Summary: Physics Opportunities for ISOLDE and n_TOF

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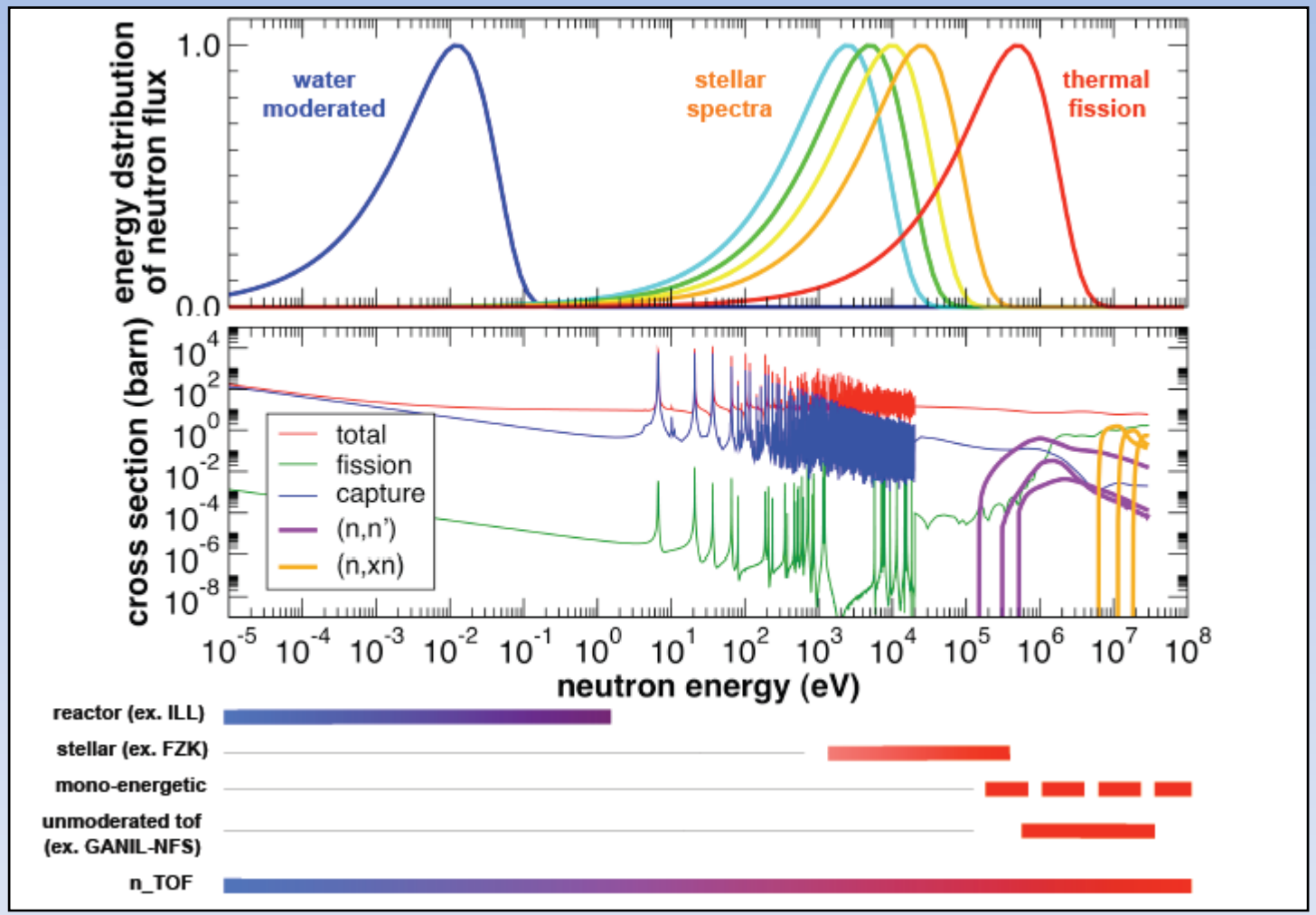
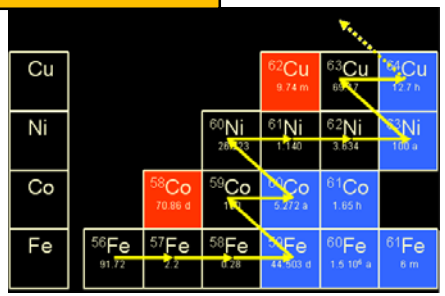
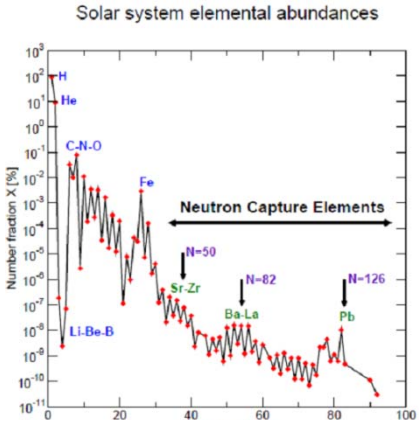
n_TOF


energy dstribution of neutron flux
1.0
0.0
water moderated
stellar spectra
thermal fission
cross section (barn)
total
fission
capture
(n,n')
(n,xn)
neutron energy (eV)
reactor (ex. ILL)
stellar (ex. FZK)
mono-energetic
unmoderated tof (ex. GANIL-NFS)
n_TOF

n_TOF current goals

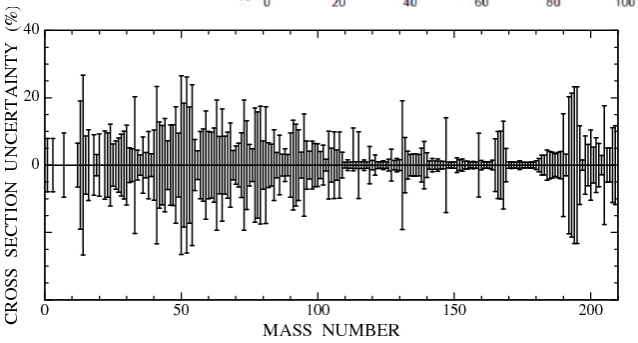
s-process and stellar cross-section rates



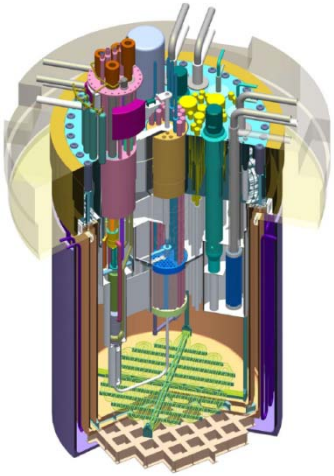


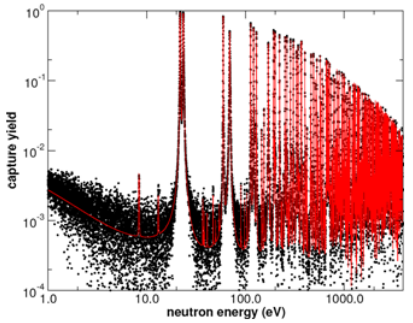
neutron-neutron interaction

$$n + {}^{2}H \rightarrow n + n + p$$



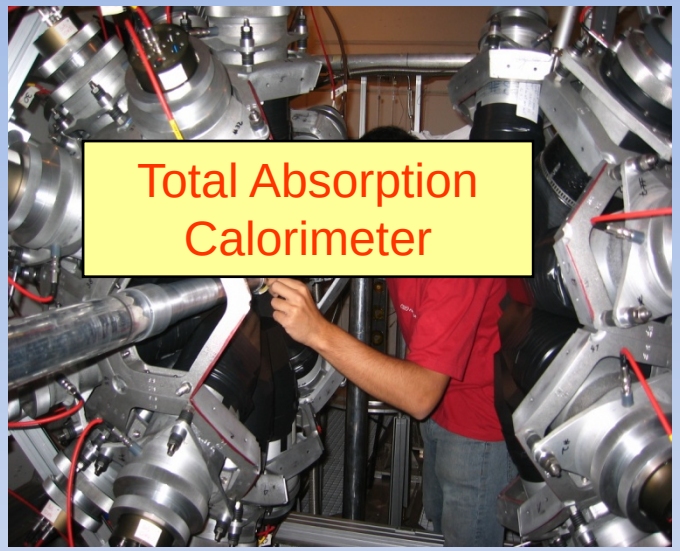
σ_a, σ_f, of actinides, fission, structure, of ADS/EA

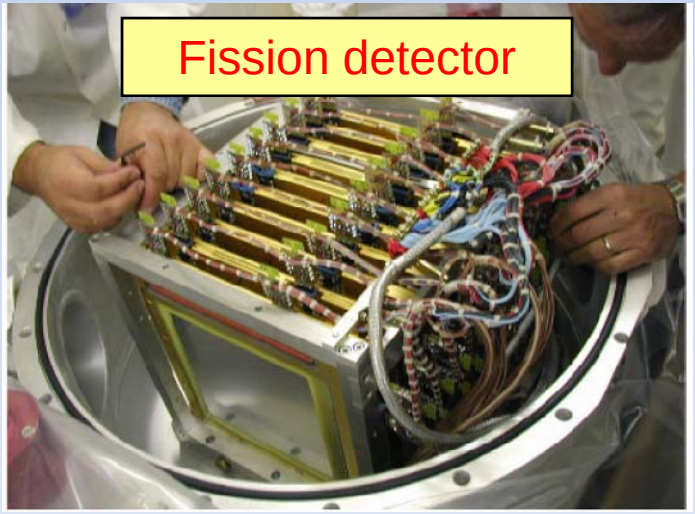




77 participants in 5 active experiments

Experimental tools





external contributions ~5 MCHF

Strategy for n_TOF

EU programmes

Existing VIth framework (-2010) NUDATRA (EUROTRANS) and EFNUDAT (TNA)
new proposal ANDES (2010-)

Complementarity (Europe)

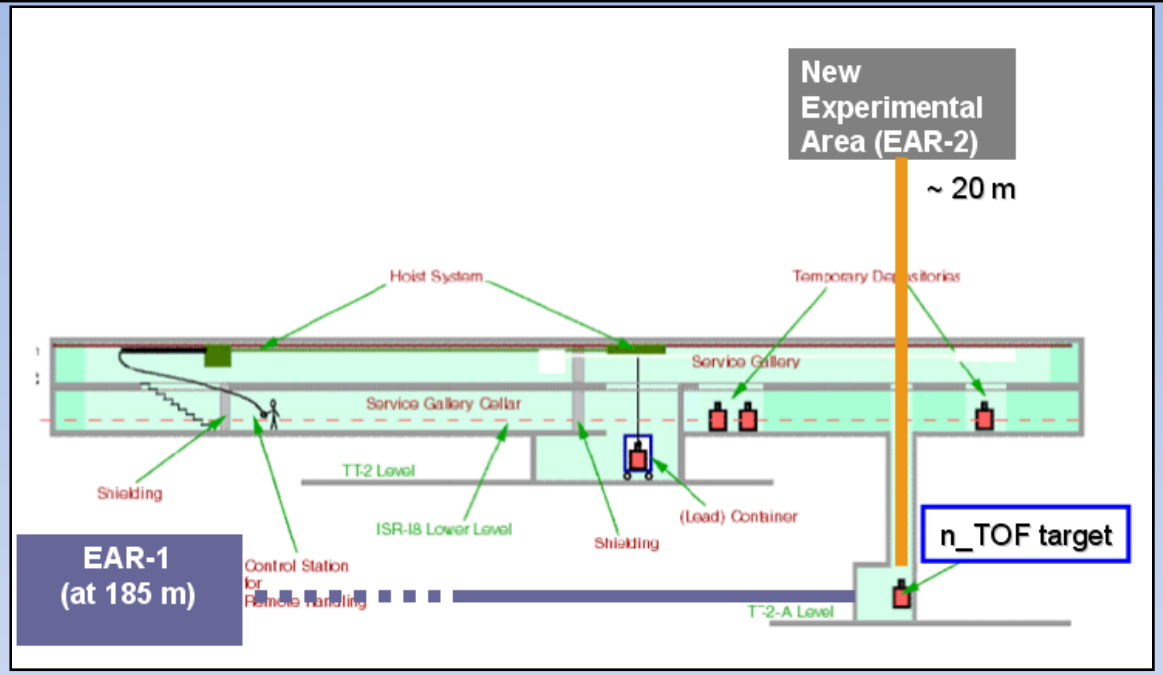
(i) GELINA (Geel) – electron linac
(ii) NFS (GANIL) – cold fission

Competition (North America & Japan)

LANSCE (Los Alamos) spallation source
ORELA (Oak Ridge) electron linac
JPARC – spallation source
n_TOF has better brightness and energy resolution

The second n_TOF beam line

(proposed by NuPAC Oct 2005)



EAR-1 class A laboratory

EAR-2

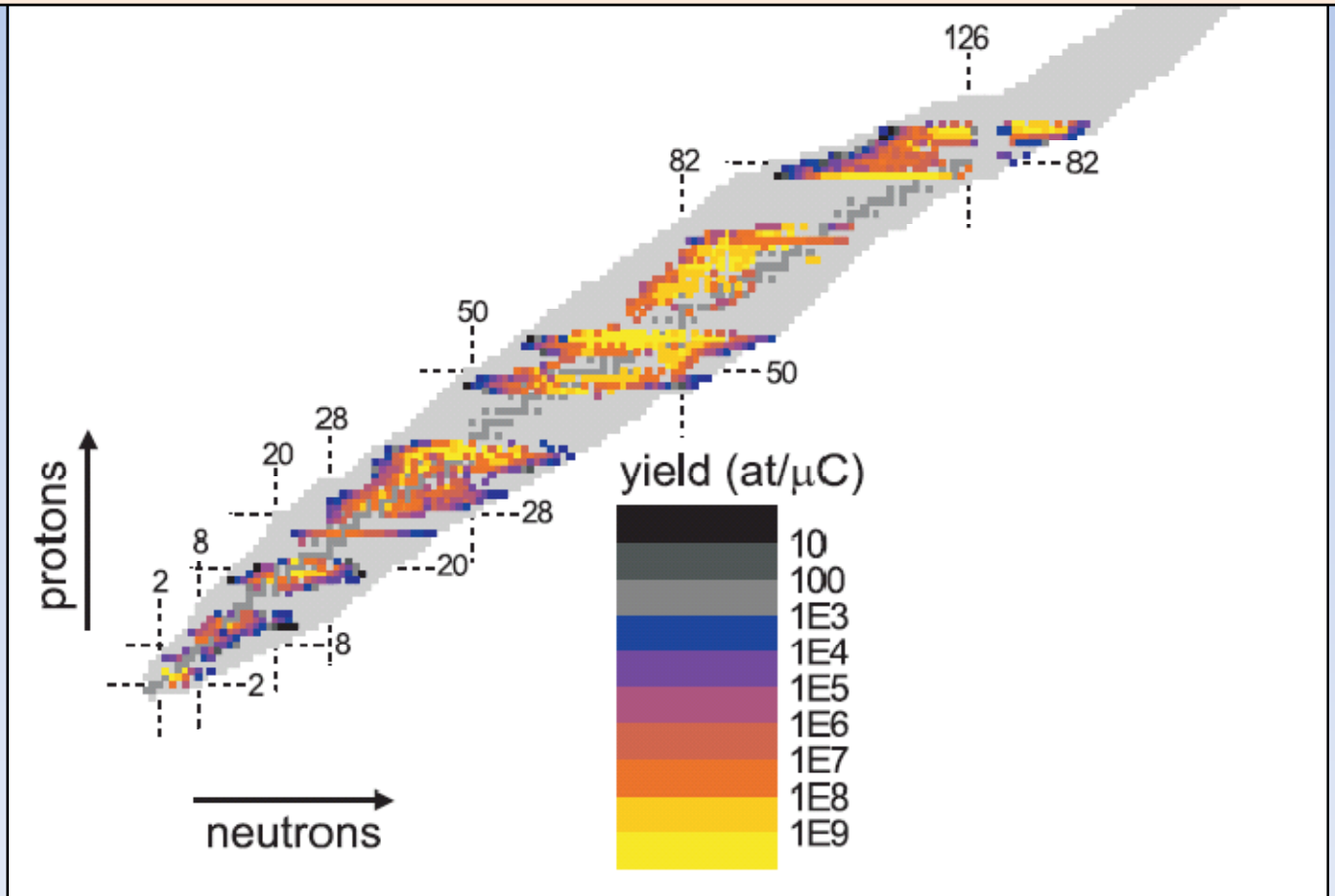
< 1 mg targets

$T_{1/2}$ of targets 10-200 years

SPL+PS2

ISOLDE

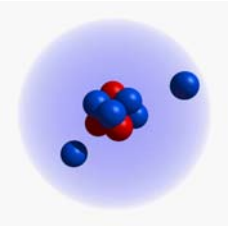
- Energy range 10^{-6} eV (10 mK) to 3 MeV/u
- Intensity 1 – 10^{10} ions/s
- Isotope range ^{6}He to ^{232}Ra (Z 2-88 N 4-144)



ISOLDE current nuclear physics goals

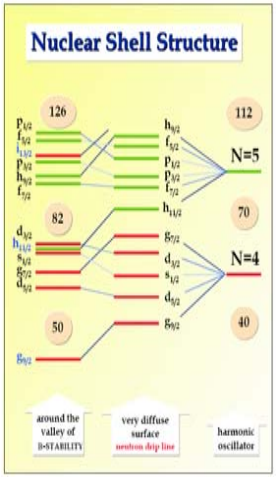
Light exotic nuclei

ab-initio from nucleon-nucleon forces



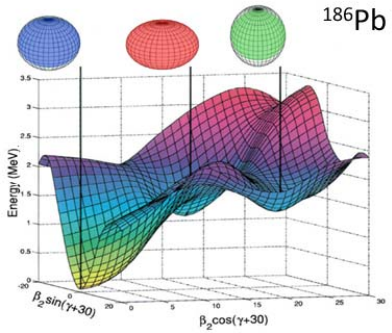
shell evolution

shell model interaction



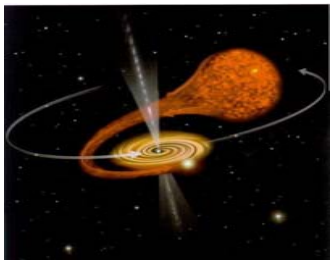
nuclear shapes at low spin

density-functional theories



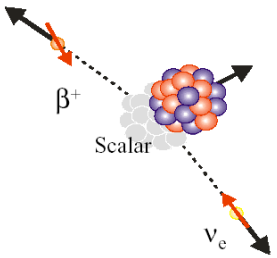
r-process and rp-process

nucleosynthesis and stellar energy generation



V_{ud}, e-ν correlations, etc.

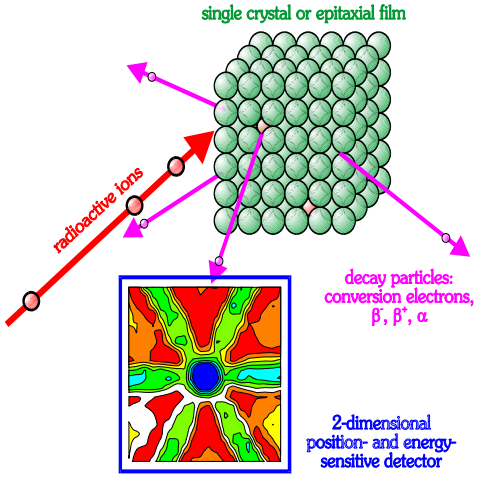
tests of SM



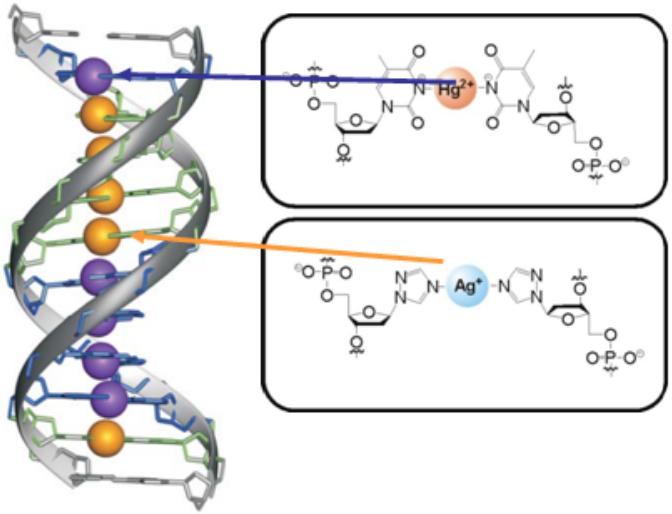
580 participants in 73 active experiments

Diversity of ISOLDE current science programme

solid state physics

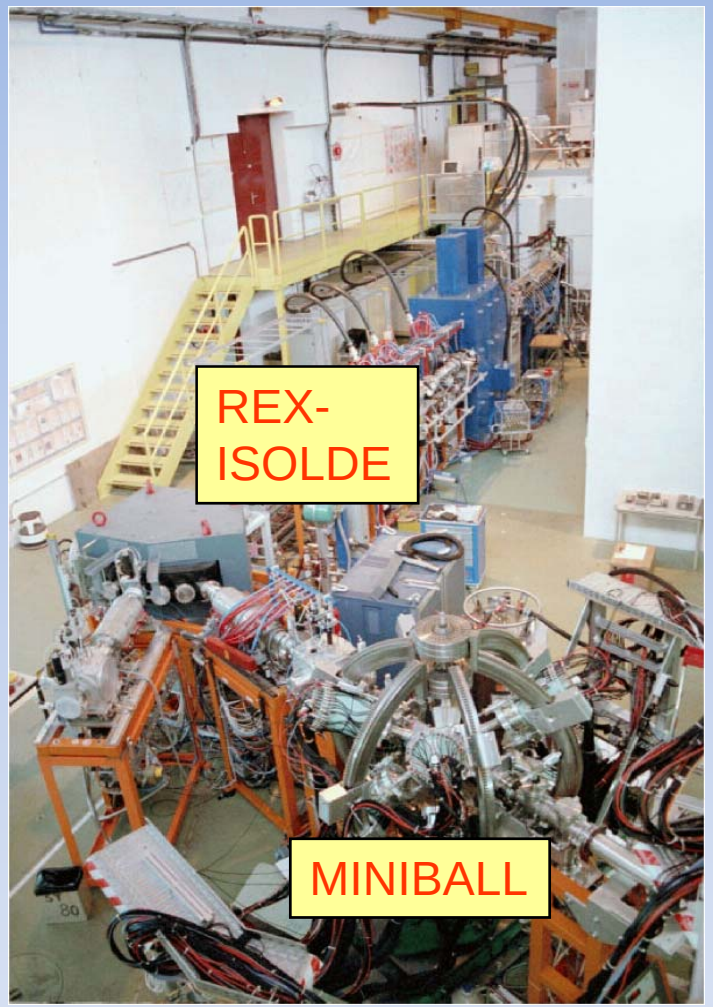


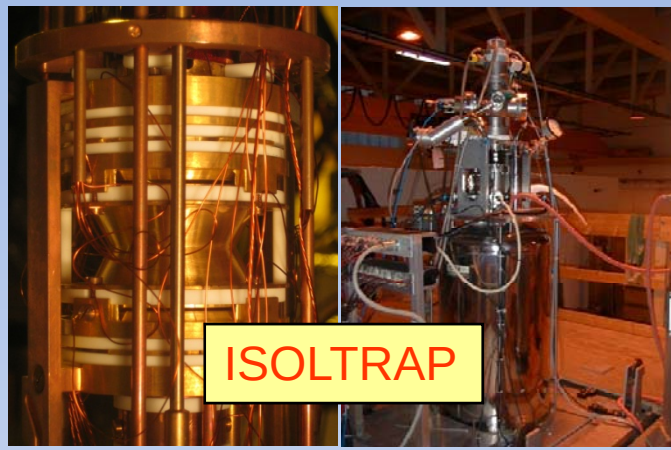
biophysics

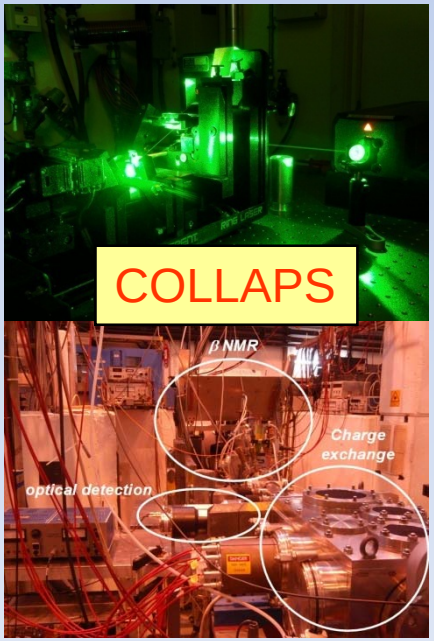


radio-pharmacology

Many different experimental tools







external contributions ~ 30MCHF

Future physics with HIE-ISOLDE

32 out of 95 abstracts

Better beam quality

shell evolution from s.p. states
(7,14, 20, 33, 53, 65, 75)

higher energy

nuclear shapes at extremes
(6, 18, 31, 52, 62, 65, 74, 83, 89, 96)

higher energy, higher intensity

nucleosynthesis (spectroscopy, reactions)
(53, 85, 93)

variable energy, higher intensity

tests of SM from EDM measurements, neutrino properties, V_{ud}
(45, 52, 59, 66, 67, 69)

higher intensity

solid state physics, biophysics, radiopharmacy
(44, 63, 64, 86, 88, 90, 93, 94, 95)

variable energy, higher intensity

Strategy for ISOLDE and European NP

~ 2000 researchers in low-energy NP require both in-flight and ISOL facilities (NuPECC LRP)

Complementarity (Europe)

(i) SPIRAL-2 – range of radionuclides

(ii) FAIR – in-flight facility

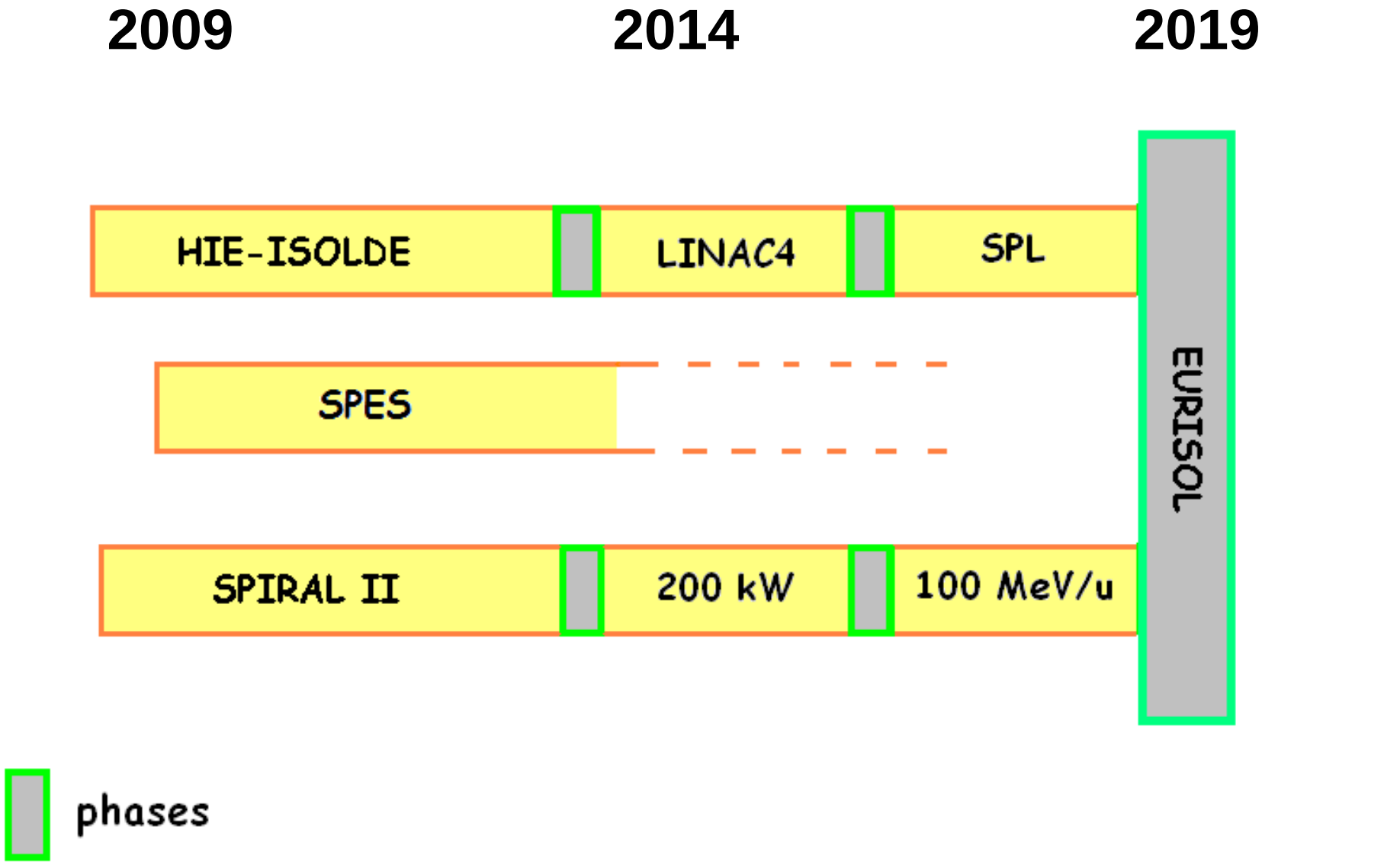
Competition (North America & Japan)

HIE-ISOLDE + SPIRAL2 well placed to compete:

ISAC-2 (TRIUMF) and FRIB (MSU) –
timeline for technological development

RIBF(RIKEN) – in-flight facility

proposed EUROPEAN ISOL ROADMAP



HIE-ISOLDE project

(proposed by NuPAC Oct 2005, presented to RB June 2006, 2 yellow reports)

- **HIE-ISOLDE 1**
  - Energy upgrade to 10 MeV/u with a SC linac
  - Design study of the intensity upgrade
    - R&D activity, part of LINAC funded from Belgium (**4.3 MCHF)**
    - Beam lines partially funded by collaboration (**1.2 MCHF**)
    - Request from UK STFC for part of LINAC (**6 MCHF**)
    - Other bids (**5 MCHF**)
    - **Request from CERN (~12 MCHF up to 2013)**
  - Other beam quality investments (new RILIS, RFQ cooler, charge breeding) – funded from Sweden, UK, D, … **(4 MCHF)**

- **HIE-ISOLDE 2 (EURISOL pre-cursor)**
  - Intensity upgrade for LINAC4 (10 kW), L-SPL (30 kW): targets, high resolution separator and charge breeder
    - **To be requested (up to 2018)**

SUMMARY

Both n_TOF and ISOLDE are unique and world-leading facilities (e.g. ISOLDE publishes 8 letters/year)

Planned upgrades

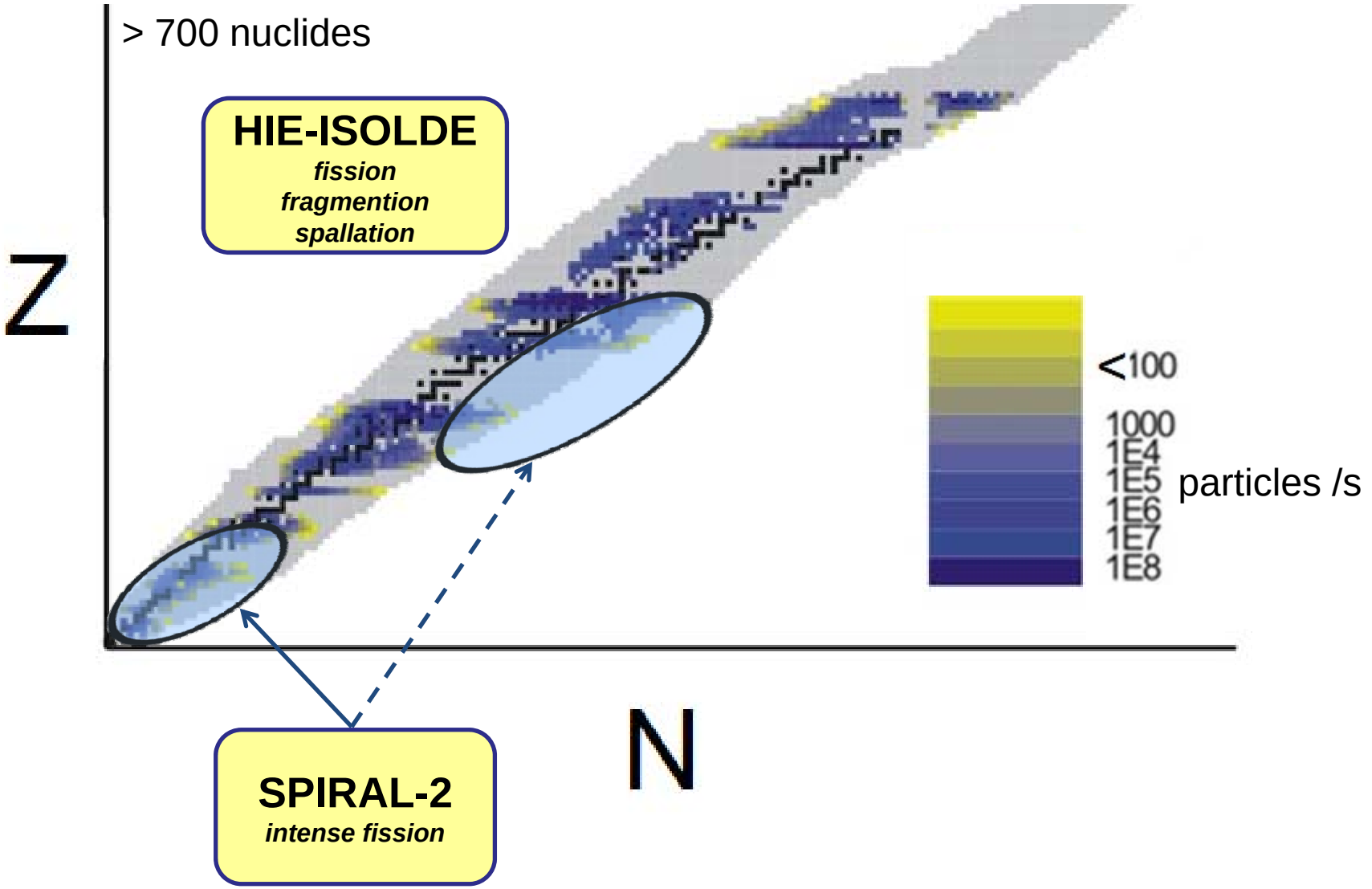
n_TOF - EAR-2 (new experimental area)

HIE-ISOLDE (higher energy & intensity)

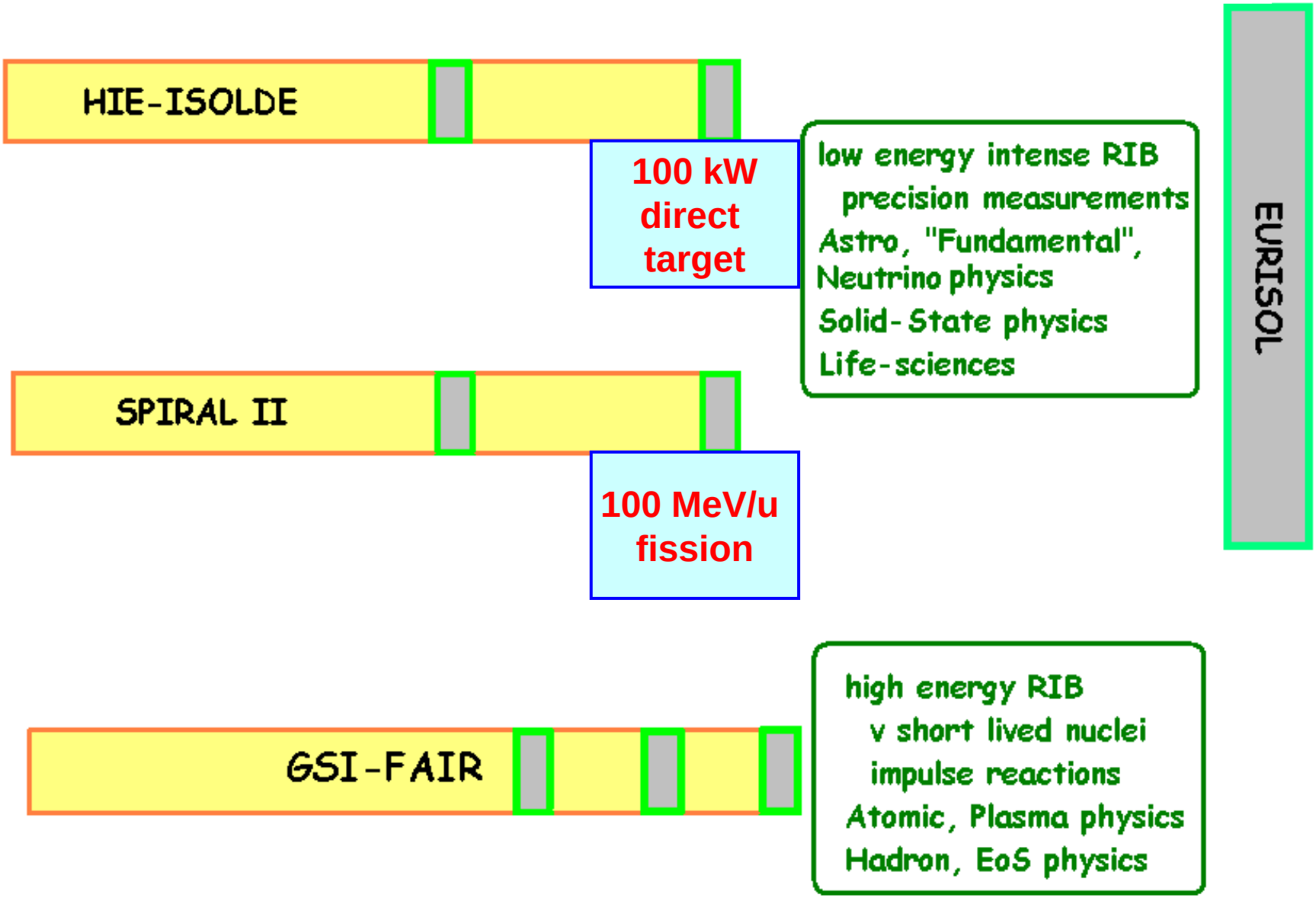
EUROPEAN ISOL

~ 65 elements

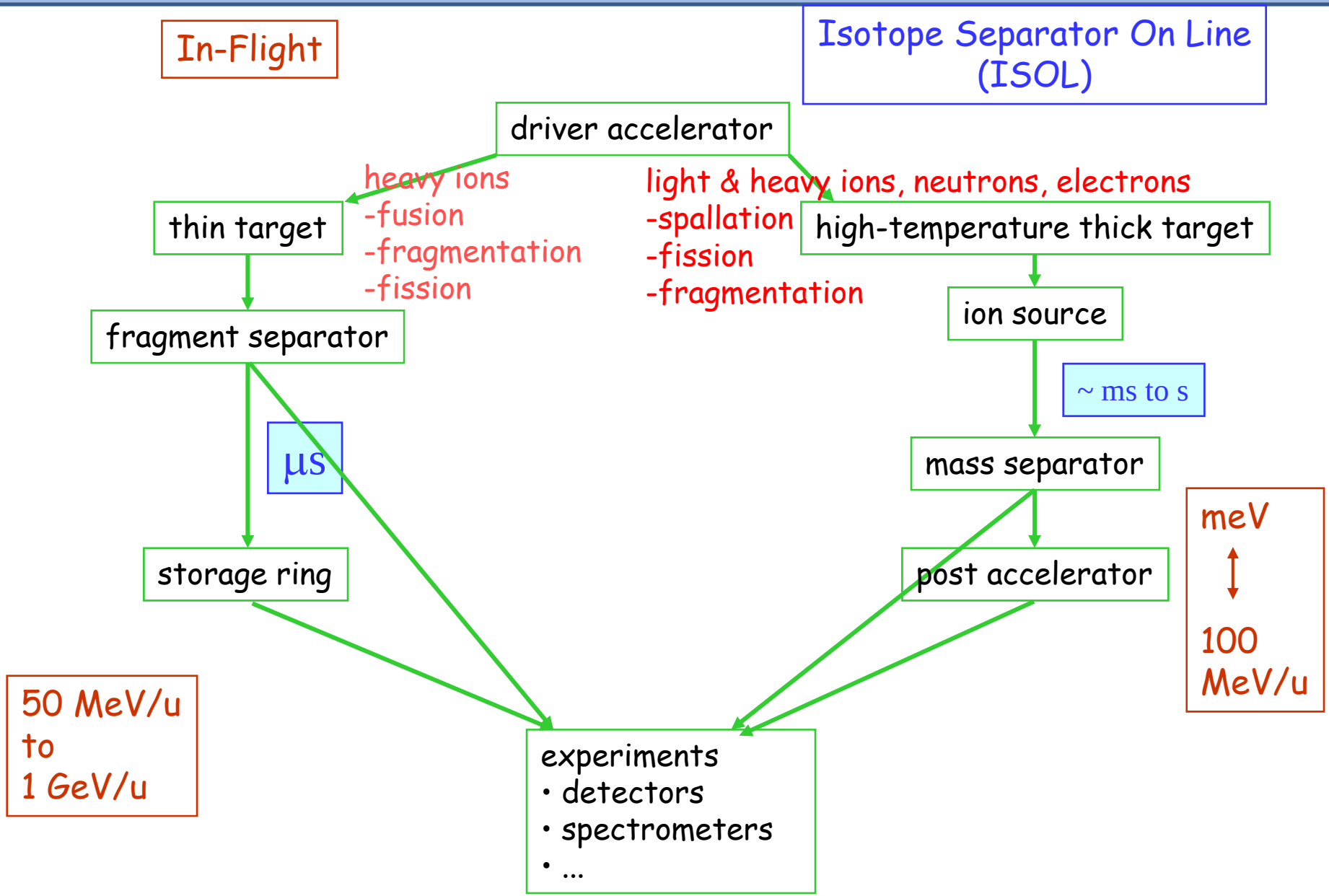
> 700 nuclides



European Roadmap for RIB facilities



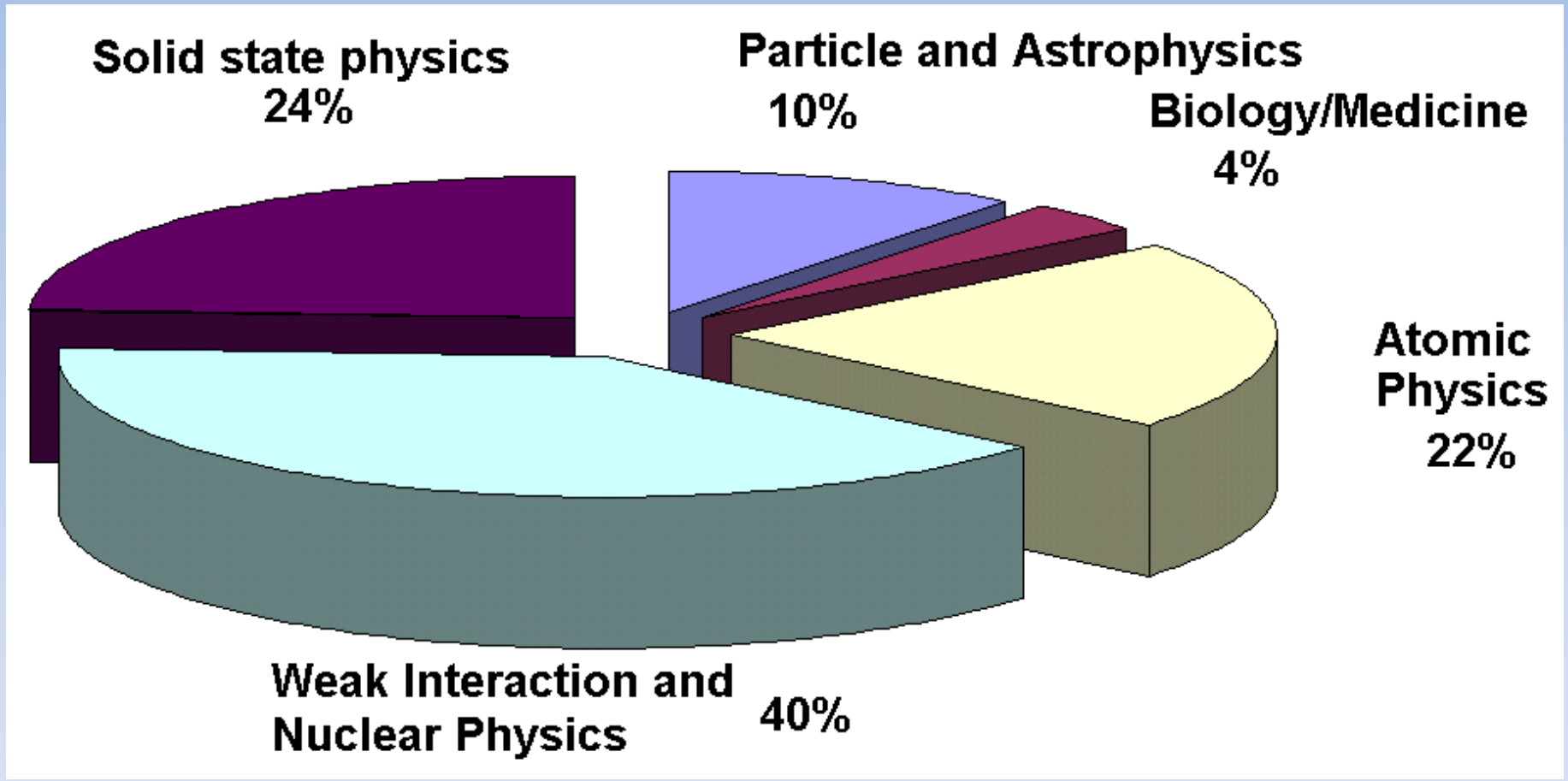
Radioactive Ion Beams: In-Flight versus ISOL



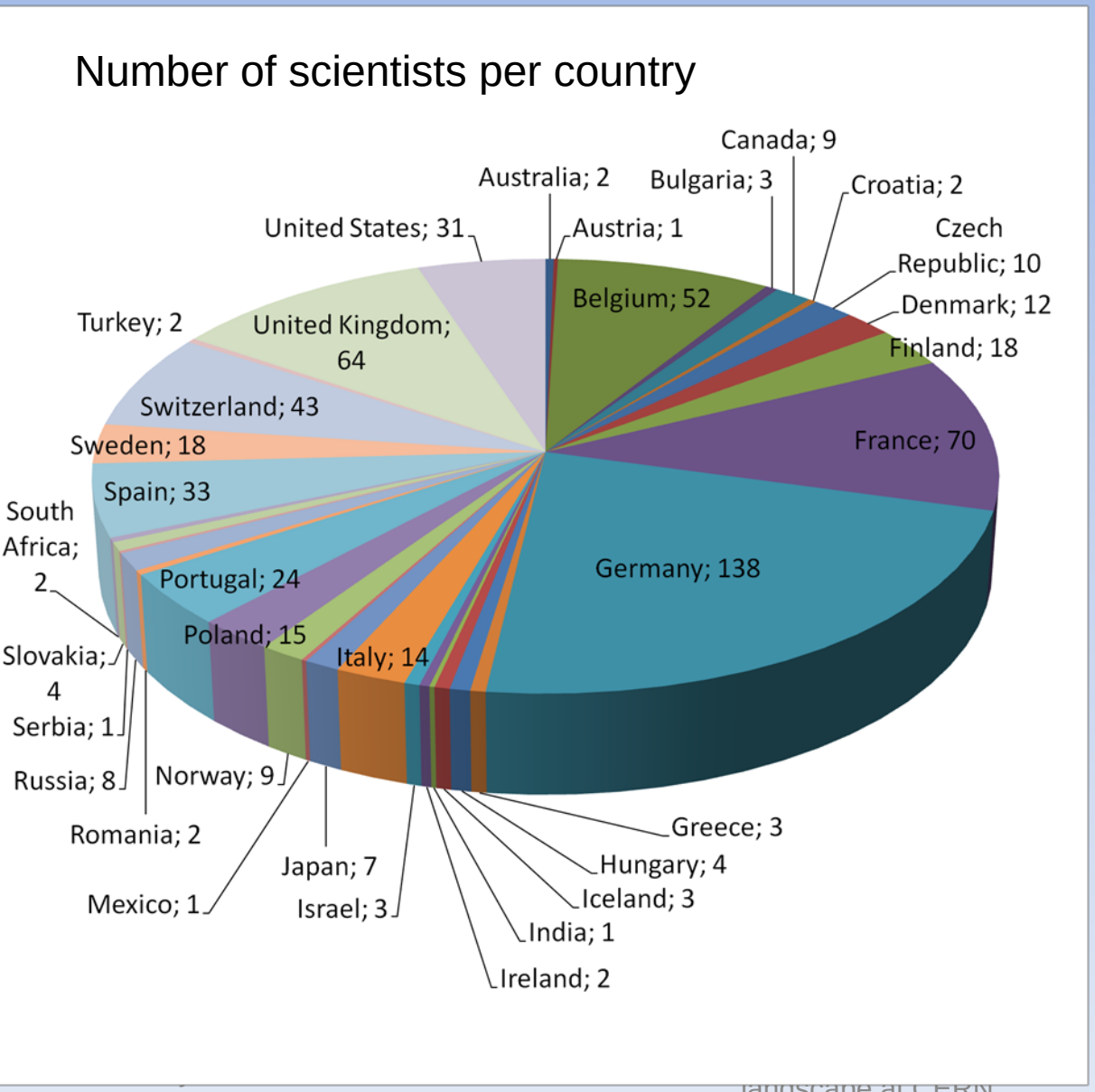
Qu.6

Physics	HIE-ISOLDE	NuSTAR
	Variable 1.2 – 10 MeV/u beams of good definition Detailed spectroscopy nearer stability	200 MeV/u- 1 GeV/u beams of any chemistry Can reach further from stability
Shell evolution	Particle, hole studies	Hole studies for lighter nuclei
Exotic collectivity	Sign of deformation Multiple excitation	Single step excitation of highly excited states
Nucleosynthesis, energy generation	Direct and surrogate s.p. structure	Coulomb dissociation, masses, etc.
np-pairing, nn correlations	d transfer to T=0, T=1 2n transfer	Correlations from knock-out reactions
Isospin mixing	Precise B(E2) values	Energy levels
Halo nuclei	Study of resonances E1 response by (p,p')	Mass radii Momentum distributions
High spin structure at extreme T_z	High spin states in p-rich nuclei	Isomers in n-rich nuclei

Research with Radioactive Ion Beams



ISOLDE users community



2004 – 2008

68 approved experiments
579 scientists
134 institutes
34 countries

236 publications in refereed journals

of which 42 in "Letters"

more than 20 PhD's