

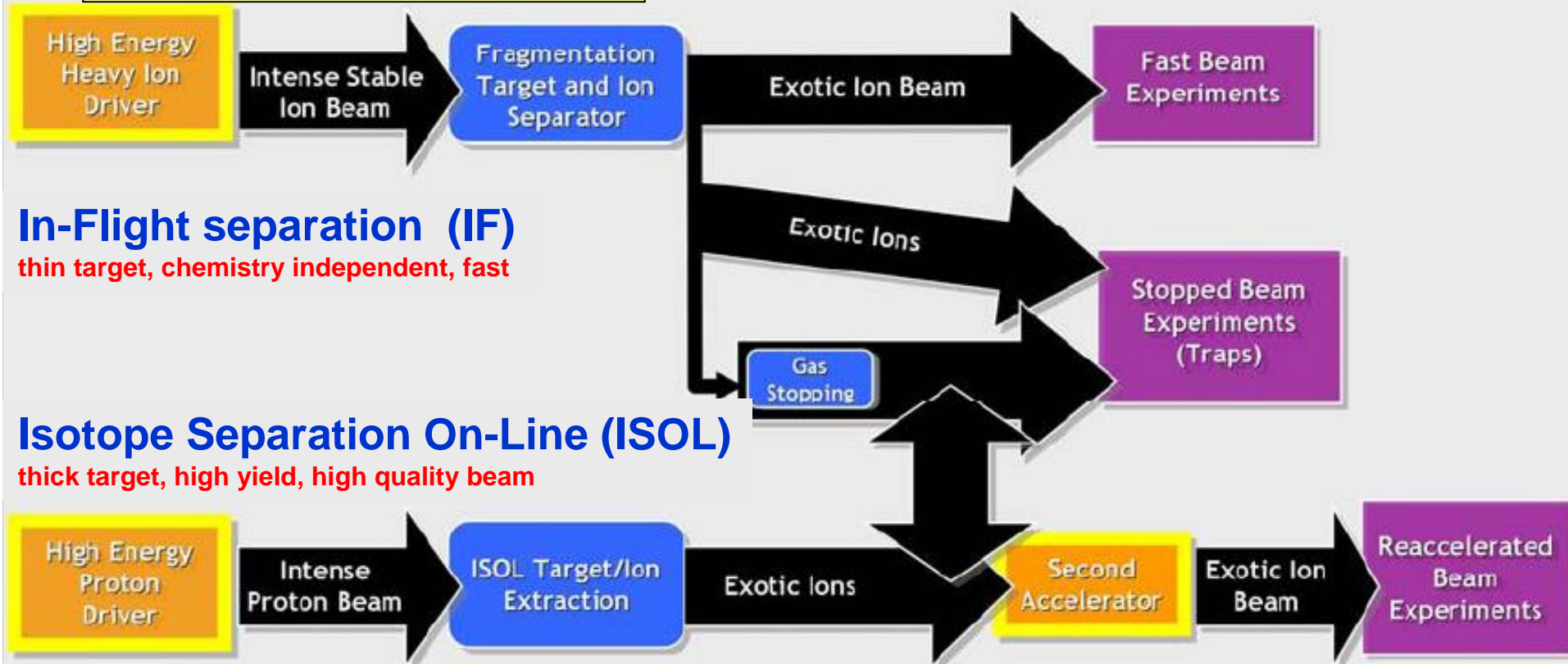
Radioactive Beams

Peter Butler



Radioactive ion production

GANIL, GSI, MSU, RIKEN
FAIR

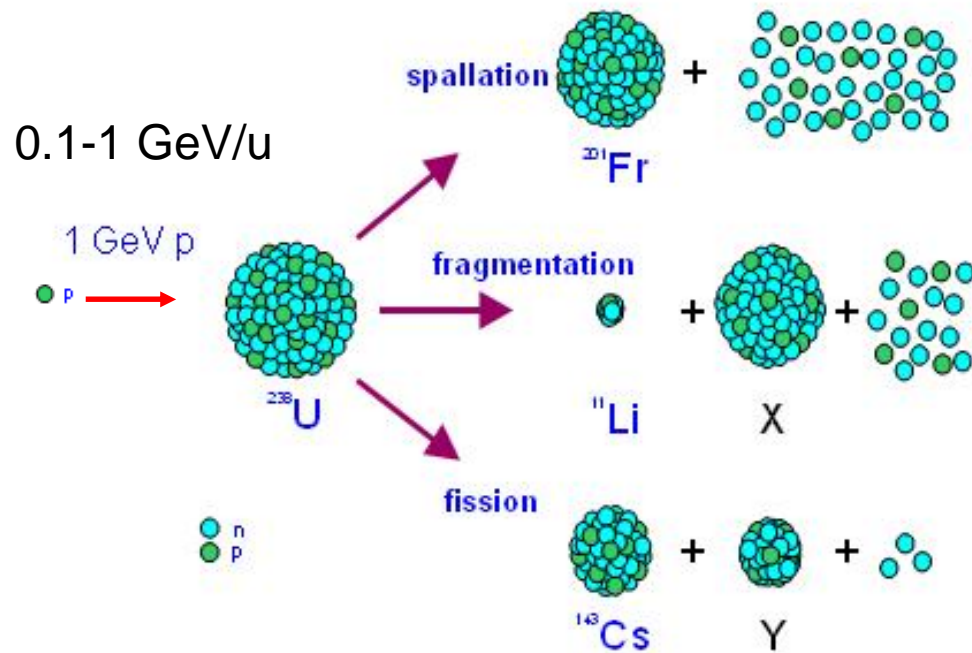


In-Flight separation (IF)
thin target, chemistry independent, fast

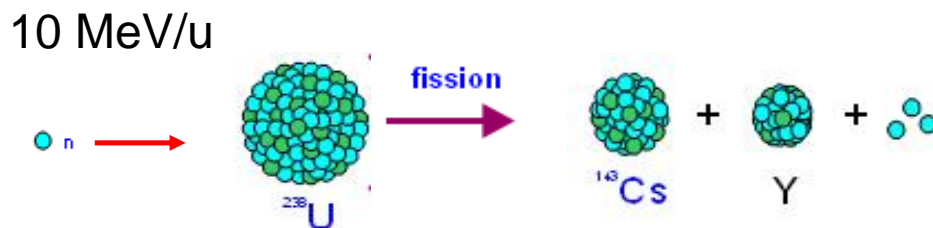
Isotope Separation On-Line (ISOL)
thick target, high yield, high quality beam

REX-ISOLDE, SPIRAL-1, HRIBF, ISAC
HIE-ISOLDE, SPIRAL-2
EURISOL, FRIB

Production of exotic ions

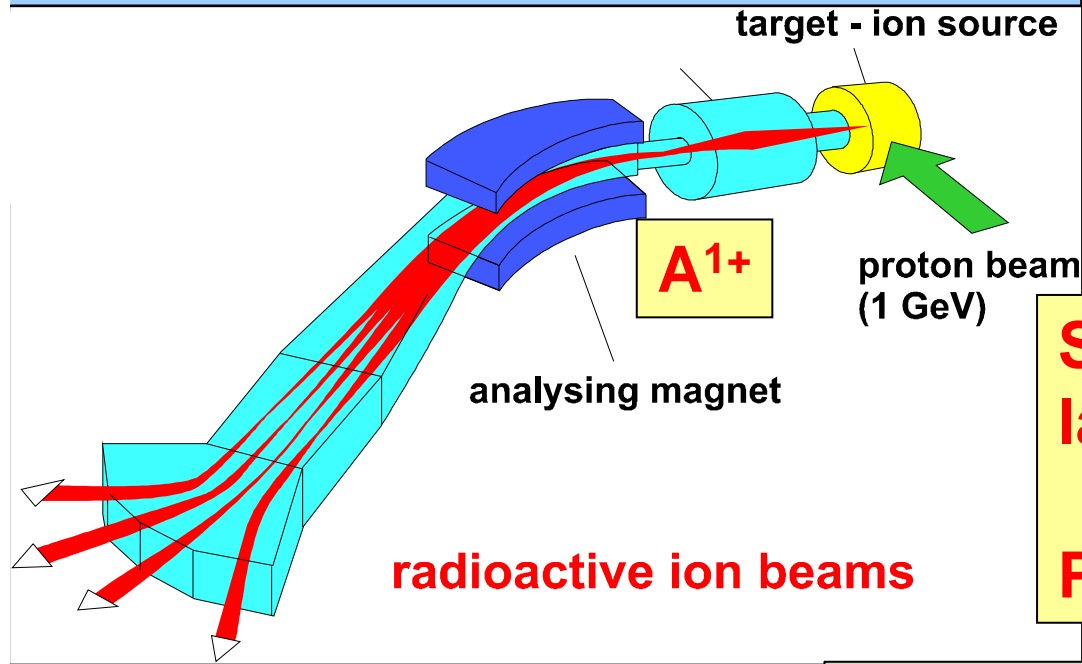


ISOLDE, SPIRAL-1, TRIUMF
GSI, RIKEN, MSU



HRIBF, SPIRAL-2

ISOL: Isotope Separation On-Line



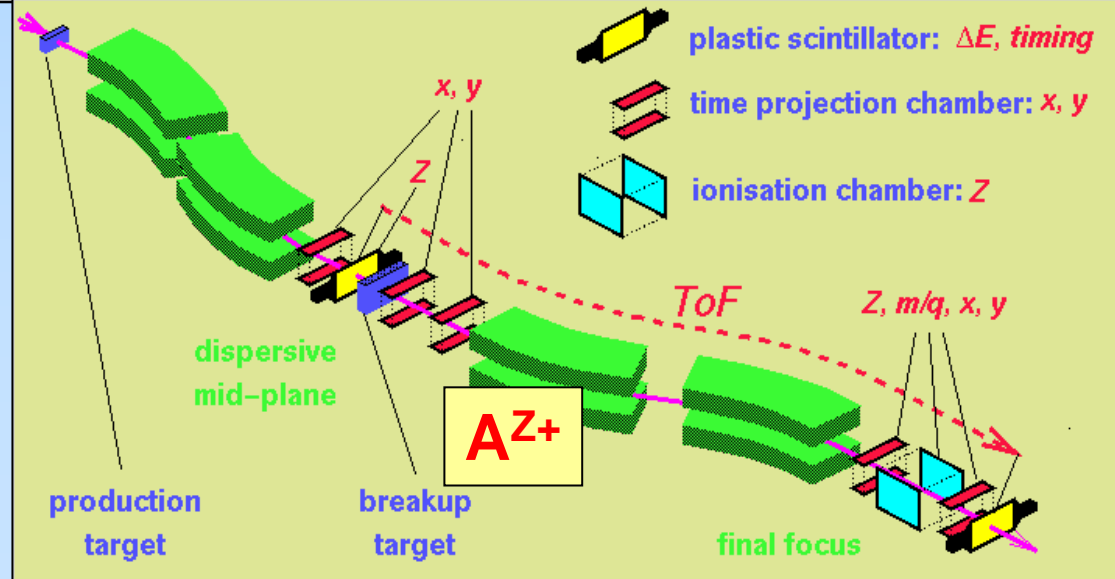
Select nucleus using M, laser ionisation, ...

Post-accelerate from 50keV

IF: In-Flight separation

Select nucleus from Z, A

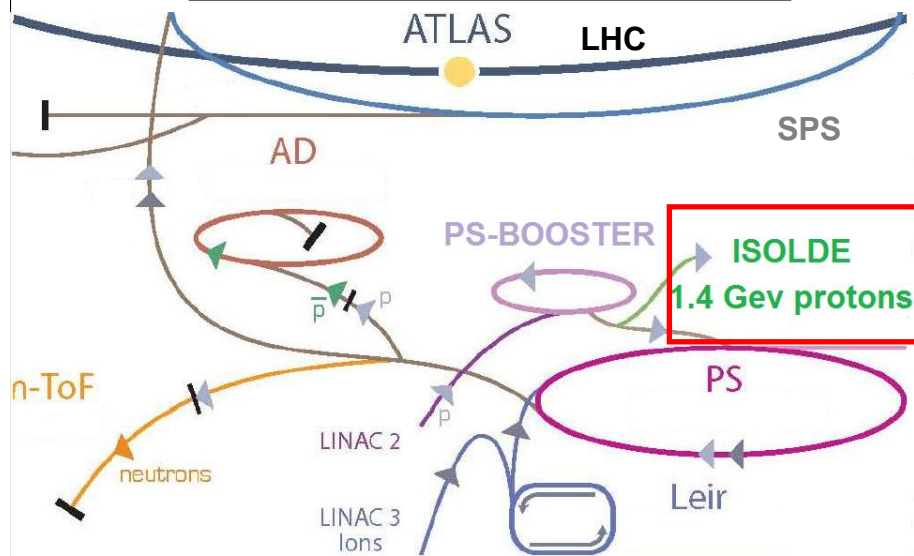
Decelerate from GeV/u



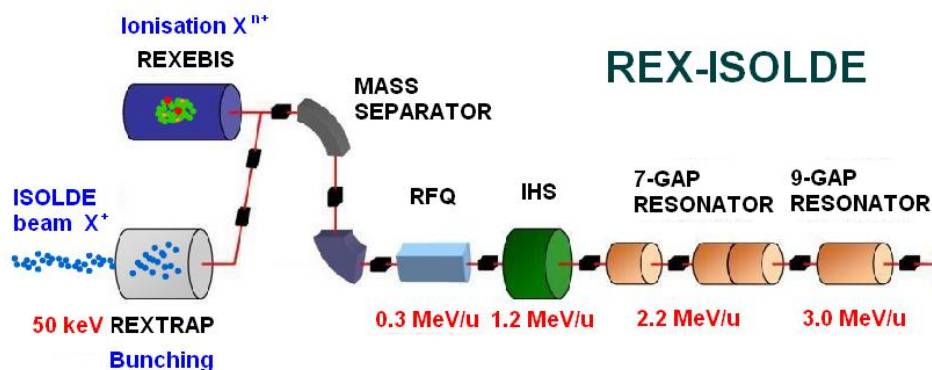
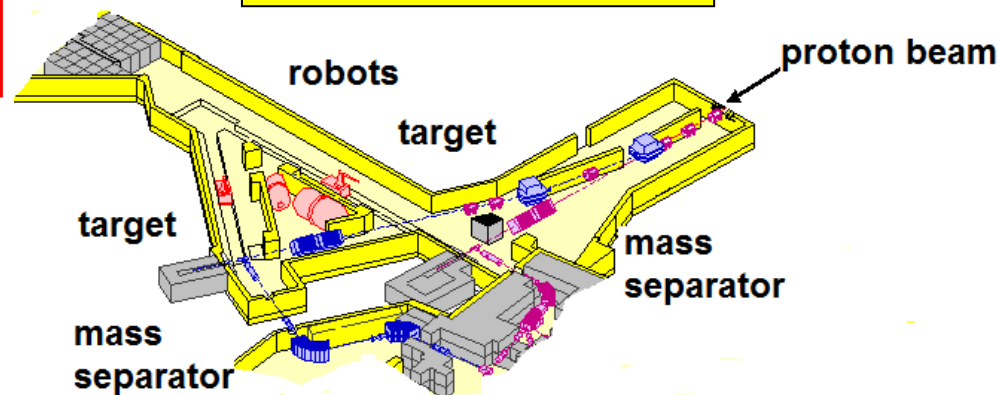
ISOL method of radioactive ion beam production

DRIVER ACCELERATOR

e.g. CERN-ISOLDE

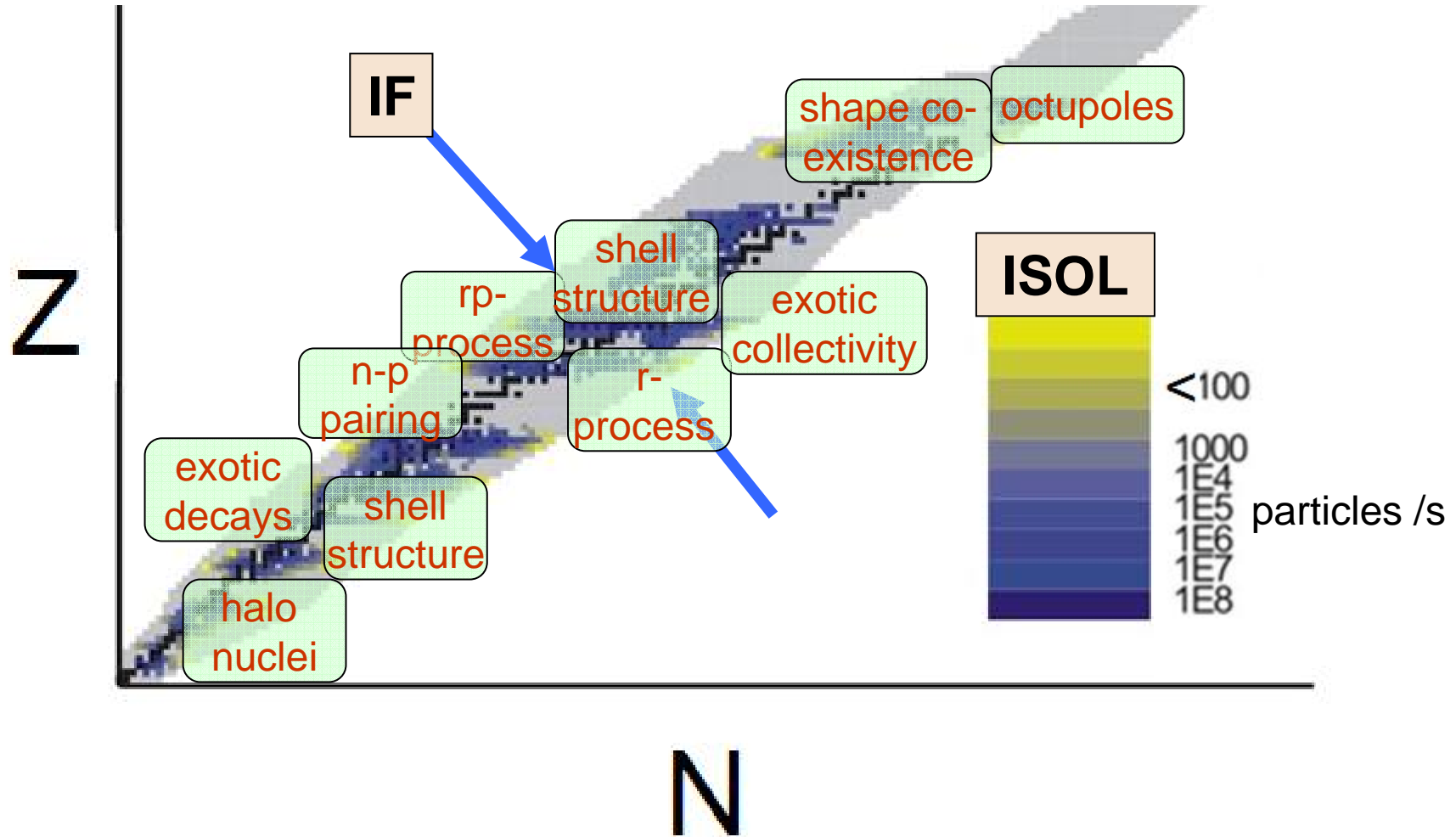


PRIMARY TARGET

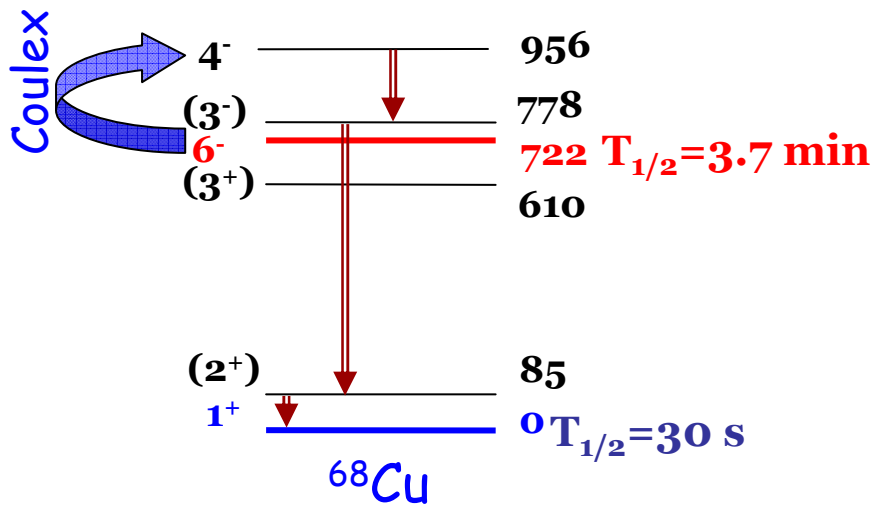


POST-ACCELERATOR

available beams

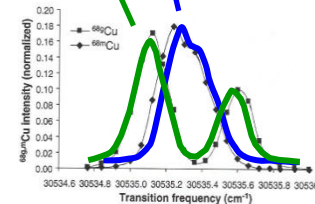
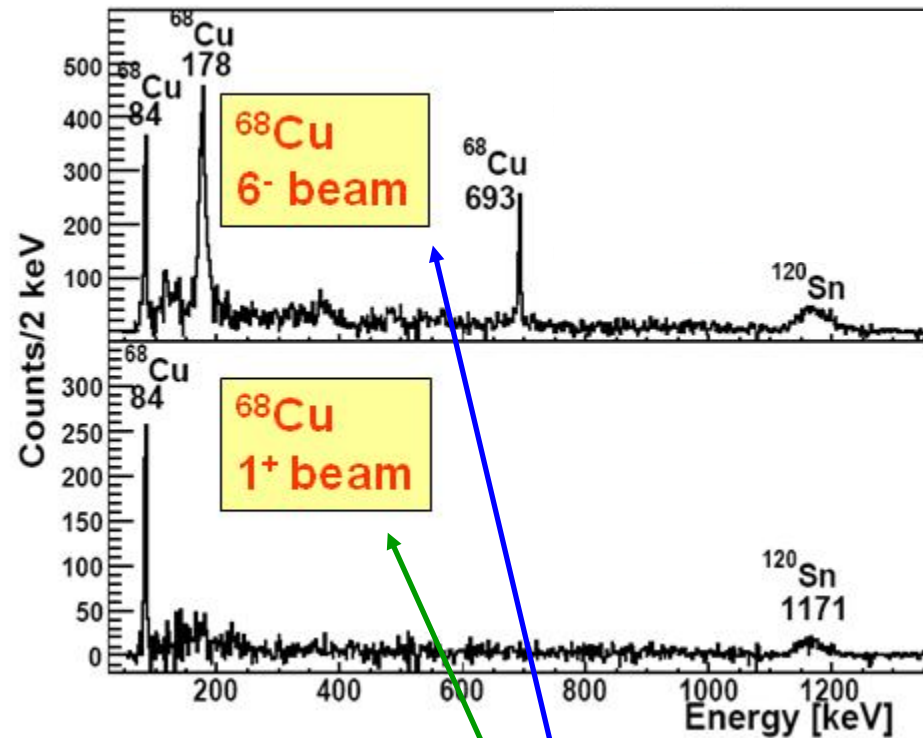


Induced instantaneous depopulation of an isomer (ISOL)

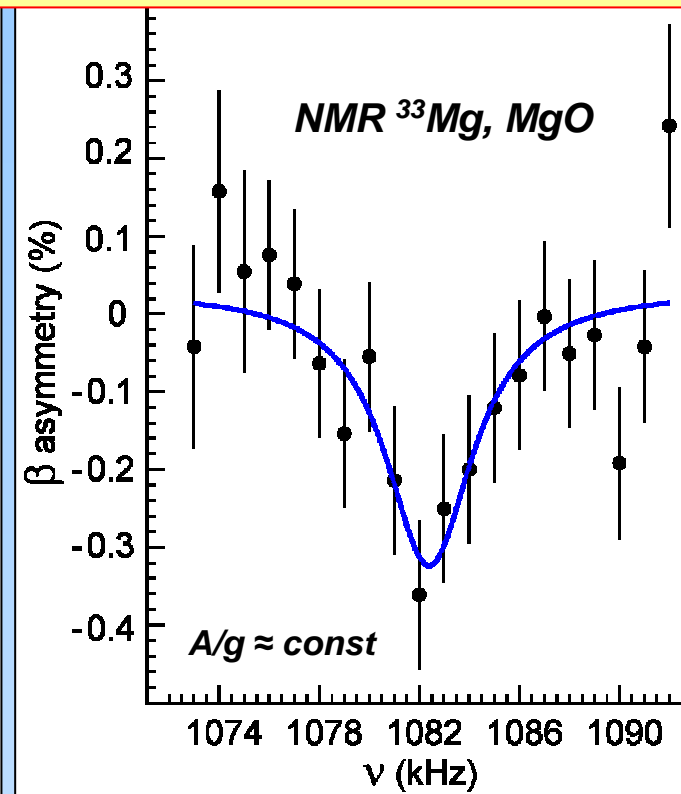
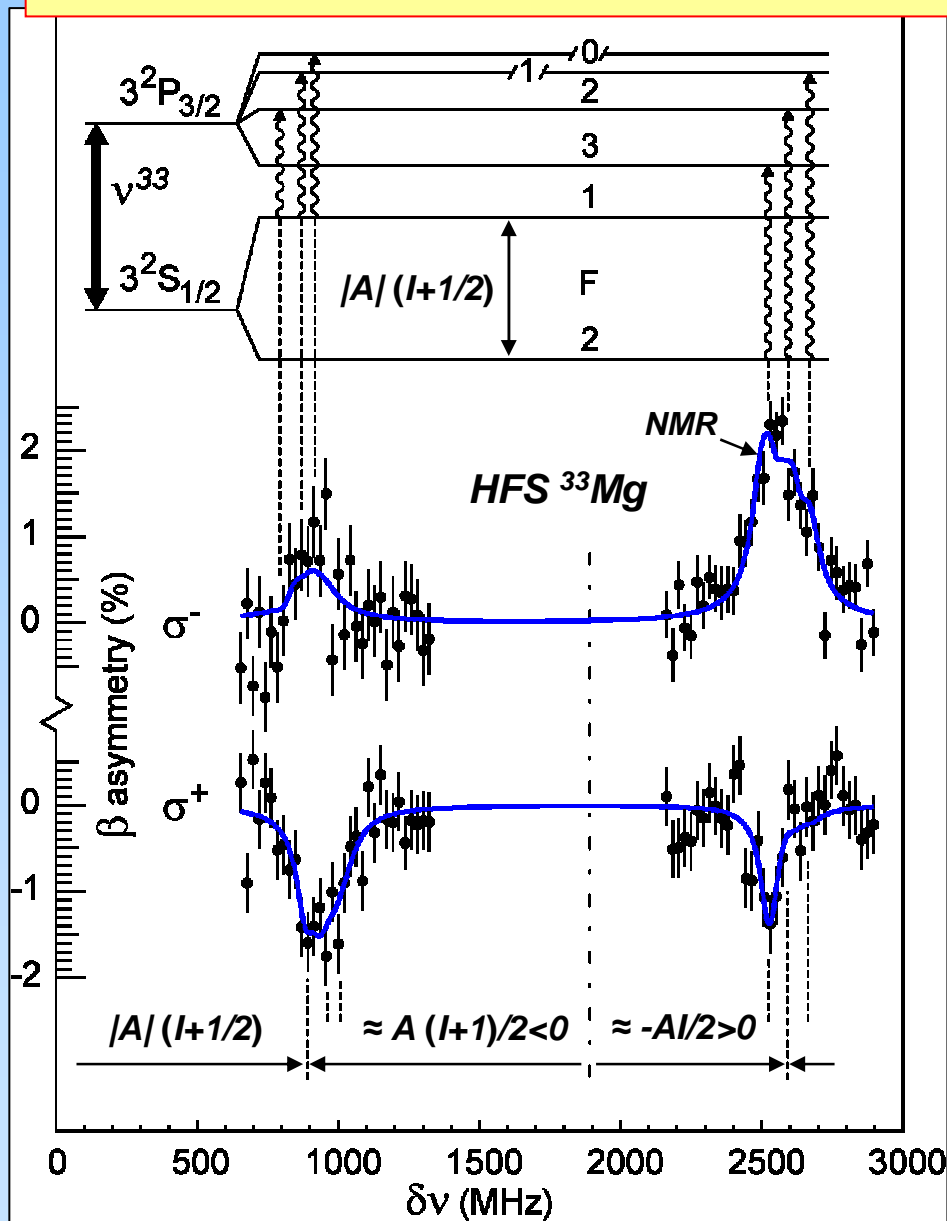


Population via Coulex (E2)

heaviest stable is ${}^{65}\text{Cu}$



Is ^{33}Mg near a closed shell? (ISOL)

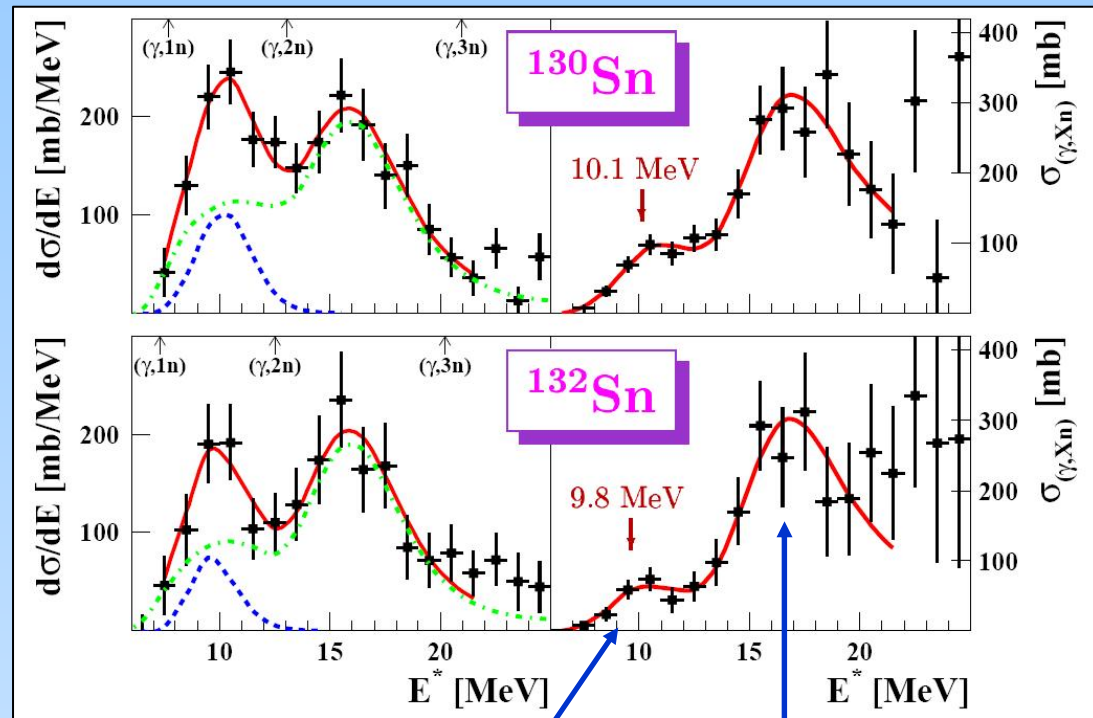
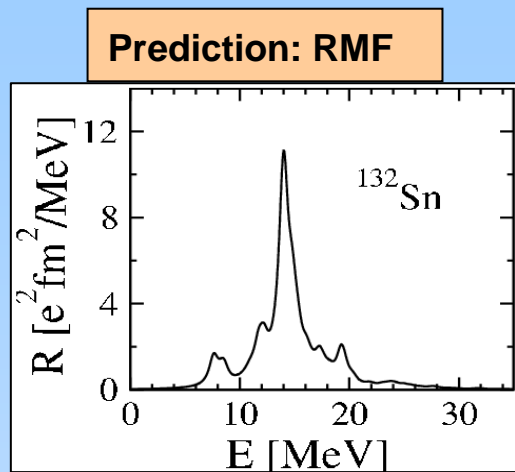


Experimental results

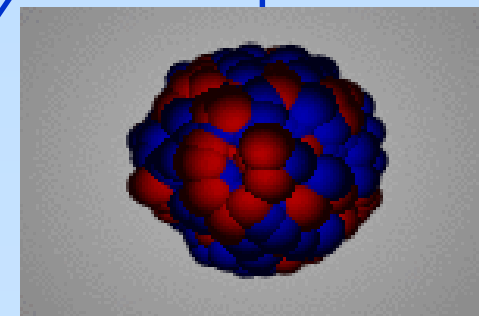
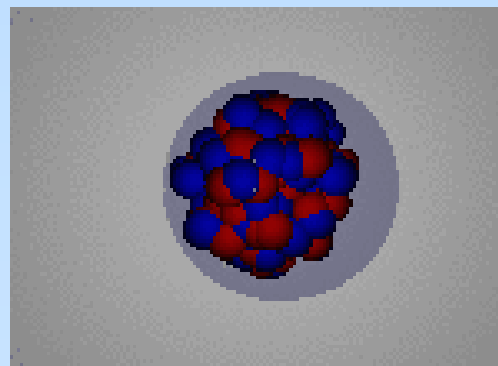
| | |
|------------------|-----------|
| $g = -0.4971(4)$ | $I = 3/2$ |
|------------------|-----------|

heaviest stable is ^{26}Mg

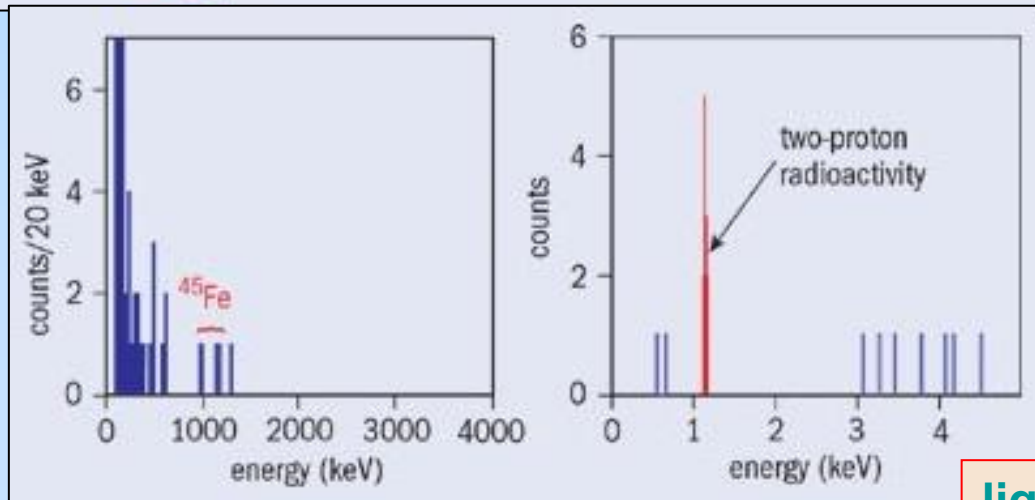
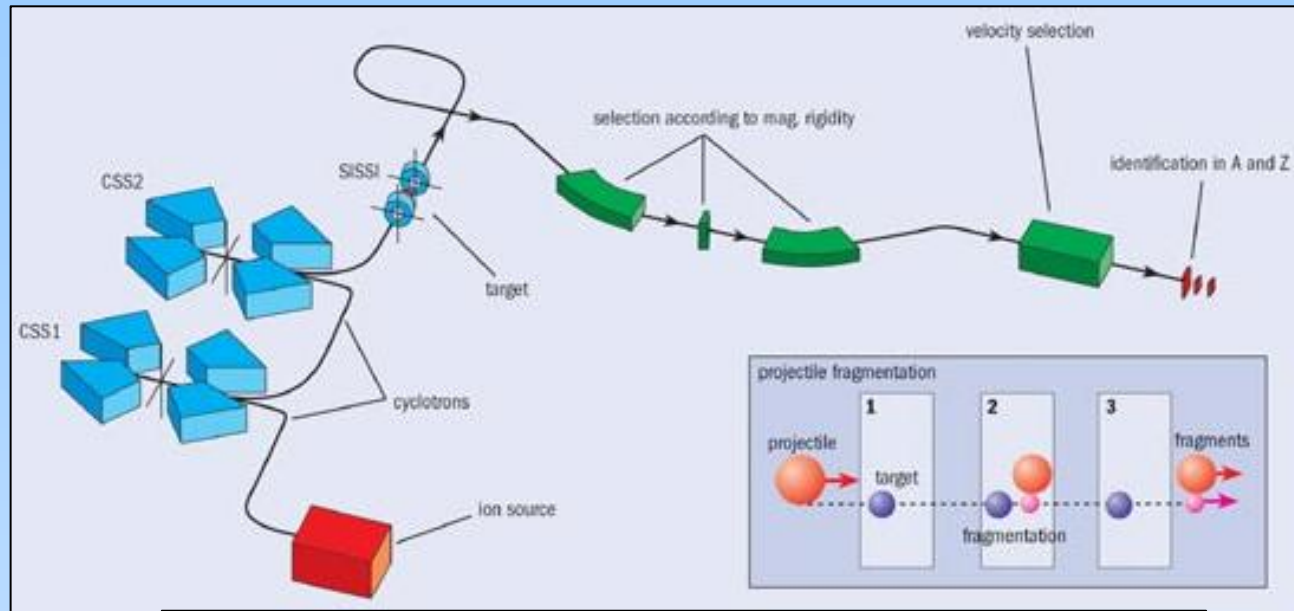
The dipole response of neutron-rich nuclei (IF)



heaviest stable is ^{124}Sn



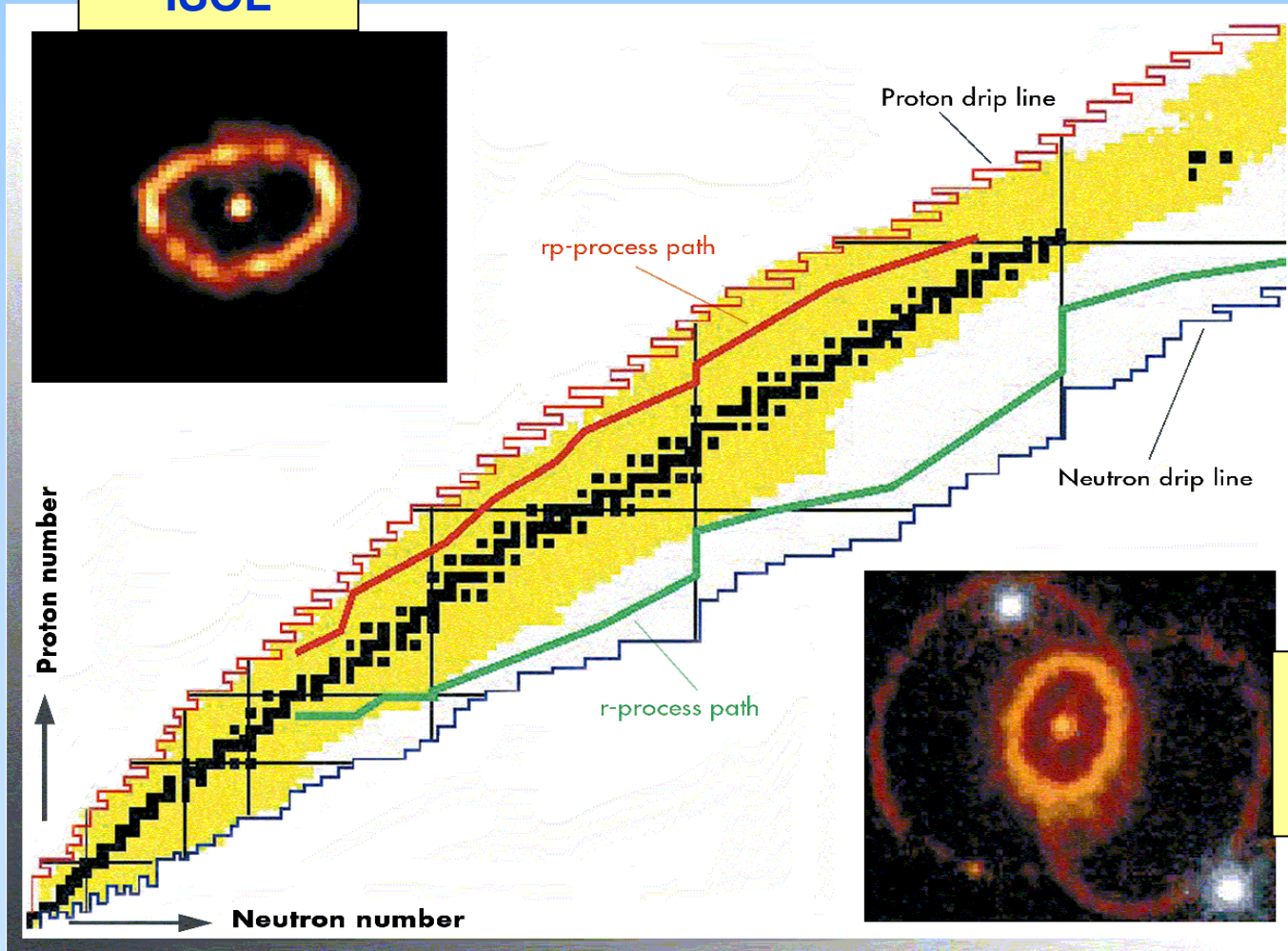
two-proton decay of ^{45}Fe (IF)



lightest stable is ^{54}Fe

Nucleosynthesis pathways

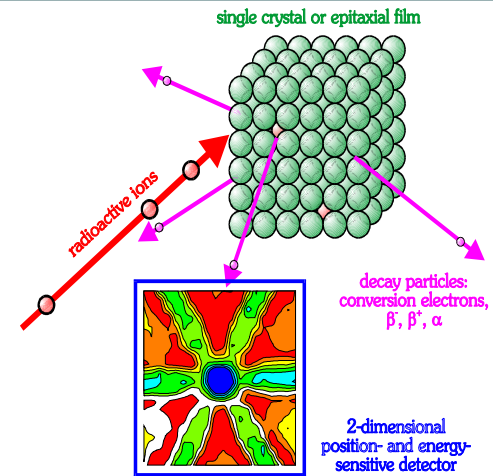
rp-process
X-ray burst
ISOL



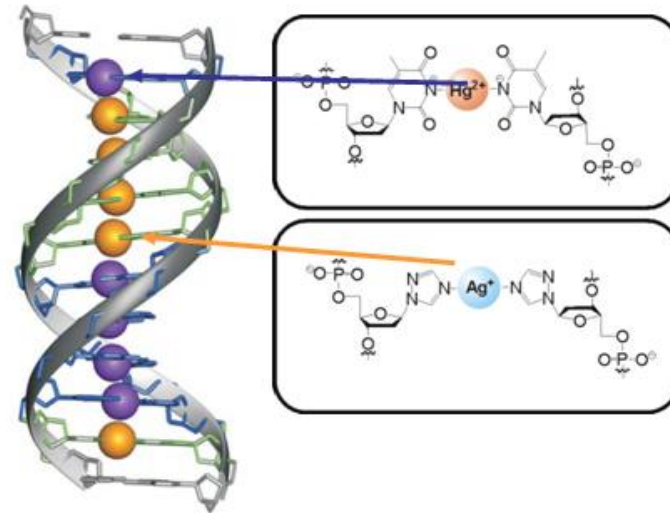
r-process
supernova
IF

other science

solid state physics



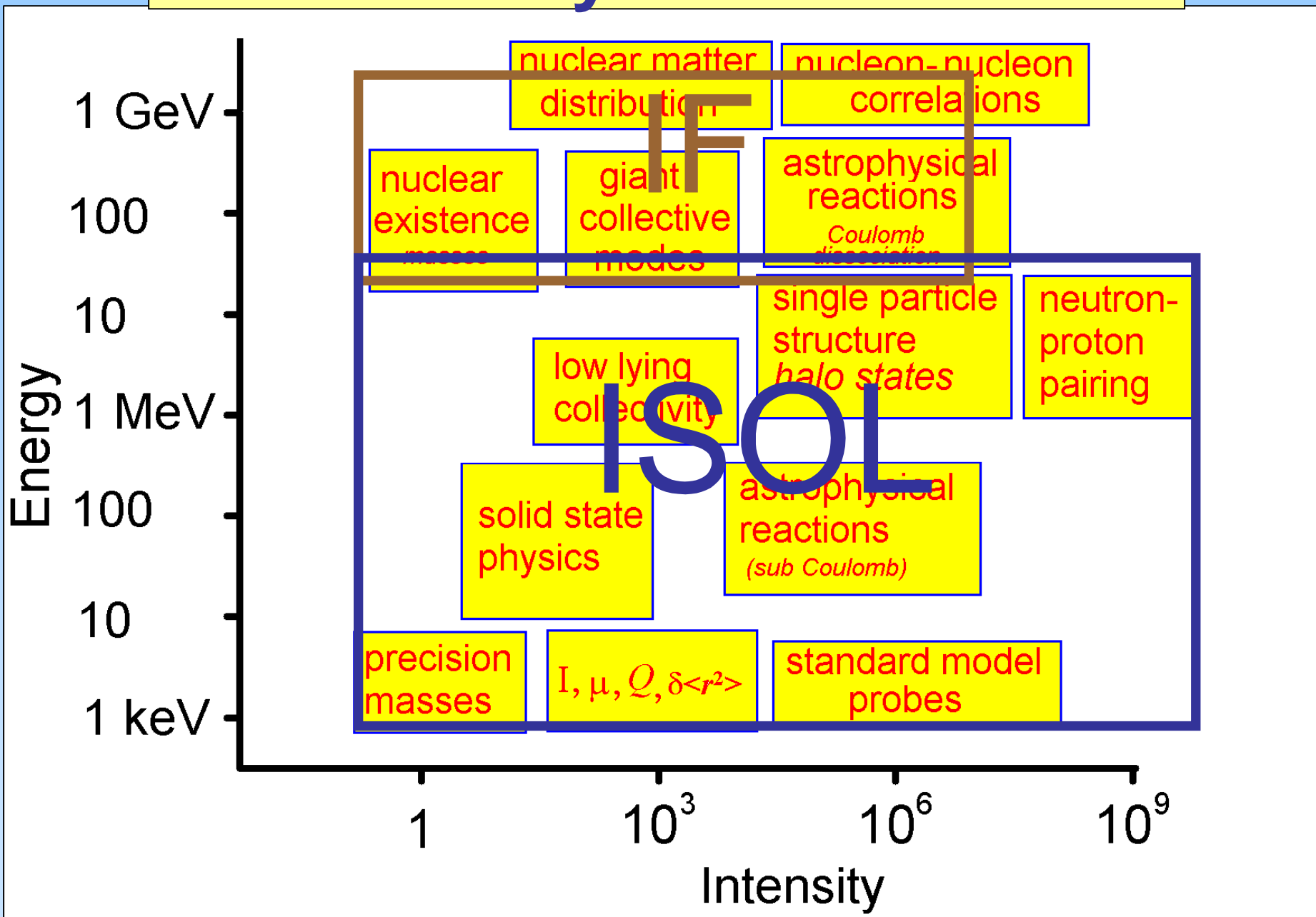
biophysics



radio-pharmacology



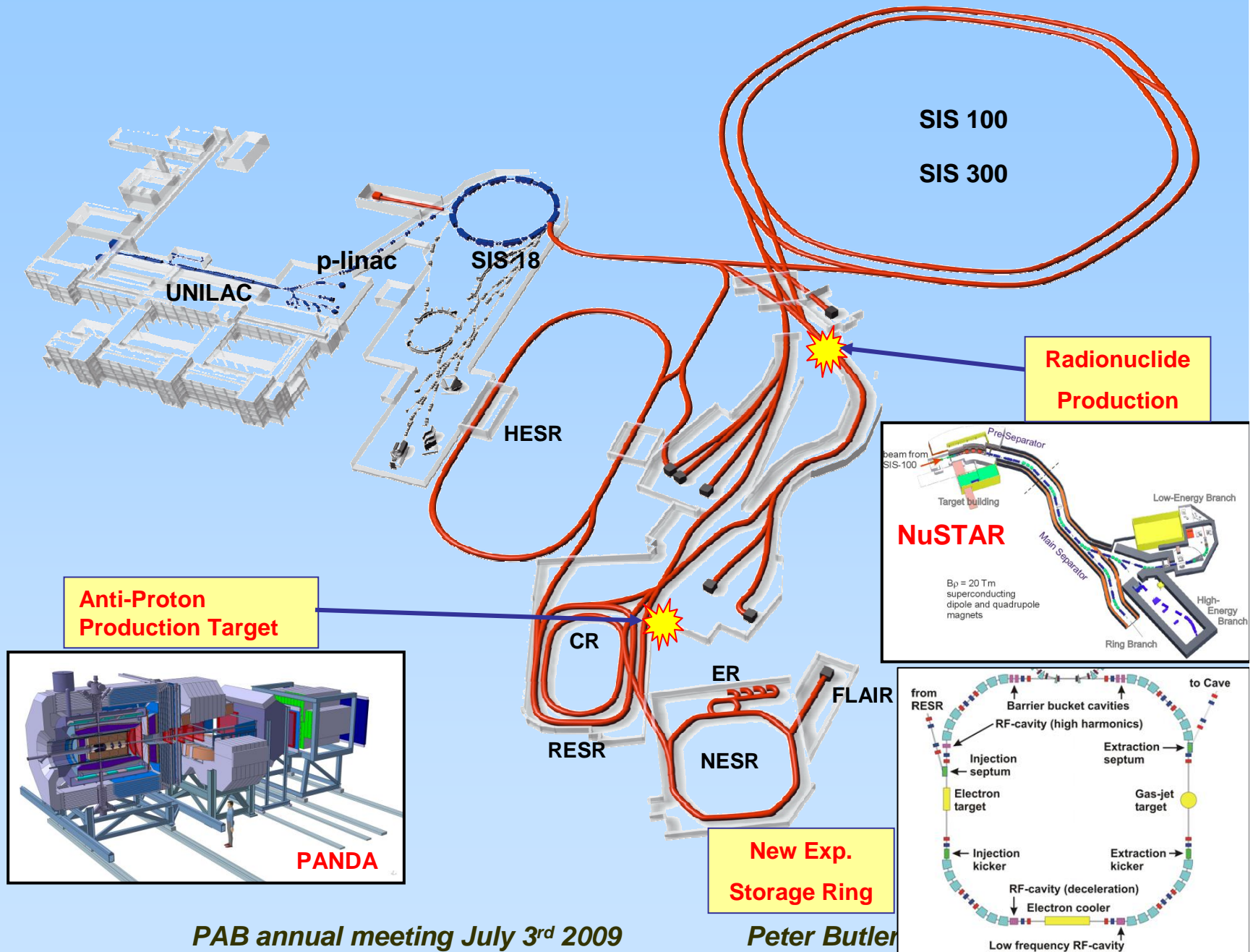
RIB Physics Reach



Future World-Wide RIB

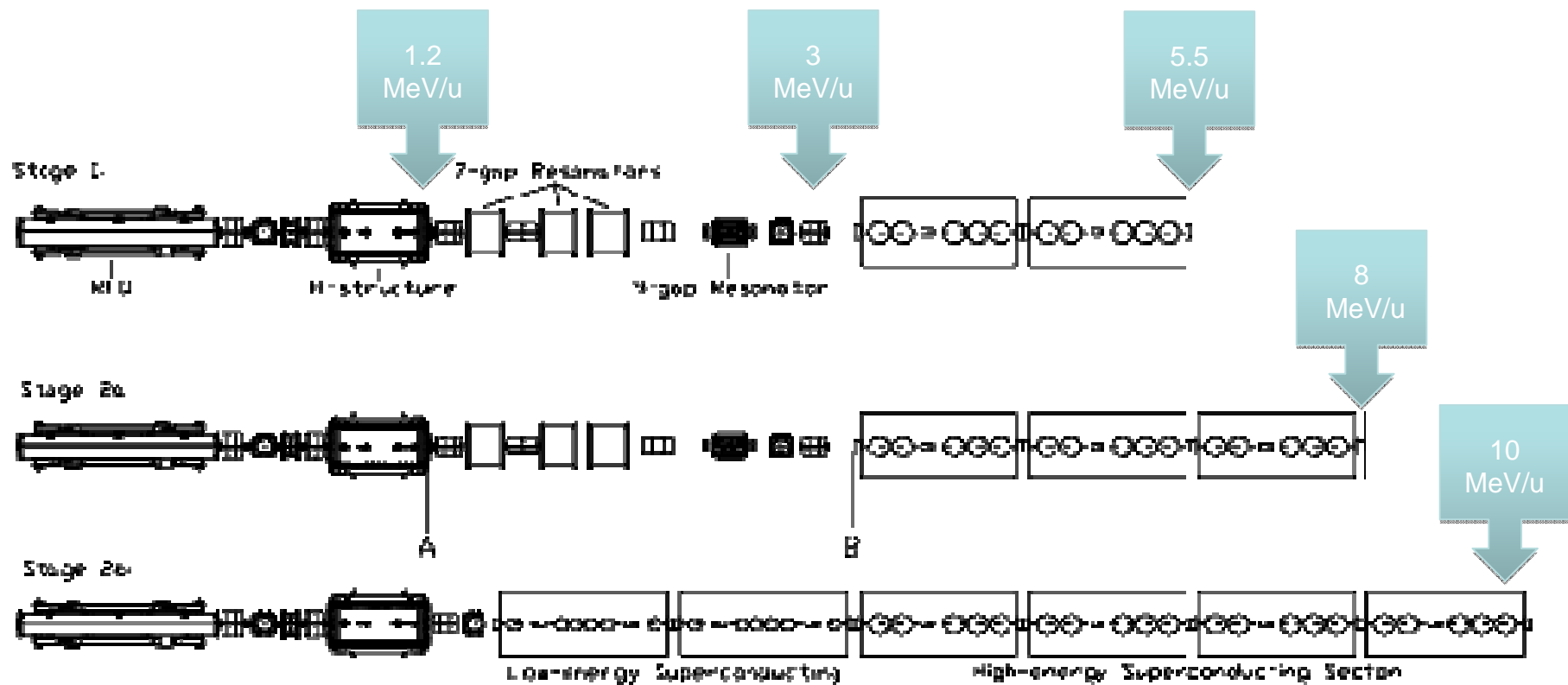


The FAIR Accelerator Complex



HIE-ISOLDE

3 stages installation



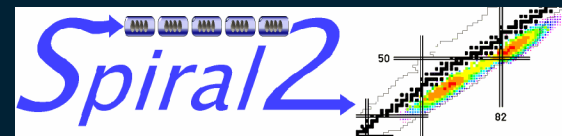
Major intensity upgrade when SPL replaces PS Booster

intense beams of fission fragments and N=Z nuclei

existing GANIL

low energy DESIR facility

fission production target/separator

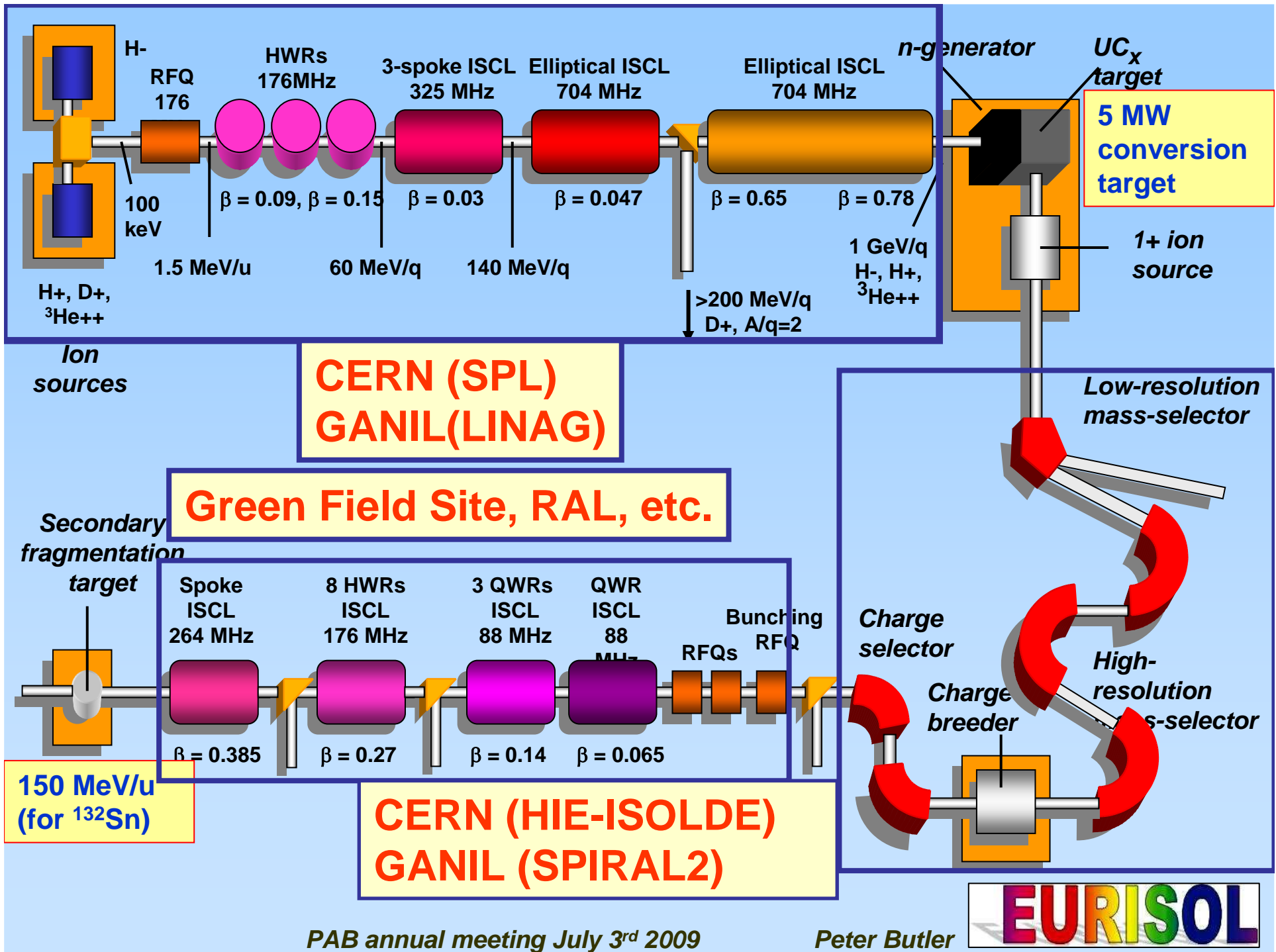


new s/c linac driver LINAG
40 MeV deuterons, 5 mA

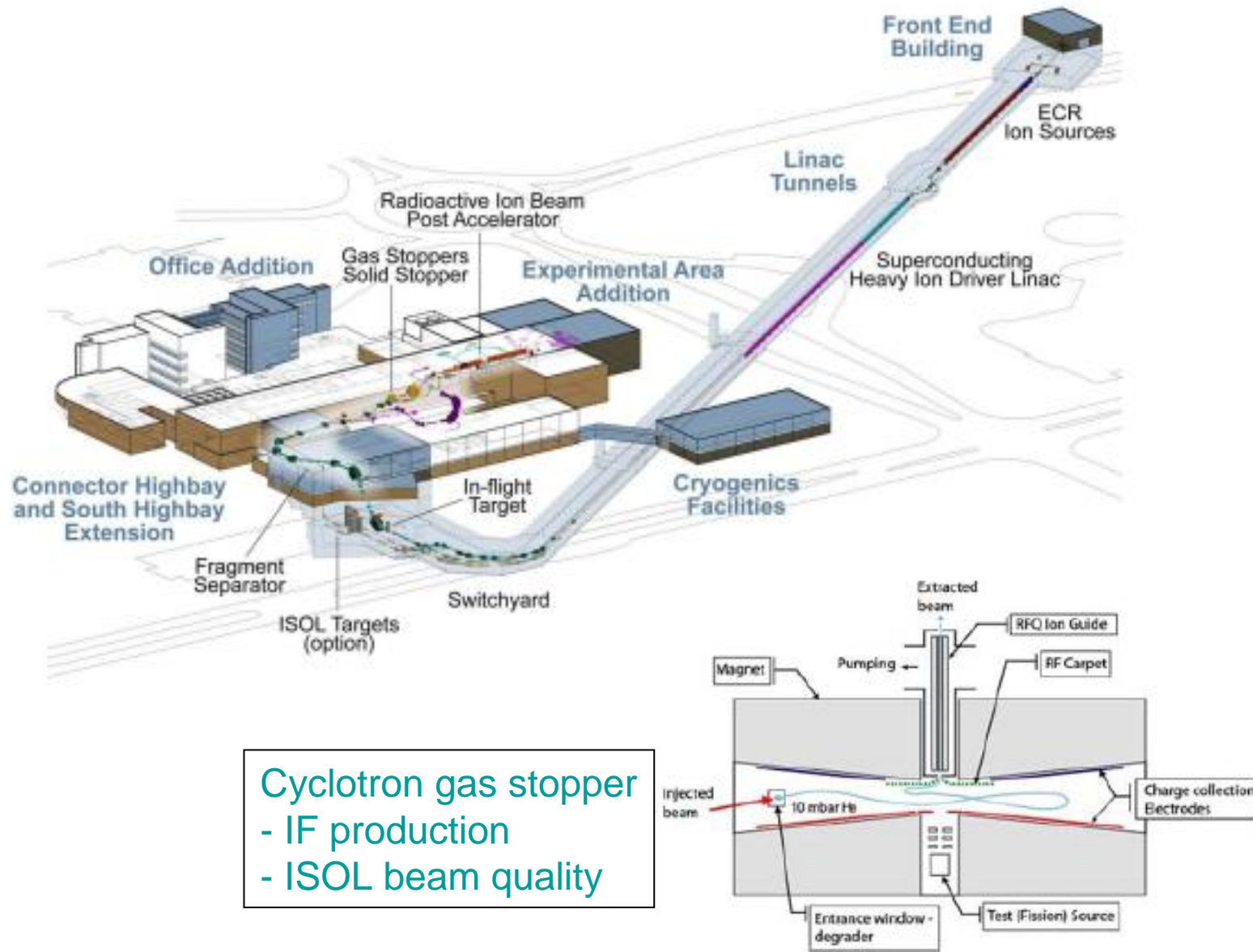
super intense stable beams
S³ spectrometer

also, heavy ions

New construction

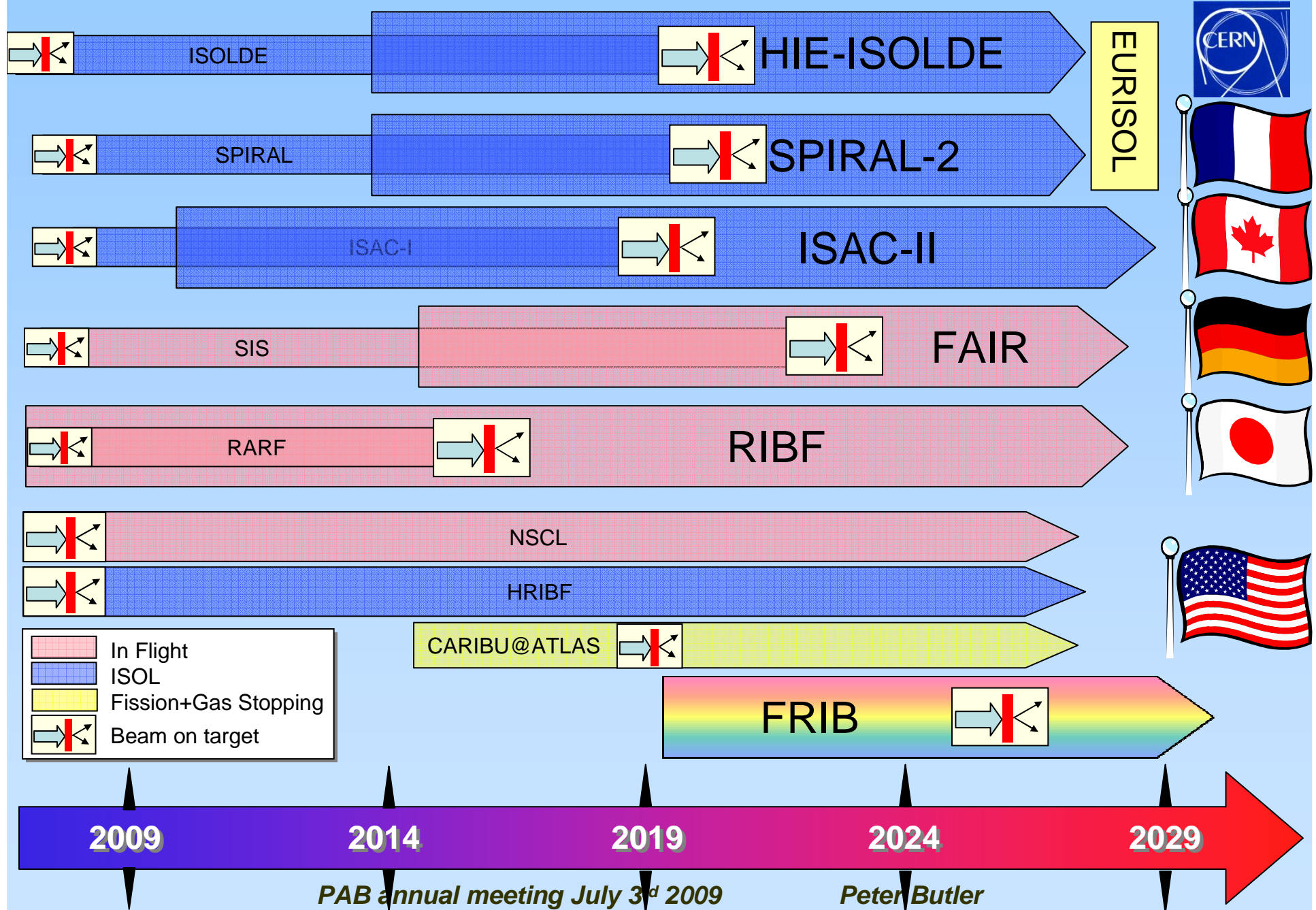


FRIB \$500M radioactive beam facility at Michigan



Cyclotron gas stopper
- IF production
- ISOL beam quality

Radioactive Ion Beam Facilities Timeline



FINIS