ISOLDE Decay Station (IDS)

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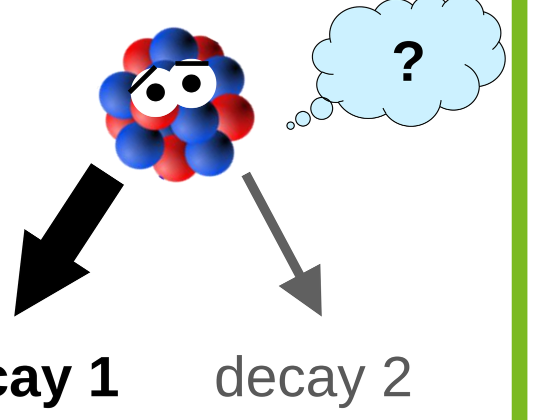
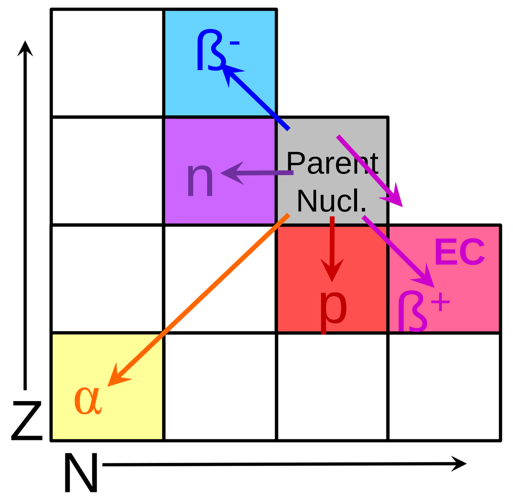
on behalf of the
IDS Collaboration

WHAT we measure?

- Decay scheme
- Branching ratio
- Lifetime of the daughter nuclei
- Lifetime of the excited state



Different decay modes

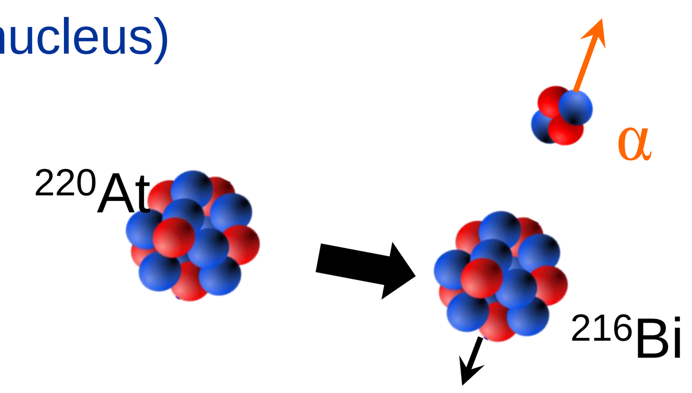


Every kind of radiation following the decay of the parent nucleus must be detected in order to comprehensively study nuclear properties.

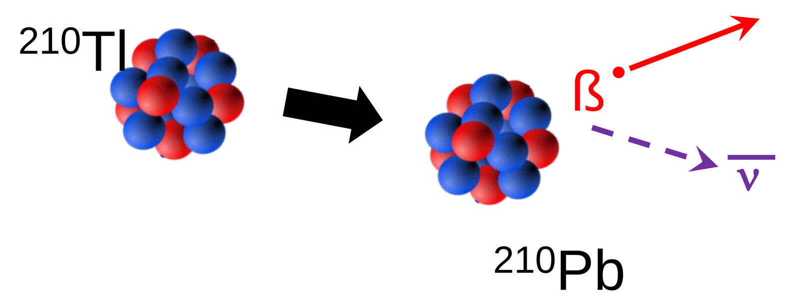
- ß⁻ beta- decay
- n neutron emission
- α alpha decay
- p proton emission
- ß⁺ beta+ decay
- EC electron capture

α decay: emission of an α-particle

(^{4}He nucleus)

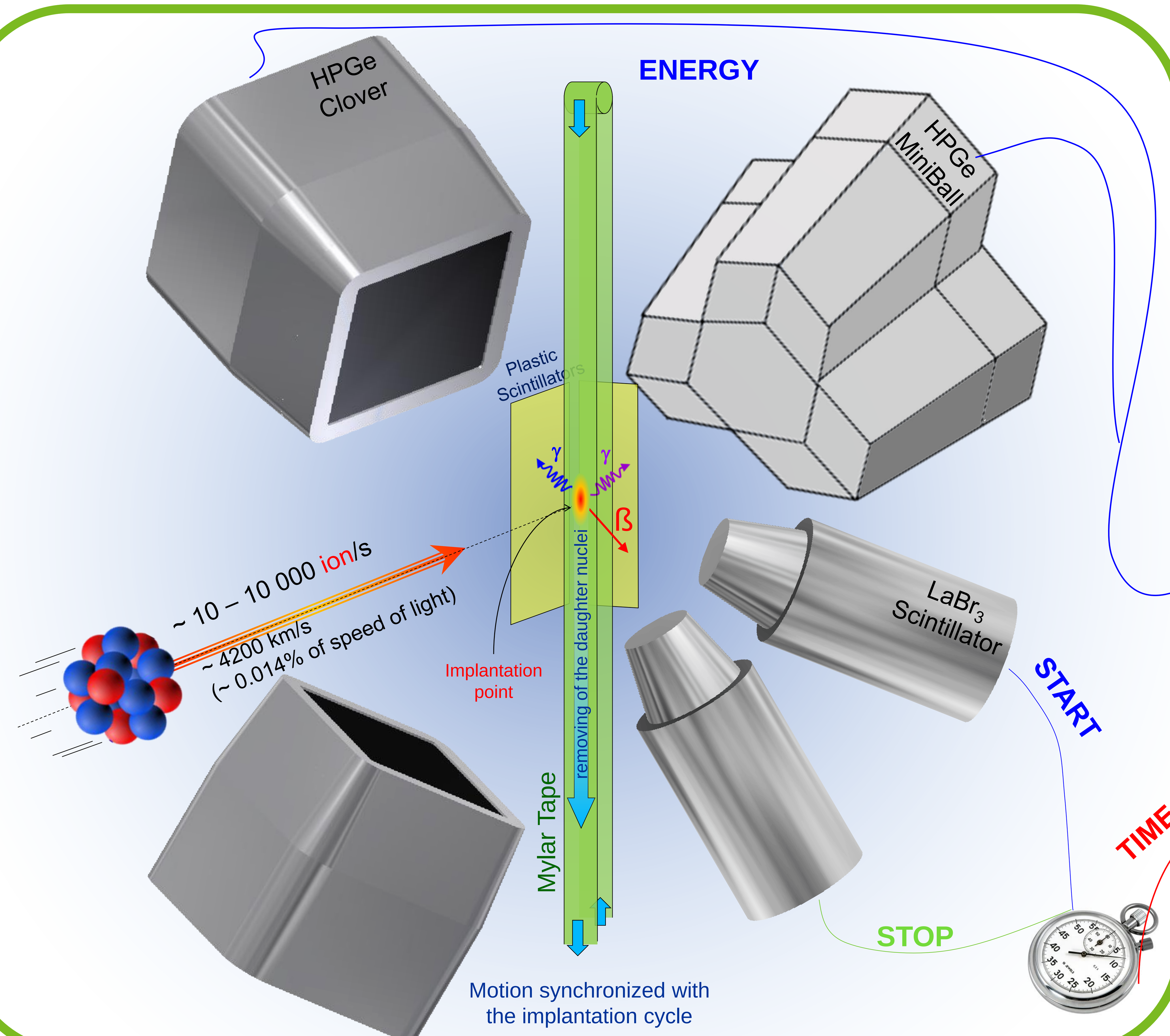


ß- decay: emission of an electron



many others decay modes:

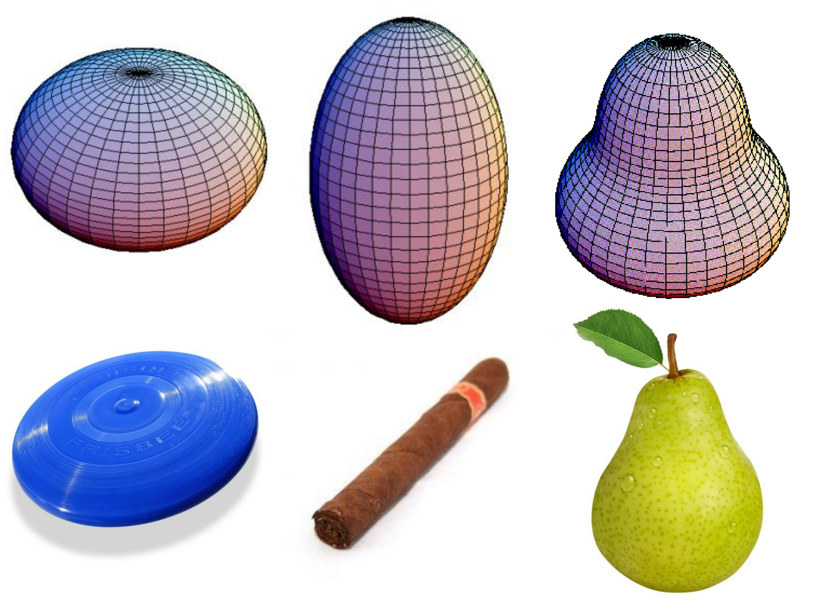
- γ decay
- ß-delayed Neutron Emission
- ß-delayed Proton Emission
- ß-delayed Fission …



WHY is it important and useful?

THE TINIEST PARTS OF THE UNIVERSE

Measuring the decay schemes can tell us a lot about the properties of the nuclei. We can for example study the nuclear shapes, which are not always spherical!



THE UNIVERSE ITSELF

Studying the decay properties of the nuclei involved in stellar nucleosynthesis (e.g. rp-processes), helps to explain the reason for the present composition of Z>26 (Fe) elements in the Universe.

http://www.milwaukeeastro.org/images/nebulae/RosetteMasterRGBCropPhS11-6-2014.jpg

EXAMPLE

Measuring an extremely short lifetime (10^{-11} → 10^{-9} s)

10^{-9} s (nanosecond) is **5 million faster** than a hummingbird flaps its wings!

http://www.thriftyfun.com/tf/Pets/Birds/Attracting-Hummingbirds.html

1) Level of interest is selected using high resolution γ-γ coincidences in HPGe clovers

2) Lifetime measured from the time difference observed in $LaBr_3$ detectors.

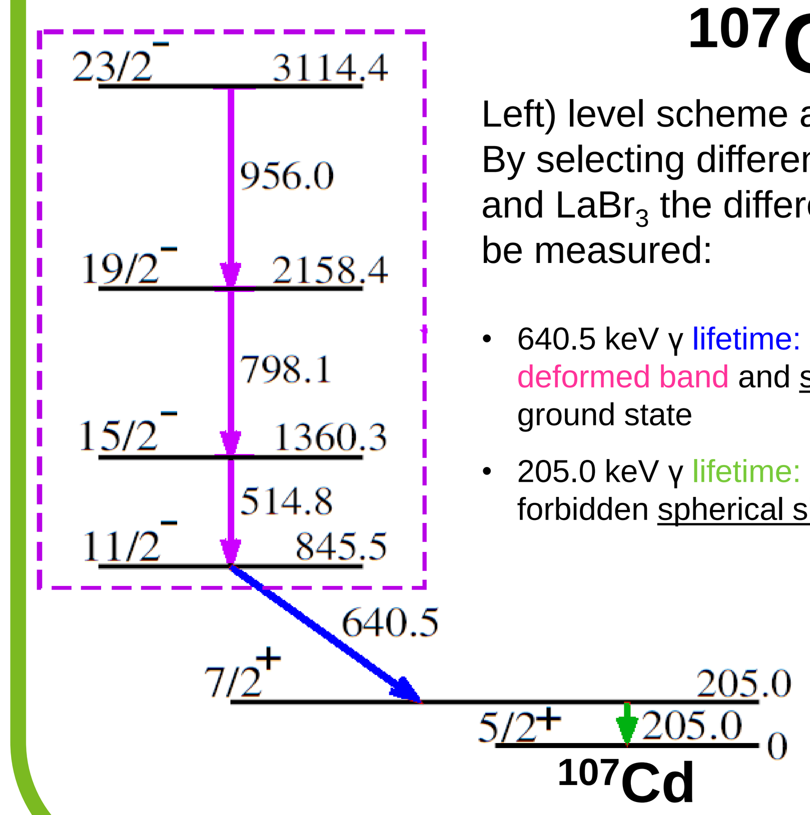
3) The level lifetime depends on the nuclear structure of the initial and final levels

$$\langle \Psi_i | \mathcal{M}_\ell | \Psi_f \rangle \propto t_{1/2}$$

Typical phenomena studied in fast timing experiments:

- high-spin states of rotating nuclei
- Multiple deformation states in a single nucleus
- Single particle structure close to shell closures

^{107}Cd



Left) level scheme and γ emission in ^{107}Cd. By selecting different γγ gates in the HPGe and $LaBr_3$ the different levels lifetimes can be measured:

- 640.5 keV γ lifetime: shape transition between deformed band and spherical states close to the ground state
- 205.0 keV γ lifetime: transition between forbidden spherical single particle states

$T_{1/2}$ = 71(5)ns

$T_{1/2}$ = 0.69(3)ns

N. Mărginean *et al.*, Eur. Phys. J. A46(2010)329