EuNPC Master Class, 2015

"Basics of Precision Nuclear and Atomic Mass Measurements for Fundamental Studies – Part 3"

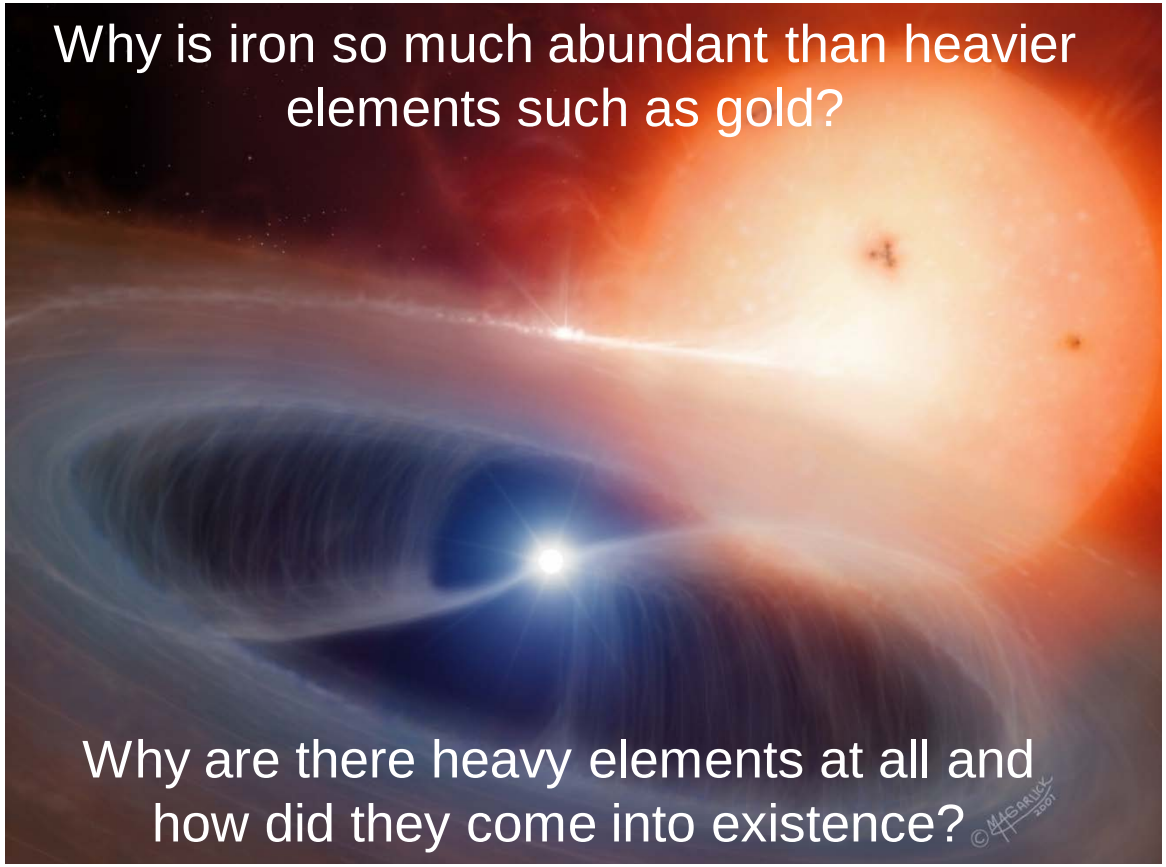
Klaus Blaum

30th Aug 2015

Klaus.blaum@mpi-hd.mpg.de

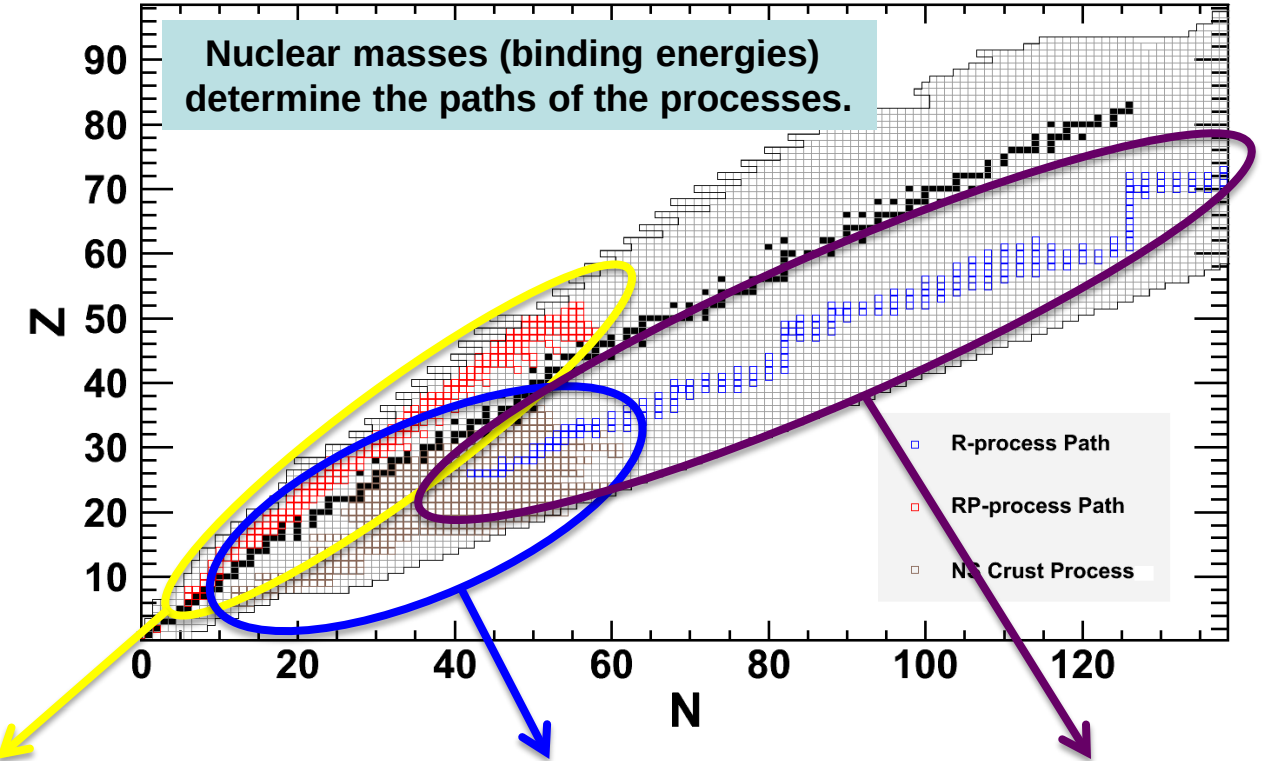
Nuclear masses for astrophysics

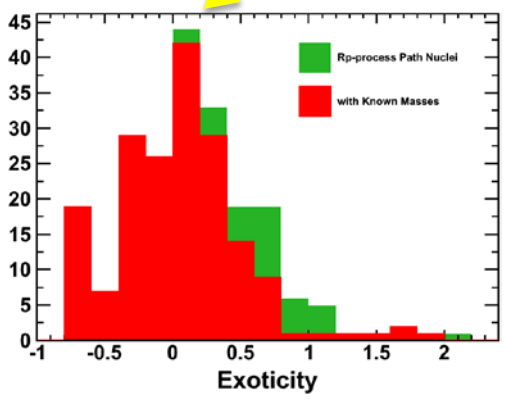
Nuclear astrophysics studies

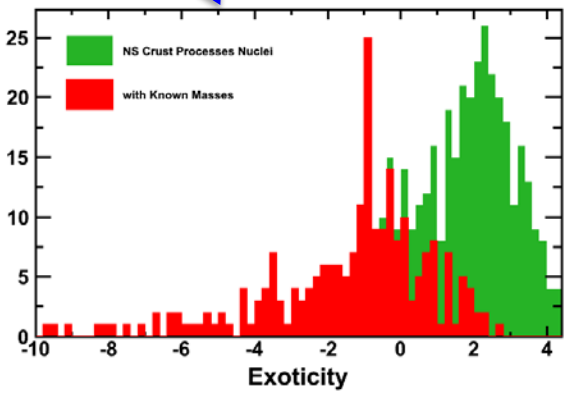


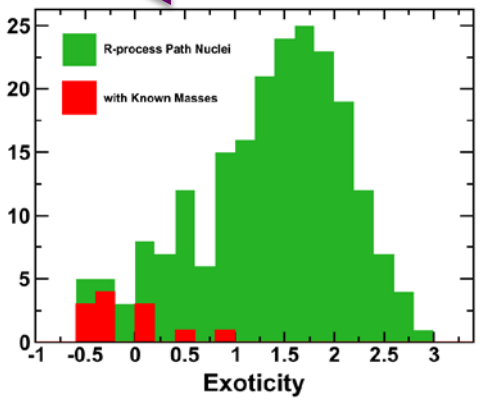
CPT, CSRe, ESR, ISOLTRAP, JYFLTRAP, LEBIT, SHIPTRAP, TITAN

Mass spectrometry for nucleosynthesis









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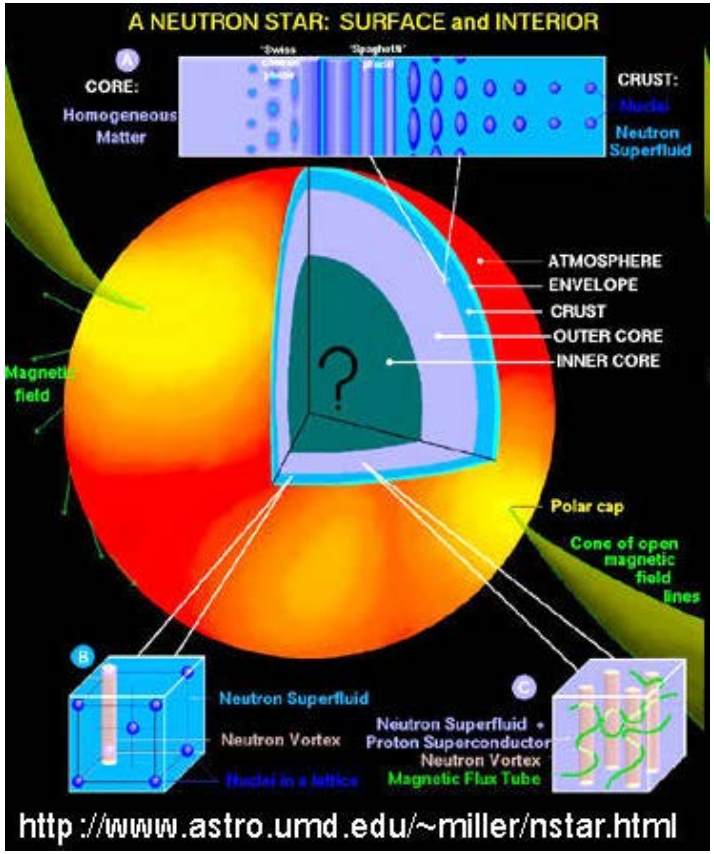
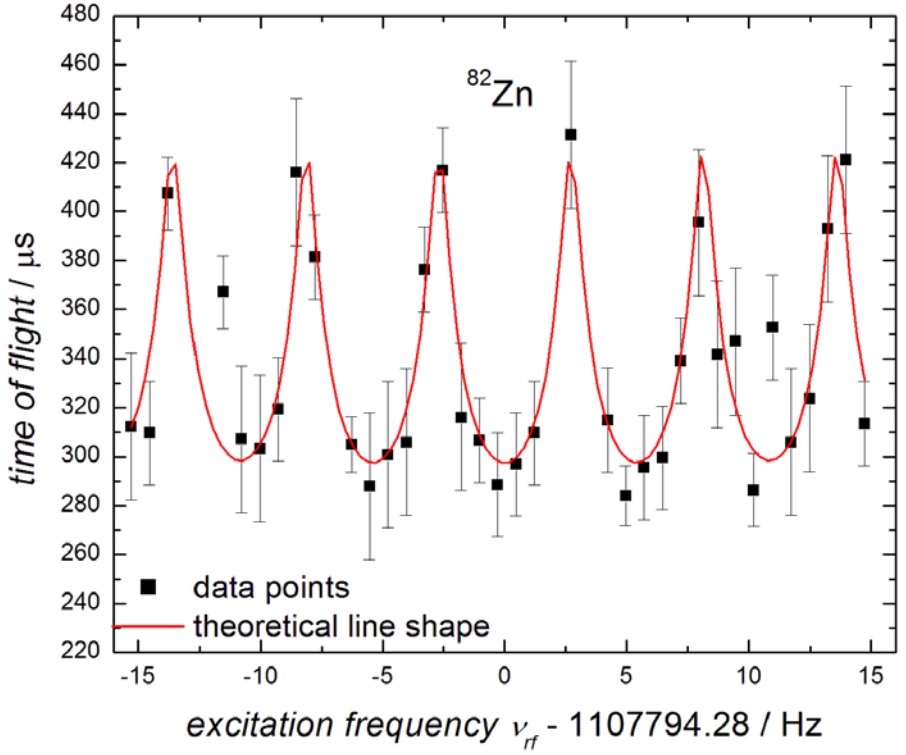
Nuclear astrophysics

Composition of the outer crust of a neutron star





80 ions in 35 minutes!
δm/m = 4•10^{-8}

R. Wolf *et al.*, Phys. Rev. Lett., 110, 041101 (2013)

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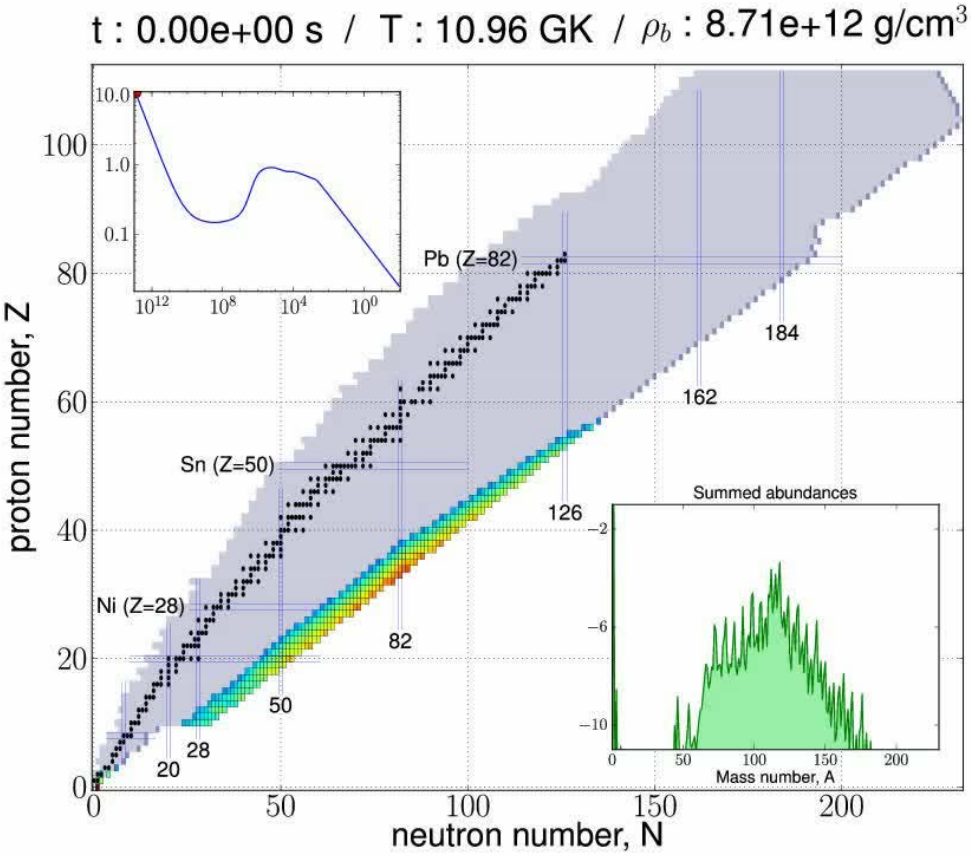
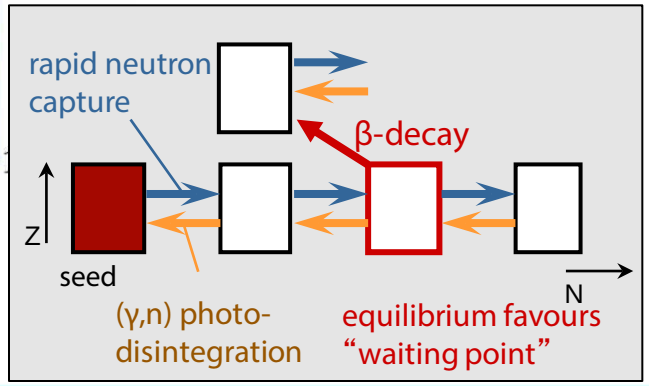
Nuclear astrophysics: r-process

Compare calculated abundance to observation



Mismatch comes from:
- n-star-merger conditions!
- Nuclear physics input not correct.

→ Need nuclear physics experiments & theory for predictions!



A. Arcones et al.,2012 MNRAS.426.1940

H. Schatz et al.

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Matter-antimatter symmetry test

Test of CPT symmetry

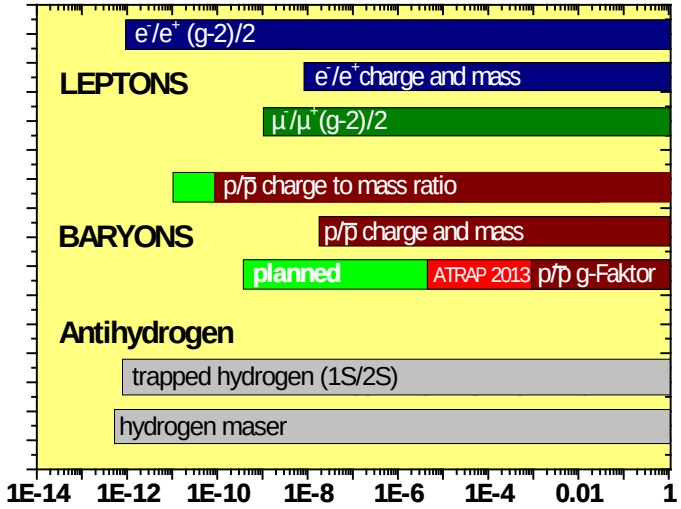
CERN, GSI, Mainz, MPIK, RIKEN

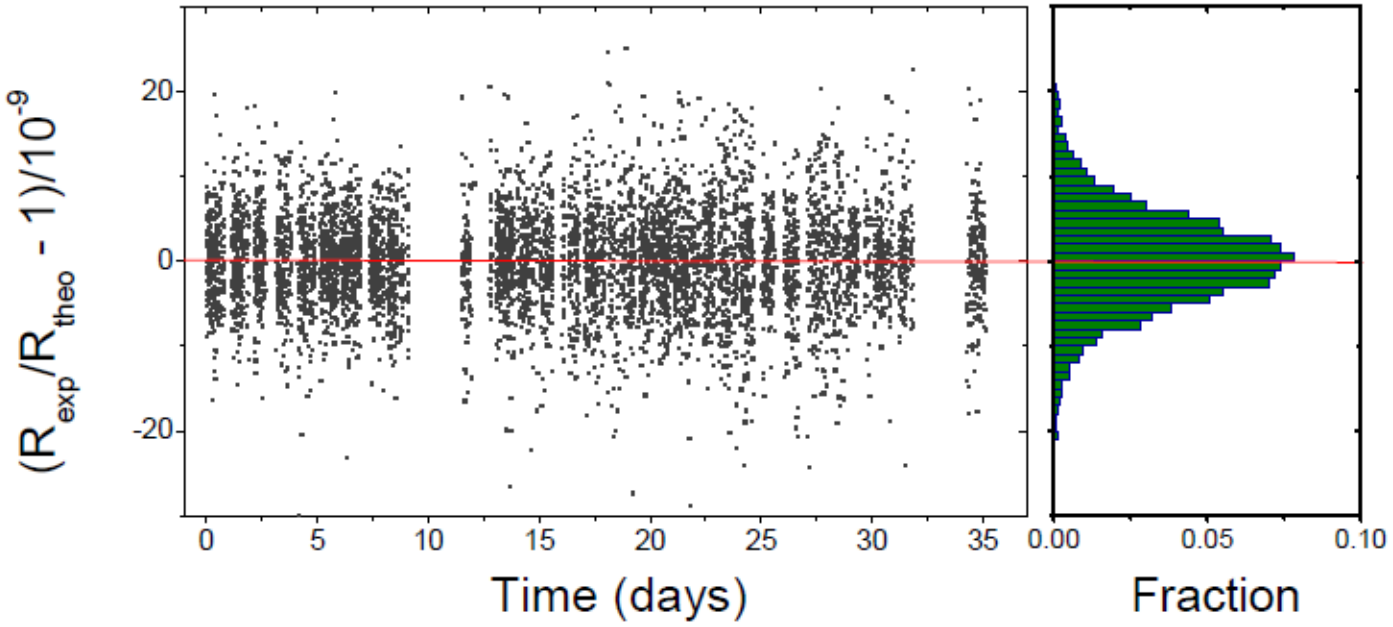
Most stringent baryonic CPT test

Compare charge-to-mass ratios *R* of p and $\bar{p}$:

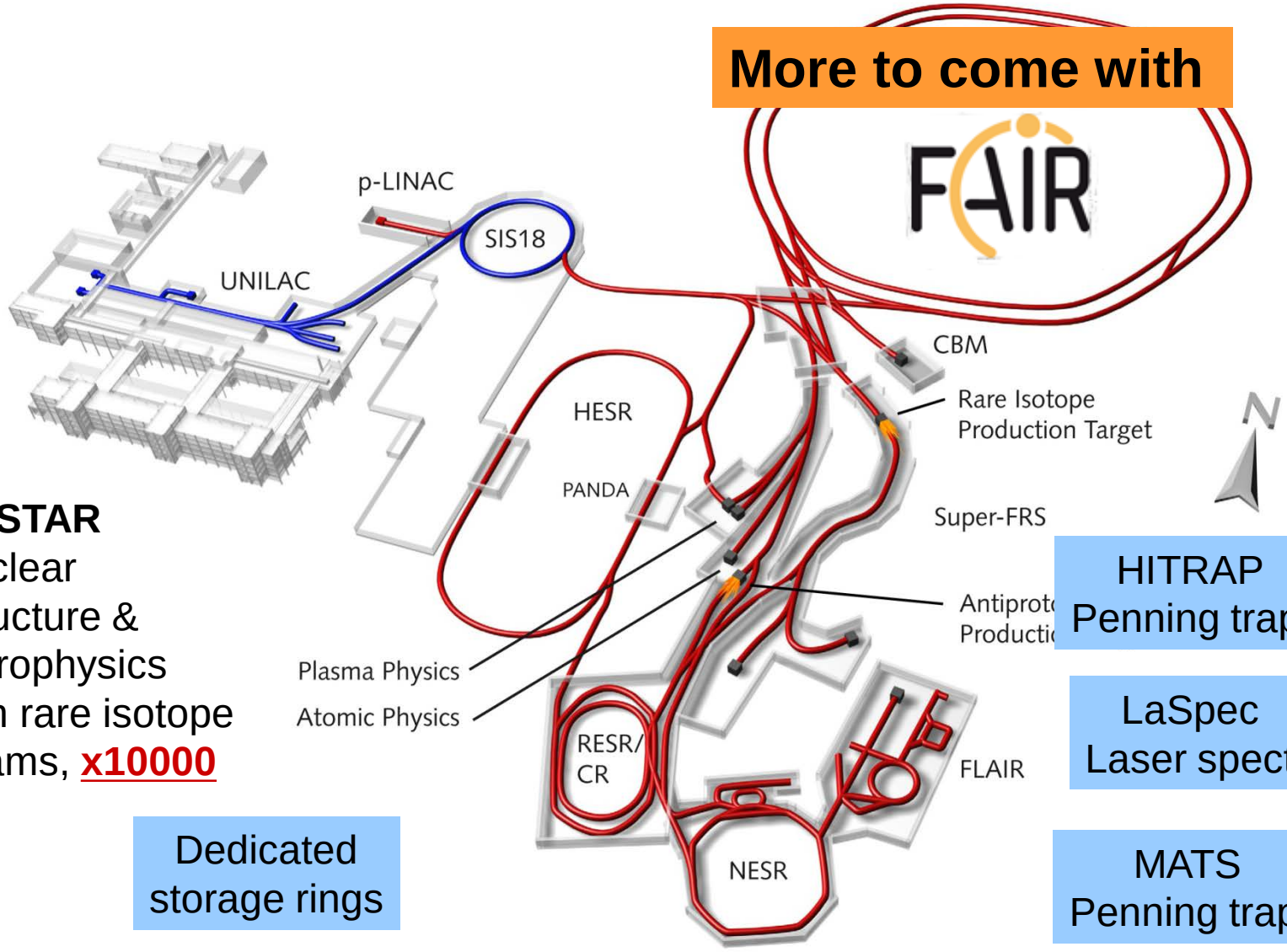
$$(qlm)_{\bar{p}} / (qlm)_p = 1.000\ 000\ 000\ 001\ (69)$$

S. Ulmer *et al*., Nature 524, 196 (2015)





Future trap/ring/laser facilities at FAIR



NUSTAR
Nuclear Structure & Astrophysics with rare isotope beams, **x10000**

HITRAP
Penning traps

LaSpec
Laser spect.

Dedicated
storage rings

MATS
Penning traps

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Summary

Precision masses provide detailed information and insights into nuclear structure properties!

- Tools: Penning traps and storage rings
- Observables: masses, binding energy, (half-lives)
- Nuclear structure / astrophysics / fund. studies:
  - Halos and separation energies
  - Magic numbers and shell evolution
  - Nucleosynthesis studies
  - Fundamental symmetry tests
  - Nuclear masses for neutrino physics

Thanks

Thanks a lot for the invitation and your attention!

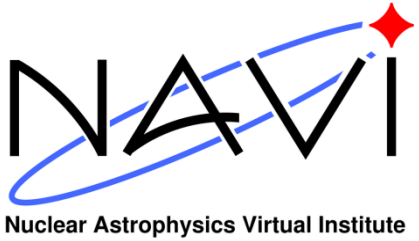
Email: klaus.blaum@mpi-hd.mpg.de

WWW: www.mpi-hd.mpg.de/blaum/

Max-Planck Society

Helmholtz Alliance (HA216)

Adv. Grant MEFUCO (#290870)



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