The primary target for the hyper-nuclear experiment at $\bar{P}$ANDA

S. Bleser[1], F. Iazzi[2], ●M. Martínez Rojo[1], J. Pochodzalla[1,3], N. Rausch[3],
A. Sanchez Lorente[1], M. Steinen[1] – on behalf of the $\bar{P}$ANDA collaboration

[1]Helmholtz-Institut Mainz, Germany; [2]Politecnico di Torino and INFN, Sezione di Torino, Italy;
[3]Institut für Kernphysik, Mainz,Germany;

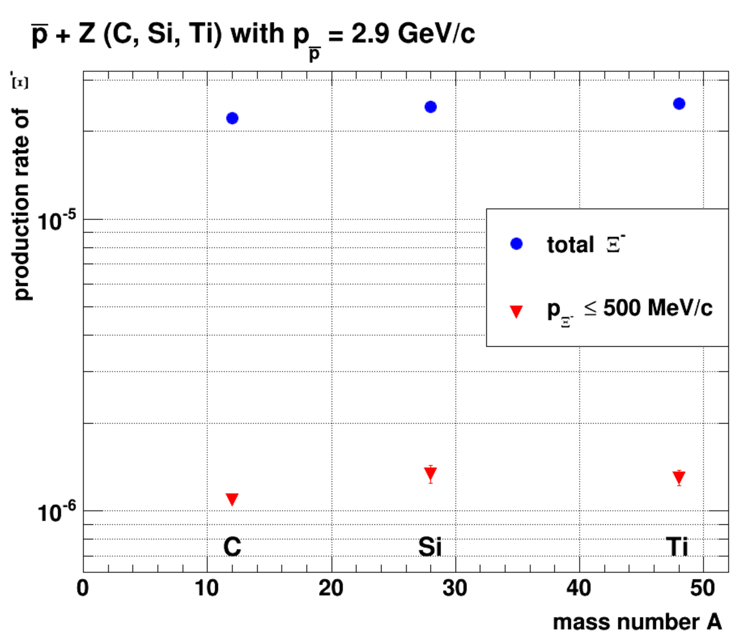
HELMHOLTZ GEMEINSCHAFT
Helmholtz-Institut Mainz

Choice of the primary target

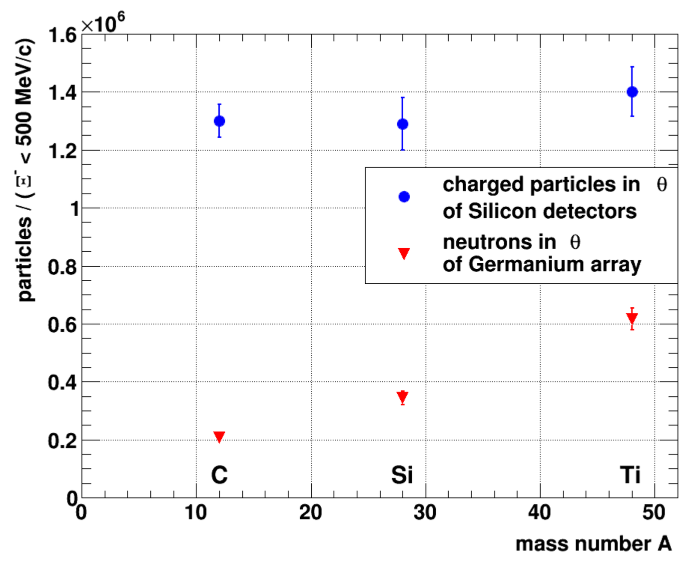
For the production of ΛΛ hypernuclei at $\bar{P}$ANDA a devoted two-stage target system is needed. The task of the primary target is the production of Ξ^- .

The primary reactions $\bar{p}$ on nuclei are simulated in GiBUU calculations. The results using C, Si and Ti targets are shown on the right.

The table below lists the production and stopping probabilitiy in the secondary target, the expected beam losses and in addition the combined FoM. From this point of view carbon is the best choice for the target material.

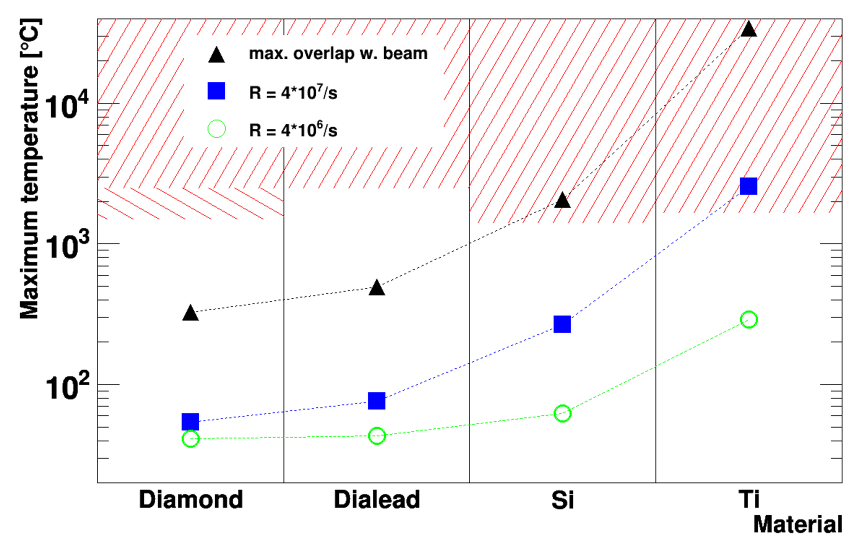


Material	production rate	stopping probability	σ_h/σ_{total}	FoM
^{12}C	$(2.221 \pm 0.021) \cdot 10^{-5}$	$(4.662 \pm 0.295) \cdot 10^{-3}$	0.539	$(5.581 \pm 0.357) \cdot 10^{-8}$
^{28}Si	$(2.418 \pm 0.040) \cdot 10^{-5}$	$(3.751 \pm 0.459) \cdot 10^{-3}$	0.339	$(3.074 \pm 0.380) \cdot 10^{-8}$
^{48}Ti	$(2.483 \pm 0.034) \cdot 10^{-5}$	$(5.233 \pm 0.455) \cdot 10^{-3}$	0.245	$(3.183 \pm 0.280) \cdot 10^{-8}$

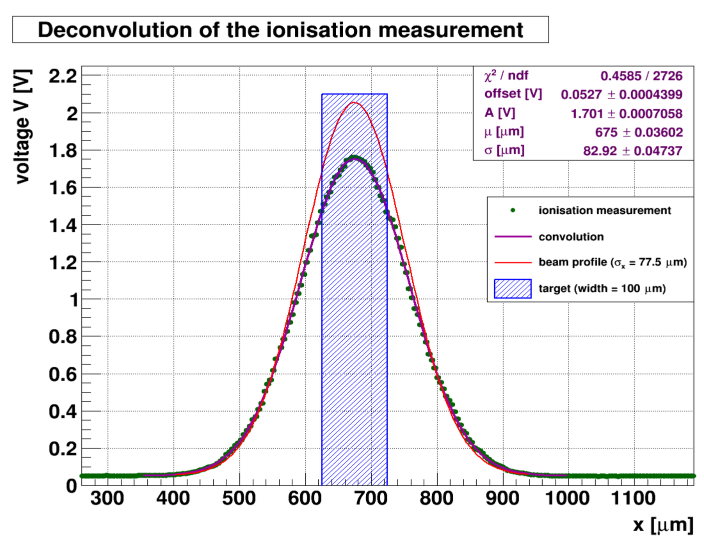


For the performance of silicon strip detectors in the secondary target and the germanium detector array the hadronic background has to be kept low. The picture above shows the number of background particles in the specific polar angle θ normalized by the number of produced Ξ^-. Due to the rise of neutrons with increased A a carbon target is favored.

A critical issue is the thermal dissipation of $\bar{p}$ in the target. The picture below compares the maximum temperatures of the studied target materials including the carbon fiber Dialead K13D2U. The melting points are marked by the red areas. This study excludes Ti and also Si as target material.

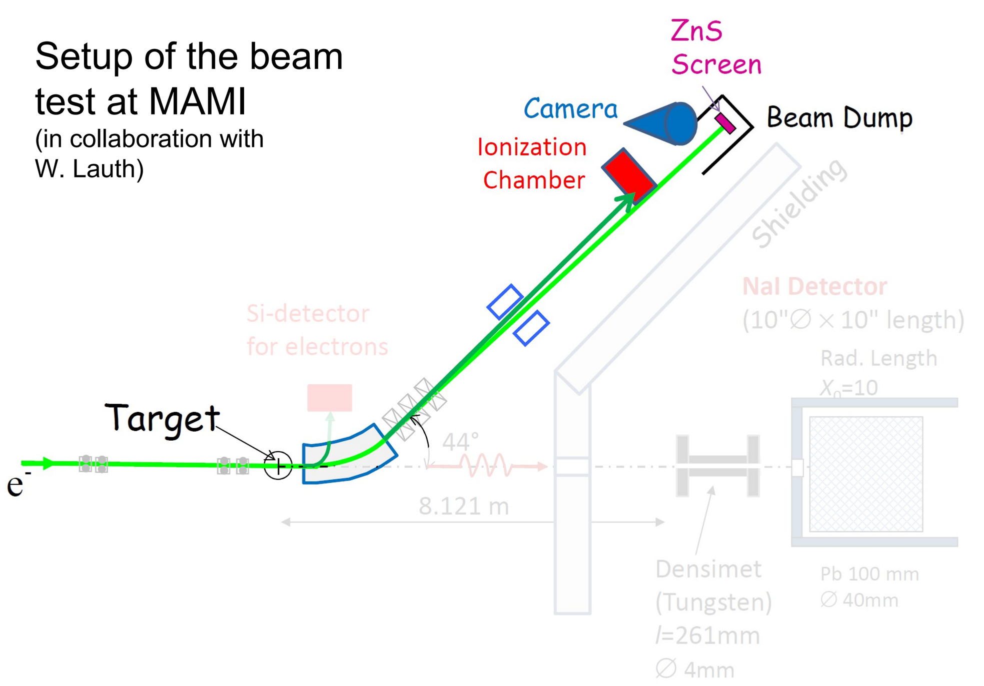


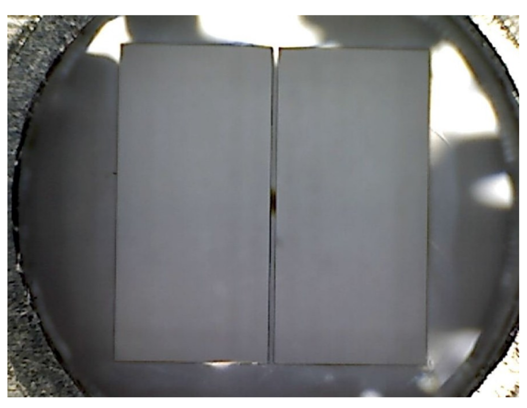
Target irradiation test at MAMI



An irradiation test has been performed to validate the results of the thermal simulations. A diamond filament has been irradiated at MAMI with an electron beam of 855 MeV and 0.5 μA. The plot on the filament shows the beam position on the filament and their overlap. The deconvolution of the scan yields an overlap of 48%. The energy deposition of the electrons in the target amounts 0.53 mW, which is roughly ten times the power deposition under the foreseen experimental conditions at $\bar{P}$ANDA.

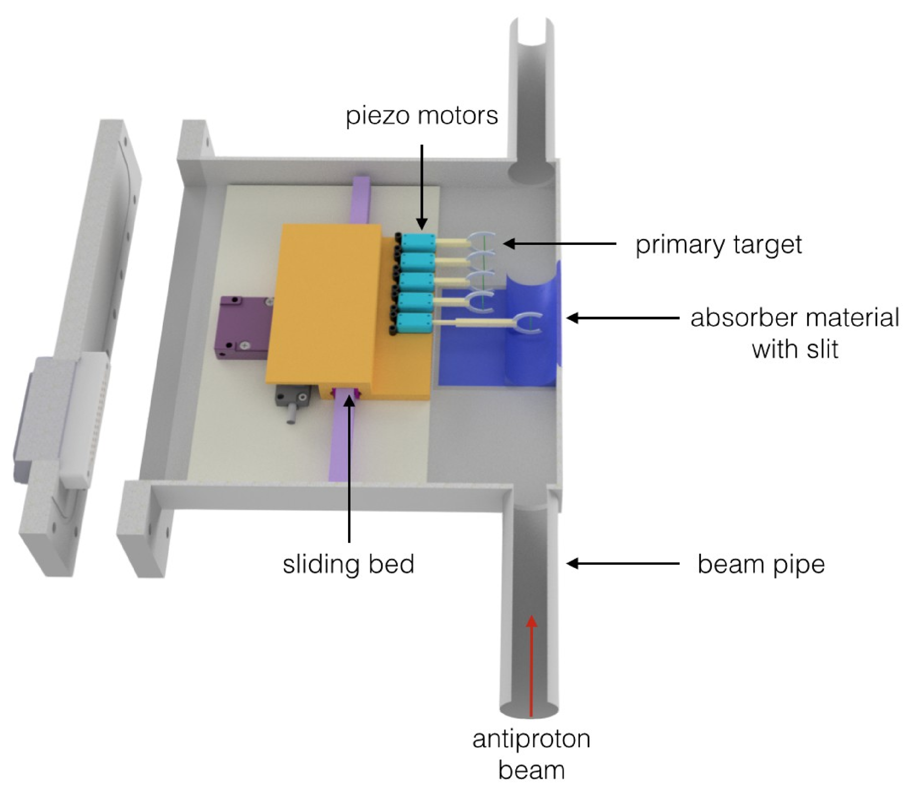
Setup of the beam test at MAMI
(in collaboration with W. Lauth)



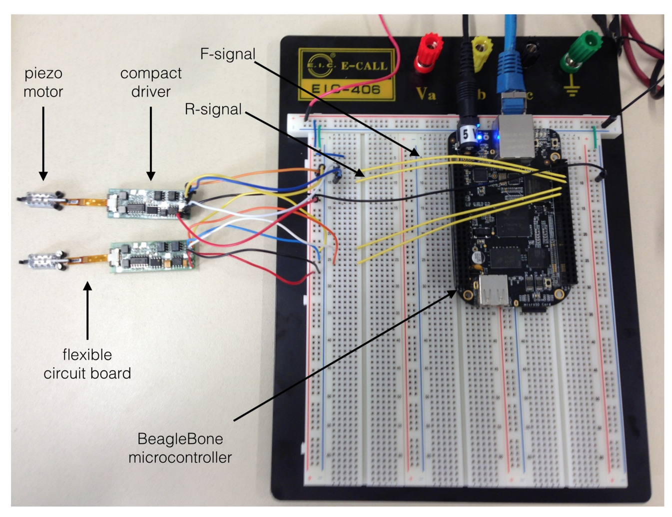


The picture above shows the target after the irradiation test. The only visible change is a black spot in the middle of the diamond filament which has to be investigated further.

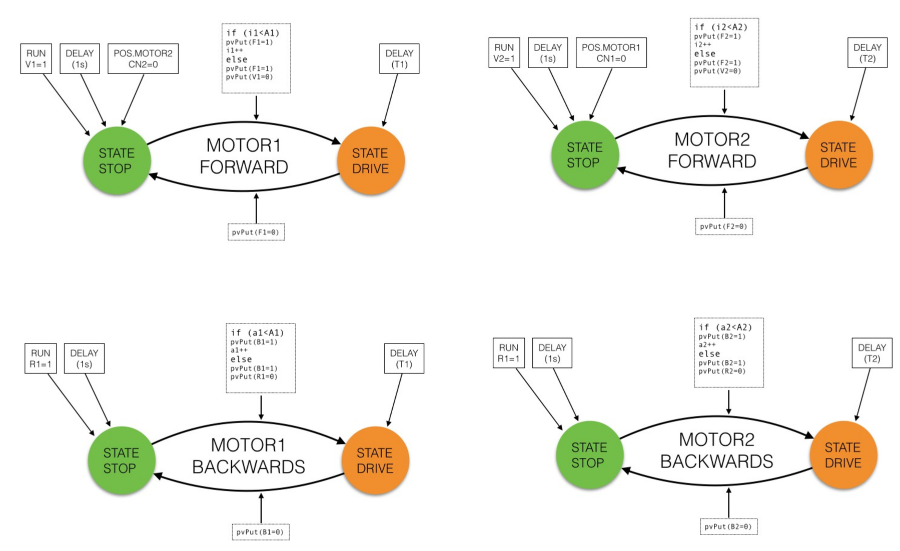
Target control system



The primary internal target system has to be compact to allow the stopping of the Ξ^- in the secondary target. Due to this size limitation a system of piezo motors will be used to position the primary target precisely in two dimensions and to provide the replacement of eventually broken target wires.



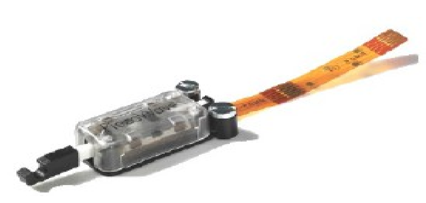
The picture above shows the control system of two PiezoWave motors. As EPICS is planned for the $\bar{P}$ANDA DCS this framework is implemented on a Beaglebone Black.
Down right the state diagram shows the logic of the control system. It is important to ensure that only one rod can be driven out at the same time.



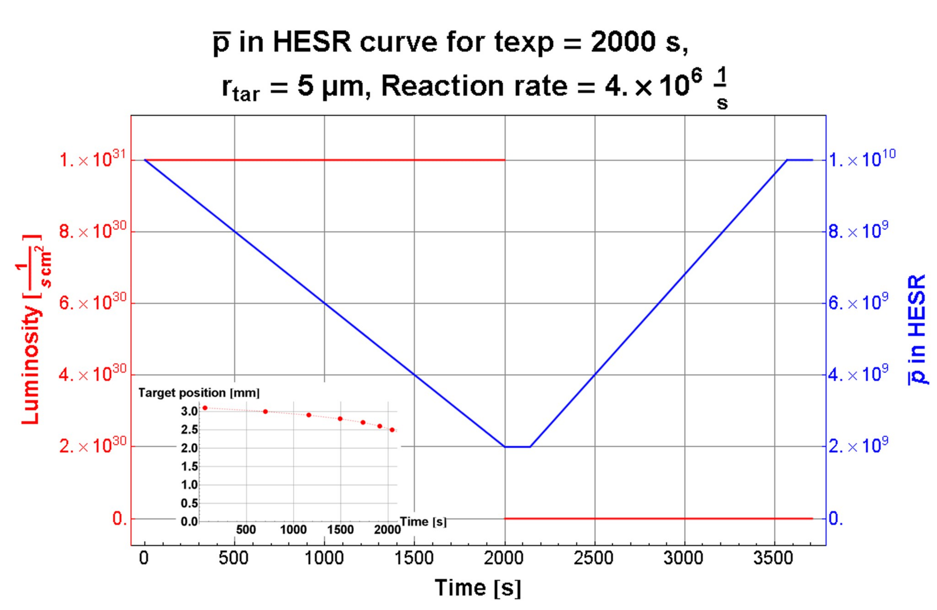
Verification of piezo motor properties

Features	Manufacturer	Standard conditions	Vacuum	Magnetic field	After radiation test
Stroke maximum	8 mm	8 mm	....	8 mm	8 mm
Average step	0.5 – 1.0 μm	0.96 μm	....	0.94 μm	0.95 μm
Dynamic force	0.10 N	0.14 N	0.15 N	....	0.14 N
Holding force	0.30 N	0.88 N	0.9 N	....	0.87 N

The specifications provided by the manufacturer PiezoMotor have been checked under working conditions similar to the ones at $\bar{P}$ANDA. The results show that the performance of the piezo motors is not affected by vacuum, magnetic field or irradiation.



Luminosity considerations



In the storage ring HESR the number of $\bar{p}$ (production rate: 5.6 · 10^6 $\bar{p}$/s) decreases in a measurement cycle. The luminosity can be kept constant by adjusting the target position by 0.5 mm in total. The average interaction rate including beam preparation and refilling time is 2.2 · 10^6/s.

In gemeinsamer Trägerschaft des
GSI Helmholtzzentrums für Schwerionenforschung, Darmstadt und der Johannes Gutenberg-Universität Mainz

GSI
JOHANNES GUTENBERG UNIVERSITÄT MAINZ