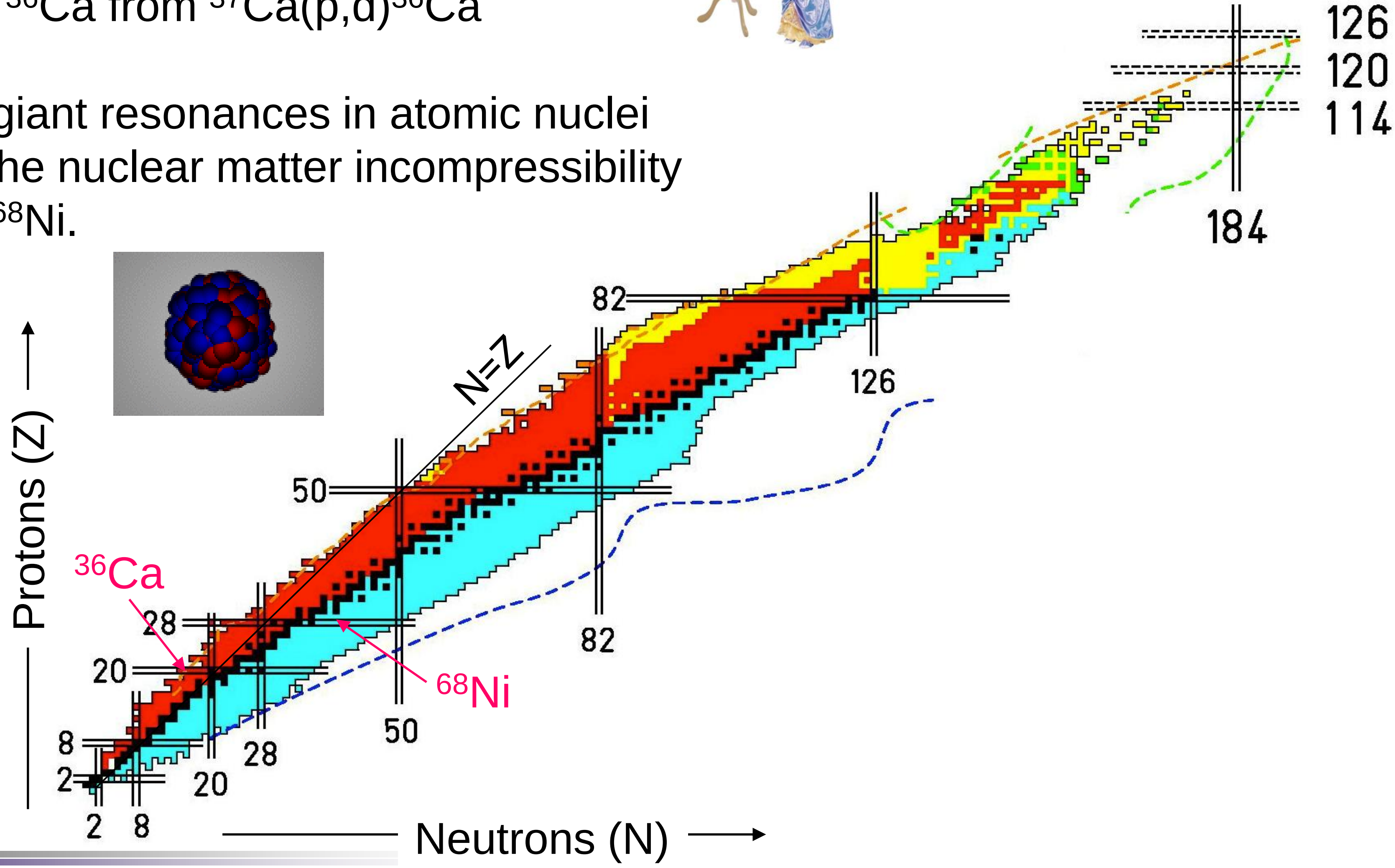
Selected physics highlights obtained at GANIL
(O. Sorlin - GANIL)

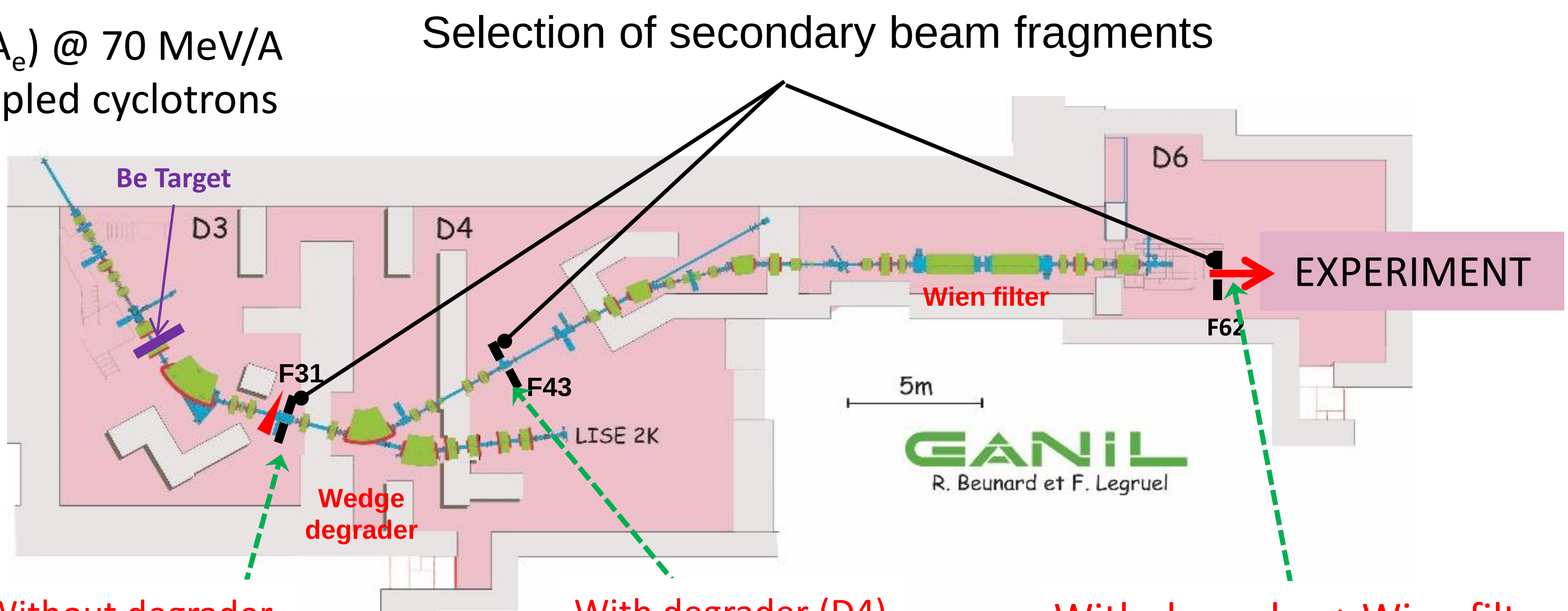
Breaking of mirror symetry in atomic nuclei
& astrophysical implications
Study of ^{36}Ca from $^{37}Ca(p,d)^{36}Ca$

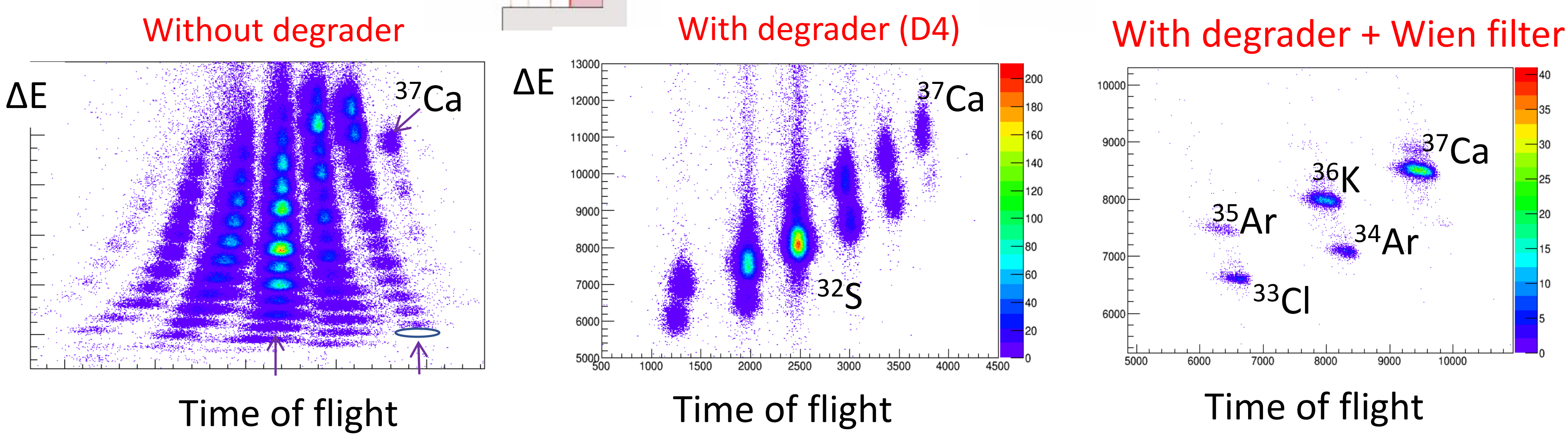
Study of giant resonances in atomic nuclei
to study the nuclear matter incompressibility
Study of ^{68}Ni.



Produce a secondary beam of ^{37}Ca (about 4000 pps)

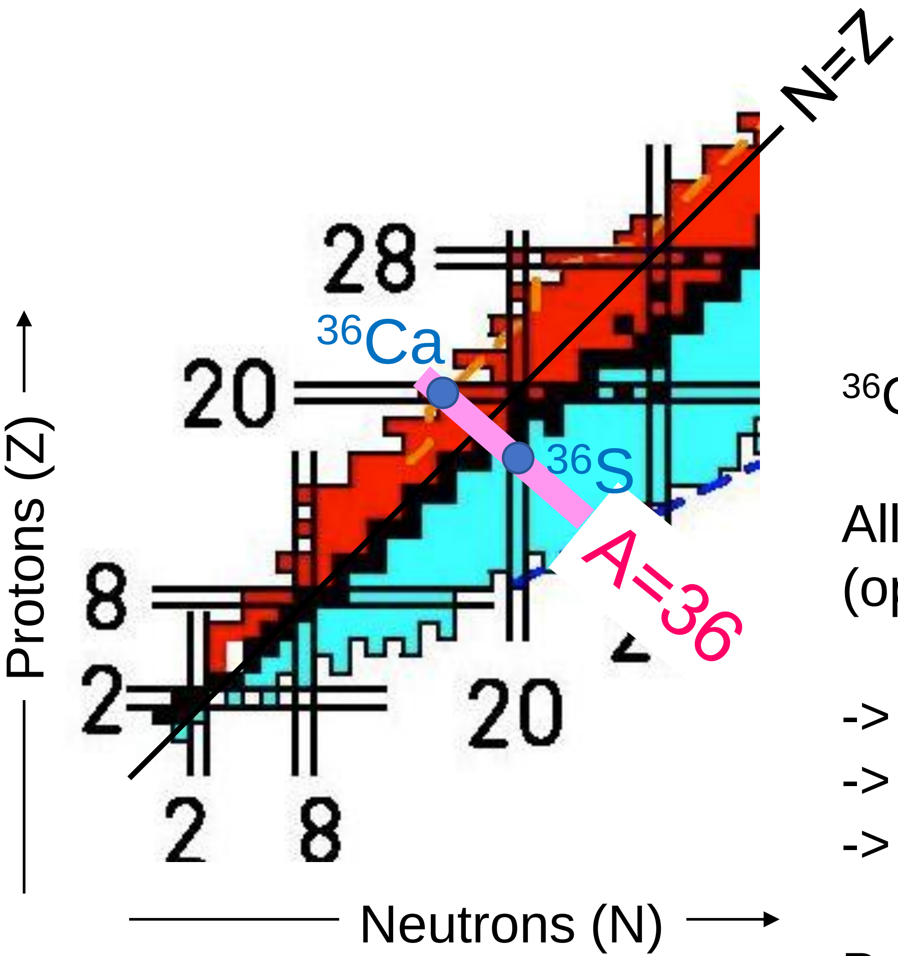
^{40}Ca (2μA$_e$) @ 70 MeV/A
from coupled cyclotrons



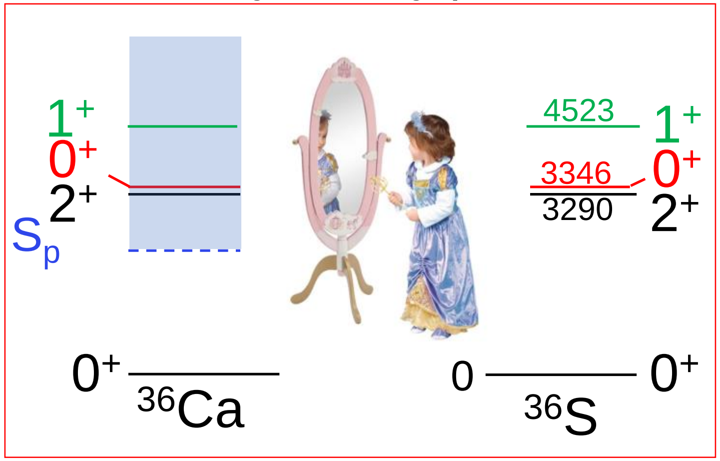


Mirror my beautiful mirror: tell me how does ^{36}Ca look like ?

(knowing the structure of ^{36}S...)



If mirror symmetry preserved



^{36}Ca is very weakly bound

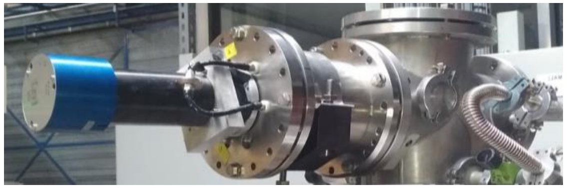
All excited states are unbound states (open quantum systems)

-> excited states can be shifted in energy
-> they acquire a width (short lifetime)
-> they can decay by p or γ emission

Produce them using a transfer (p,d) reaction

Preliminary results from $^{37}Ca(p,d)^{36}Ca$

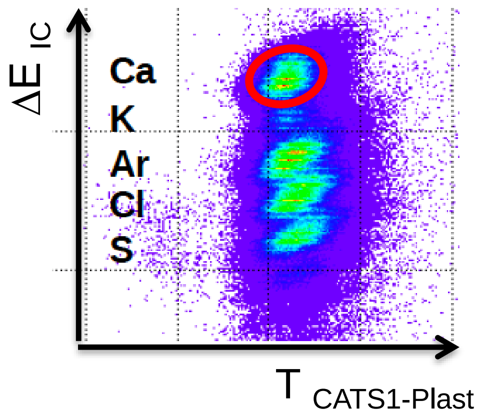
HI residues

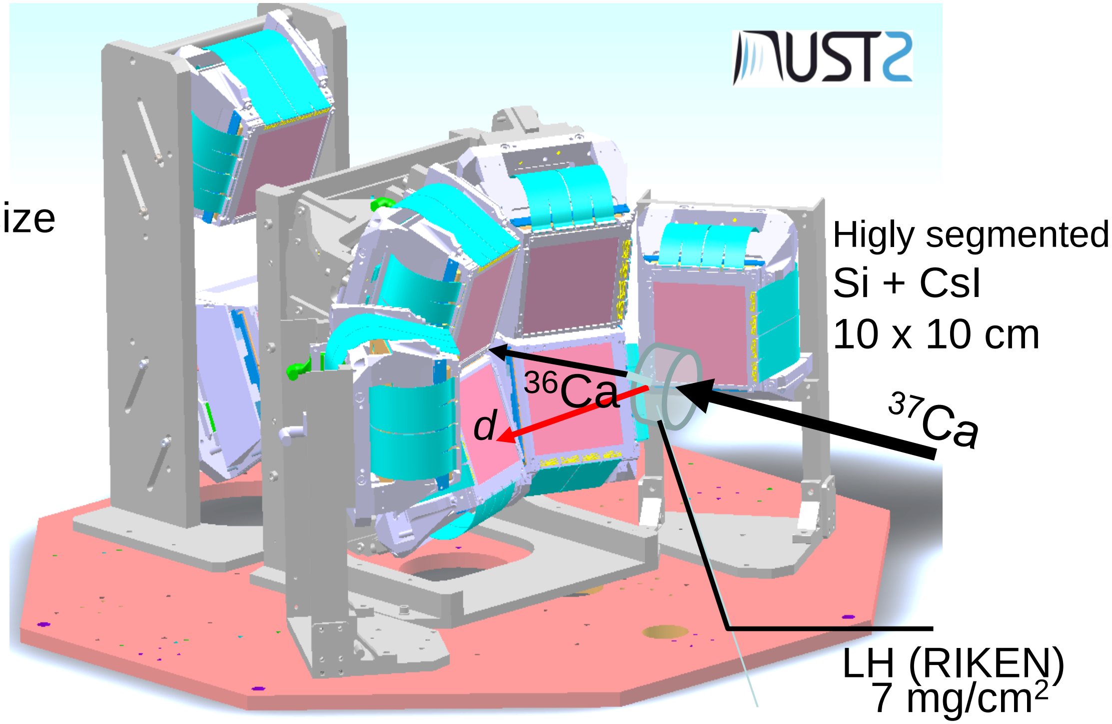


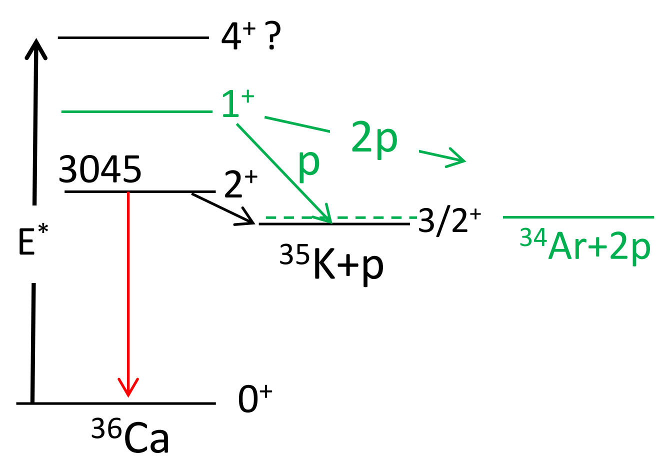
Drift chamber (X,Y) - 7 cm size

Ionization chamber ΔE – 5 cm size

Digital electronics







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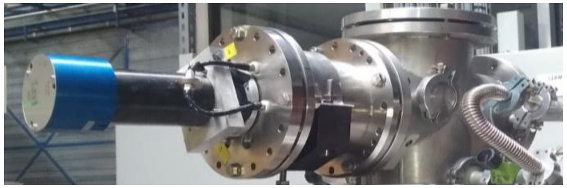

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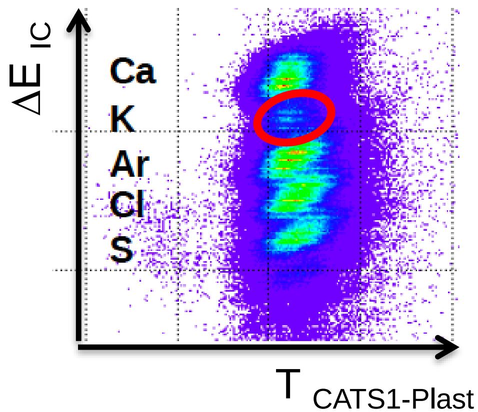

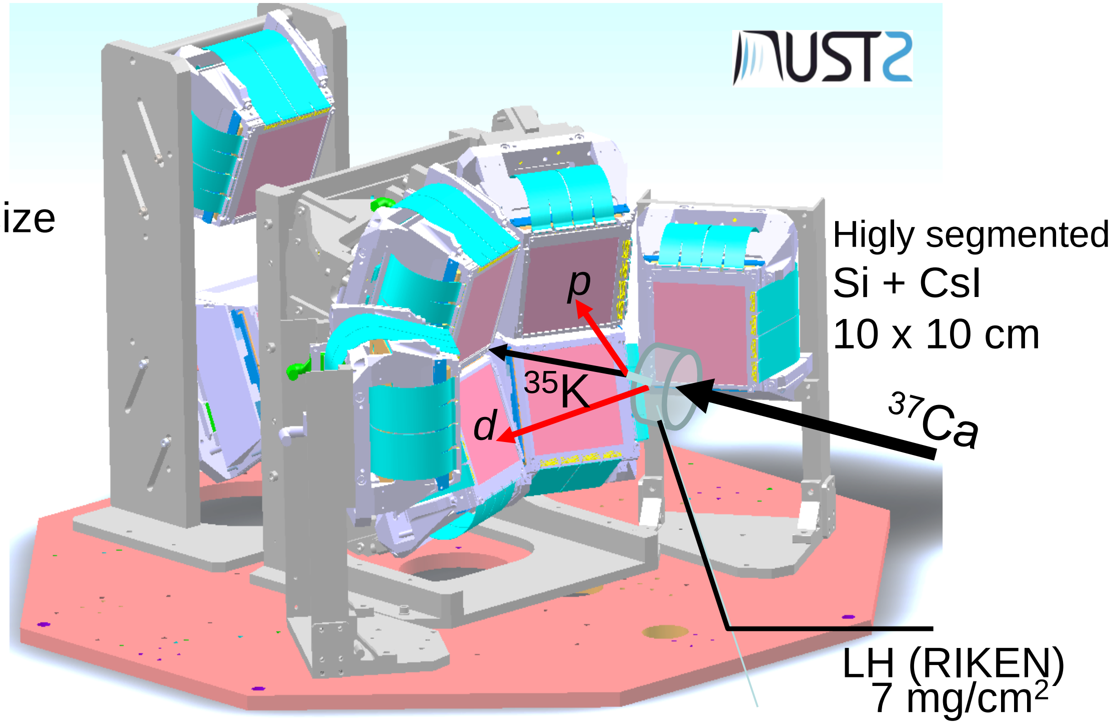

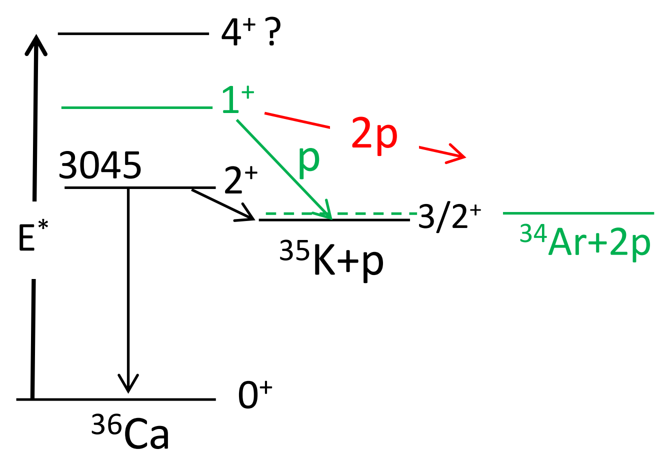

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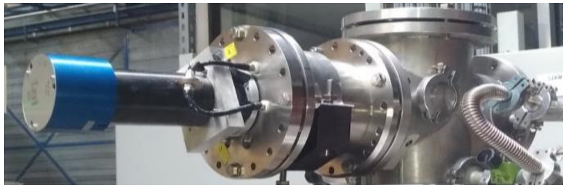

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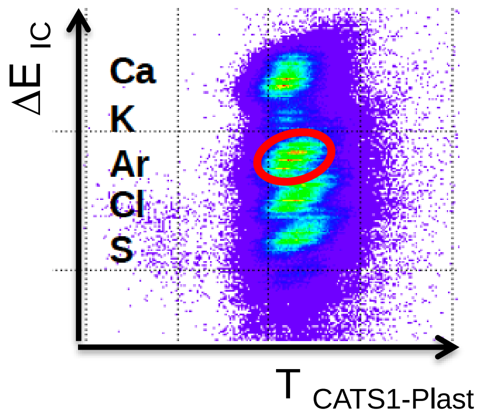

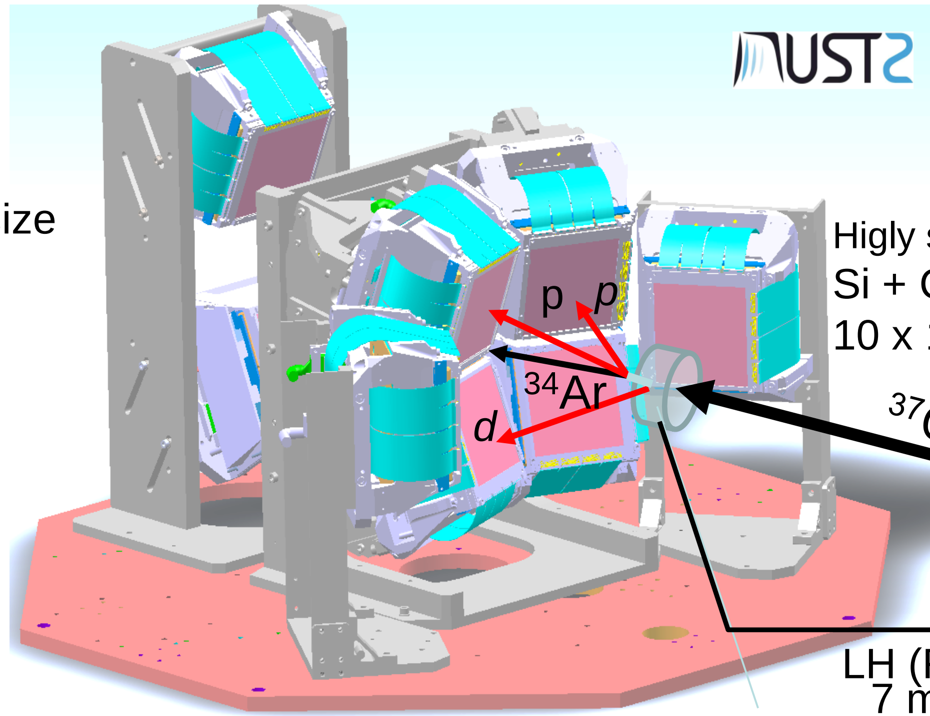

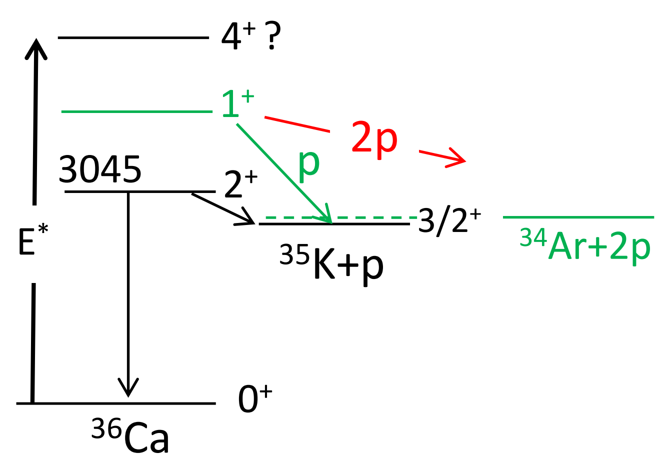

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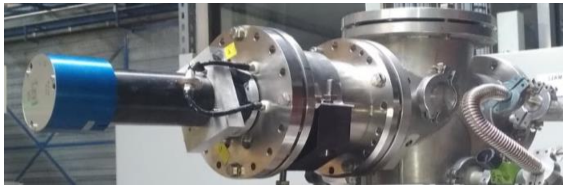

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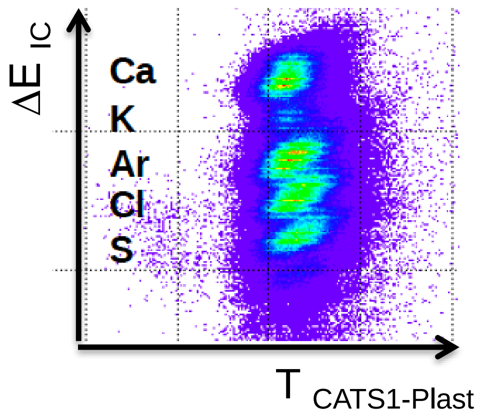
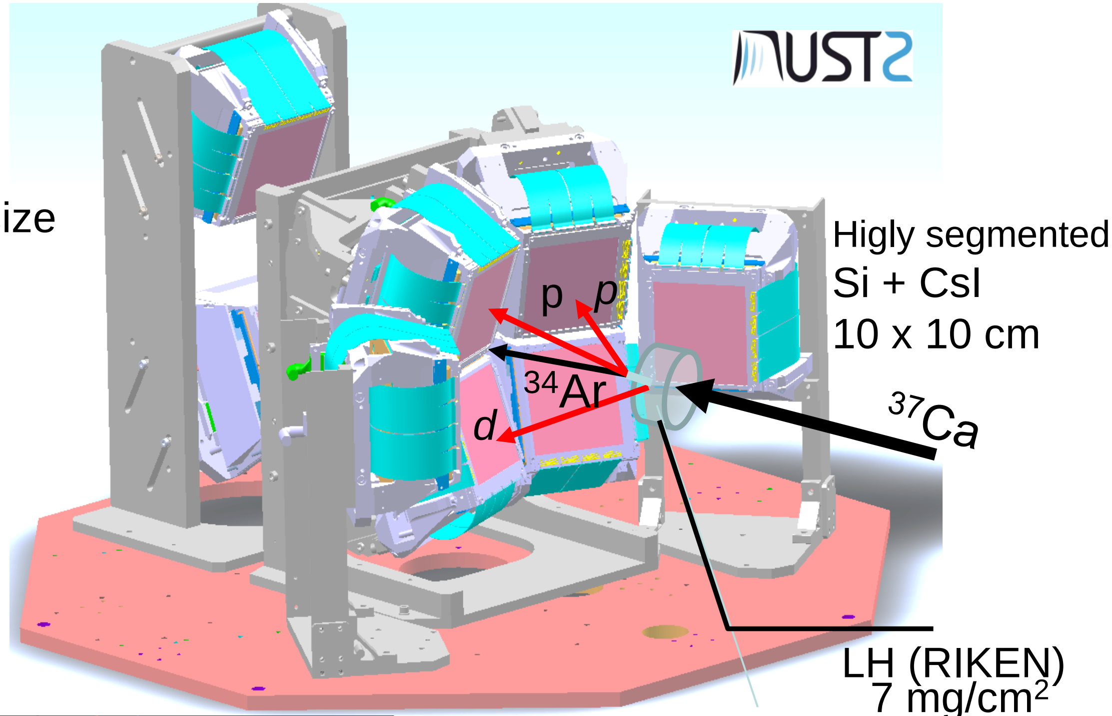
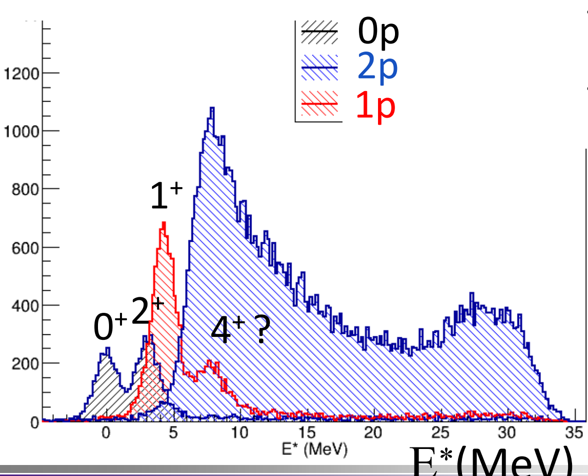
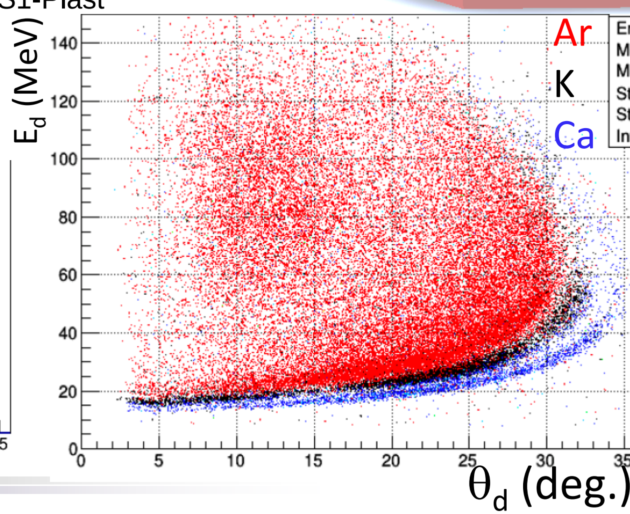
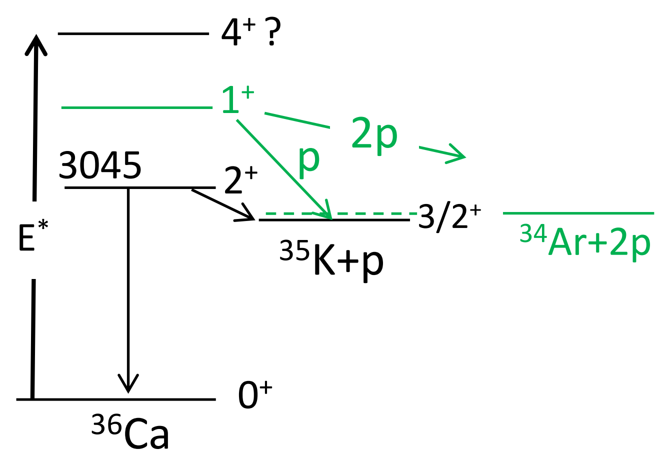




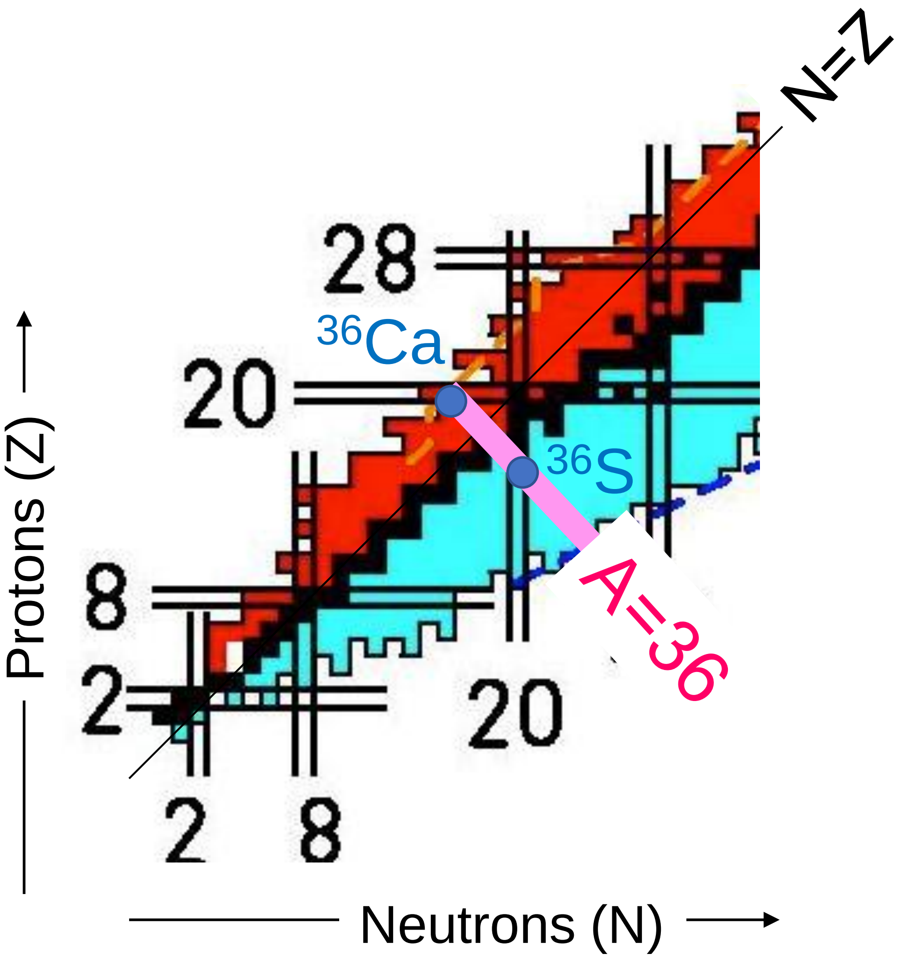




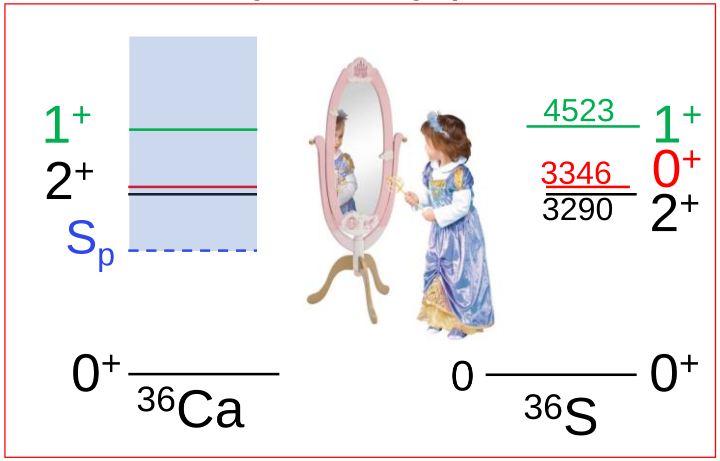


MUST2 telescopes for charge particle detection

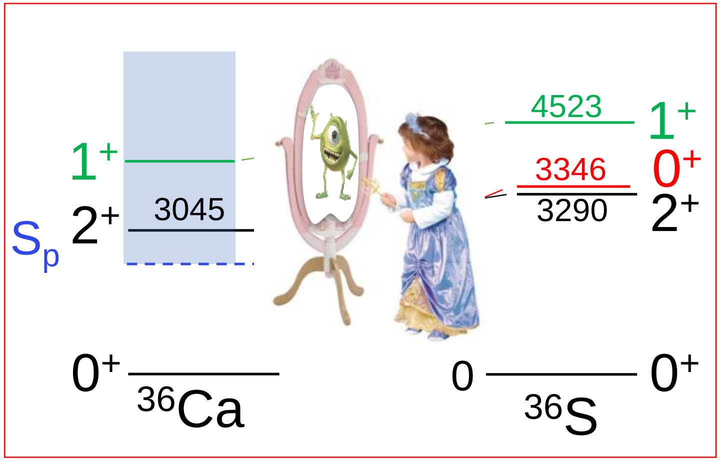
Broken mirror symmetry between ^{36}S and ^{36}Ca



If mirror symmetry preserved

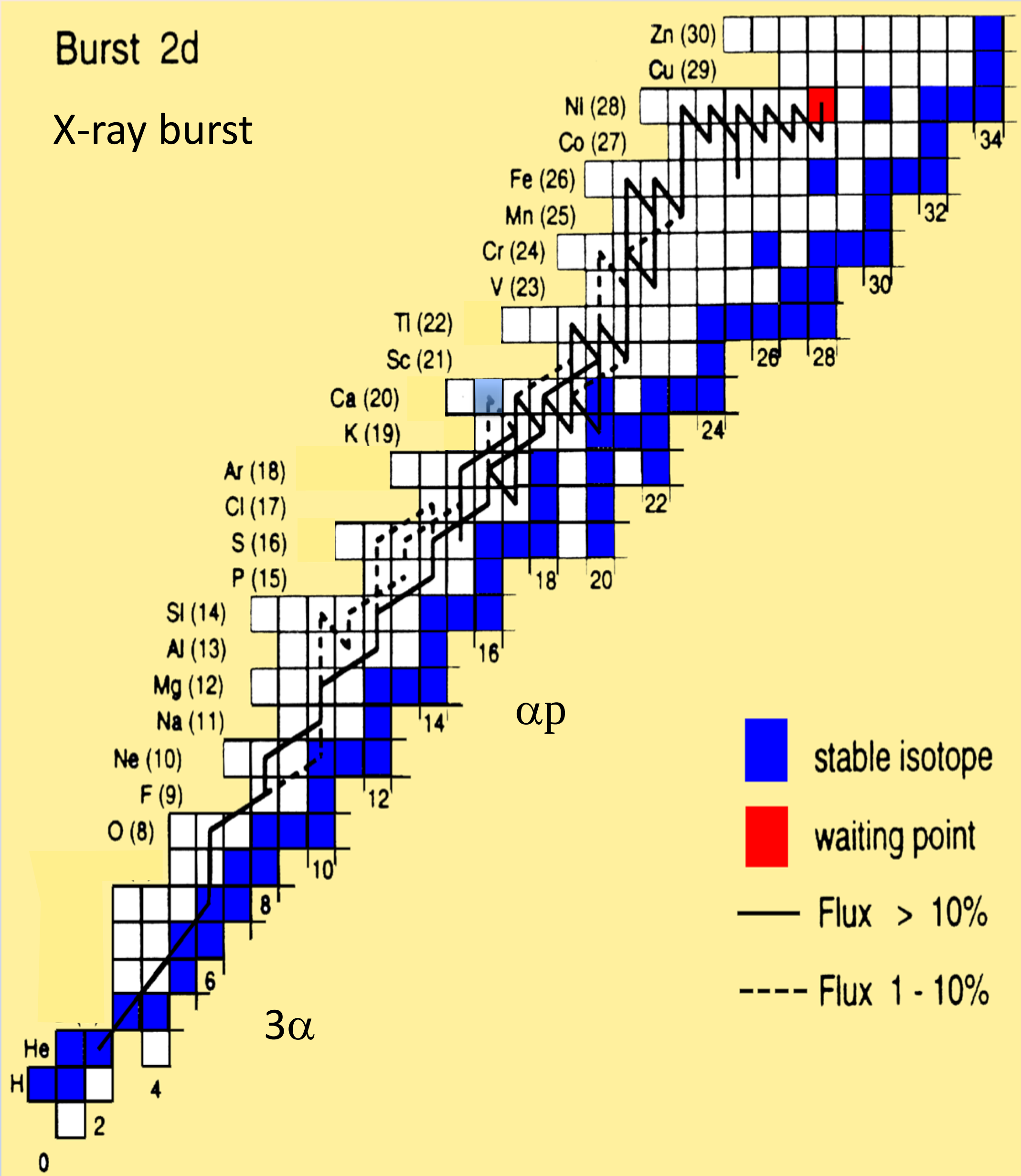


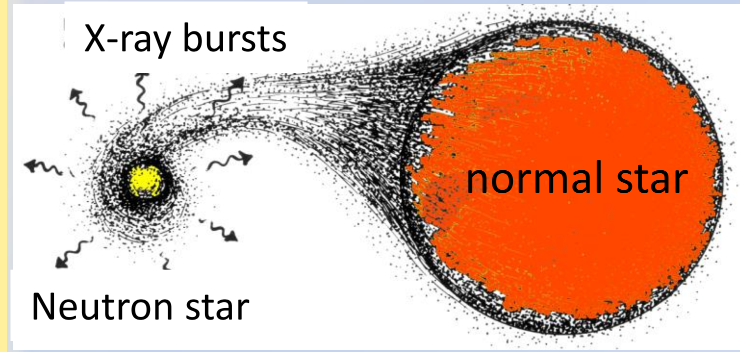
Experiment-> Mirror symmetry broken

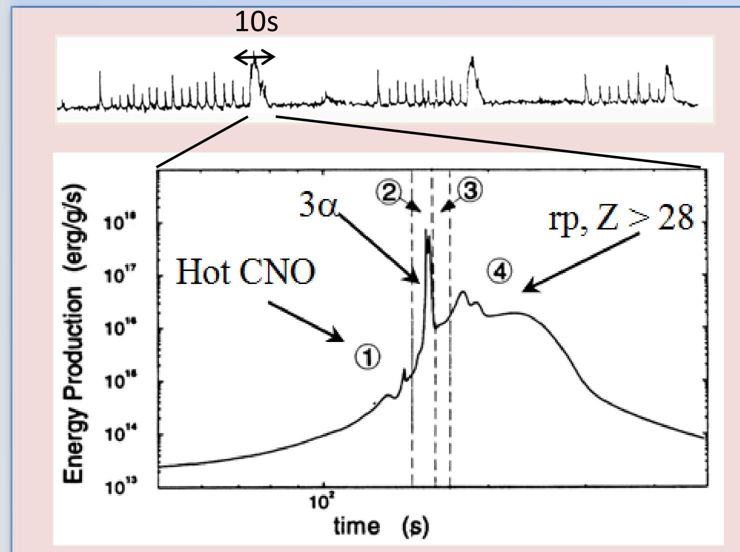


0^+ predicted to be shifted by 600 keV !

When shell structure meets nuclear astrophysics

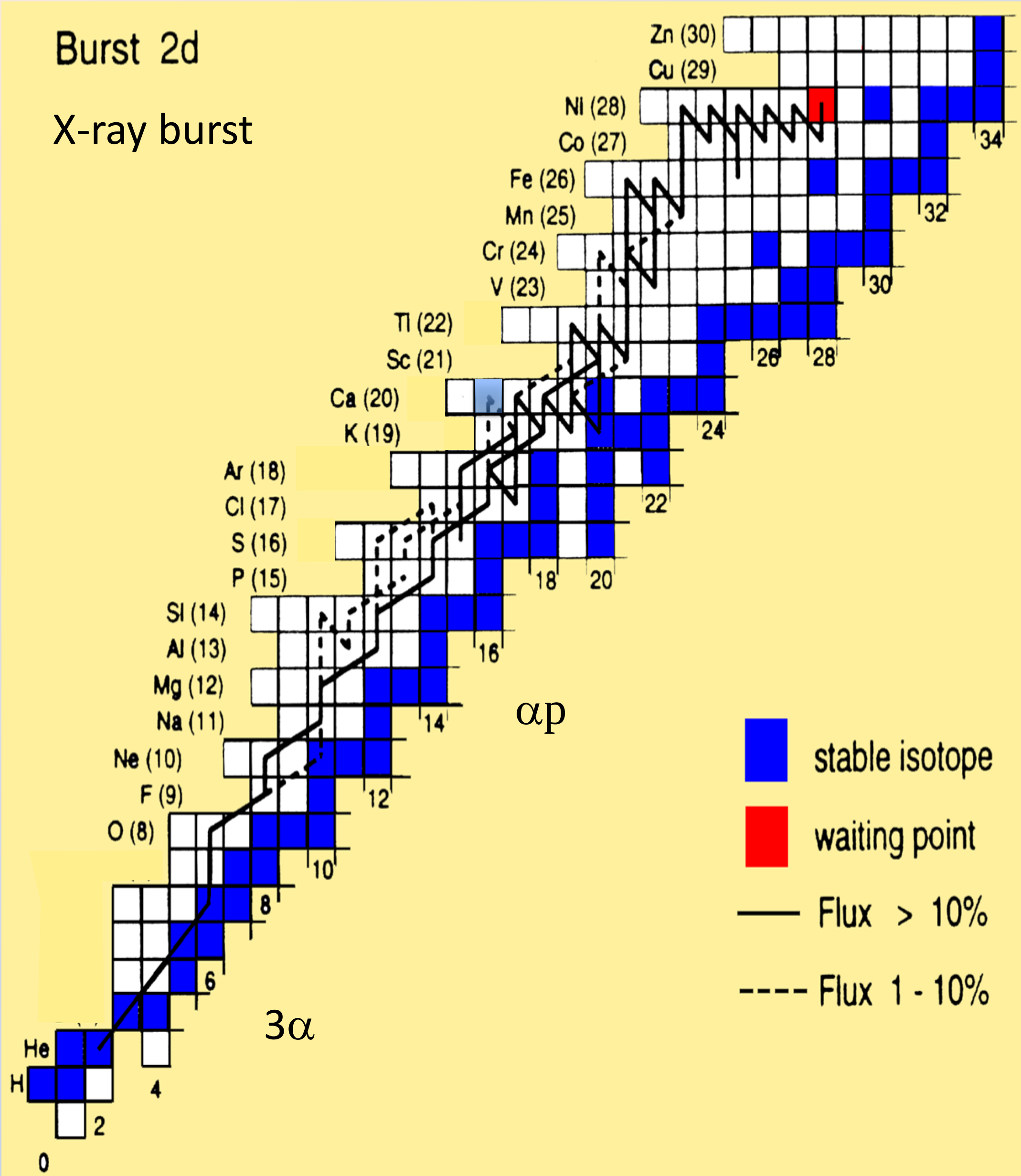


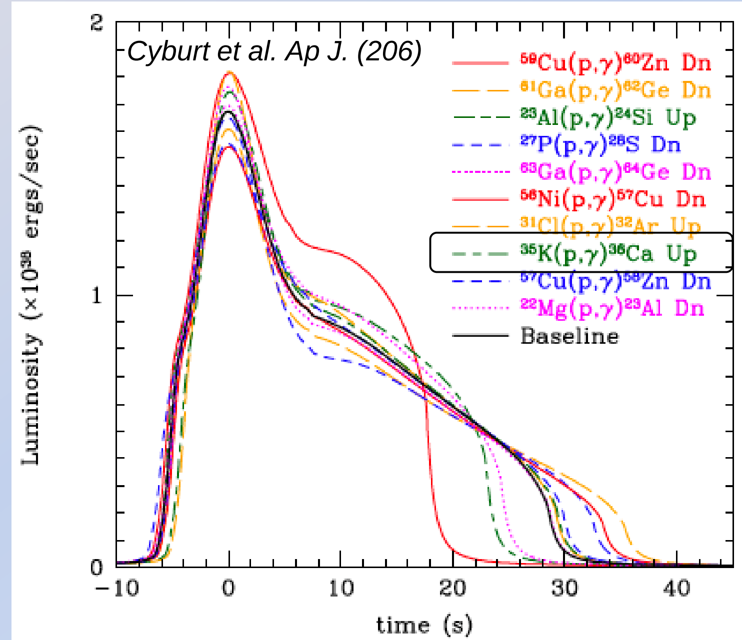




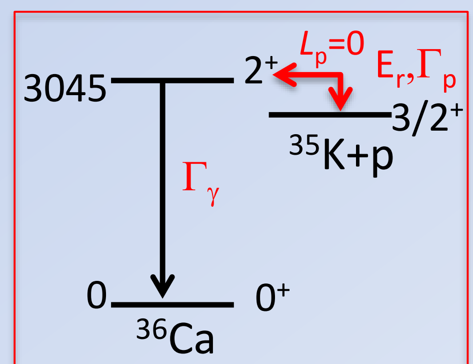
Light curve at late times depends on p capture rates and β-decay lifetimes

When shell structure meets nuclear astrophysics





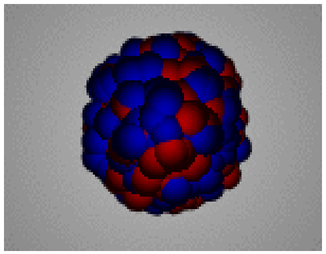
Some (unknown) reaction rates infleunce more the light curve.

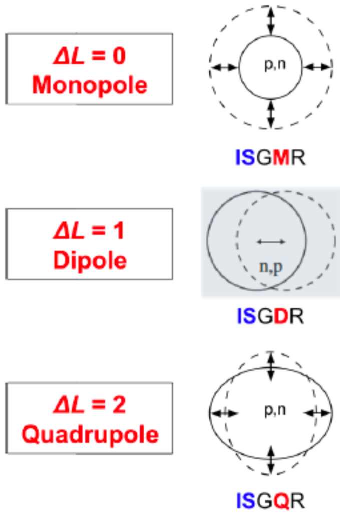


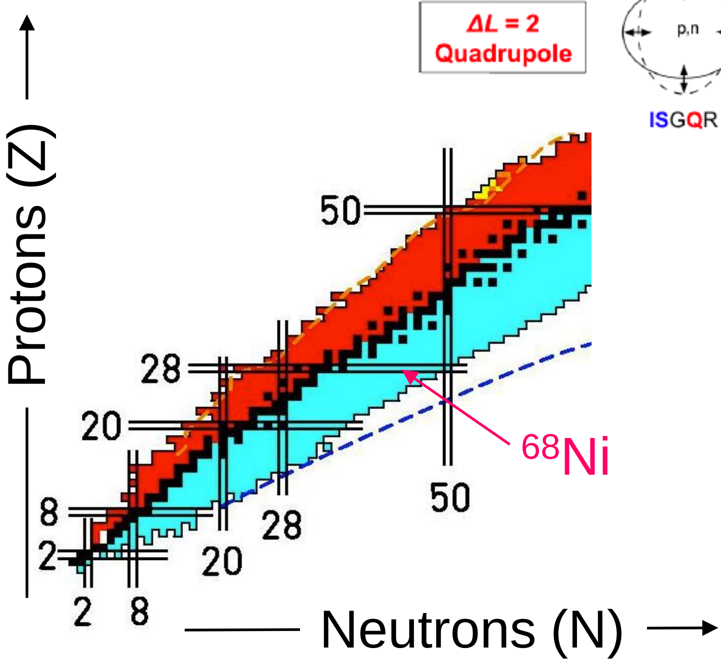
Energy of the resonant state in ^{36}Ca and decay widths must be studied

Search for compression modes in ^{68}Ni

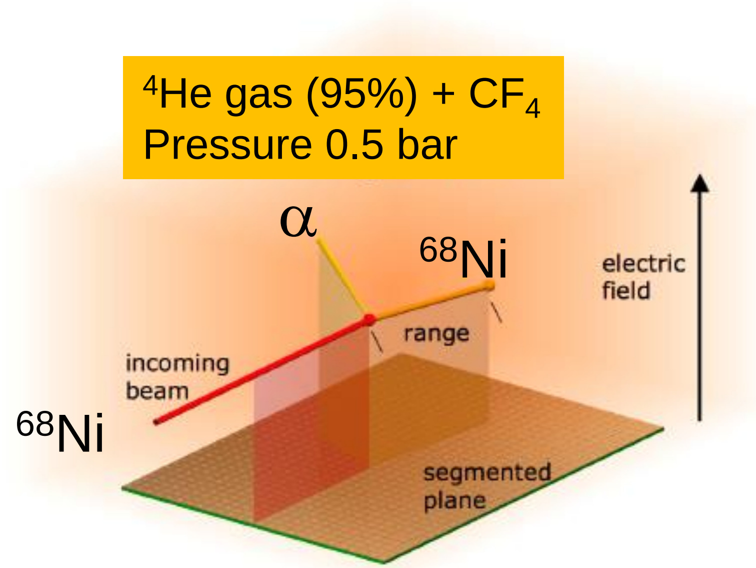
Giant resonances in atomic nuclei
& the nuclear matter incompressibility
Study of ^{68}Ni.





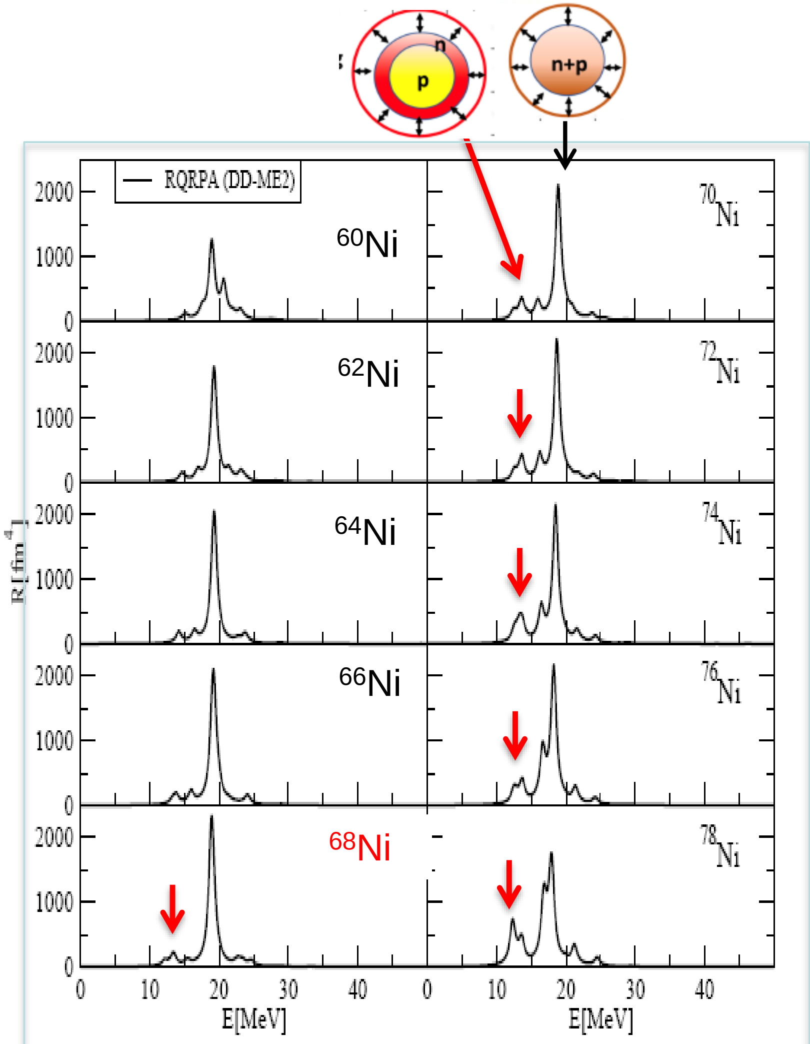


Excite the collective motion of neutrons and protons using (α,α') scattering



Use of an active target (MAYA)
-> Detect α particles of very small energy with high efficiency
-> Reconstruct the vertex of the reaction
-> Energy and angular distrib. of the resonances
-> Search for compression modes

Predictions of the monopole strength with increasing N



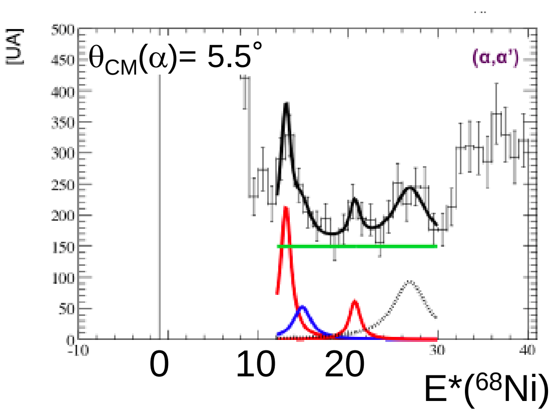
According to predictions, the compression of neutrons and protons in phase occurs at large E

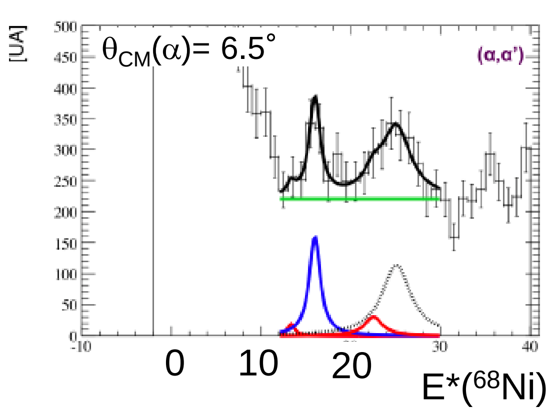
With increasing neutron excess, a soft compression mode develops at low energy

In this mode, only neutrons oscillate !

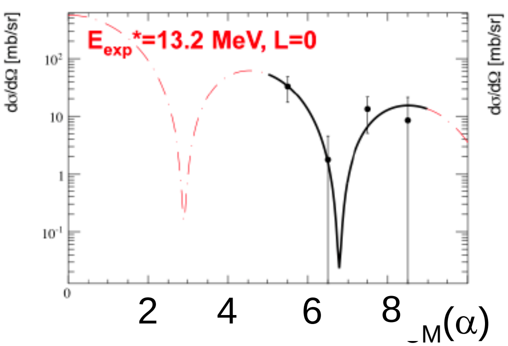
The study of such modes is essential to model the equation of state of nuclear matter in neutron-rich environments, such as core-collapse supernovae or / and neutron stars

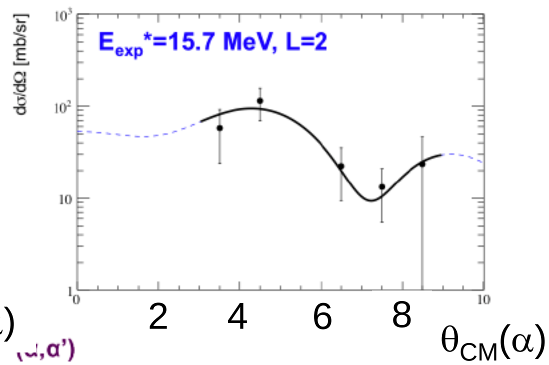
Experimental result for ^{68}Ni

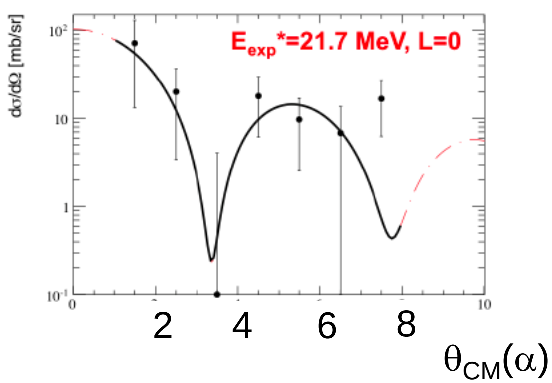




L=0
L=2

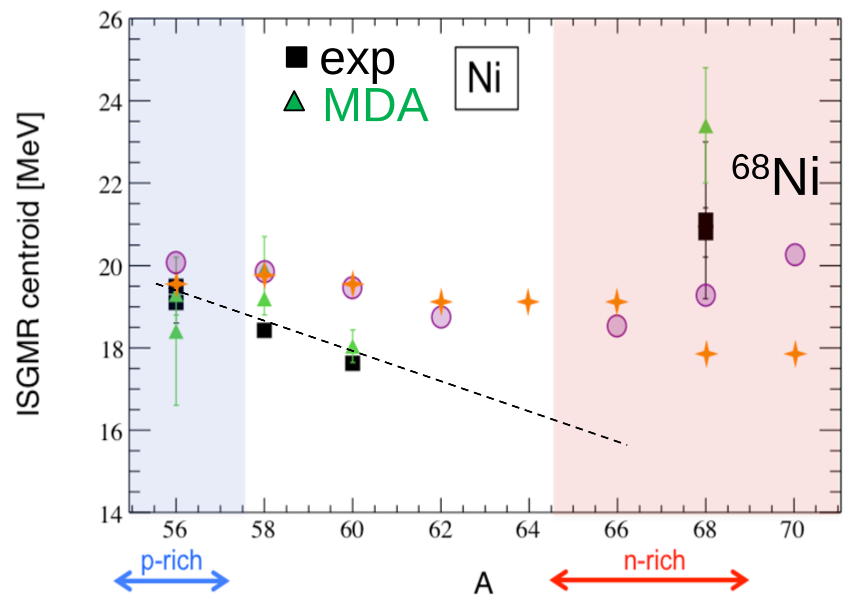






Results show for the first time a giant compression mode at 22 MeV in a neutron-rich nucleus and a soft mode at 13 MeV

Conclusions / perspectives

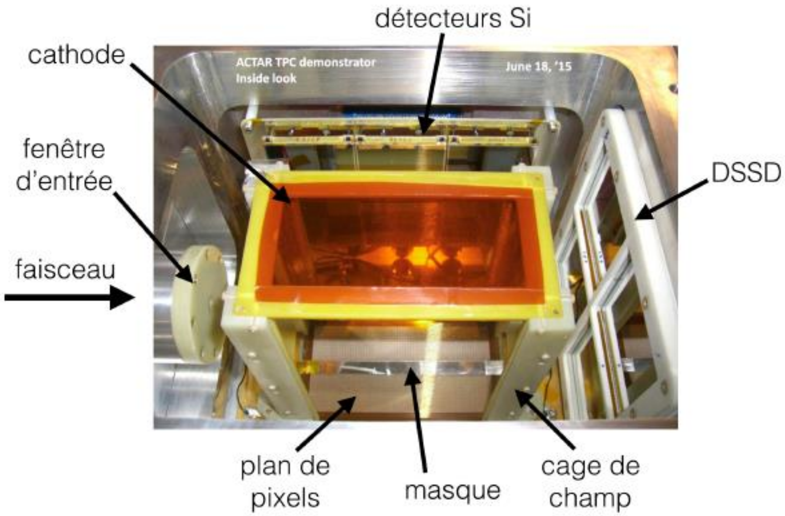


The centroid of the giant monopole mode is suprisingly higher than calculated

Its energy does not follow the decreasing trend from existing experimental data

As the statistics was rather poor, the energy resolution not very good, and the angular coverage limited for very low angles, the experiment will be repeated soon with ACTAR-TPC

You will see the detector while visting GANIL ☺



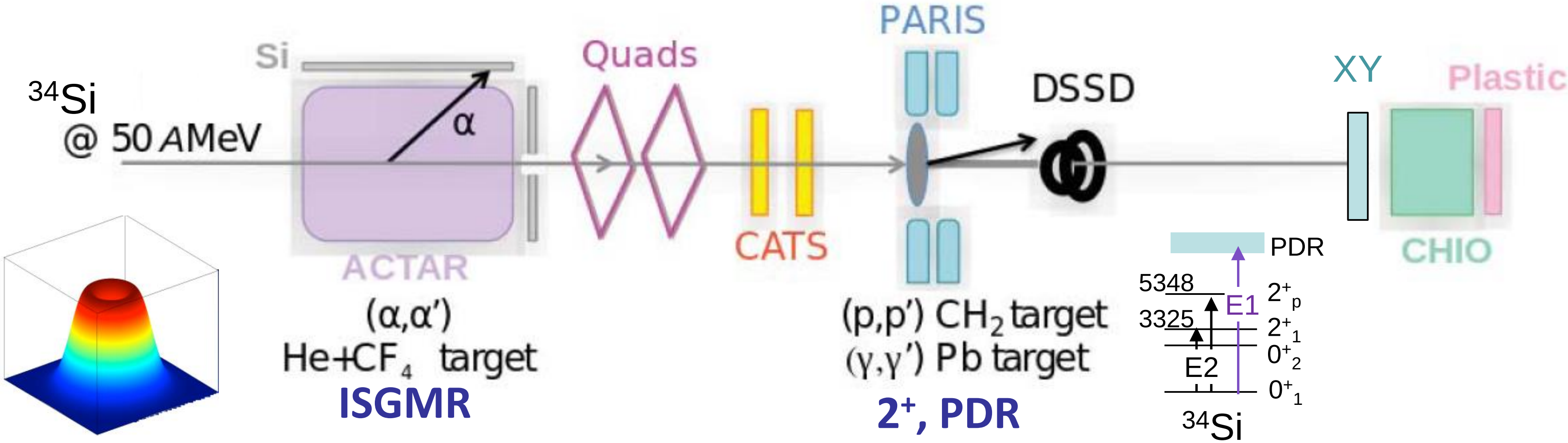
Backup slides

Cryogenic liquid hydrogen target

Future campaigns to be discussed @ LISE meeting Feb 2019

2020

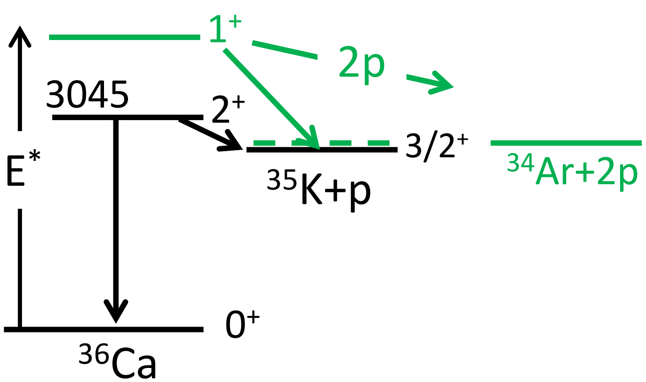
- Experiments with ACTAR standalone (e.g. 2p decay of ^{48}Ni or ^{54}Zn)
- Campaign combining study of soft and giant modes in exotic nuclei (‘brochette’)
- Others

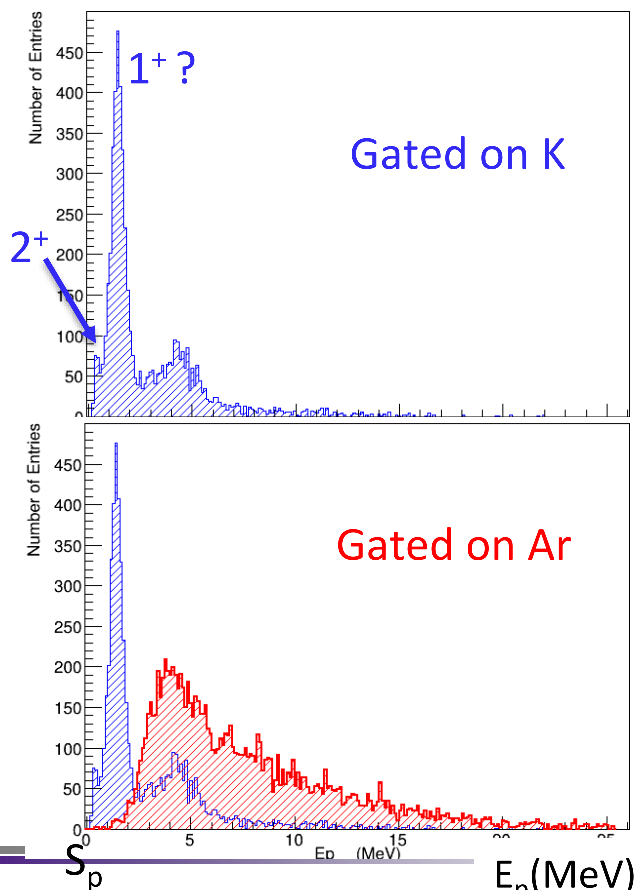


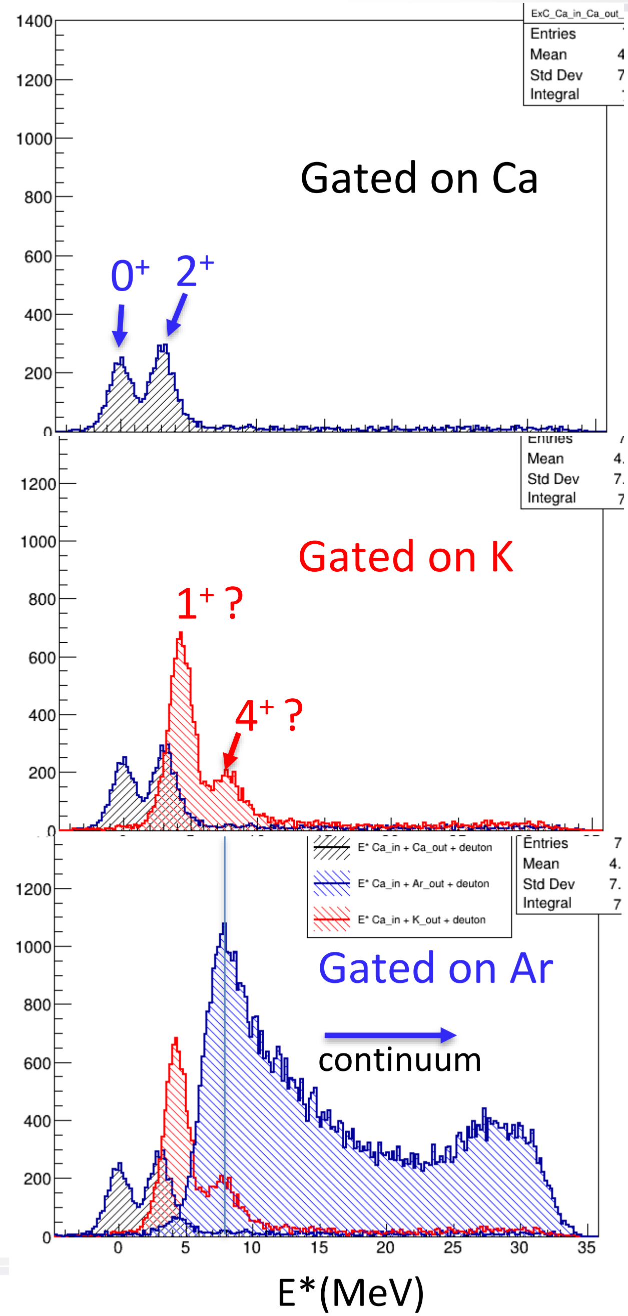
2021 and after

- Transfer experiments (MUST2 / GRIT) in combination with ACTAR - TPC ?
  e.g. perform (d,^{3}He) and (p,d) or (p,t) reactions in the same experiment
- Use of cryogenic targets H, ^{3}He...
- Benefit from new SPIRAL 1 beams

Preliminary results for $^{37}Ca(p,d)^{36}Ca$ reaction

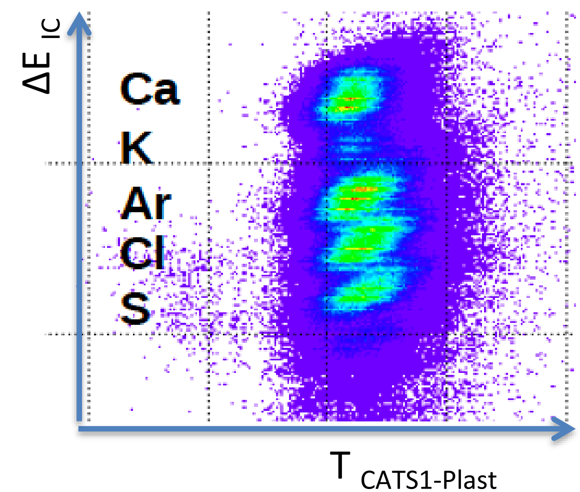






Gated on 'd' in MUST2

'outgoing Z' in IC



PhD Louis Lalanne

Start Oct 2018