Photo-disintegration experiments at ALBA

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Physics case

Experimental design

Outlook

Physics case

What can we learn with a source of gamma rays?

- **Nuclear Physics: Structure of low-energy continuum of break-up states.**
- **Astrophysics: Reaction rates relevant to the p-process.**

Nuclear Physics

- **Reaction cross sections of weakly bound nuclei are strongly affected by the coupling to the low energy break-up continuum.**
- **Information of the low energy continuum arising from nuclear reactions has uncertainties associated to the interplay of nuclear and coulomb forces.**
- **Photodisintegration experiments give clean information on the electromagnetic transition rates between the ground state and the break-up states.**
- **Measurements of (γ, α) and (γ, p) cross sections on weakly bound stable nuclei such as d, ^{6,7}Li and ^{9}Be will provide information on the continuum.**

Astrophysical applications

- **Some proton-rich nuclei are generated by the p-process, occurring in the oxygen/neon layers of highly evolved massive stars during their presupernova phase or during their explosion.**
- **The p-process consist on (γ, n) photo-disintegrations, followed by (γ, p) and/or (γ, α) reactions.**
- **The reaction ^{181}Ta$(\gamma, n)^{180}$Ta has been recently measured in Japan using a Laser Inverse Compton (LIC) γ-ray source similar to the one at ALBA.**
- **Measurements of (γ, n) reactions on many more nuclei are certainly necessary, but the investigation of (γ, α) and (γ, p) reactions in the energy range of interest is still a challenging prospect.**

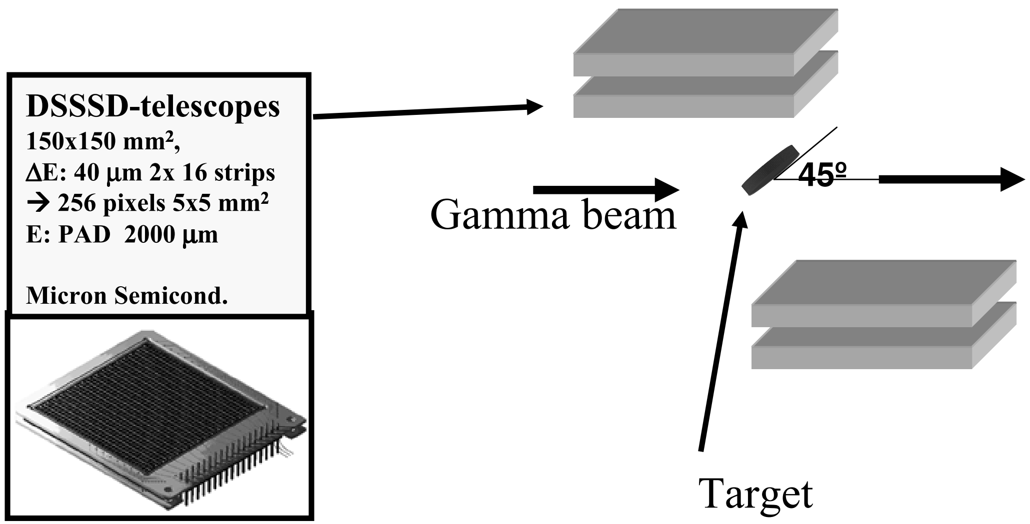
Experimental design

Objective of the experiment

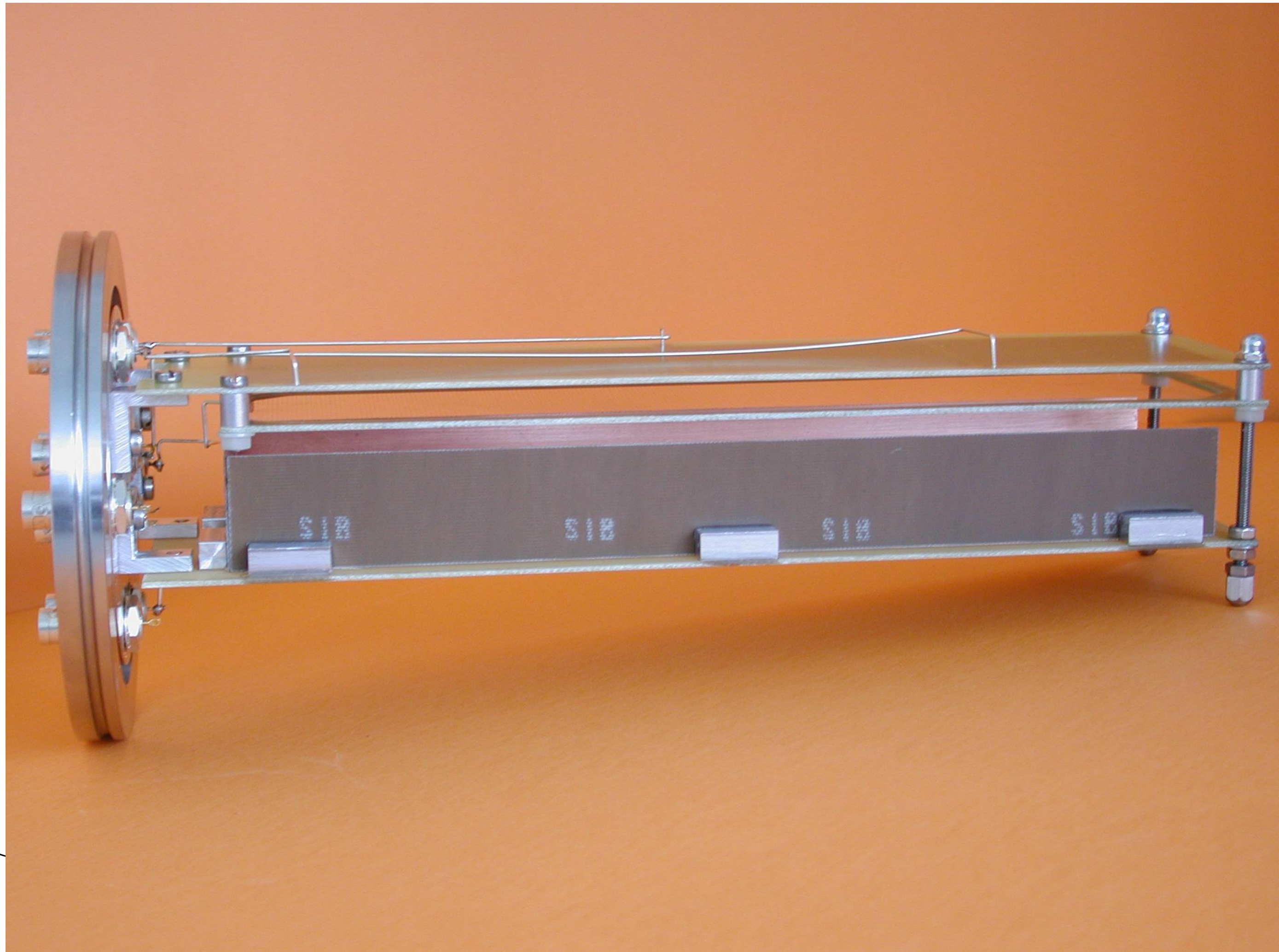
- **Measure cross section of the (γ, p) and (γ, α) processes on proton rich nuclei as a function of the energy of the γ.**
- **Measure the energy distribution of the p and α coming out.**
- **Obtain the multipole components of the angular distribution of p and α.**
- **Obtain the asymmetries of the distribution of p and α, as a function of the photon polarization.**

Particle detection setup using silicon telescopes

EXPERIMENTAL SETUP



Particle detection setup using a Ionization chamber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Beam requirements

- **Energy of the γ: 8-20 MeV.**
- **Energy resolution: 0.5 MeV.**
- **Intensity of the beam: 10^7 photons/s.**

Other requirements and estimates

- **Target thickness: about 10 mg/cm^2.**
- **Cross sections: 10 mb.**
- **Outgoing charged particles: 6 per second.**
- **Efficiency of the detector array: 10-50 %.**
- **Time for a cross section measurement: about 1 day.**

Outlook

- **The measurement of photodisintegration cross sections is an interesting possibility of ALBA. There is current interest in the spanish community in the results of such measurement, both from astrophysics and from nuclear physics.**
- **Performing these experiments could be done with the present equipment of spanish groups. However, it would be more convenient to build a dedicated detector array, using ionization chambers.**
- **Spanish groups have the know-how to design and build a dedicated ionization chamber for ALBA. What is required is manpower (1 PhD student, full time, 4 years), and financing (mostly for the electronic associated).**
- **The expertise of spanish experimental groups on the detection of low energy charged particles could be easily adapted to perform the (γ, p) and (γ, α) measurements. Manpower, as well as local support, would be required to perform these measurements.**