Status of the Secondary Target

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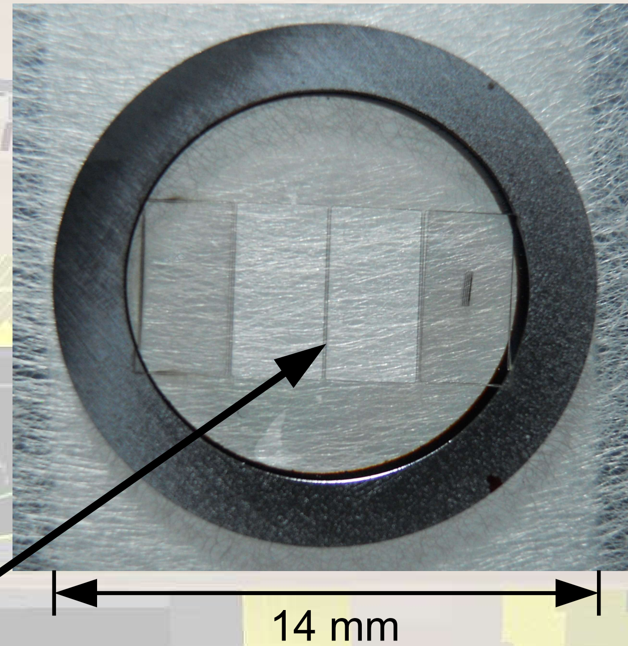
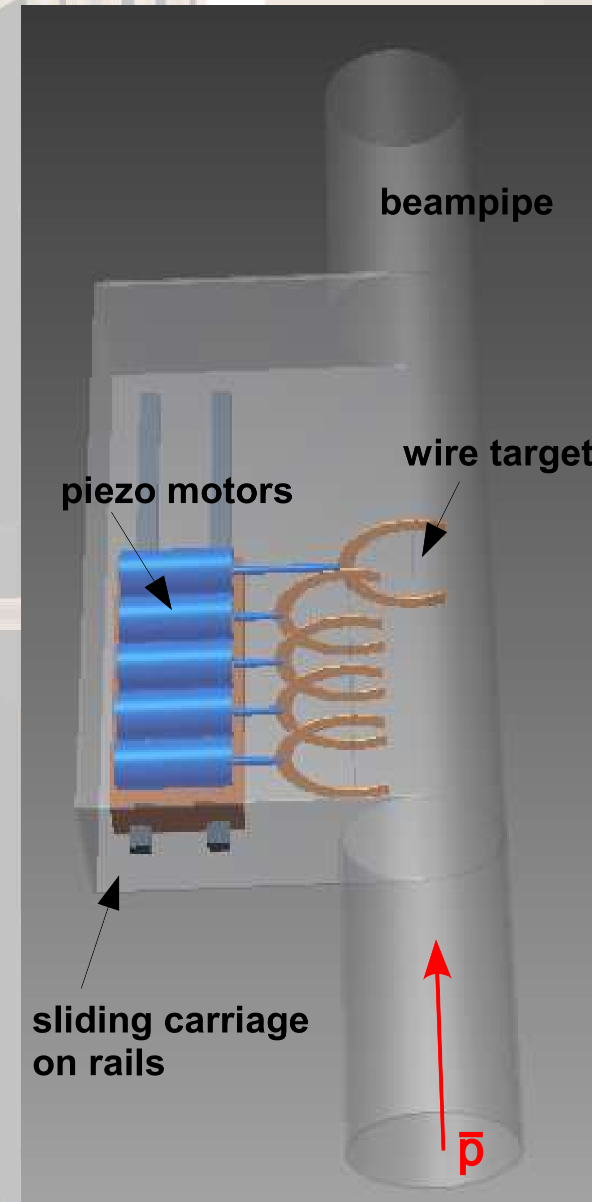
Primary target

Task of the primary target:
production of slow Ξ^-

Requirements:
- minimal hadronic background in backward direction
- constant luminosity of $\bar{p}$-beam
  $\Rightarrow$ beam losses, mainly due to coulomb scattering, must be kept low

$\Rightarrow$ ^{12}C micro-wire target with thickness 3 µm, width 100 µm





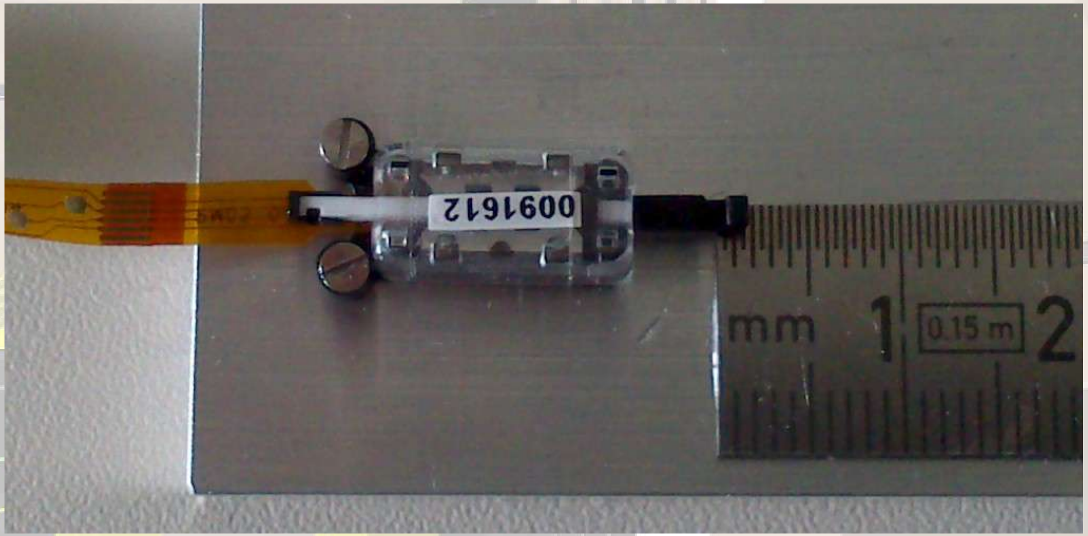
Insertion to the beam:
- controlling interaction rates by moving target into beam halo
- easy replacement

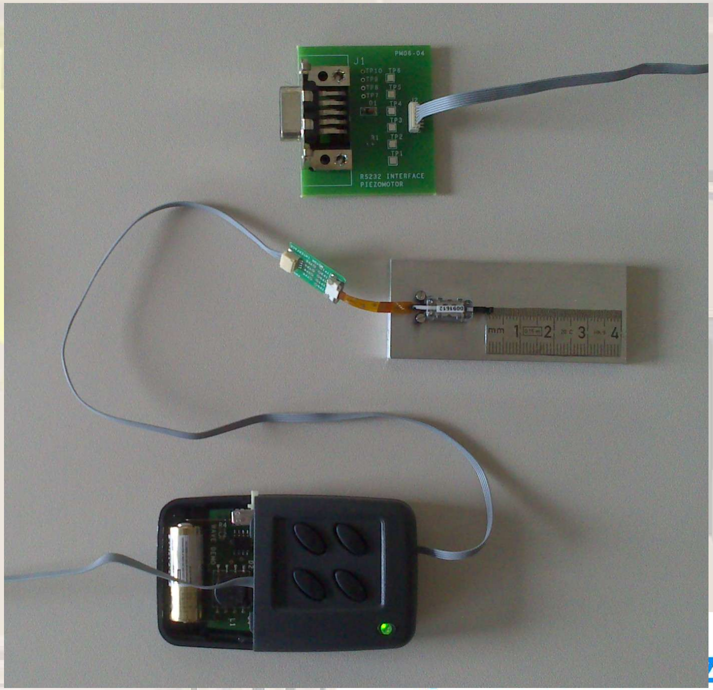
Piezo motor

First piezo motor for tests:

PiezoWave Linear 0.1 N
Manufacturer: PiezoMotor Uppsala AB

Specifications:
Stroke max: 8 mm
Maximum speed: 50 - 100 mm/s
Average step: 0.5 - 1.0 µm
Dynamic force: 0.1 N
Holding force: 0.3 N
Weight: 0.5 g
Size: 14.0 mm x 7.2 mm x 4.4 mm





Experimental tests:

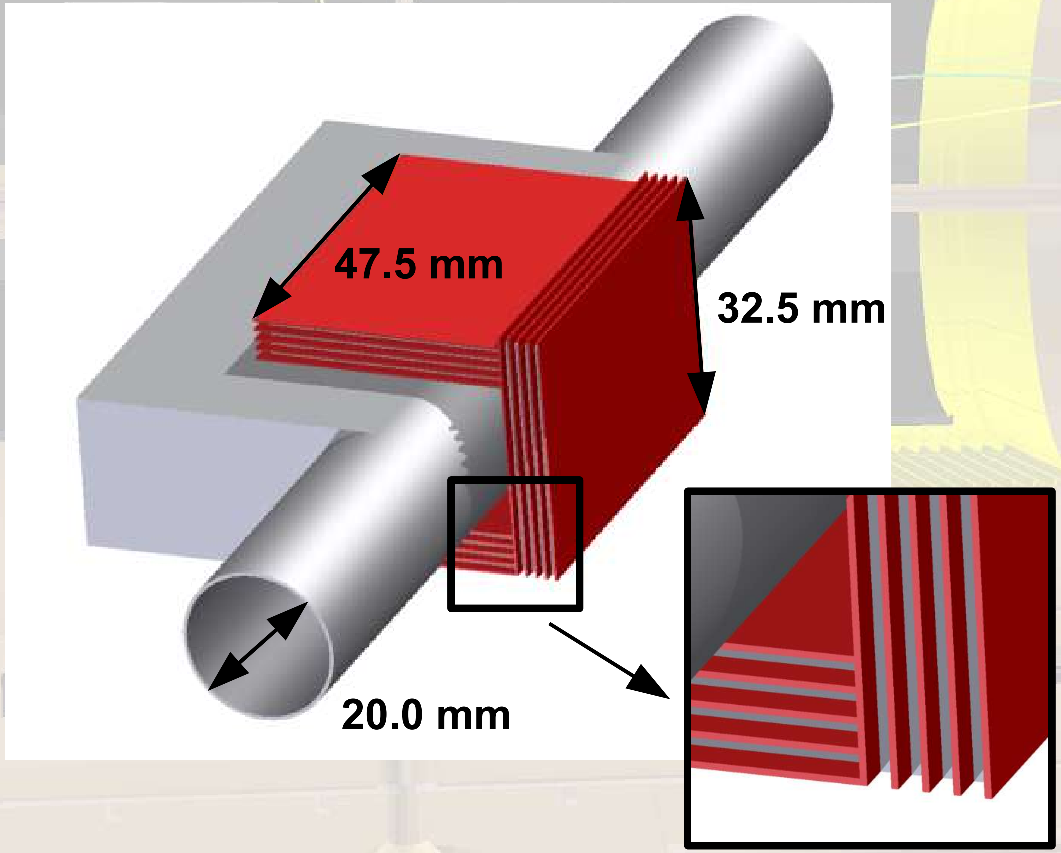
The PiezoWave is operated by the Starterkit Demo-Wave-10 and works as expected.

→ Next step: vacuum integration and performance tests

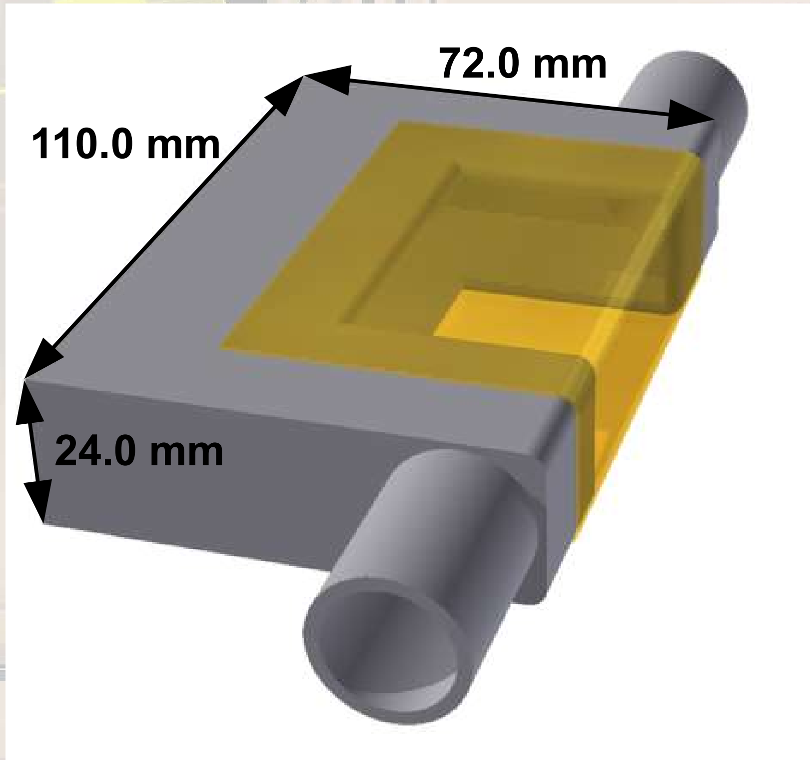
Design of the target system

Very short life time of Ξ^-: $\boldsymbol{\tau}$ = 0.164 ns ⇒ compact structure essential

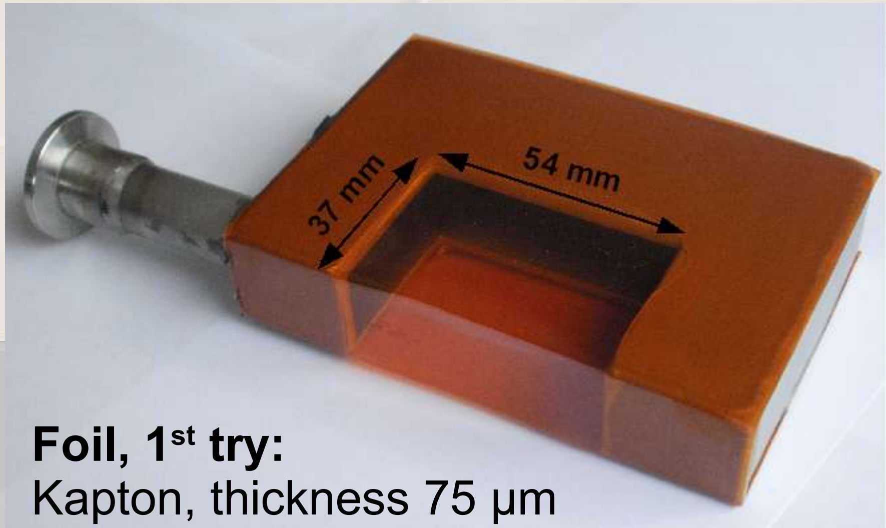
Arrangement of DSSD-absorber-assemblies directly around the target chamber and beampipe
→ minimization of beampipe diameter



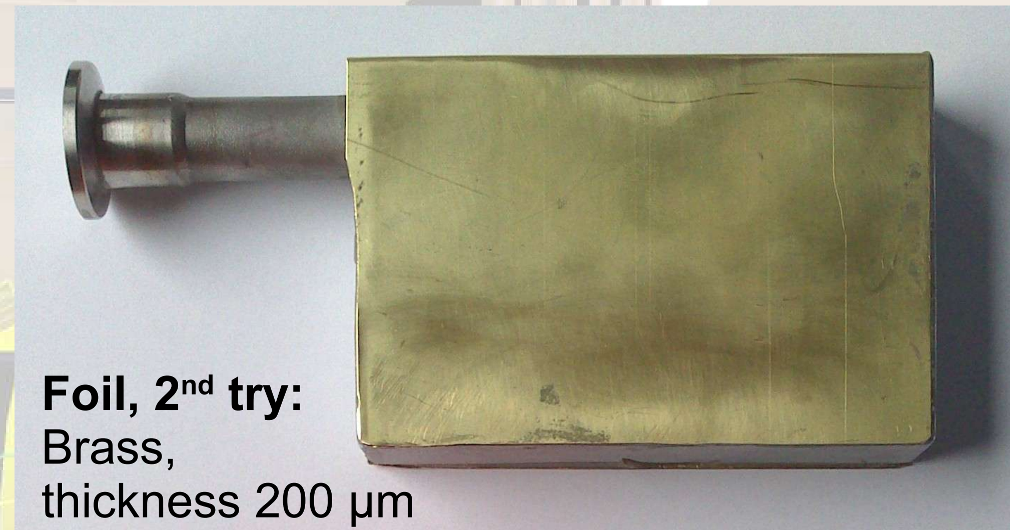
Minimization of material budget
→ reduction of thickness



Target chamber development

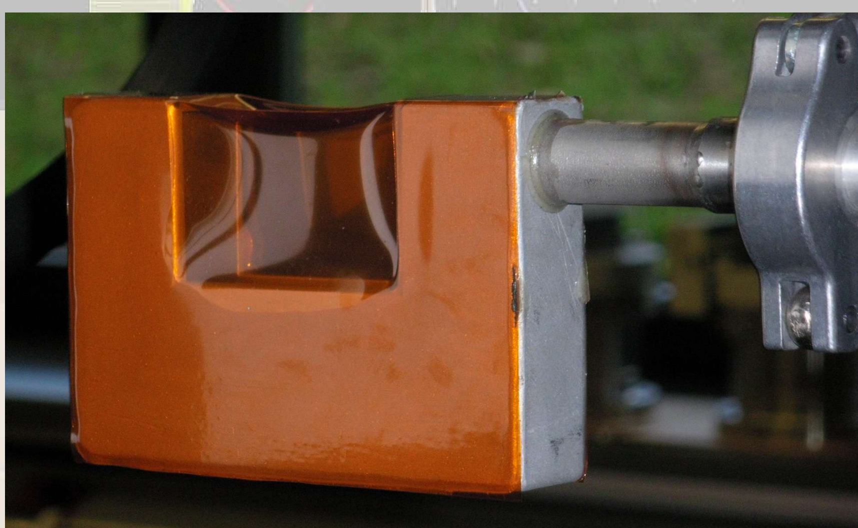


Foil, 1st try:
Kapton, thickness 75 µm



Foil, 2nd try:
Brass,
thickness 200 µm

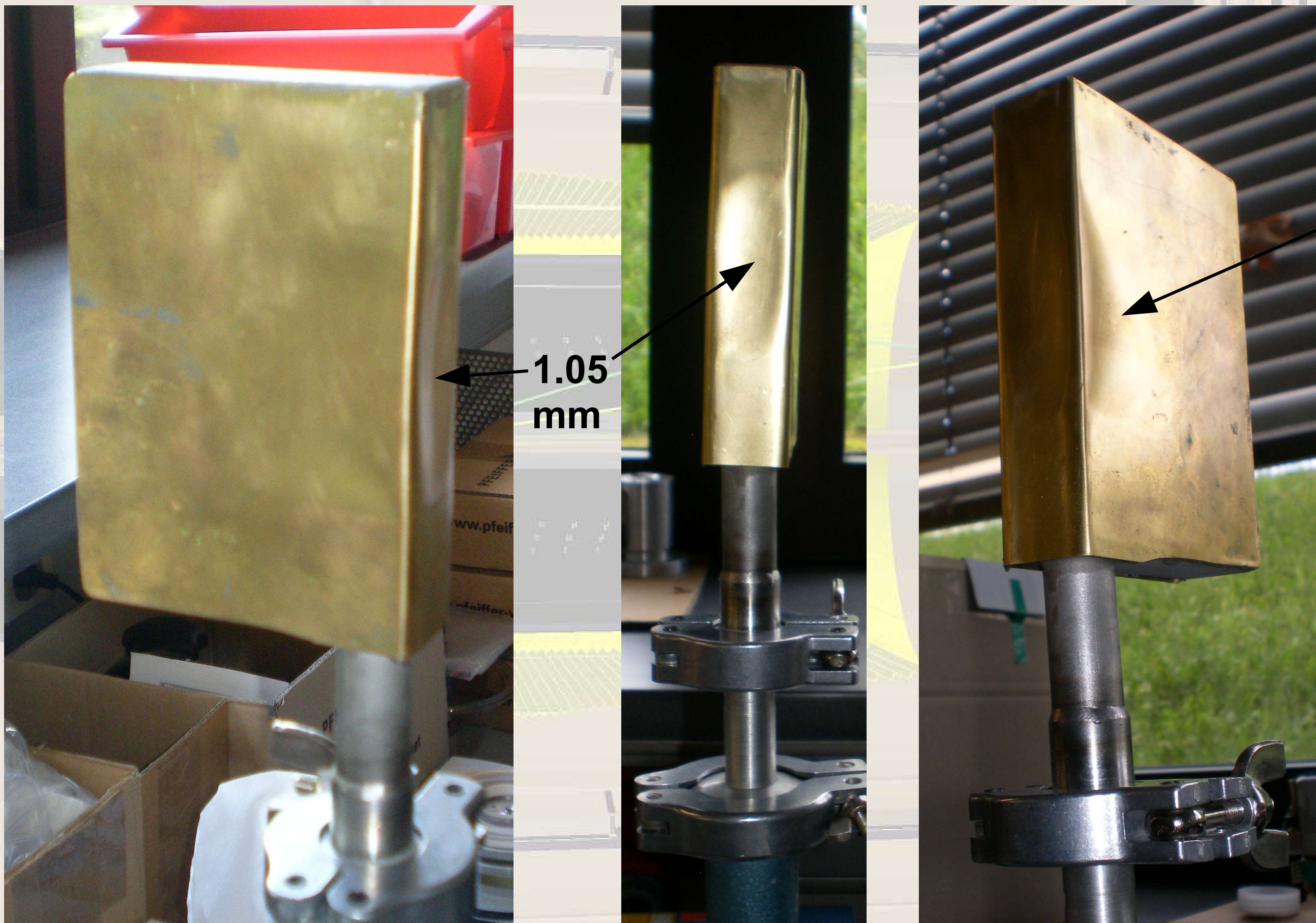
Stability tests in vacuum:



- Kapton foil did not tear but is highly bent to the inside (≈ 7 mm per side)
  → not applicable
- Maximum bending of brass foil ≈ 1.2 mm
  → but brass not practical for high vacuum

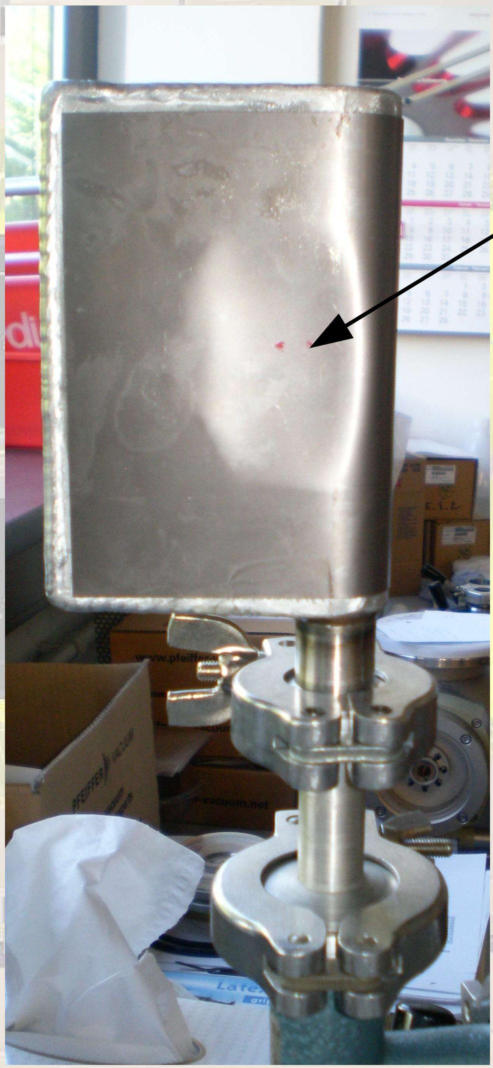
⇒ further thicknesses and materials for tests (titanium, AlMg alloy, fiber reinforced plastics) and tests of material fatigue

Target chamber development

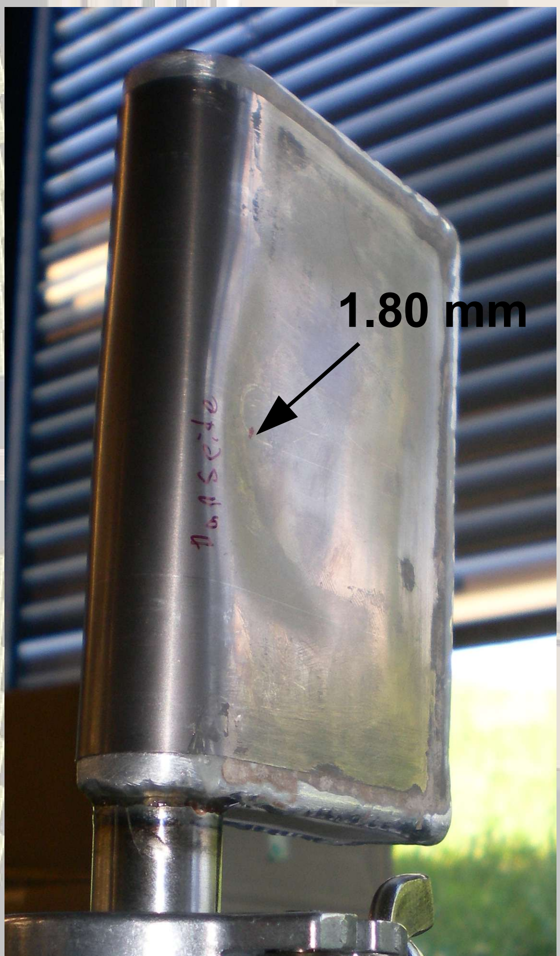


Target chamber development

2nd target chamber design with titanium, thickness 200 µm:



1.57 mm



no significant changes after 50 cycles of evacuation and decompression

Design of the secondary target

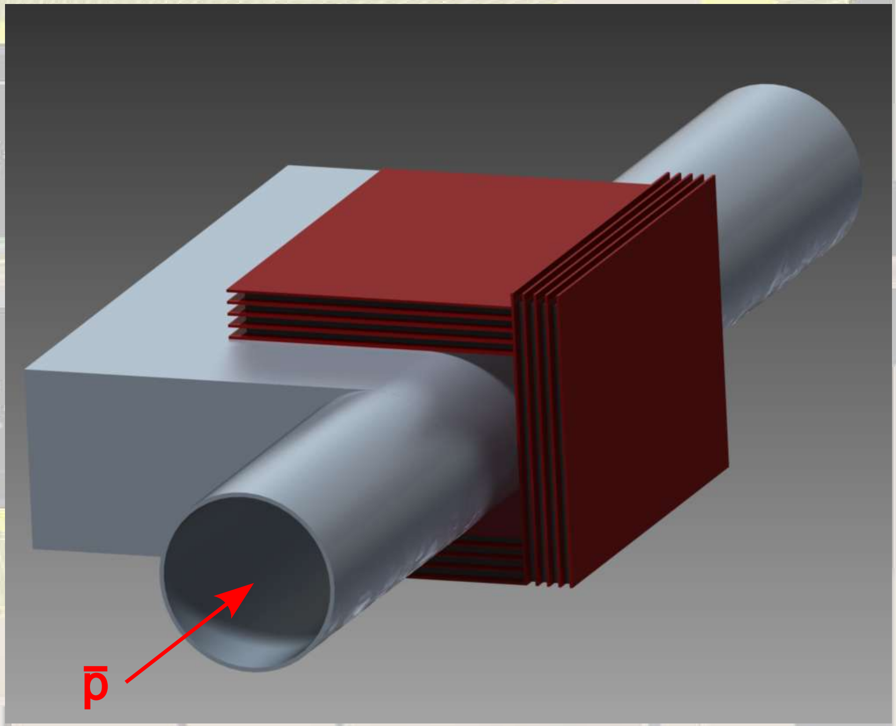
Requirements for the secondary target

- adjusted to stop time and life time of Ξ^- (τ = 0.164 ns) as well as geometry

  ⇒ compact structure without gaps (t_{stop} ≈ 0.06 ns)

- tracking of Ξ^- and the decay products of Λ-Λ-hypernuclei

  ⇒ alternating layers of Si strip detectors and absorber material



red:

5 layers of double sided silicon strip detectors (thickness 300 µm) in each block

gray:

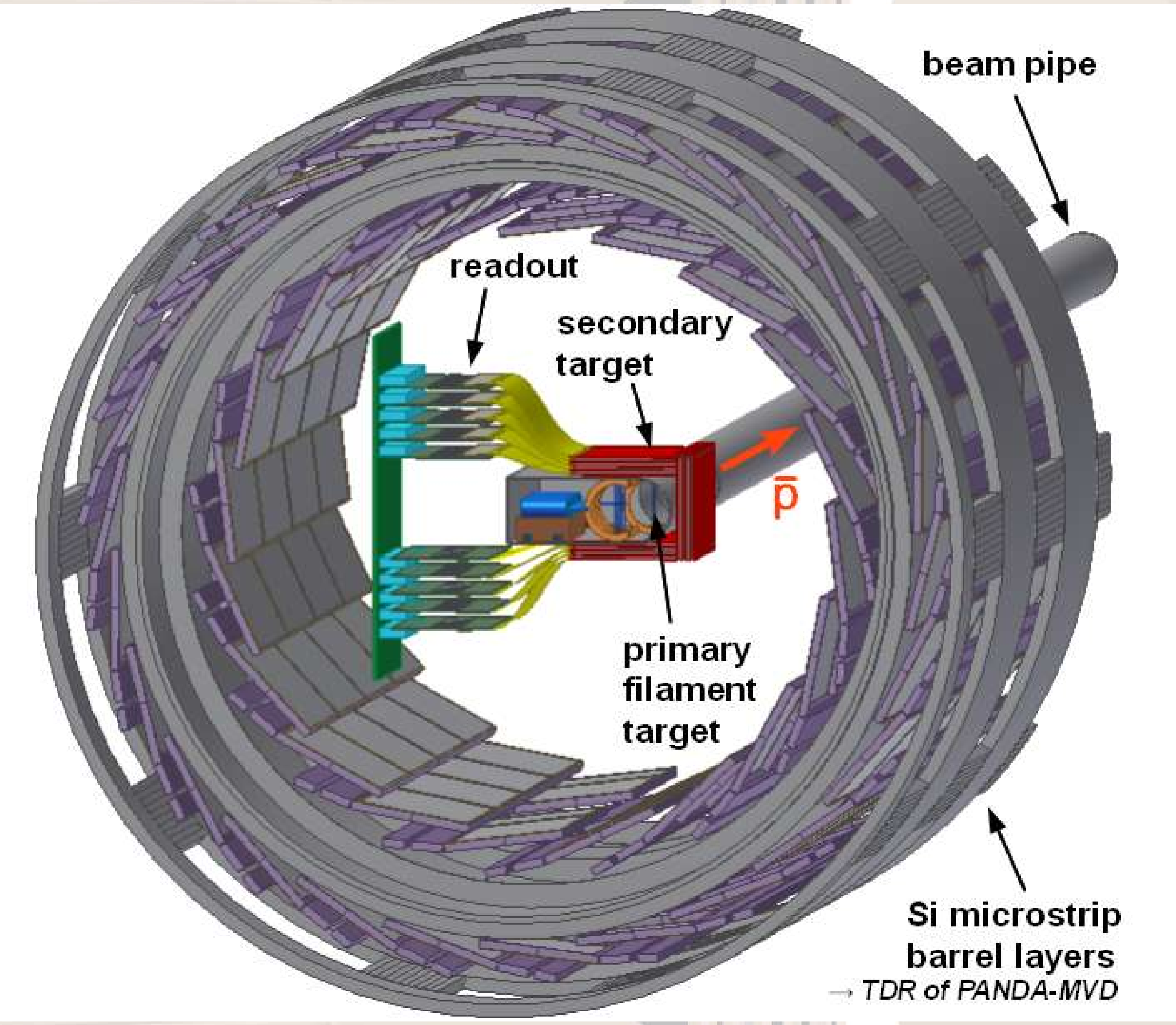
4 layers of absorbers (thickness 1 mm) different for each block (^{9}Be, ^{10,11}B or ^{12,13}C)

Pion tracking

Setup:

Outer detector layers will be needed for a better resolution of tracks of pions as weak decay products of double Λ hypernuclei

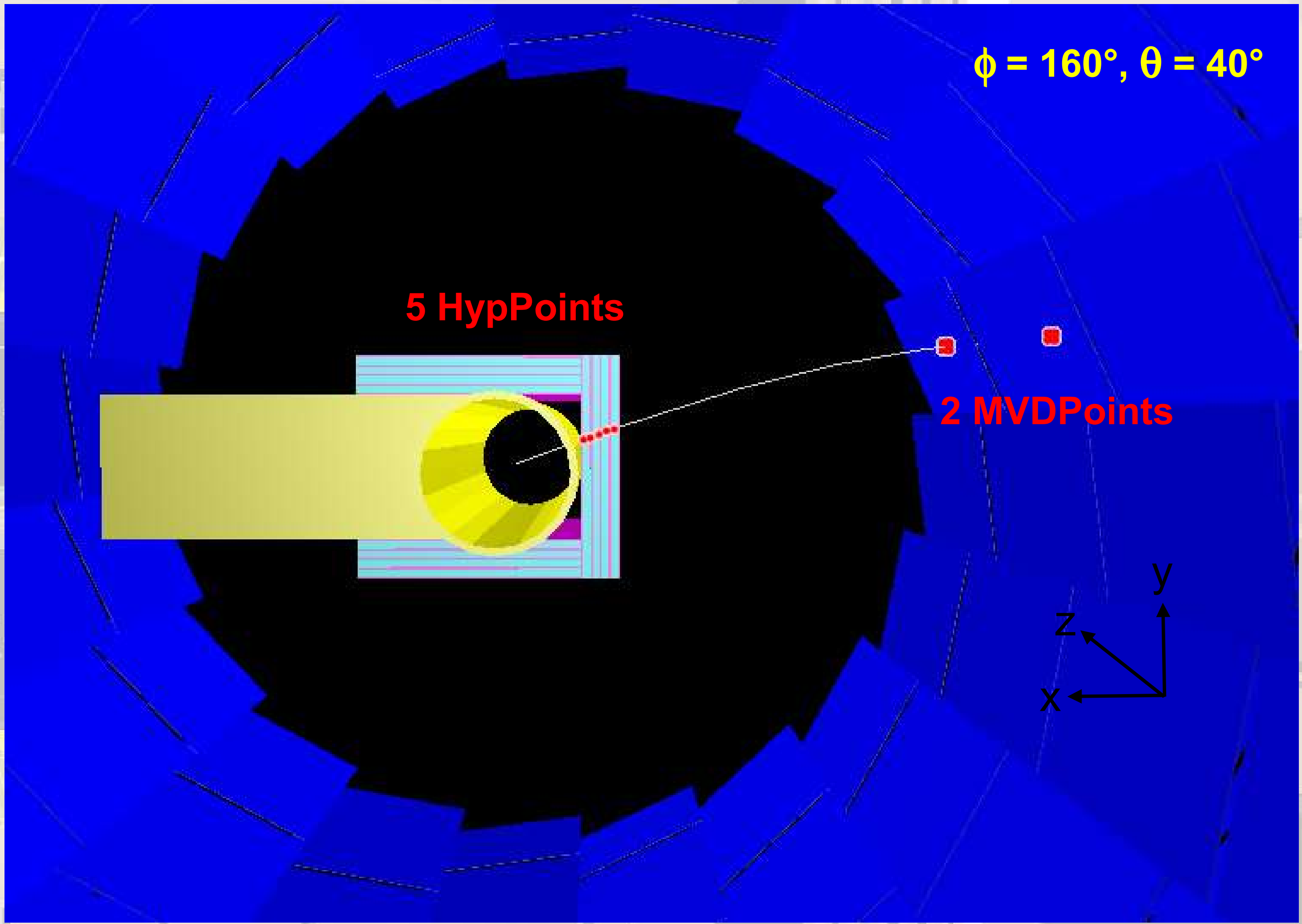
→ test of a copy of the MVD strip barrel layers



Pion tracking

MC Simulations:

- 100 MeV/c pions
- polar angle varied from θ = 40° - 140°
- starting point at the primary vertex



Event display of a pion from the primary vertex in a magnetic field of 0.5 T

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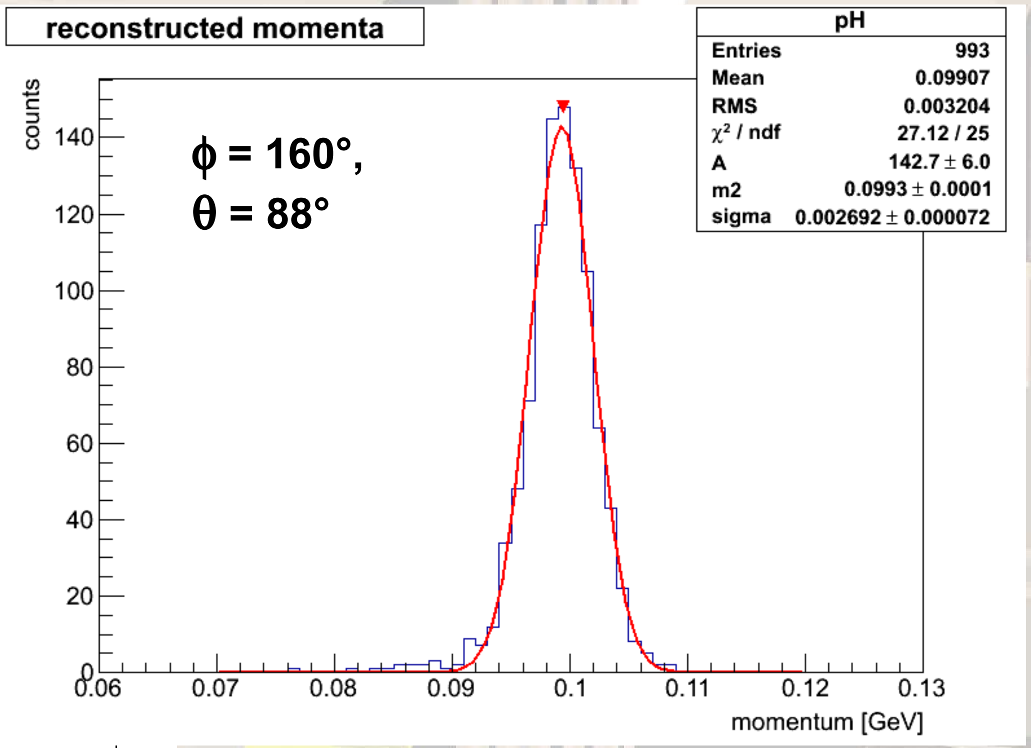
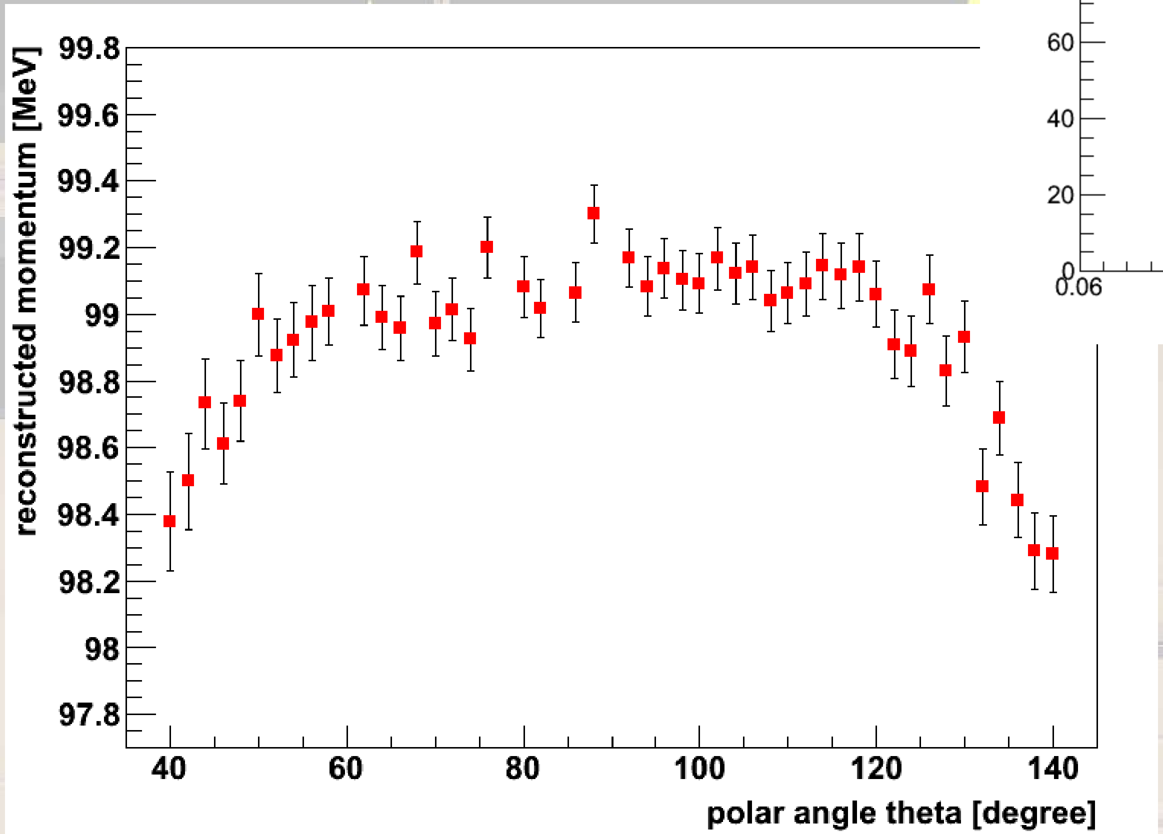
Pion tracking

1. **smearing of the points with spatial resolution**
2. **track finding and track fitting**
3. **momentum reconstruction**



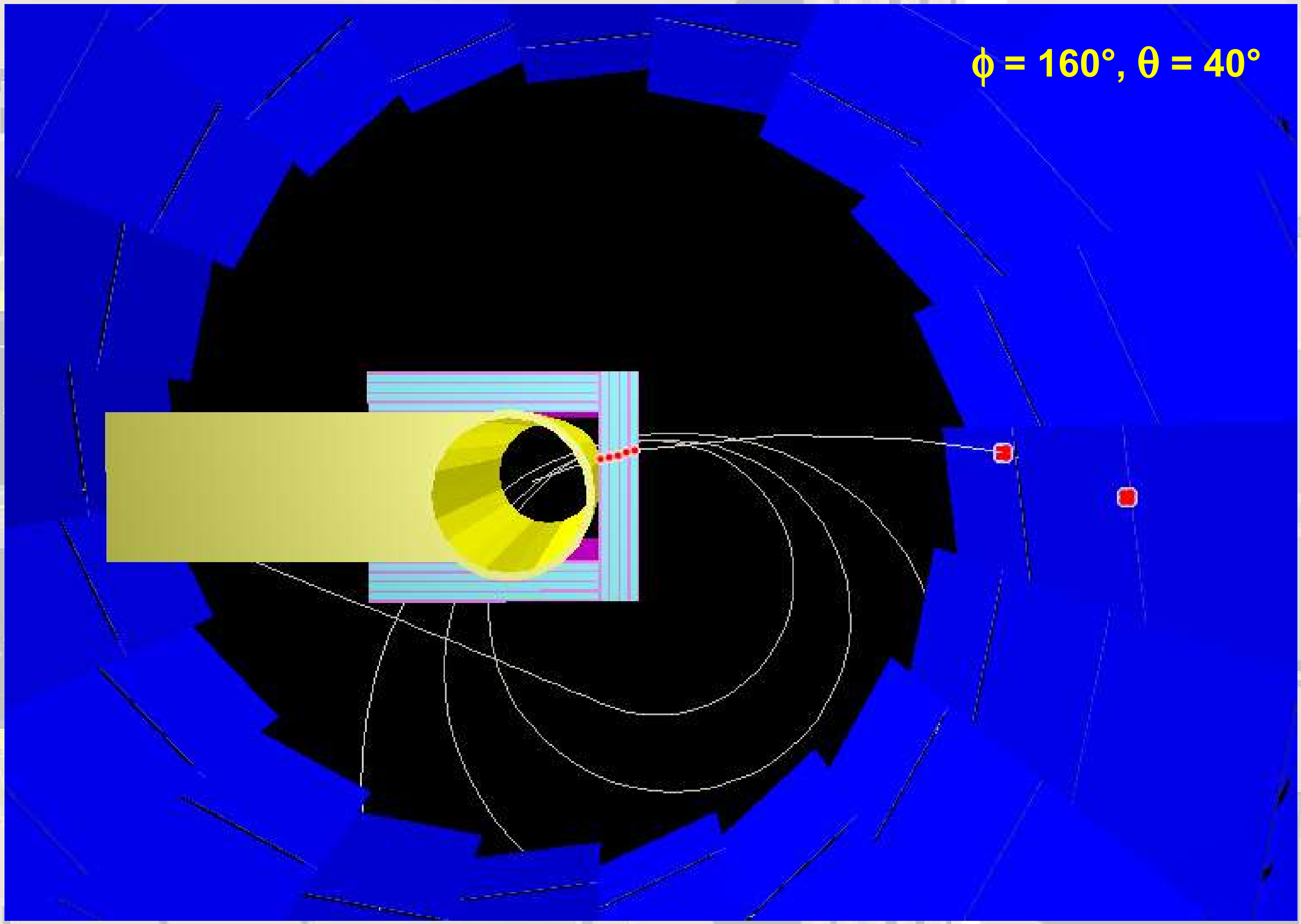


Pion tracking

1. Variation of the magnetic field:

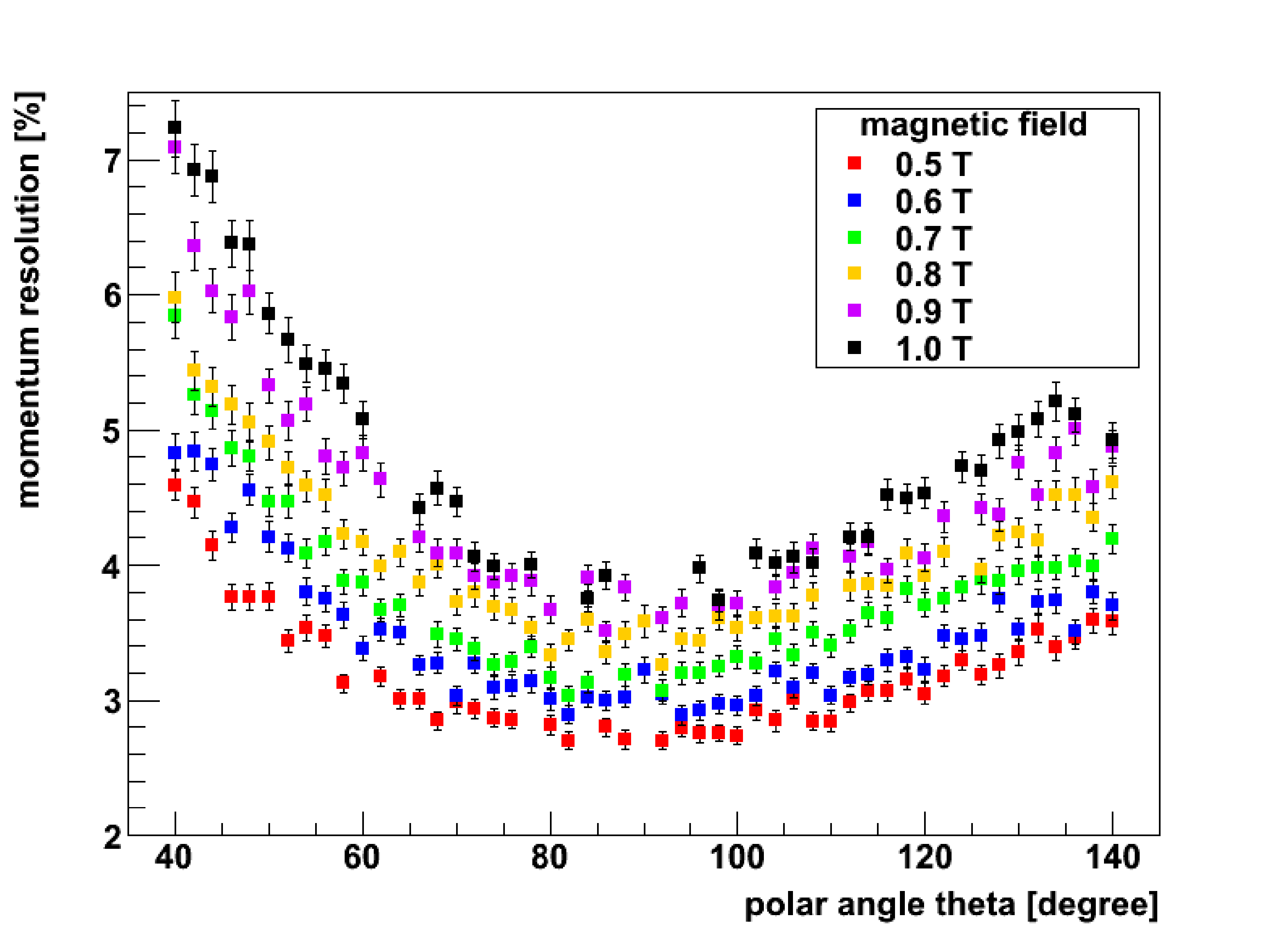
from
lower limit 0.5 T
to 1.0 T

ϕ = 160° fixed



Event display of a pion from the primary vertex in a magnetic field of 1.0 T

Pion tracking



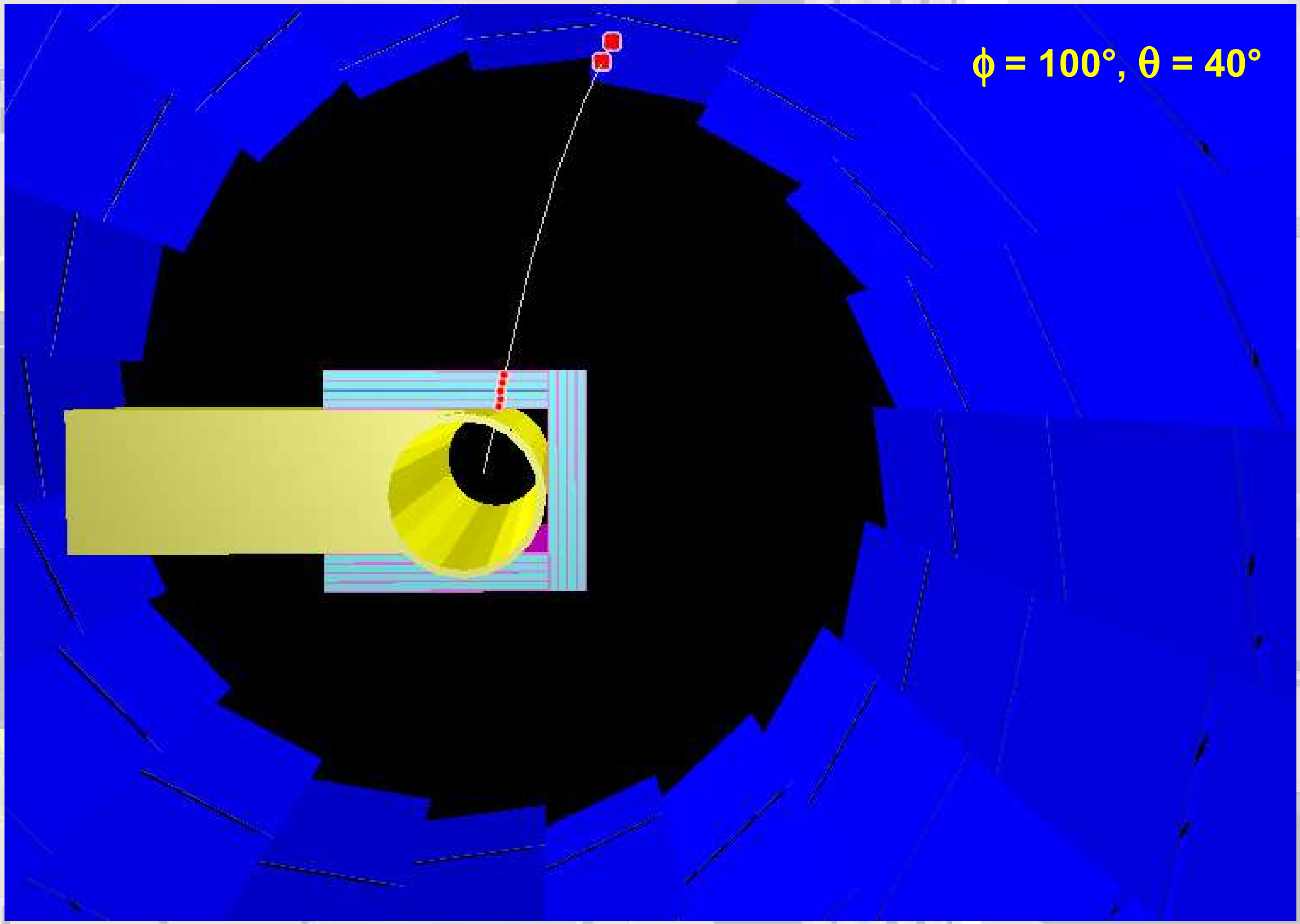
Pion tracking

2. Variation of the azimuth angle:

from

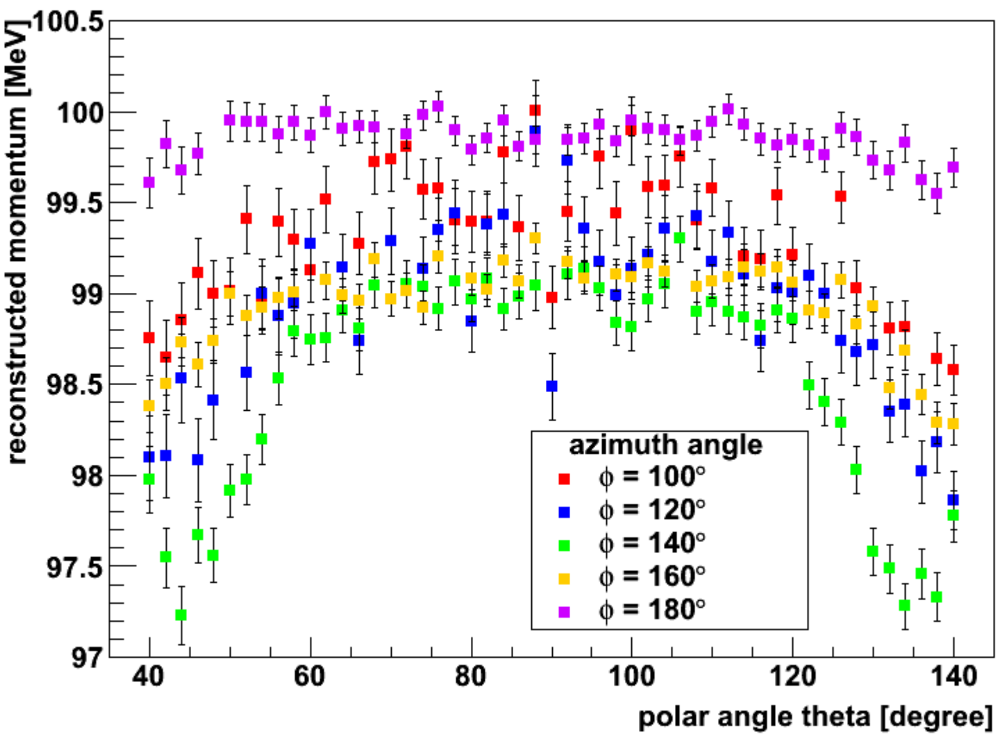
ϕ = 100° to 180°

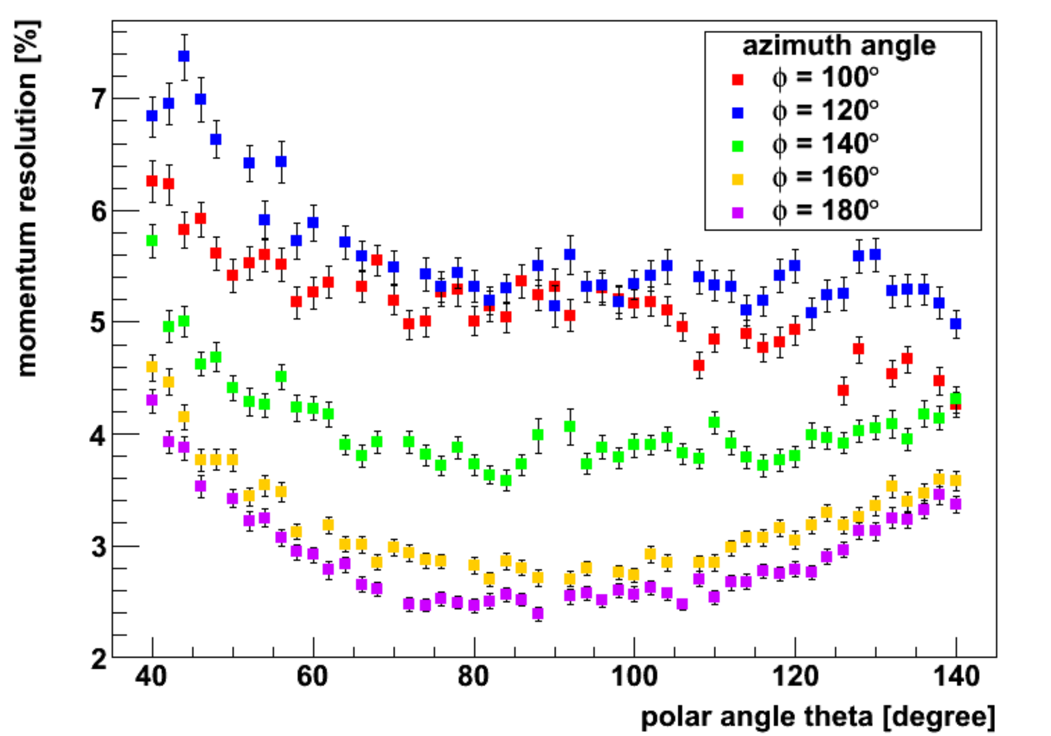
B = 0.5 T fixed



Event display of a pion from the primary vertex in a magnetic field of 0.5 T

Pion tracking





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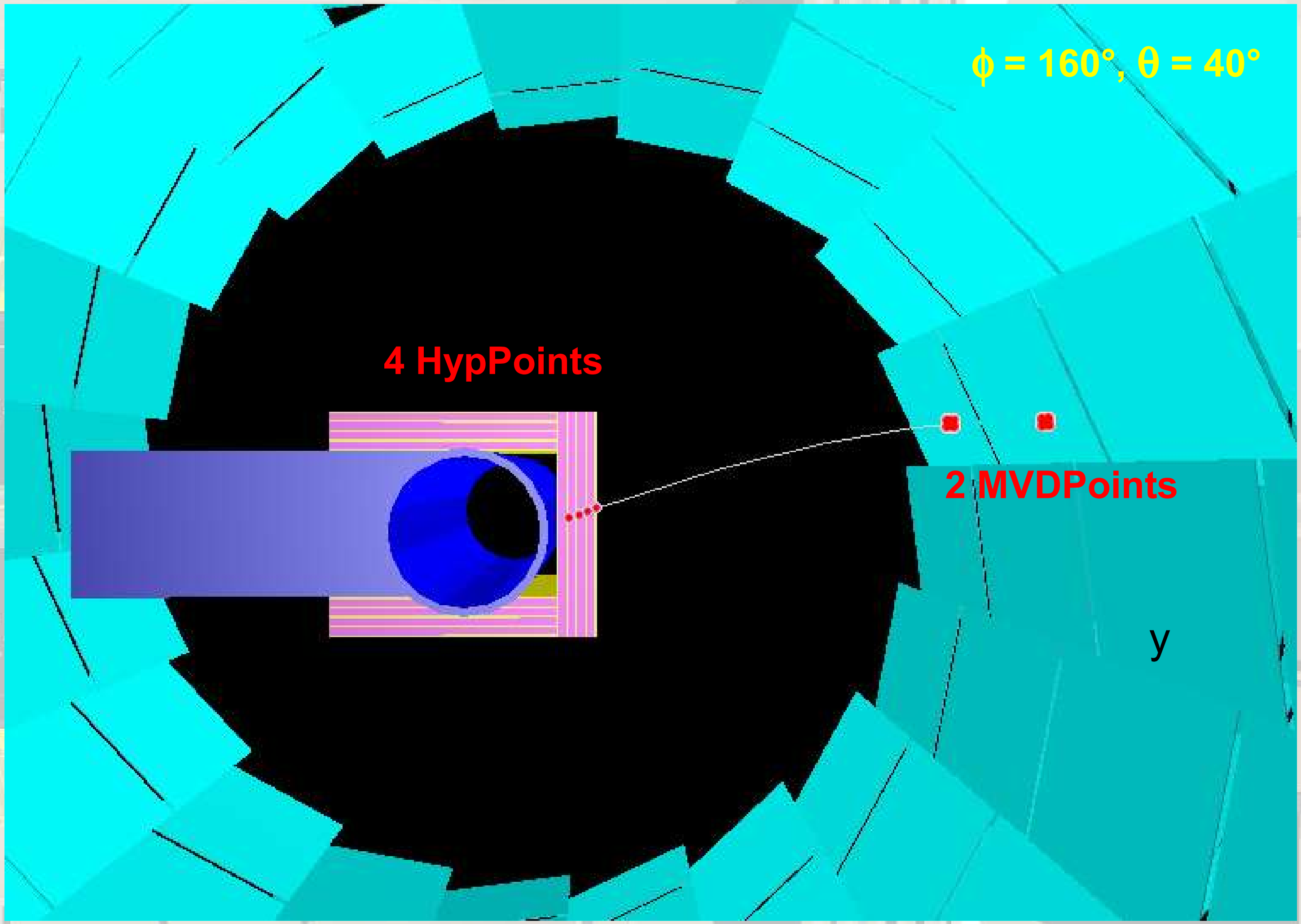
Pion tracking

3. More realistic situation:

   Starting point of pions in absorber layers

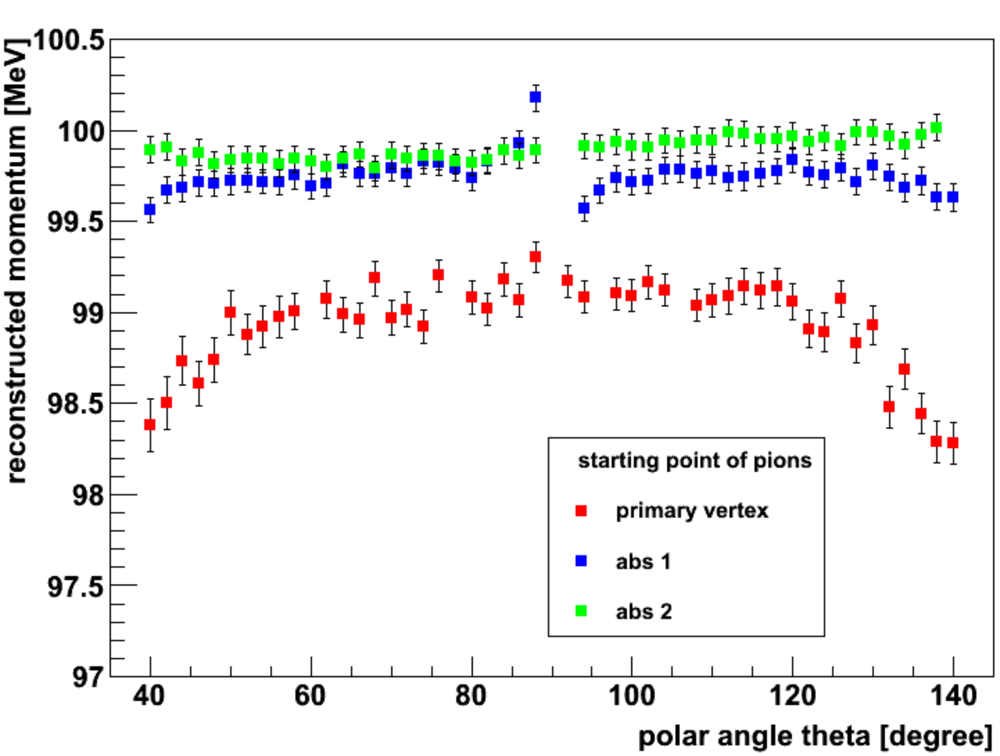
   ϕ = 160° and
   B = 0.5 T fixed

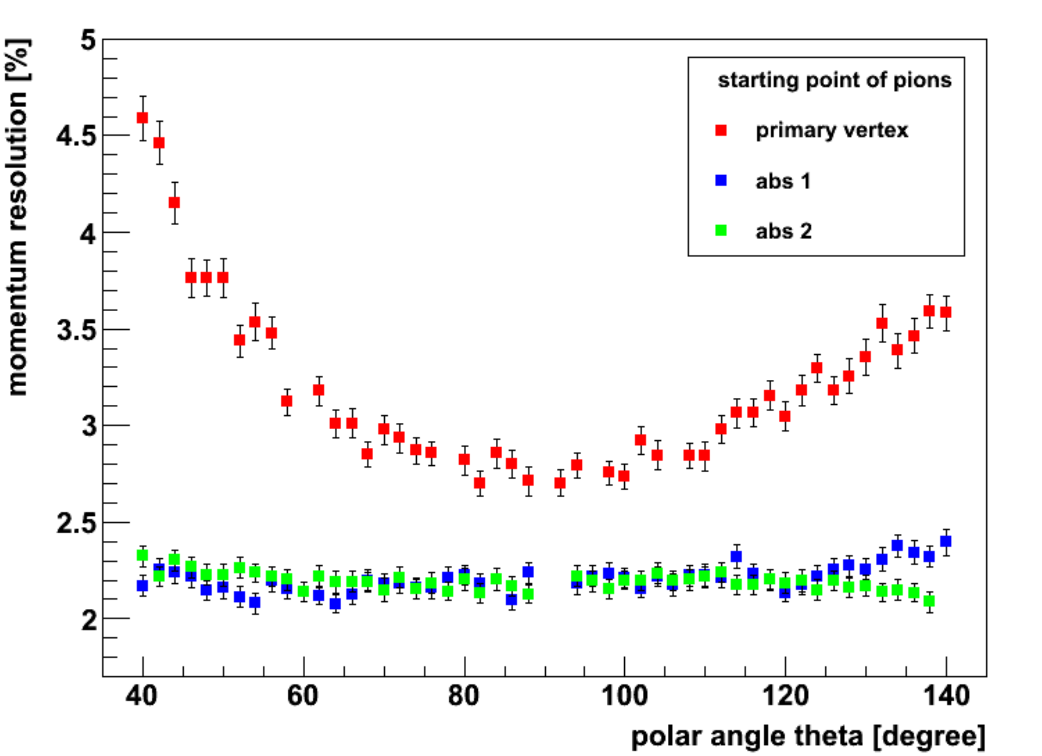
BoxGenerator modified
→ absorber layers
  define the origin



Event display of a pion from the first absorber layer in a magnetic field of 0.5 T

Pion tracking



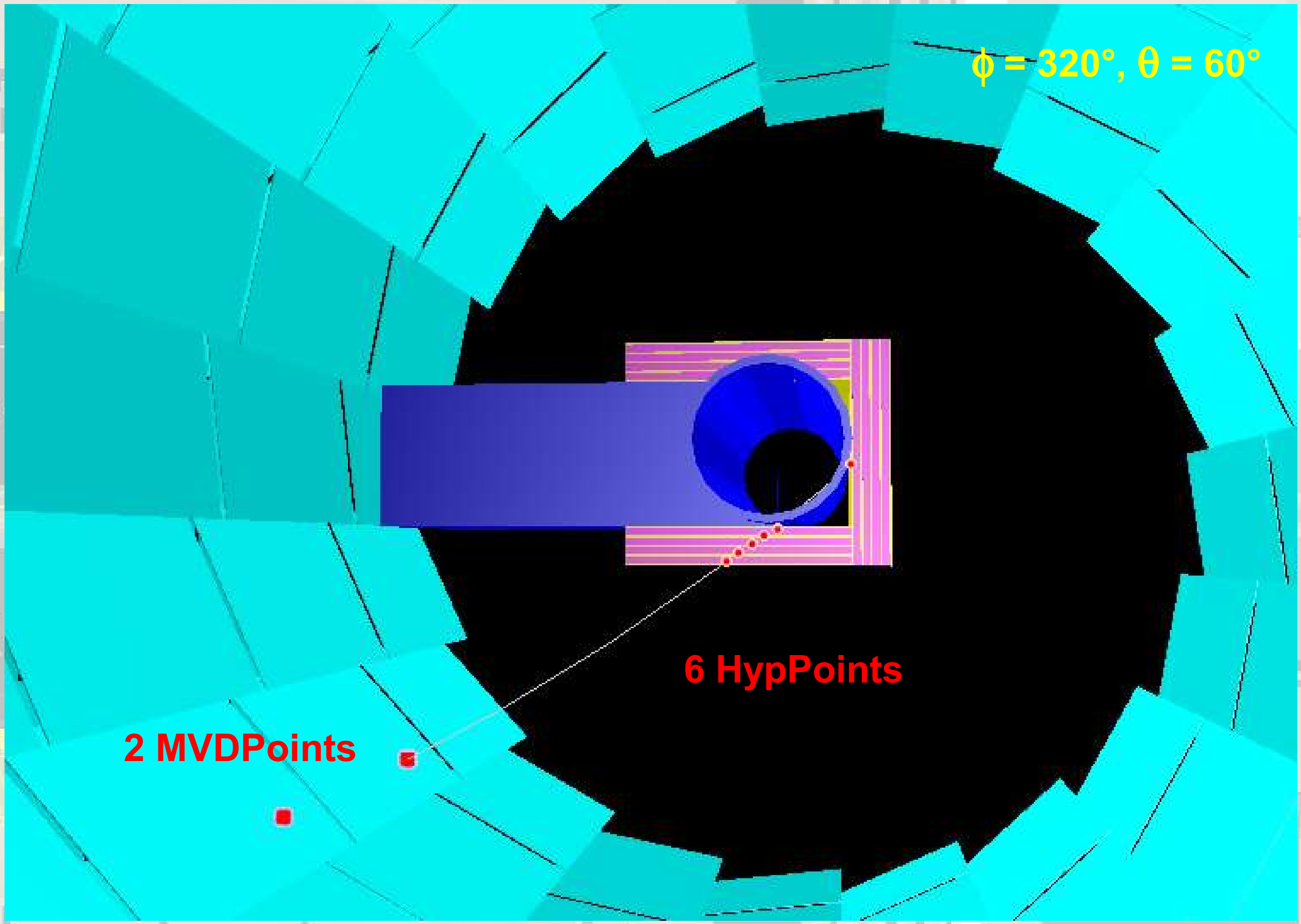


Pion tracking

3. More realistic situation:

   Starting point of pions in absorber layers

   ϕ = 320° and
   B = 0.5 T

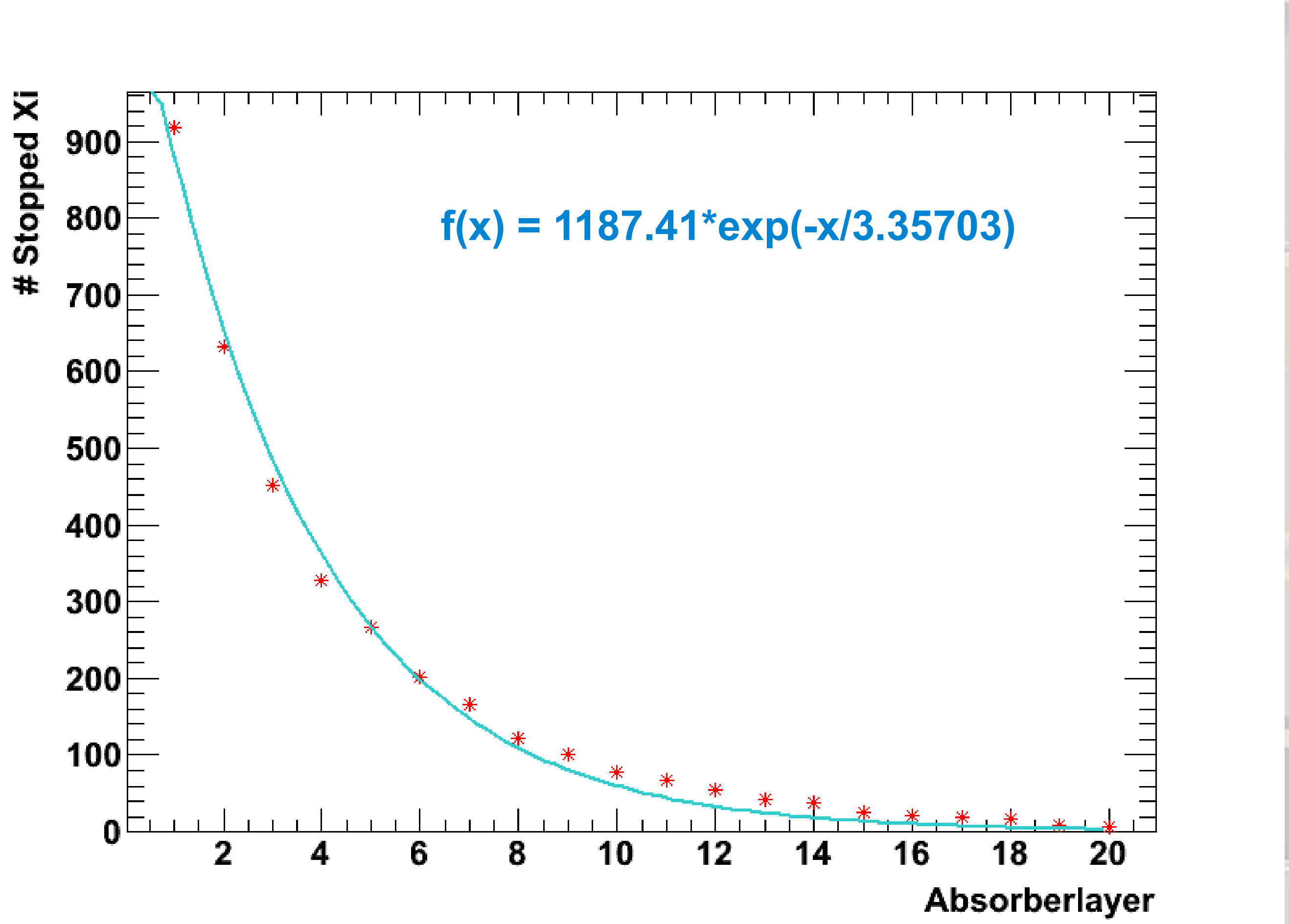


Event display of a pion from the first absorber layer in a magnetic field of 0.5 T

Pion tracking

Next step:

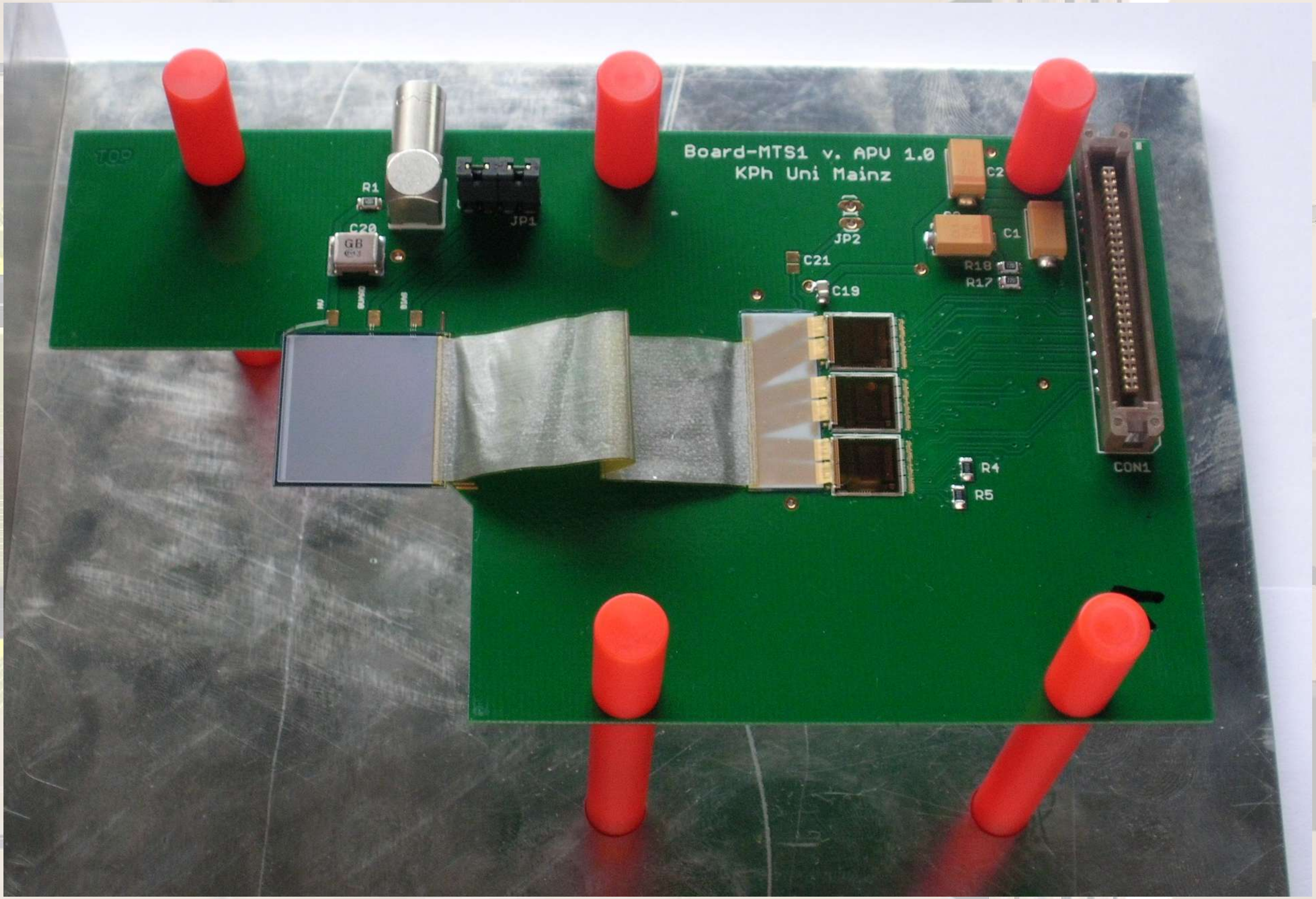
Combining the results of the stopping of Ξ^- in the absorber layers with the origin of pions for their tracking



Outlook

- test of piezo motors:
  use in vacuum, radiation hardness, reliability, …
- further development of the target chamber
- designing support structures
- development and simulations of the whole setup

Testboard for cables



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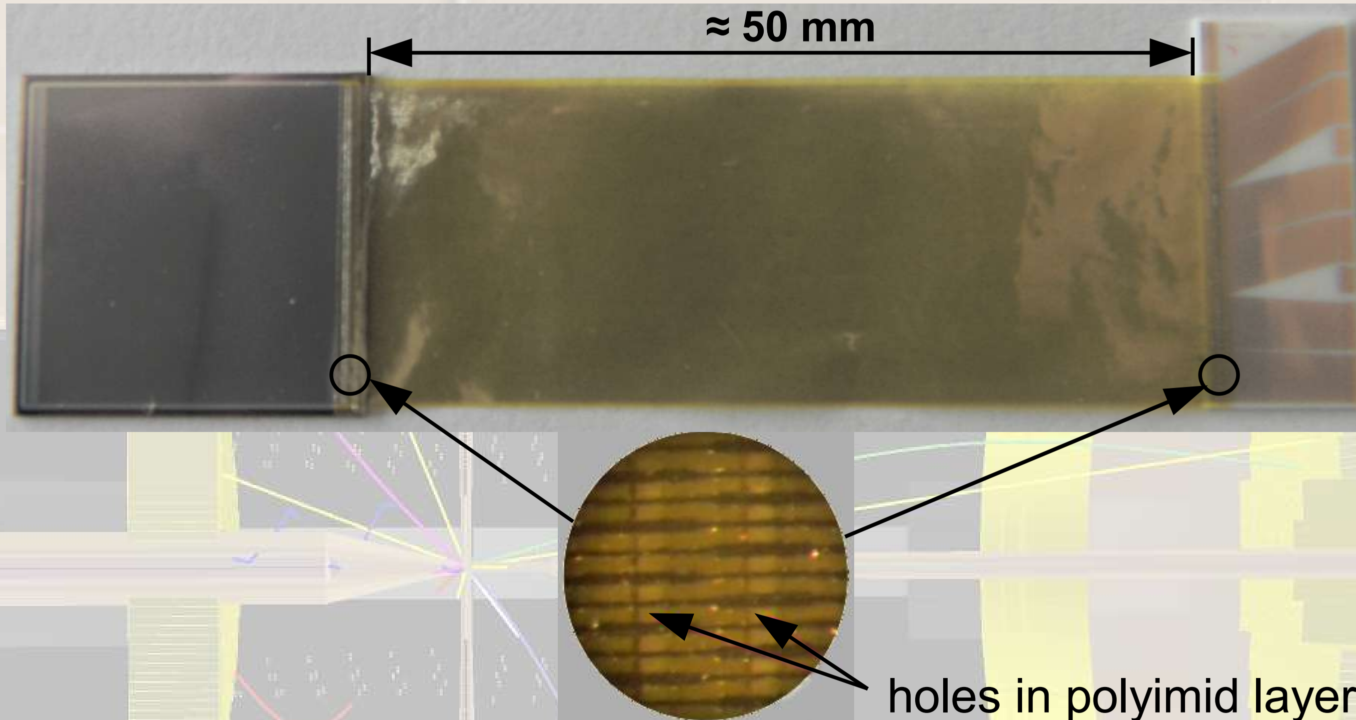
Ultra-thin flexible cables



Manufacturer of cables:

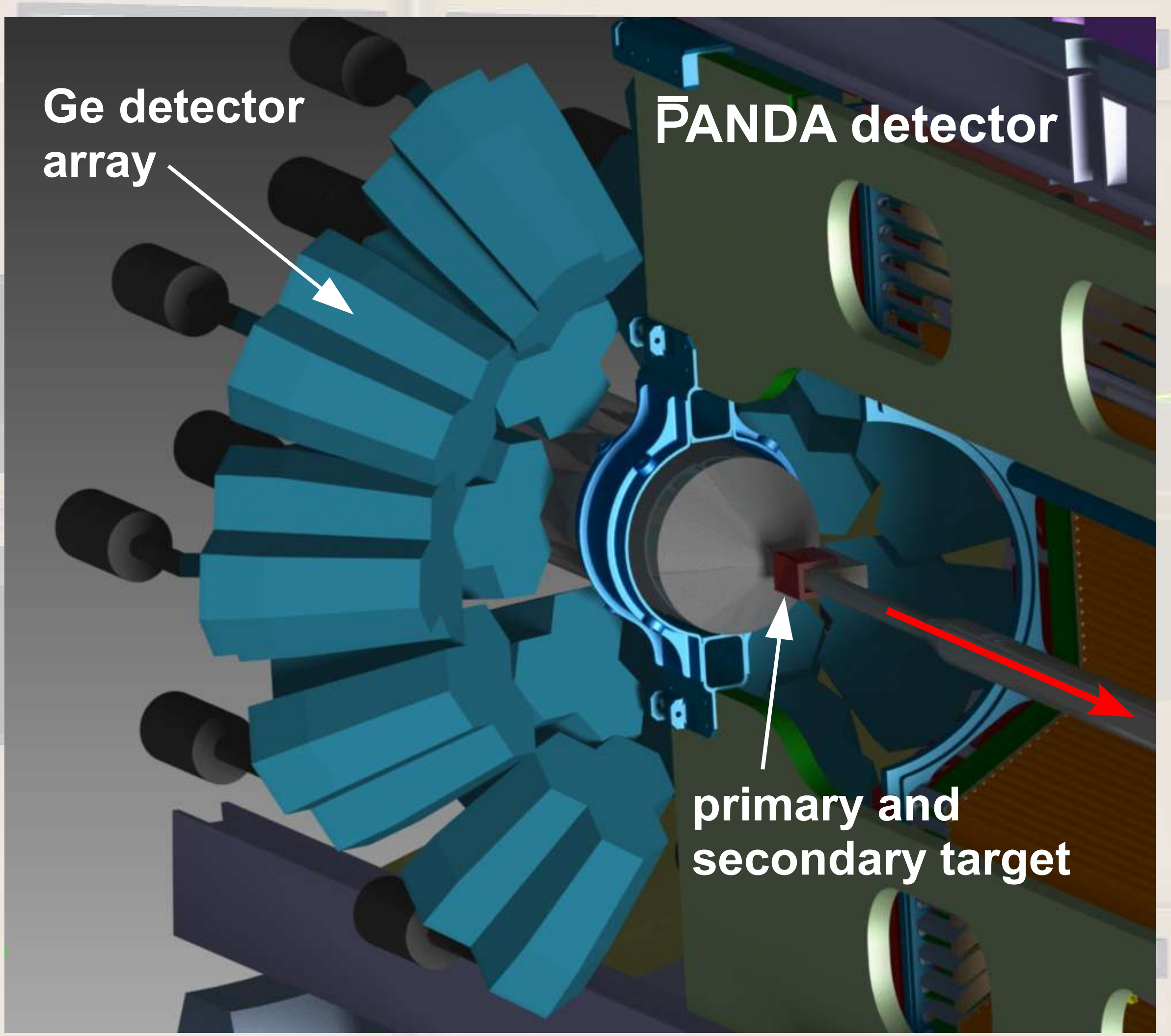
State Enterprise Scientific Research Technological Institute of Instrument Engineering (Ukraine)

material: “foiled dielectric“ FDI-A-20

- 10µm aluminium layer
- 10µm polyimide layer

⇒ very low material budget: ≈ 99.75% of 1 MeV photons pass 10 cables

Hypernuclear setup

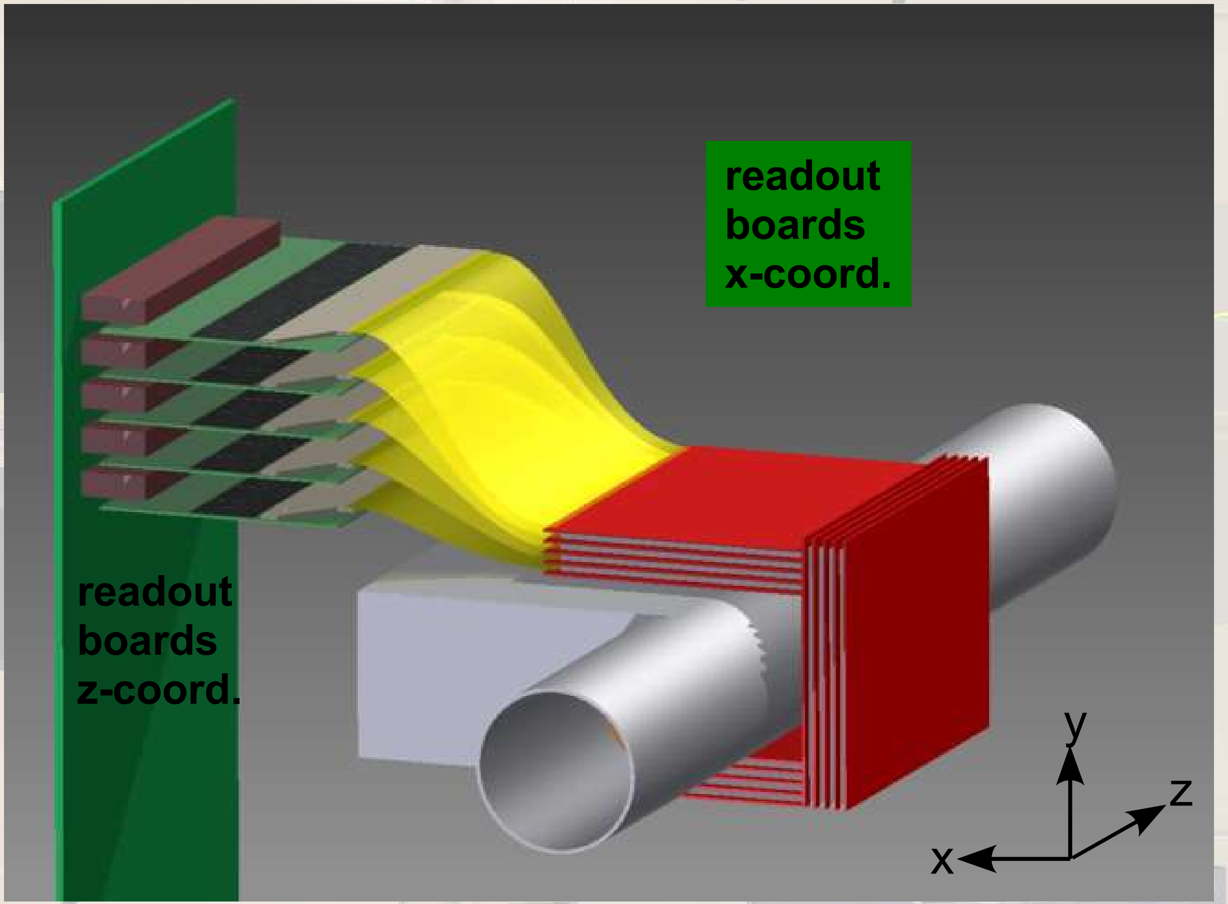


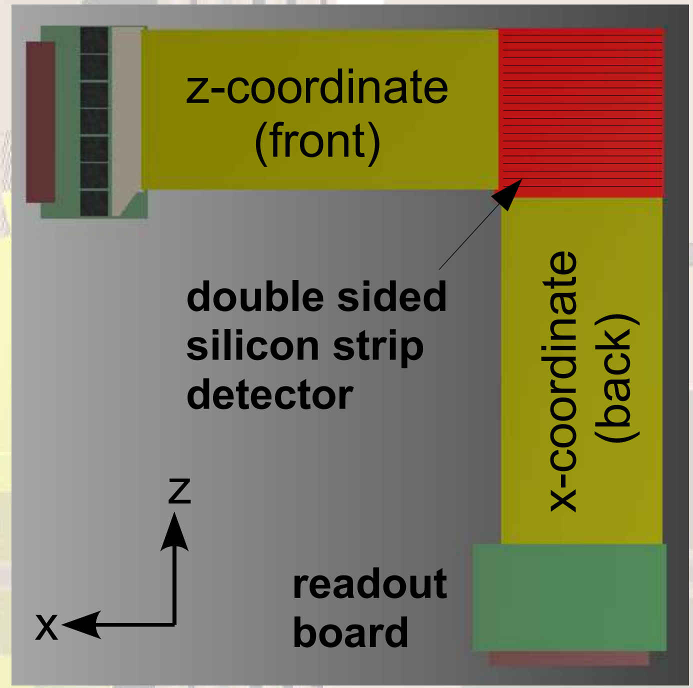
- photons from excited double hypernuclei emitted isotropically
- high particle flux in forward direction

⇒ arrangement of Germanium detector array in backward direction

Readout of the secondary target

tiny compact structure and high irradiation
⇒ fan out the readout electronics





Readout of double sided silicon strip detectors:

Sensor and readout boards connected by ultra thin microcables via TAB bonding (Tape Automated Bonding)

Readout boards hosting pitch adapter, frontend chips and connector