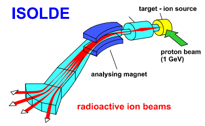
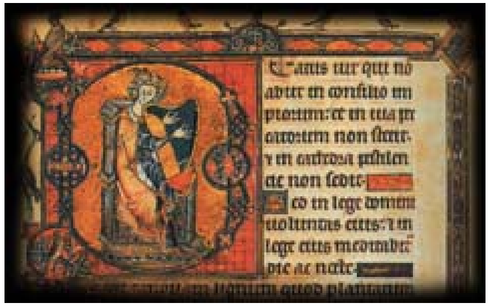
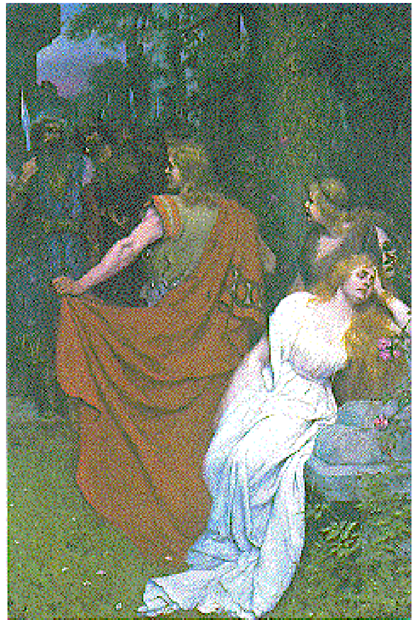




ISOLDE

Isotope Separation On-Line
(ISOL)



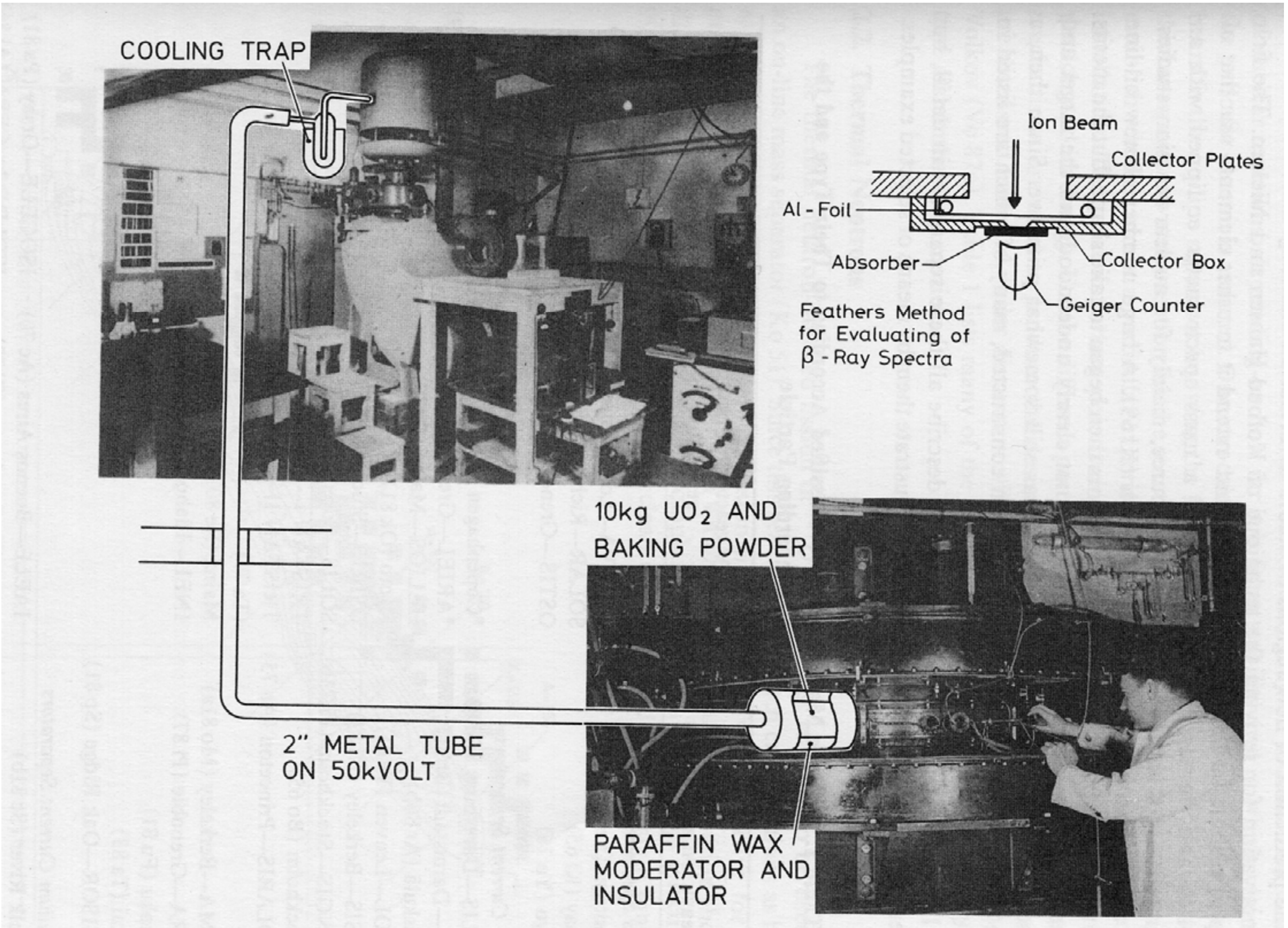
TRISTAN UND ISOLDE: Act II

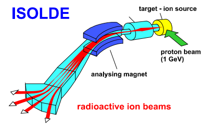
Mats Lindroos

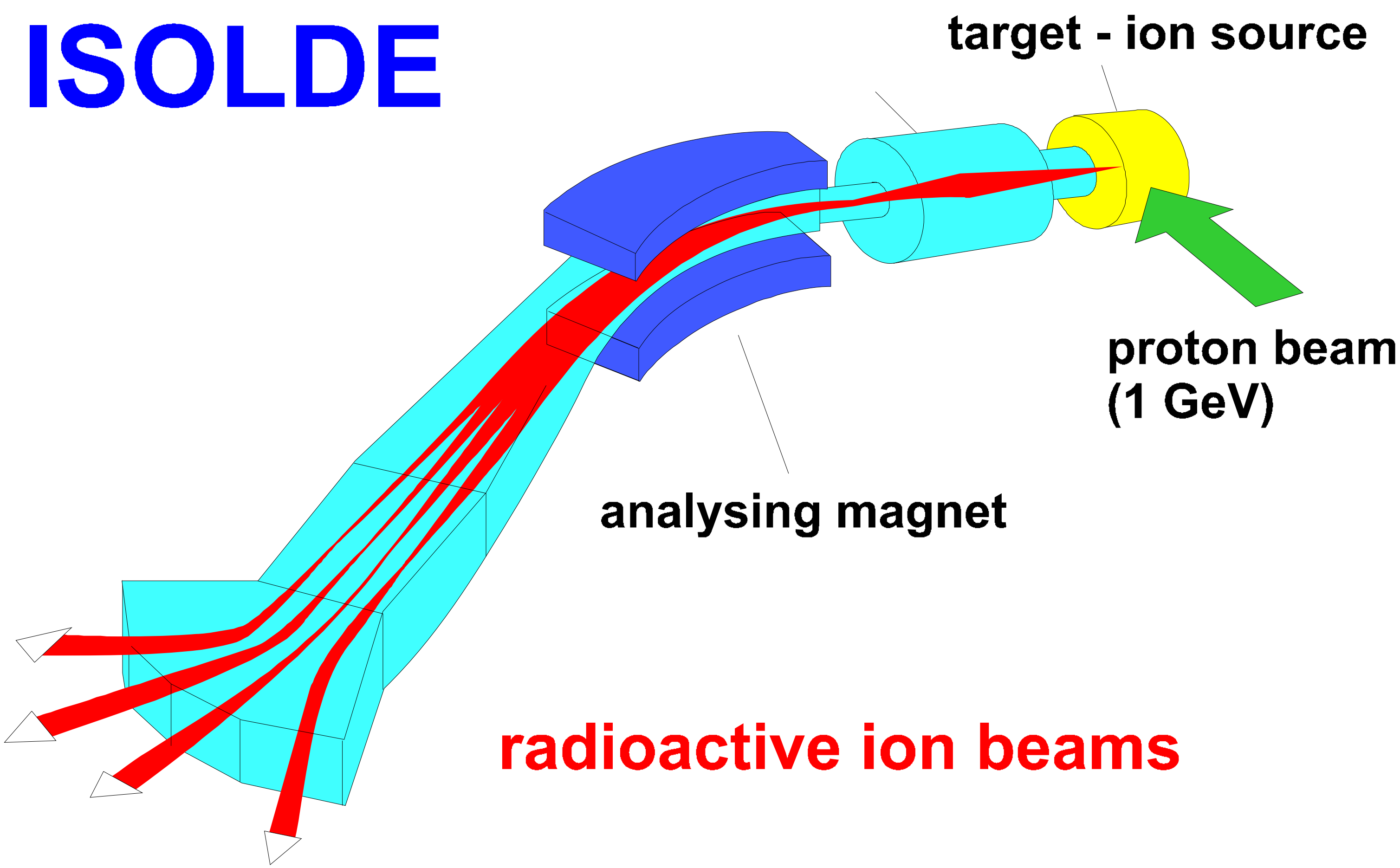
on

behalf of the CERN ISOLDE team

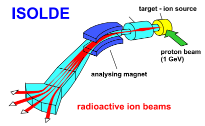
ISOL HISTORY




ISOLDE
target - ion source
proton beam
(1 GeV)
analysing magnet
radioactive ion beams

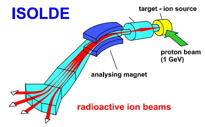

ISOLDE
target - ion source
proton beam
(1 GeV)
analysing magnet
radioactive ion beams

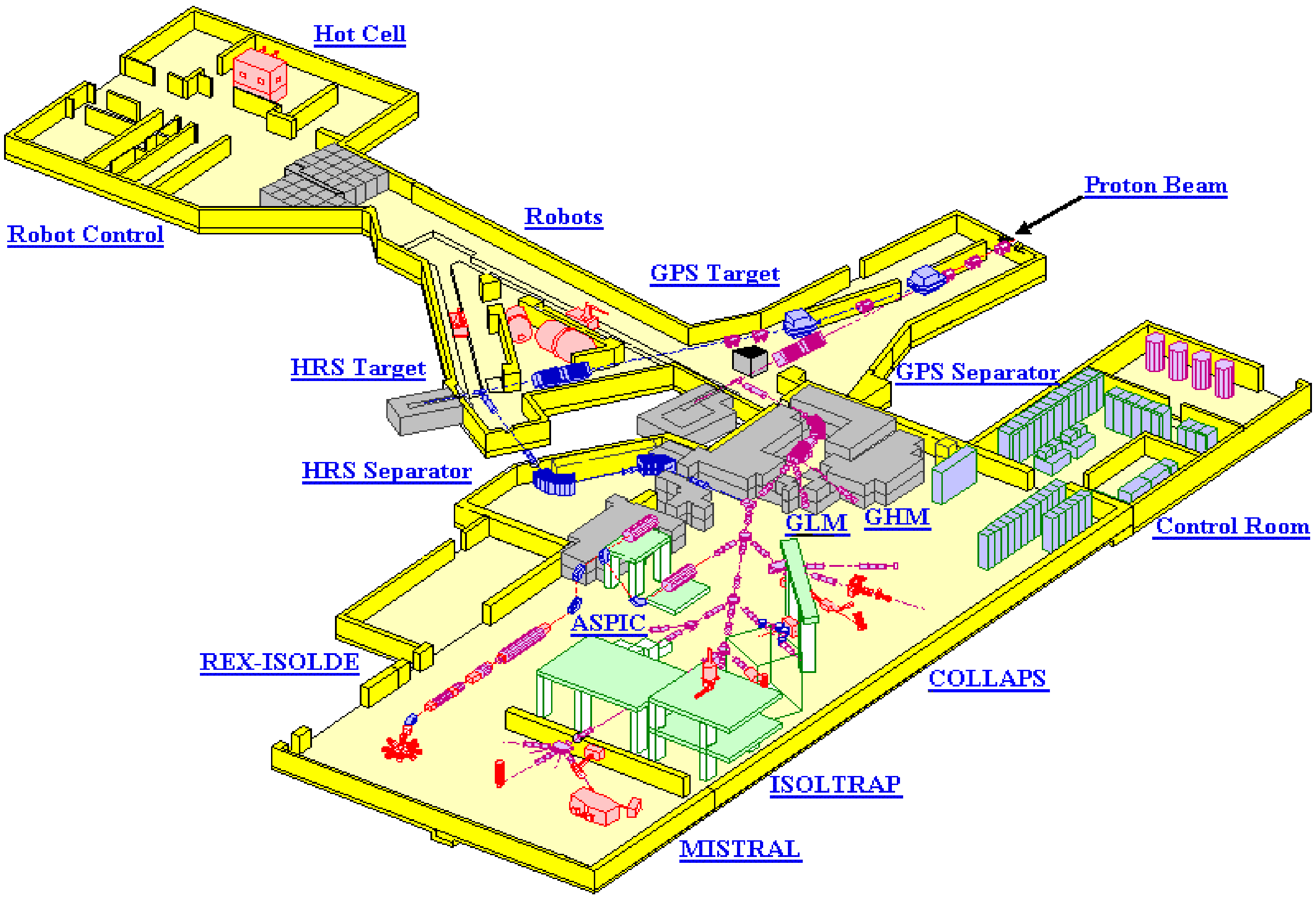
OUTLINE



- Overview of the ISOL technique
- ISOLDE-REX, post acceleration of radioactive ions
- Physics at ISOLDE
- Future plans
- Visit

ISOLDE@CERN





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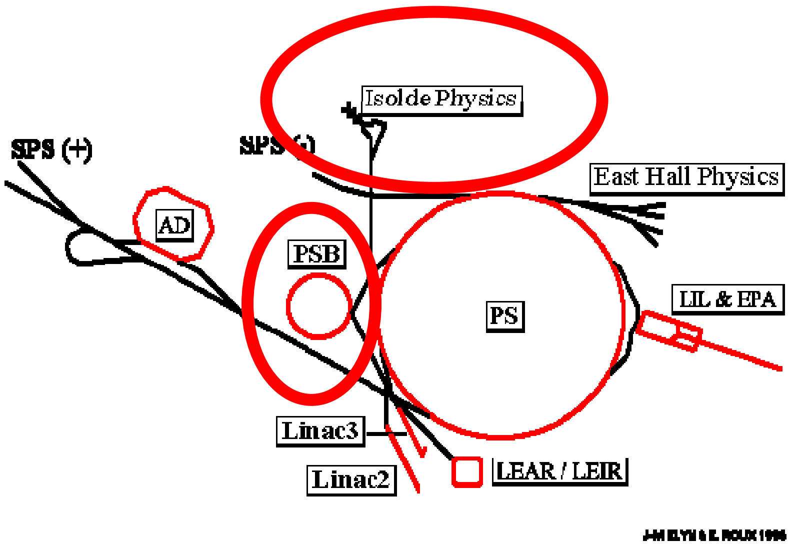
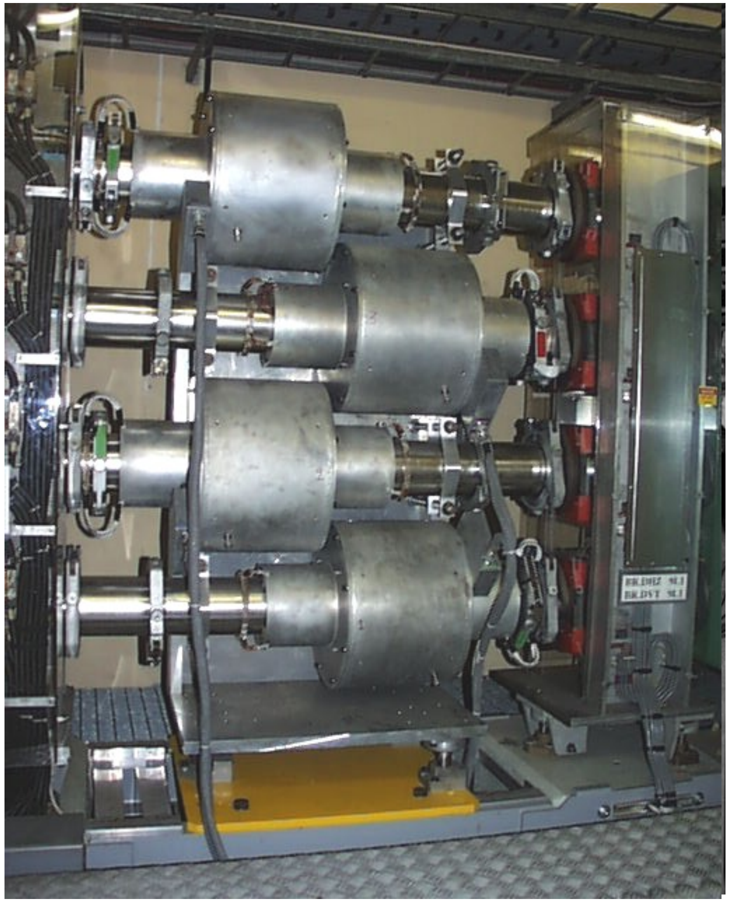
Mats Lindroos on behalf of the ISOLDE team

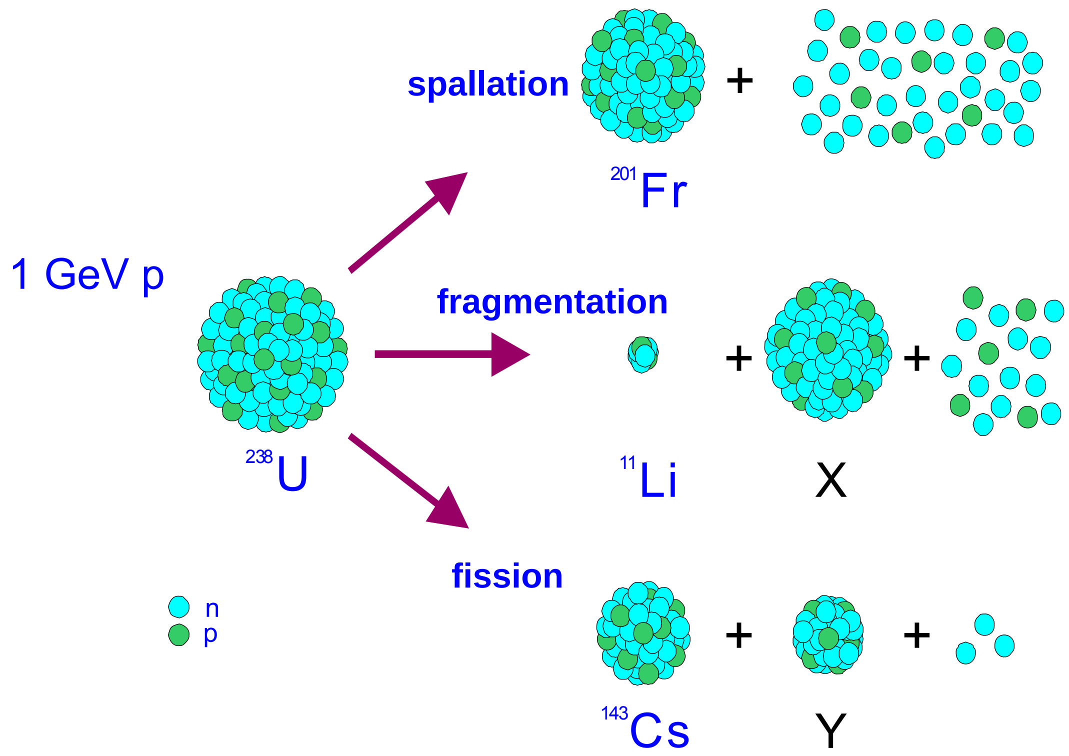
PS Booster



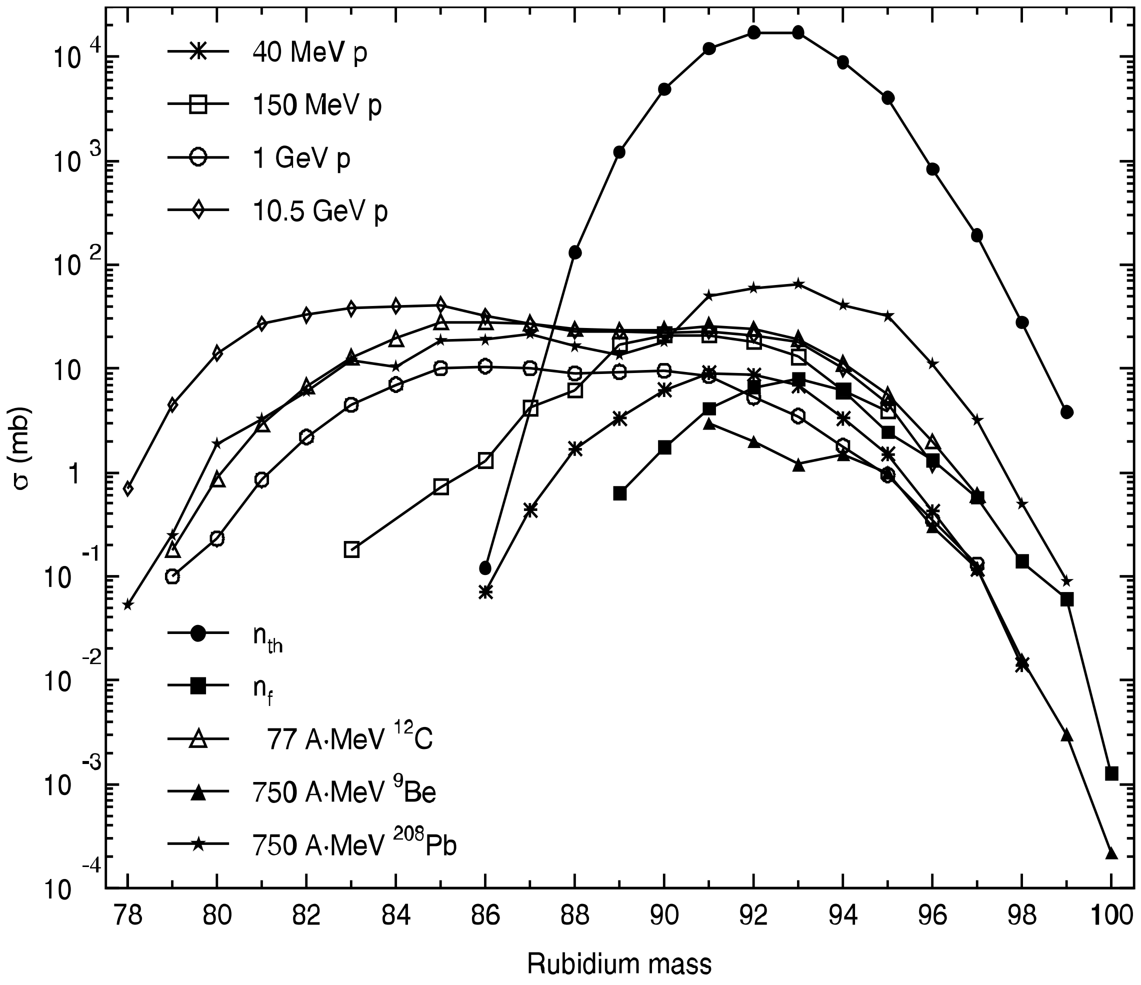
Isolde Physics
SPS (+)
SPS (-)
East Hall Physics
AD
PSB
PS
LIL & EPA
Linac3
Linac2
LEAR / LEIR



Production of exotic ions

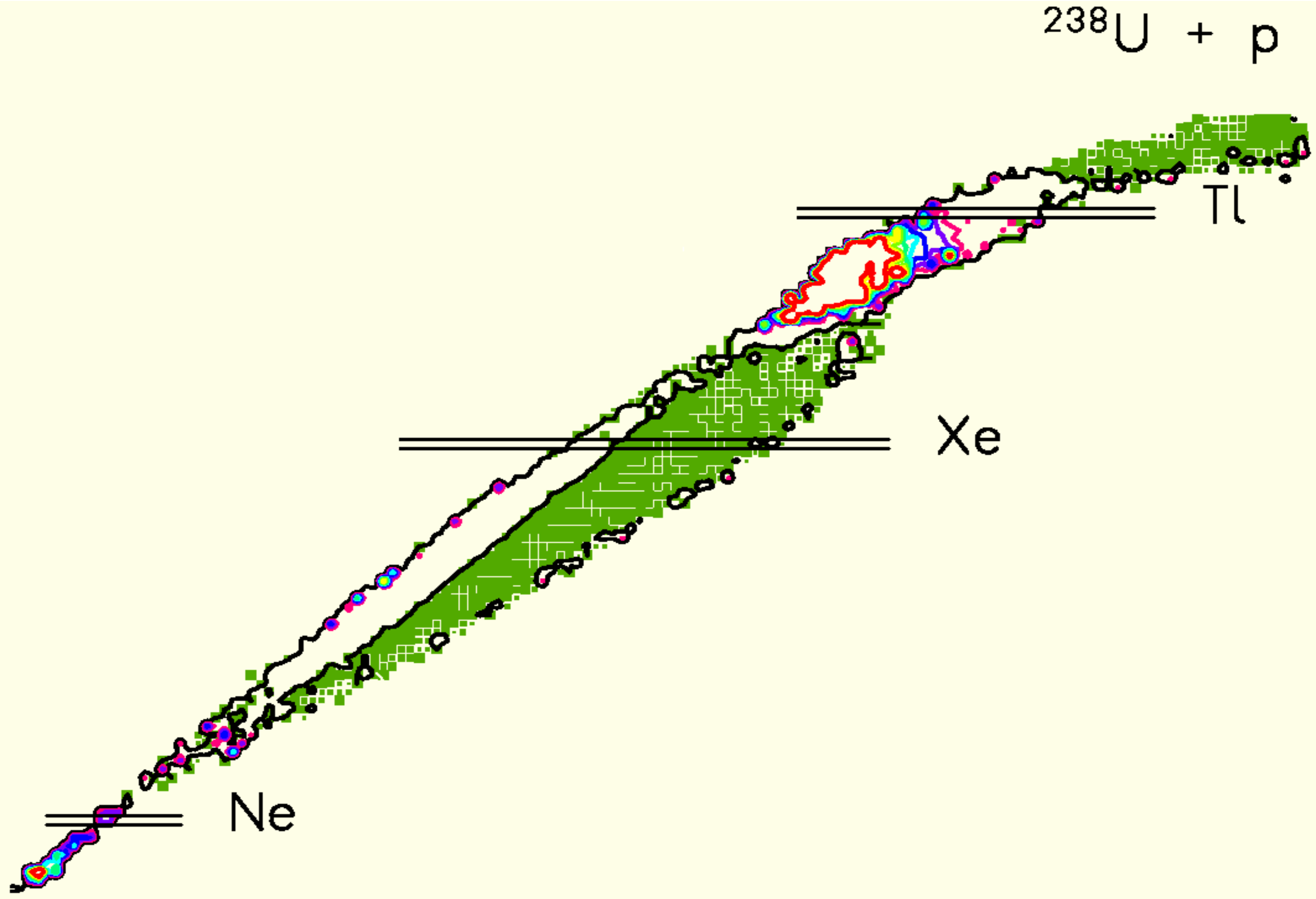


PRODUCTION YIELDS



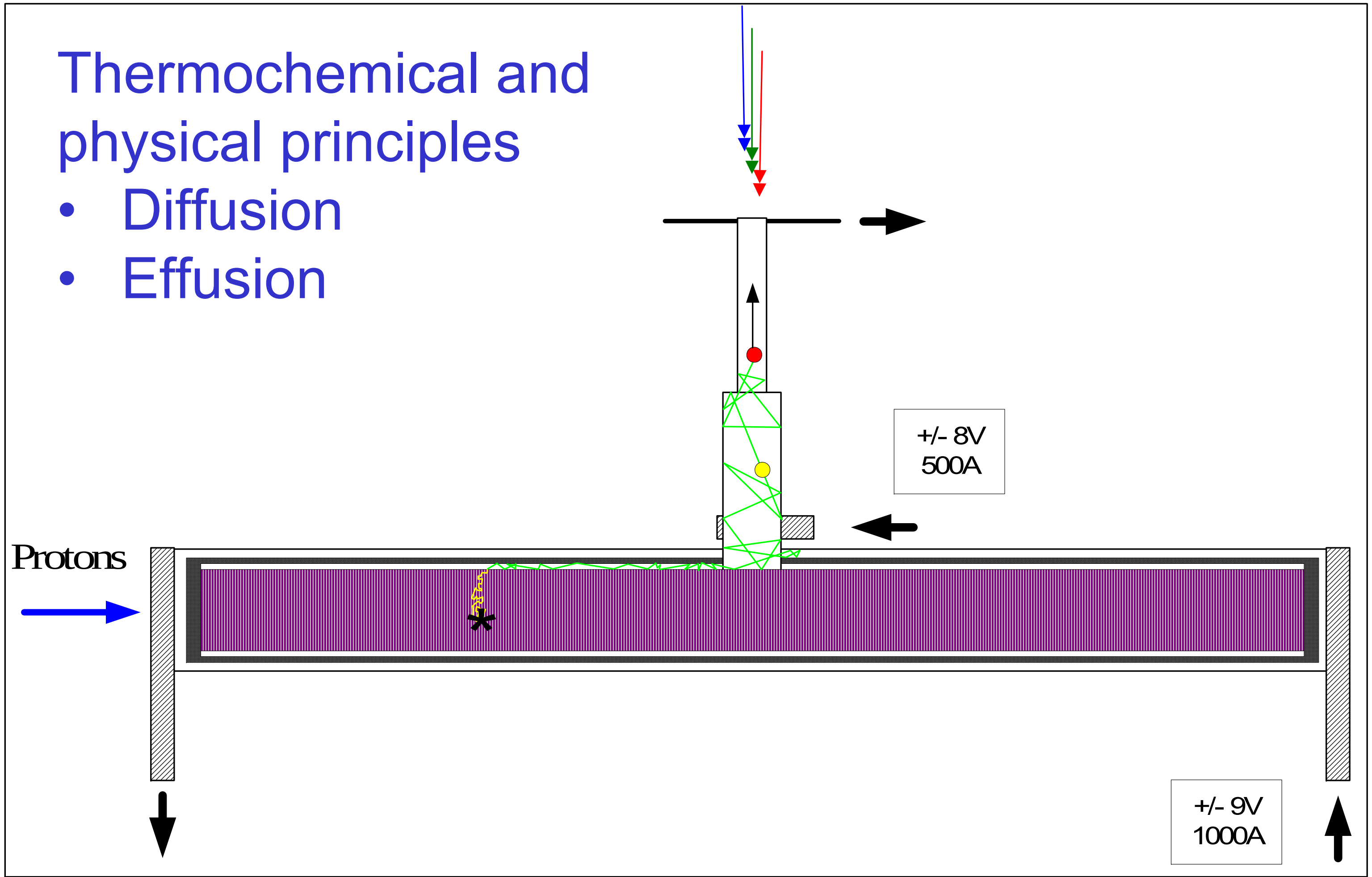
Cross sections

energy dependence

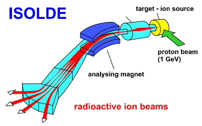


Thermochemical and physical principles

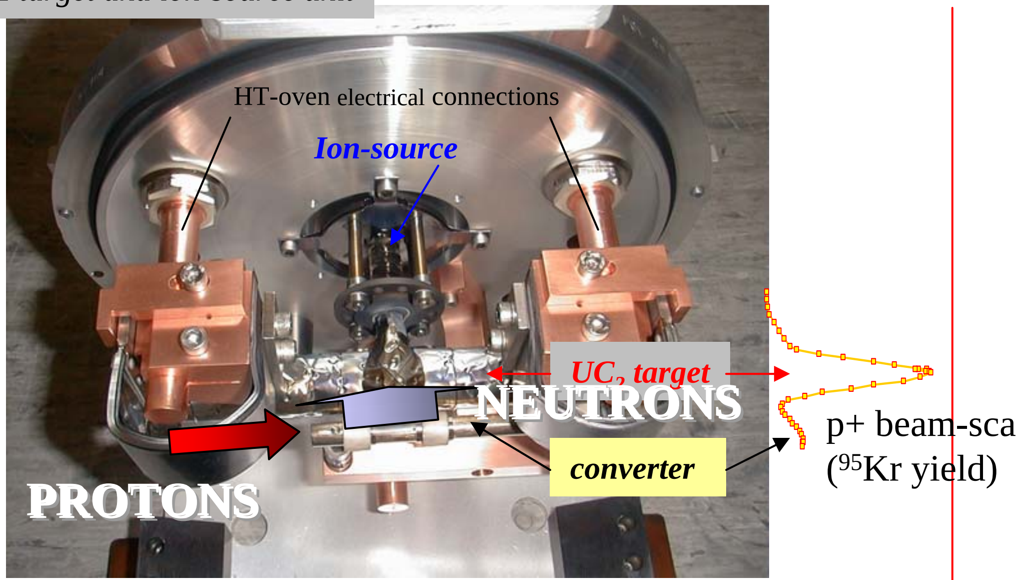
- Diffusion
- Effusion



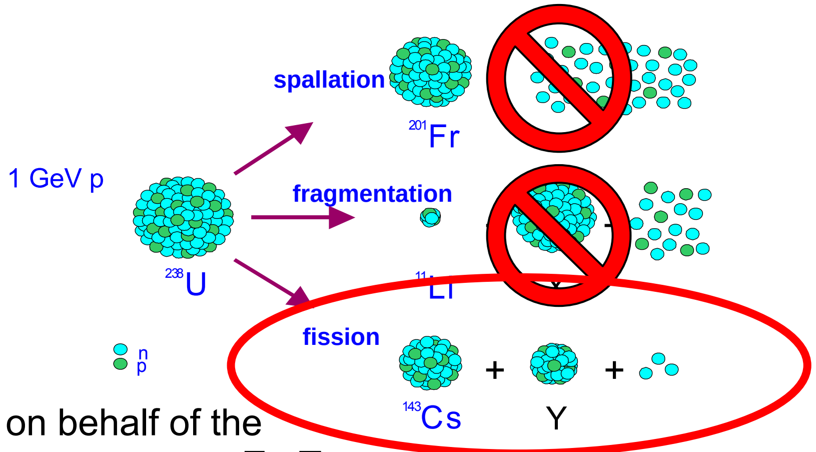
Target



ISOLDE target and ion-source unit

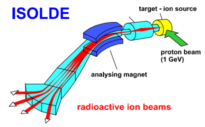


The thermal shock of the proton's dE/dx is transferred to the "cold" converter.



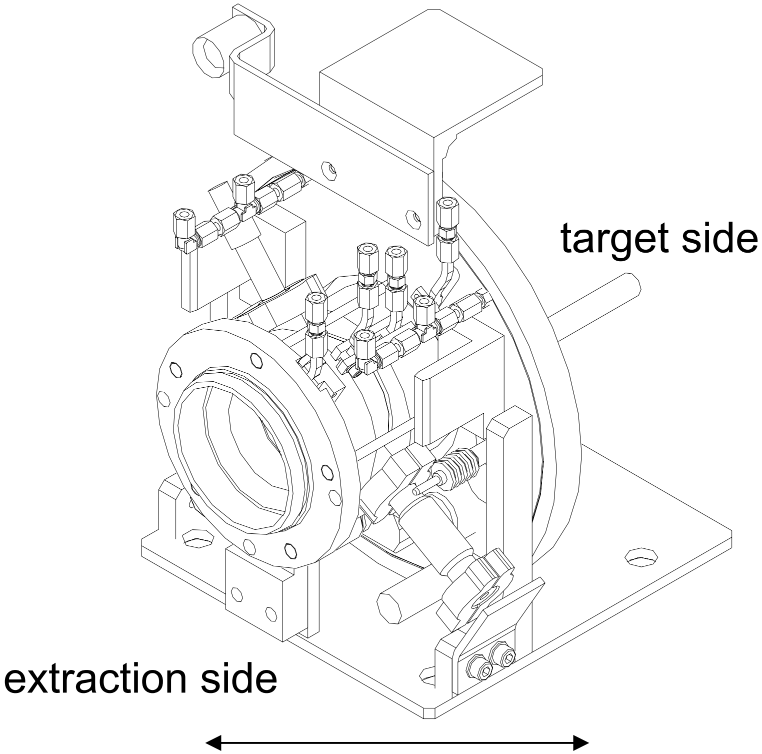
J. Lettry et al.

MONOECR (AT ISOLDE)



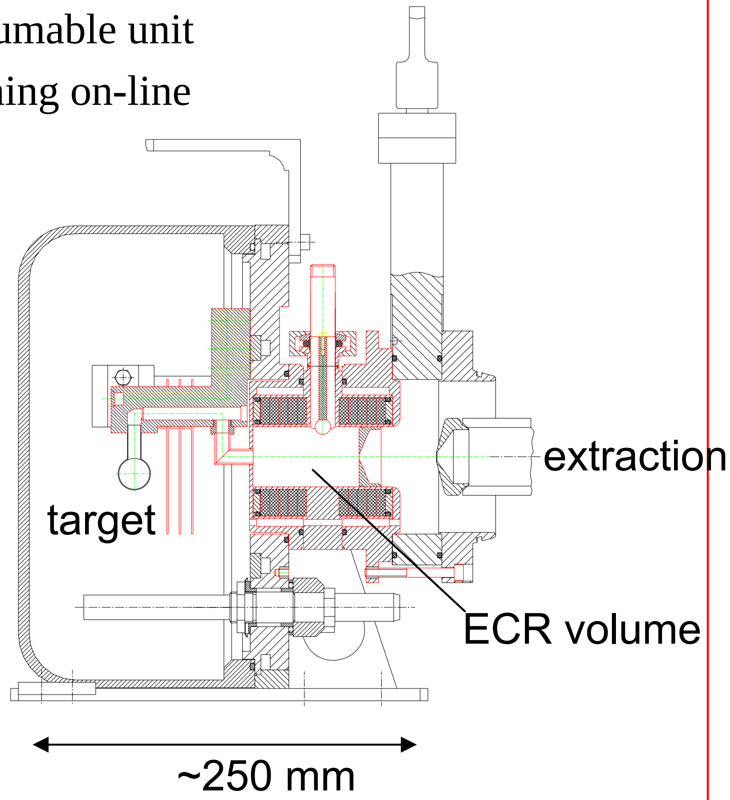
ISOECRIS

- based on a ISOLDE unit
- coils
- consumable unit
- Running off-line



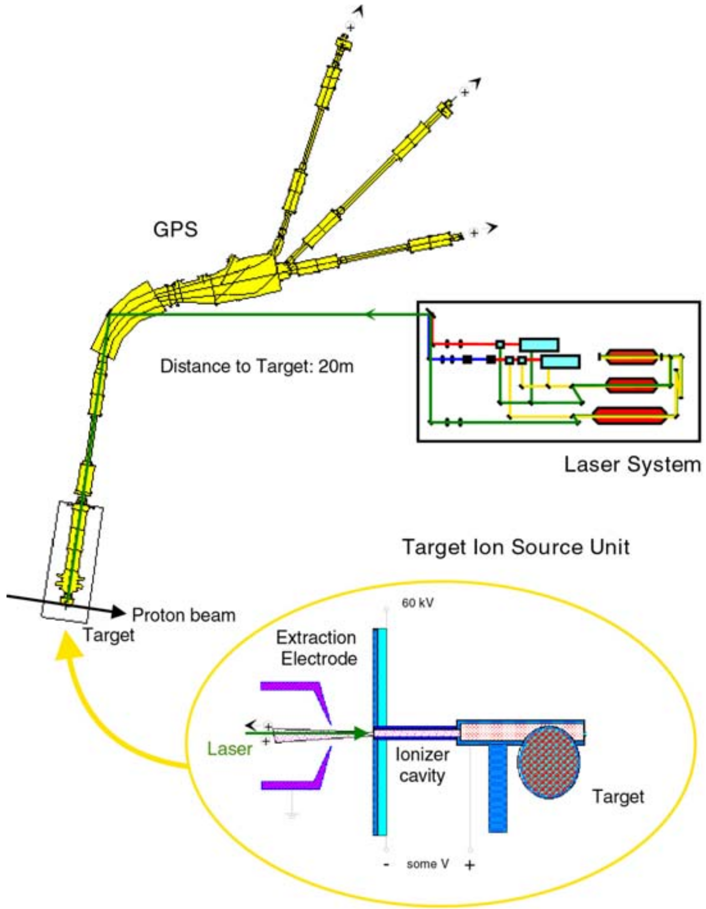
MINIMONO ISOLDE

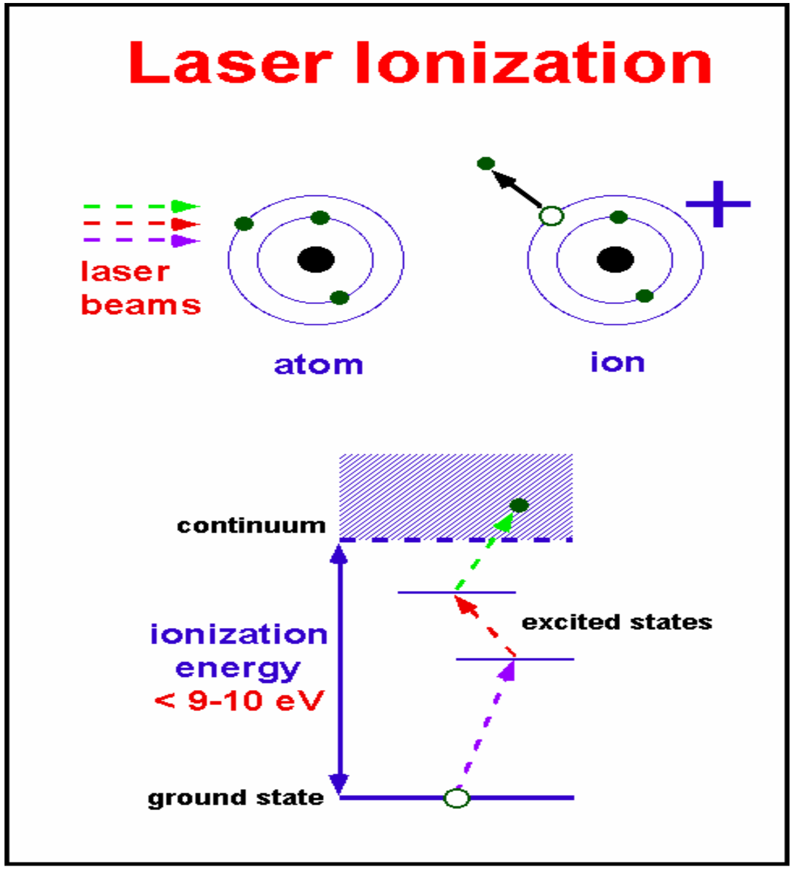
- GANIL design [1,2]
- ‘standard’ ISOLDE unit
- permanent magnets
- consumable unit
- Running on-line



F. Wenander, J.Lettry

Ion source
Laser ionization





ISOLDE target change

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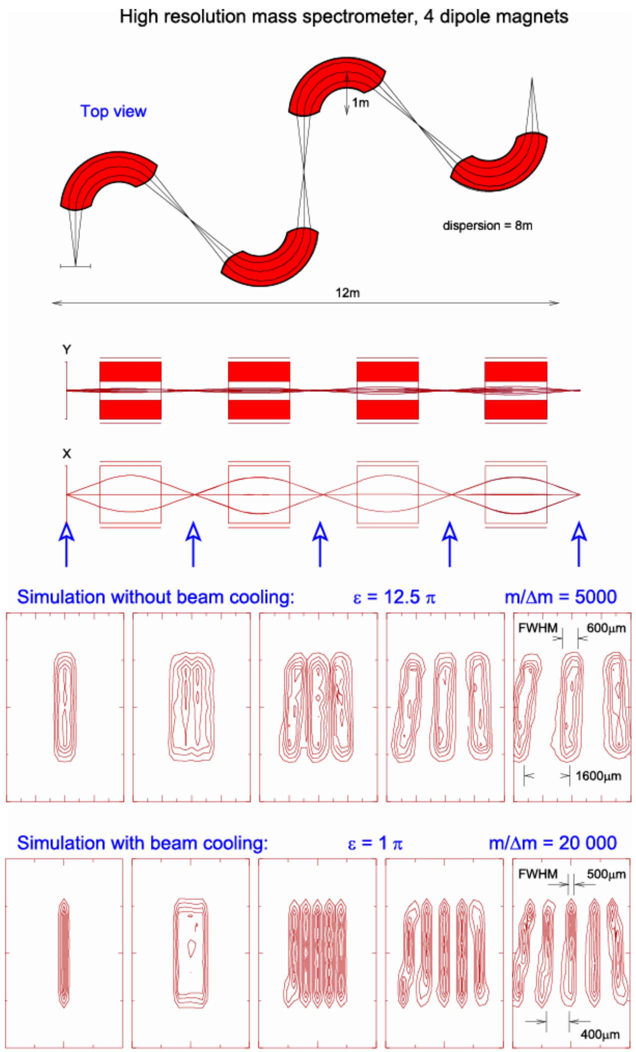
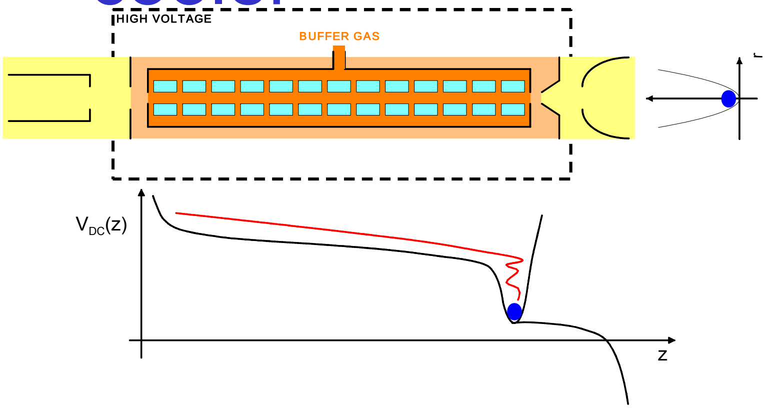
Mats Lindroos on behalf of the ISOLDE team

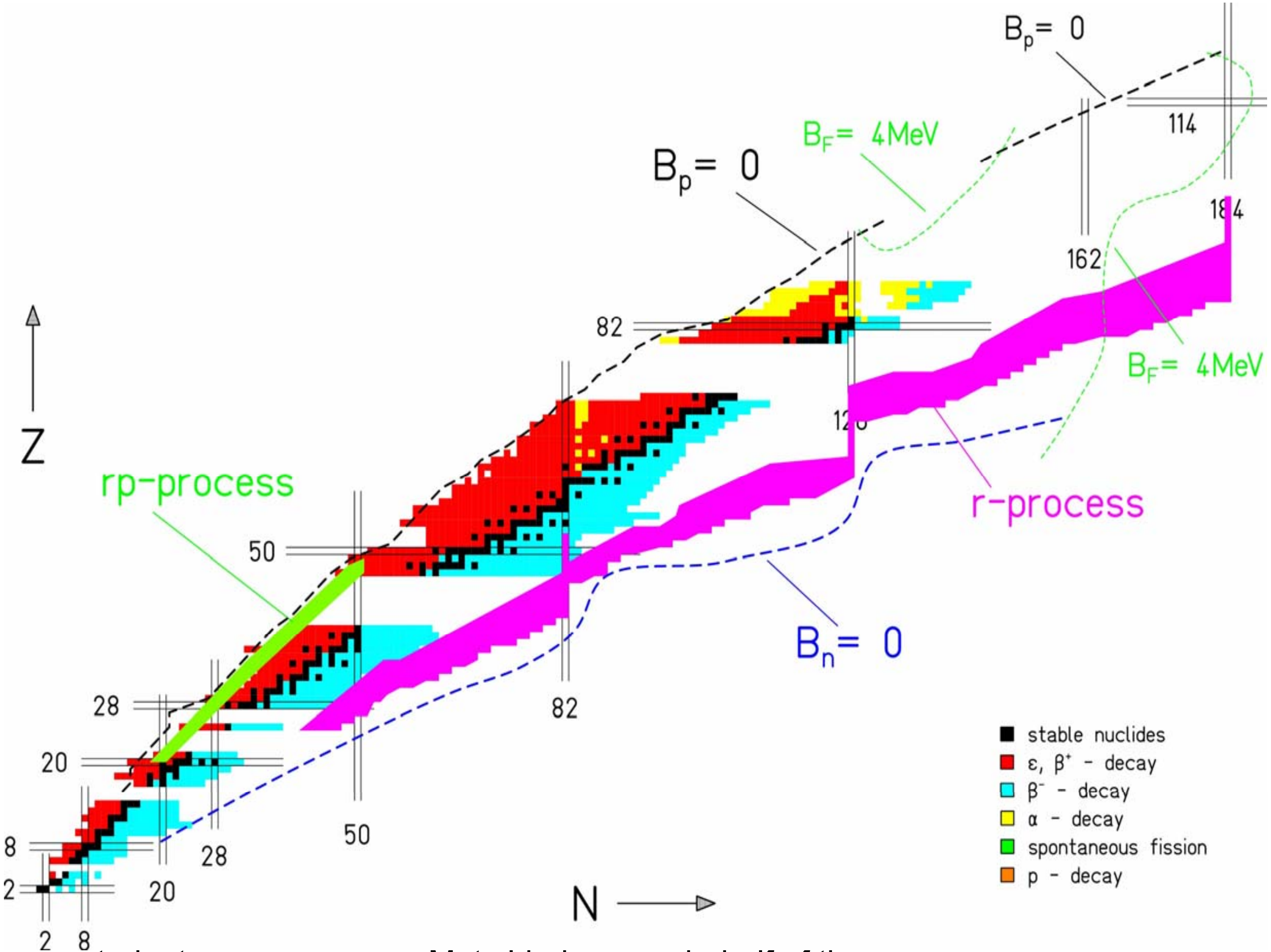
Magnetic separation



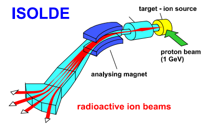
- "Isobaric" separation
- Separation limited by the beams transverse size
- Cooling at low energy with RFQ cooler



Nuclear chart @ ISOLDE



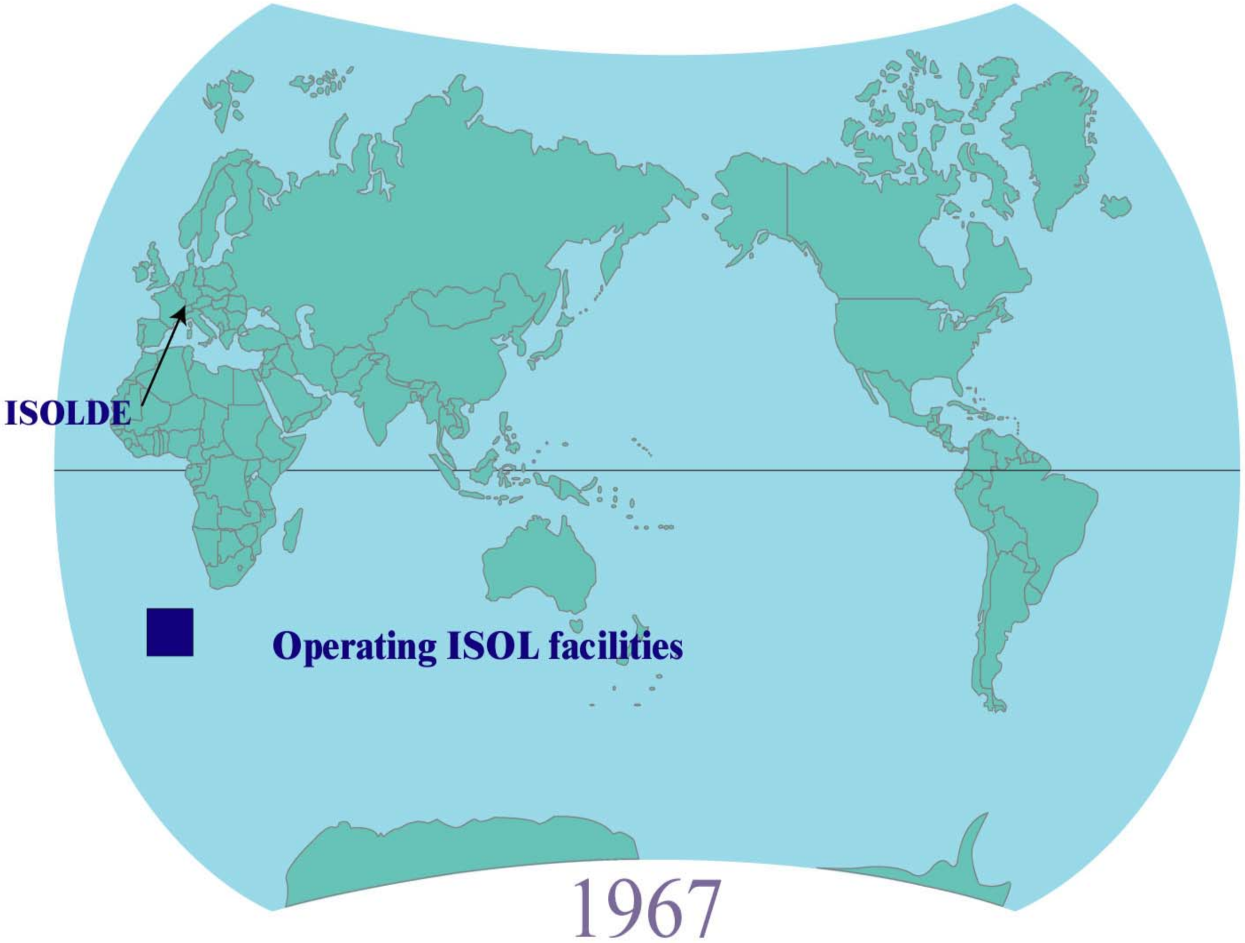
Pure beams?



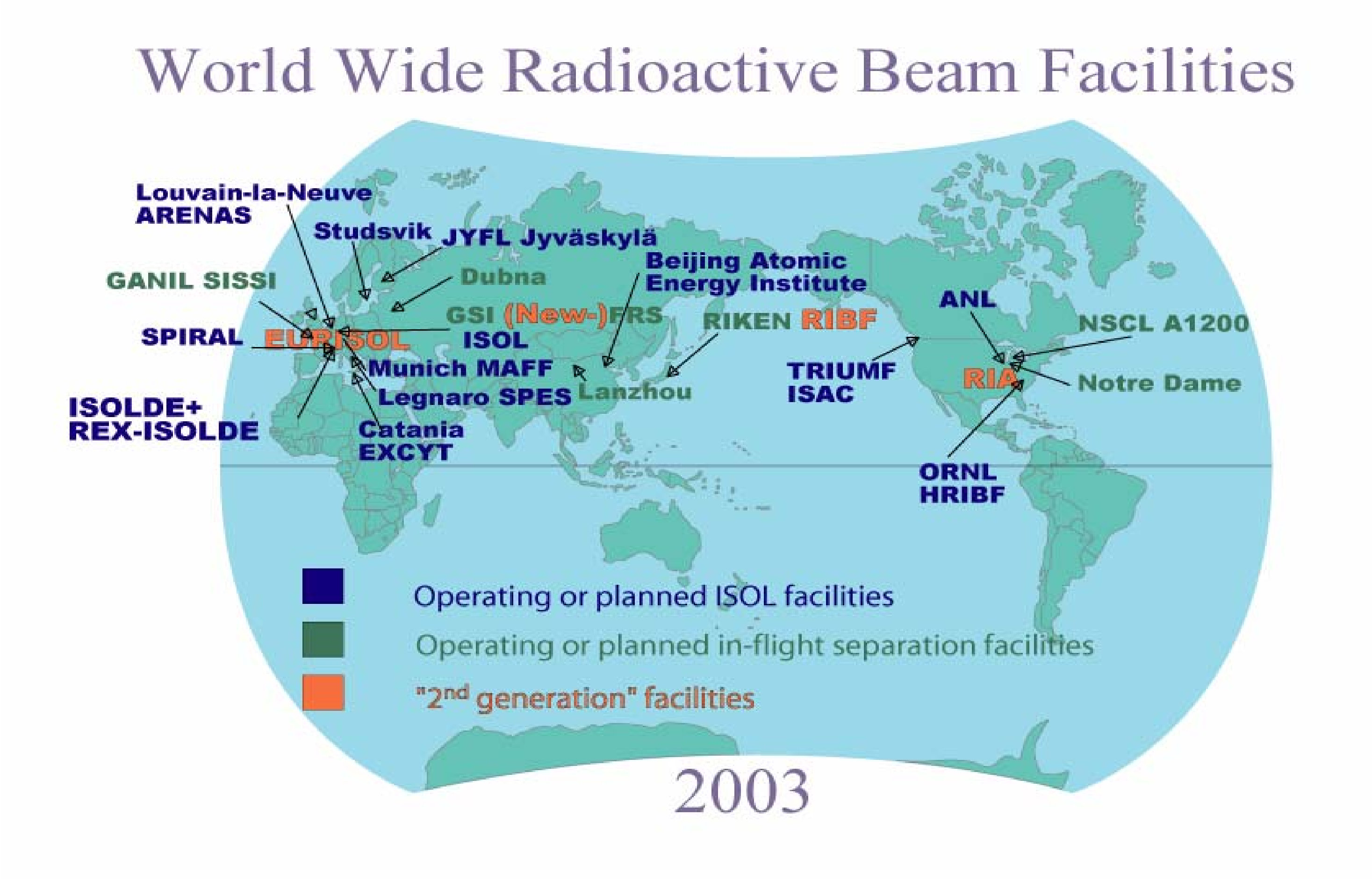
To get pure beams free from isobaric contamination:

- Target material
- Target and ion source chemistry
- Proton energy
- Ion source
- Magnetic separation

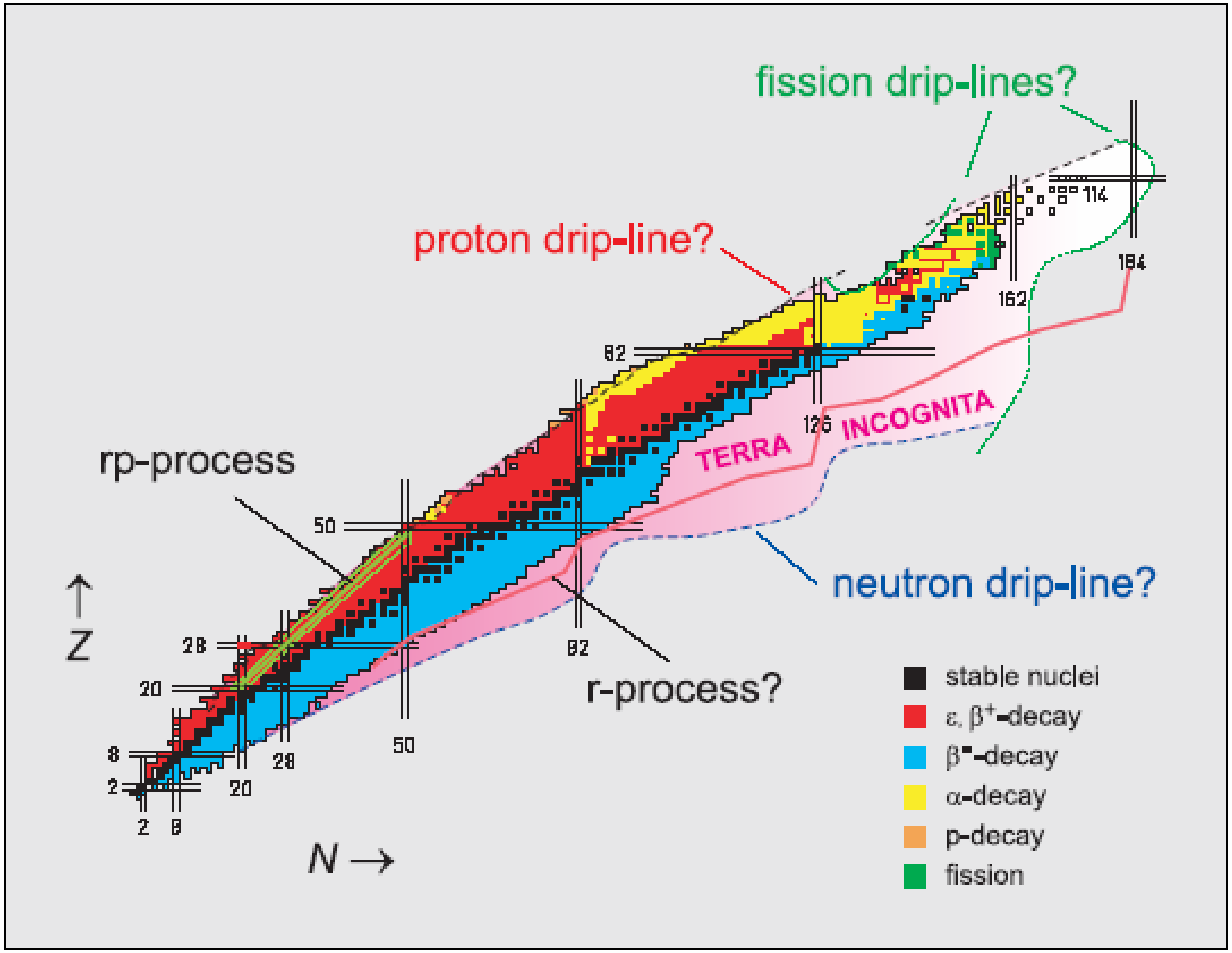
ISOL facilities 1967



ISOL facilities 2003



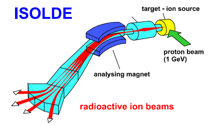
Nuclear Landscape



Why bother?

- A few-body system of hadrons (neutrons and protons) with many remaining question marks
- “Largest” system where strong and weak interaction are manifested
- “Applications”
  - Astrophysics
  - Condensed matter
  - Energy
  - Medicine

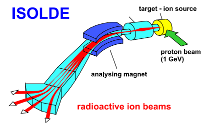
Why Nuclear physics?

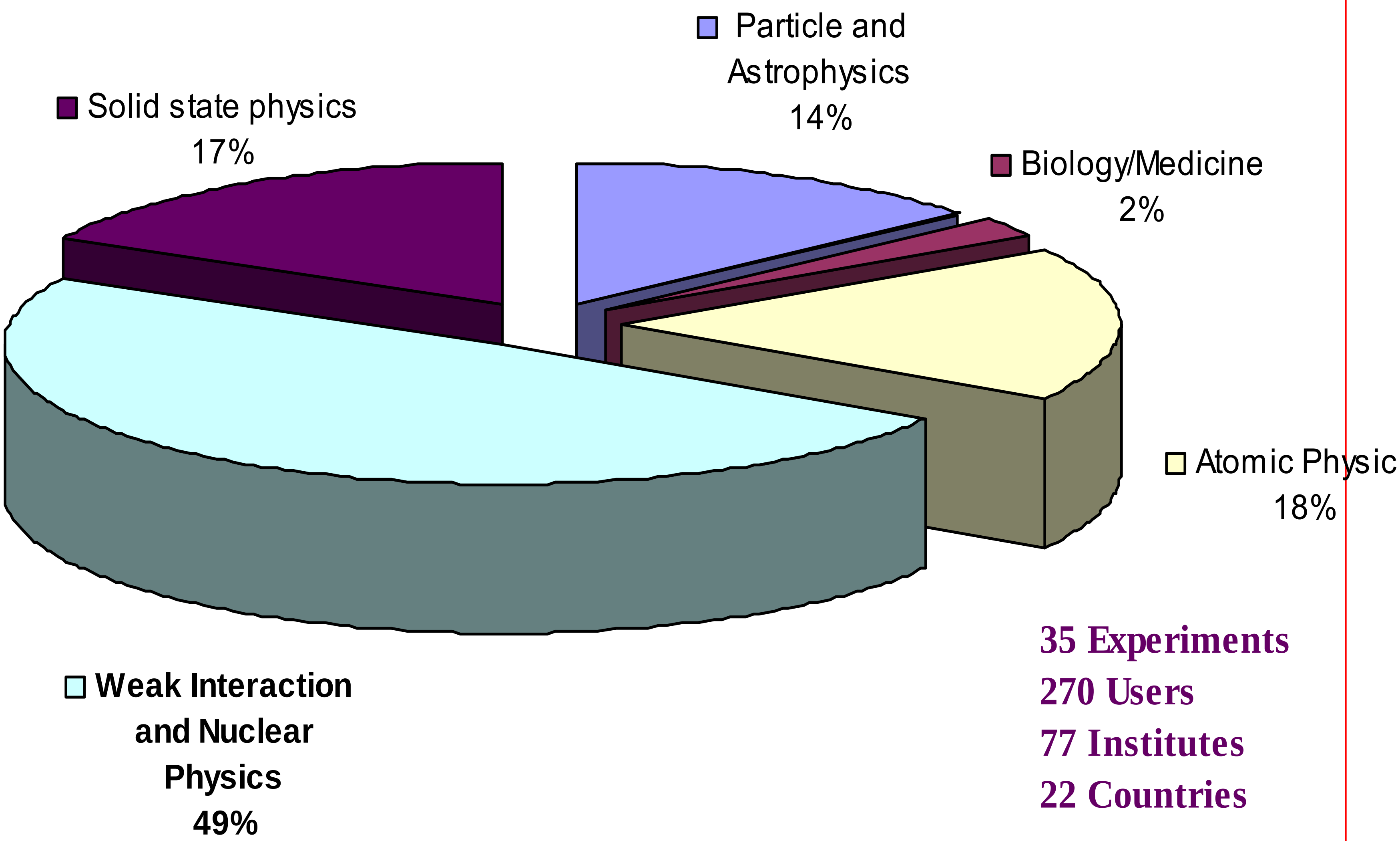


"And why nuclear physics? My answer is the same as that of the young student who chose nuclear physics – *it is a field of basic research with fascinating fundamental problems and applications to many other areas* such as medicine and material science. I believe that nuclear physics is so broad that it is well on the way to becoming *the most general natural science*."

Professor Paul Kienle, 1993

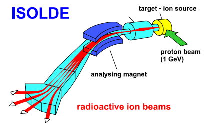
Physics at ISOLDE

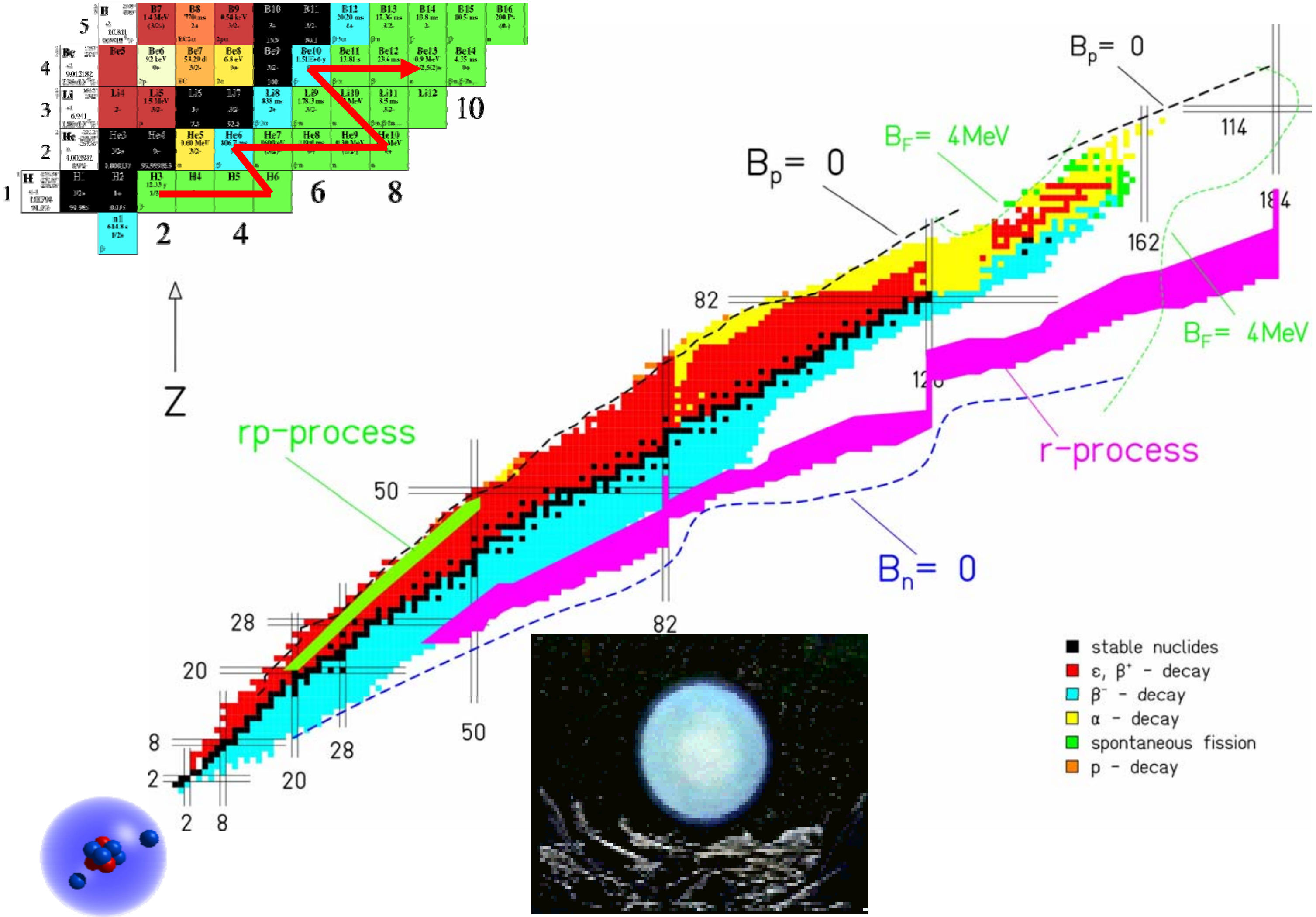




35 Experiments
270 Users
77 Institutes
22 Countries

ASTROPHYSICS





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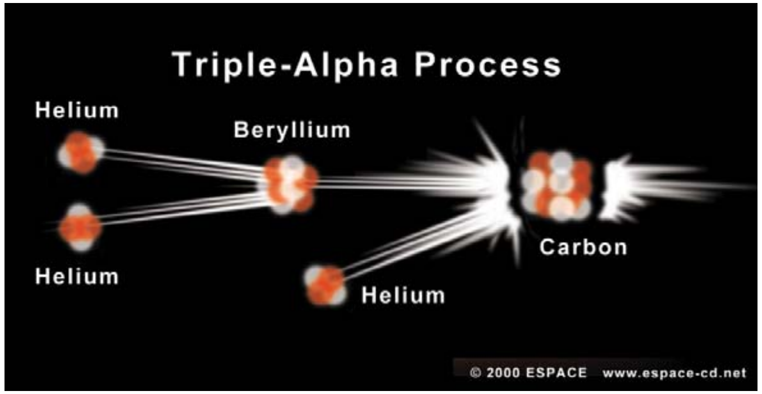
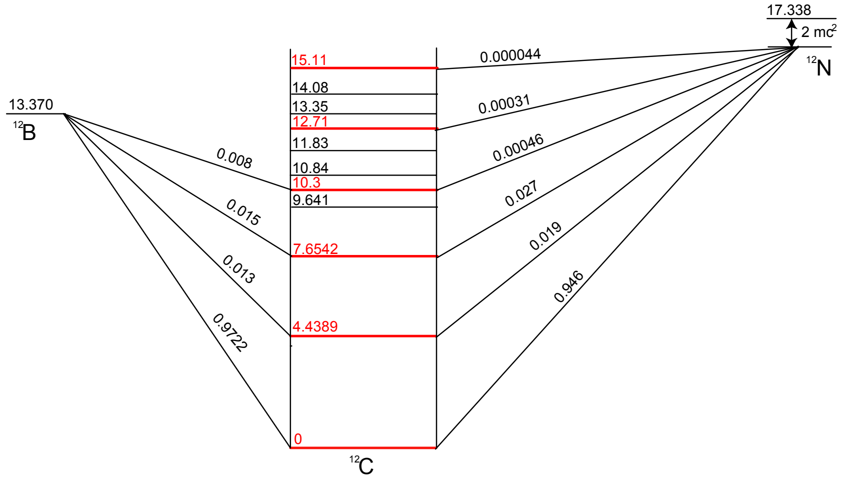
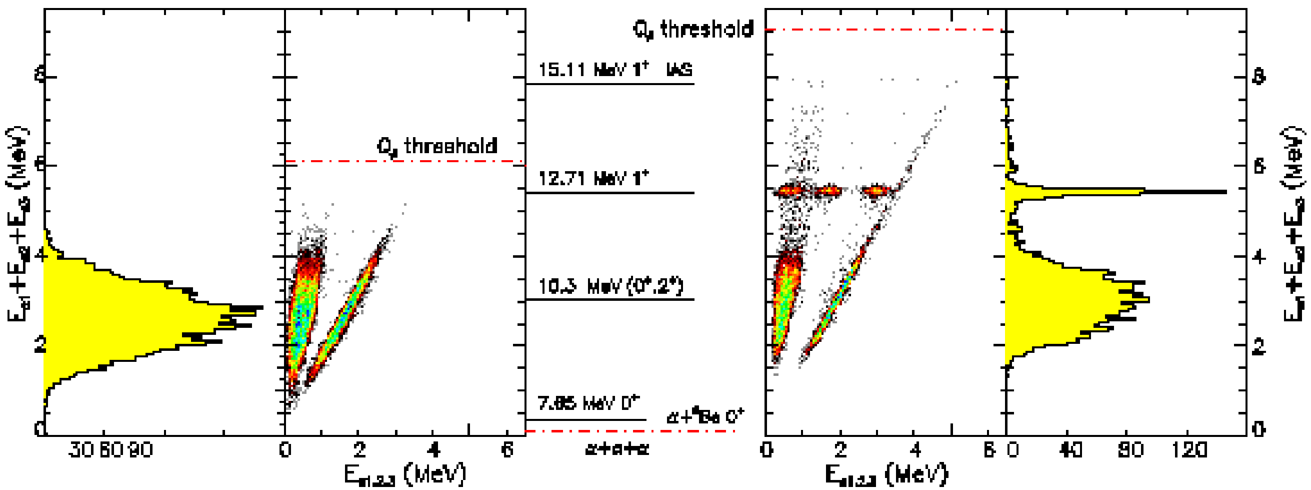
ISOLDE team

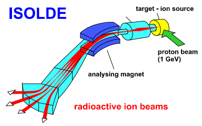
Three-particle break-up of light nuclei (¹²C)

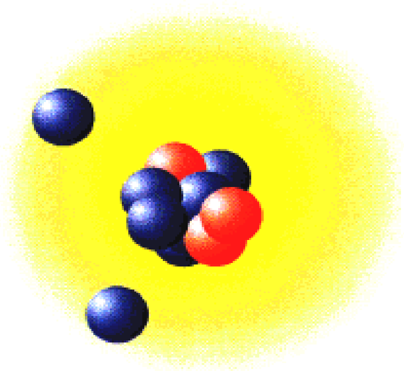




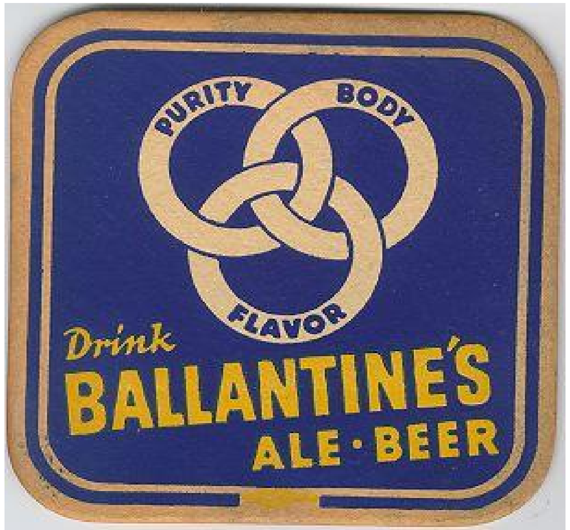


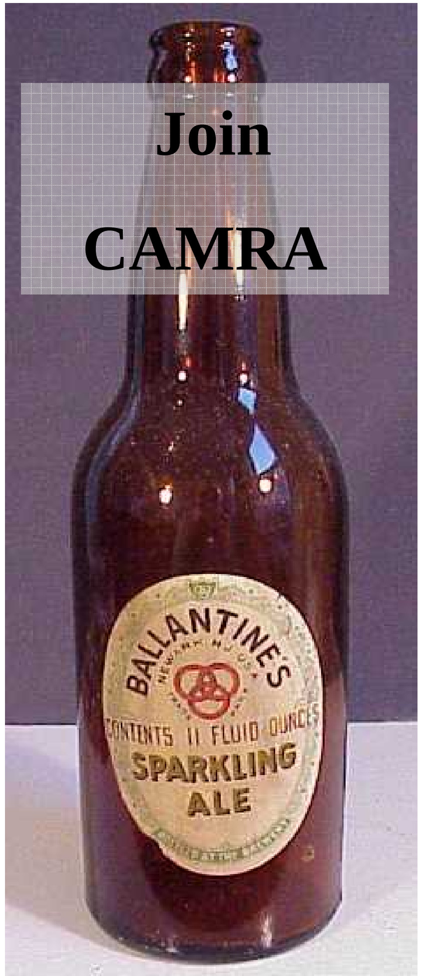
HALO NUCLEI





^{11}Li: Borromean Halo Nucleus





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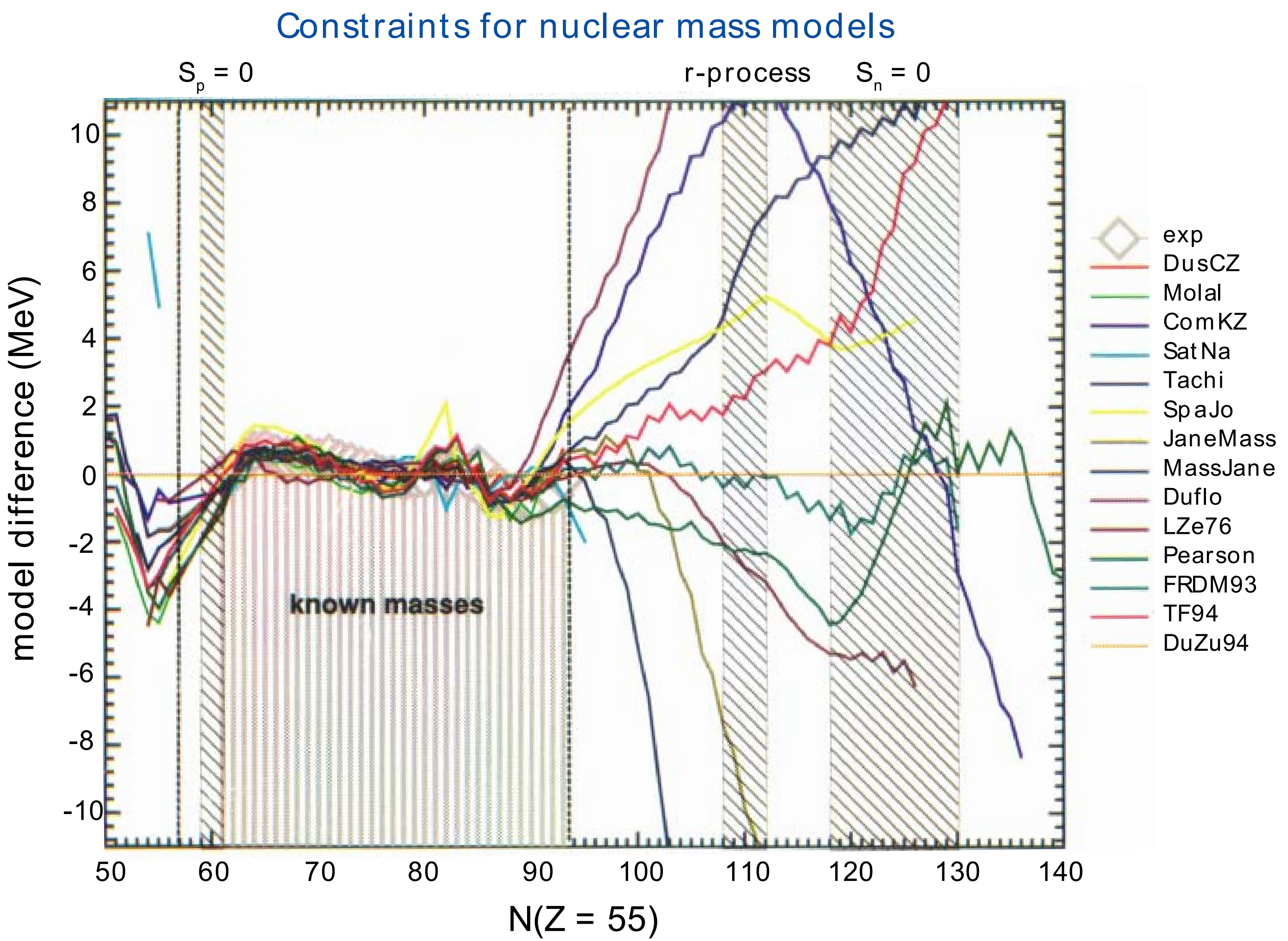
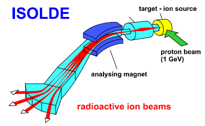
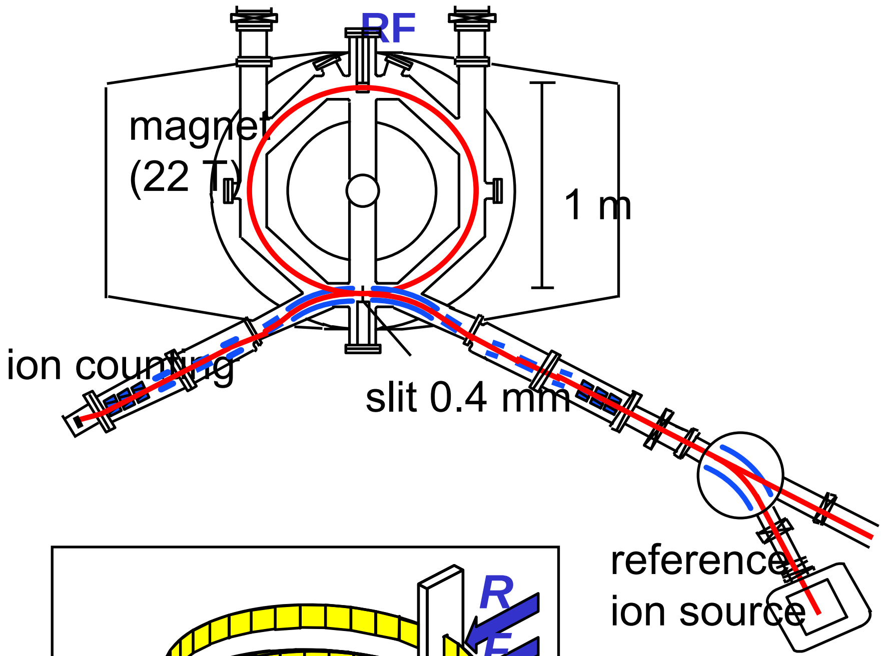
Mass models

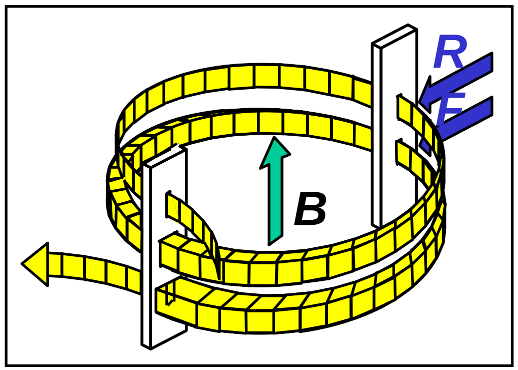


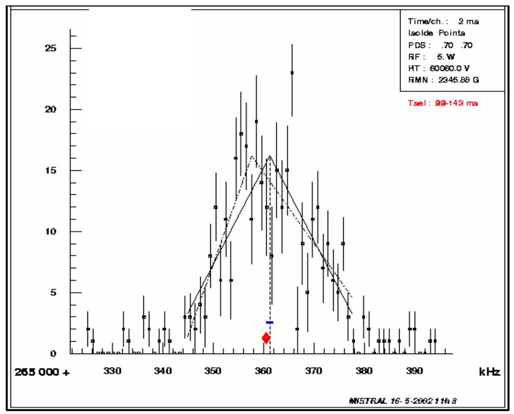
Constraints for nuclear mass models
$S_p = 0$
r-process
$S_n = 0$
model difference (MeV)
known masses
N(Z = 55)
exp
DusCZ
Molal
ComKZ
SatNa
Tachi
SpaJo
JaneMass
MassJane
Duflo
LZe76
Pearson
FRDM93
TF94
DuZu94

Mass measurements

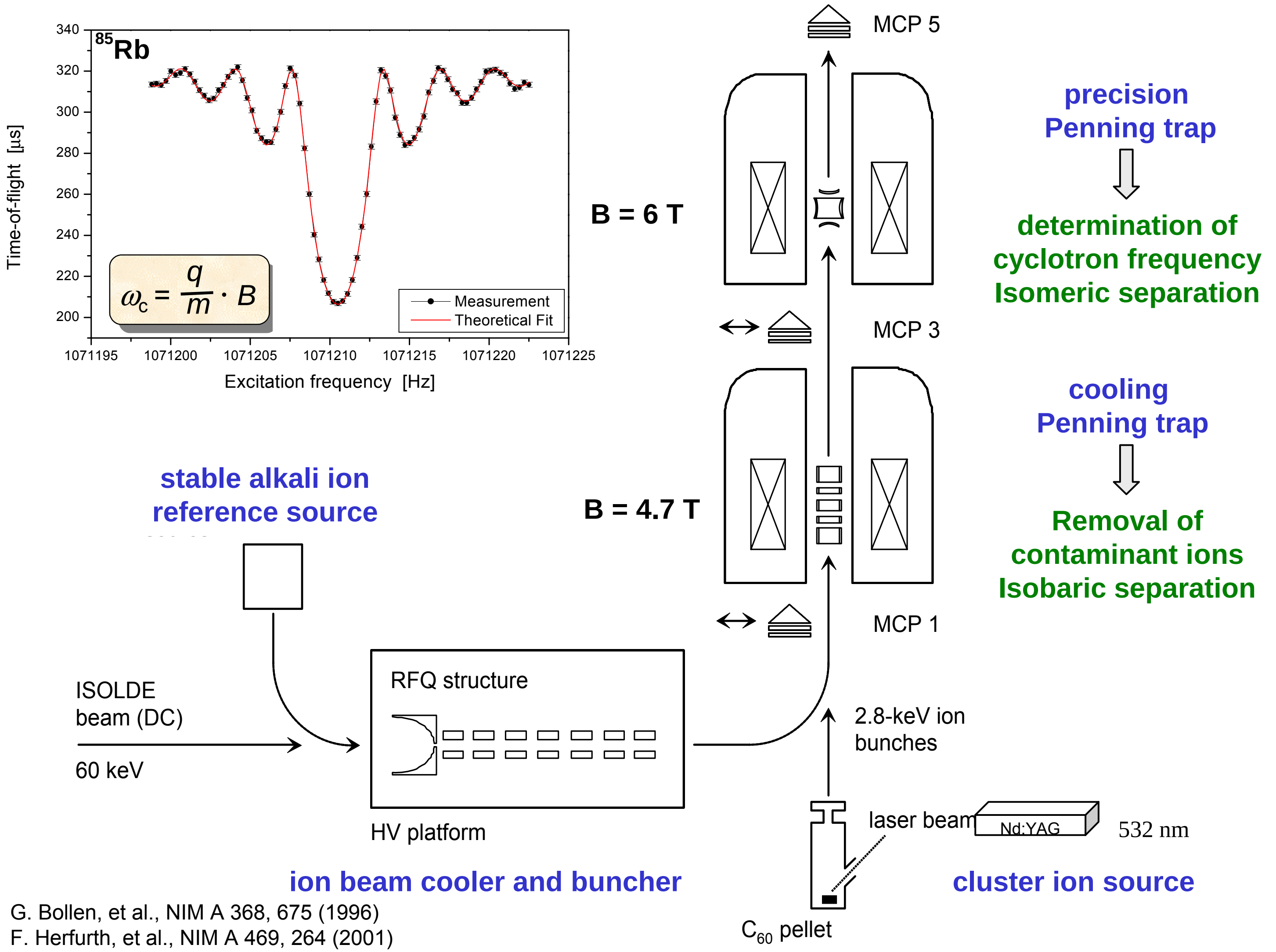








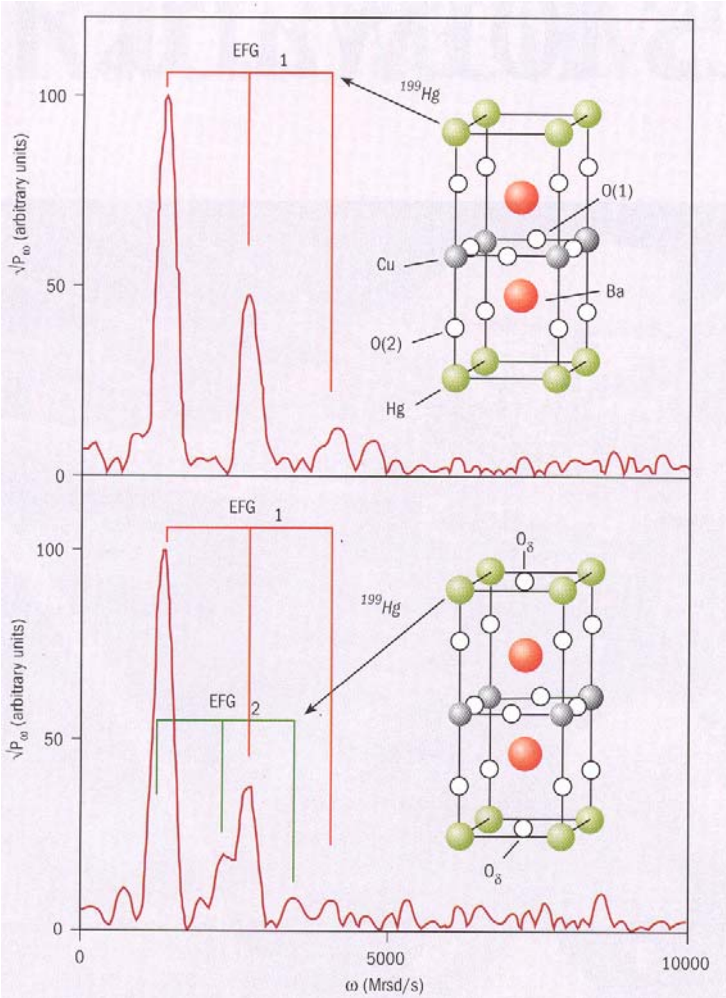
Mass measurements



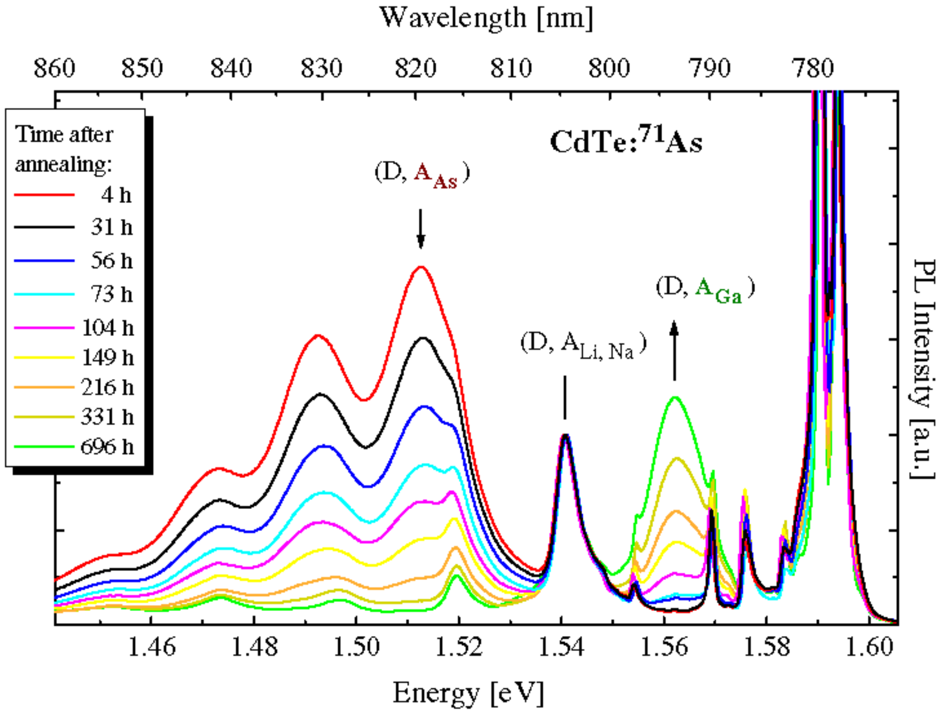
G. Bollen, et al., NIM A 368, 675 (1996)
F. Herfurth, et al., NIM A 469, 264 (2001)

Solid state physics

Radioactive ions as "spies" (PAC) in high-Tc superconductors…

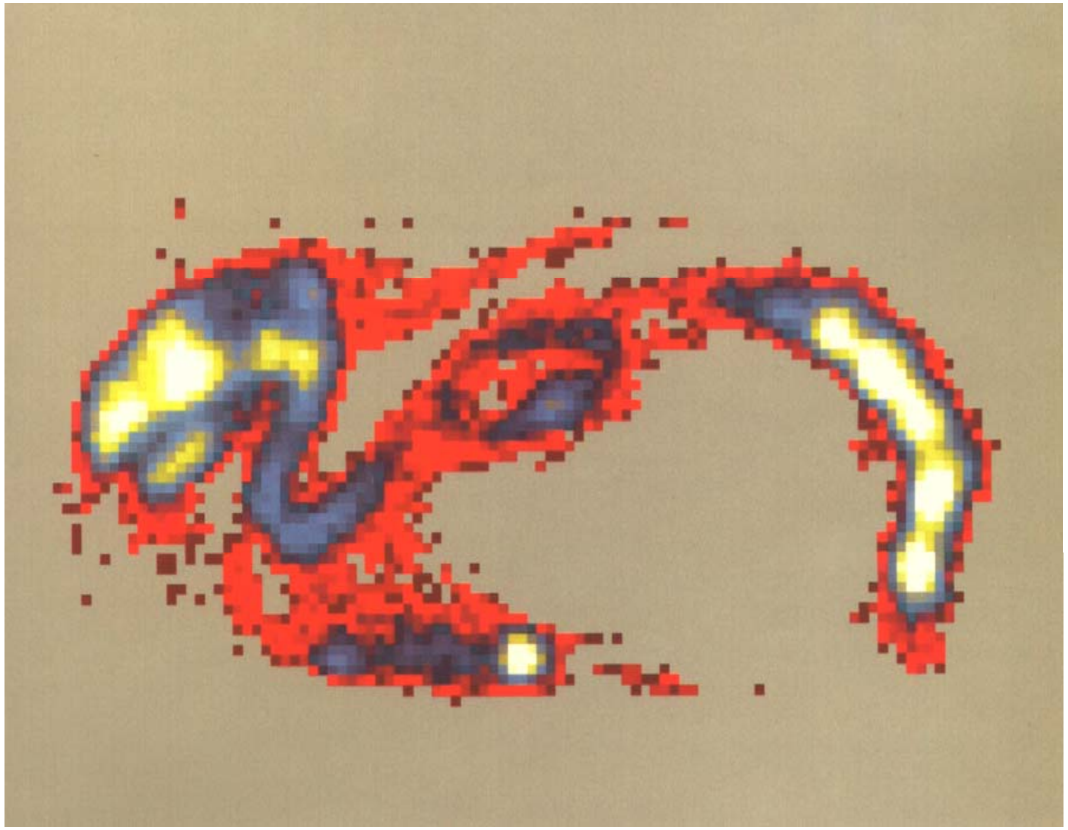


… or as dopants in semiconductors that change with time.



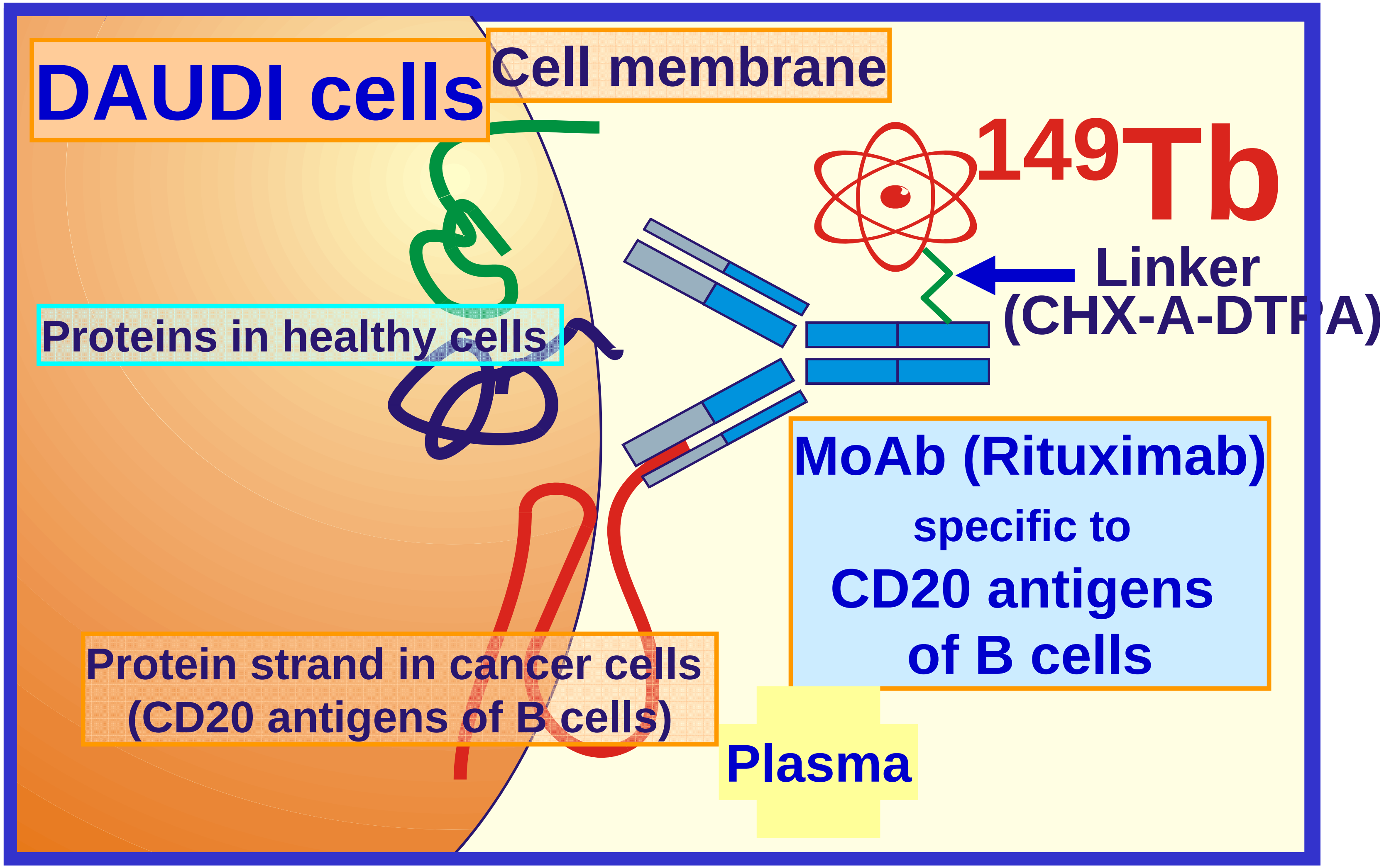
MEDICAL PHYSICS

- Example: samarium isotopes
- “in vivo” dosimetry by positron emission tomography (PET)
- 142-Sm (e, T1/2 = 72m) -> 142-Pm (ḅ, T1/2 = 40s)
- Therapy: 153-Sm (b̃ , T1/2 = 47h)



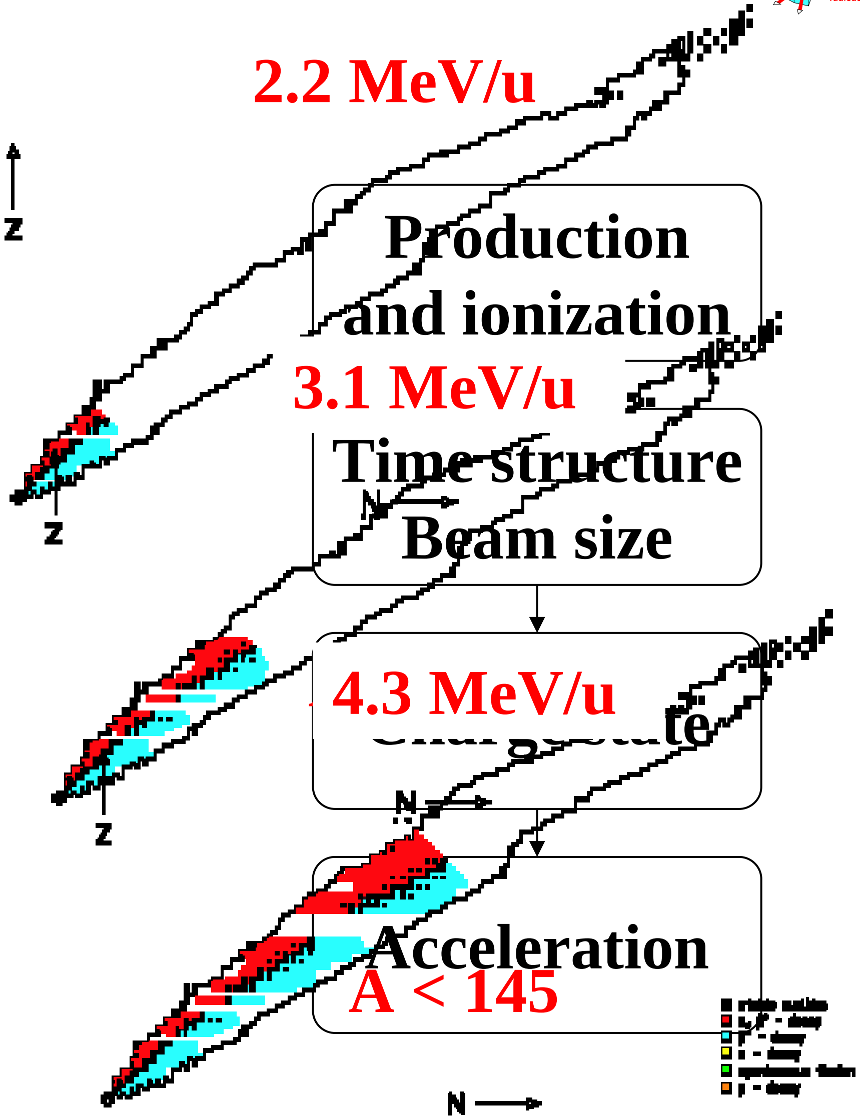
PET scan of a rabbit 60 min p.i. of ISOLDE produced 142-Sm in EDTMP solution

Principle of Radioimmunio Therapy

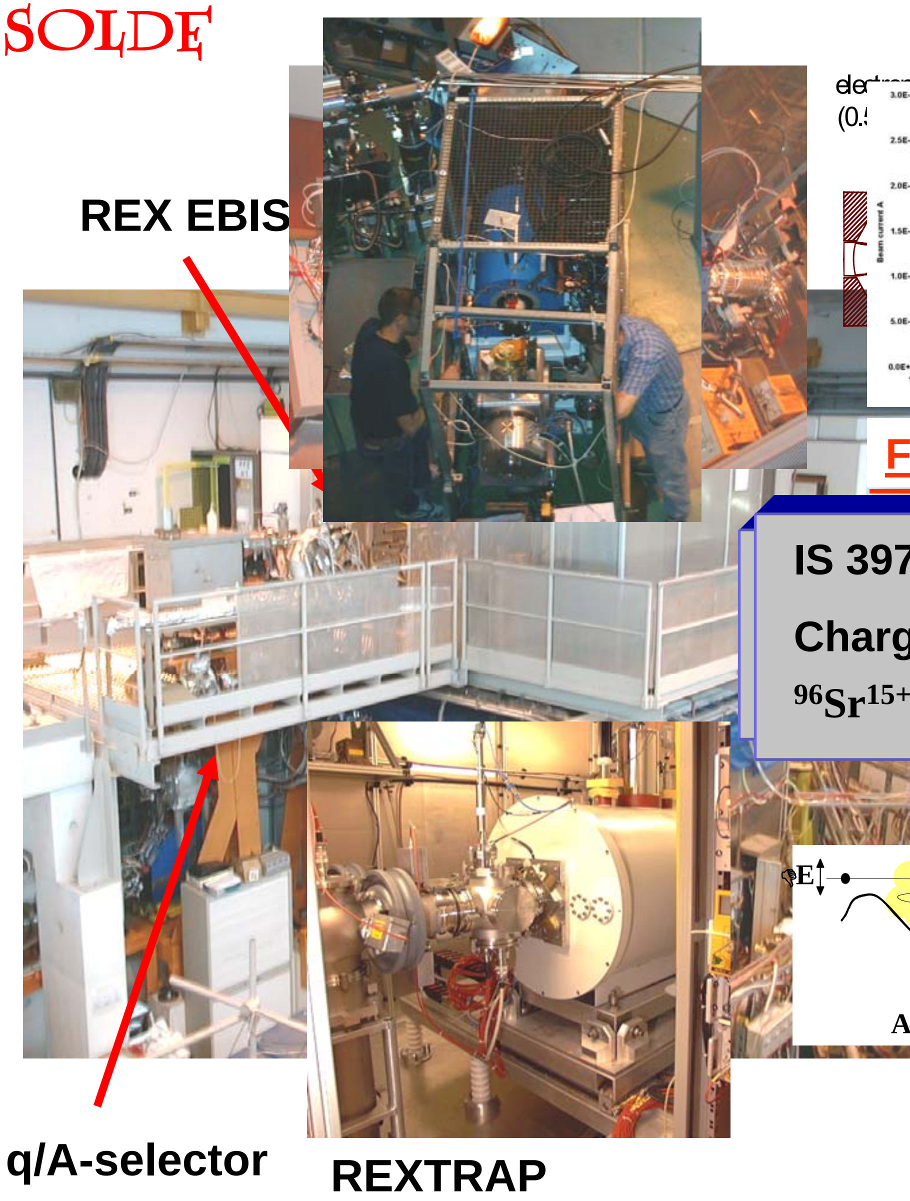


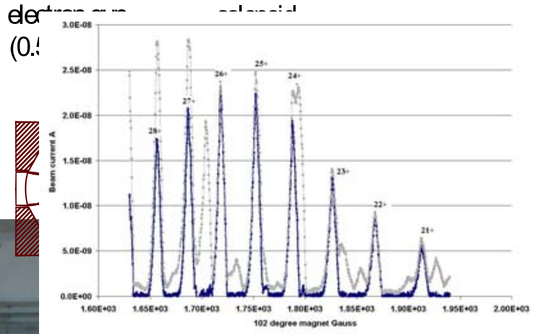
Post acceleration

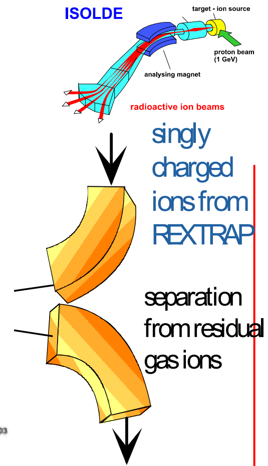
- Challenges when accelerating radioactive ions:
  - Low intensity
  - Short half lives
  - Charge state



ISOLDE





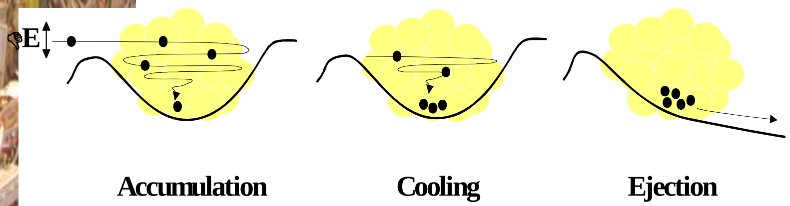


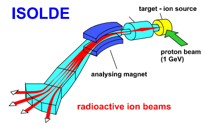
For A > ?:

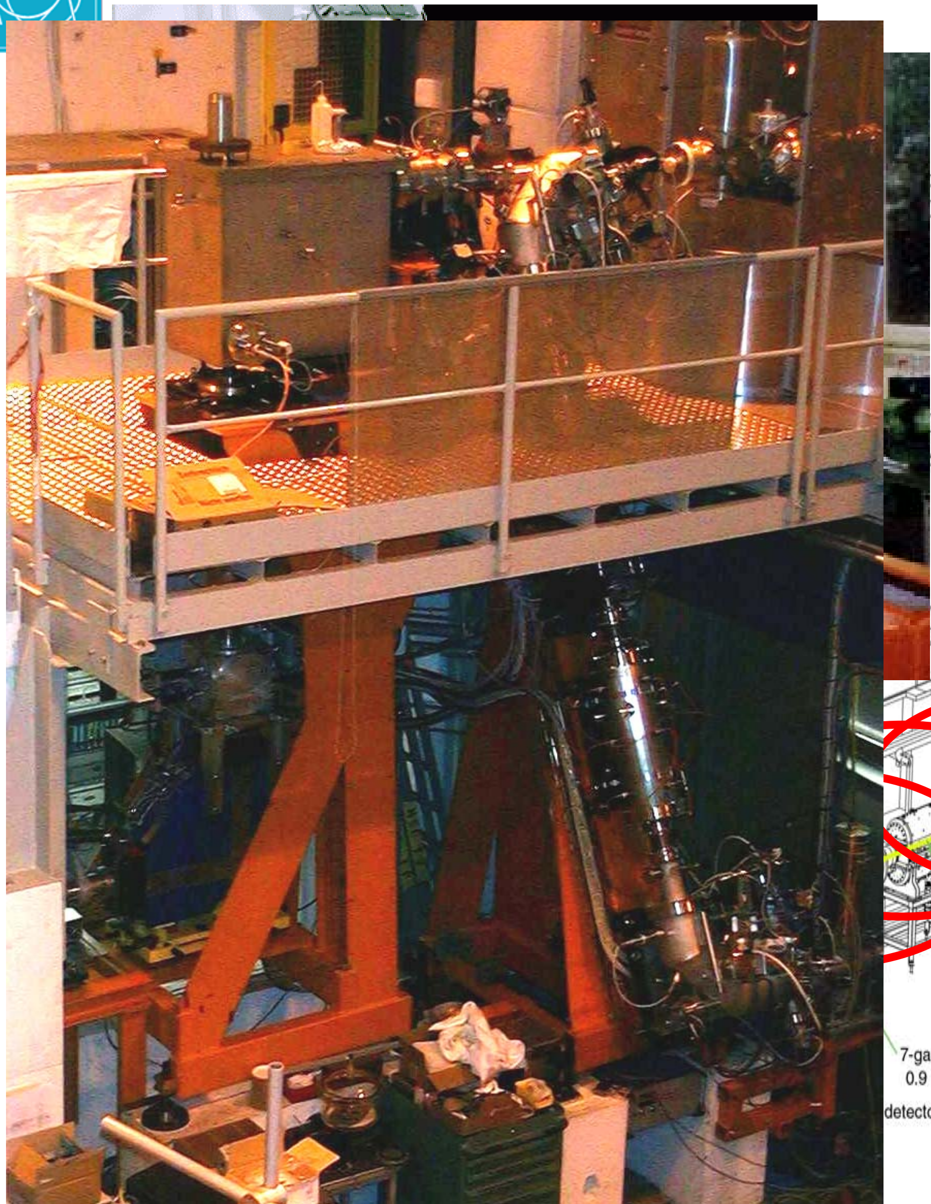
IS 397 team

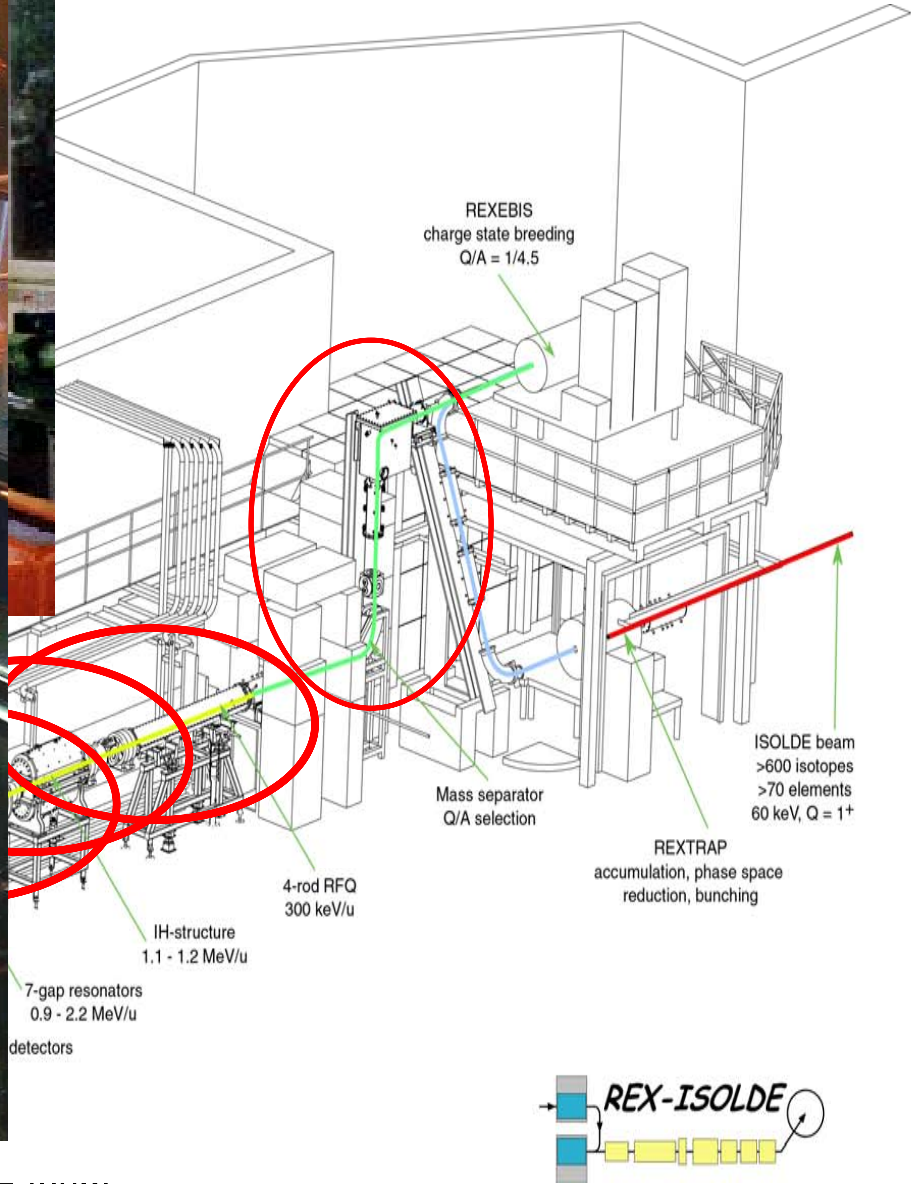
Charge breeding of Uranium and

$^{96}Sr^{15+}$, $^{94}Rb^{15+}$









Summer
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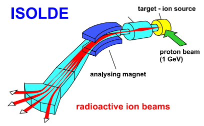
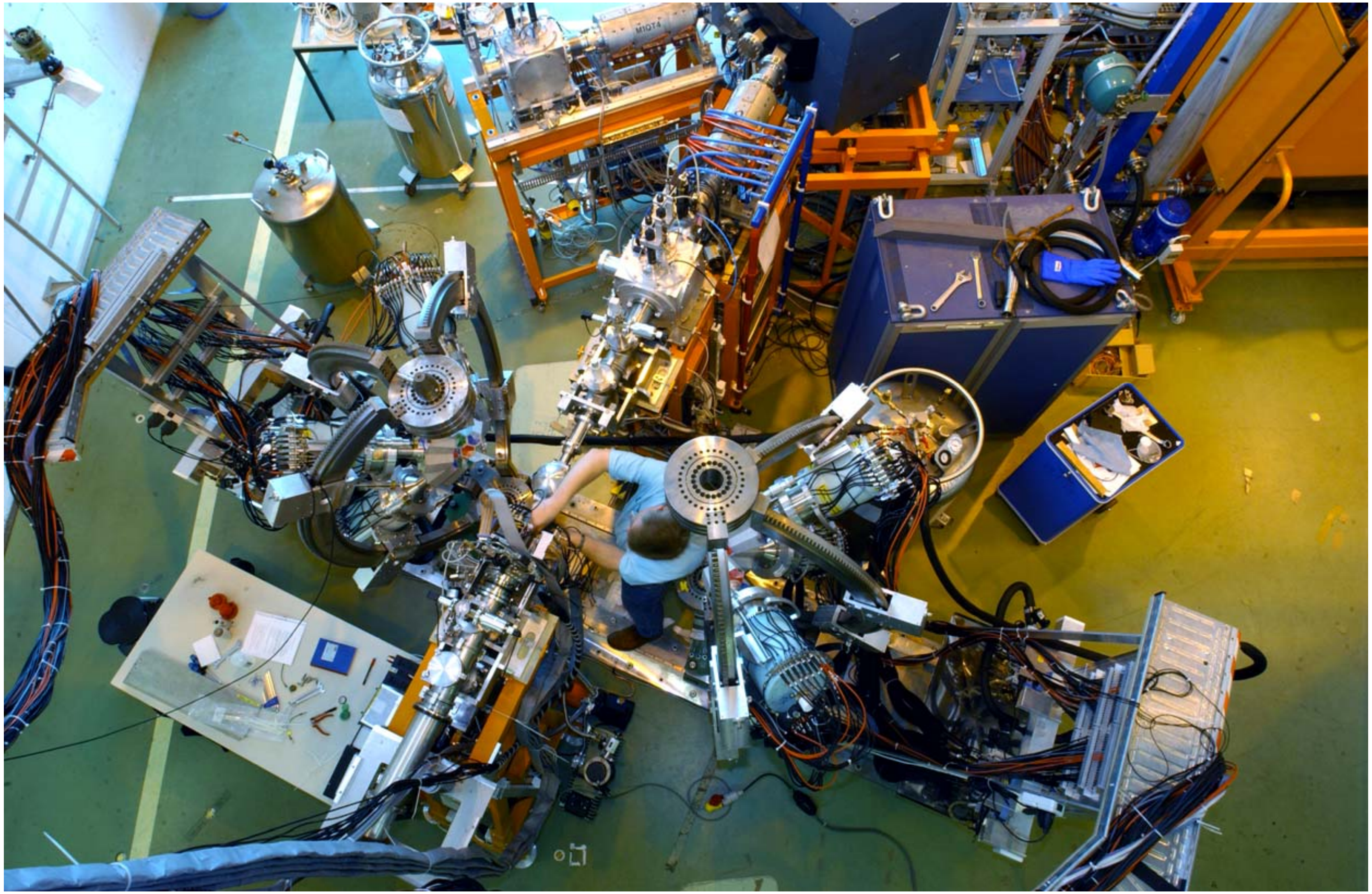
ISOLDE team

REX MINIBALL





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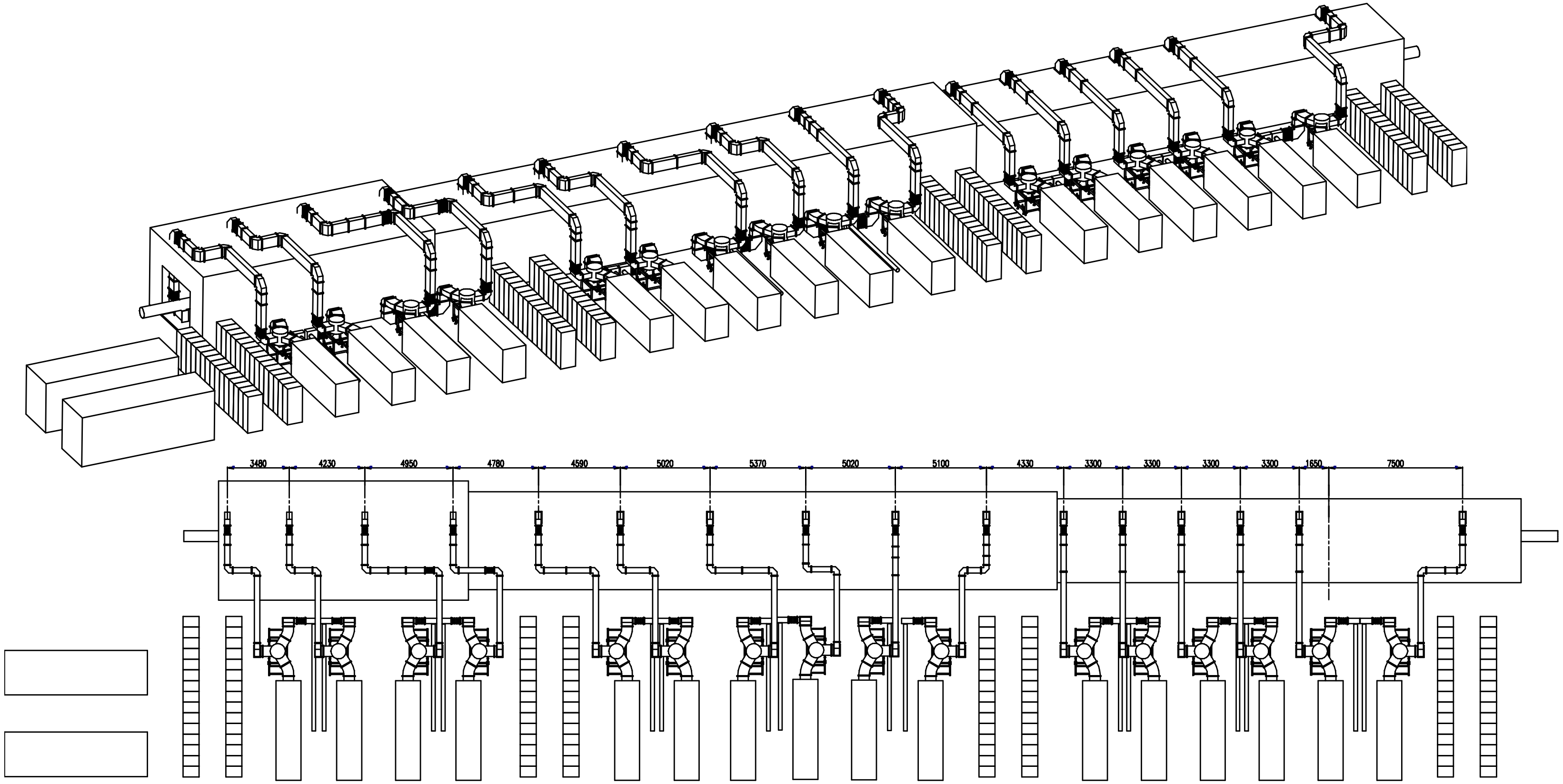
Mats Lindroos on behalf of the
ISOLDE team

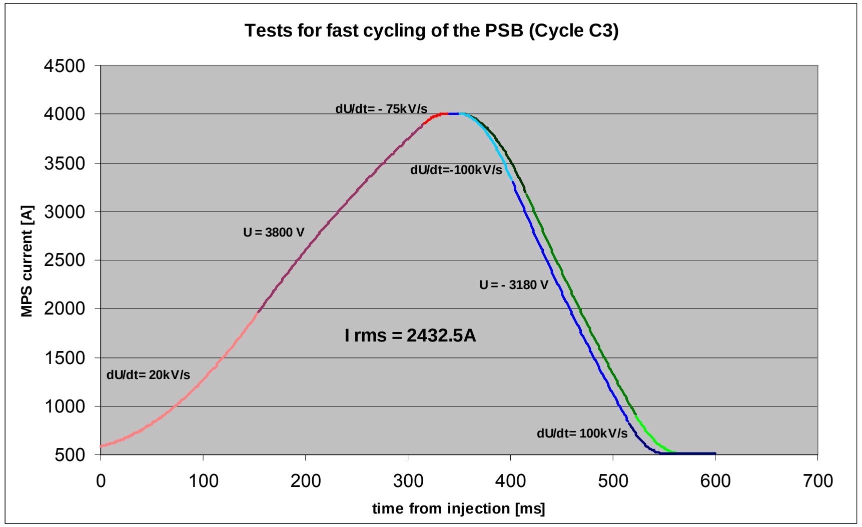
Future Plans
More protons: Linac 4



From M. Vretenar

900 MS CYCLING OF THE PS BOOSTER

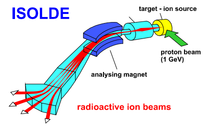
- Present PSB cycle 1.2 s
- Increase PSB capacity to cope with increased demands for protons at CERN
- Major proton users to benefit: LHC, ISOLDE, CNGS

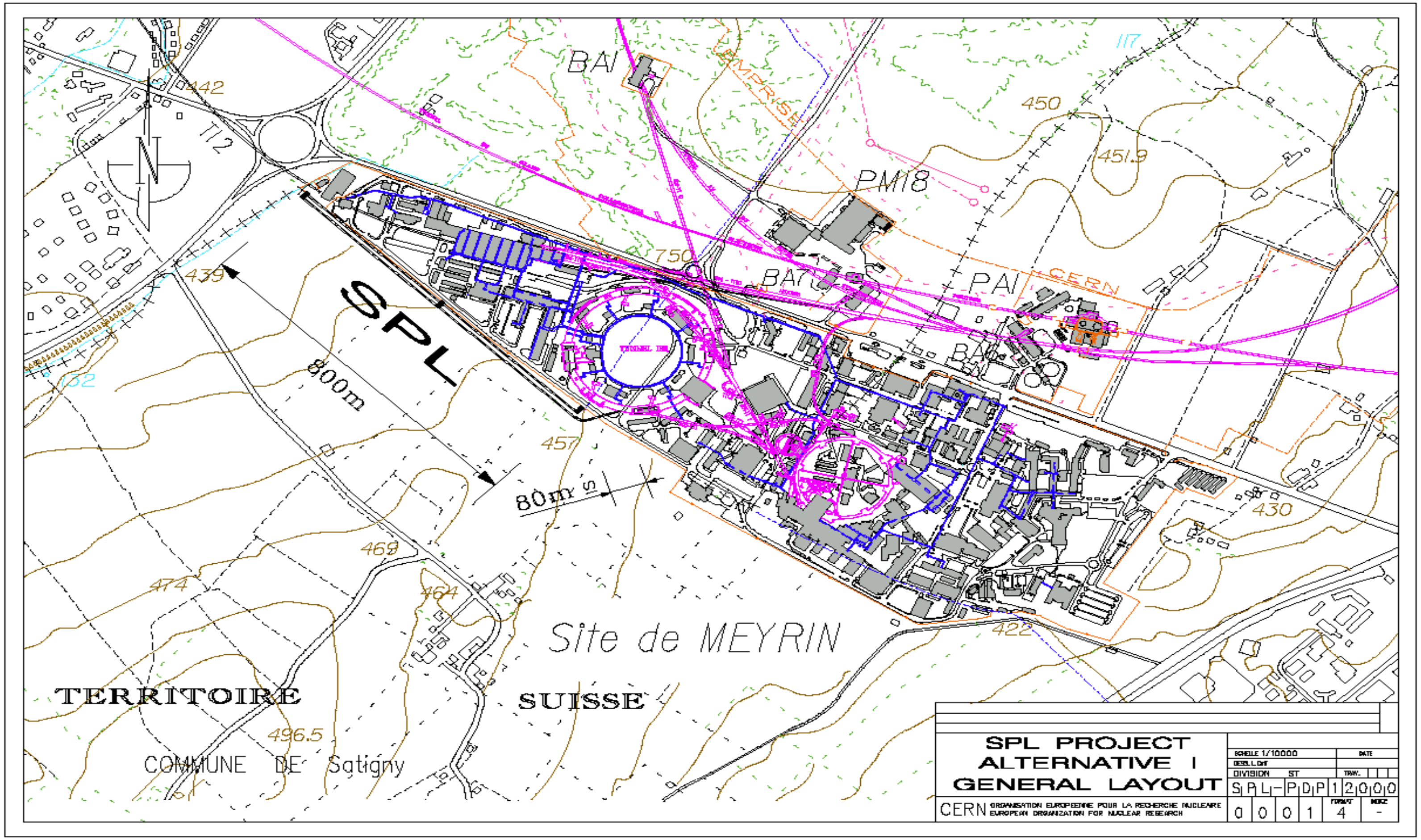


From M. Benedikt, AB, CERN

Future Plans

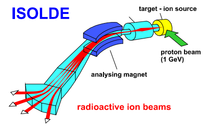
The SPL

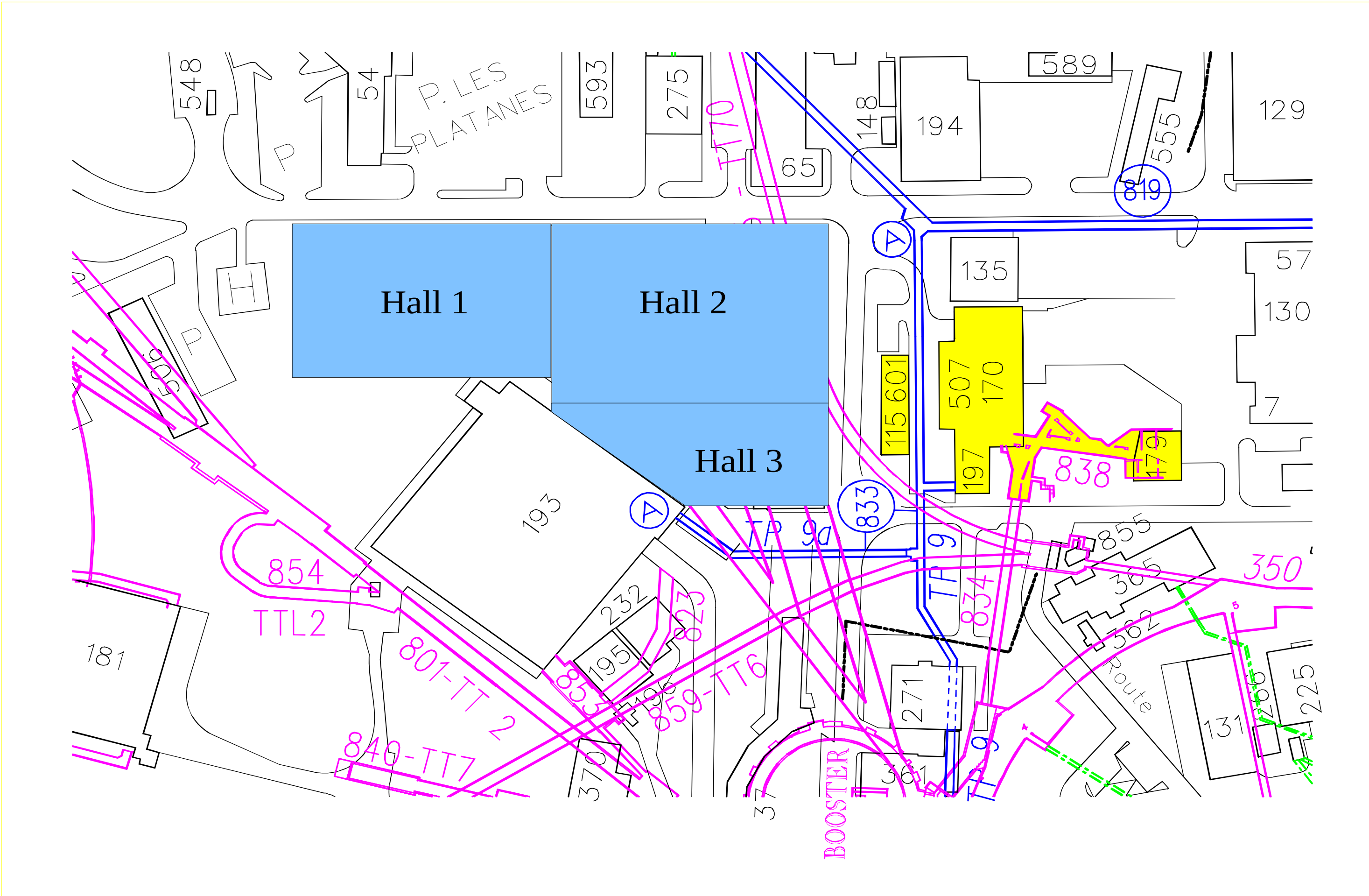




Future plans

A next generation RNB facility

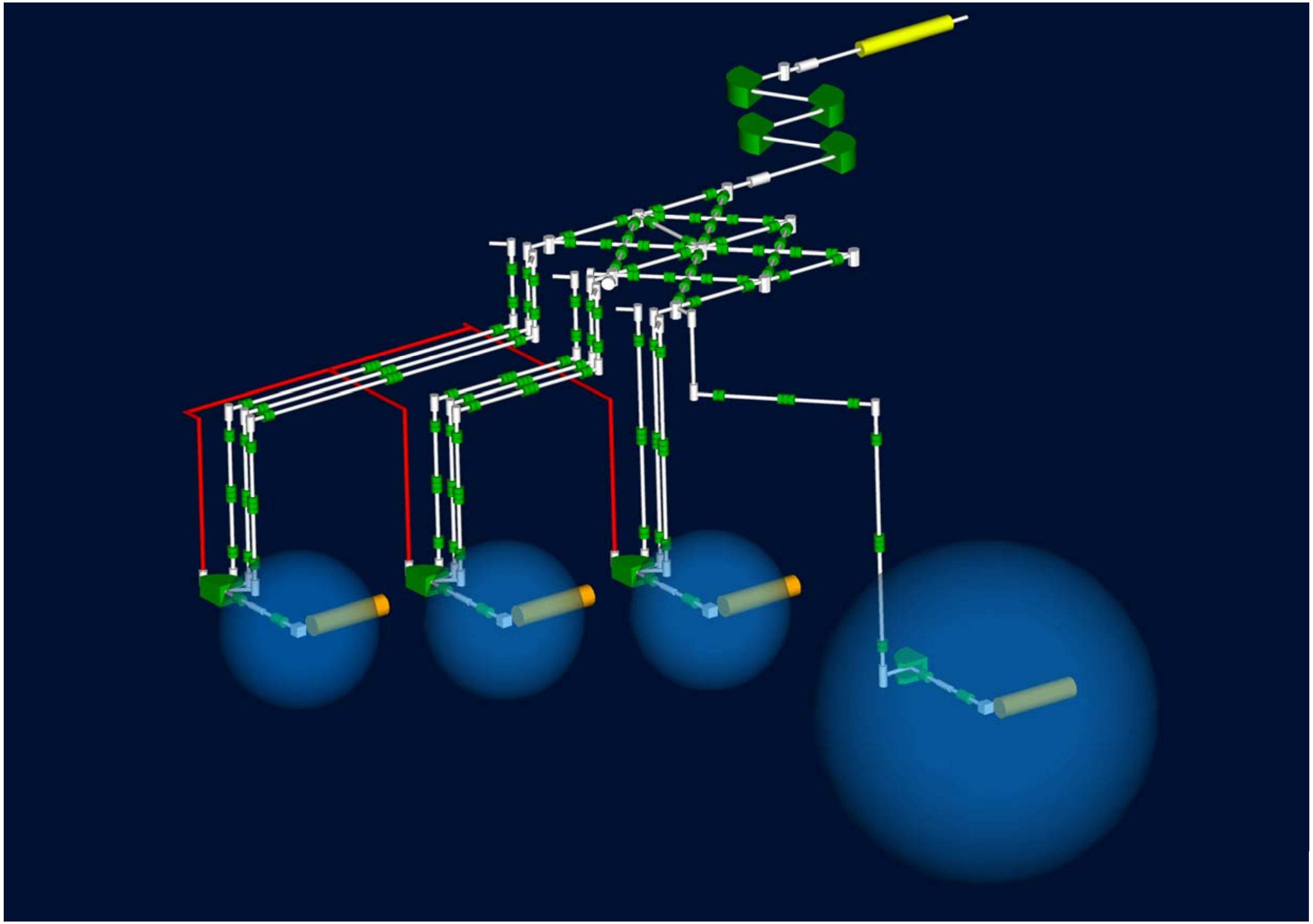




Summer students
2005

Mats Lindroos on behalf of the
ISOLDE team

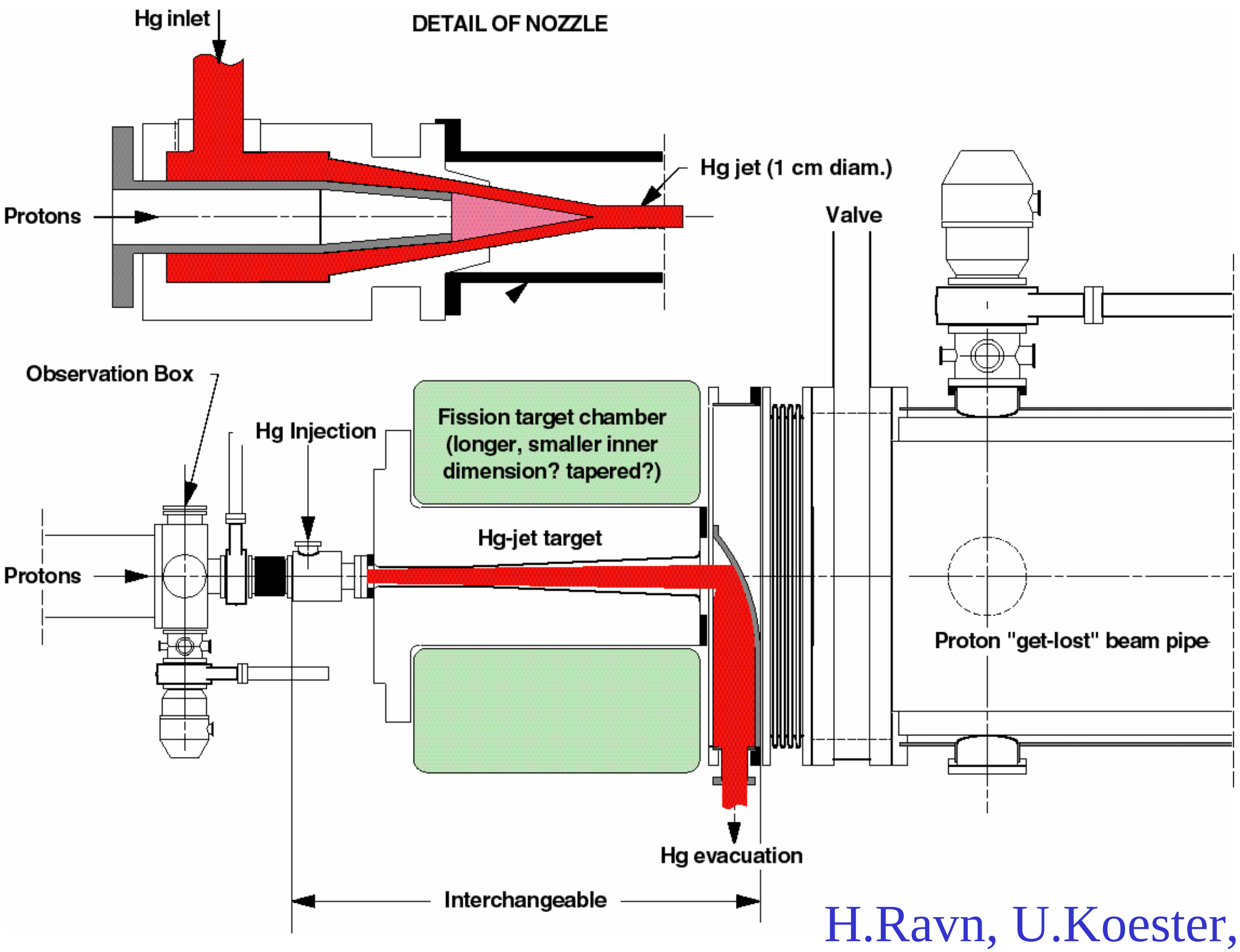
EURISOL



Summer students 2005

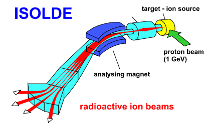
Mats Lindroos on behalf of the ISOLDE team

Target Development

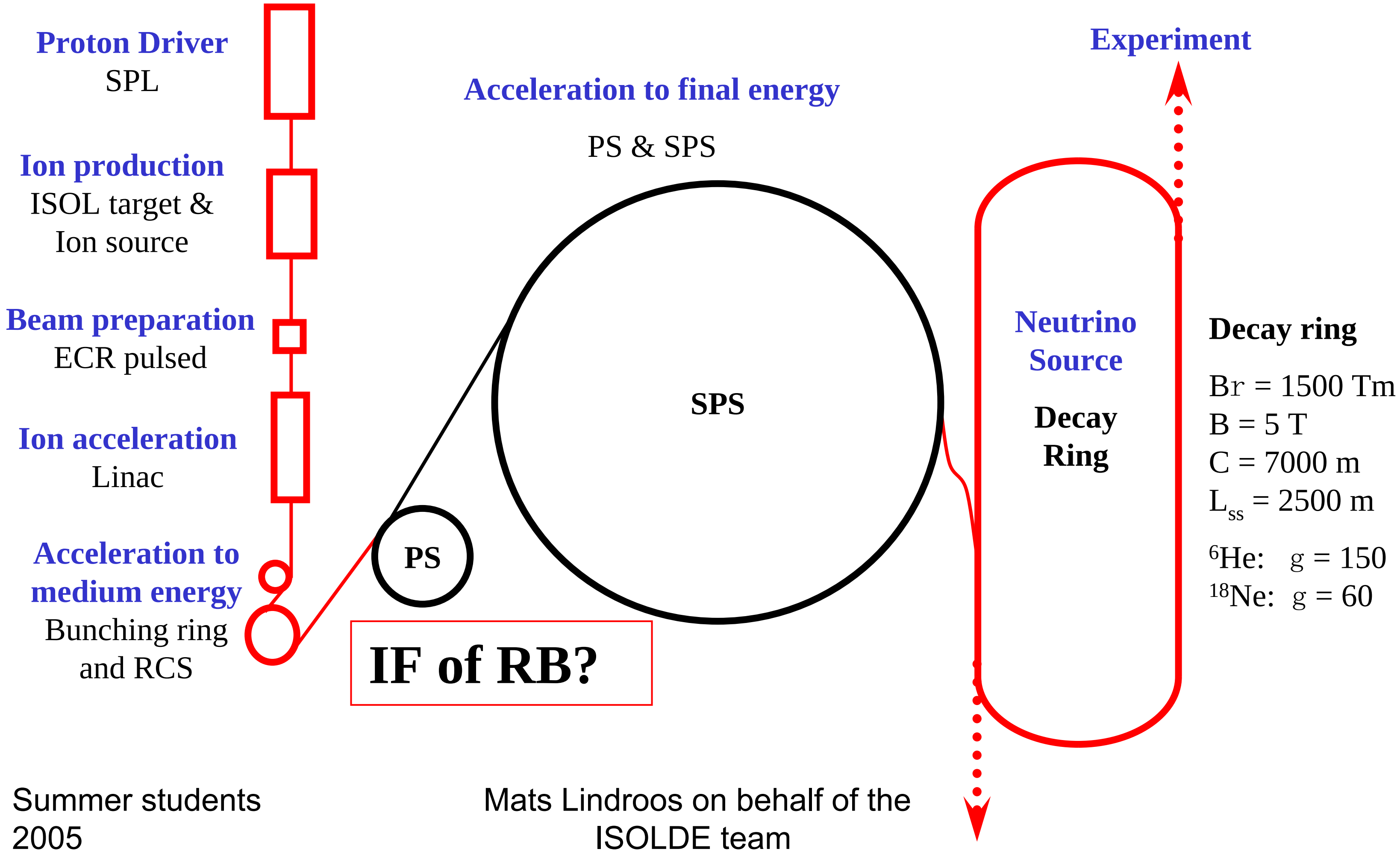


H.Ravn, U.Koester, J.Lettry, S.Gardoni, A.Fabich

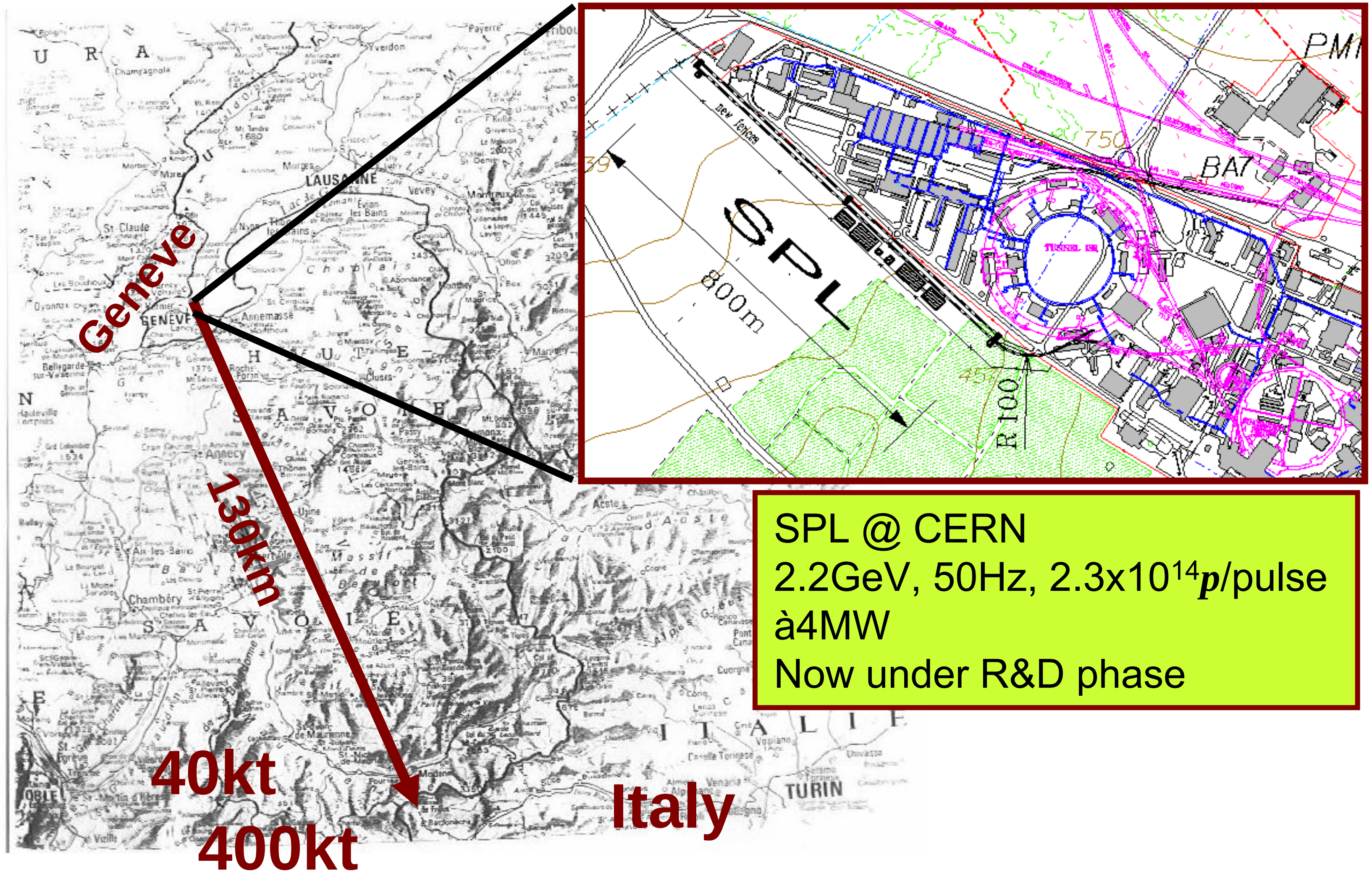
THE BETA-BEAM



AIM: provide beams of electron (anti) neutrinos by decay of beta active ions.

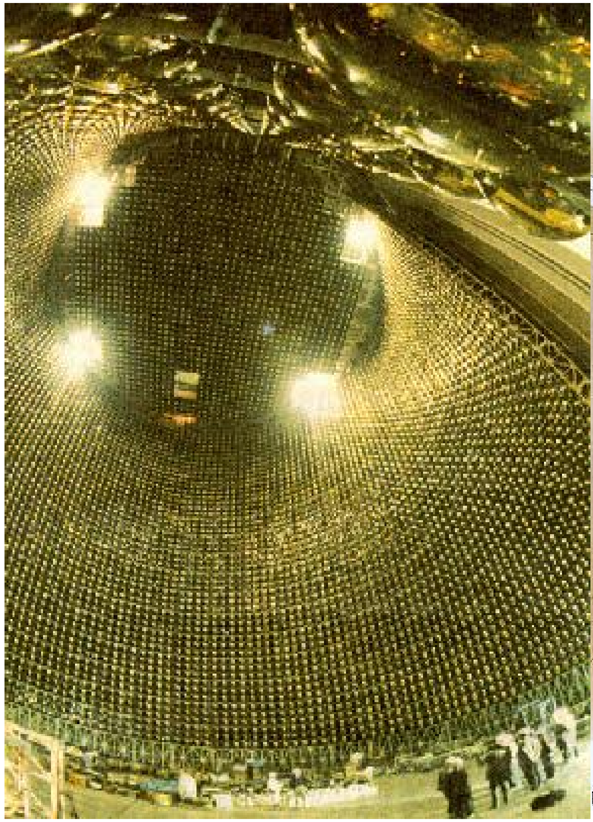


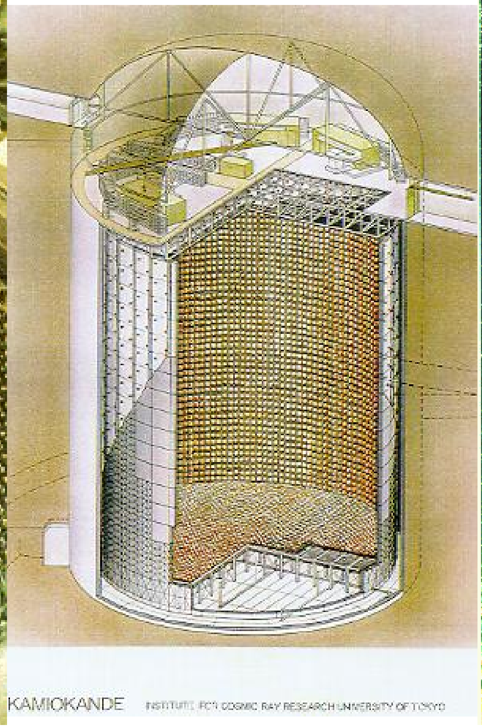
CERN to FREJUS

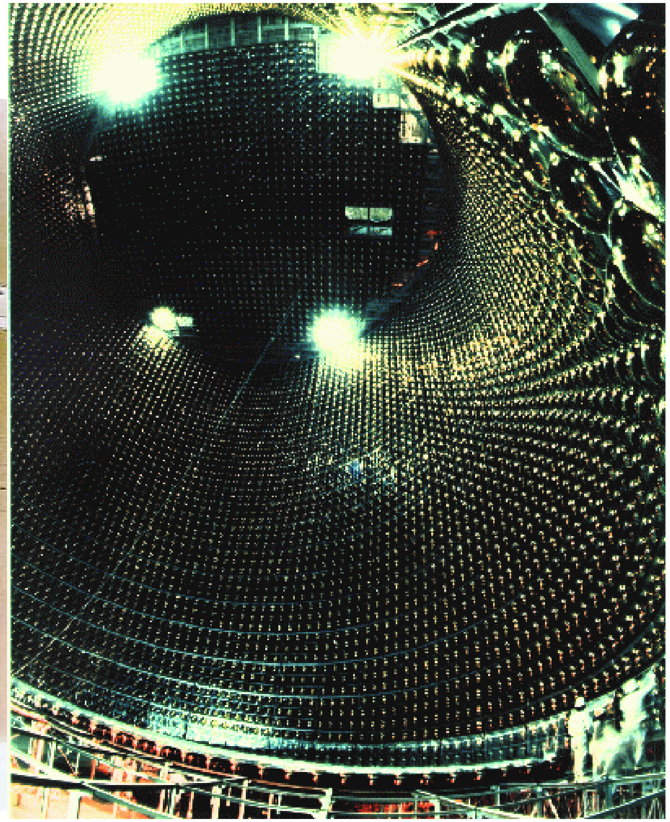


SPL @ CERN
2.2GeV, 50Hz, 2.3x10^{14} p/pulse
à4MW
Now under R&D phase

Water Cherenkow
Super Kamiokande

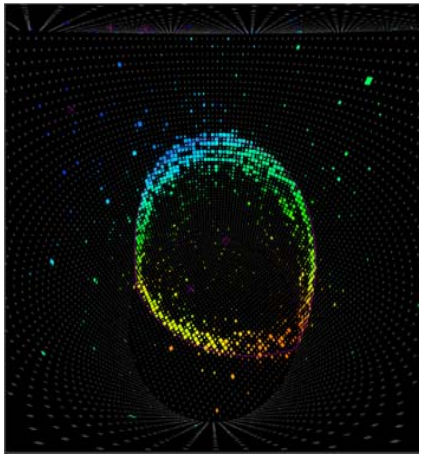


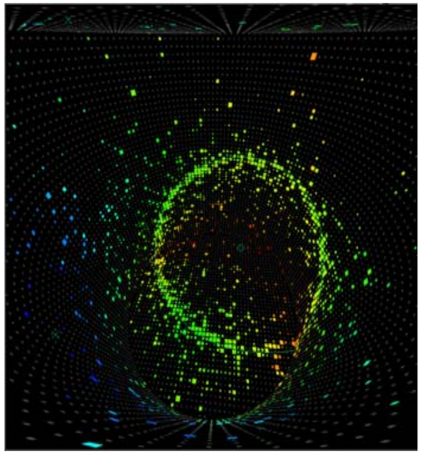




MultiUSER detector: Astrophysics, Beta-beam, Super Beam, Proton Decay

Combination of beta beam with low energy super beam





Unique to CERN:

combines CP and T violation tests

$$\nu_e \rightarrow \nu_\mu \quad (\beta+) \quad \overset{T}{\Longleftrightarrow} \quad \nu_\mu \rightarrow \nu_e \quad (\pi^+)$$

$$\Updownarrow \; CP \qquad\qquad\qquad\qquad \Updownarrow \; CP$$

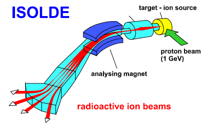
$$\bar{\nu}_e \rightarrow \bar{\nu}_\mu \quad (\beta-) \quad \overset{T}{\Longleftrightarrow} \quad \bar{\nu}_\mu \rightarrow \bar{\nu}_e \quad (\pi^-)$$

A. Blondel

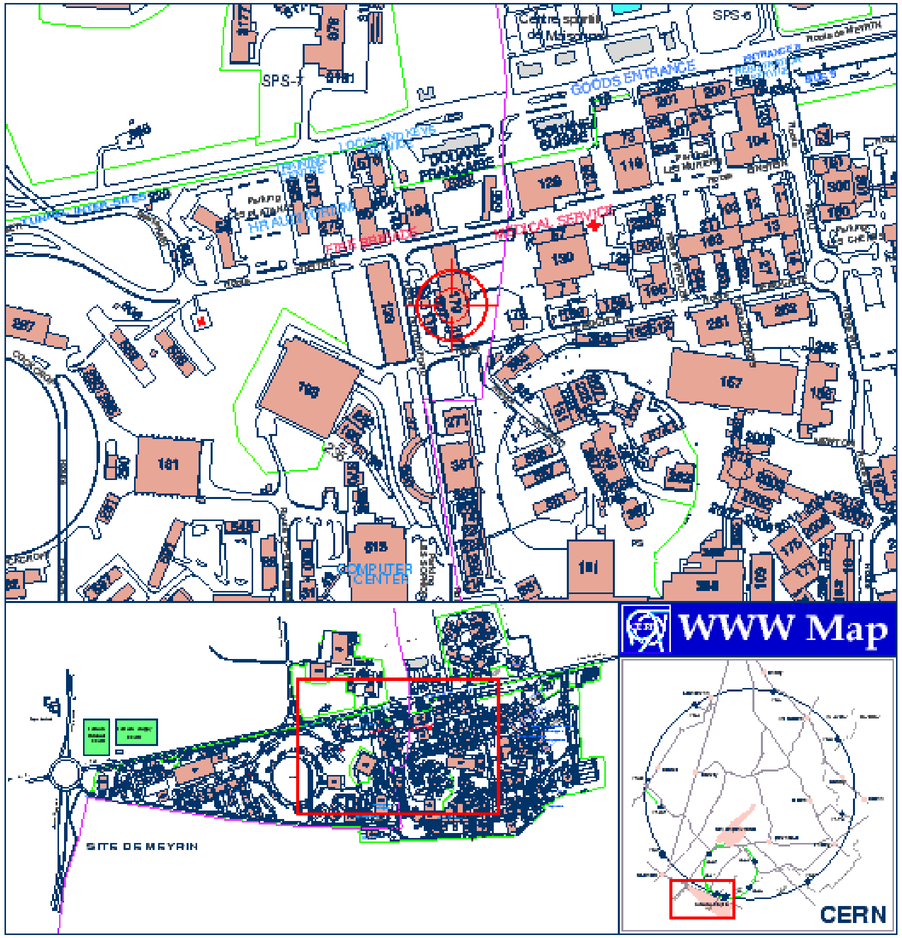
Conclusions

- Nuclear physics and its applications:
  - are fascinating subjects
  - have an exciting future at new large scale facilities
  - holds exciting research opportunities for you; for a Ph.D. and a future research career
- Thank you for your attention!

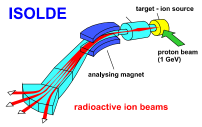
ISOLDE VISIT

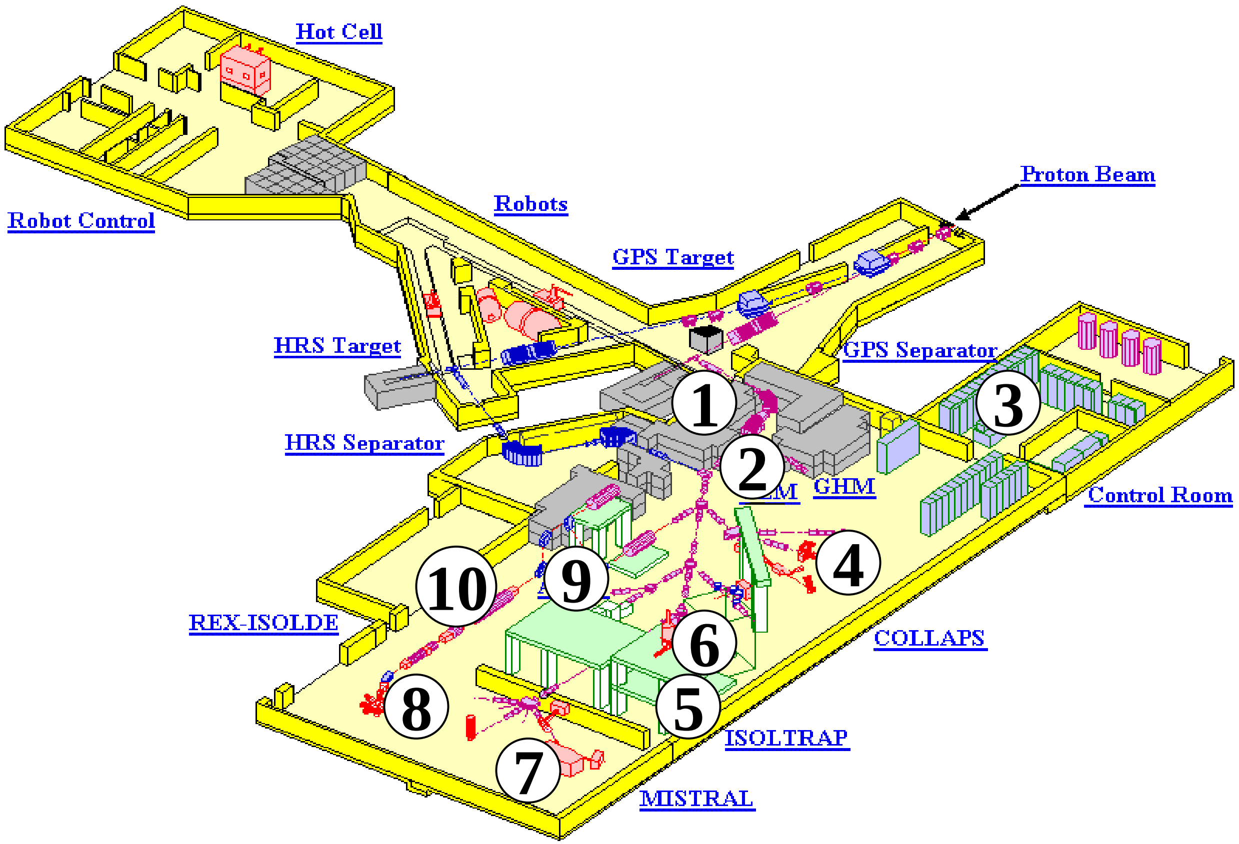


- Today at 15.00!
- Bring your filmbadge
- We are meeting outside the ISOLDE hall (Building 170)



ISOLDE visit





1. RILIS
2. Collections (medical physics, solid state physics)
3. Control room and targets
4. COLLAPS, COMPLIS and Tilted foil
5. ISOLDE Posters
6. ISOLTRAP
7. MISTRAL and NICOLE
8. MINI-BALL
9. ASPIC
10. REX