Bad Honnef, April 2013

Measurements of nuclear masses and isomers near and beyond doubly magic ^{132}Sn

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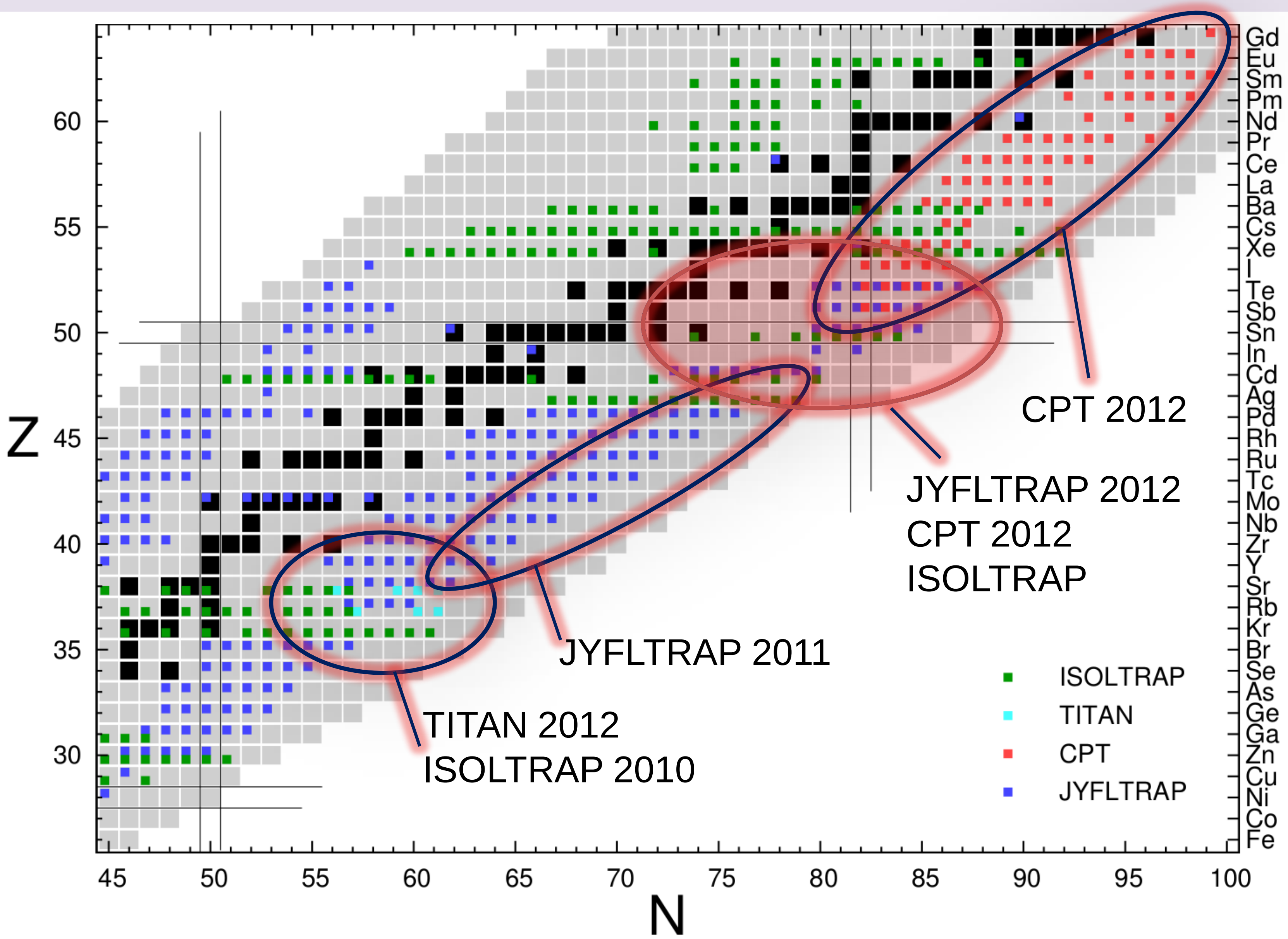
JYVÄSKYLÄN YLIOPISTO

MAX-PLANCK-INSTITUT FÜR KERNPHYSIK

Penning trap mass harvest



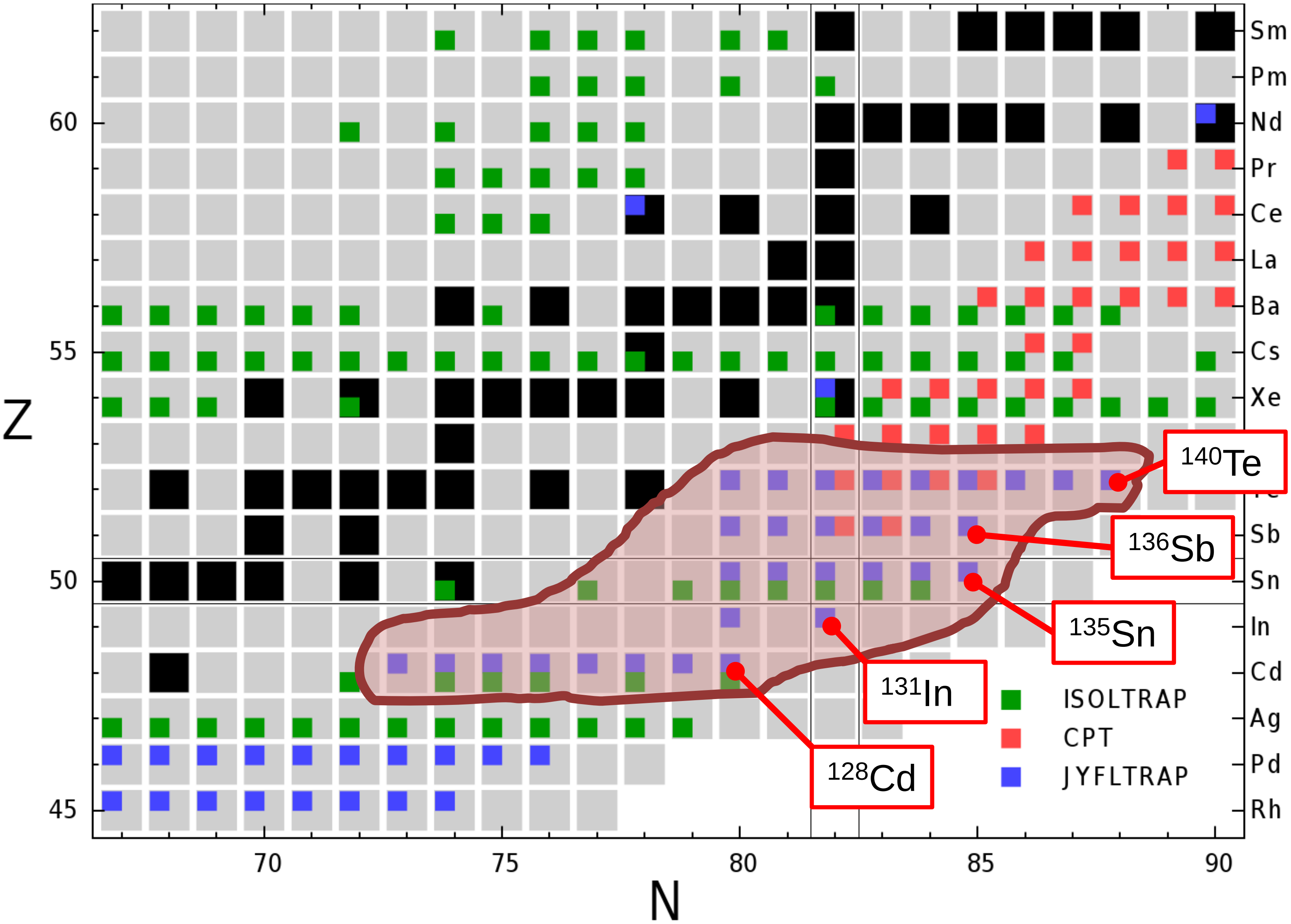
CPT 2012

JYFLTRAP 2012
CPT 2012
ISOLTRAP

JYFLTRAP 2011

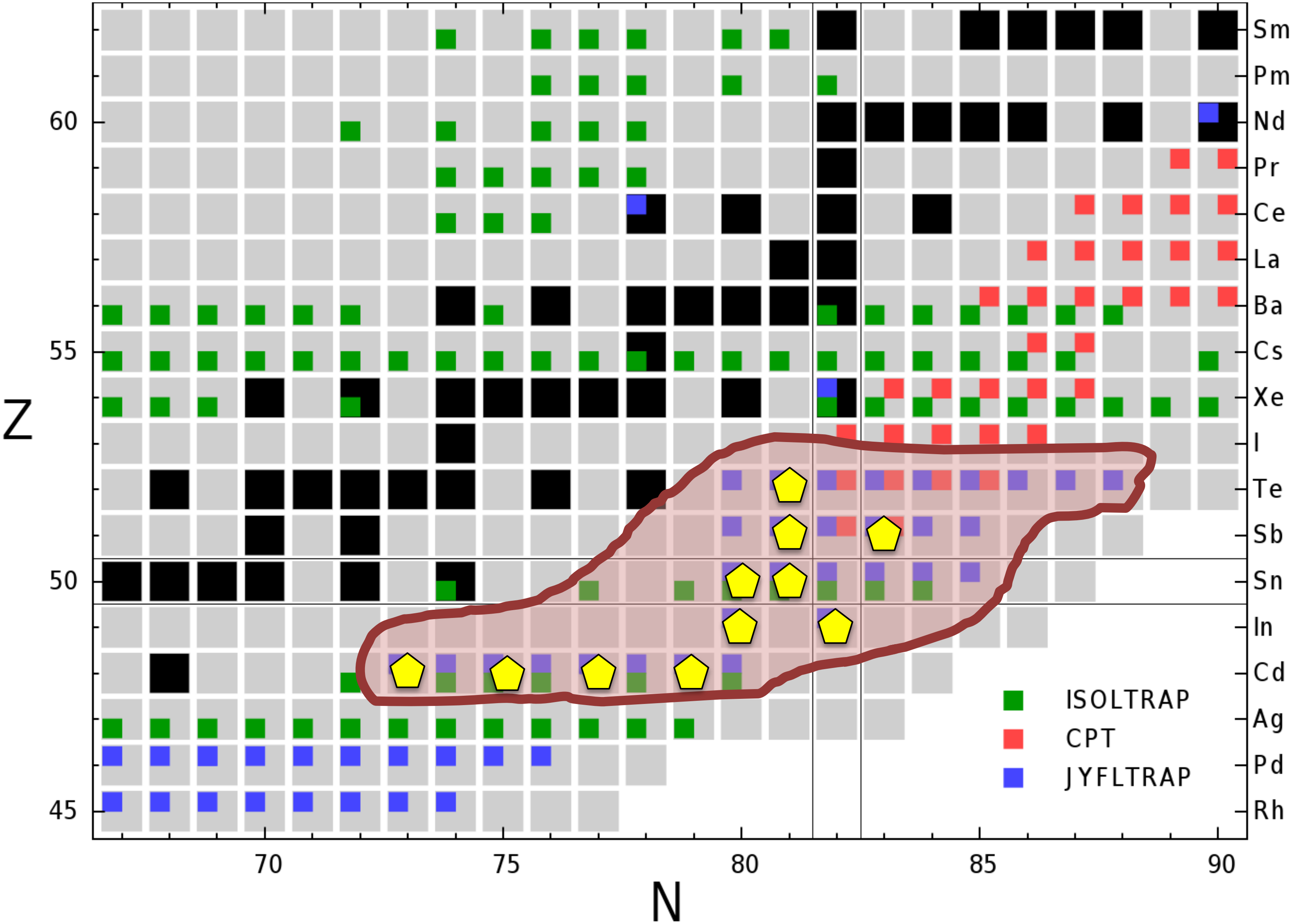
TITAN 2012
ISOLTRAP 2010

Recent JYFLTRAP measurements at ^{132}Sn region

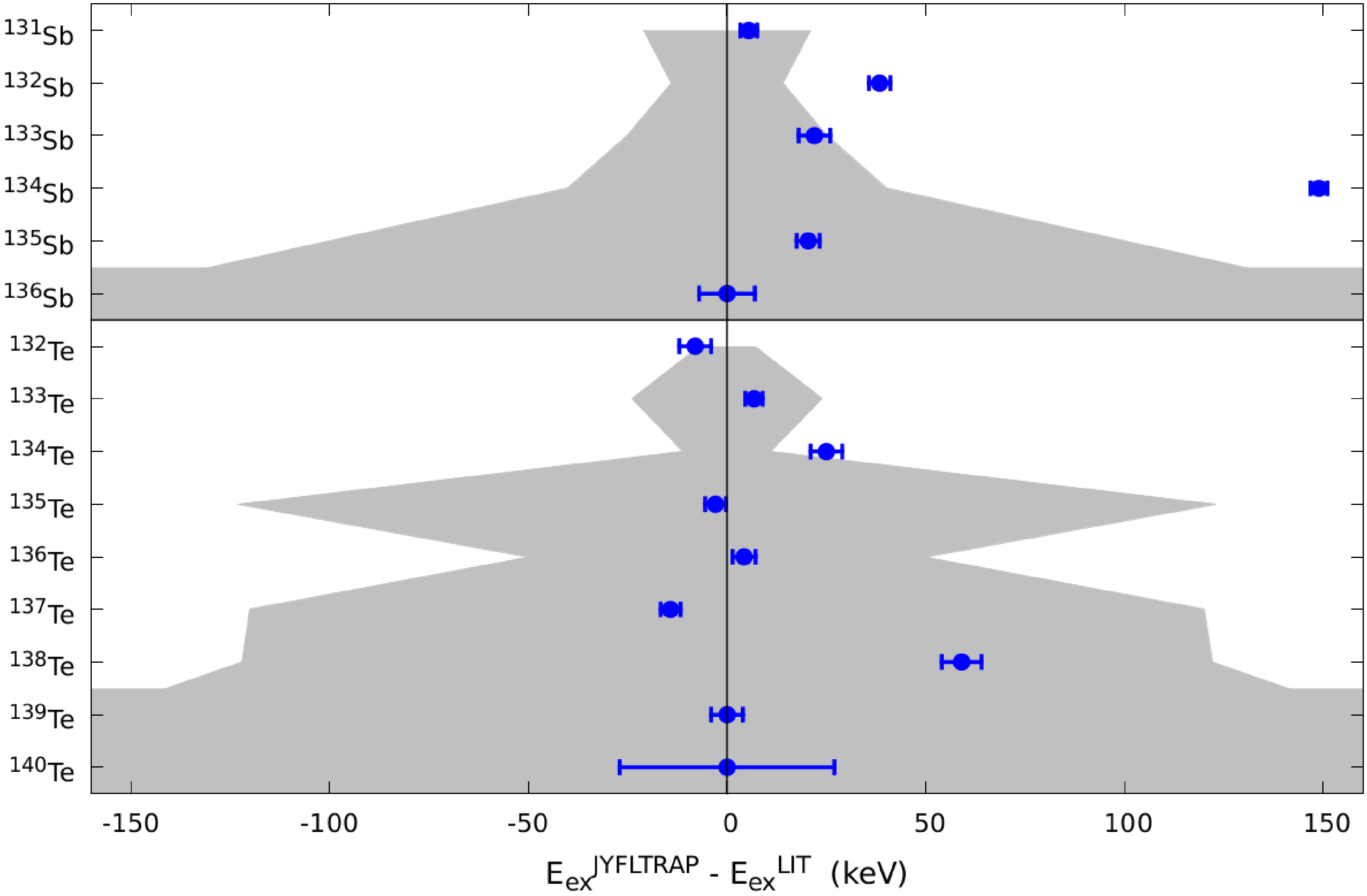


Isomeric states

$T_{1/2} > 100$ ms



Results Sb - Te



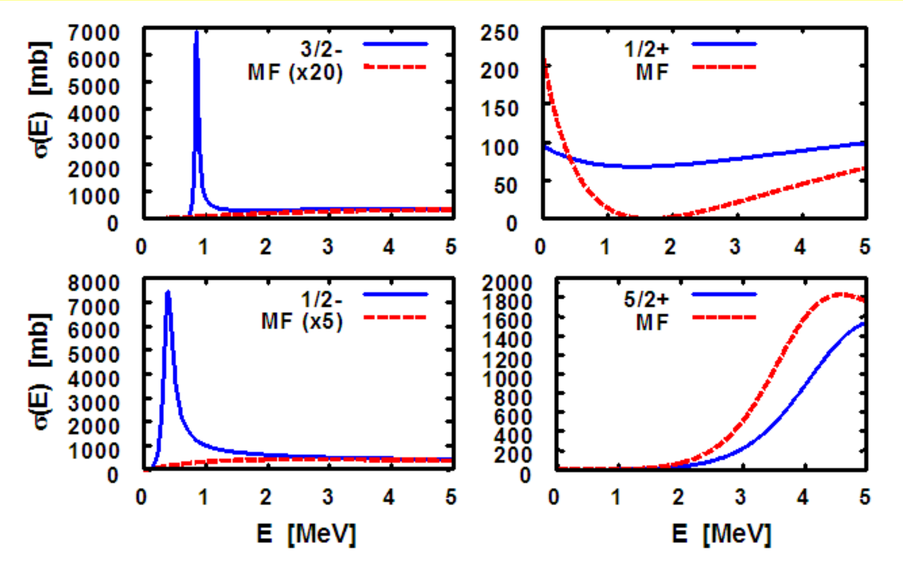
Summary

- Masses beyond ^{132}Sn measured
- Down to ≈100 ms half-life, 10 keV accuracy
- Isomers resolved & removed
- Our focus was nuclear structure
- Nuclear astrophysicists: *Bon appetit!*
  - Ground state masses are in AME2012
    - J. Hakala, J. Dobaczewski et al., PRL **109**, 032501 (2012)
  - Isomers - A. Kankainen et al., PRC **87**, 024307 (2013)
    - Role of the isomers in the r-process?

Continuum Dynamics in Exotic Nuclei

H. Lenske
Institut für Theoretische Physik
U. Giessen

Single Particle Continuum Spectral Strength

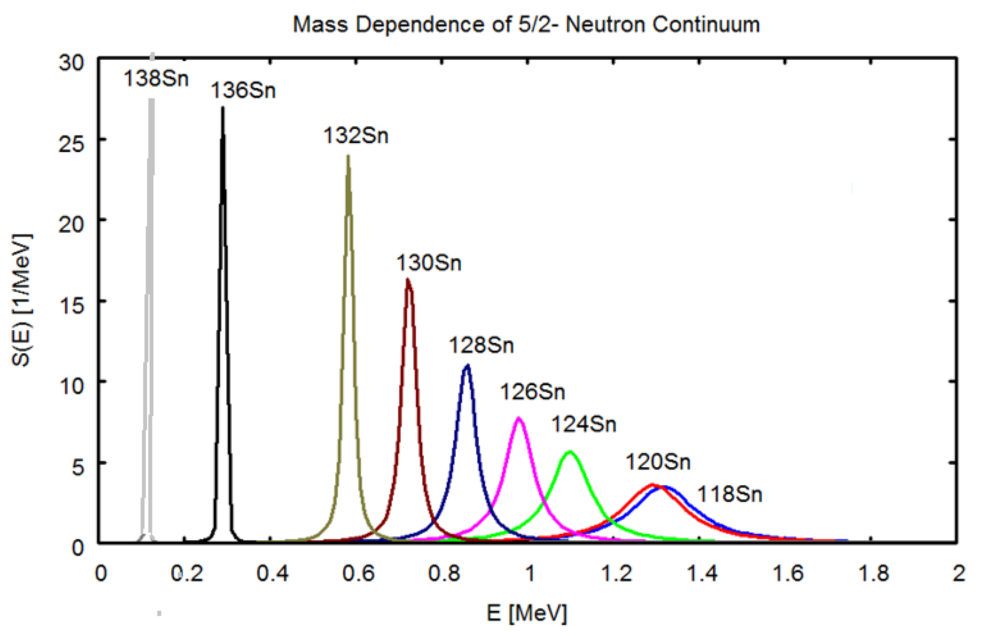


$$\begin{pmatrix} T_q + U_q - 2\lambda_q + e_\alpha & \Delta_q(\vec{r}) \\ -\Delta_q^\dagger(\vec{r}) & -\left(T_q + U_q - e_\alpha\right) \end{pmatrix} \begin{pmatrix} u_{\alpha q}(\vec{r}) \\ v_{\alpha q}(\vec{r}) \end{pmatrix} = 0$$

S. Orrigo, H.L., PLB 677 (2009) &
ISOLDE newsletter Spring 2010, p.5

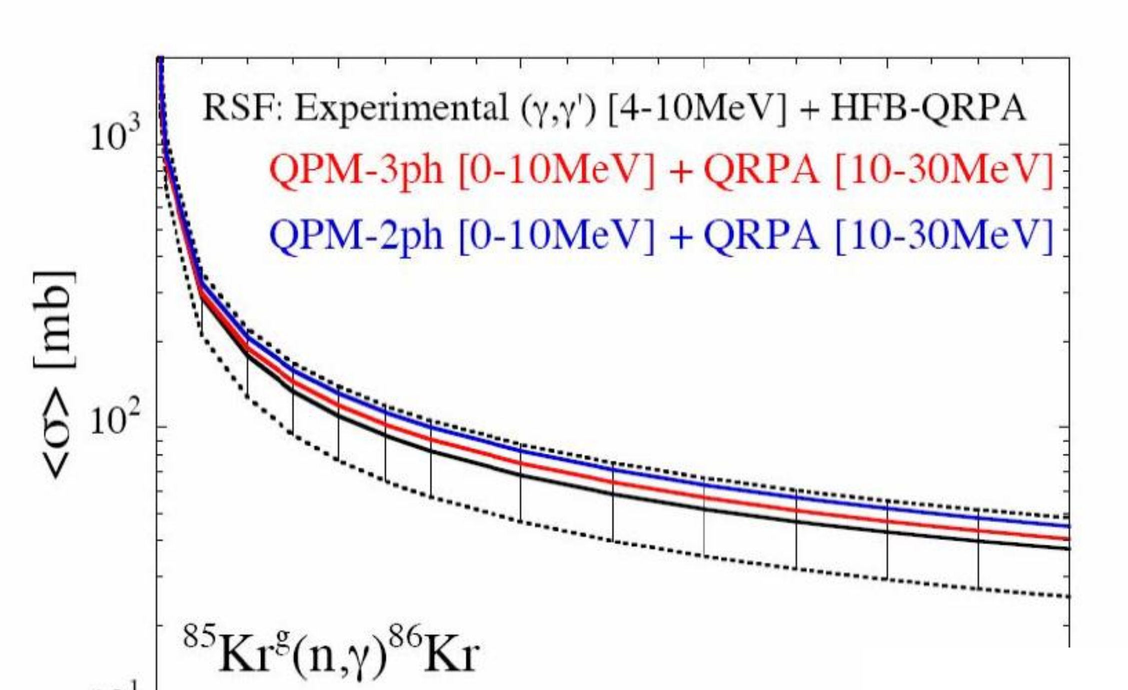
$$S_{j\ell}(E) = \frac{1}{\pi}\frac{d\delta_{j\ell}}{dE}$$

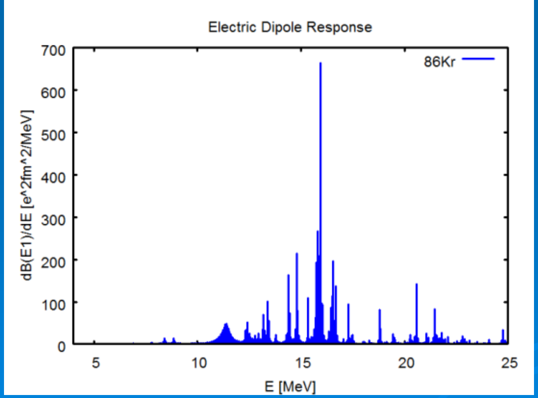
N. Tsoneva, H.L., Phys. Lett. B695,
174180 (2011).



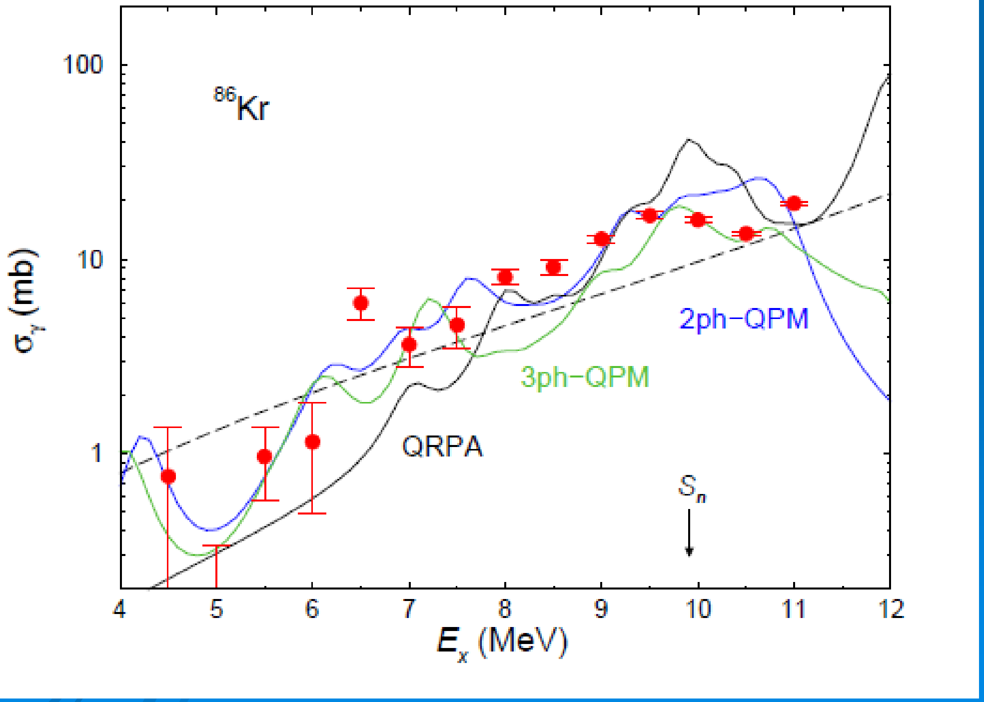
Astrophysical capture cross sections by HFB-QPM Theory

S. Goriely, N. Tsoneva et al., in prep.





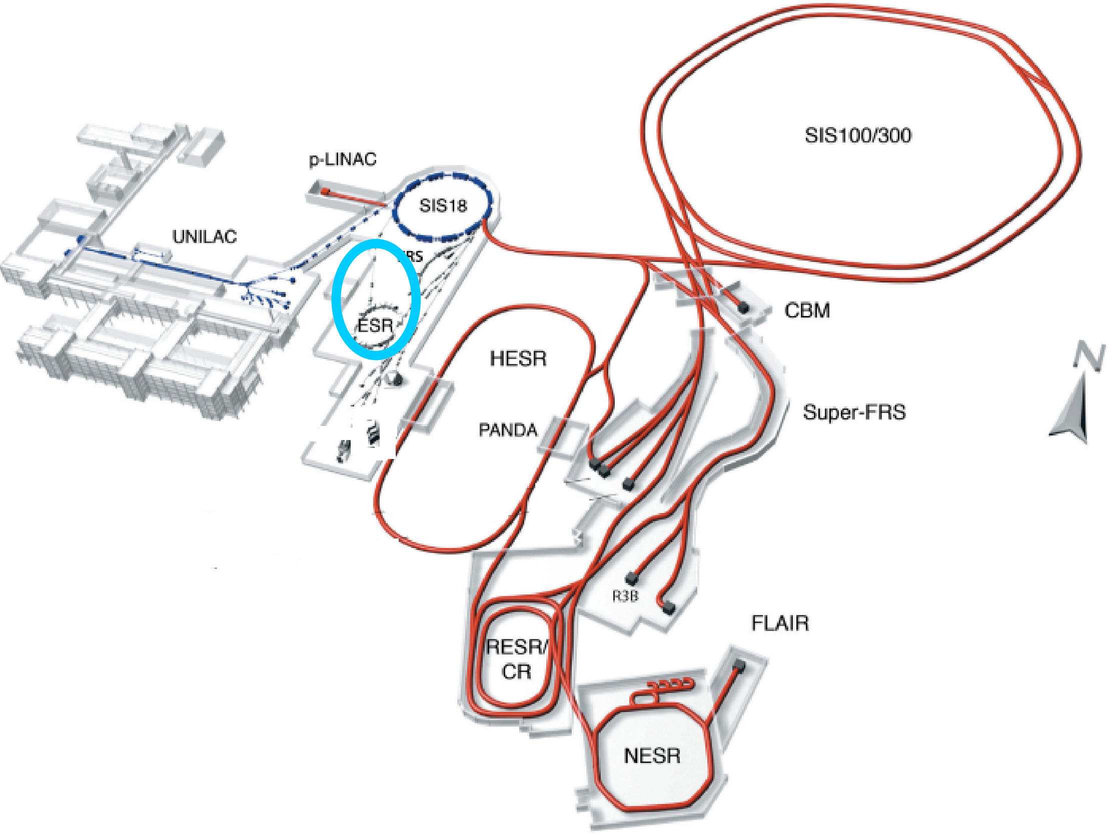
R. Schwengner, N. Tsoneva et al., PRC 87:024306 (2013)

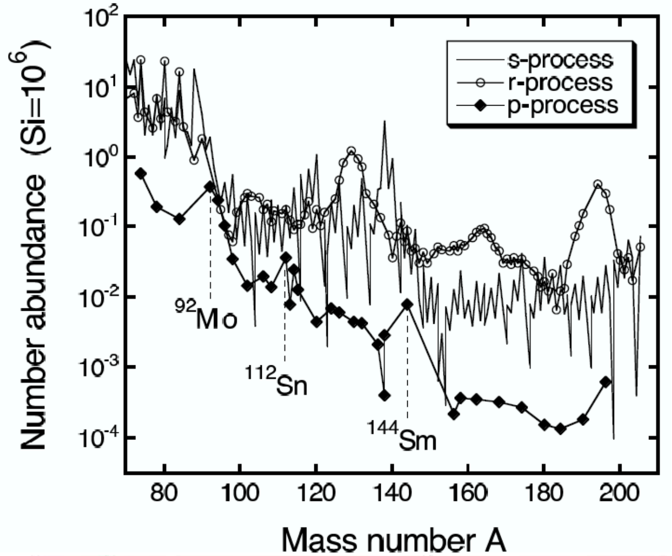


Measurements of proton induced reaction rates for p-process at ESR

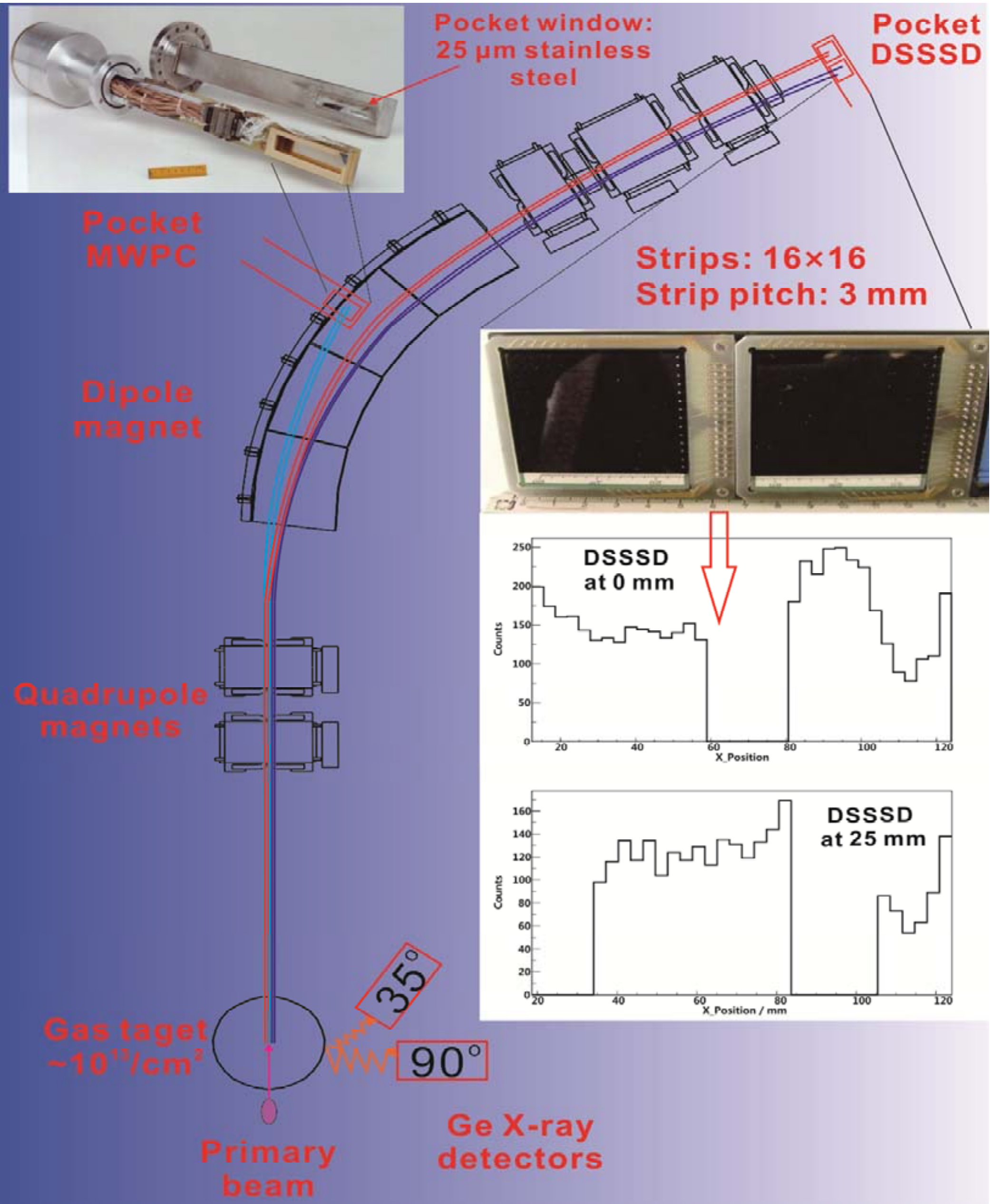
Bo Mei
G. Rastrepina, R. Reifarth, M. Heil, and E062 collaboration

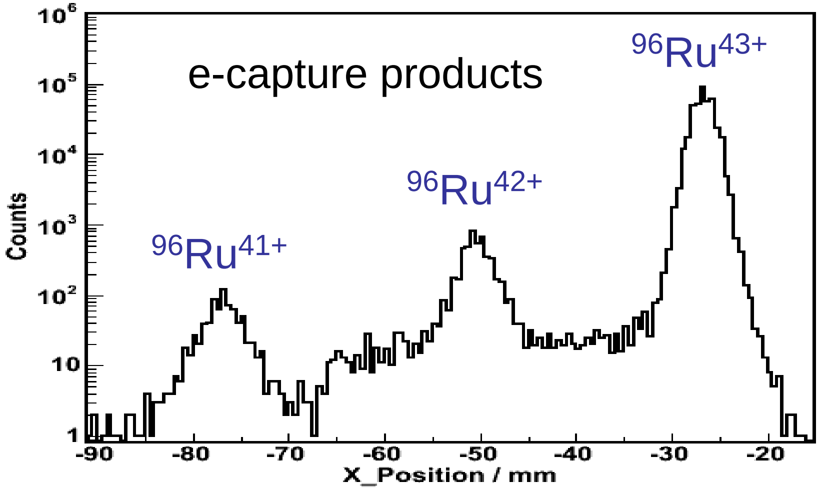
GSI / Frankfurt University

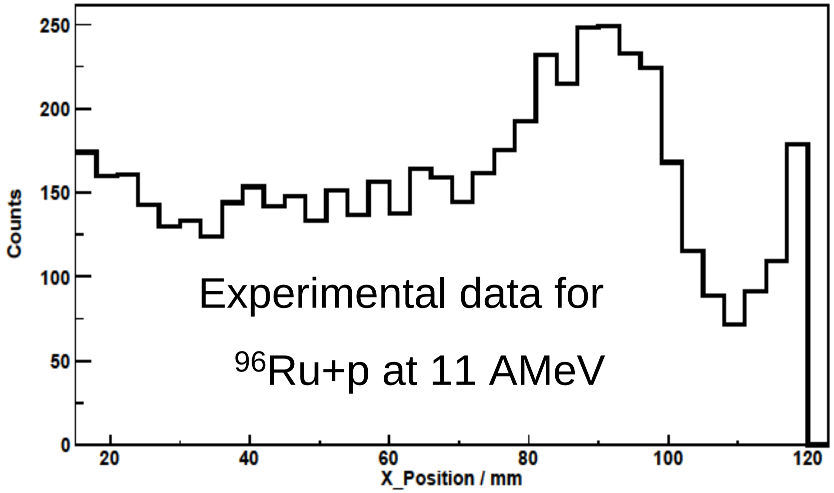




^{96}Ru(p,γ) reaction measurement

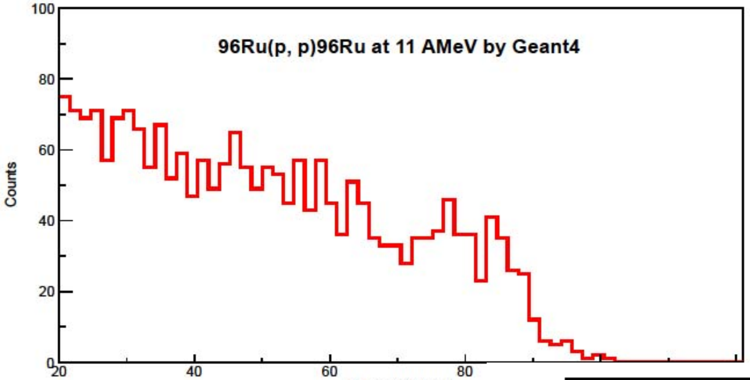


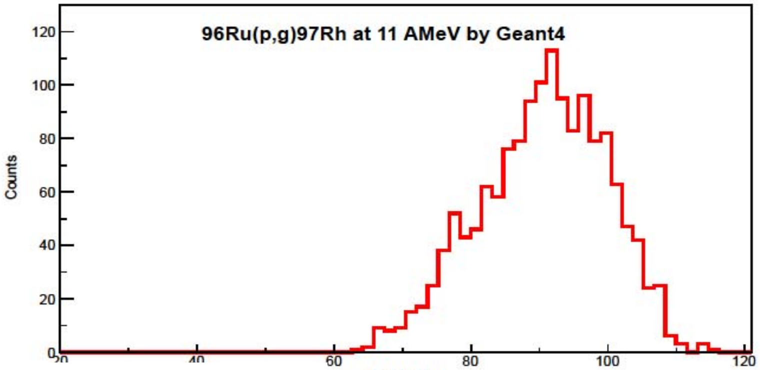

e-capture products


Experimental data for

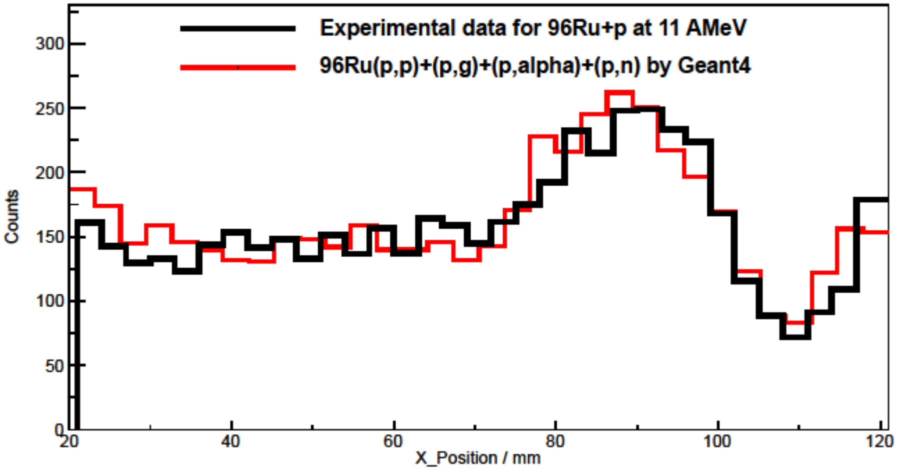
^{96}Ru+p at 11 AMeV

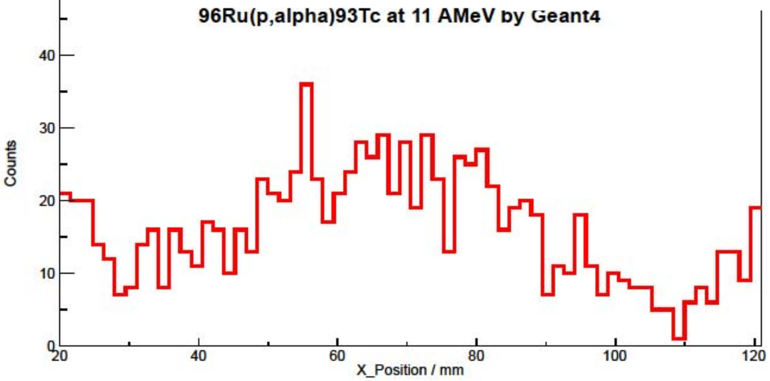
Data Analysis by Geant4 simulation

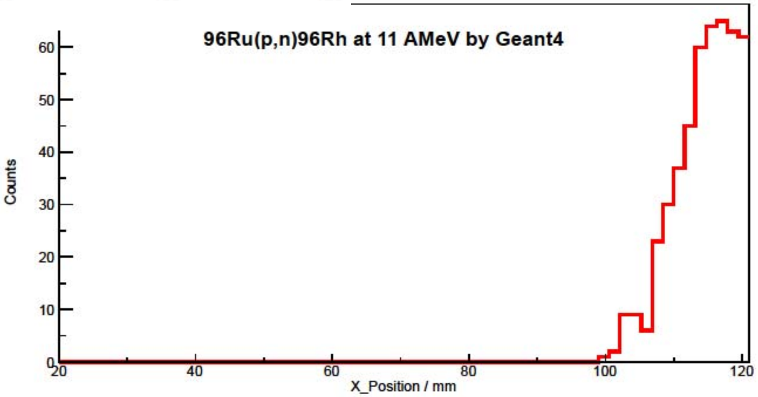


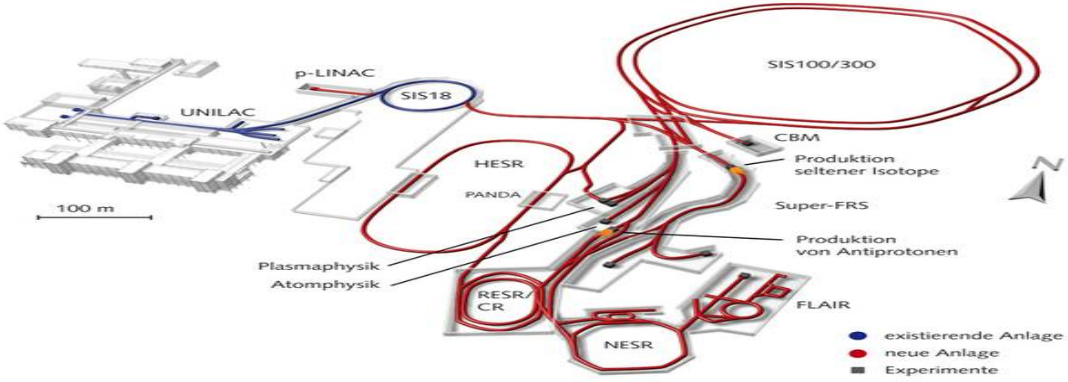


Preliminary result at 11 AMeV : (p, γ) cross section 3.5±0.8 mbarn, agree with NON-SMOKER

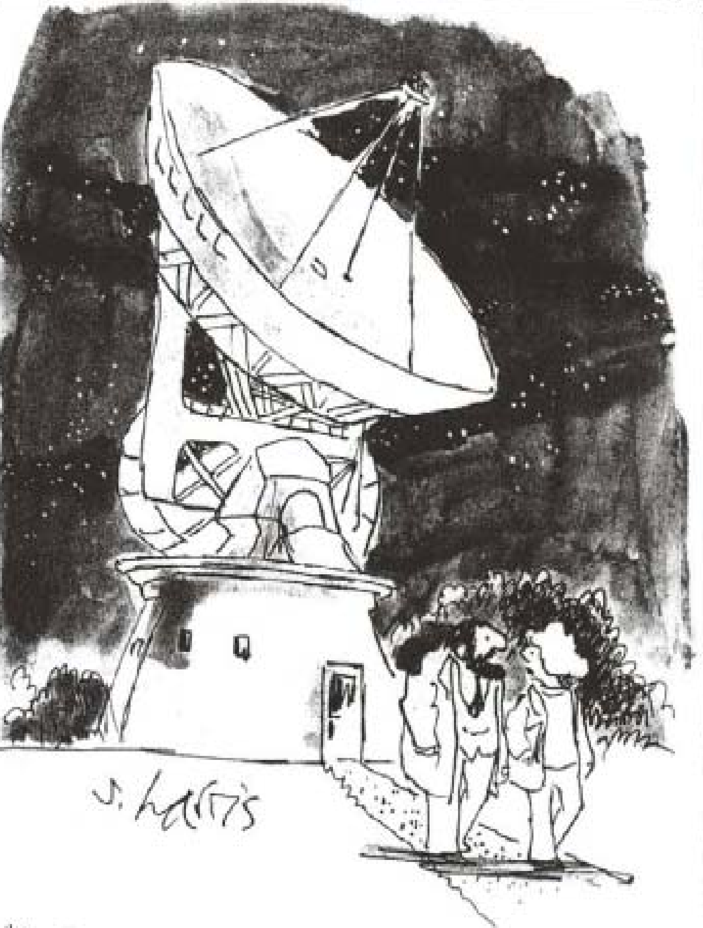








Experimental data from both nuclear physics and astrophysics.



"I'LL BE WORKING ON THE LARGEST AND SMALLEST OBJECTS IN THE UNIVERSE —SUPERCLUSTERS AND NUCLEONS. I'D LIKE YOU TO HANDLE EVERYTHING IN BETWEEN."

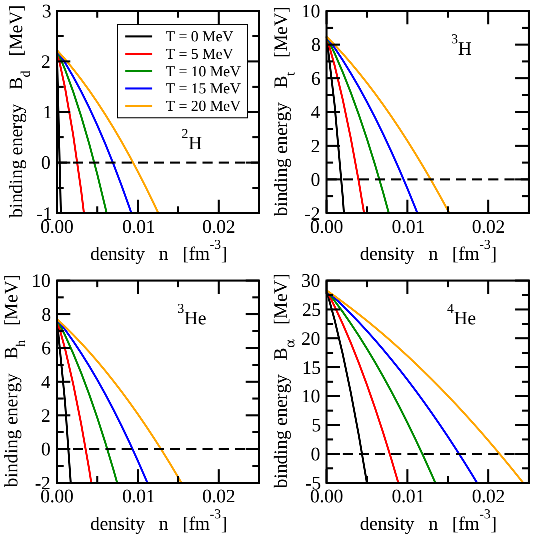
Thanks for y0ur attention!

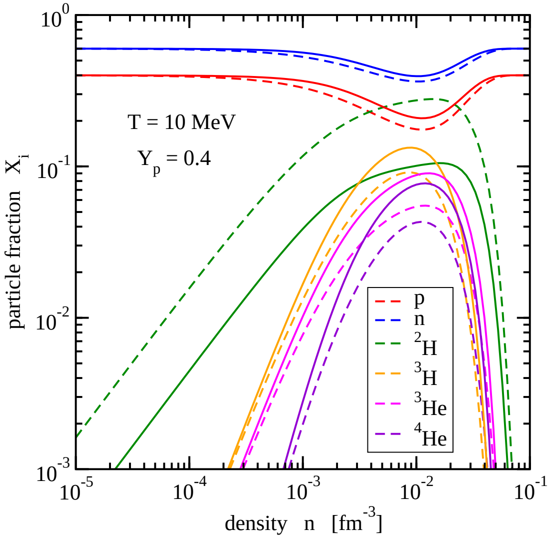
Binding Energies of Nuclei in Dense Stellar Matter

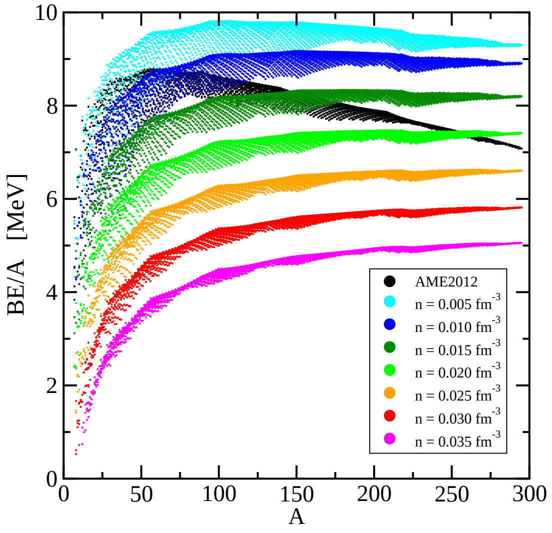
S. Typel[1], G. Röpke[2], T. Klähn[3], D. Blaschke[3], H.H. Wolter[4], M.D. Voskresenskaya[1]

[1]GSI Darmstadt, [2]Universität Rostock, [3]Uniwersytet Wrocławski, [4]LMU München

- modification of nuclear binding energies in the medium: two main effects
  - ◦ screening of Coulomb potential by electron background
    - ⇒ increase of binding energies (high-Z nuclei!)
  - ◦ blocking of states due to Pauli principle
    - ⇒ reduction of binding energies, dissolution of nuclei, change of chemical composition
- theoretical formulation: generalized relativistic density functional
  - ⇒ global equation of state of stellar matter for astrophysical applications



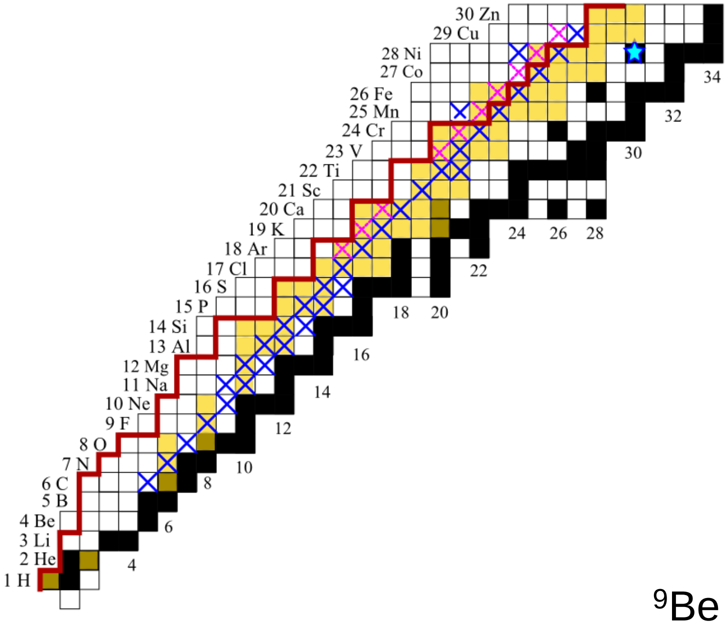




Direct mass measurements of ^{58}Ni projectile fragments at CSRe

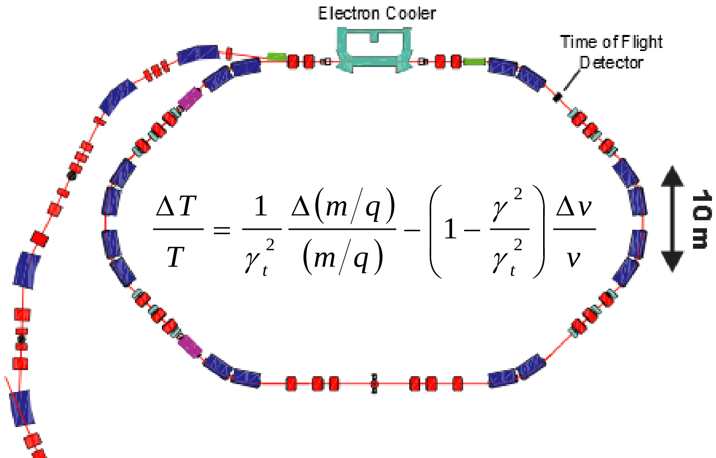
Poster presented by Xinliang Yan
Institute of Modern Physics, Chinese Academy of Sciences; Graduate University of the Chinese Academy of Sciences;
Max-Planck Institute for Nuclear Physics; GSI Helmholtzzentrum für Schwerionenforschung GmbH

★ ^{58}Ni Primary beam

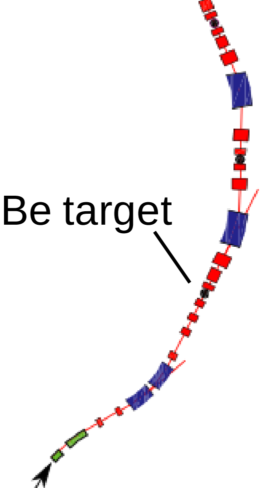


▬ Border of previously known masses [AME'11]

🟨 Rapid proton capture Nuclear synthesis path

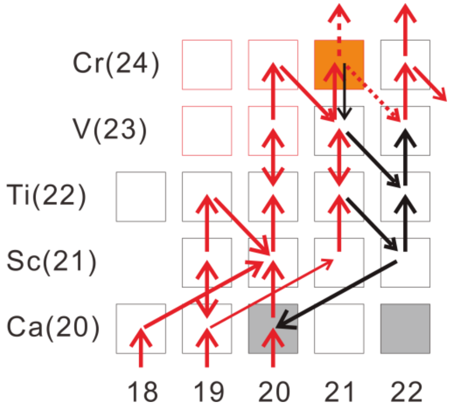


$$\frac{\Delta T}{T} = \frac{1}{\gamma_t^2}\frac{\Delta(m/q)}{(m/q)} - \left(1-\frac{\gamma^2}{\gamma_t^2}\right)\frac{\Delta v}{v}$$



^{9}Be target

463.36MeV/u ^{58}Ni;
~10^8/spill, every 24s



Ca-Sc cycle in X-ray burst

The role of nuclear masses in r-process nucleosynthesis

Joel Mendoza-Temis
TU-Darmstadt

Nuclear Physics input

- neutron capture and fotodissociation rates (from statistical model) for nuclei ranging from Zn to Bi.
- Mass models:

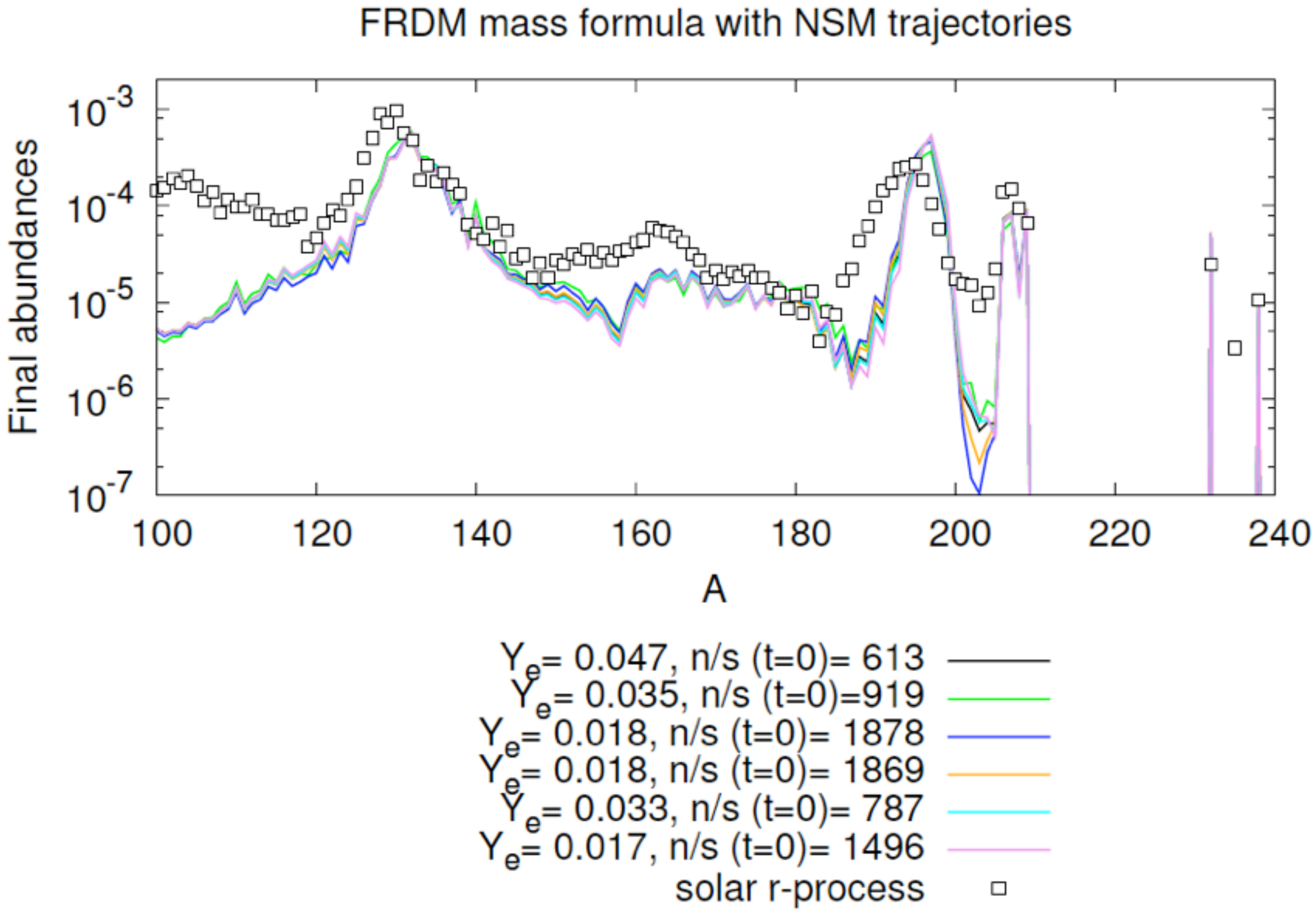
  DZ31

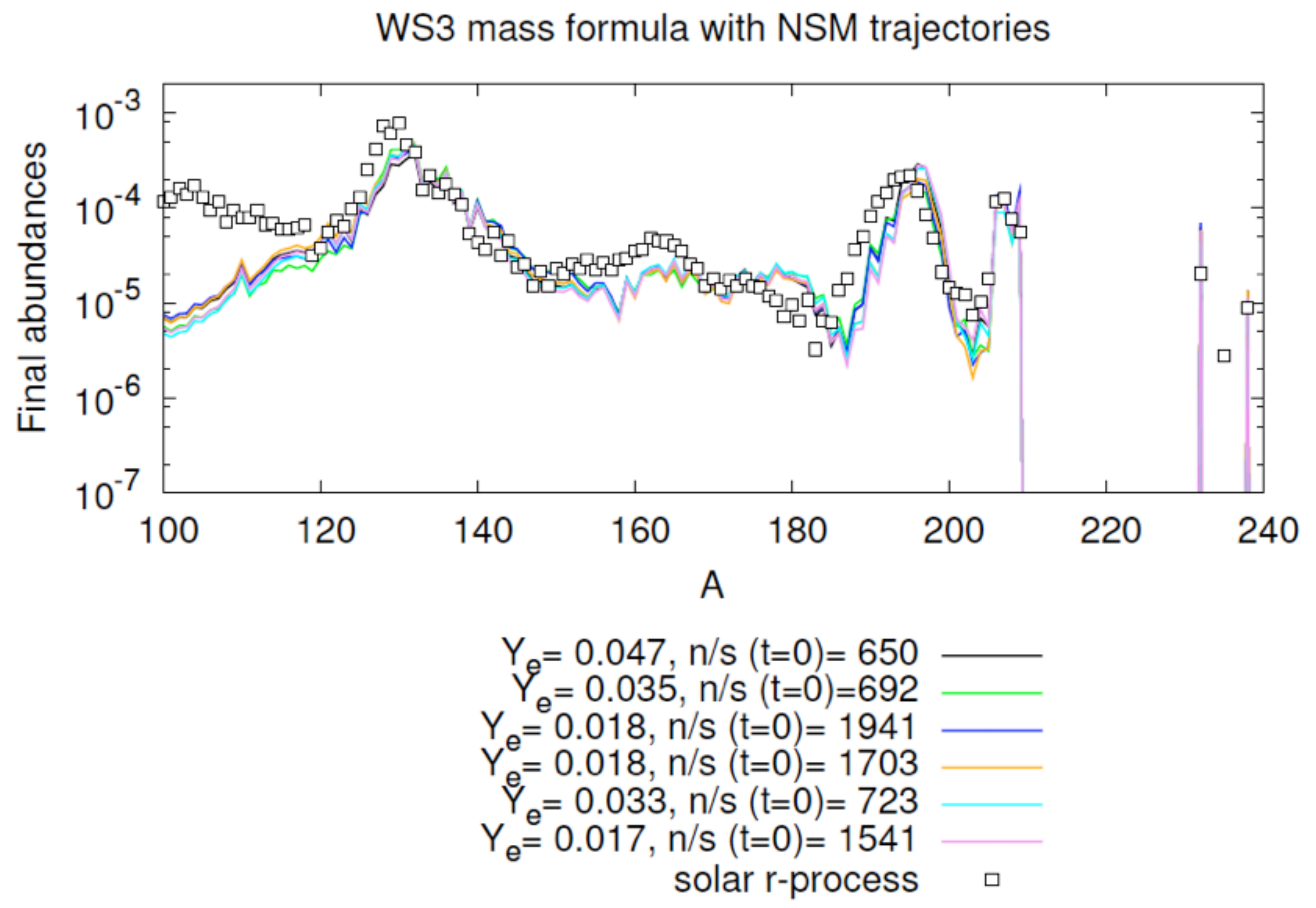
  DZ10

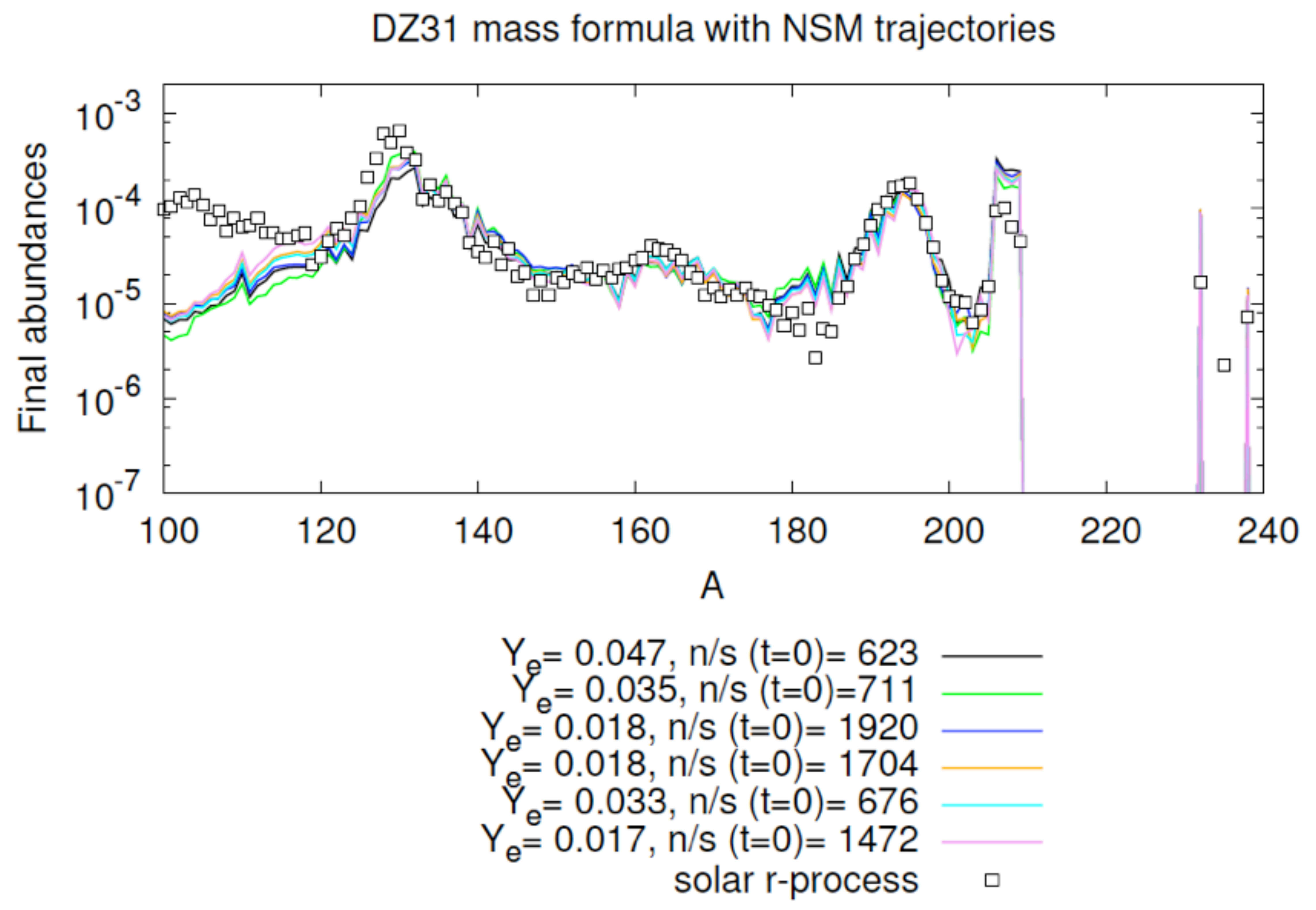
  WS3
- HFB21 (Talys code)

Astrophysical sites

- Neutrino driven wind from CCSNe
- Neutron Star Mergers


FRDM mass formula with NSM trajectories
Final abundances
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
100
120
140
160
180
200
220
240
A
Y_e= 0.047, n/s (t=0)= 613
Y_e= 0.035, n/s (t=0)=919
Y_e= 0.018, n/s (t=0)= 1878
Y_e= 0.018, n/s (t=0)= 1869
Y_e= 0.033, n/s (t=0)= 787
Y_e= 0.017, n/s (t=0)= 1496
solar r-process


WS3 mass formula with NSM trajectories
Final abundances
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
100
120
140
160
180
200
220
240
A
Y_e= 0.047, n/s (t=0)= 650
Y_e= 0.035, n/s (t=0)=692
Y_e= 0.018, n/s (t=0)= 1941
Y_e= 0.018, n/s (t=0)= 1703
Y_e= 0.033, n/s (t=0)= 723
Y_e= 0.017, n/s (t=0)= 1541
solar r-process □


DZ31 mass formula with NSM trajectories
Final abundances
10^{-3}
10^{-4}
10^{-5}
10^{-6}
10^{-7}
100
120
140
160
180
200
220
240
A
Y_e= 0.047, n/s (t=0)= 623
Y_e= 0.035, n/s (t=0)=711
Y_e= 0.018, n/s (t=0)= 1920
Y_e= 0.018, n/s (t=0)= 1704
Y_e= 0.033, n/s (t=0)= 676
Y_e= 0.017, n/s (t=0)= 1472
solar r-process