TEST OF FAZIA-PROTOTYPES

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ABSTRACT

In the framework of the first R&D phase of the recently started FAZIA Collaboration (the full list of the members is reported at the end of the document), a set of eight telescope prototypes have been prepared, with associated digital electronics. These prototypes implement new solutions for improving the Z and A identification performances, necessary for the Physics cases addressed by the FAZIA Collaboration (*Characterization of the Nuclear Equation Of State (NEOS) with respect to the the isospin degree of freedom*).

We propose an experiment dedicated to test, under beam conditions, the prototypes. In particular the new Silicon detectors cut along a skew “random” angle with respect the <100> crystal axis will be used. The Single Chip configuration will also be compared with standard photo-diode readout. The sensitivity of the identification performances on the doping uniformity of the Silicon detectors will be studied and –for punching through particles-- of the CsI(Tl) element, too. Finally a novel system, based on light flashes, to determine the time offset of the used silicon detectors will be tested.

The GARFIELD scattering chamber will be used for the tests.

DESCRIPTION OF THE EXPERIMENT

According to the Letter of Intent entitled “*R&D-FAZIA: Prototype development Phase*”, we present a proposal aimed at testing eight detector prototypes developed in the framework of the FAZIA Collaboration. The idea is to test the prototypes and the associated Front End Electronics under realistic beam conditions. In particular the first issue mentioned in the LoI will be addressed.

In the final high-energy configuration of the FAZIA prototypes, each telescope will include three elements: Si-SI-CsI(Tl). However, since the energies provided by the accelerators in LNL are relatively low, the eight telescopes will include all the most interesting and critical solutions presently envisaged in the collaboration, but with only one Silicon element and the CsI(Tl). Namely, all include a seemingly “standard” ☐E-E configuration (Silicon-CsI(Tl)), however implemented in our original ways. In fact all the front Silicon detectors are coupled to pre-amplifiers (PACI) able to produce charge and current outputs. These outputs will be digitized by fast ADC. In particular the current output will be sampled by the so-called MAR, an ASIC digitizer developed within FAZIA and able to convert at 2 GSamples/s with 12 physical bits. The digitized signals will be processed in order to extract all the relevant information: energy, timing, Pulse Shape (i.e. Z, A).

The Front End Electronics is schematically shown in Fig.1, while Fig.2 shows the mechanics of the telescope which has already been built.

As far as Silicon detectors are concerned, they will be mounted in the so called “reverse field” configuration, presently believed to be the best suited for optimizing the Pulse Shape performances. One of the prototype telescopes will be mounted with a “high field” (i.e. standard) configuration, to test indeed what we loose and what we gain in the two alternative solutions. A couple of telescopes will be provided with the novel Single Chip read-out, based on the idea of using the first Silicon detector to act both as ☐E element and as a photodiode to read the fluorescence of the CsI(Tl). That configuration, which already showed good performances in preliminary tests in LNL, has to be checked as a realistic and large-scale alternative to the standard solution.

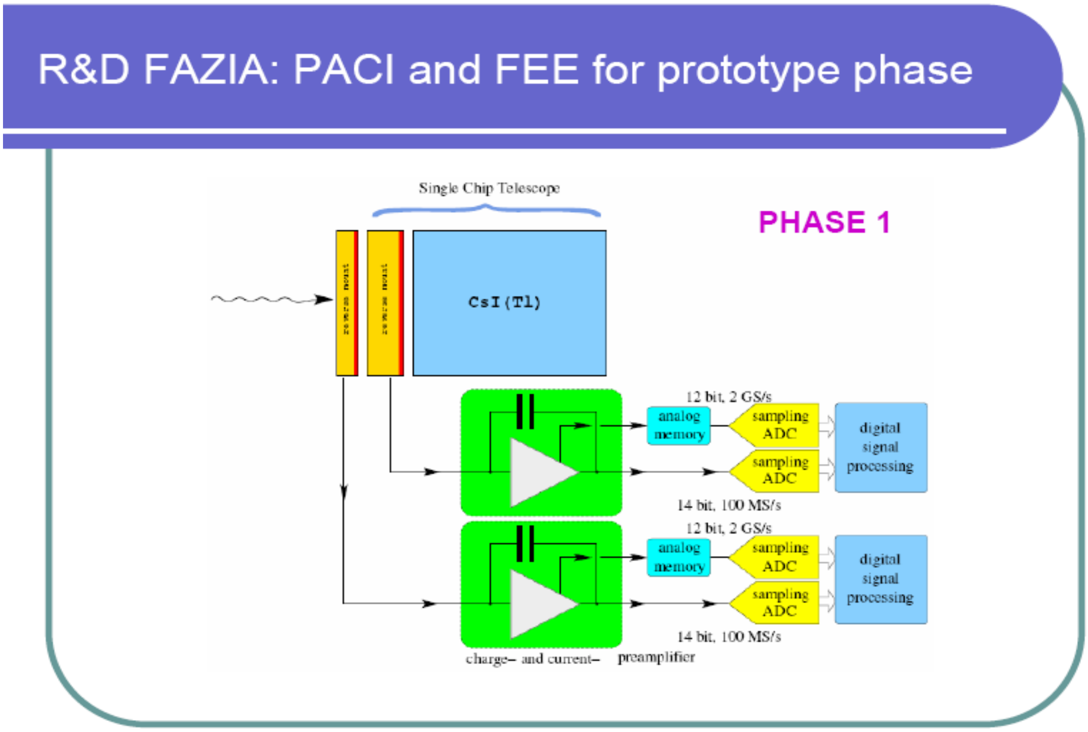

Figure 1. R&D Fazia: prototype phase, Front End Electronics

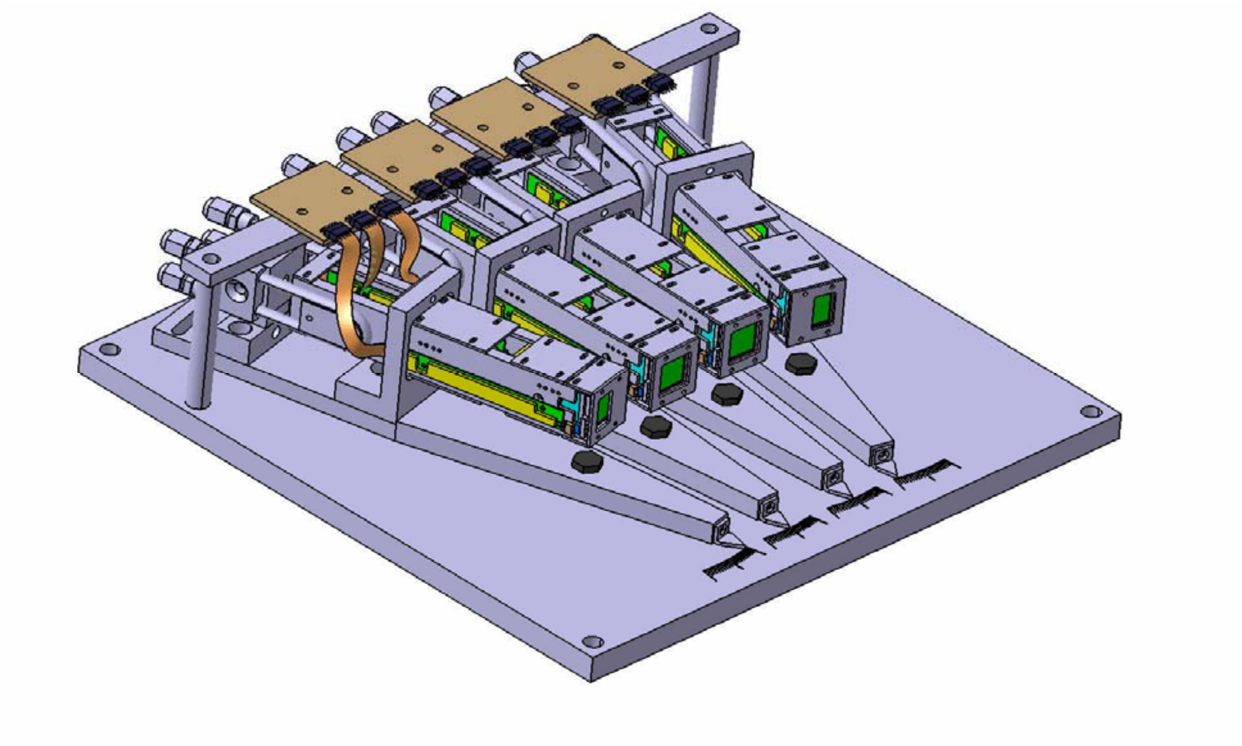

Figure 2. R&D Fazia: prototype phase, Telescope and mechanical support

Most of the Silicon detectors will be those produced according to the procedure that we suggested to the manufacturer, namely from wafers obtained by a special "random orientation" cut, starting from a <100> nTD Silicon ingot, ordered by the collaboration. From a recent experiment we learned, in fact, that this procedure guarantees the best performances because it reduces at most the channelling effects in the Silicon crystal. As an example, the left panel of Fig. 3 shows the current signals obtained during the last experiment at LNL with Se beam, when the Silicon detector was oriented perpendicular to the scattered particles (thus entering along the <100> axis), while the right side shows the same signals when the Silicon detector was oriented in the “non-channelled”, i.e. “random” direction. The improvement in the stability of the current signals is apparent.

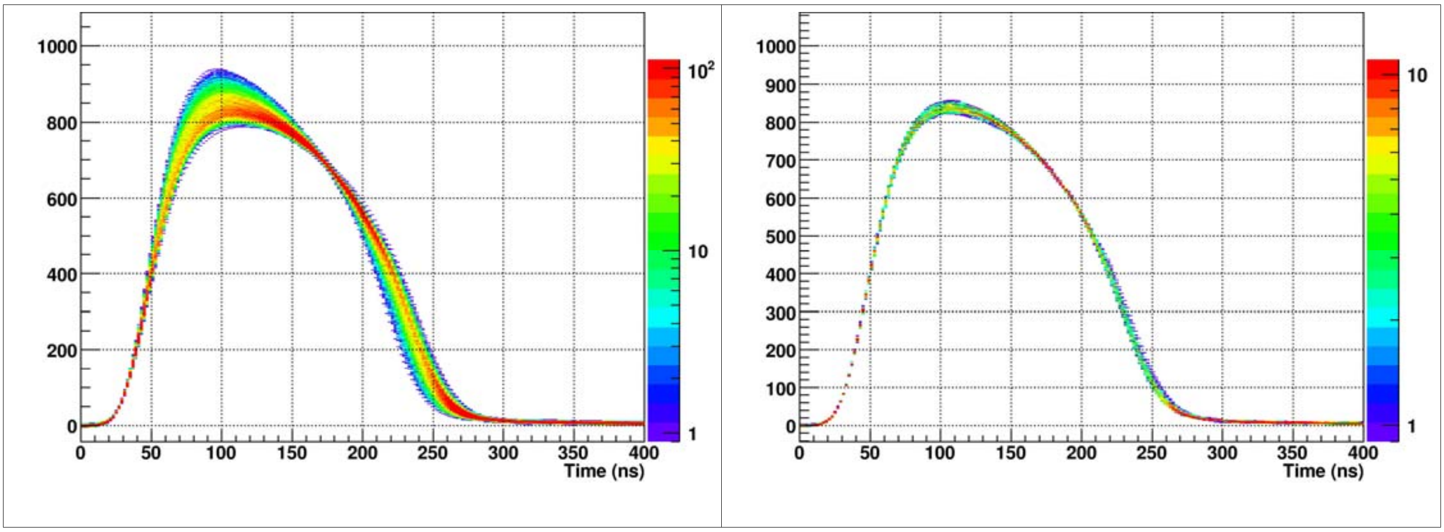

Figure 3. Current signals for channelled (left panel) and “random” entering (right) ions. The beam was ^{80}Se at 400 MeV total energy.

The mechanics of the telescopes is designed in such a way to permit also the use the <111> detectors and to orient them along “non-channelled” directions, aiming at verifying the actual improvement associated with the presently preferred <100> crystals.
One of the telescopes will be equipped with a moving collimator, precisely controlled on two orthogonal axes, in order to test the other important issue, namely the position sensitivity of the identification procedures, based on Pulse Shape Analysis. The same collimation procedure may serve to test, for punching through particles, also the uniformity of the response of the CsI(Tl).
Finally, we plan also to test a novel system for measuring Time of Flight based on synchronization of the detectors via flashes of light and on the accurate energy measurement of particles identified (in a single event) by means of the *ToF independent* identification procedures.
For the tests the GARFIELD scattering chamber appears to be well suited.

BEAM TIME REQUEST

For the measurement campaign the best suited beams would be ^{32}S and ^{58}Ni at the highest available ALPI energies. By bombarding a light Aluminium target, a good deal of reaction products will be produced. As far as current intensity is concerned, 1pnA is believed to suffice, because the tests can be done with relatively thick targets.
For the proposed program, a total of four days of beam-on-target are necessary. In fact we need to collect a statistics sufficient for the key-test of the detector uniformity and the requested four days are based on extrapolation from the results of a similar test recently performed on an elastically scattered Ni beam.

REFERENCES

Web site Fazia collaboration (http://fazia.in2p3.fr)
LOI-SPIRAL2, Dynamics & Thermodynamics of exotic nuclear systems
“Dynamics and thermodynamics with nucleonic degrees of freedom”, W.Trautmann et al eds, Springer 2006.
L.Bardelli et al, NIMA 521 (2004) 480
L.Bardelli, G.Poggi NIMA 560 (2006) 517
M.Bini et al, NIMA 515 (2003) 497
H.Hamrita et al NIMA 531 (2004) 607 and PhD thesis,tel-00010145
M.Mutterer et al, IEEE Trans.Nucl.Science 47 n.3 (2000), 756

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