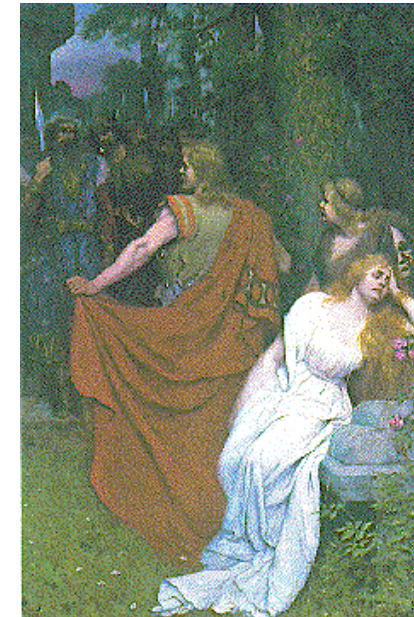


# ISOLDE

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on

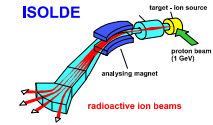
behalf of the CERN ISOLDE  
team



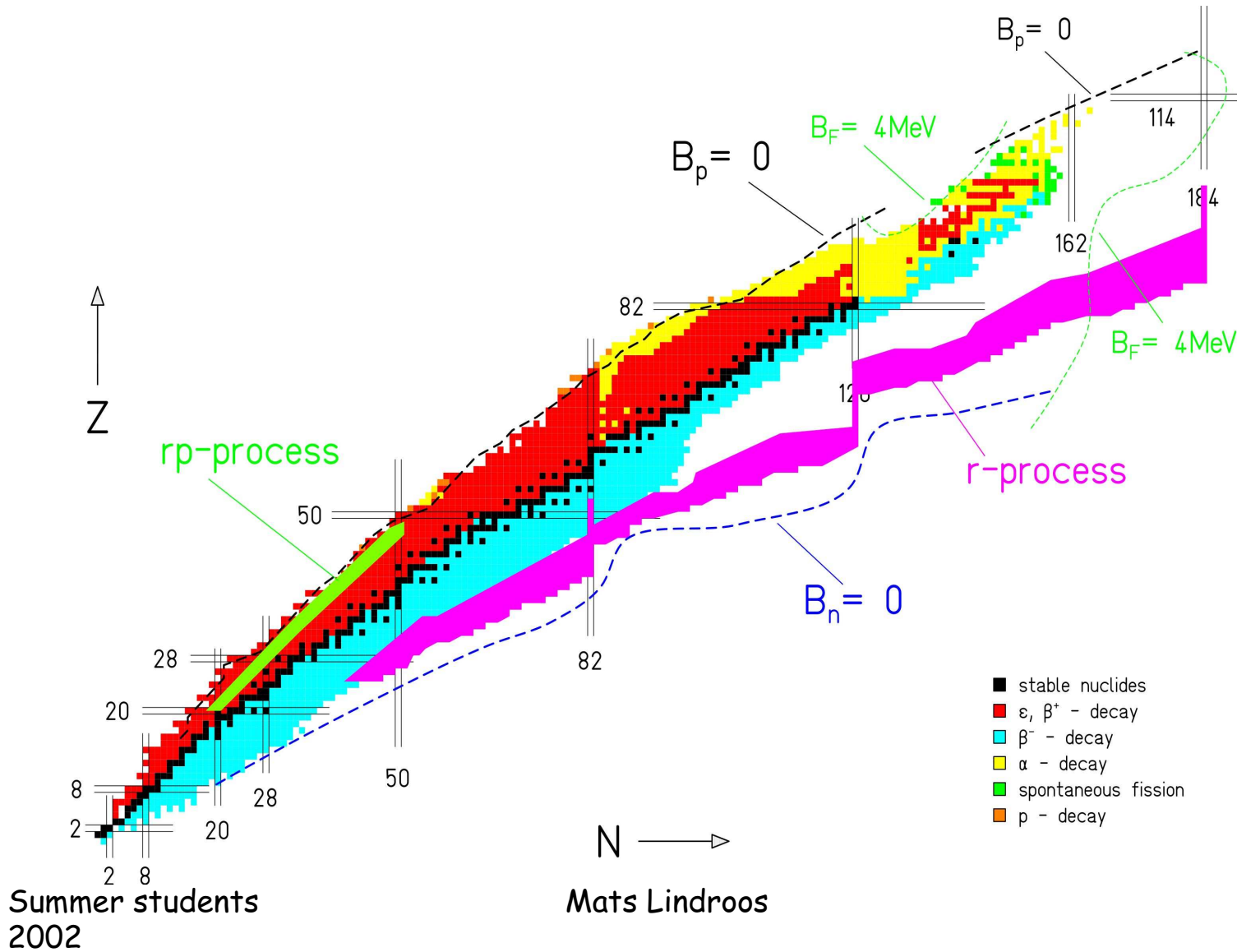
TRISTAN UND ISOLDE: Act II

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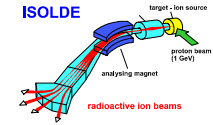
# Nuclear chart



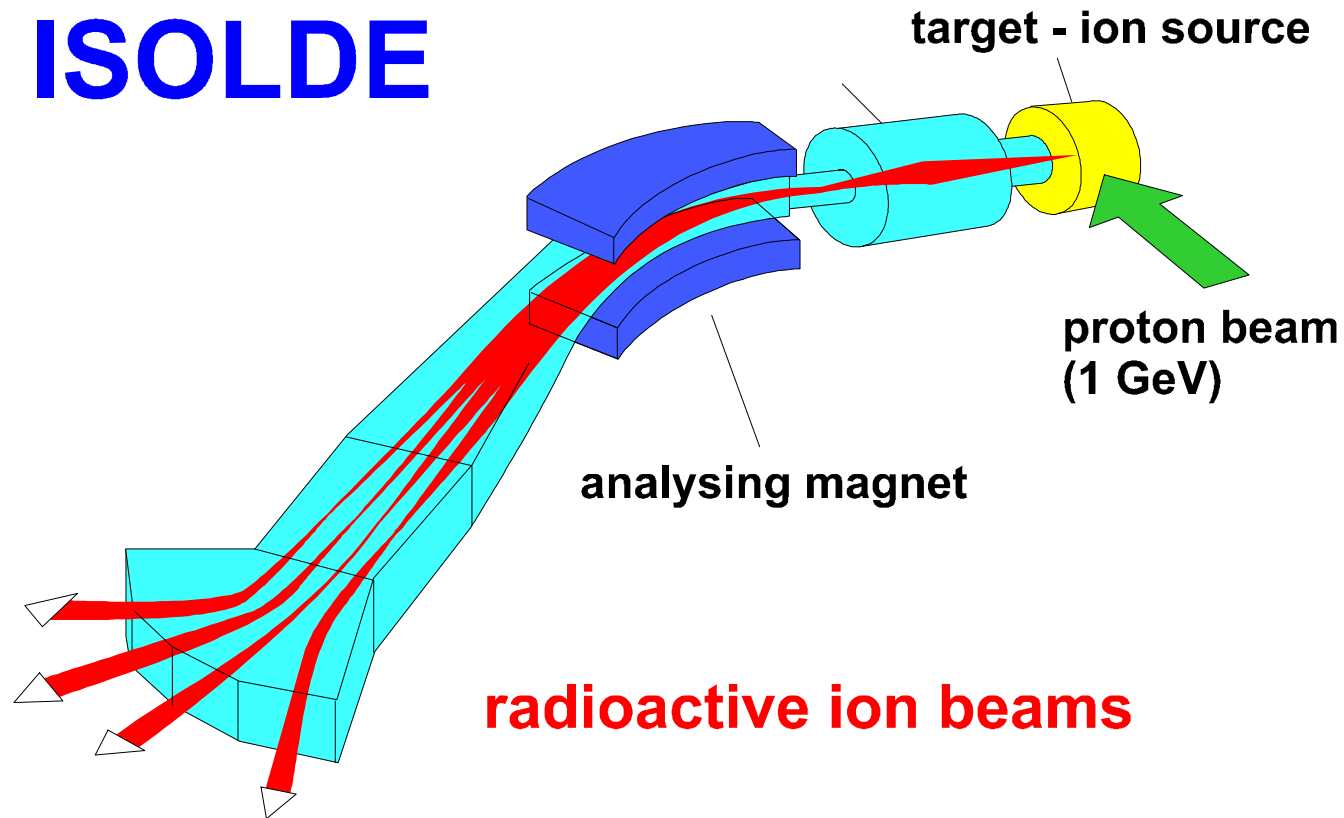


# ISOL

## Isotope Separation On-Line

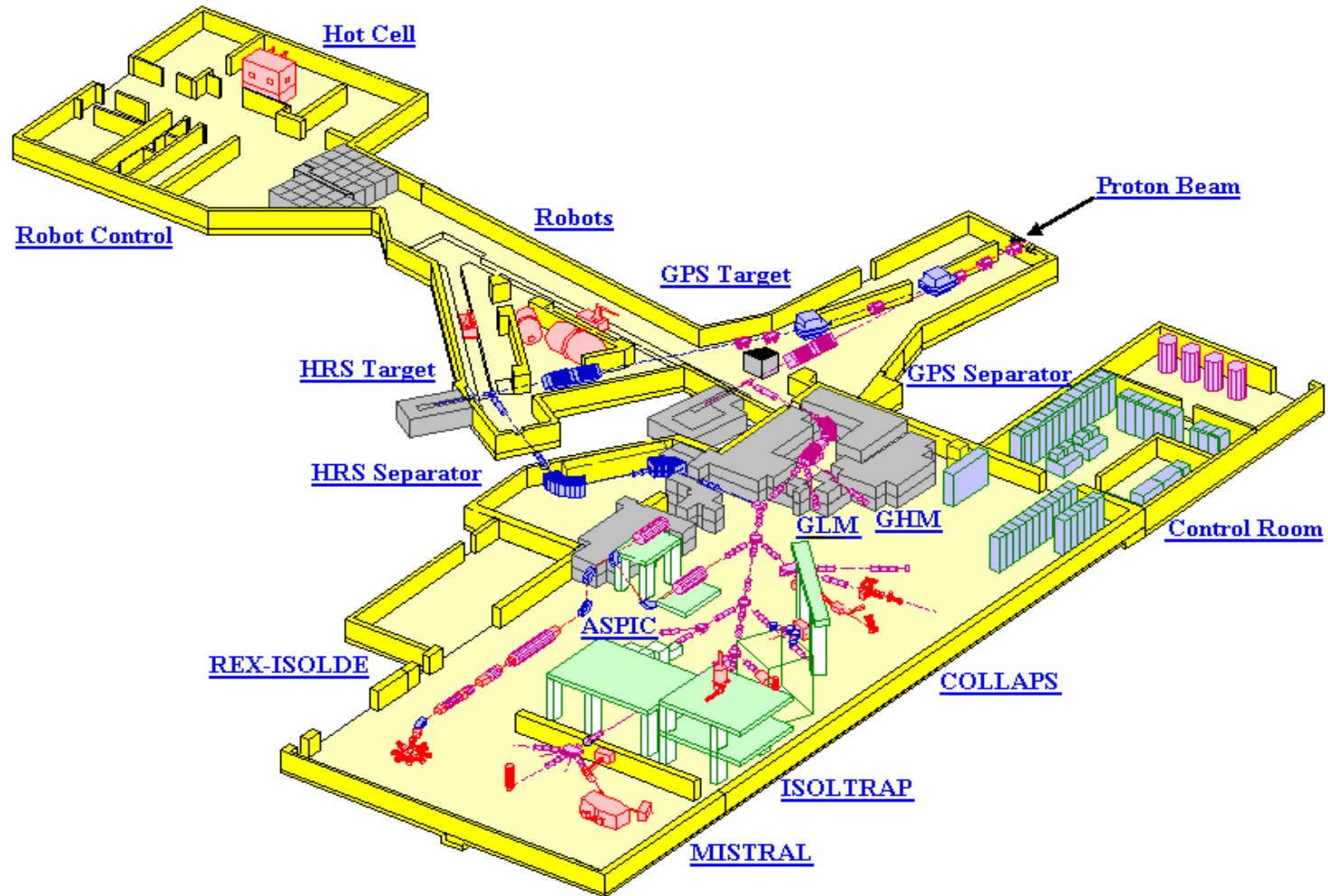
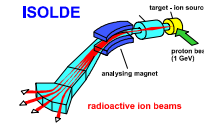


### ISOLDE





# ISOLDE@CERN

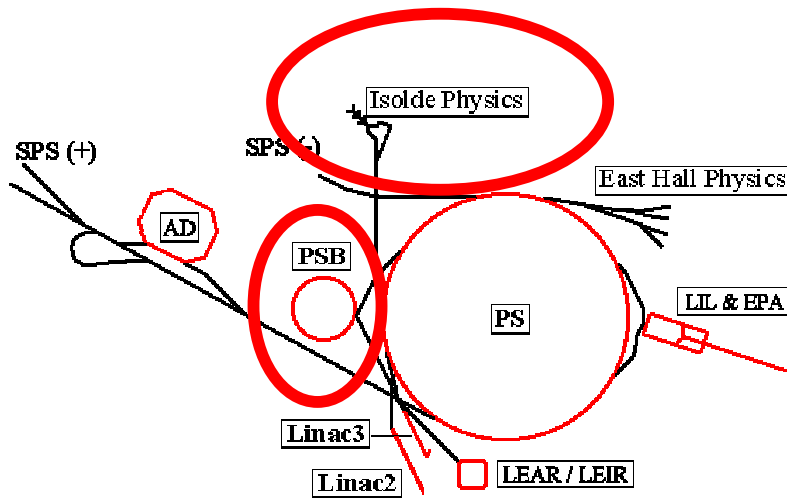
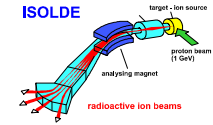


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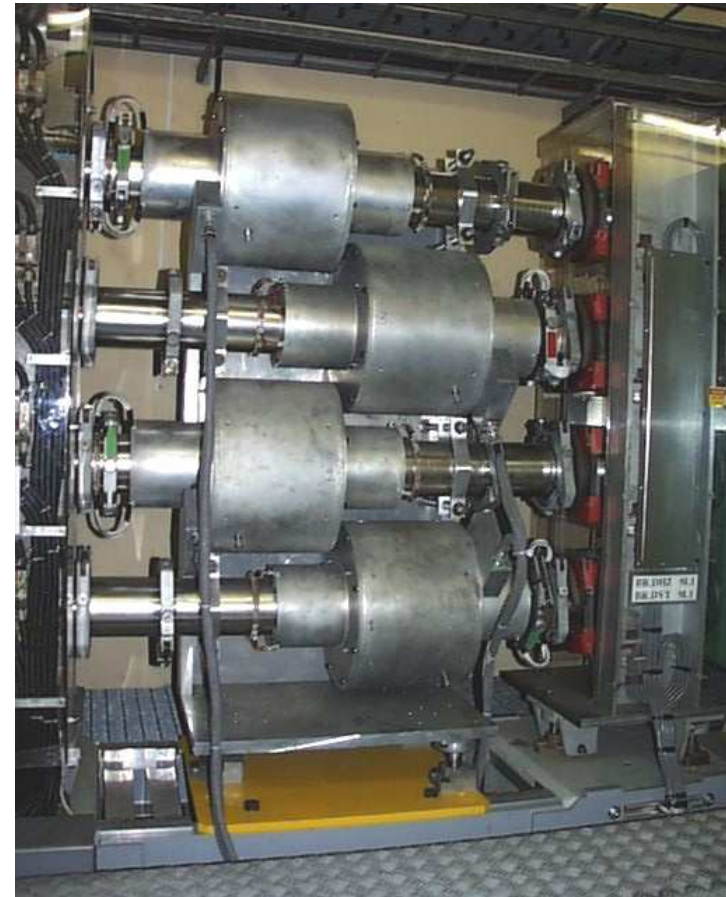
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# PS Booster



J-M ELYN & E. ROUX 1996

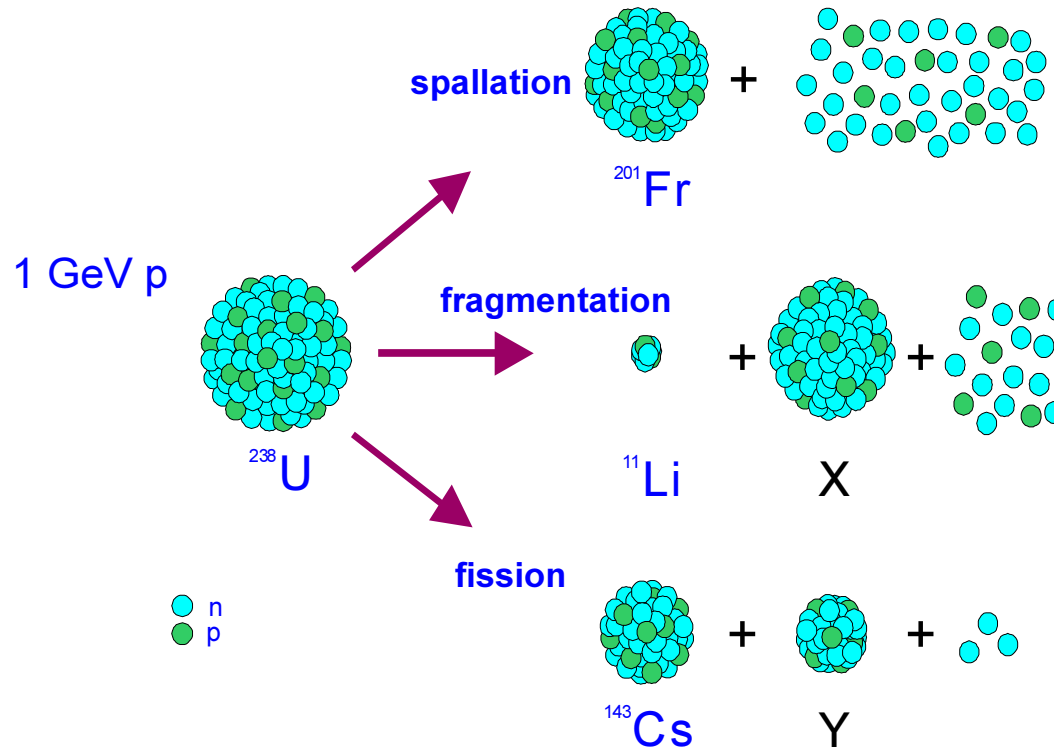
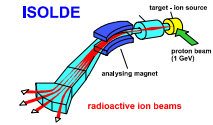


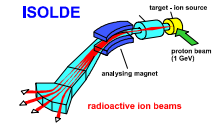
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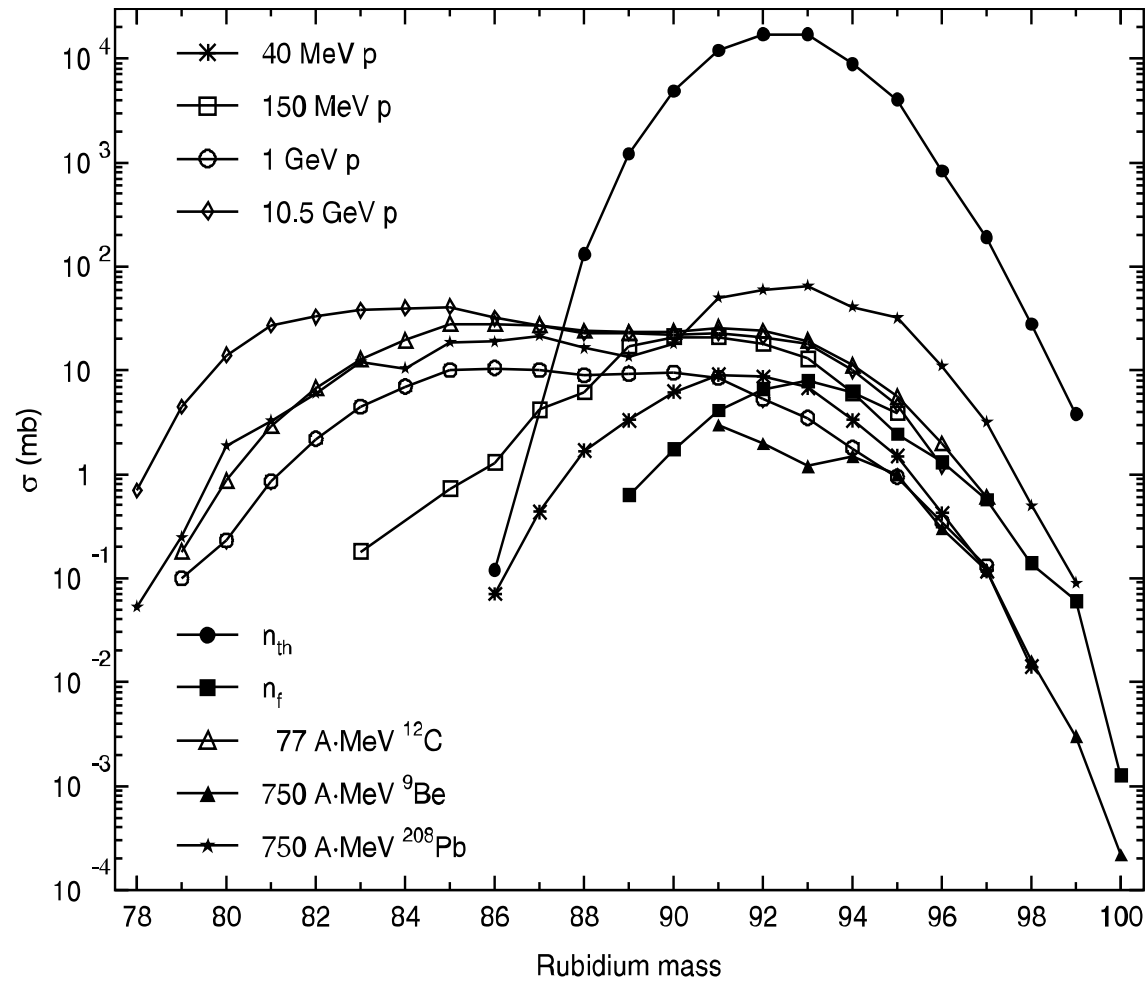


# Production of exotic ions





# Production yields

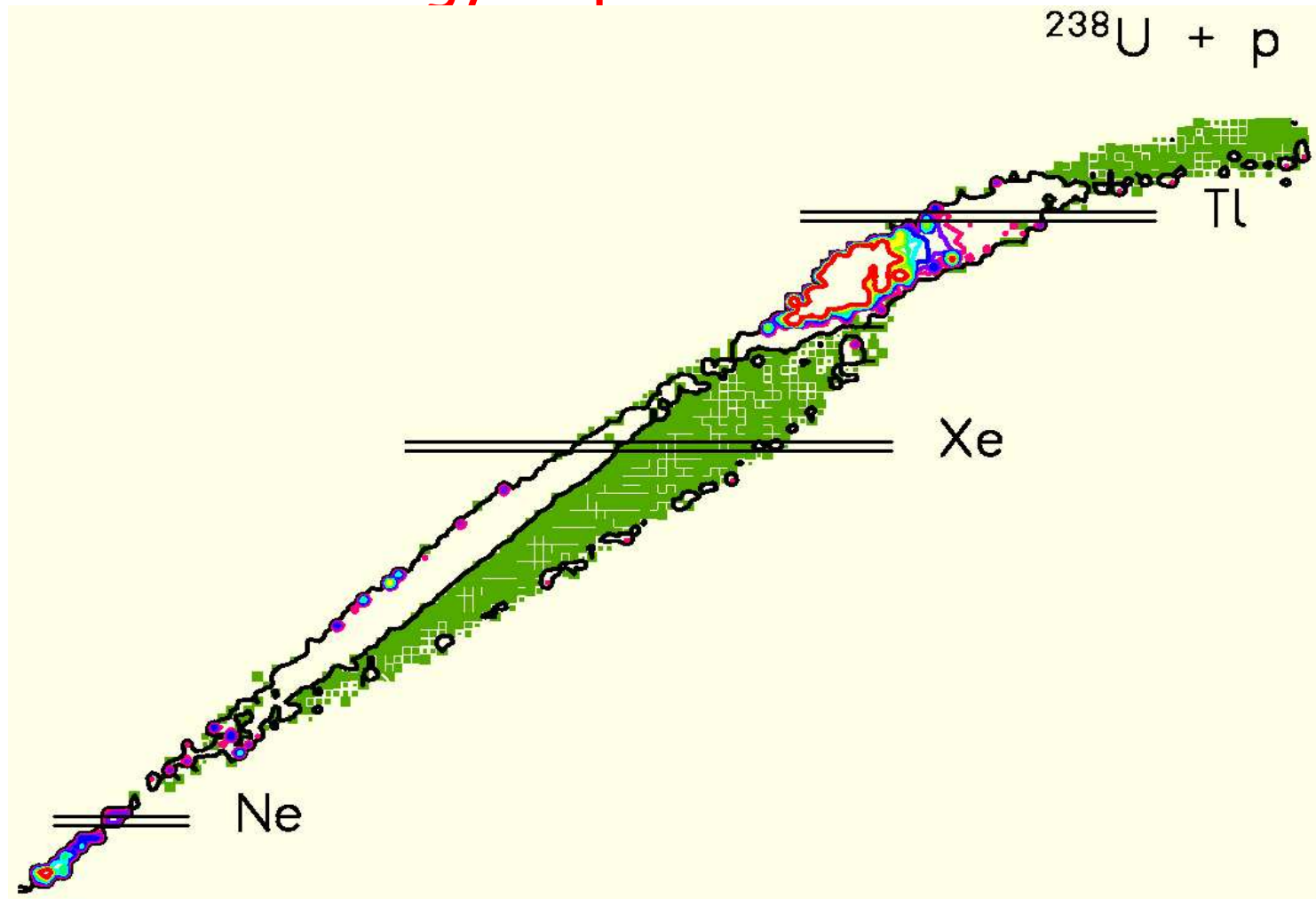
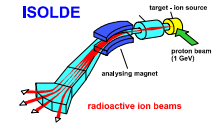


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# Cross sections energy dependence



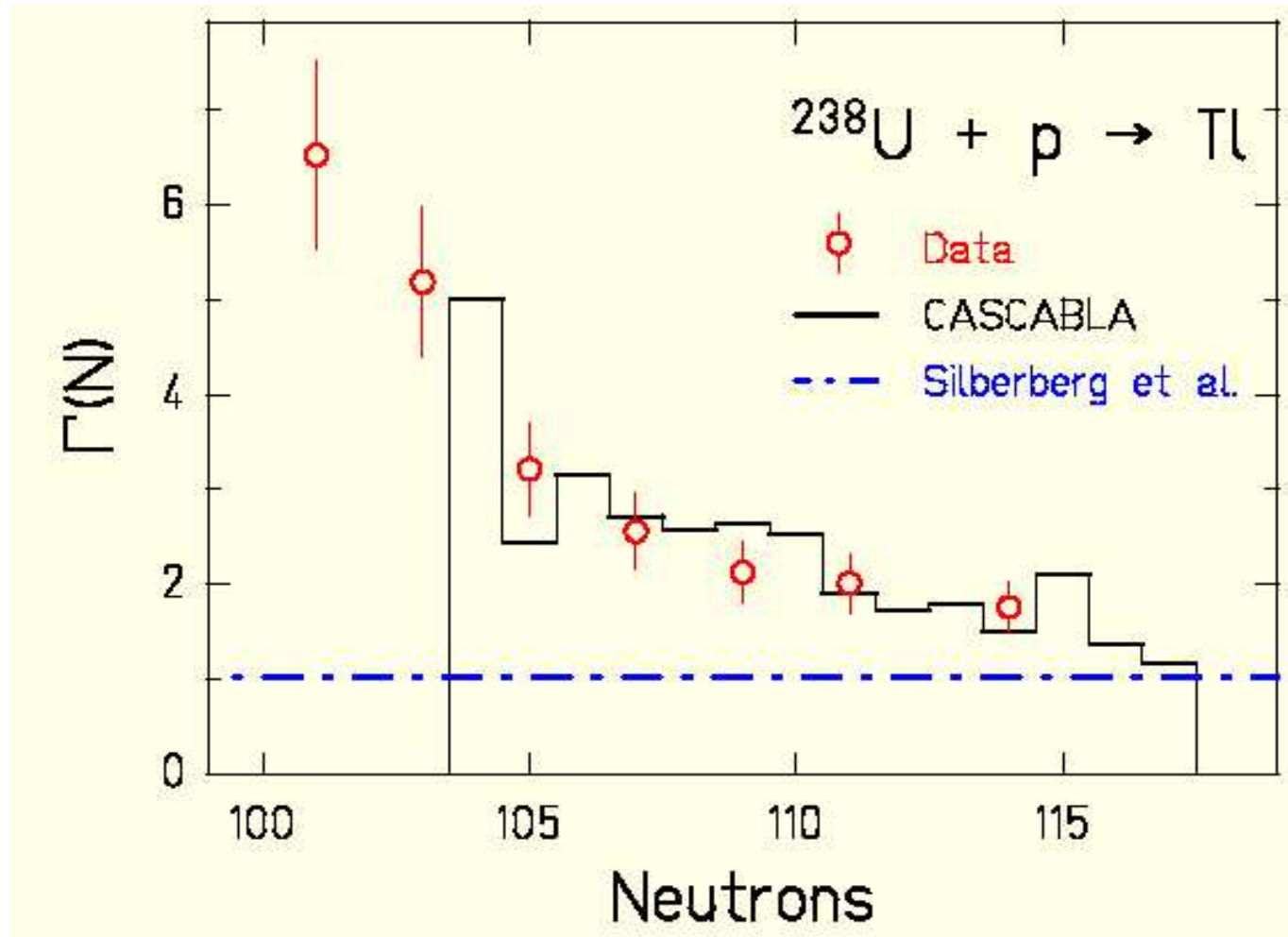
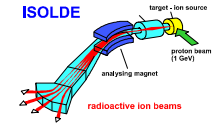
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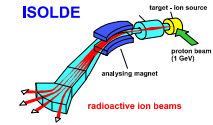


# Cross sections energy dependence

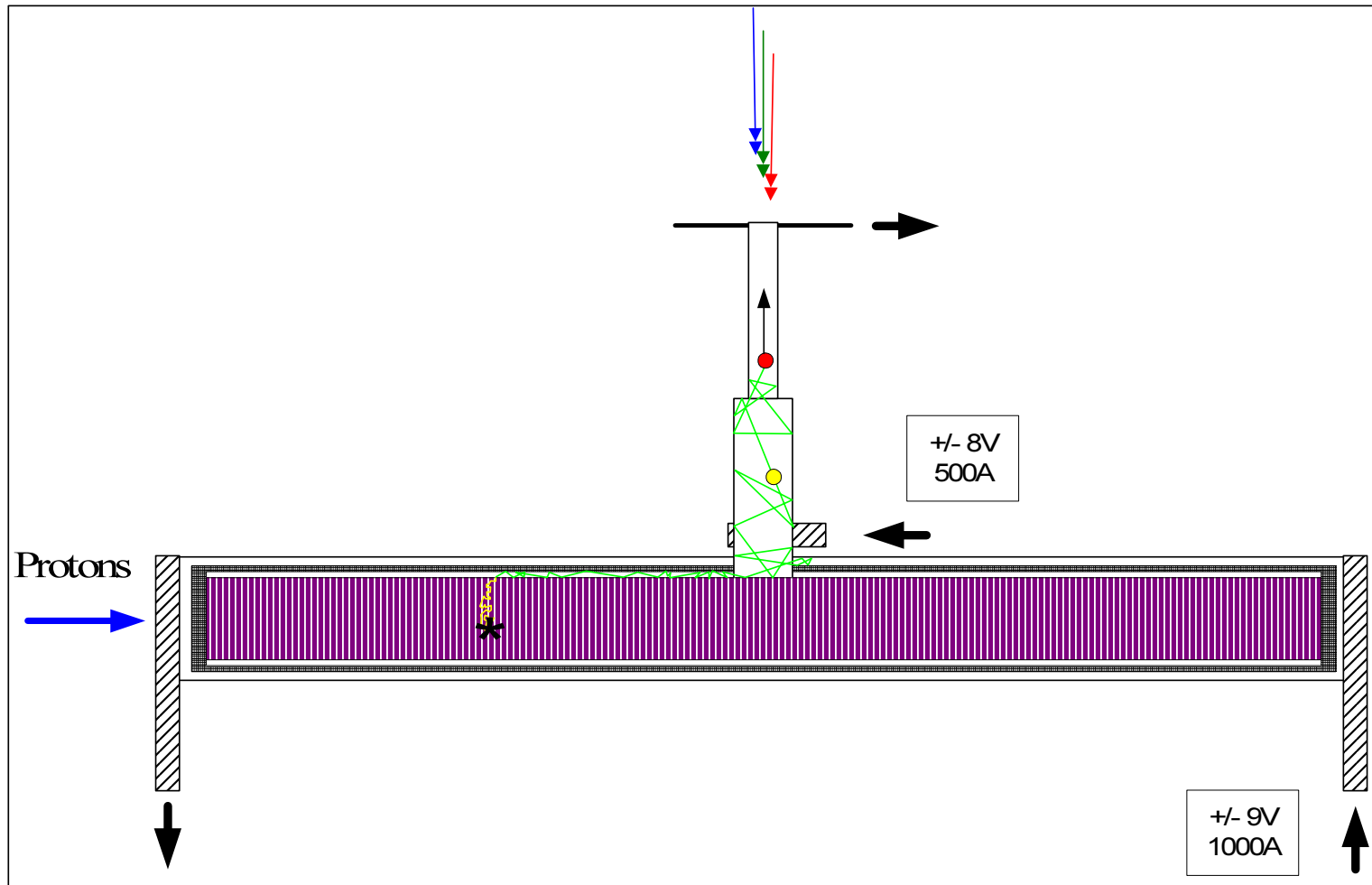


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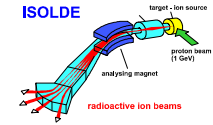


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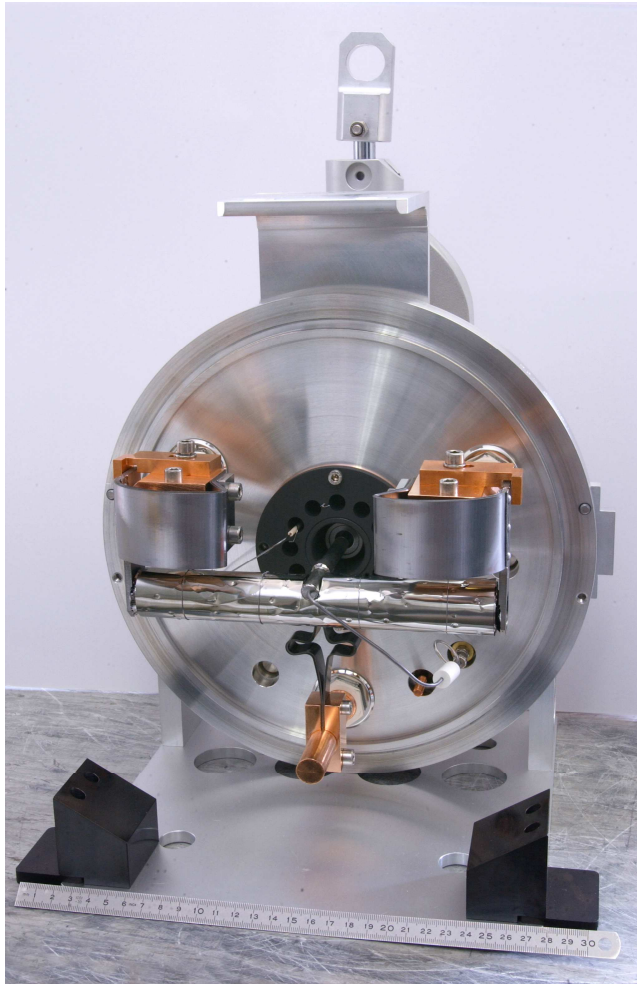


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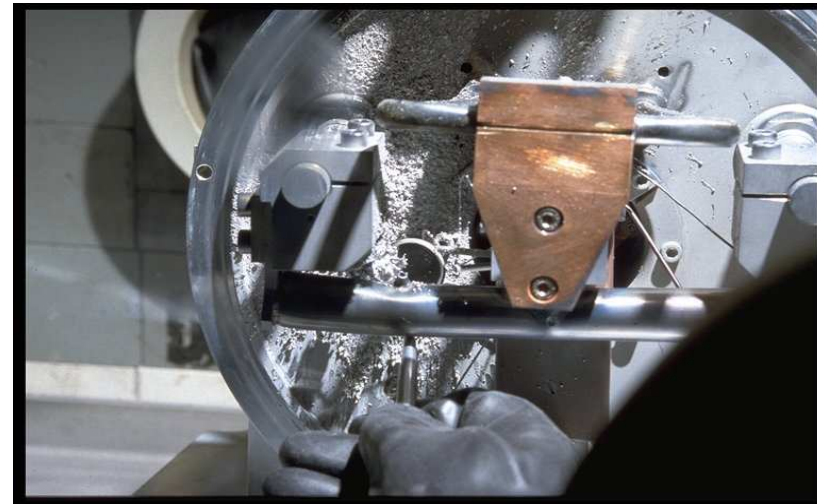
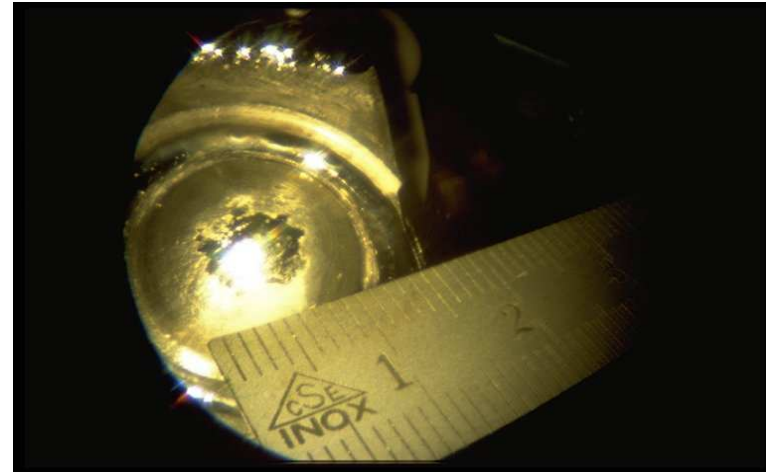
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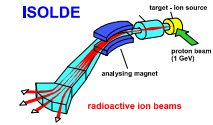
# Target



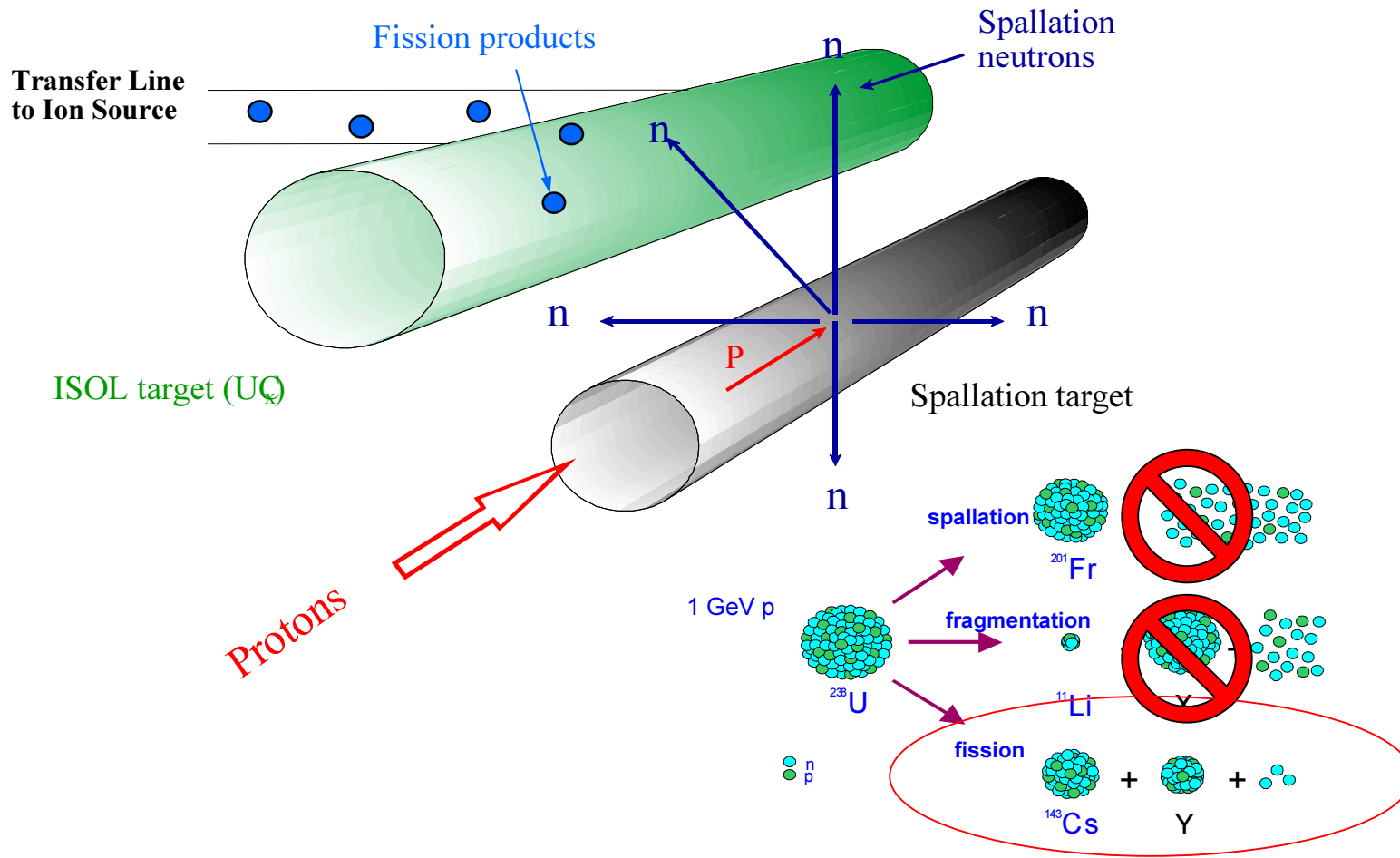
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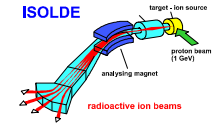


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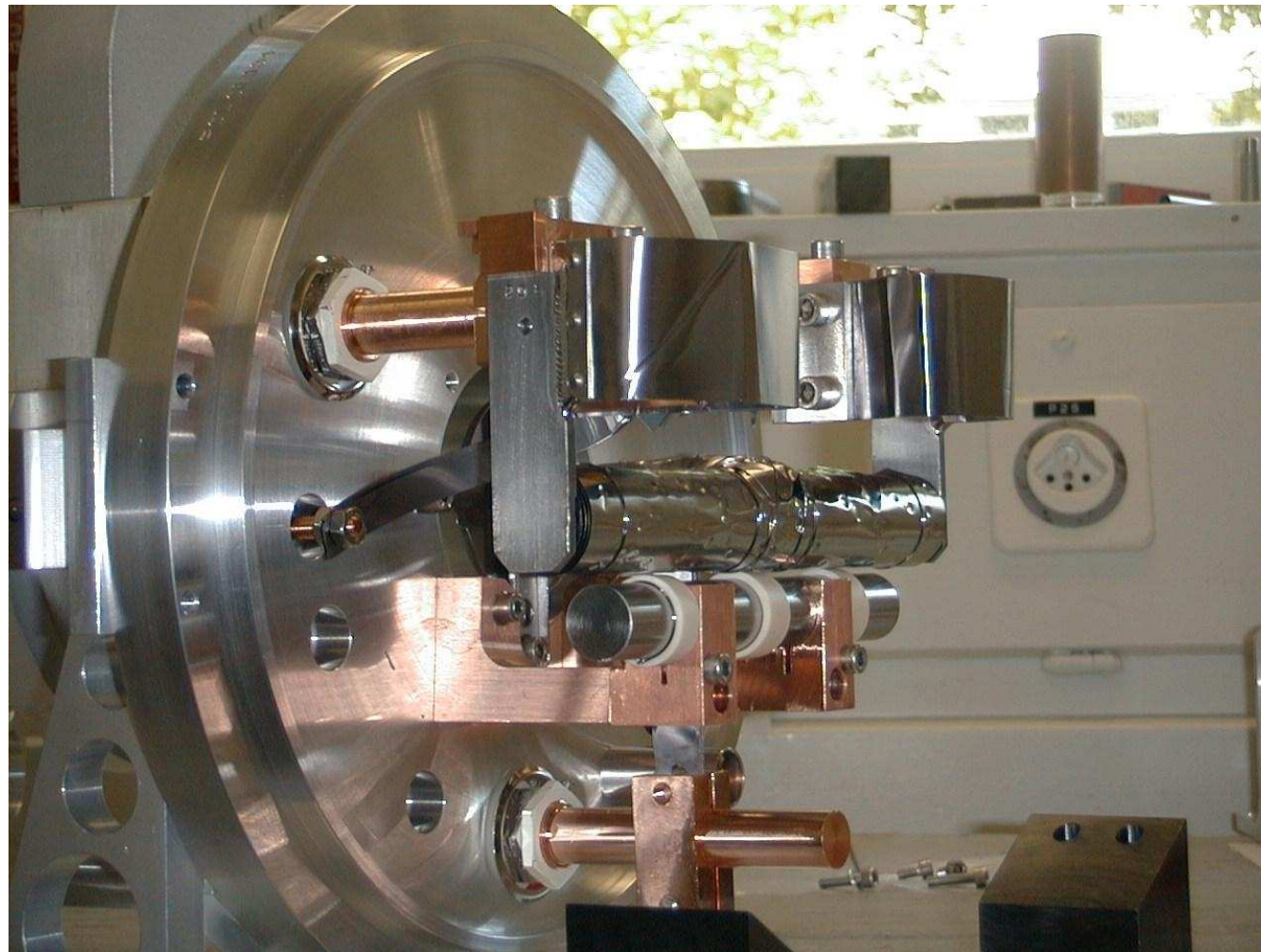


# Converter target





# Converter target

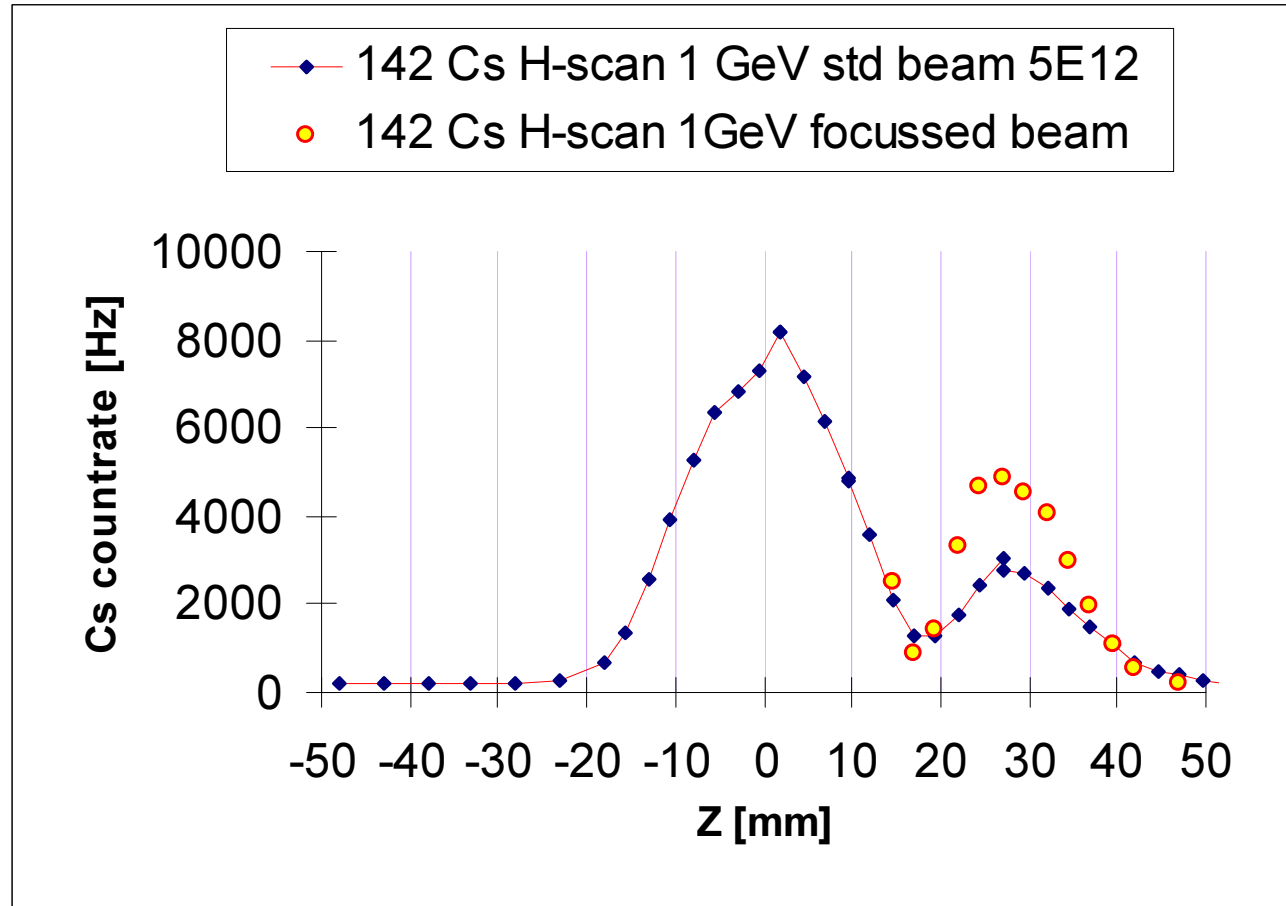
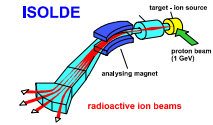


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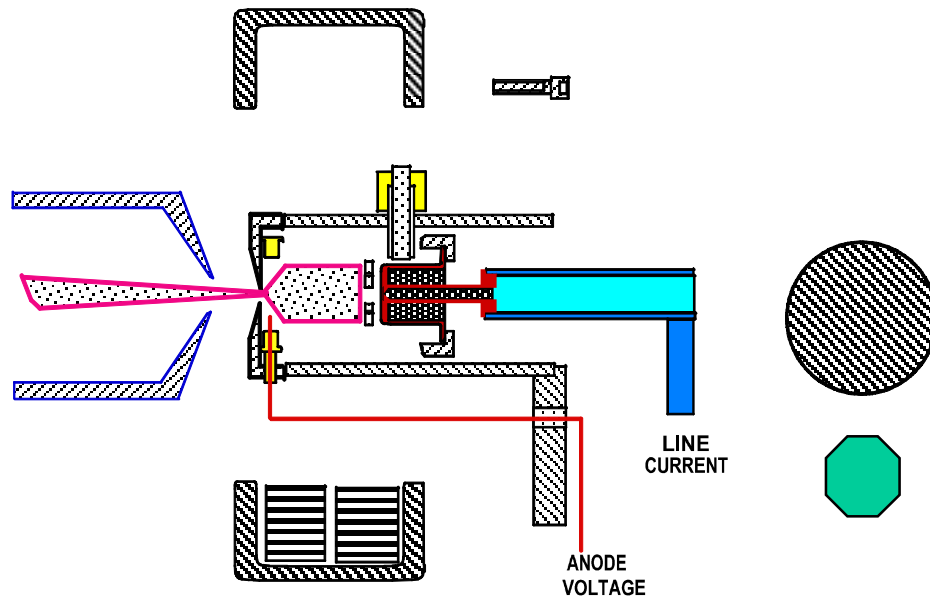
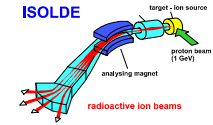
# Converter target scanning the proton beam



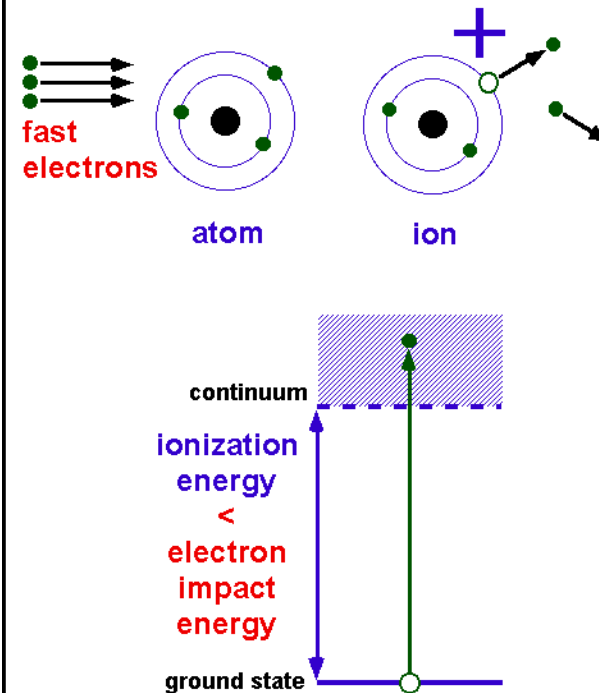


# Ion source

## Plasma ion source



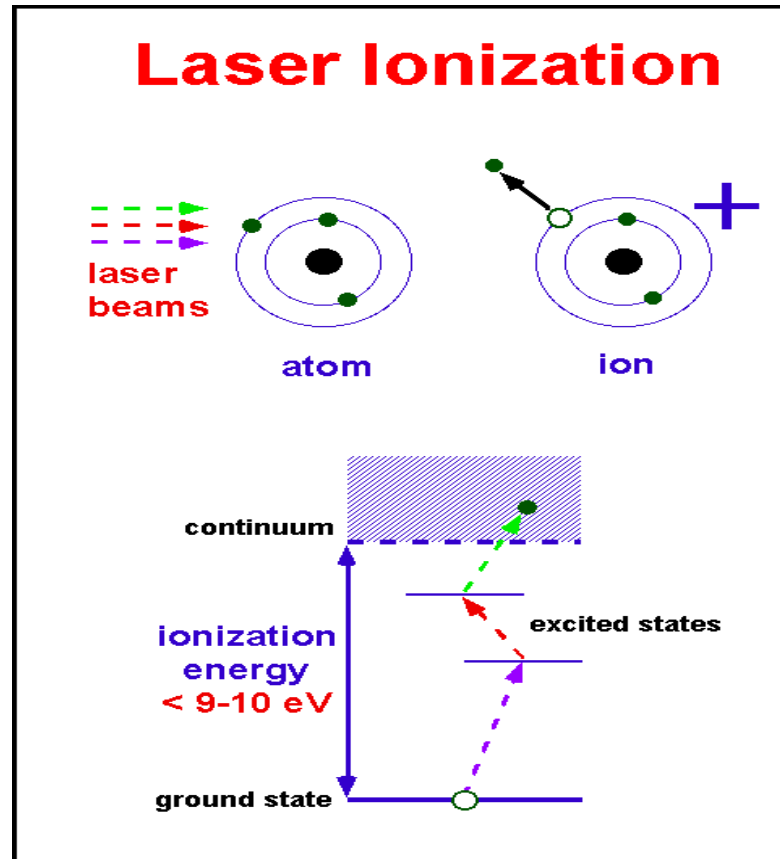
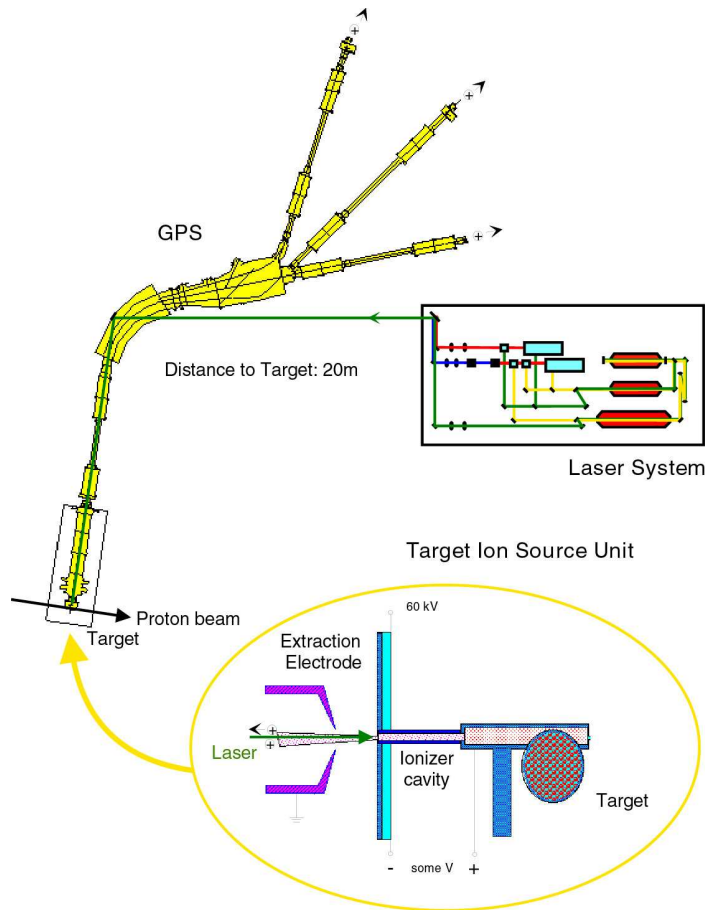
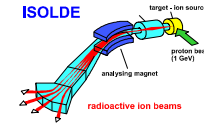
### Ionization by electron impact





# Ion source

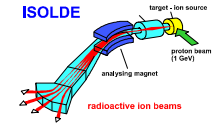
## Laser ionization







# ISOLDE target change

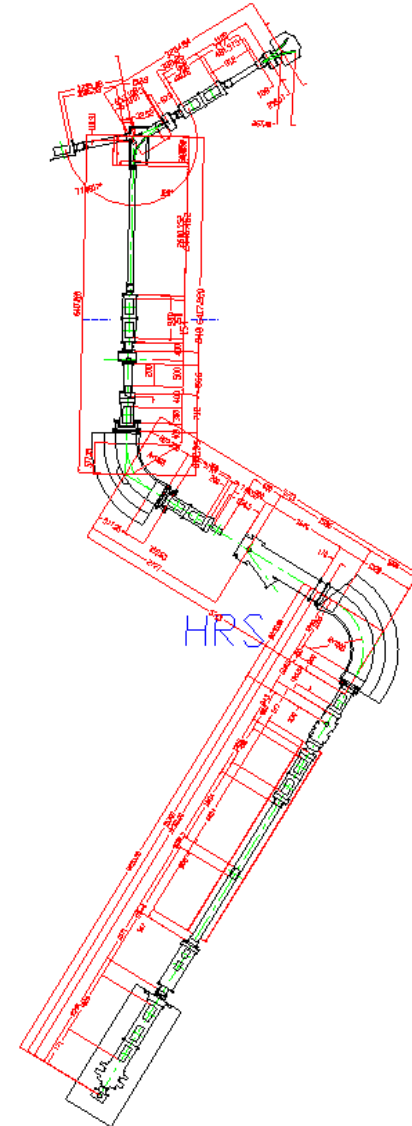
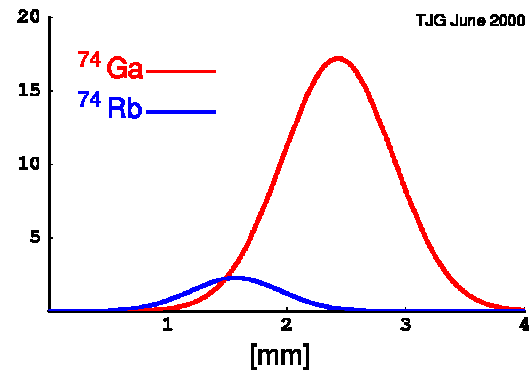
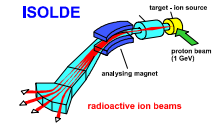


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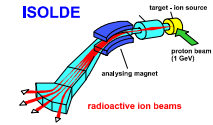


# Magnetic separation

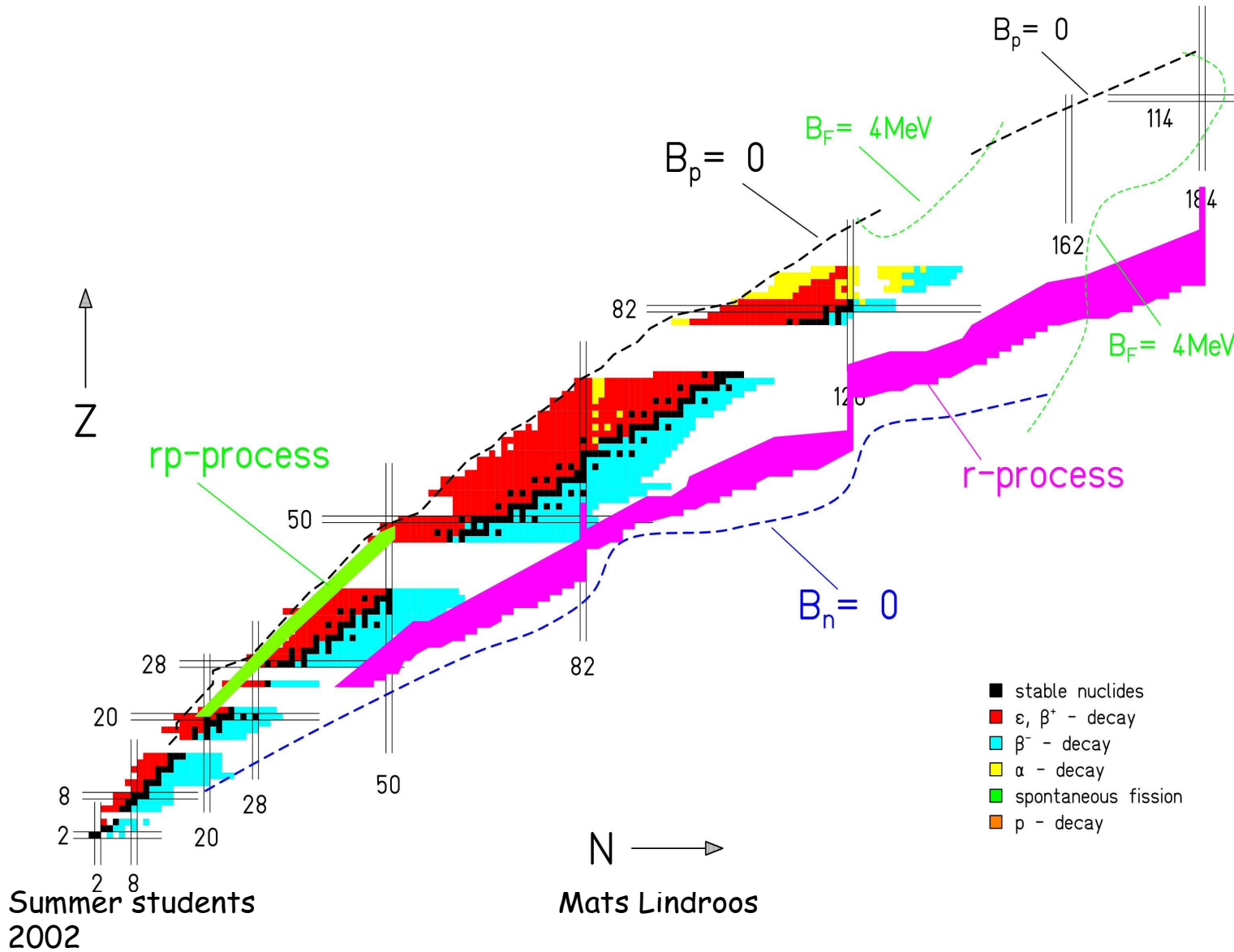


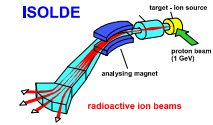
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# Nuclear chart @ ISOLDE





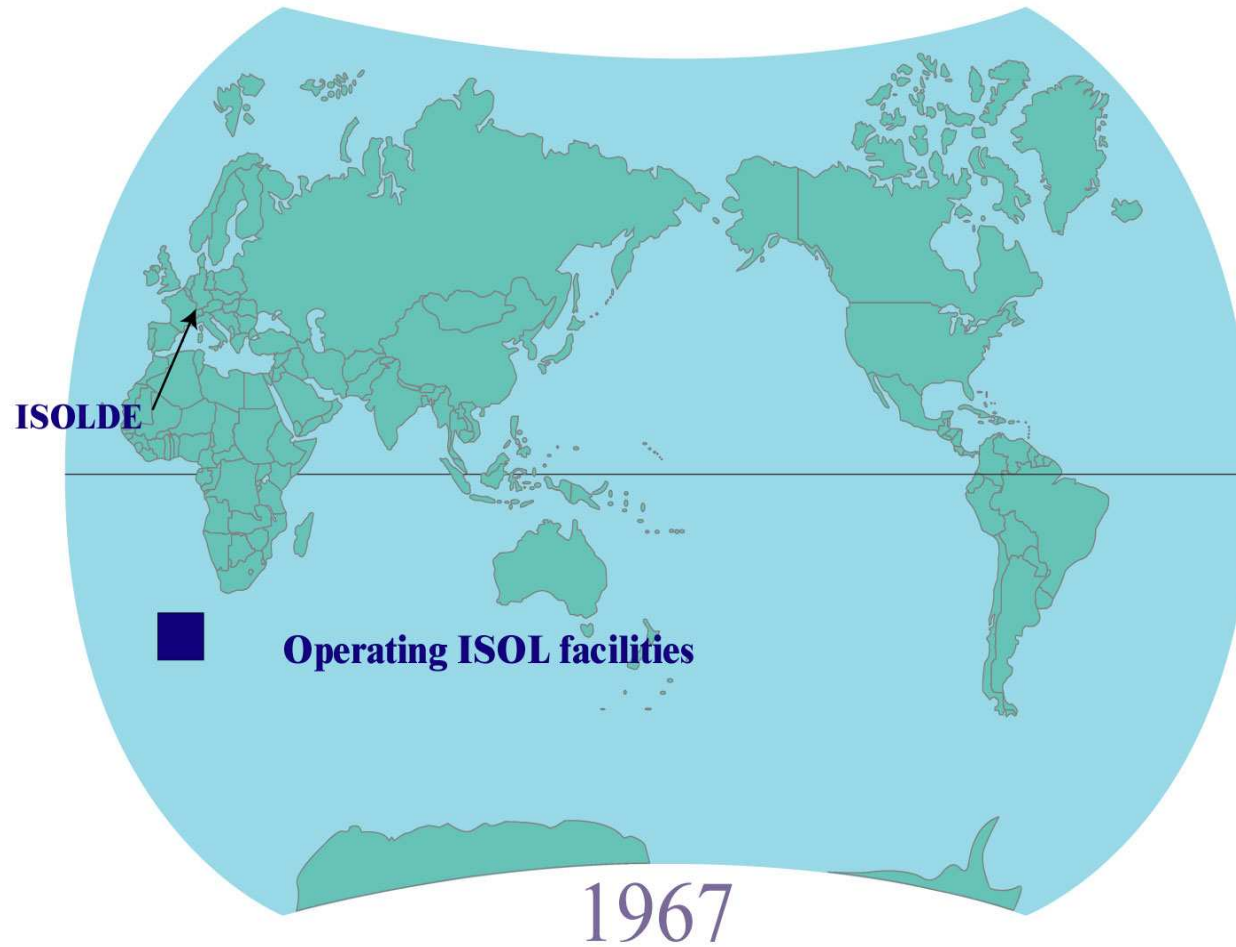
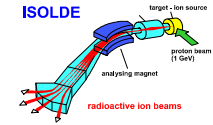
# Pure beams?

To get pure beams free from isobaric contamination:

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

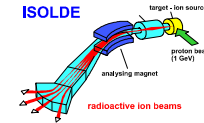


# ISOL facilities 1967



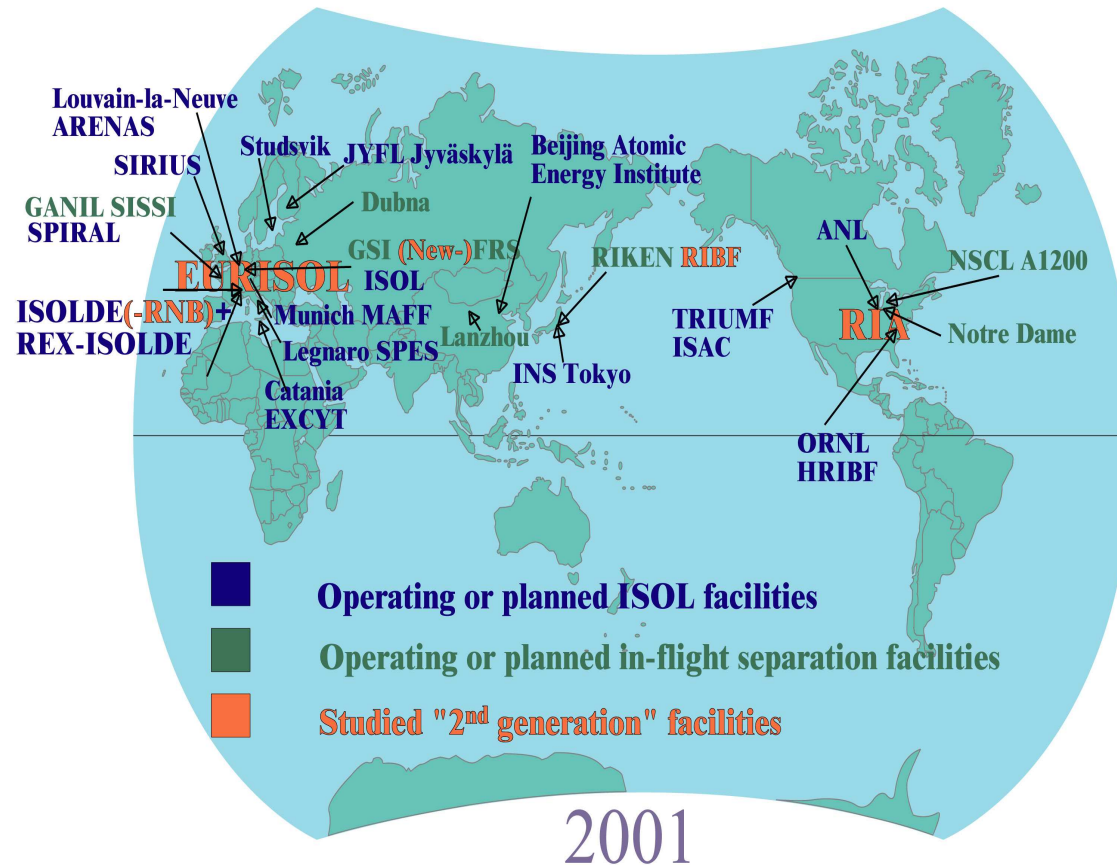
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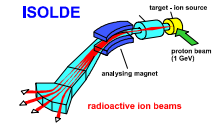
# ISOL facilities 2001

## World Wide Radioactive Beam Facilities



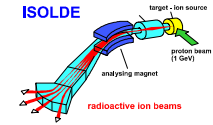
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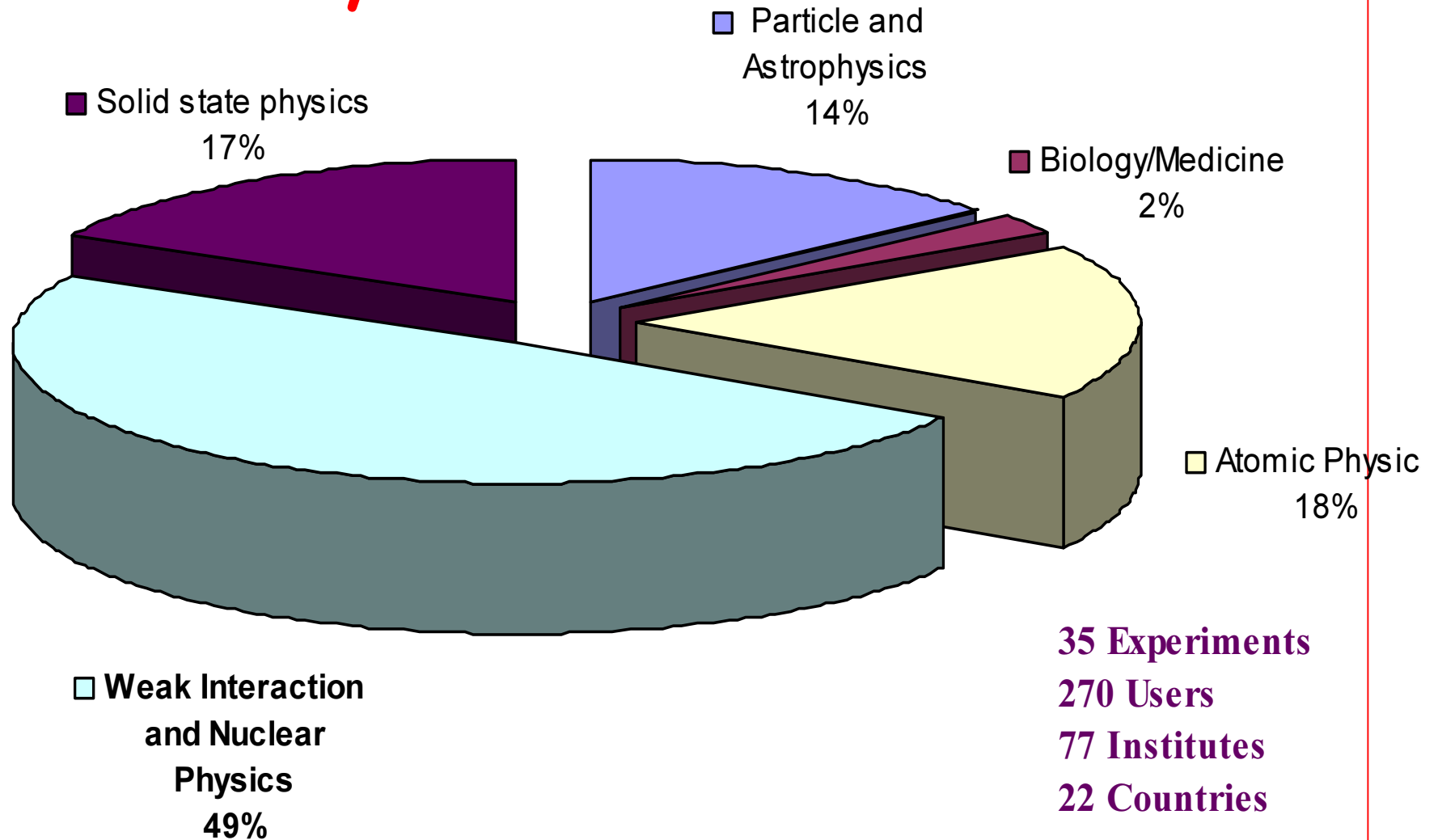


# Why bother?

- 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



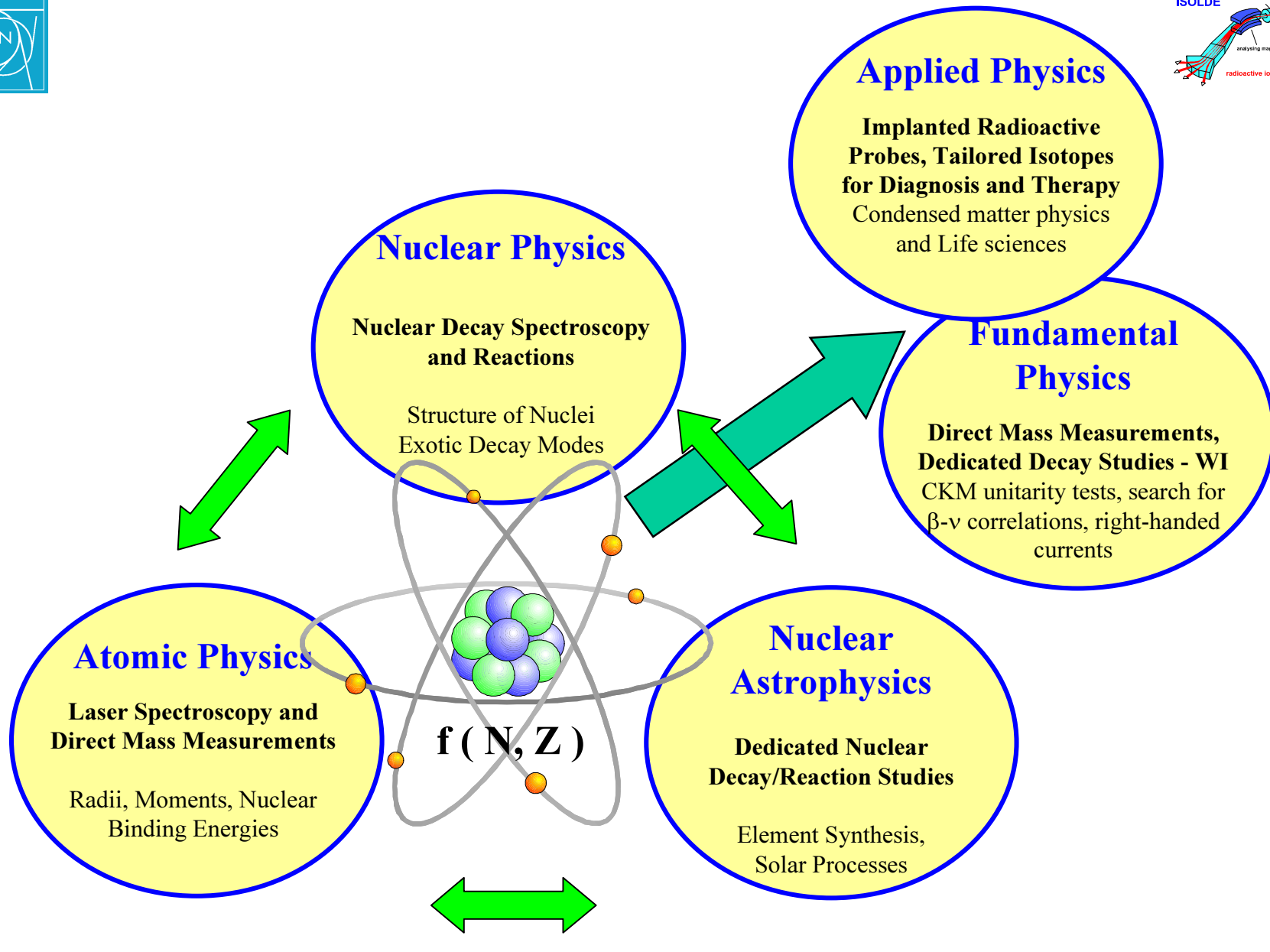
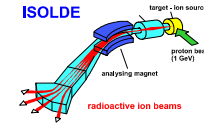
# Physics at ISOLDE



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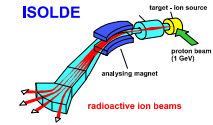
Mats Lindroos



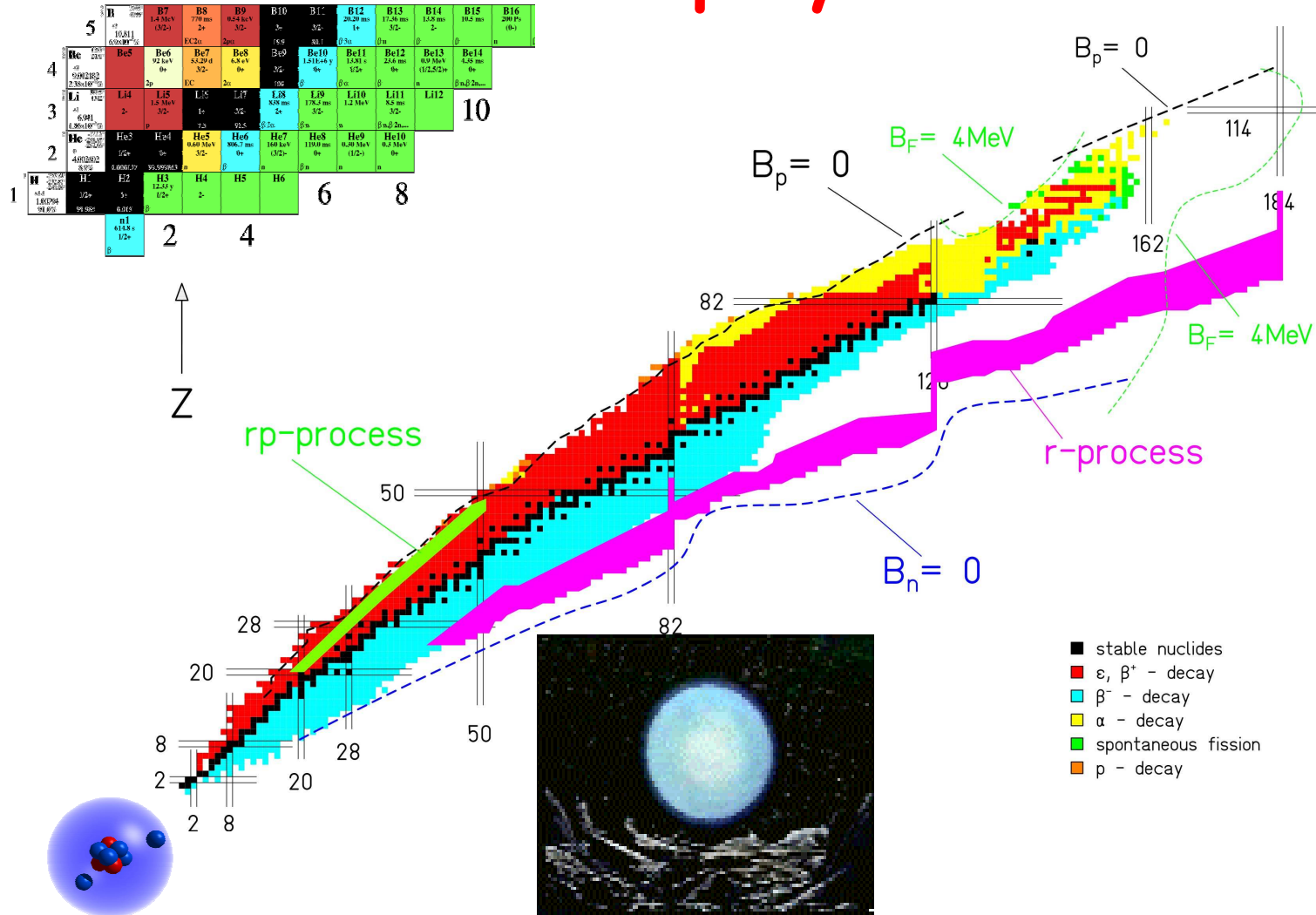


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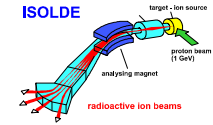


# Astrophysics

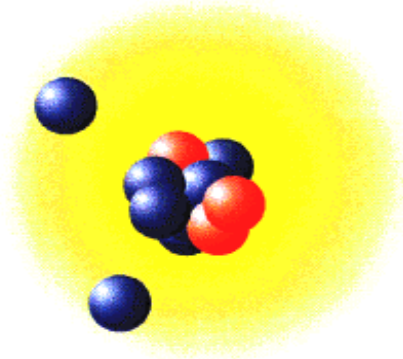


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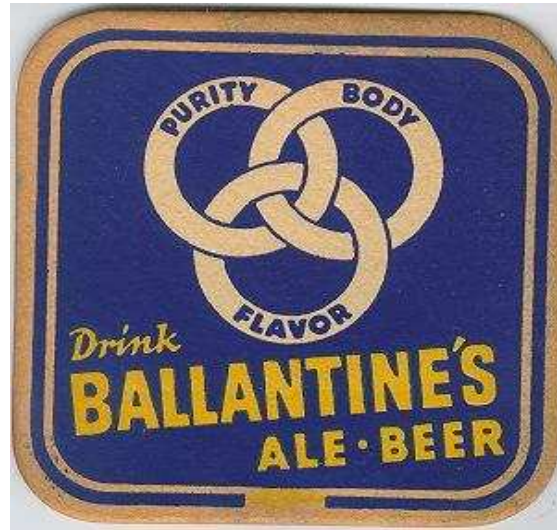
Mats Lindroos



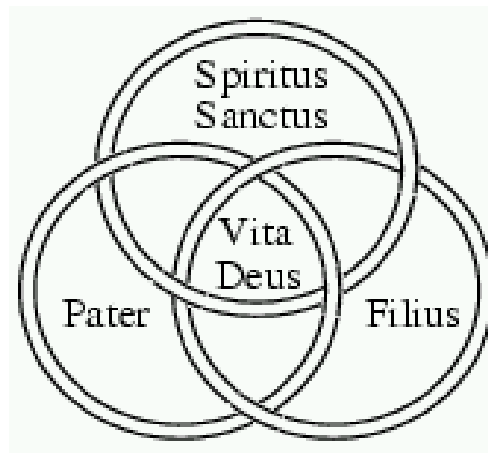
# Halo Nuclei



$^{11}\text{Li}$ : Borromean Halo Nucleus

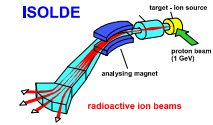


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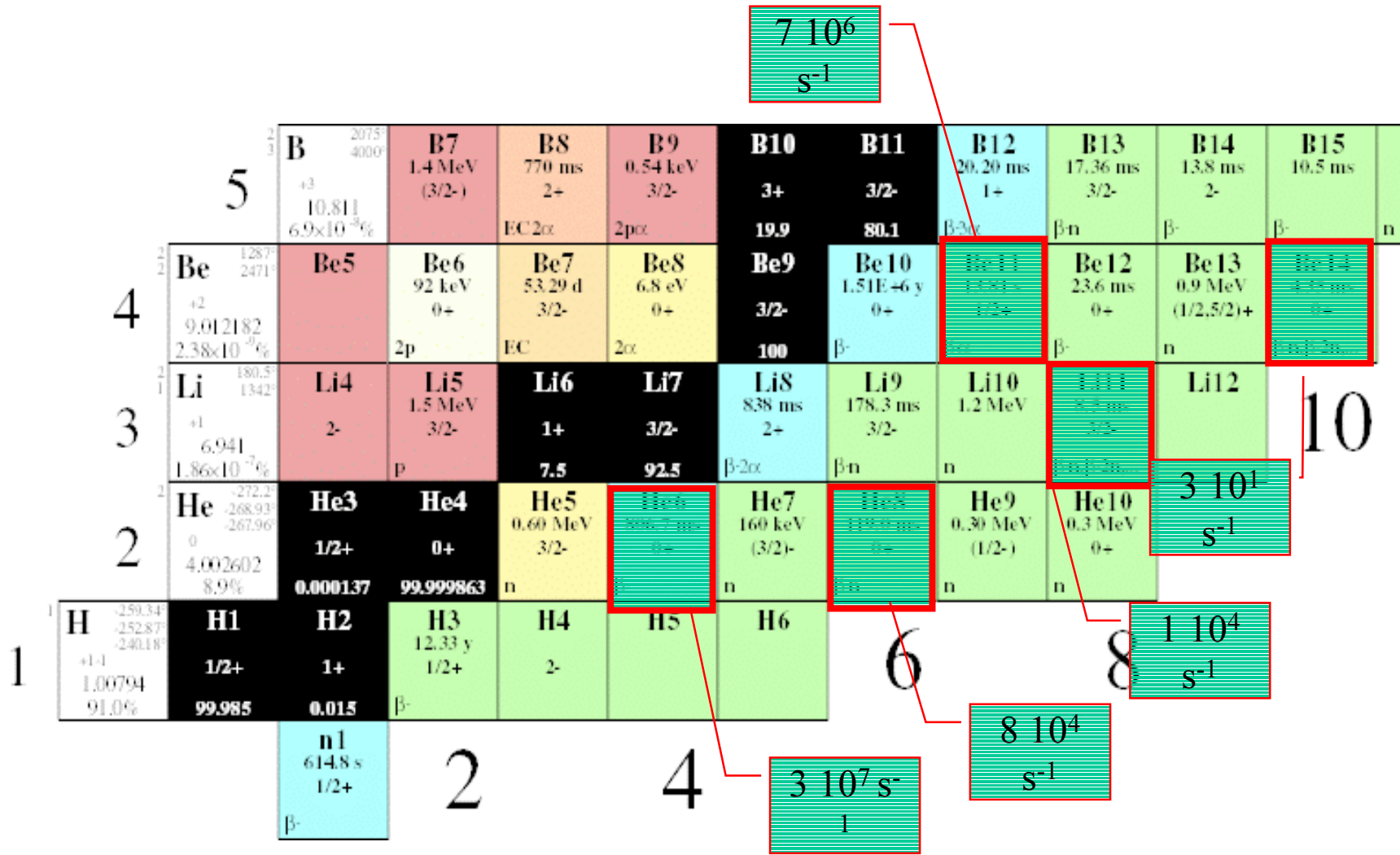


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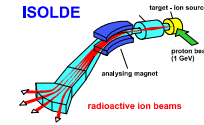


# Halo nuclei



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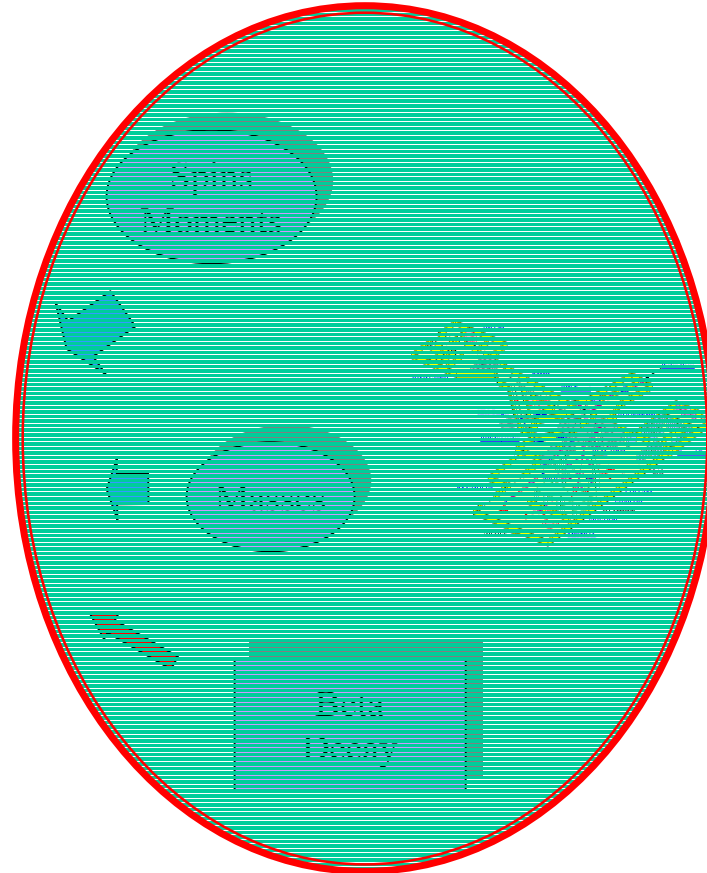
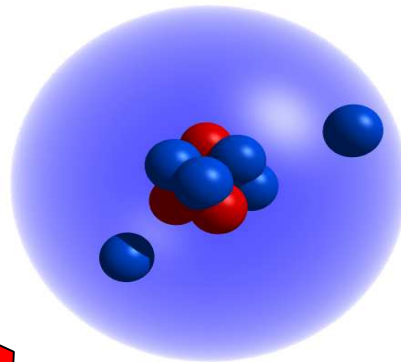
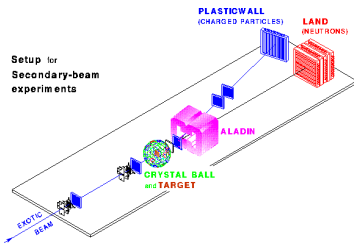
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# To get the whole picture...

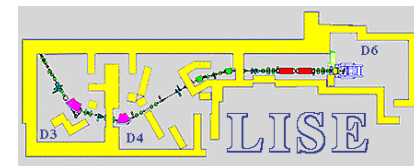
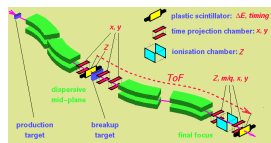
Reaction Cross Sections

Elastic Scattering



Momentum Distributions

Unbound Nuclei

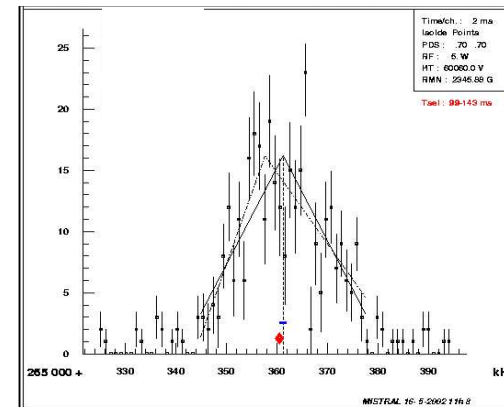
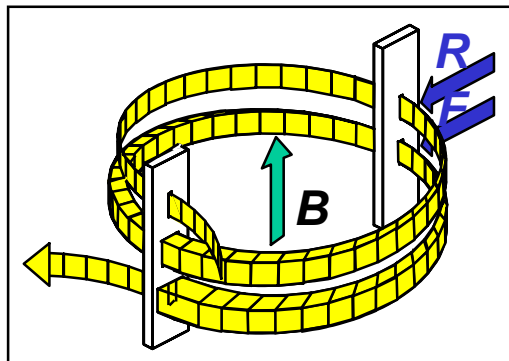
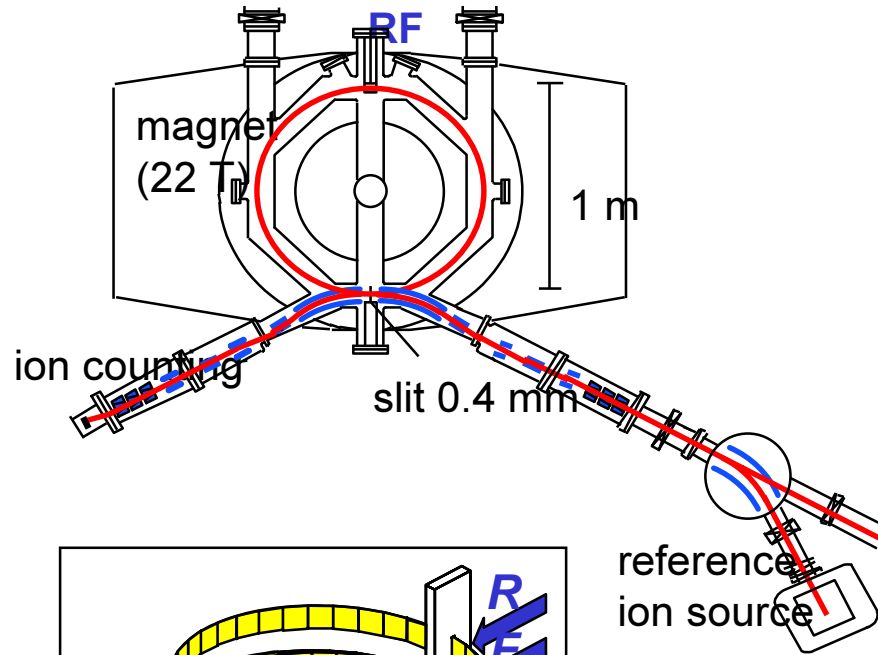
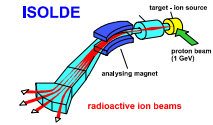


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# Mass measurements



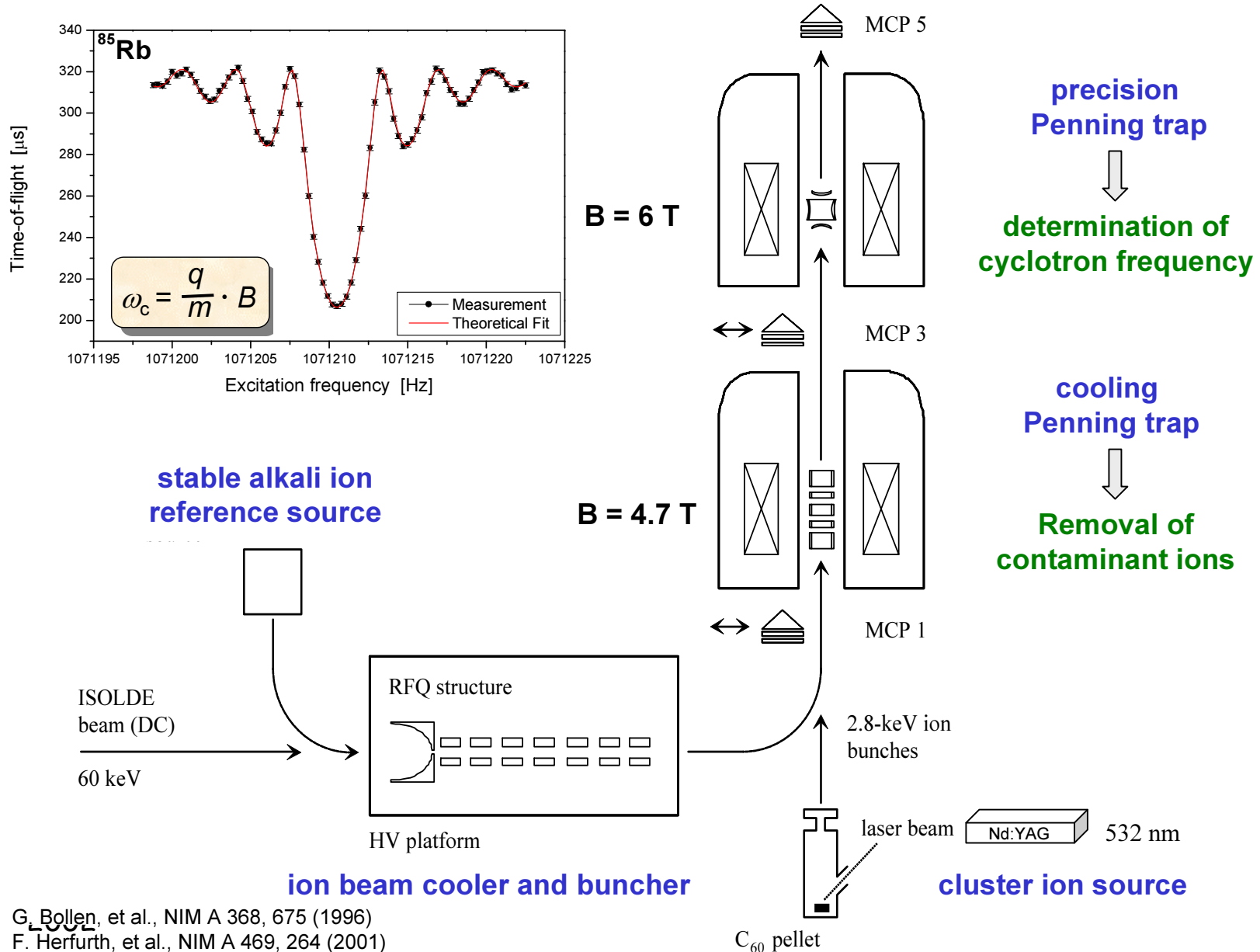
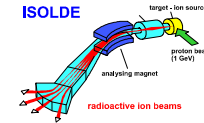
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D. Lunney



# Mass measurements

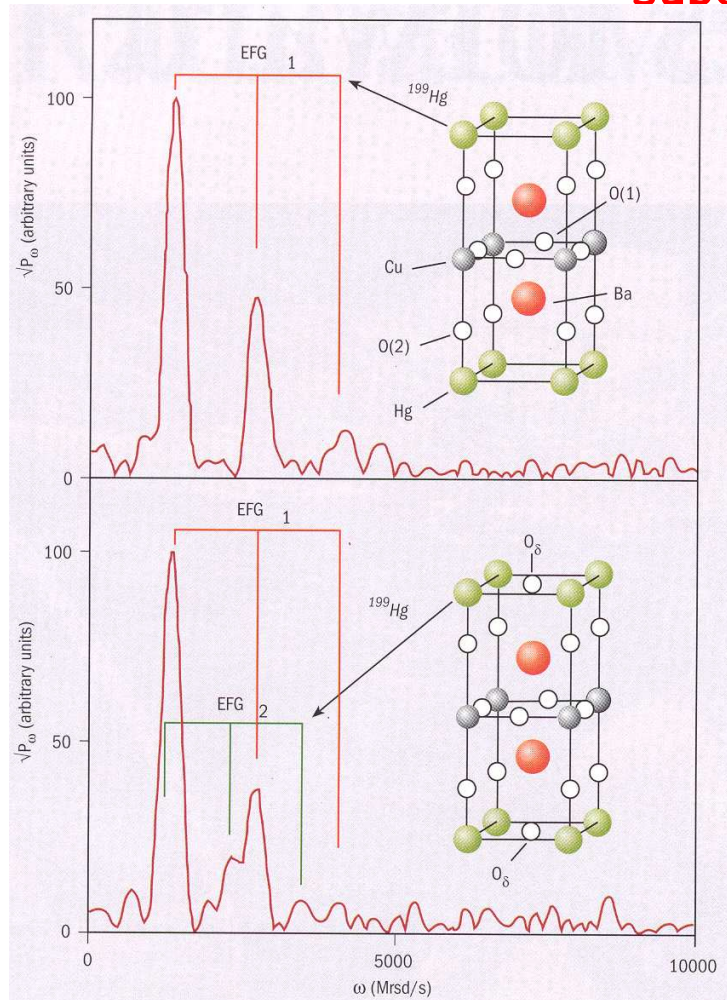
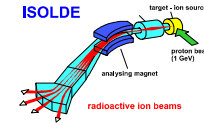


G. Bollen, et al., NIM A 368, 675 (1996)  
 F. Herfurth, et al., NIM A 469, 264 (2001)



# Solid state physics

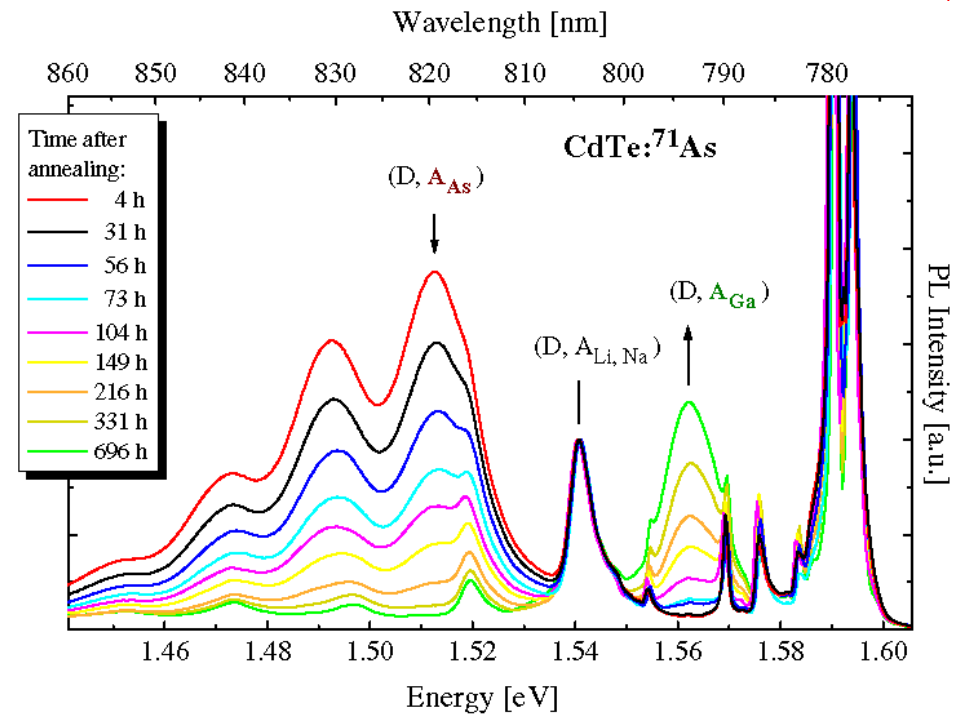
Radioactive ions as "spies" (PAC) in high-Tc superconductors...



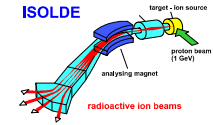
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Mat

... or as dopants in semiconductors that change with time.

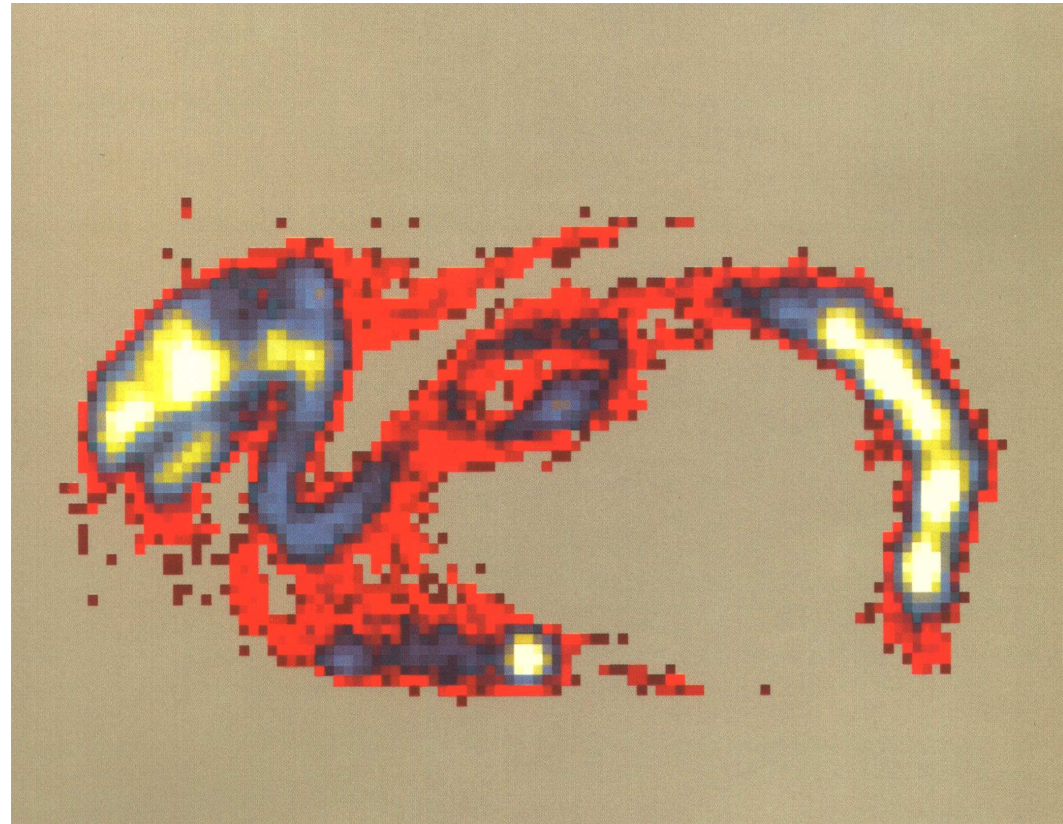






# Medical physics

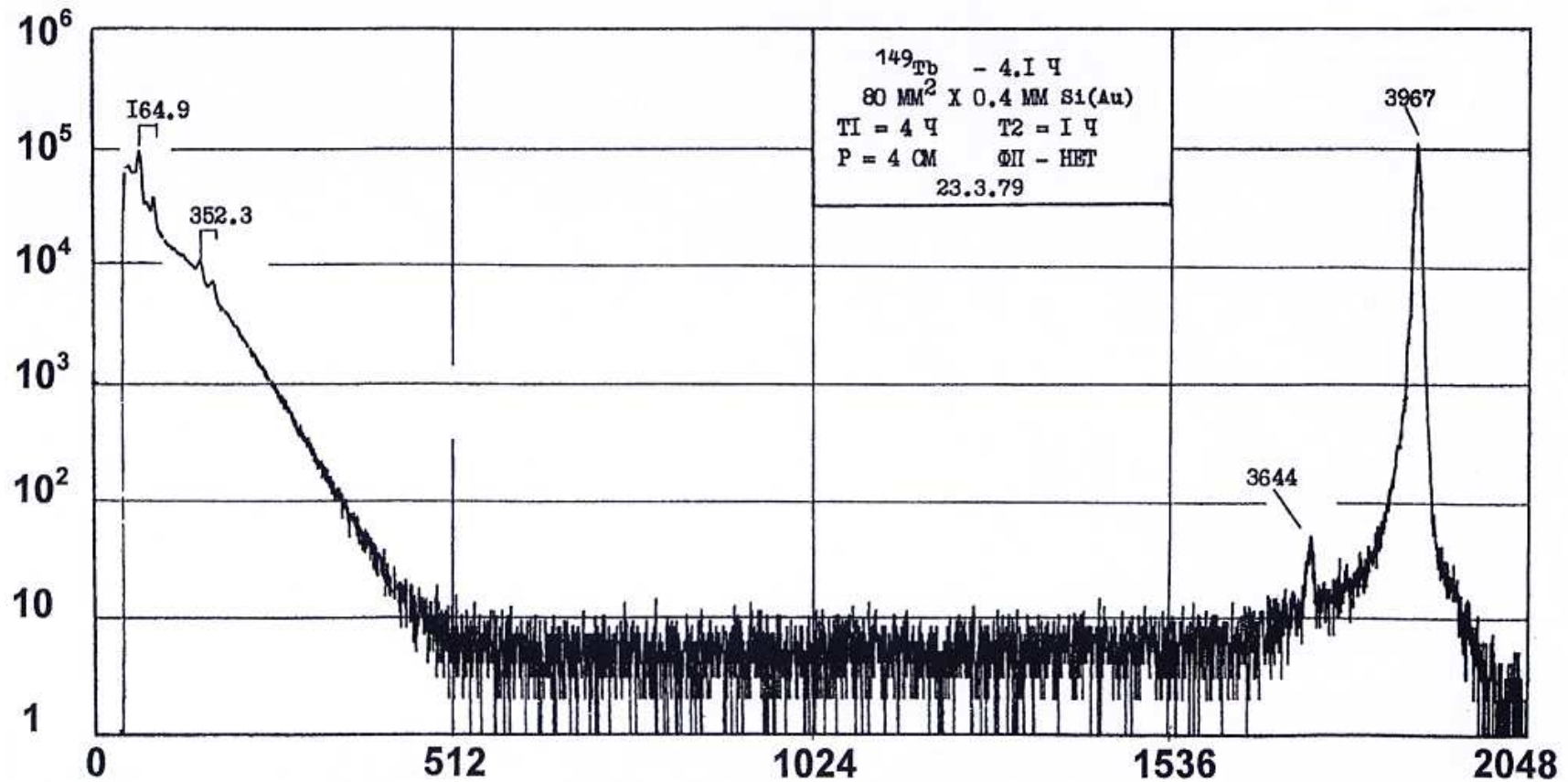
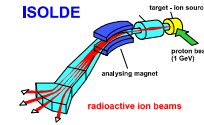
- Example: samarium isotopes
- "in vivo" dosimetry by positron emission tomography (PET)
- $^{142}\text{Sm}$  ( $\beta^+$ ,  $T_{1/2} = 72\text{m}$ )  $\rightarrow$   $^{142}\text{Pm}$  ( $\beta^-$ ,  $T_{1/2} = 40\text{s}$ )
- Therapy:  $^{153}\text{Sm}$  ( $\beta^-$ ,  $T_{1/2} = 47\text{h}$ )



PET scan of a rabbit 60 min p.i. of ISOLDE produced  $^{142}\text{Sm}$  in EDTMP solution

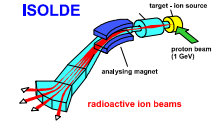


# Particle spectrum of $^{149}\text{Tm}$

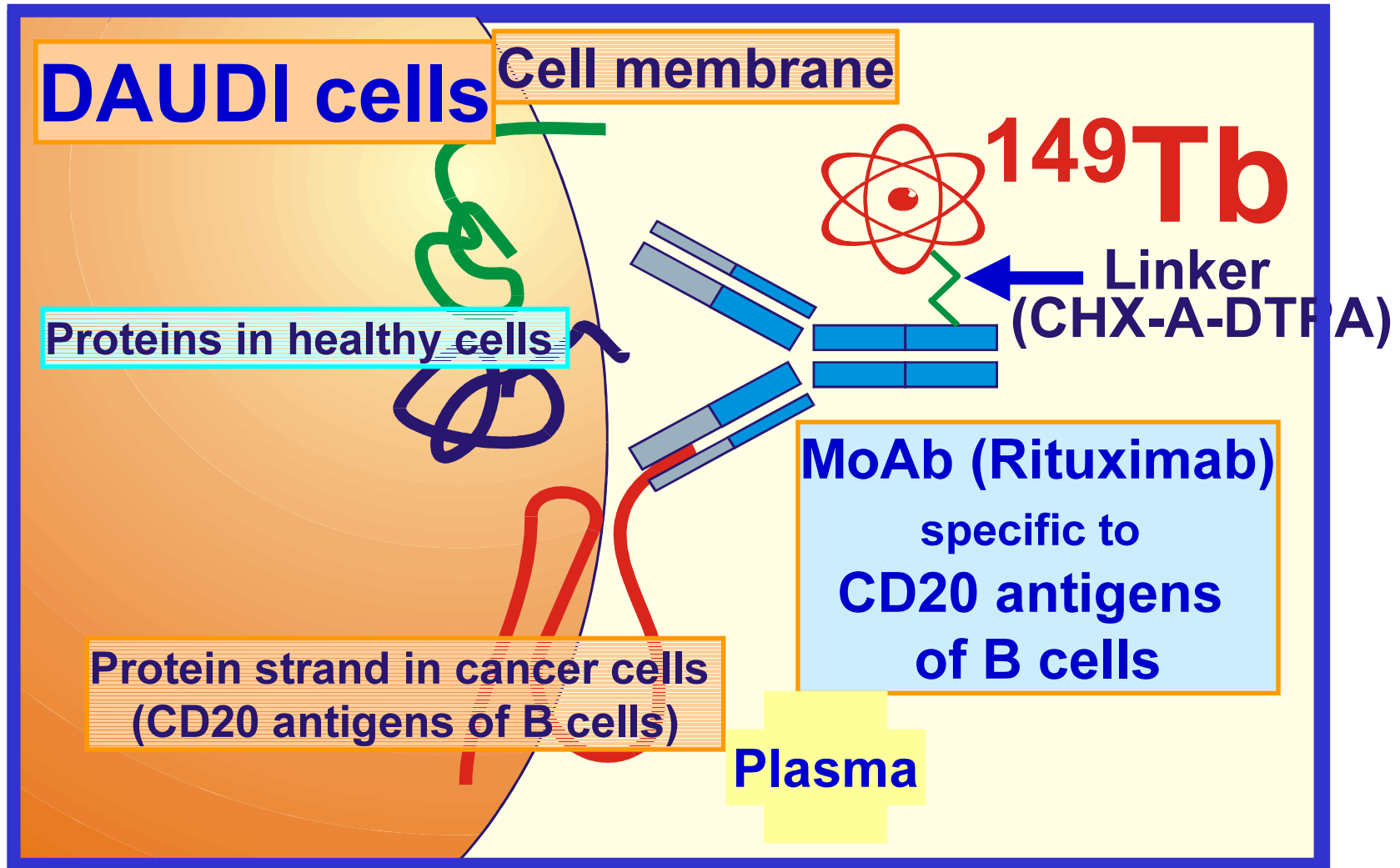


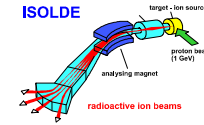
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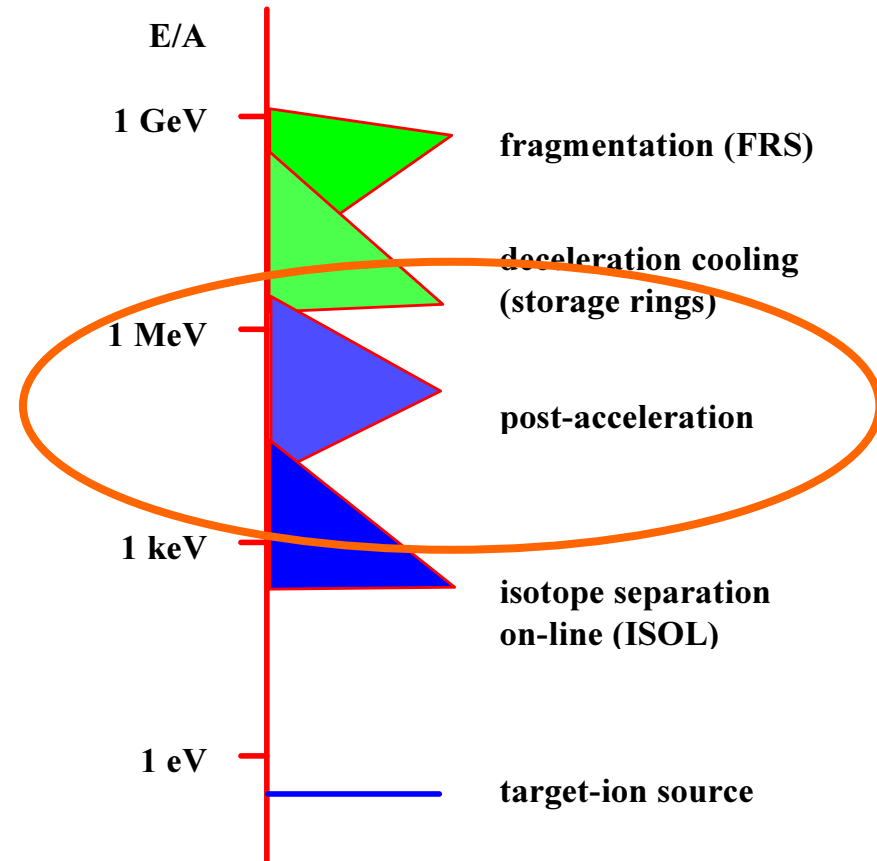
# Principle of Radioimmuno Therapy

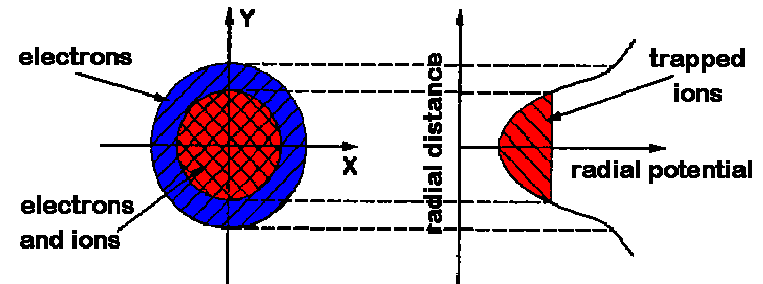
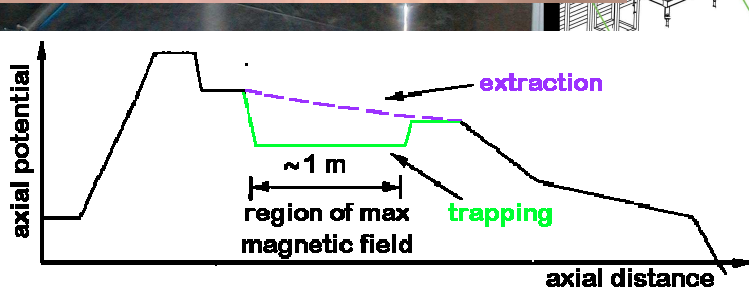
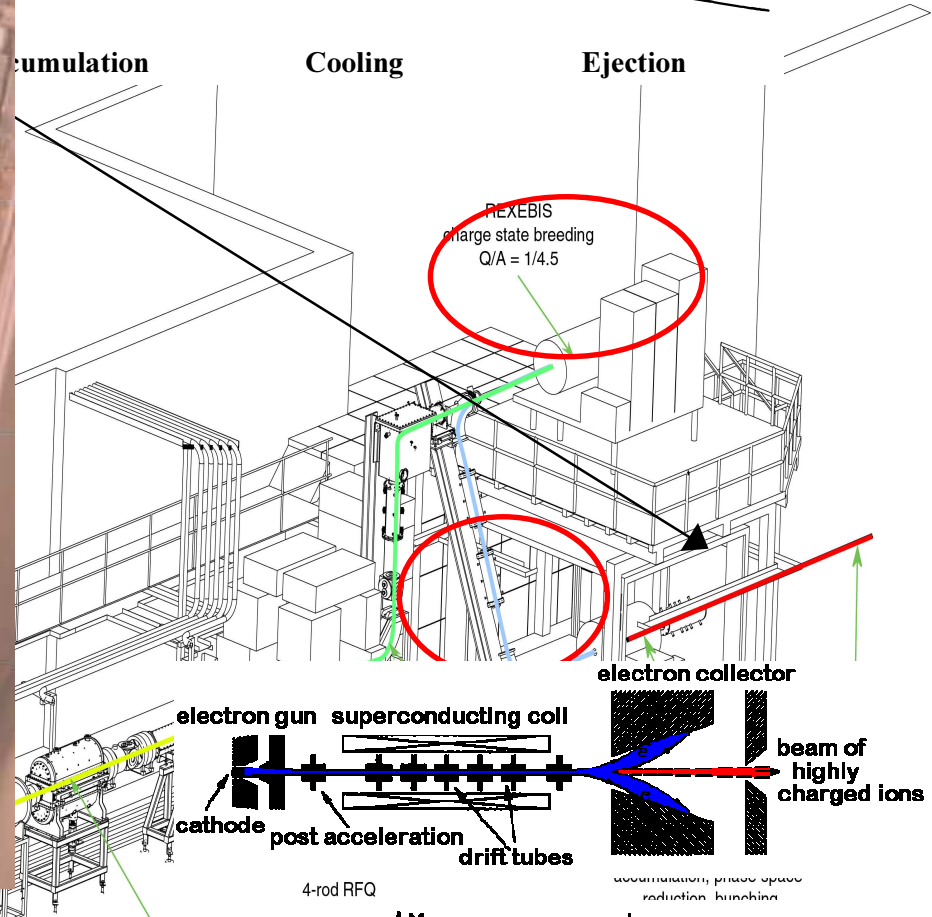
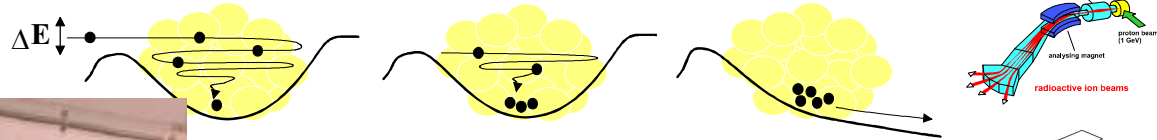




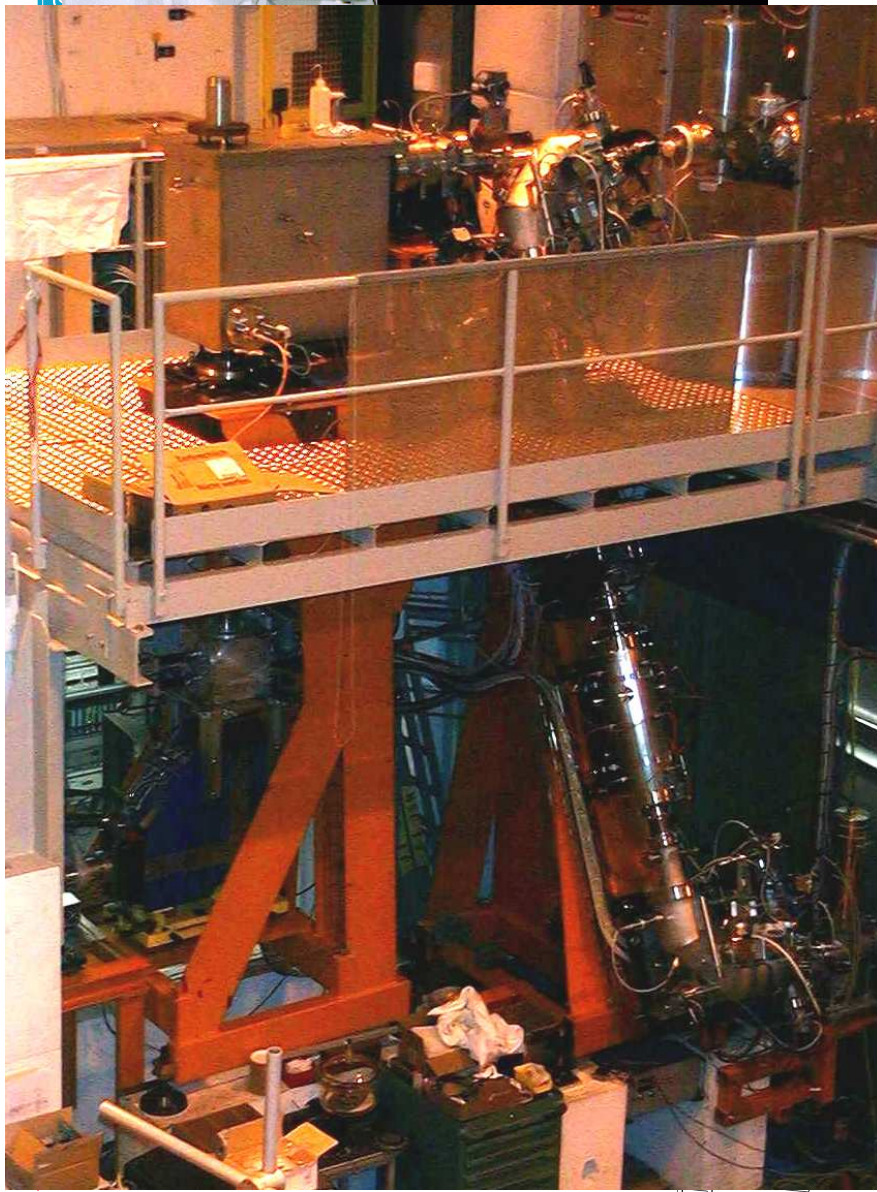
# Post acceleration

- Acceleration of radioactive ions:
  - Low intensity
  - Short half lives
  - Charge state

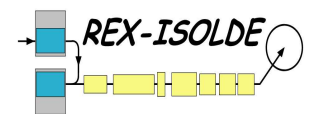
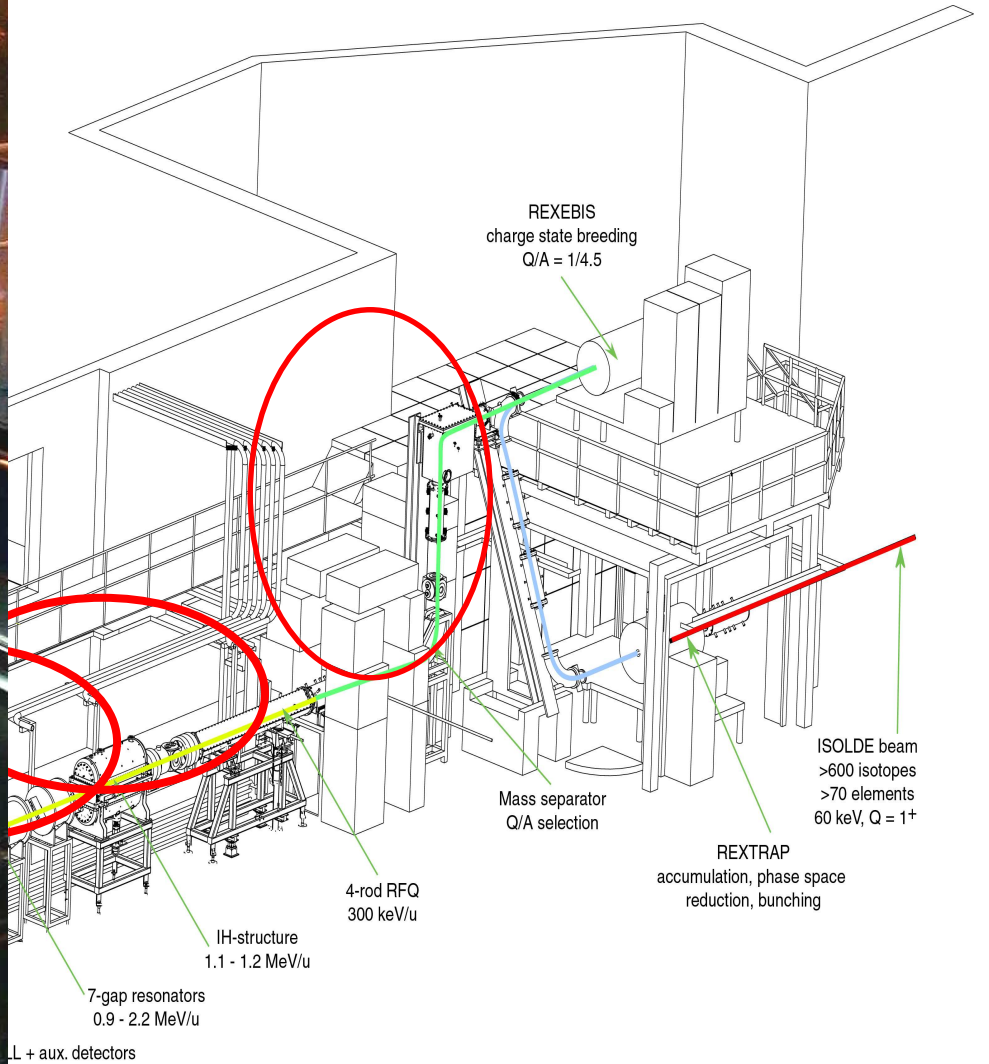
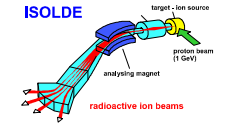


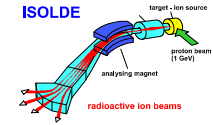


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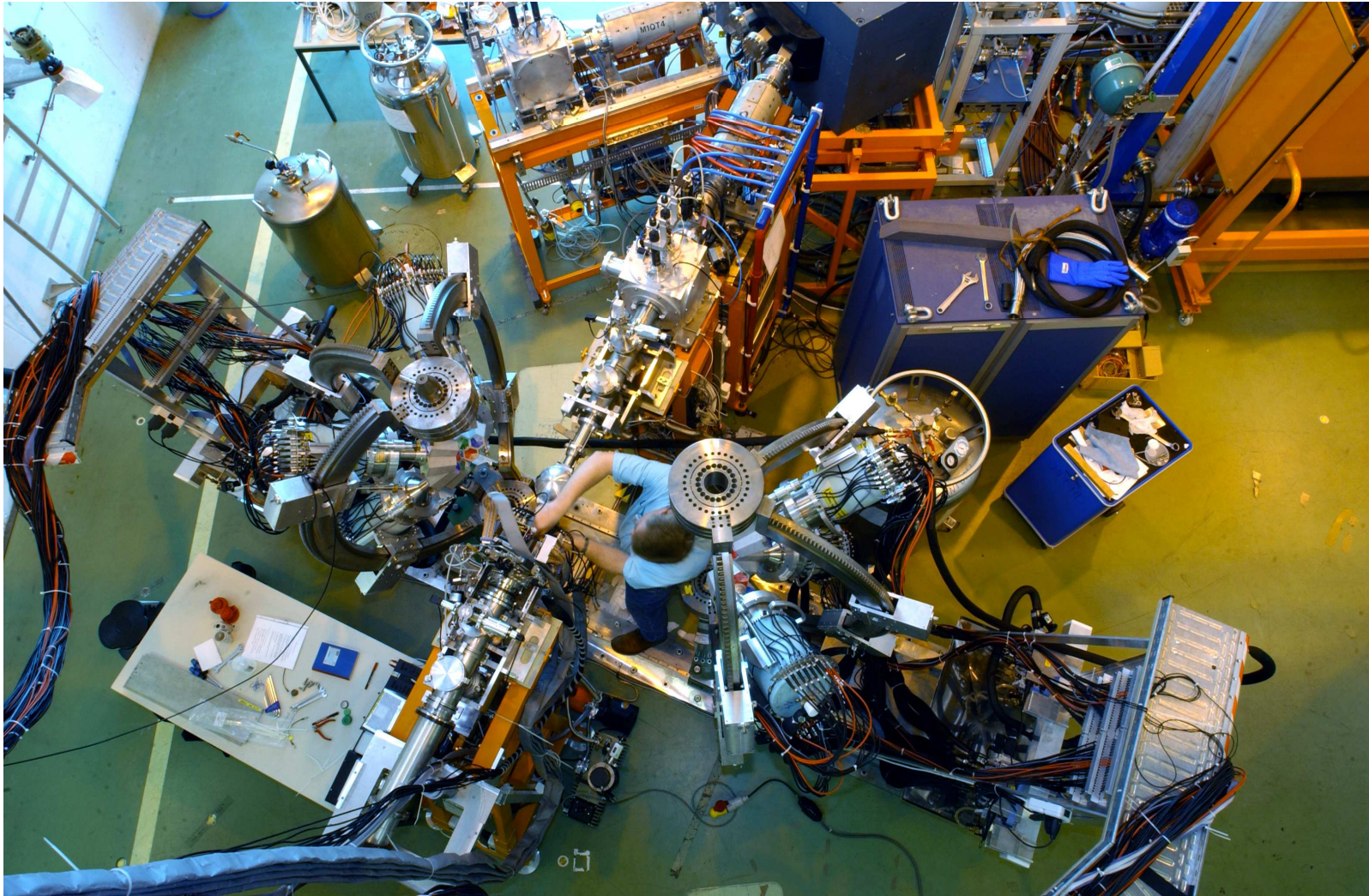


Summer  
2002





# REX mini ball



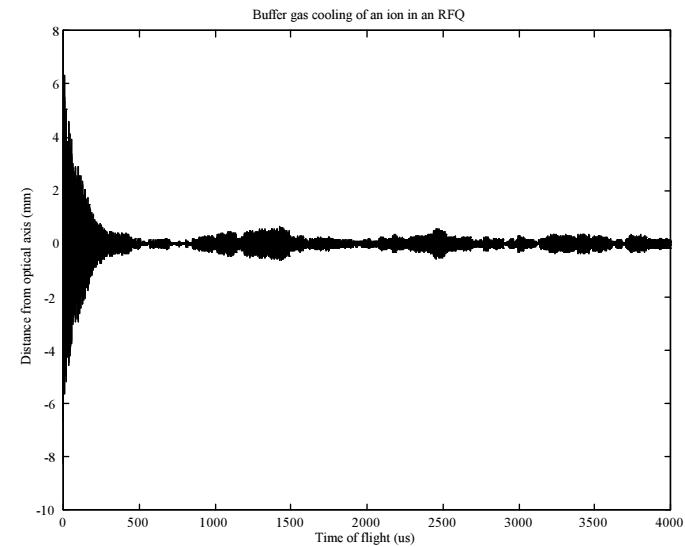
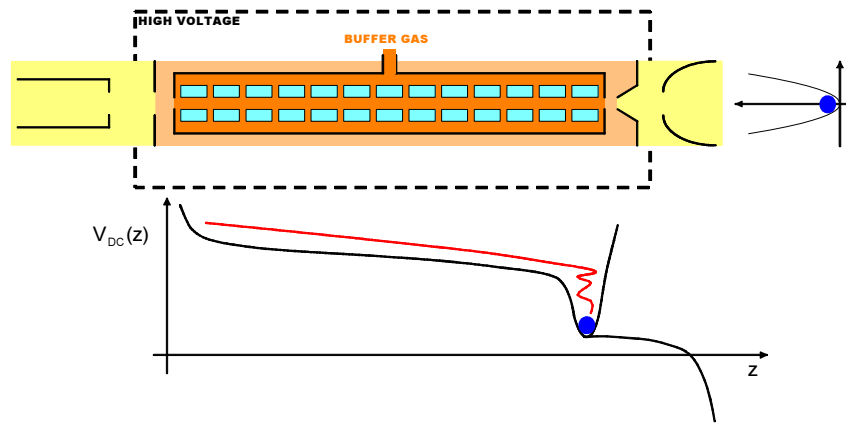
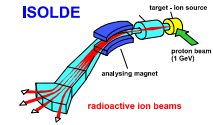
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# Future plans

## An RFQ cooler at ISOLDE



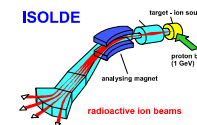
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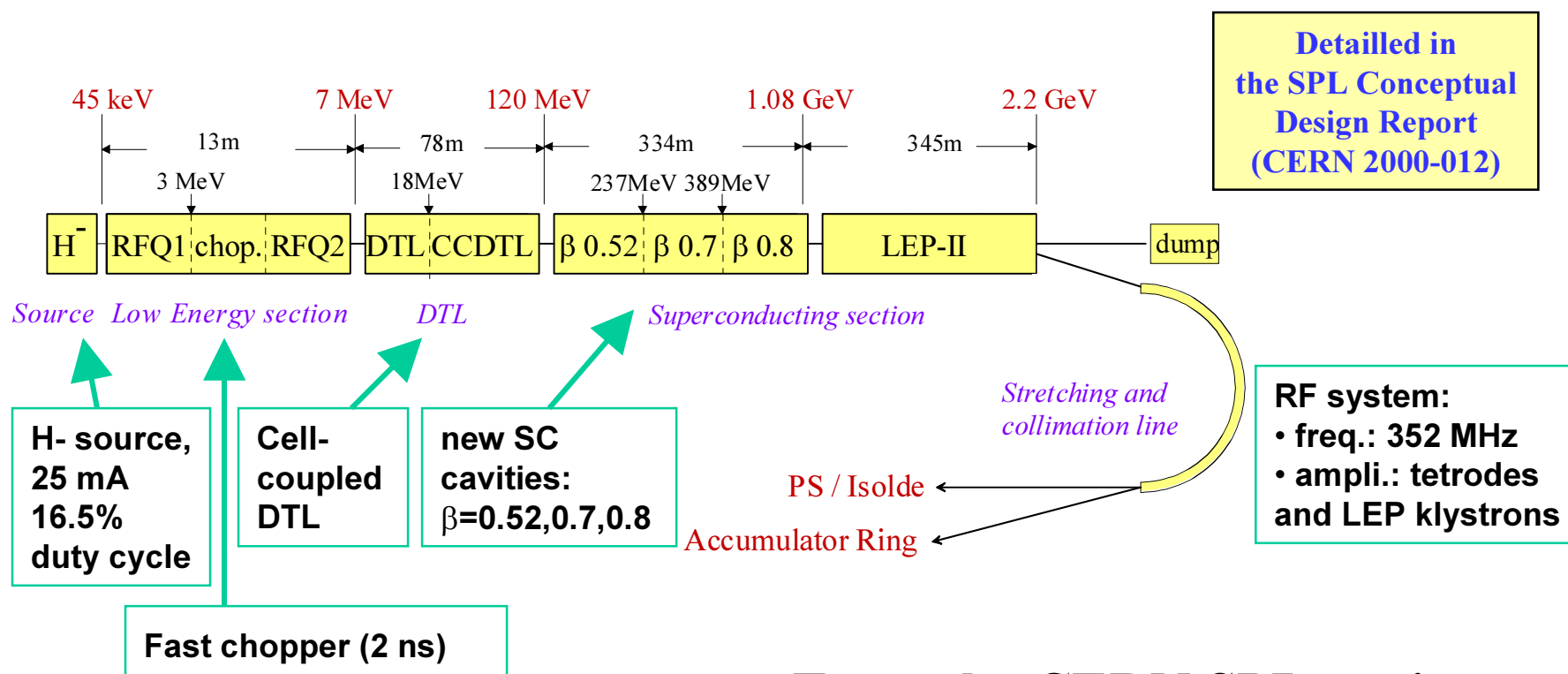




# Future plans The SPL



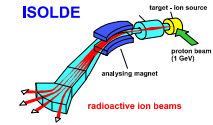
- A new high intensity proton source for CERN



From the CERN SPL project

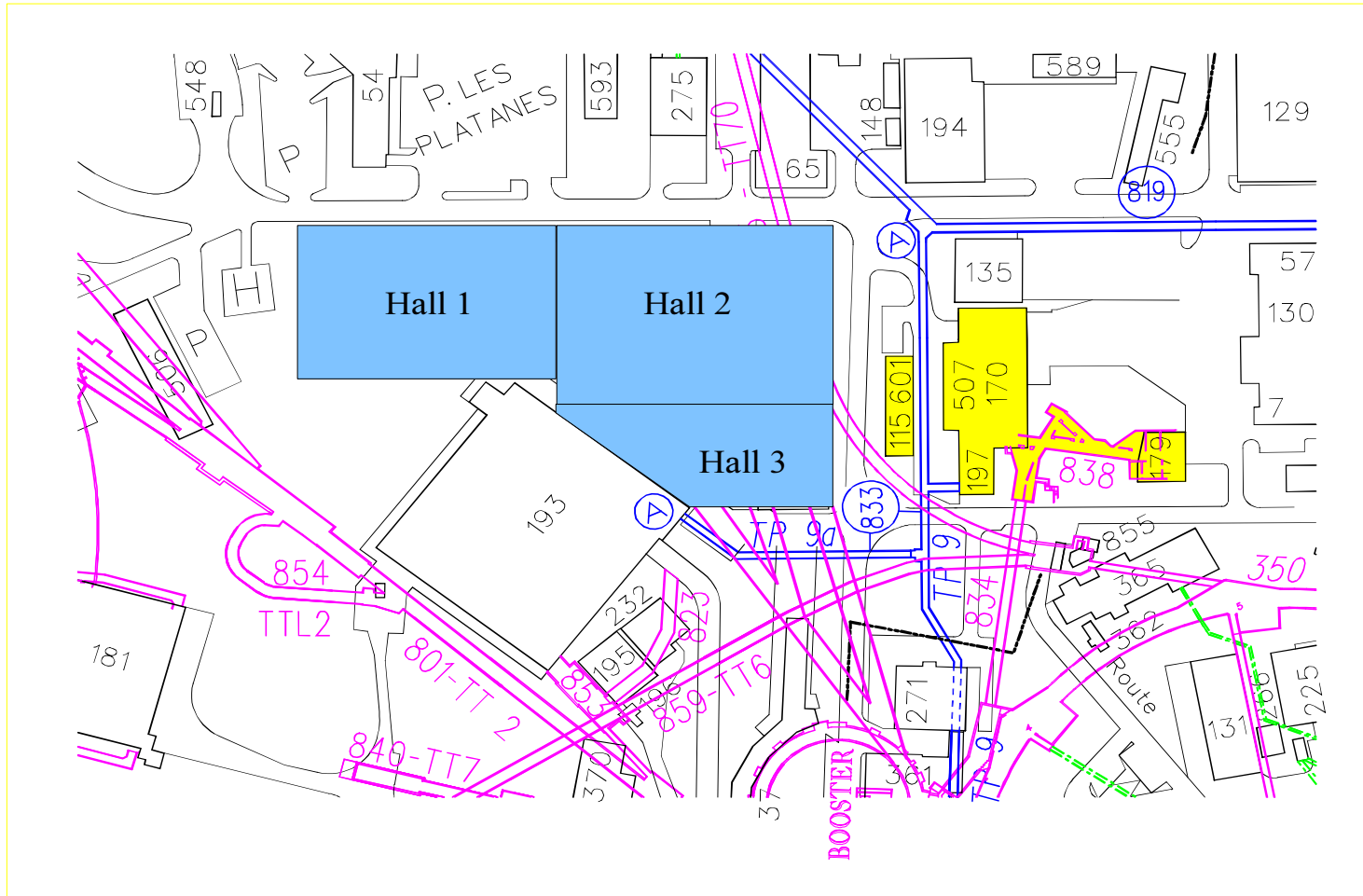
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# Future plans

## A next generation RNB facility

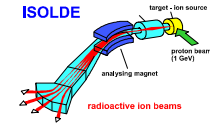


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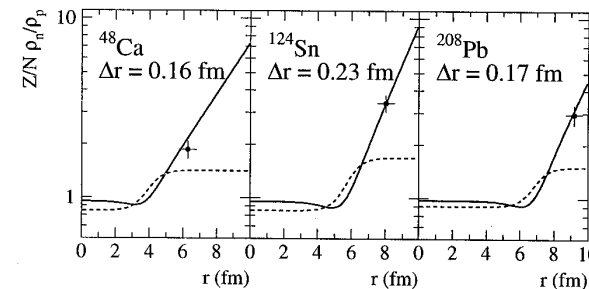
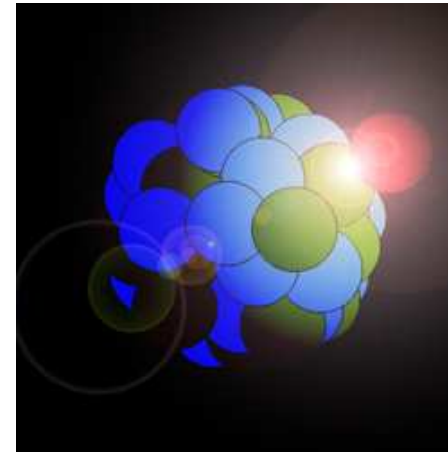
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# New probes for nuclear physics

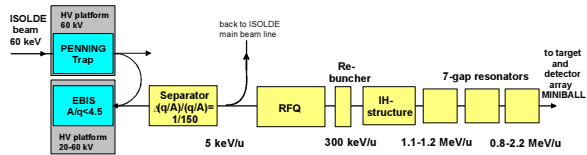
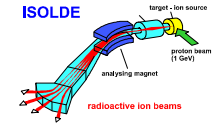


- Probing of nuclear surface
  - "Halo model" vs "Neutron skin model"
    - Neutron Density Distributions Deduced from Antiprotonic Atoms  
A. Trzcinska, J. Jastrzebski, P. Lubinski, F. J. Hartmann, R. Schmidt, T. von Egidy, and B. Klos  
Phys. Rev. Lett 87, 2001
  - Study of the annihilation residues with mass number one unit smaller than the target mass  $A_t$
  - Study in-beam antiprotonic x-rays

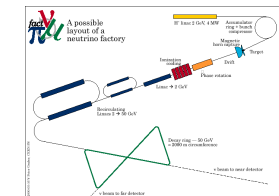
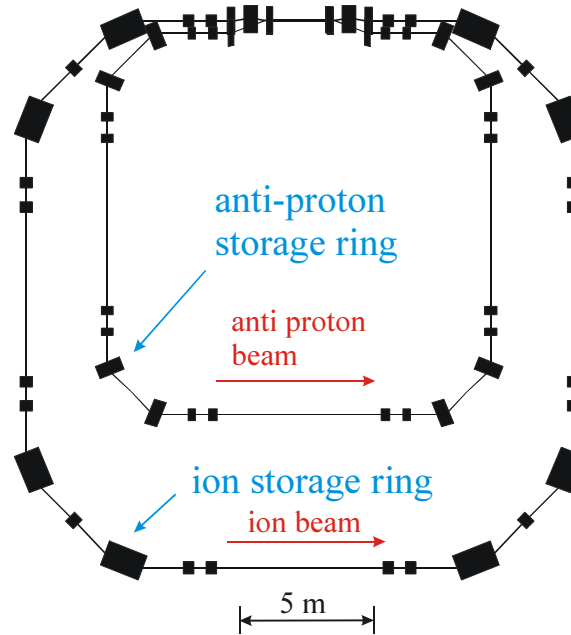
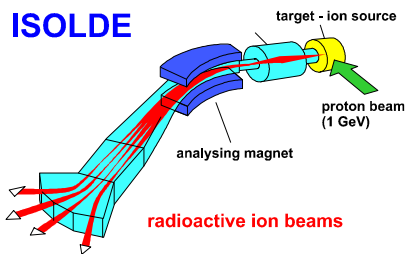
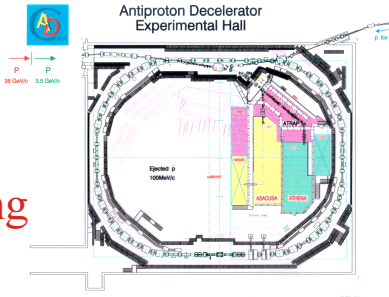




# TISR

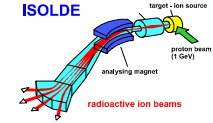


## Inter-section anti-proton ion storage ring

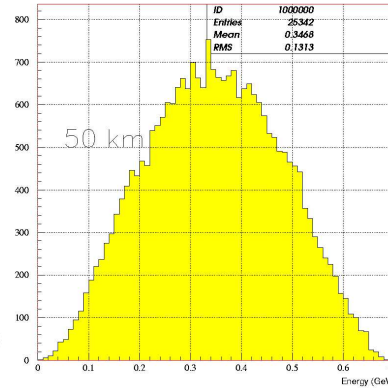
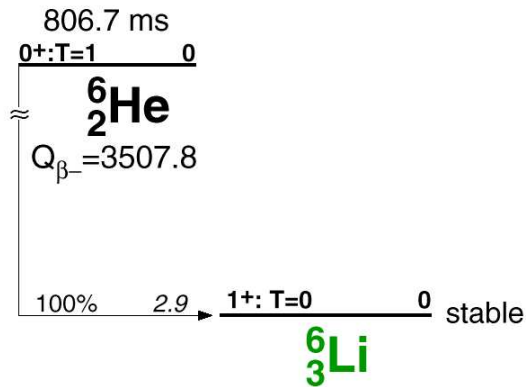


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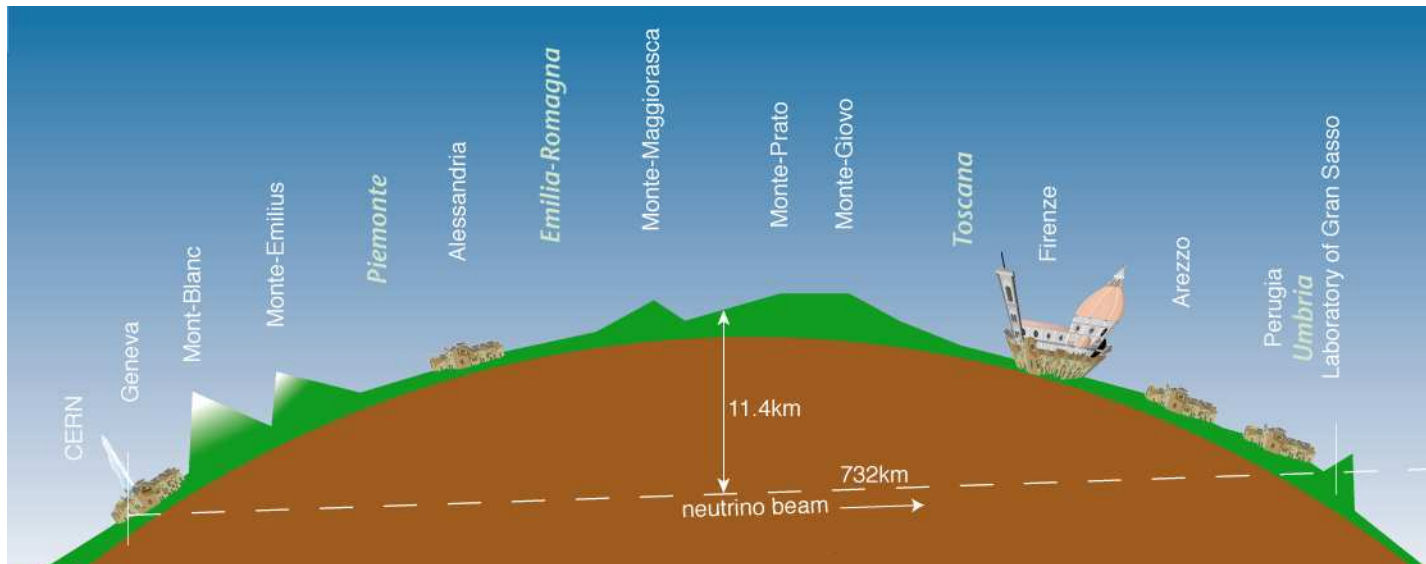
# Electron Neutrinos



$\Gamma = 100, 350 \text{ MeV}@50 \text{ Km.}$

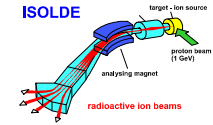
Possible neutrino physics scopes (P. Zucchelli):

1.  $\nu_e$  cross sections (astrophysics)
2. Short baseline oscillations (LSND)
3. LBL:  $\theta_{13}$  (disappearance and appearance)
4. CP violation.



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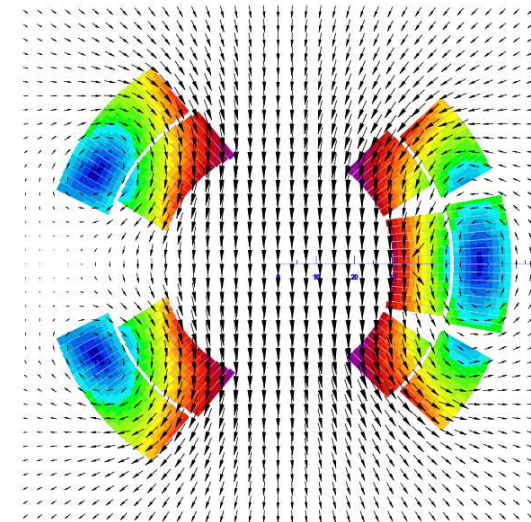
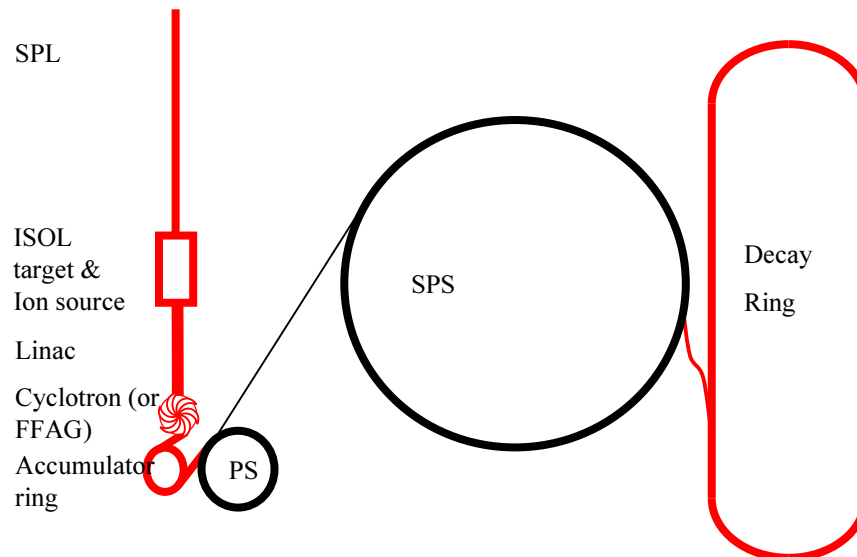


# The beta beam

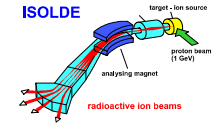
- Production of an intense collimated neutrino or anti neutrino through beta decay of accelerated radioactive ions

Dipole

02/06/20 17:12

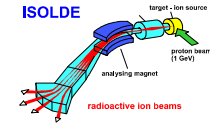


ROXIE 8.2



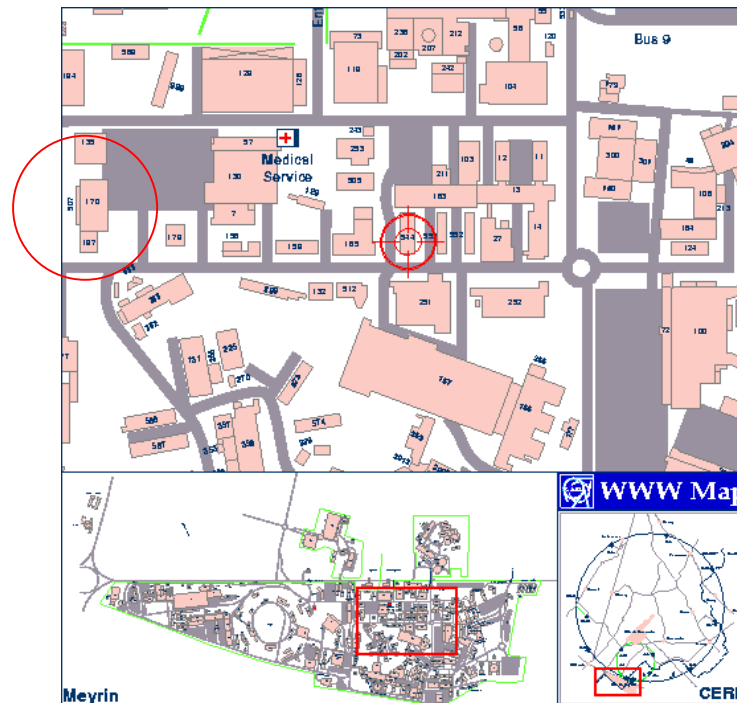
# Conclusions

- Nuclear physics and its applications:
  - are fascinating subjects
  - have an exciting future at new large scale facilities
  - are 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!
- We are meeting outside the ISOLDE hall



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