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CENBG

Beta-delayed two-proton (β2p) emission studies

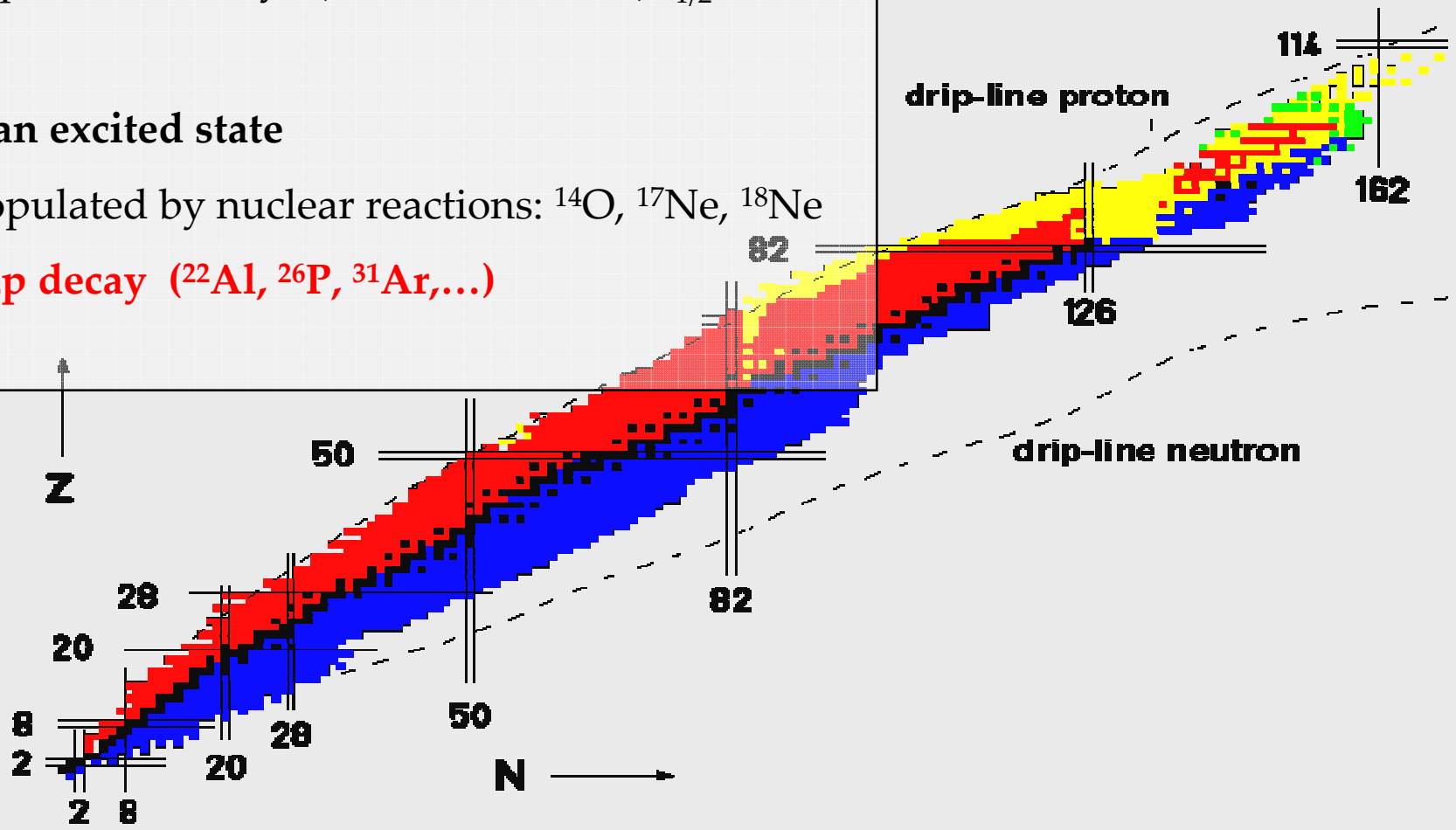
- **β2p emission**
  - Introduction
  - Experimental status
- **A new detection set-up: the Silicon cube**
  - Experimental Set-up
  - Results
- **Future experiments at DESIR**

DESIR Workshop – Leuven – 26-28 mai 2010

2p emission at the proton-drip line

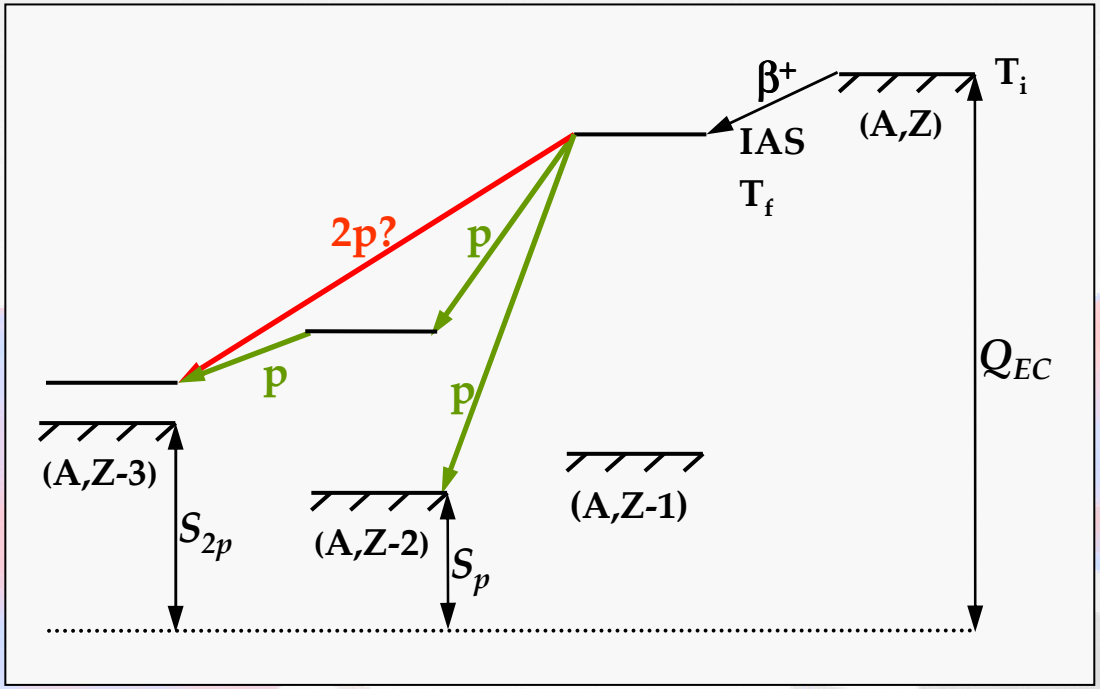
Predicted by Goldansky in the 60's

- **From the ground state**
  - light nuclei (^{6}Be, ^{12}O, ^{16}Ne) $t_{1/2}$~10^{-20} s
  - "2p radioactivity" (^{45}Fe, ^{48}Ni, ^{54}Zn, ?) $t_{1/2}$~ms
- **From an excited state**
  - populated by nuclear reactions: ^{14}O, ^{17}Ne, ^{18}Ne
  - **β2p decay (^{22}Al, ^{26}P, ^{31}Ar,…)**



β2p decay

Approaching the drip-line, Q_β increases, S_{2p} decreases…

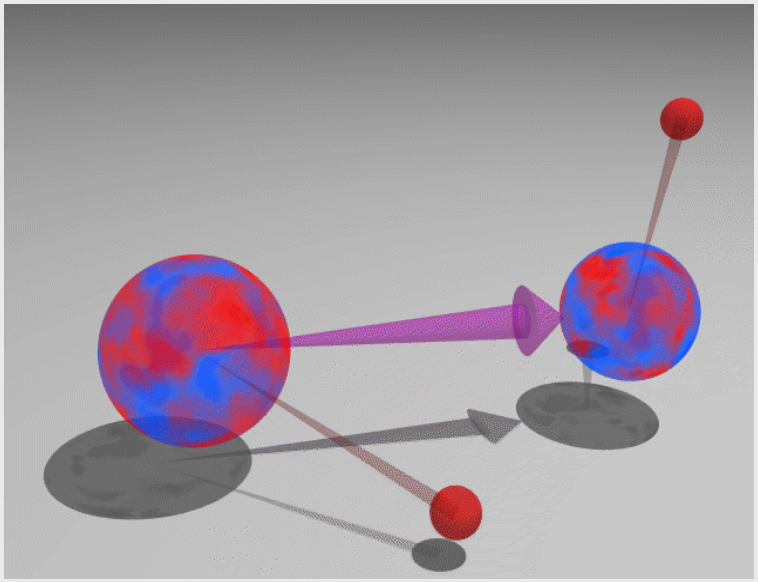


WHY study β2p?

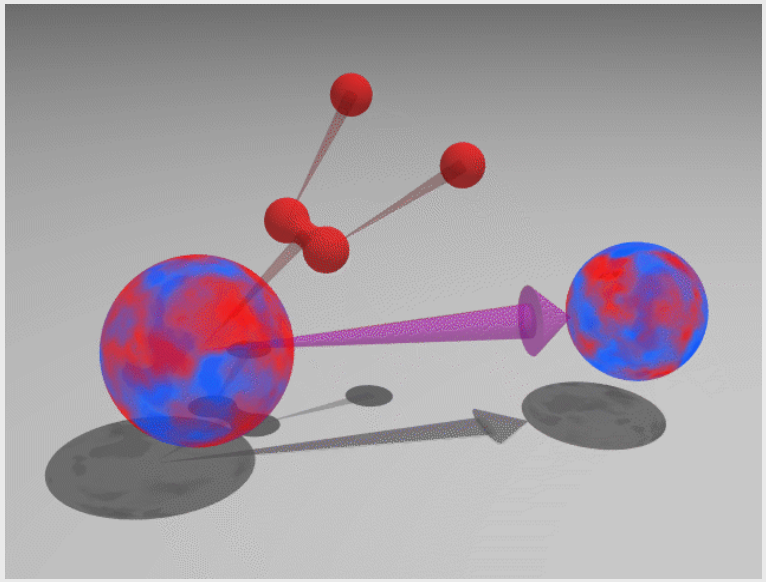
- **Establish decay schemes of proton-rich nuclei**
- **Test of isospin mixing**
- **Search of the low direct 2p branch : Mechanism of the 2p emission**

Mechanism of the β2p emission

Sequential emission



Simultaneous emission



To be measured

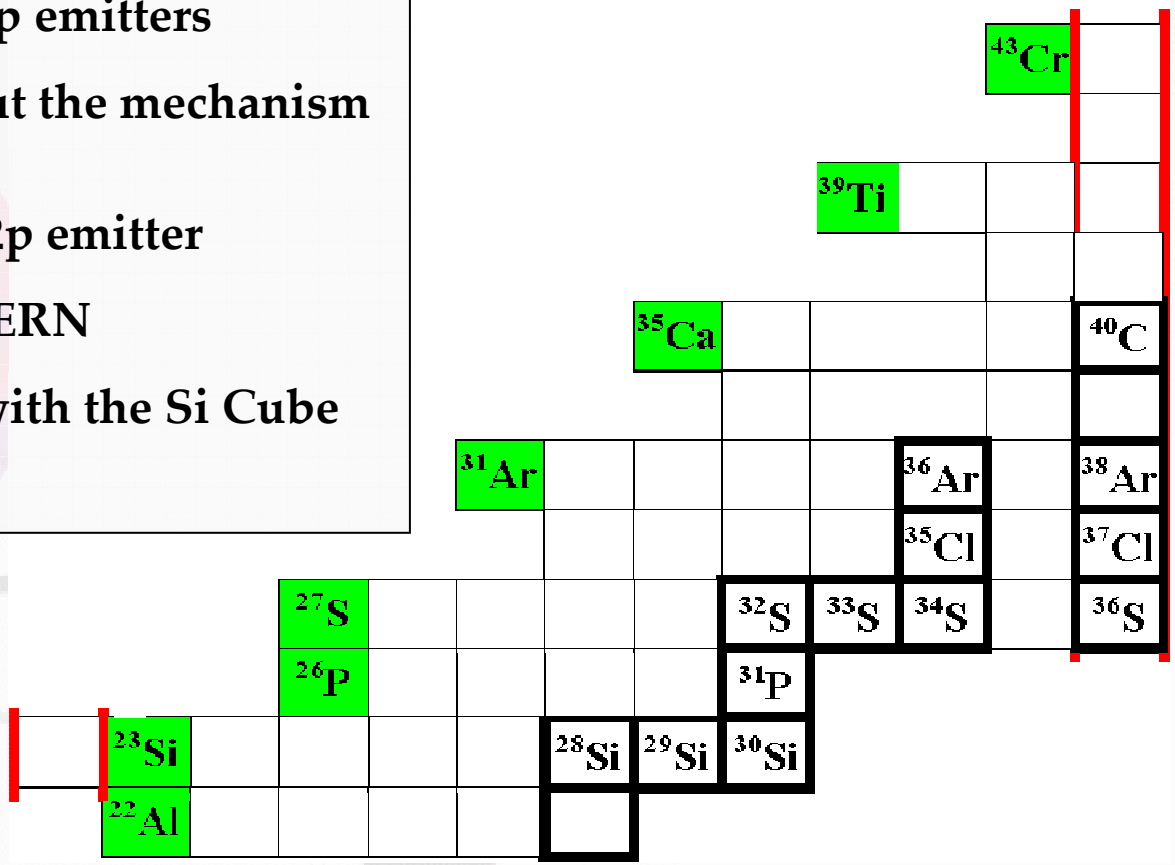
- **Individual proton energies**
- **Angular correlations between the two protons**

Emitted protons are « messengers from the nuclear interior » !

Experimental status

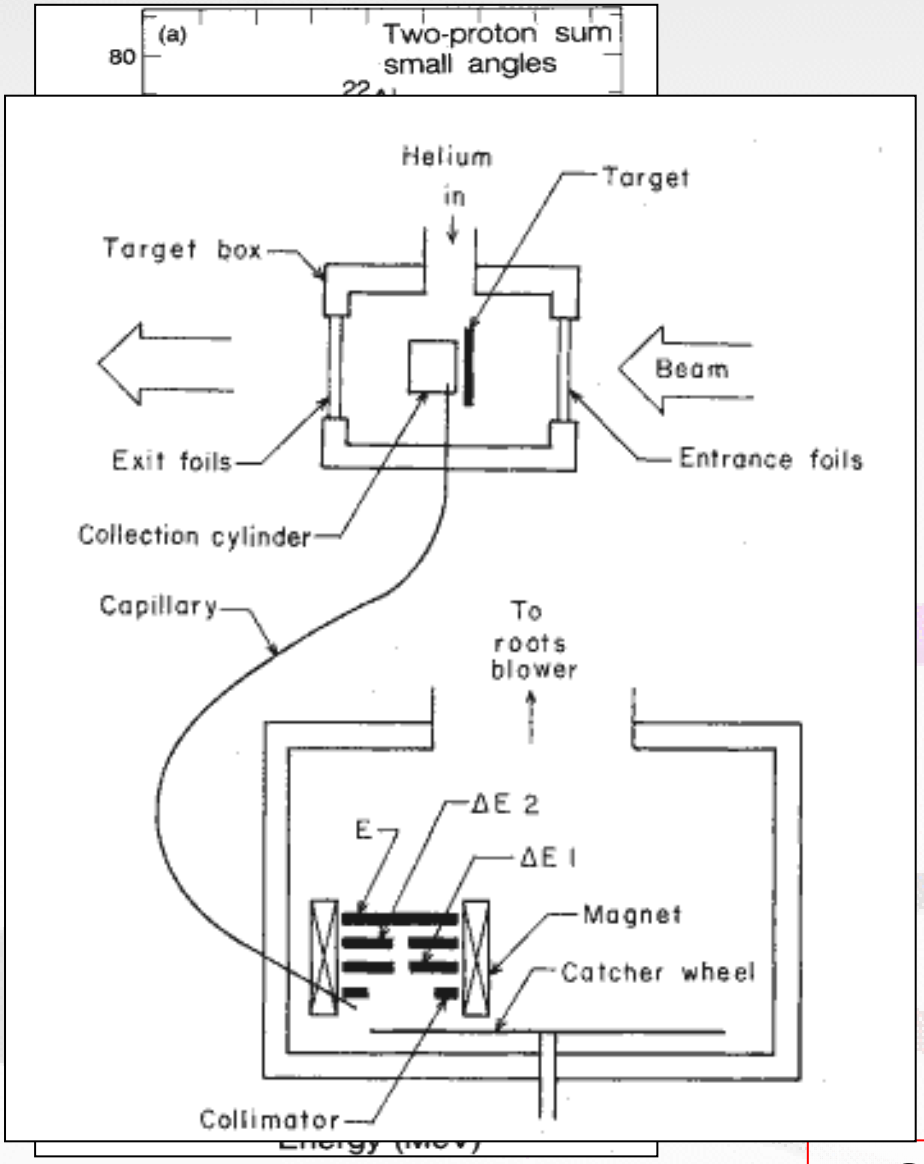
- **Studies at Berkeley in the 80's**
  - ➔ **Sequential emission is dominant**
- **Studies at LISE/GANIL**
  - ➔ **Discovery of new β2p emitters**
  - ➔ **No information about the mechanism**
- **<u>31Ar</u> : the most studied β2p emitter**
  - **Studies at ISOLDE/CERN**
  - **Recently at SPIRAL with the Si Cube**

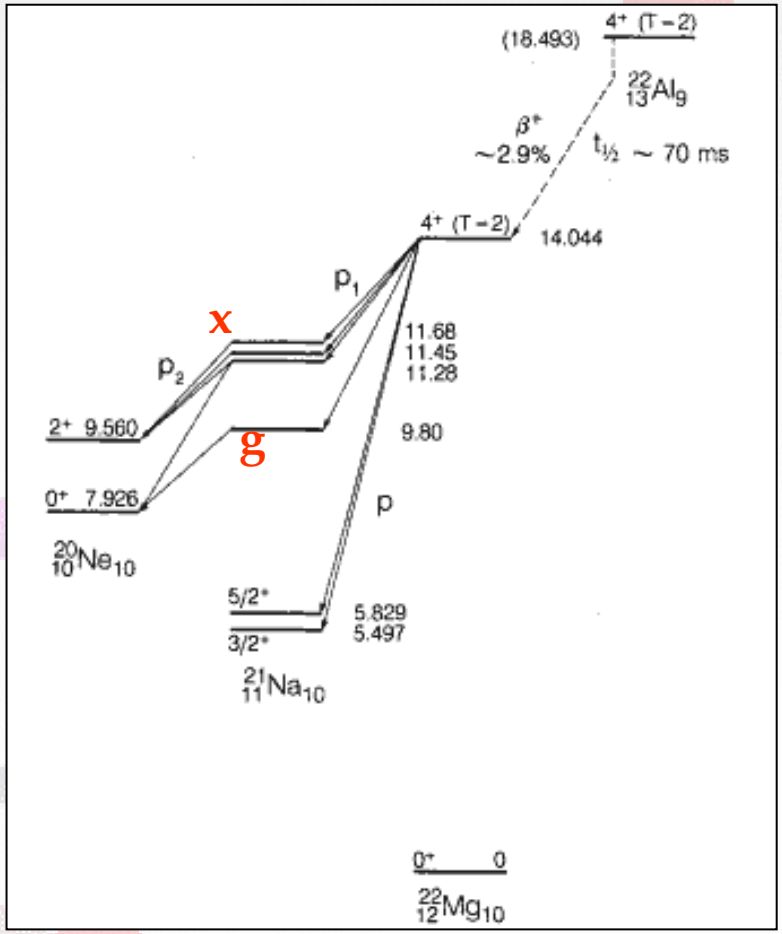
B. Blank, M.G. Borge PPNP 60 (2008)



^{22}Al : the first one

Production reaction: ^{3}He + ^{24}Mg



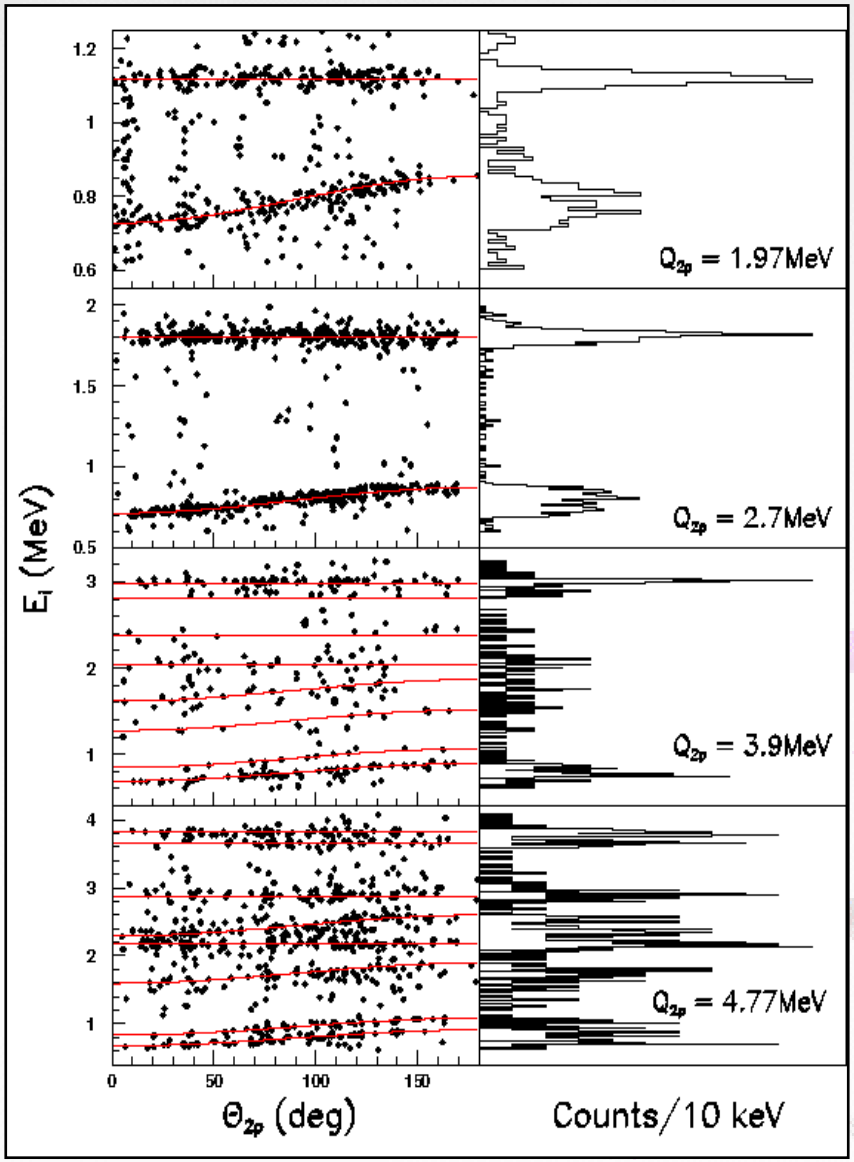


Sequential decay observed !

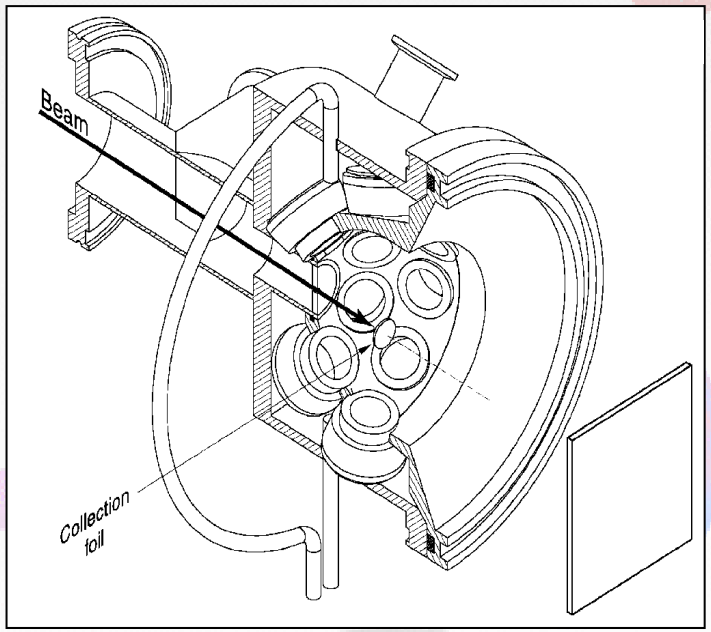
M. D. Cable et al., Phys. Rev. C, 30 (1984)

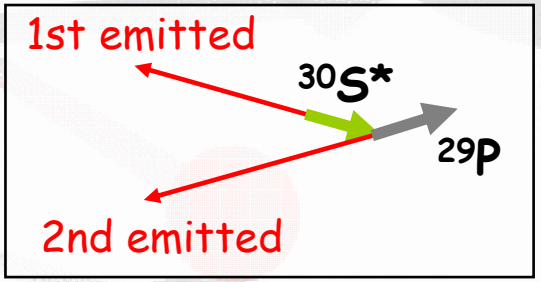
Studies at ISOLDE on ^{31}Ar

Reaction production : p(1GeV) + CaO



H. O. U. Fynbo et al. , Nucl. Phys. A677 (2000)

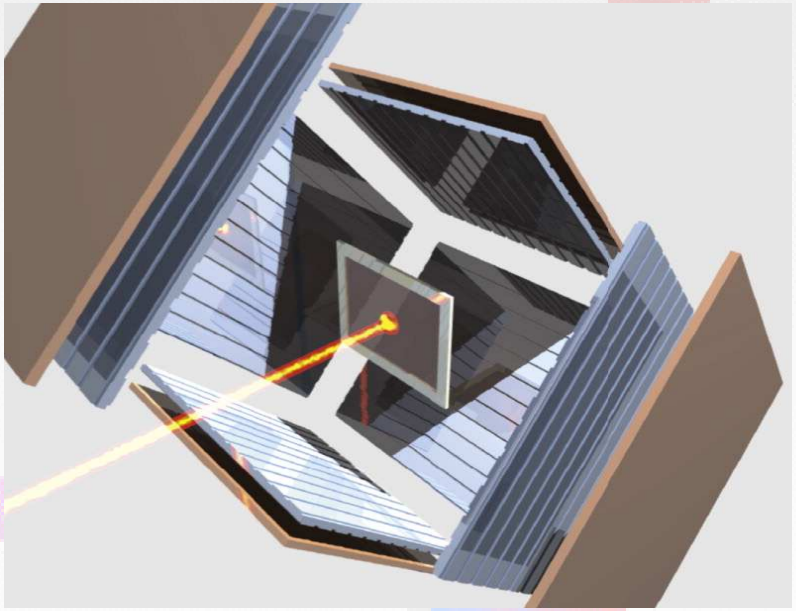


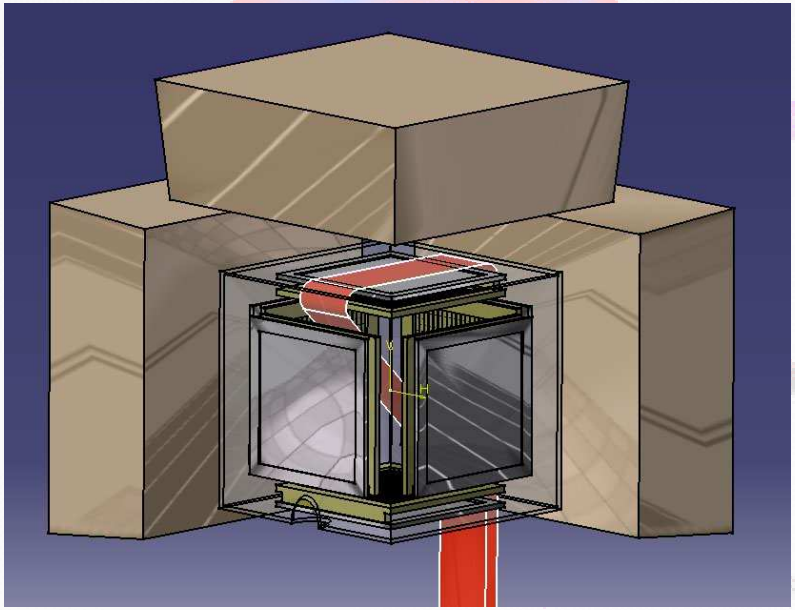


Seq. Emission!!

New experimental setup for β2p emission : The Silicon Cube

- 6 DSSSD with 16x16 strips
- 6 silicon detector behind
- 192 electronics channels
- 3 EXOGAM clovers



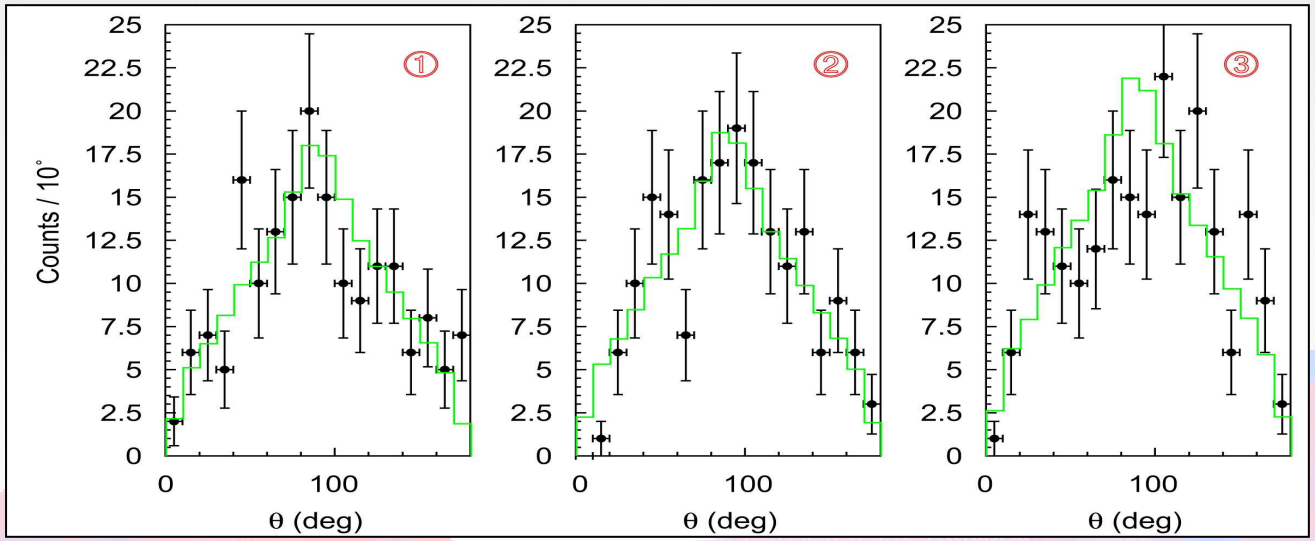


- High granularity with 1536 pixels
- Angular coverage
  - 54% for one proton detection
  - 29% for two-proton detection

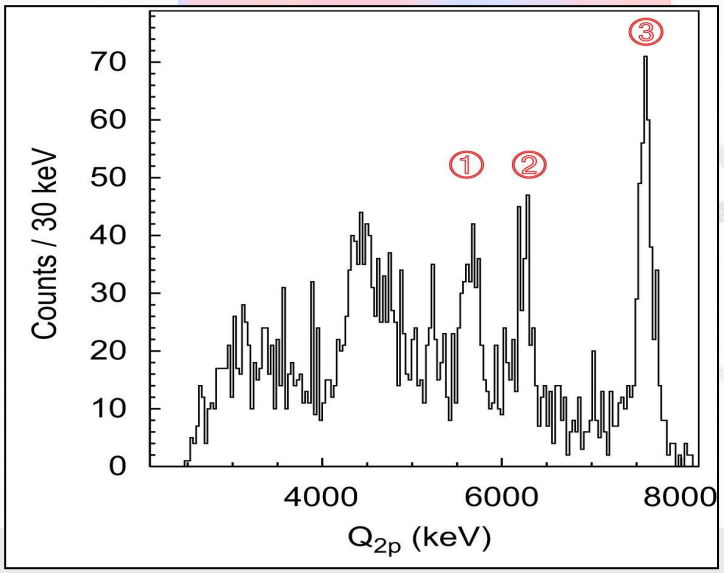
I. Matea et al, Nucl. Instr. and Meth. A 607 (2009) 576

Studies at SPIRAL on ^{31}Ar

Fragmentation of ^{36}Ar (95MeV/u)



I. Matea et al, Nucl. Instr. and Meth. A 607 (2009) 576



Problems

- **Production rates much lower than expected (0.6 pps ^{31}Ar instead of 10-15 pps)**
- **^{31}Ar strongly contaminated by ^{33}Ar**
- **One of six DSSSD did not work**
- **Veto β detectors worked only partly**

Future studies at DESIR with the Silicon Cube

^{31}Ar: βp, β2p, β3p

^{26}P: βp, β2p

^{27}S: βp, β2p, β3p?

^{35}Ca: βp, β2p, β3p?

Beam from:

- SPIRAL via fragmentation
- SPIRAL2 or S3 via ^{3}He induced reaction

^{31}Ar:

- Counting rate at SPIRAL: ~10 /s
- Branching ratio for β2p: ~2 %
- Detection efficiency: ~30 %
  - ➔ Coincidences p-p: ~10 000 /day
  - ➔ 2p direct emission: ~200 /day

7 days experiment ⇔ ~1400 simultaneous 2p events observed

Thank you for your attention!