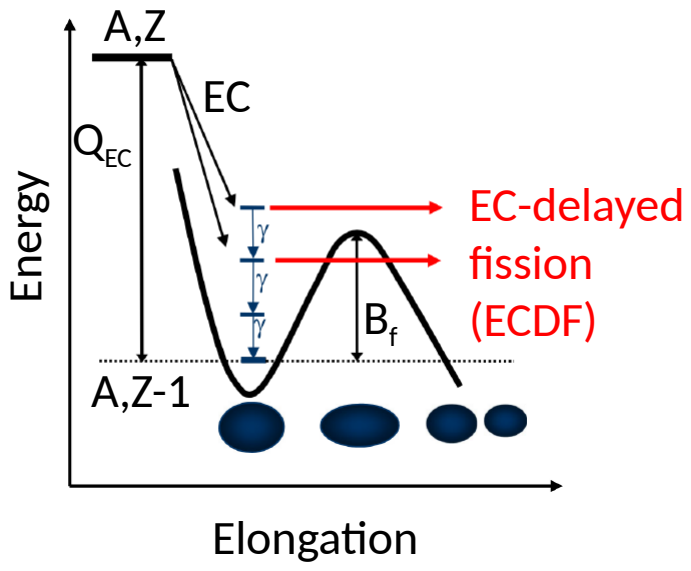
KHuK Jahrestagung 2016
Bad Honnef, Germany
Dec-2, 2016

René Reifarth
Goethe Universität Frankfurt

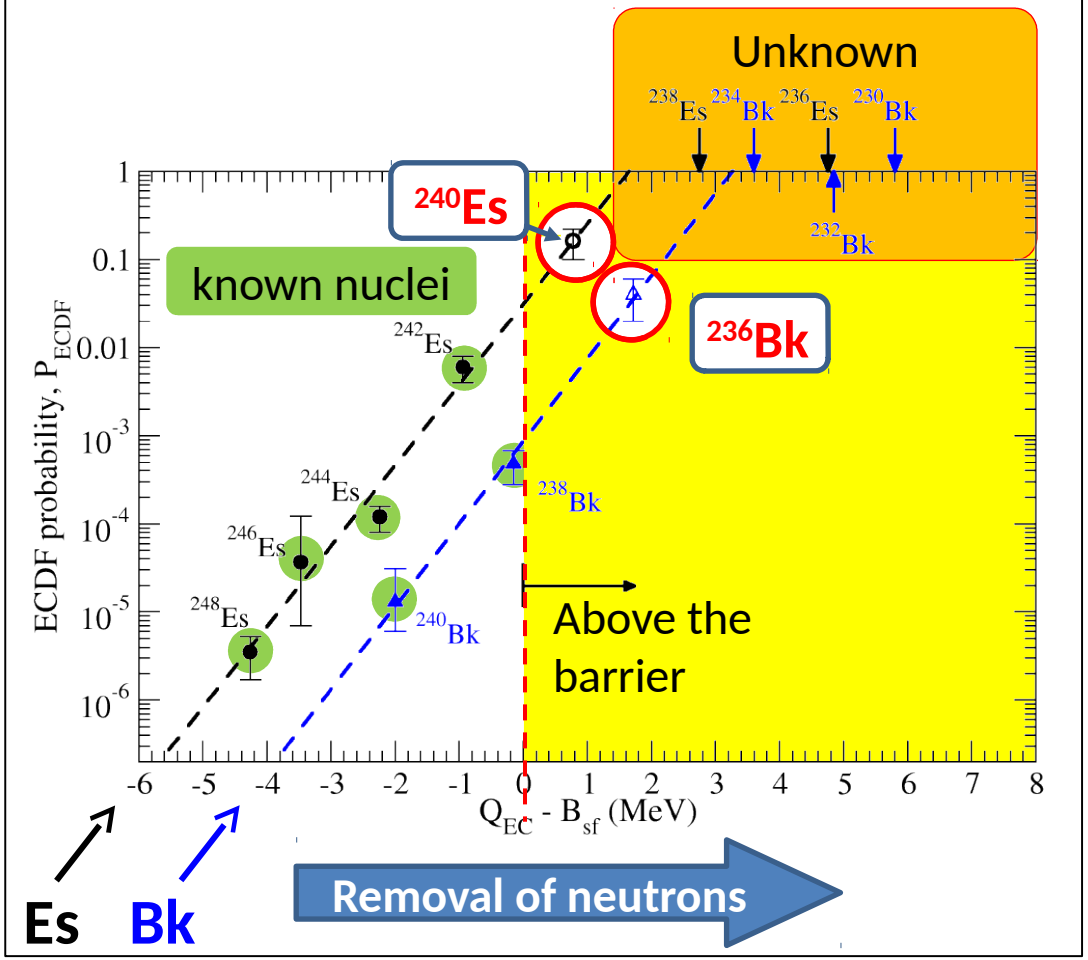
Layout of the experimental facilities at GSI



New neutron-deficient isotopes ^{240}Es and ^{236}Bk: high EC-delayed fission (ECDF) branch



$$P_{ECDF} = \frac{N(ECDF)}{N(EC)}$$

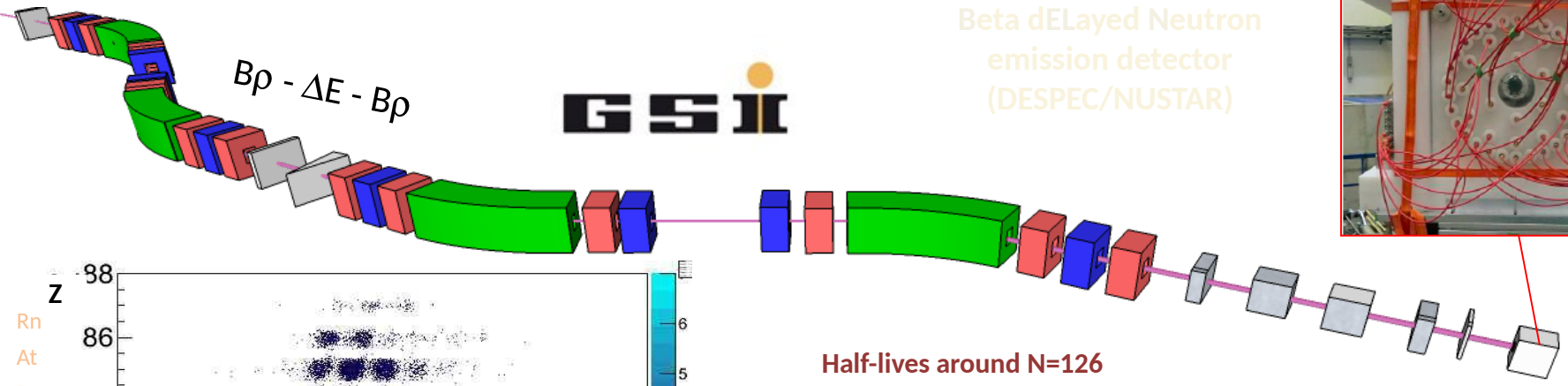


- ECDF gives access to fission studies of isotopes with hindered g.s. fission
- New ^{240}Es and ^{236}Bk expand known data to higher p_{ECDF}, populating states above fission barrier
- Pave the way to yet more n-deficient isotopes with saturated ECDF probabilities: P_{ECDF}=1

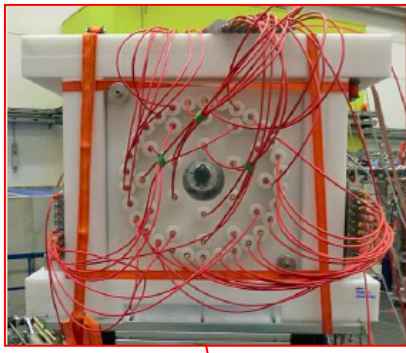
J. Konki, J. Khuyagbaatar (Spokesperson) *et al.*,
Phys. Lett. B (2016); doi: 10.1016/j.physletb.2016.11.038

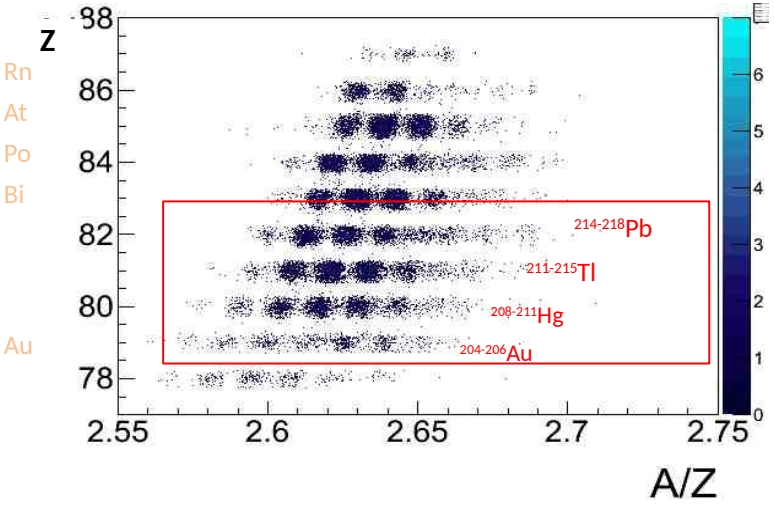
First measurement of several βn-emitters beyond N = 126

^{238}U, 1 GeV/u, 2x10^{9} pps

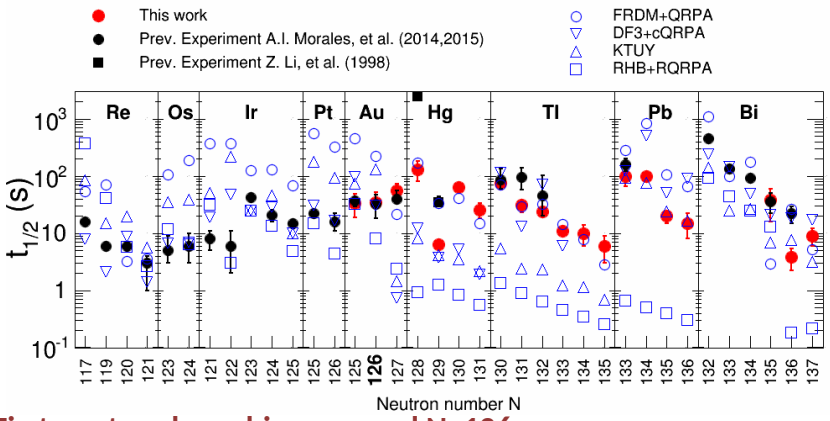


BELEN30
Beta dELayed Neutron emission detector (DESPEC/NUSTAR)





Half-lives around N=126

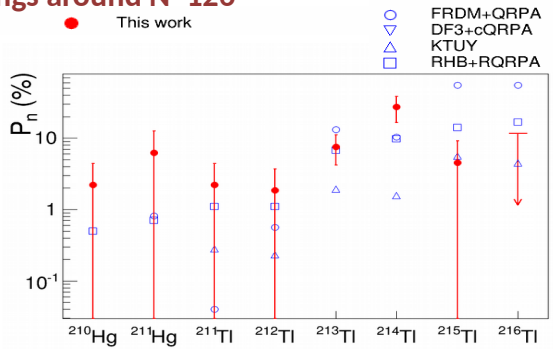


PRL 117, 012501 (2016) PHYSICAL REVIEW LETTERS week ending 1 JULY 2016

First Measurement of Several β-Delayed Neutron Emitting Isotopes Beyond N = 126

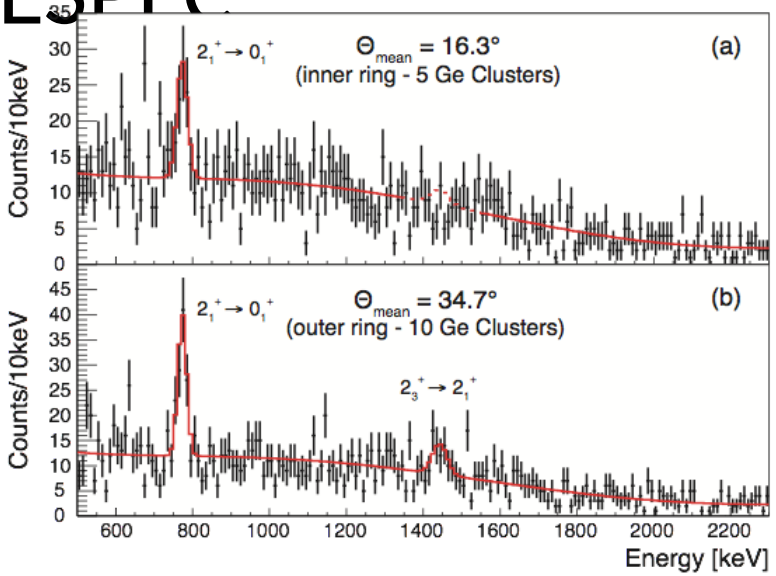
R. Caballero-Folch,[1,2] C. Domingo-Pardo,[3,*] J. Agramunt,[3] A. Algora,[3,4] F. Ameil,[5] A. Arcones,[5] Y. Ayyad,[6] J. Benlliure,[6] I. N. Borzov,[7,8] M. Bowry,[9] F. Calviño,[1] D. Cano-Ott,[10] G. Cortés,[1] T. Davinson,[11] I. Dillmann,[2,5,12] A. Estrade,[5,13] A. Evdokimov,[5,12] T. Faestermann,[14] F. Farinon,[5] D. Galaviz,[15] A. R. García,[10] H. Geissel,[5,12] W. Gelletly,[9] R. Gernhäuser,[14] M. B. Gómez-Hornillos,[1] C. Guerrero,[16,17] M. Heil,[5] C. Hinke,[14] R. Knöbel,[5] I. Kojouharov,[5] J. Kurcewicz,[5] N. Kurz,[5] Yu. A. Litvinov,[5] L. Maier,[14] J. Marganiec,[18] T. Marketin,[19] M. Marta,[5,12] T. Martínez,[10] G. Martínez-Pinedo,[5,20] F. Montes,[21,22] I. Mukha,[5] D. R. Napoli,[23] C. Nociforo,[5] C. Paradela,[6] S. Pietri,[5] Zs. Podolyák,[9] A. Prochazka,[5] S. Rice,[9] A. Riego,[1] B. Rubio,[3] H. Schaffner,[5] Ch. Scheidenberger,[5,12] K. Smith,[5,21,22,24,25] E. Sokol,[26] K. Steiger,[14] B. Sun,[5] J. L. Taín,[3] M. Takechi,[5] D. Testov,[26,27] H. Weick,[5] E. Wilson,[9] J. S. Winfield,[5] R. Wood,[9] P. Woods,[11] and A. Yeremin[26]

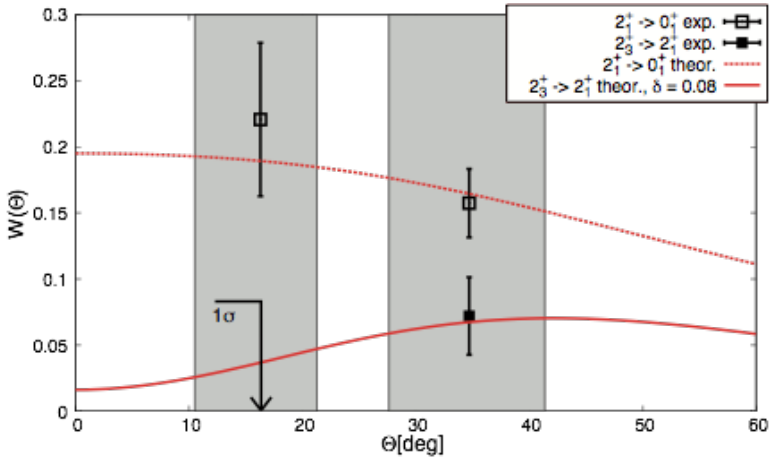
First neutron branchings around N=126



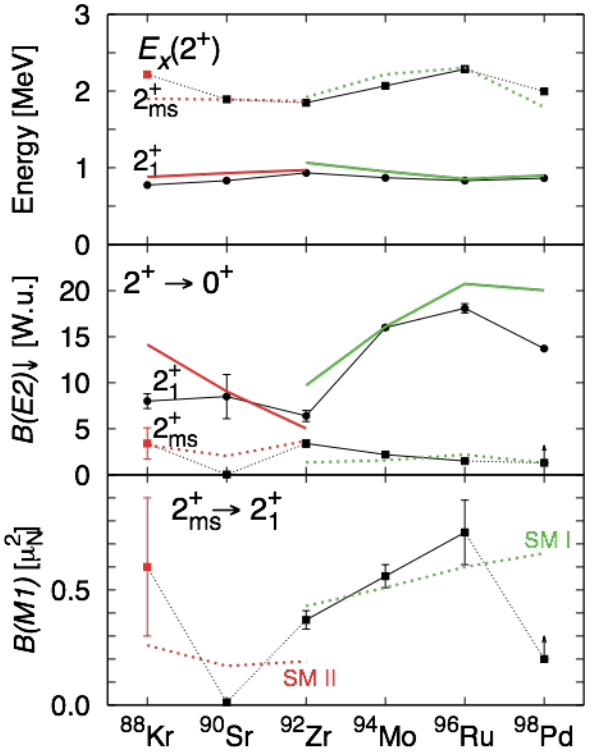
+ PhD Thesis: R. Caballero-Folch (UPC-Barcelona), 2015, Phys. Rev. C under prep.

S369: Relativistic Coulomb excitation of ^{88}Kr at PRESPEC*





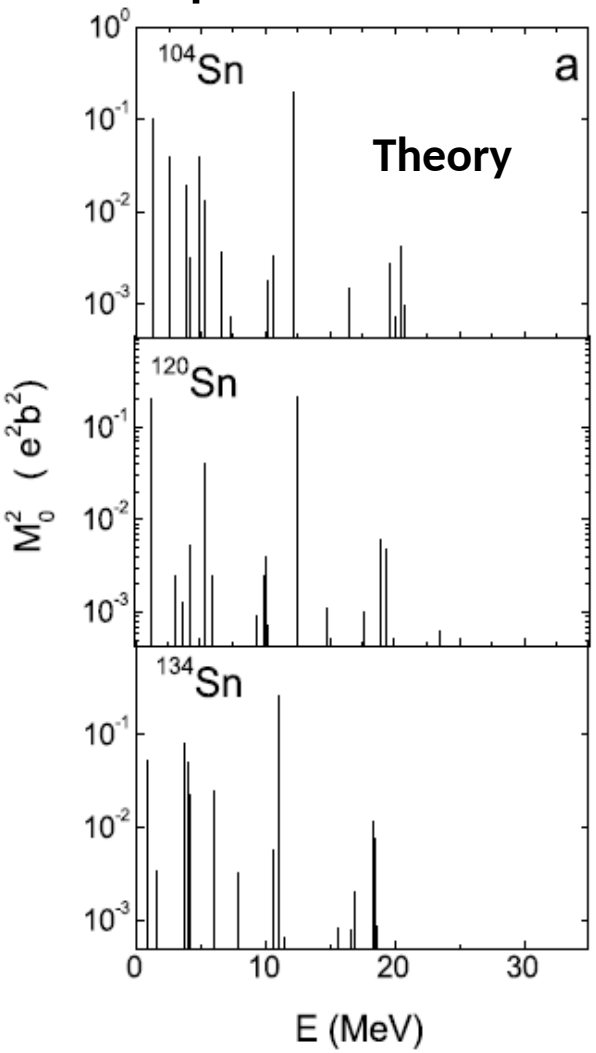
Transition	σL	$B(\sigma L)_{exp}$
$2_1^+ \rightarrow 0_{g.s.}^+$	$E2$	$\leq$1.0 W.u.
$2_3^+ \rightarrow 0_{g.s.}^+$	$E2$	3.4(17) W.u.
$2_3^+ \rightarrow 2_1^+$	$E2$	$1.0^{+1.7}_{-0.9}$ W.u.
$2_3^+ \rightarrow 2_1^+$	$M1$	0.6(3) μ_N^2



*K. Moschner, A. Blazhev, J. Jolie, N. Warr, P. Boutchakov et al., Phys. Rev. C **94**, 054323 (2016)

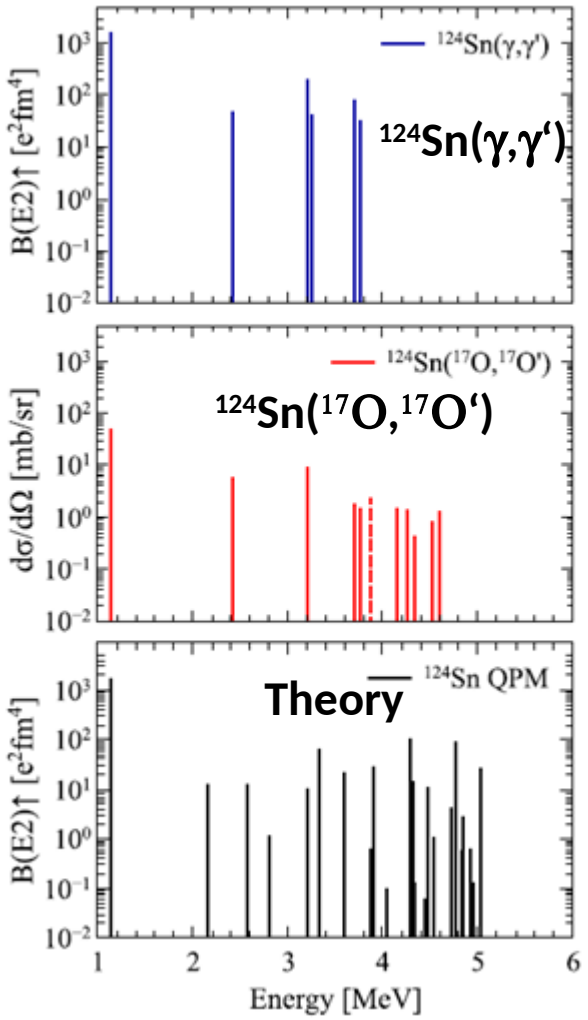
The PQR Mode – Isoscalar Quadrupole Oscillations of the Neutron Skin

…predicted in 2011:

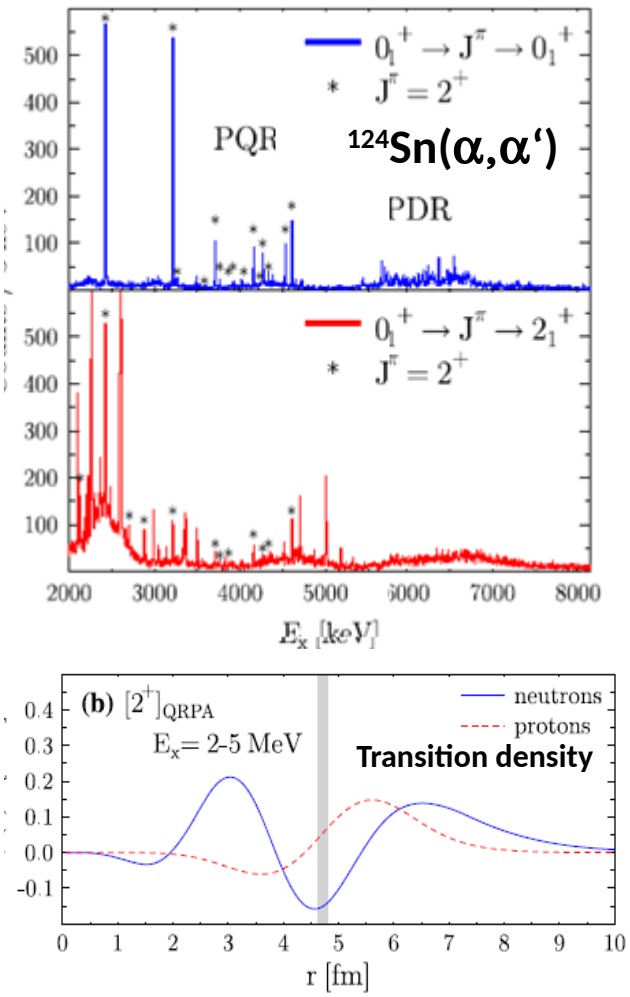


N. Tsoneva, H. Lenske, PLB 695 (2011)

…experimentally confirmed in 2015/2016:

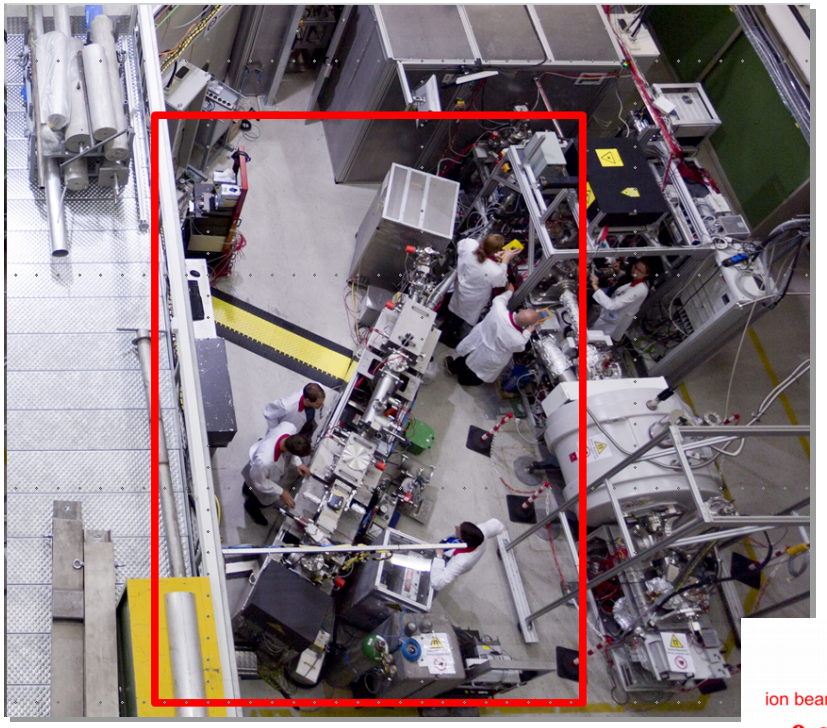


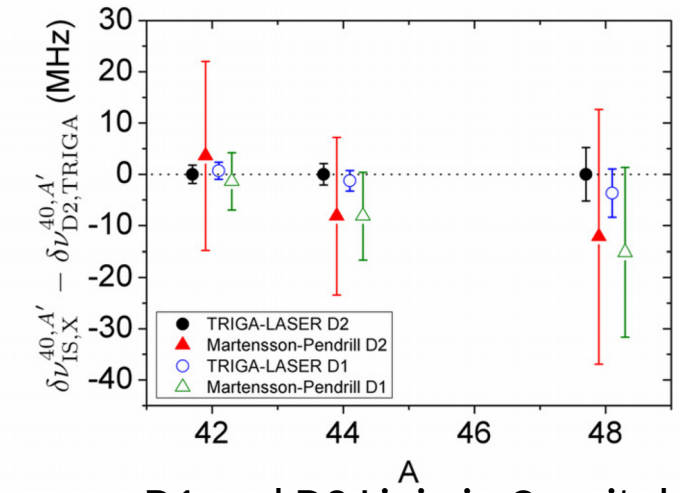
L.Pellegri, N. Tsoneva et al., PRC C 92, 014330 (2015)



M. Spieker, N. Tsoneva et al., PLB 752 (2016)

LASPEC Aktivitäten

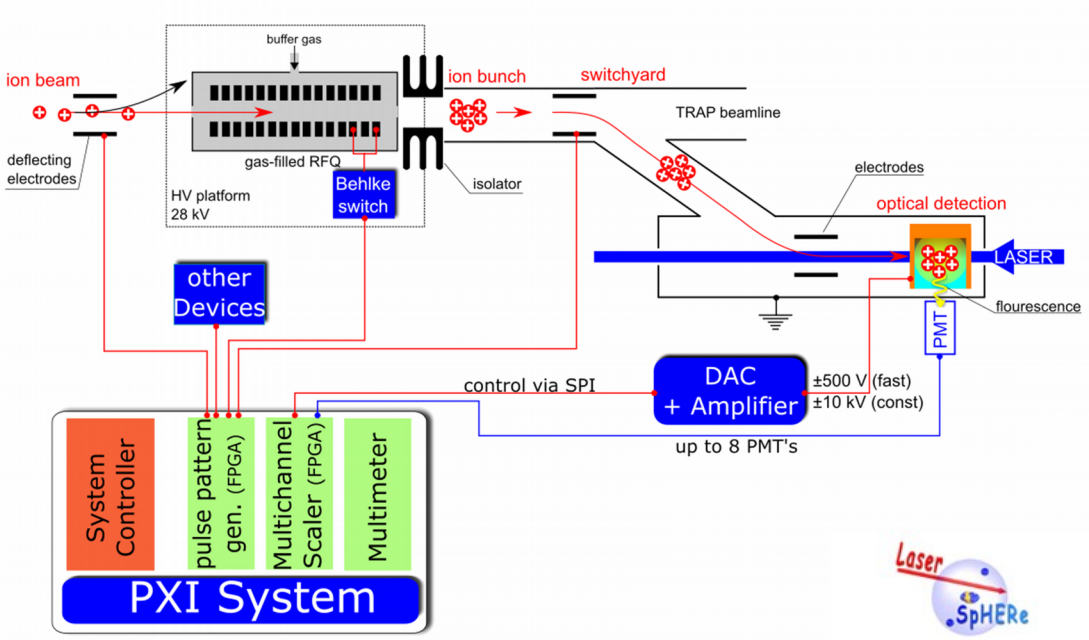




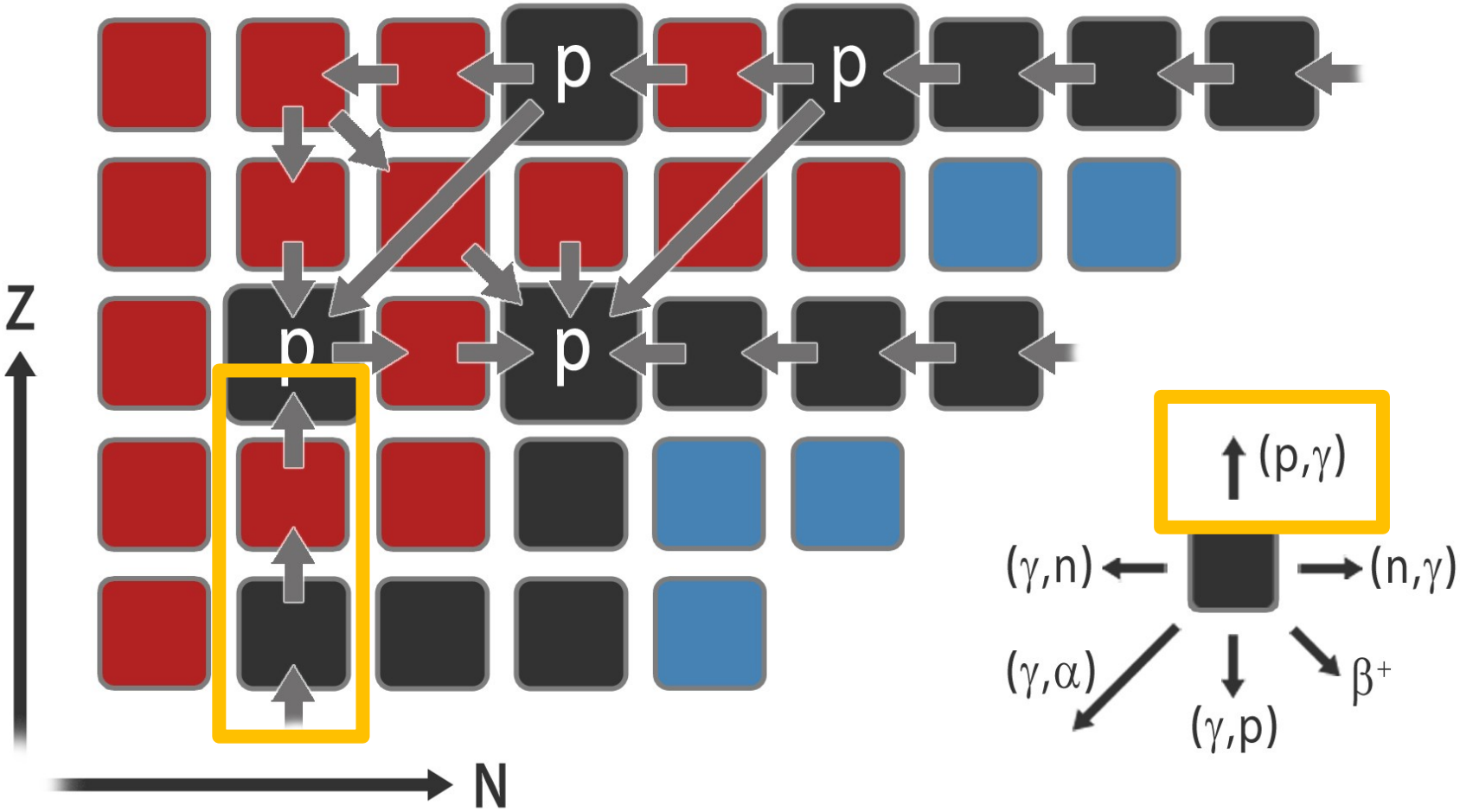
Messungen an D1 und D2 Linie in Ca mit deutlich verbesserter Genauigkeit, J Phys. B **48**, 245008

Tätigkeiten 2016 am TRIGA Mainz:
2016: **Entwicklung der Datenaufnahme für Spektroskopie an gepulsten Strahlen**

Dezember 2016: **Abbau der Beamline --> Transport nach Argonne (ATLAS / CARIBU)**

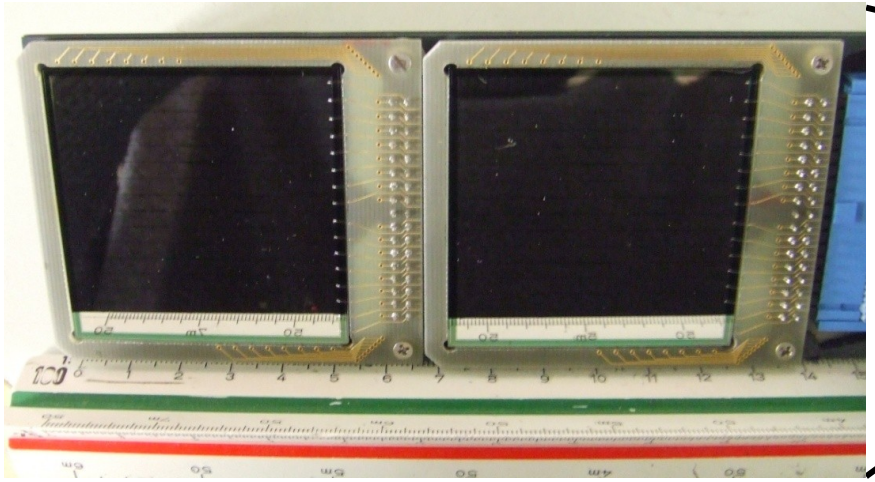


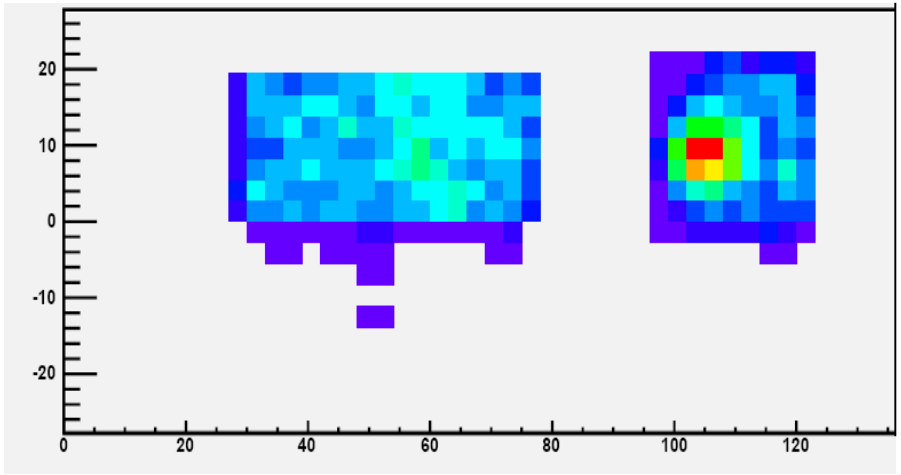
p process

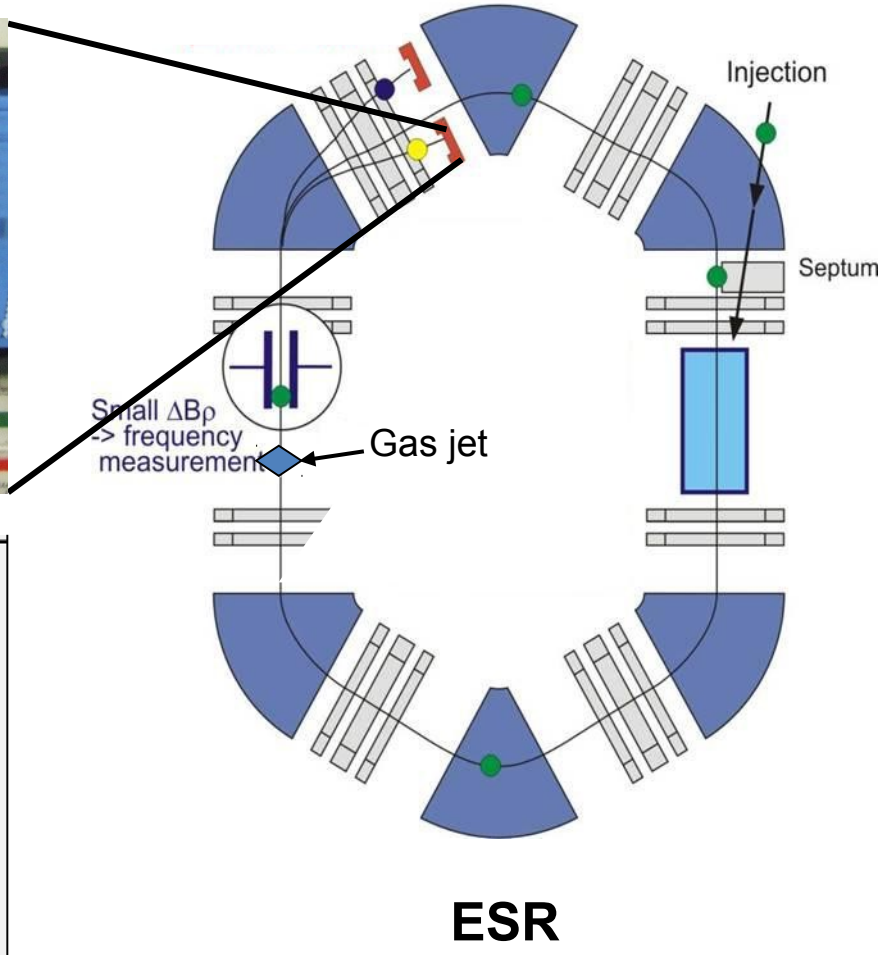


Reaction studies at the ESR

rticle detectors: Double sided silicon strip (16 x 16) inside pockets

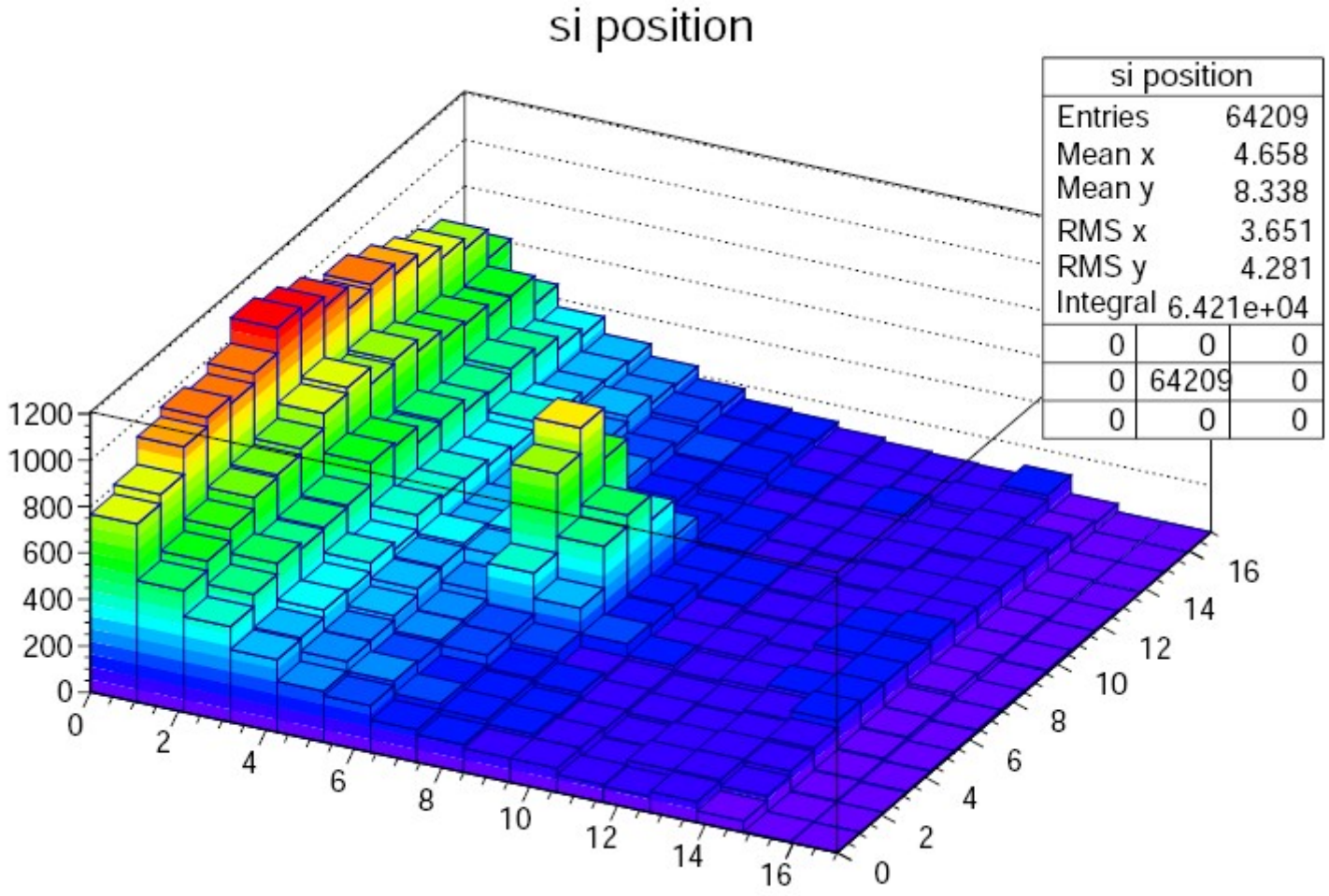






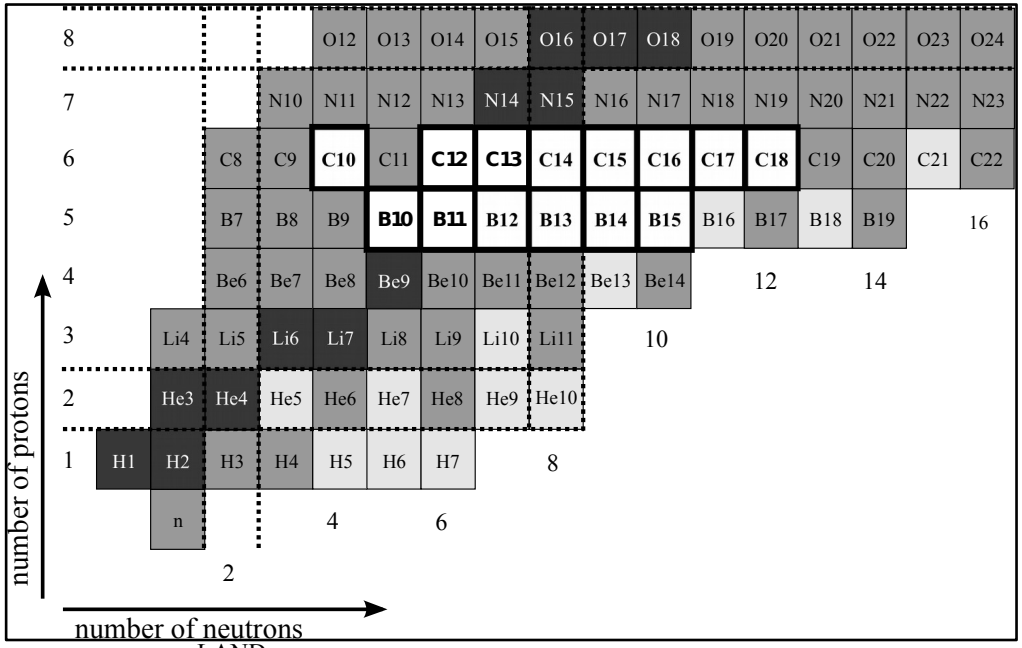
ESR Beam Time – **June 2016**

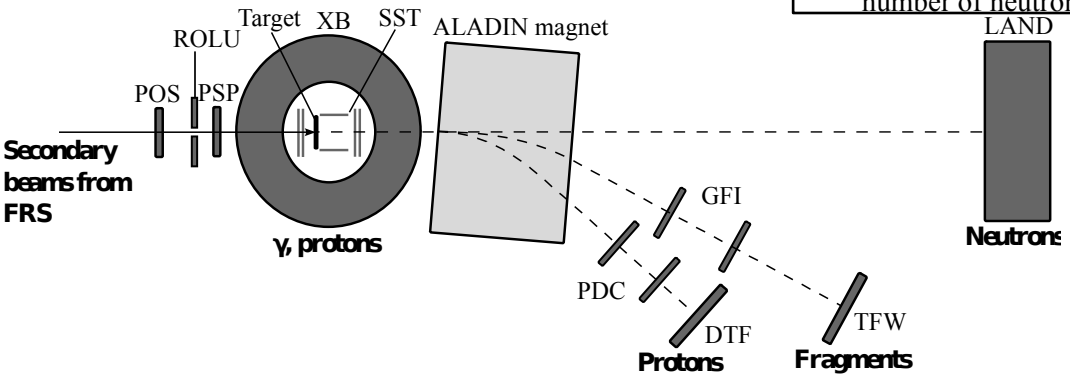
$^{124}Xe(p,\gamma)^{125}Cs$ – with hydrogen



Experiment

- ^{40}Ar at 490 MeV/u primary beam
- select 14 radioactive beams
- secondary target: C
- measure 1pxn cross sections of B and C isotopes

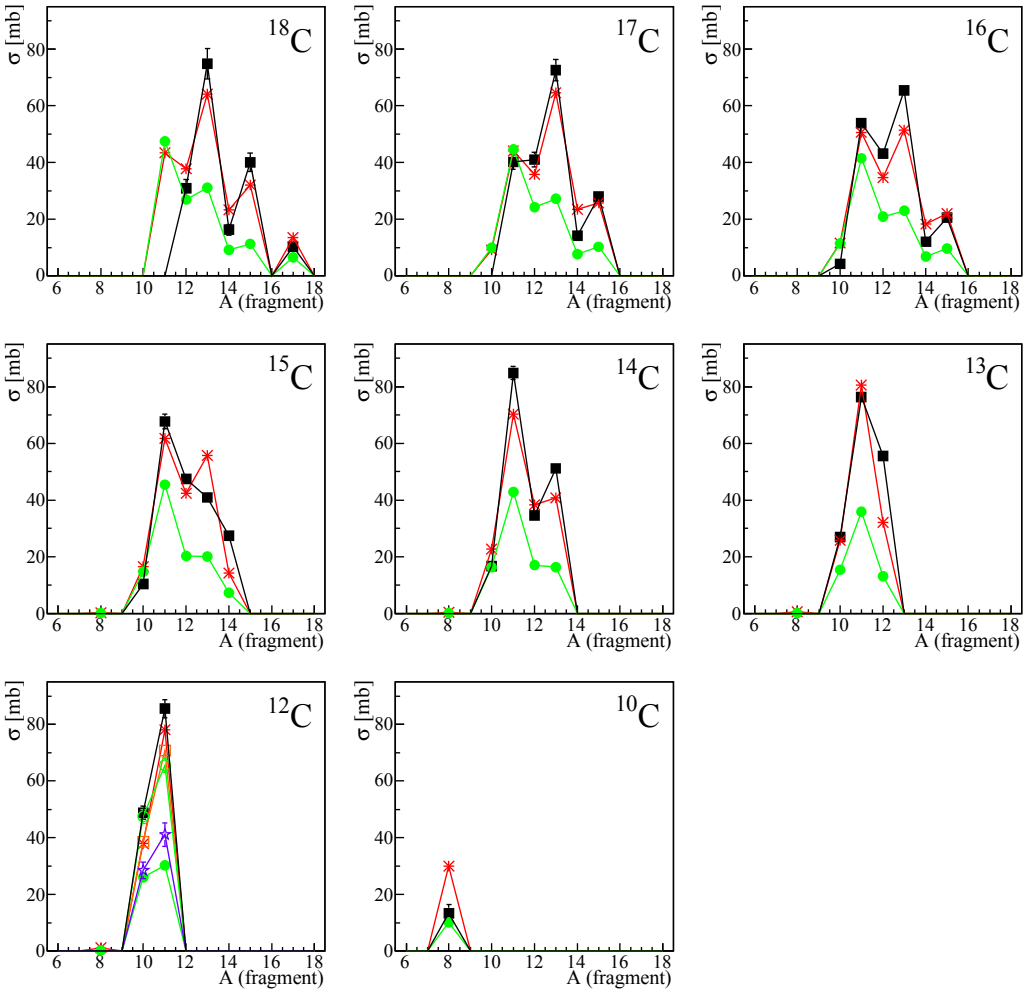




Lots of data!

R. Thies et al., Phys. Rev. C93, 054601 (2016)

Modify f_{ee}



R. Thies et al., Phys. Rev. C93, 054601 (2016)

Data

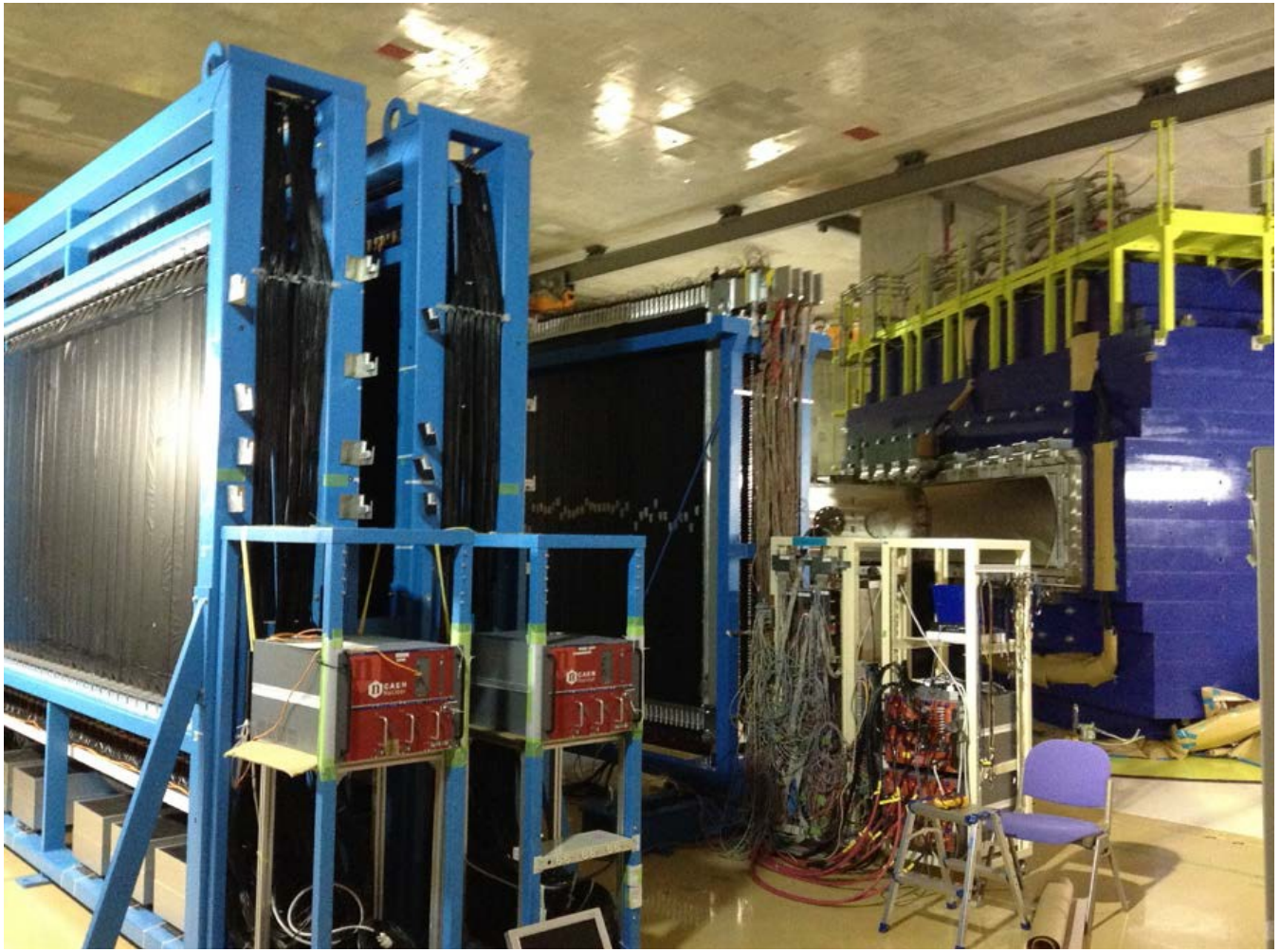
ABRABLA07

ABRABLA07 with f_{ee} = 0.6 (best fit)

GLAD arrived

RIKEN

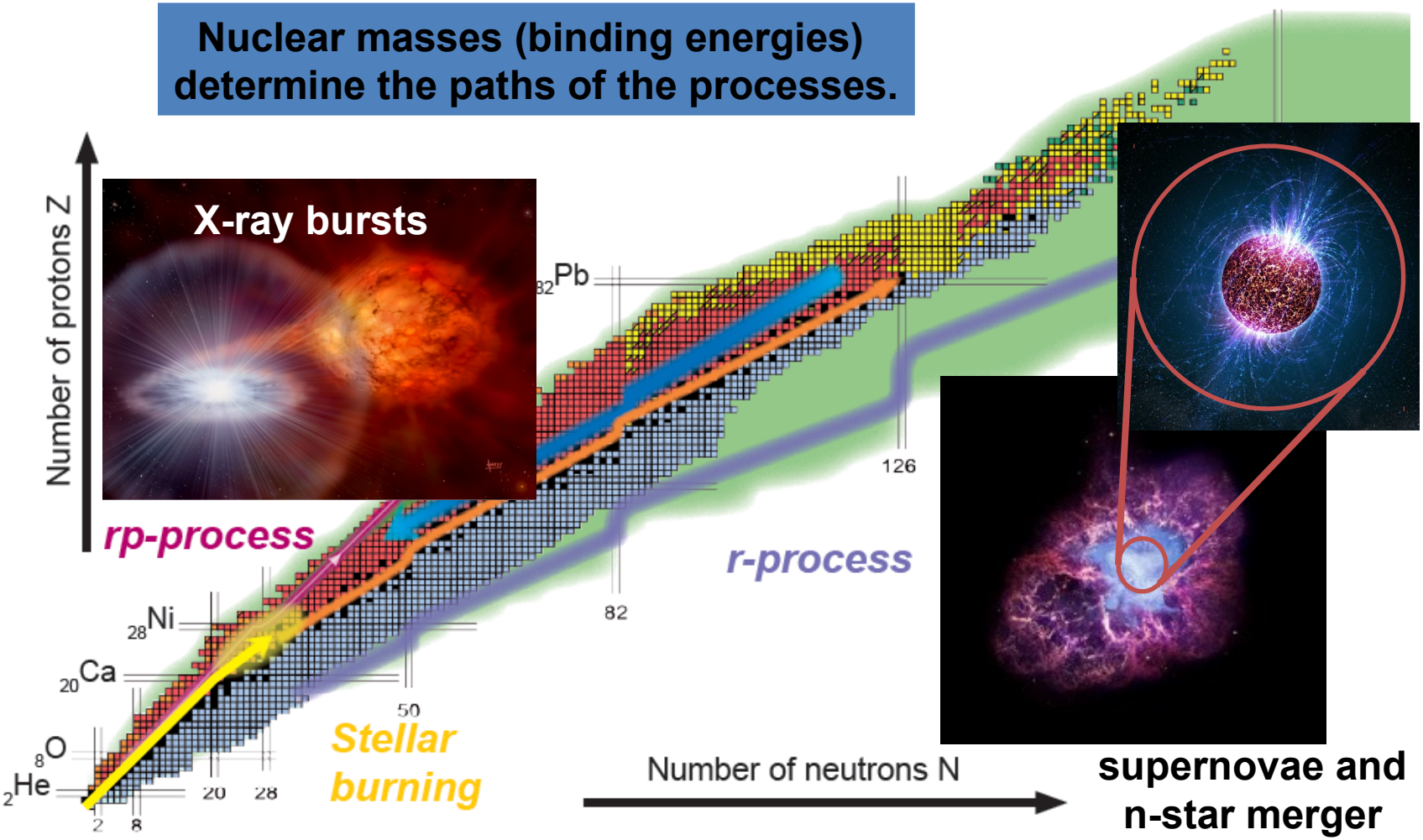
R3B/NeuLAND @ RIKEN



CERN

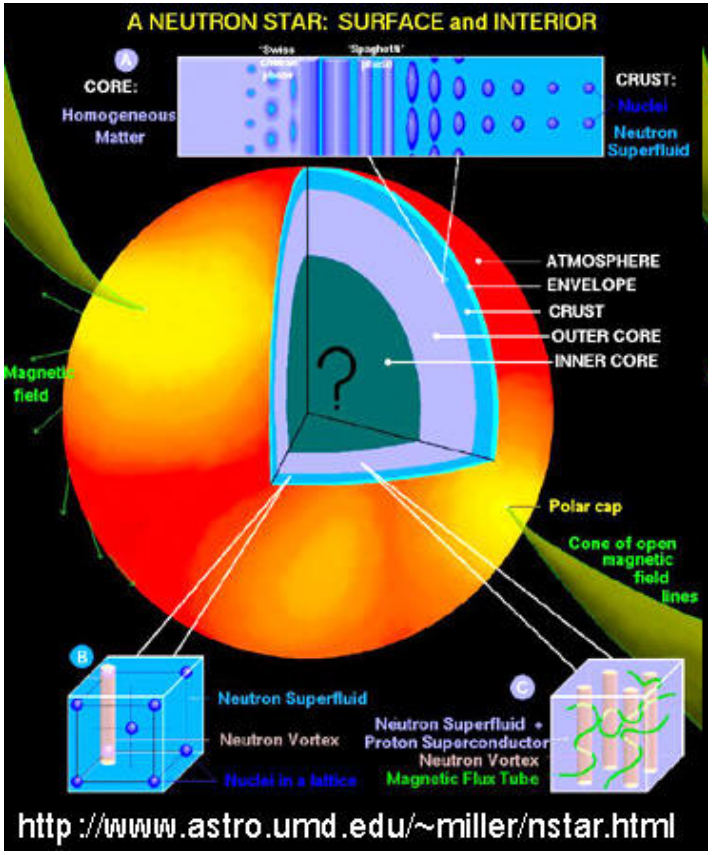
The nucleosynthesis paths

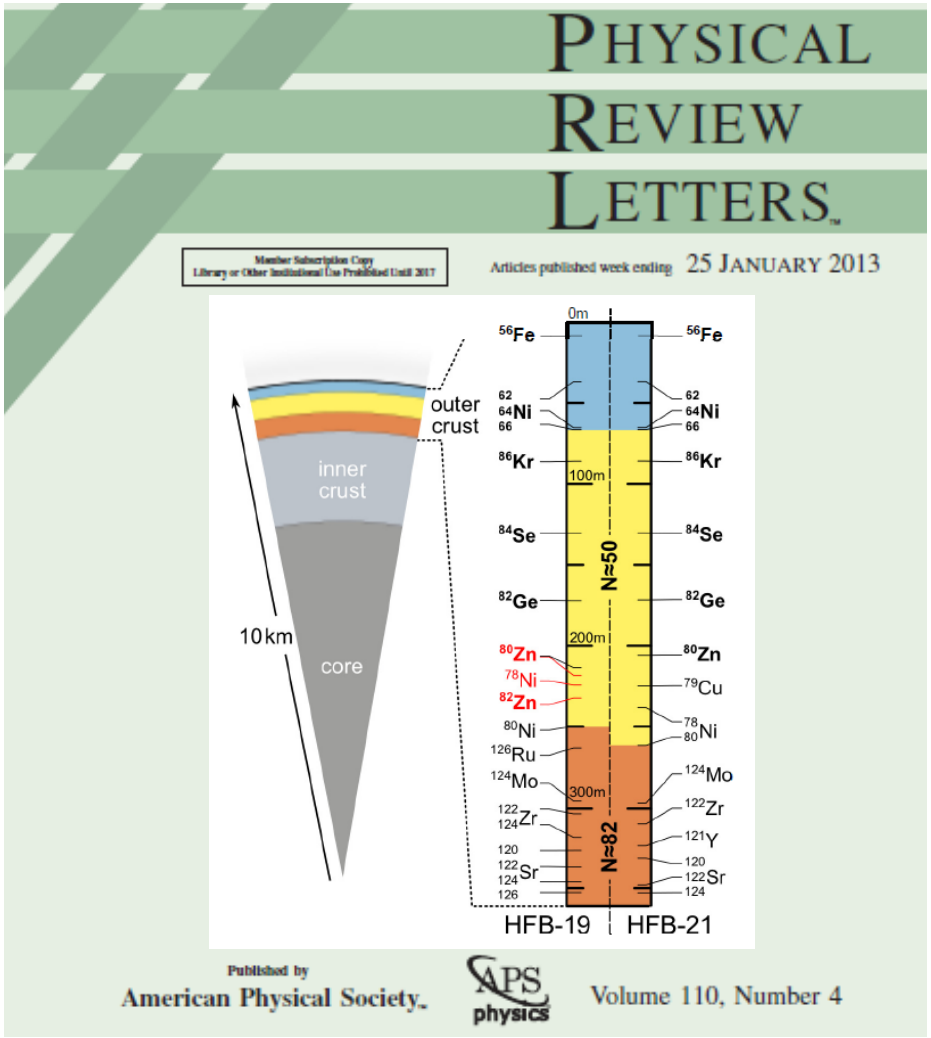
Nuclear masses (binding energies) determine the paths of the processes.



Masses for nuclear astrophysics

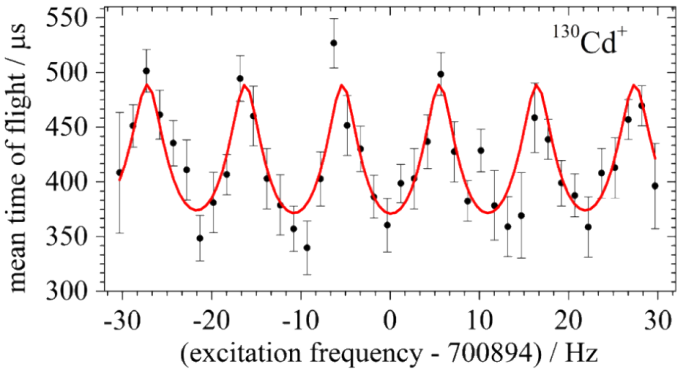
Composition of the outer crust of a neutron star

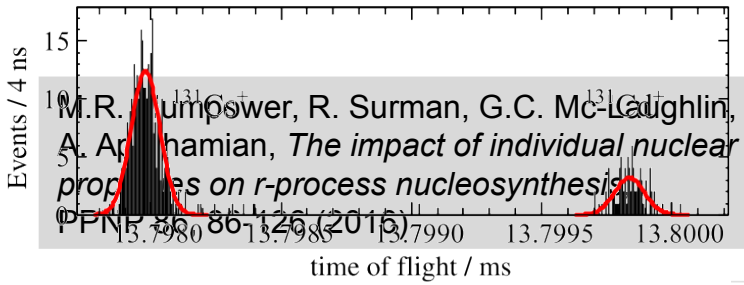


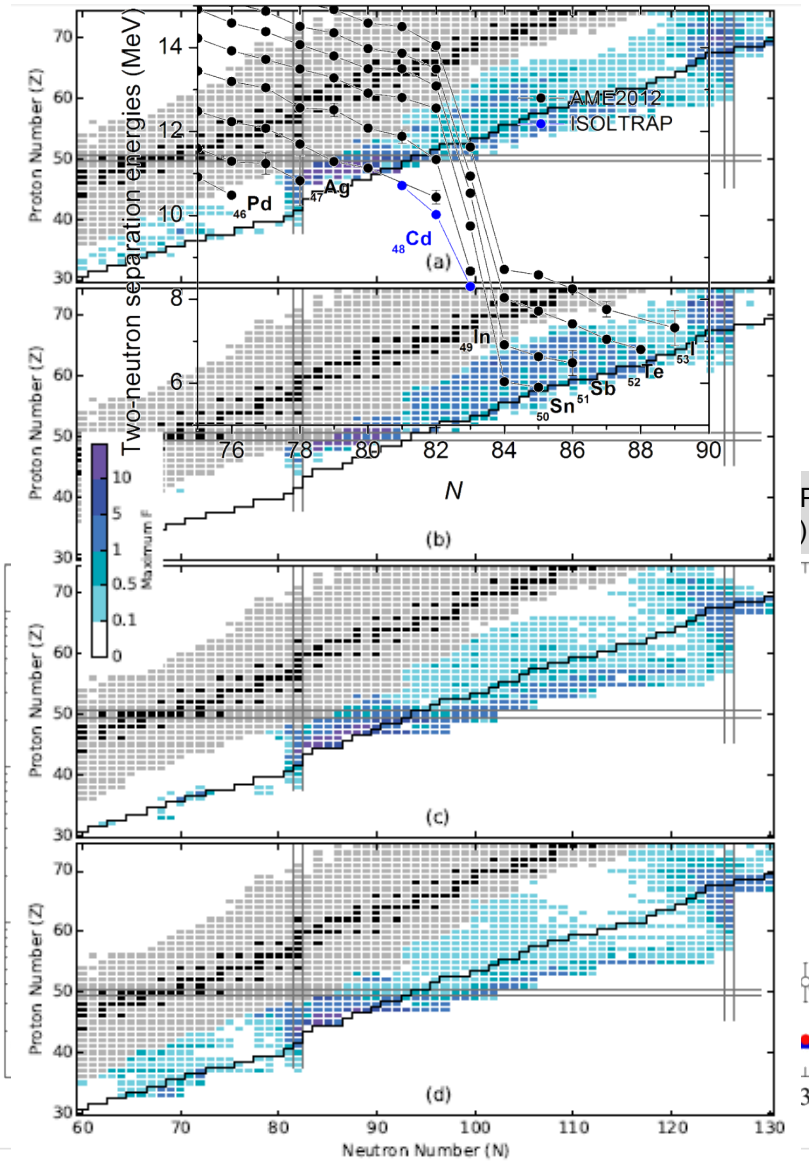


n-rich Cd masses for r-process studies

Cd	Measured with	Half life /ms	Yield /ions/uC
129	Penning trap MR-ToF-MS	(242?) (104?)	12000
130	Penning trap MR-ToF-MS	162	330
131	MR-ToF-MS	68	39







M.R. Mumpower, R. Surman, G.C. Mc-Laughlin, A. Aprahamian, *The impact of individual nuclear properties on r-process nucleosynthesis*, PPNP 86, 86-126 (2016)

Credits and thanks to:

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Andreas Heinz
Jan Jolie
Oleg Kiselev
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Wilfried Nörtershäuser