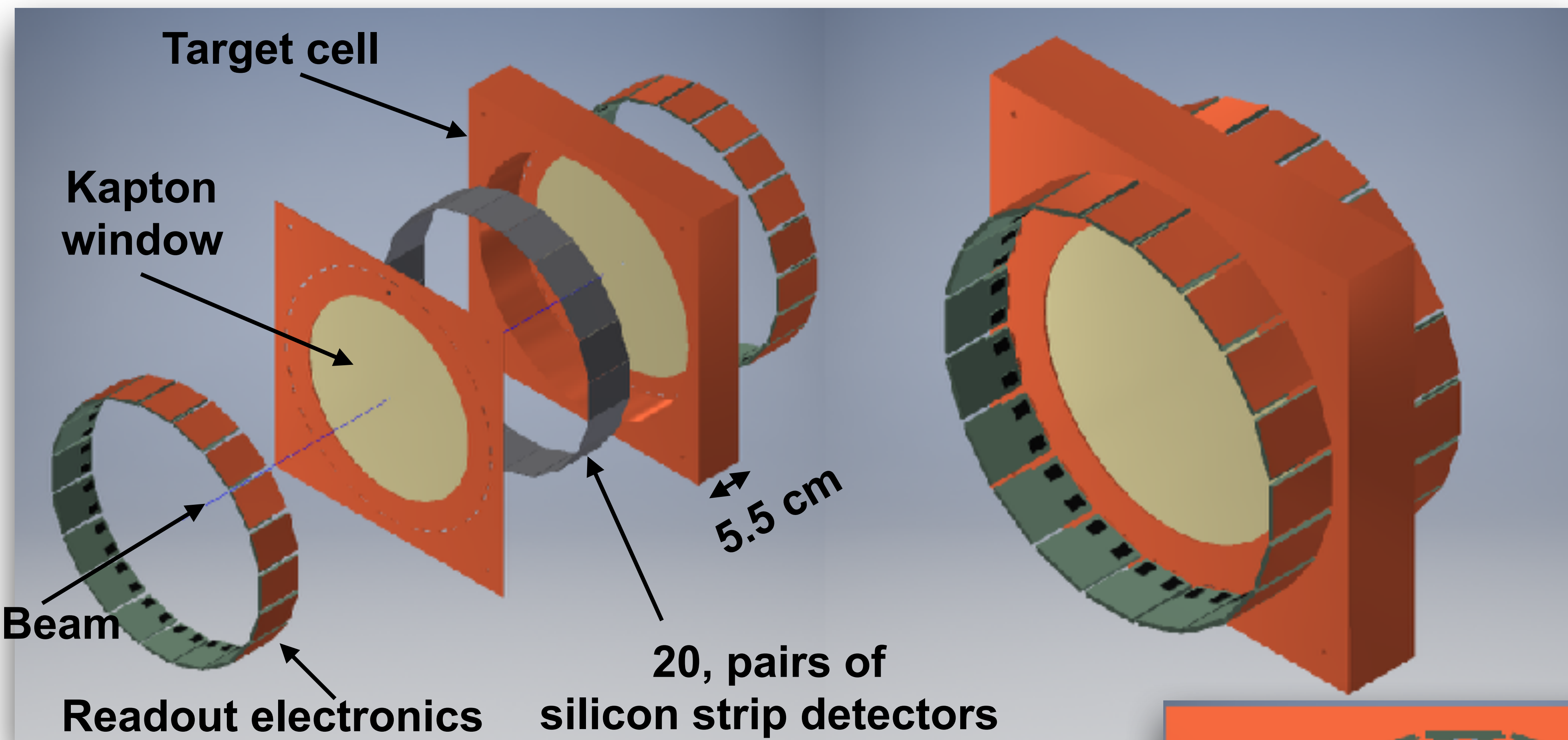
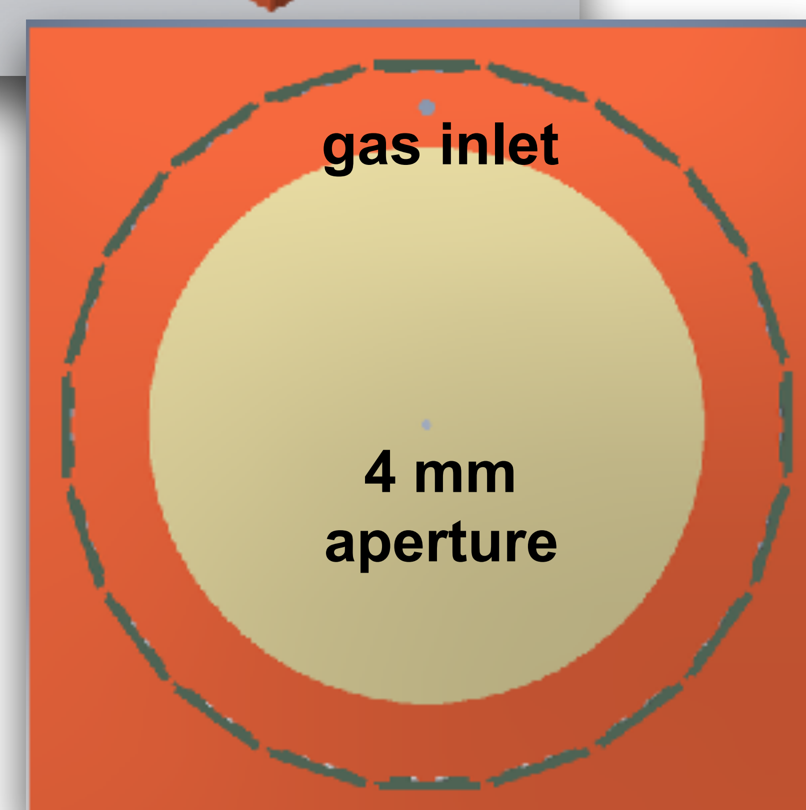
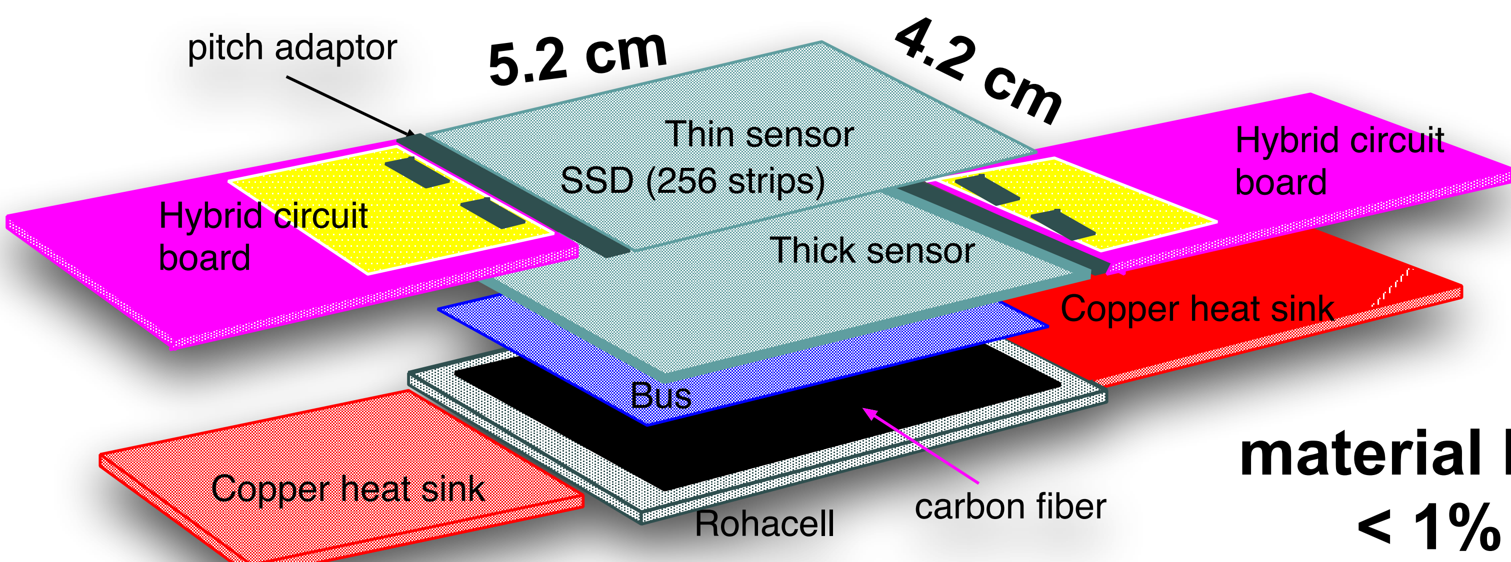
The Recoil Detector Calibration

Windowless Target and Recoil Detector





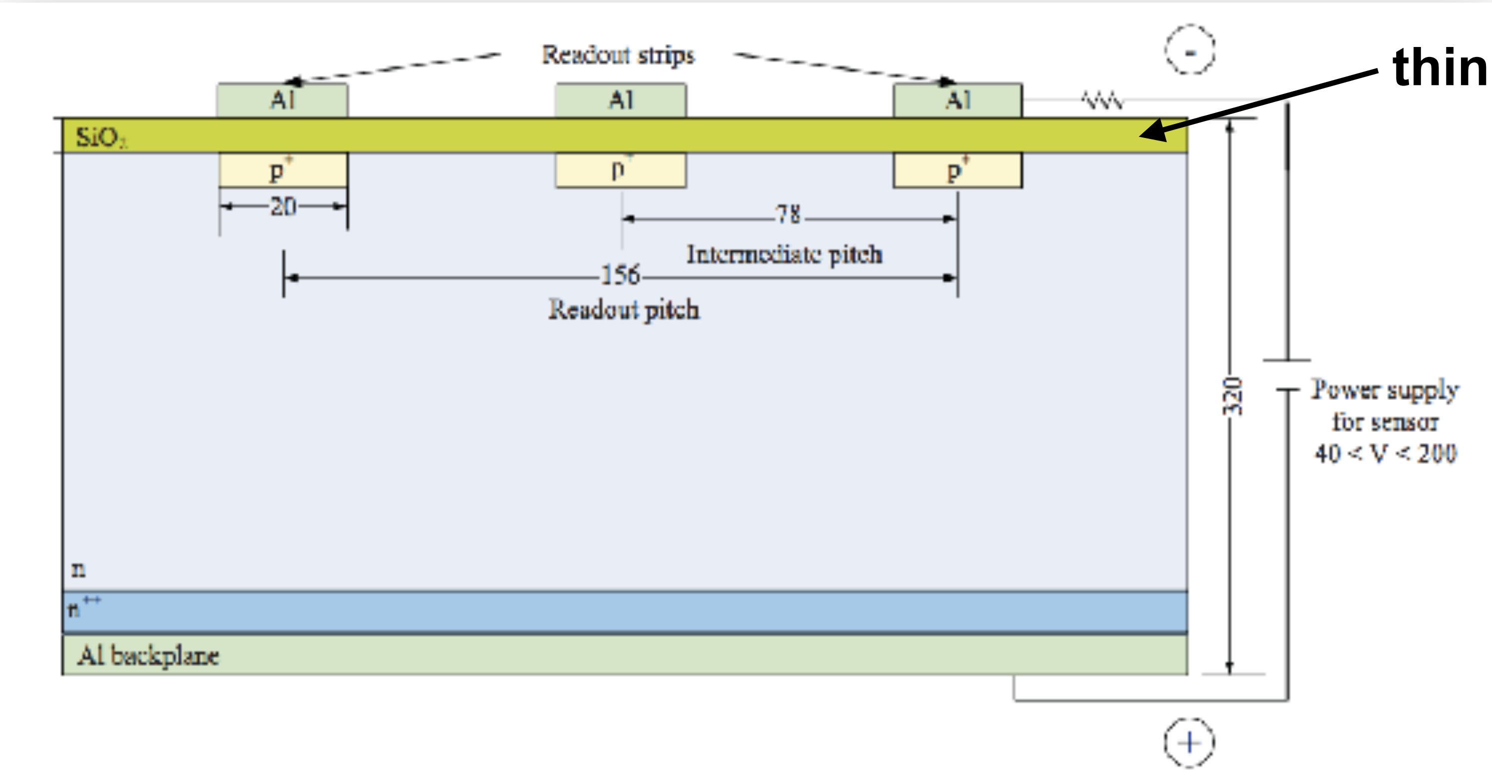
Front view



a single pair of
silicon strip detectors

material budget
< 1% r.l.

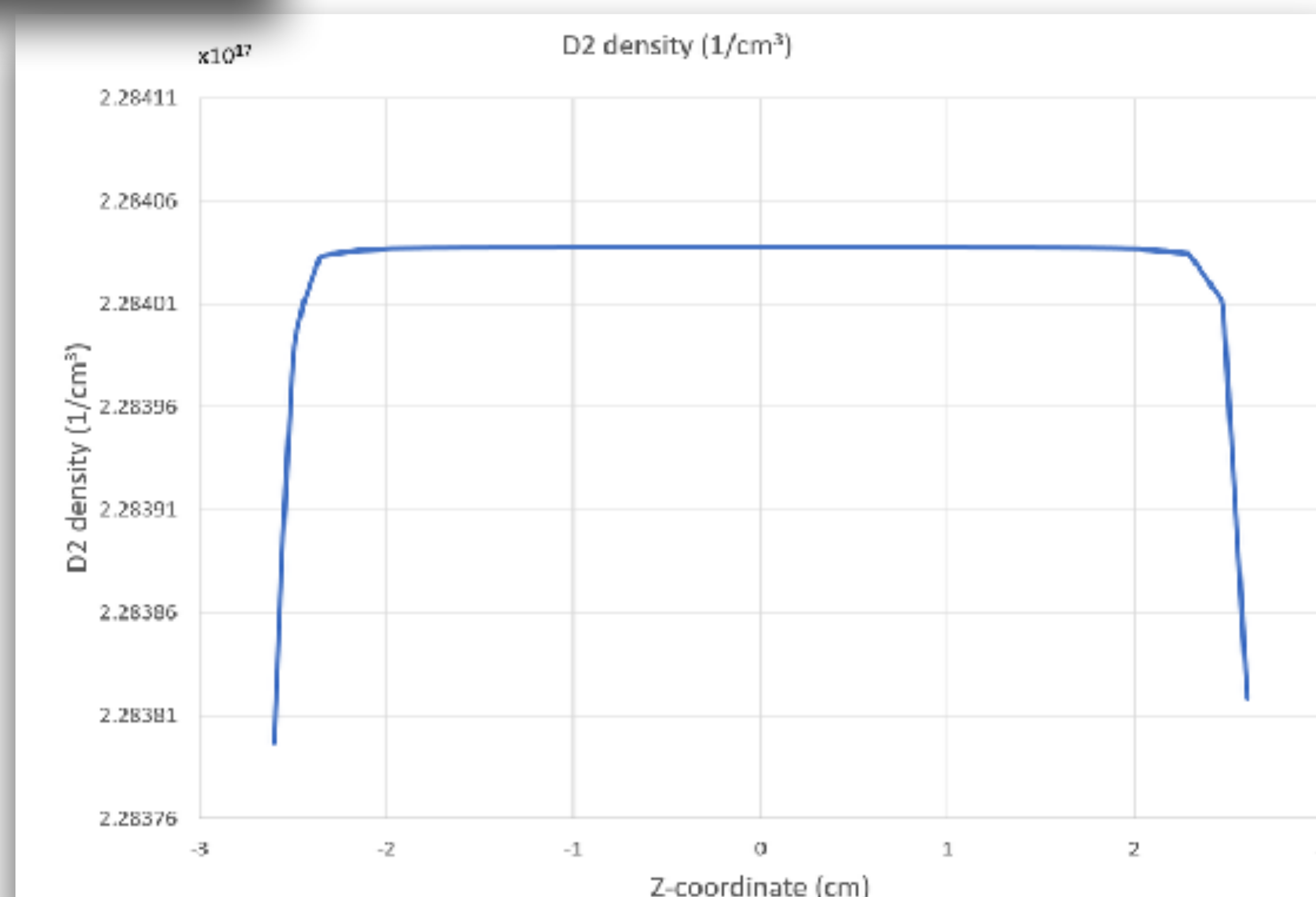
Windowless Target and Recoil Detector



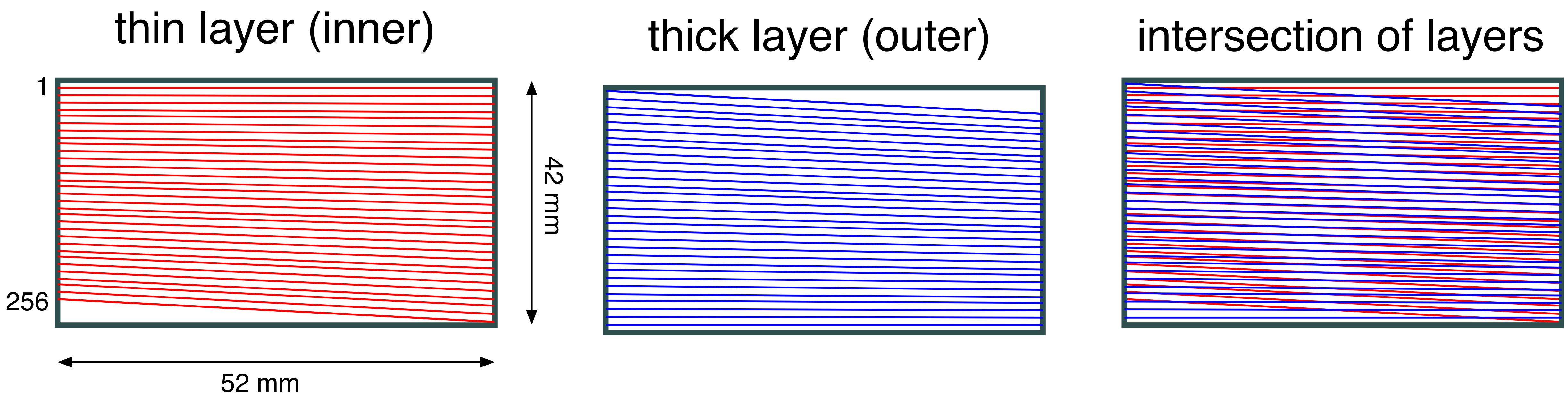
thin SiO_2 “passivation” layer

Cross section of silicon strip detector

Target density profile along z



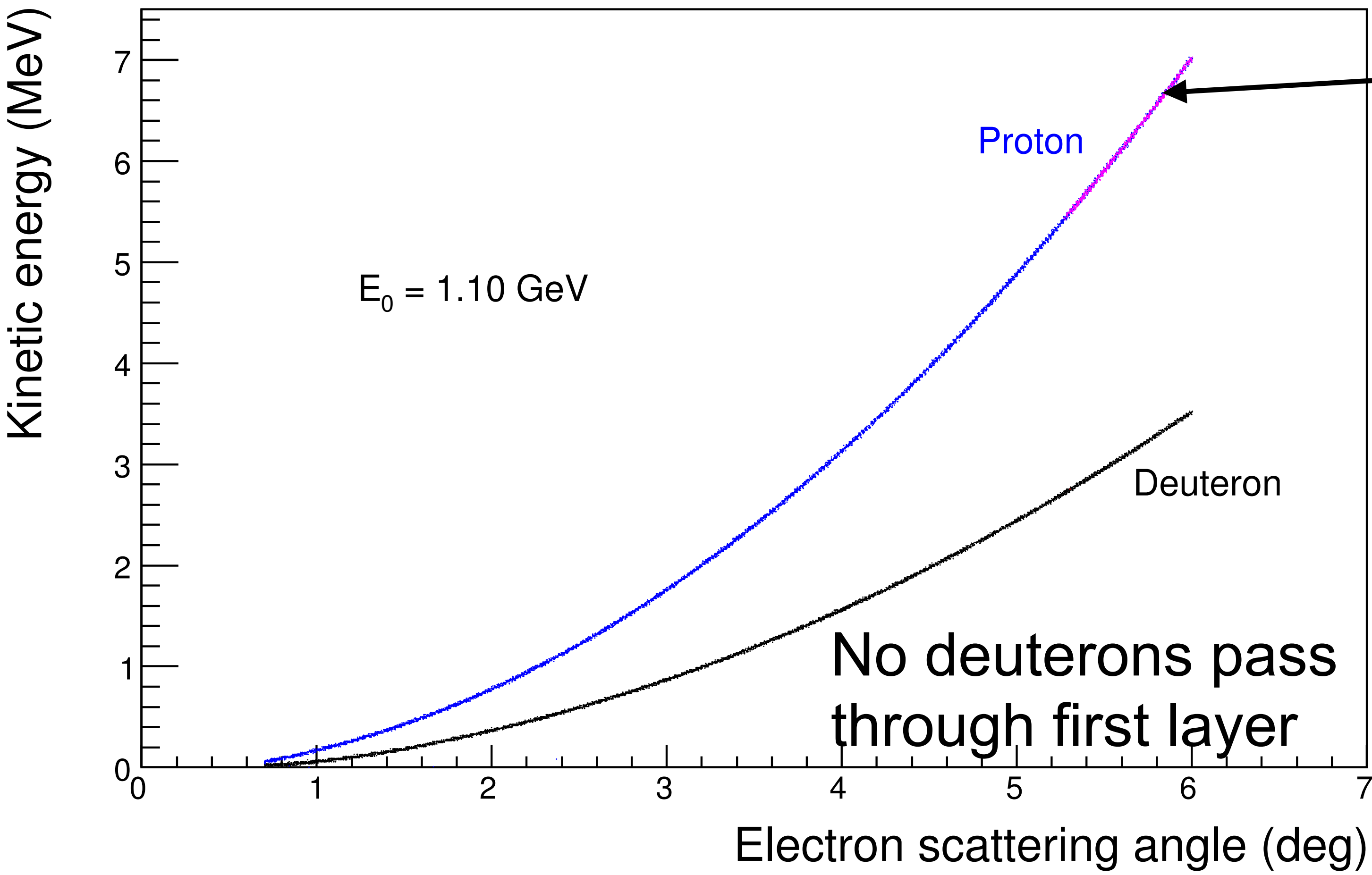
Strip Pattern



256 strips with linearly varying angles of 0 - 3 deg to minimizes dead zones. The strips will have a constant pitch of ~200 m (~1/85 deg^{-1}). The angular resolution of $\delta\varphi \lesssim 5$ mrad and $\delta\theta \lesssim 10$-20 mrad.

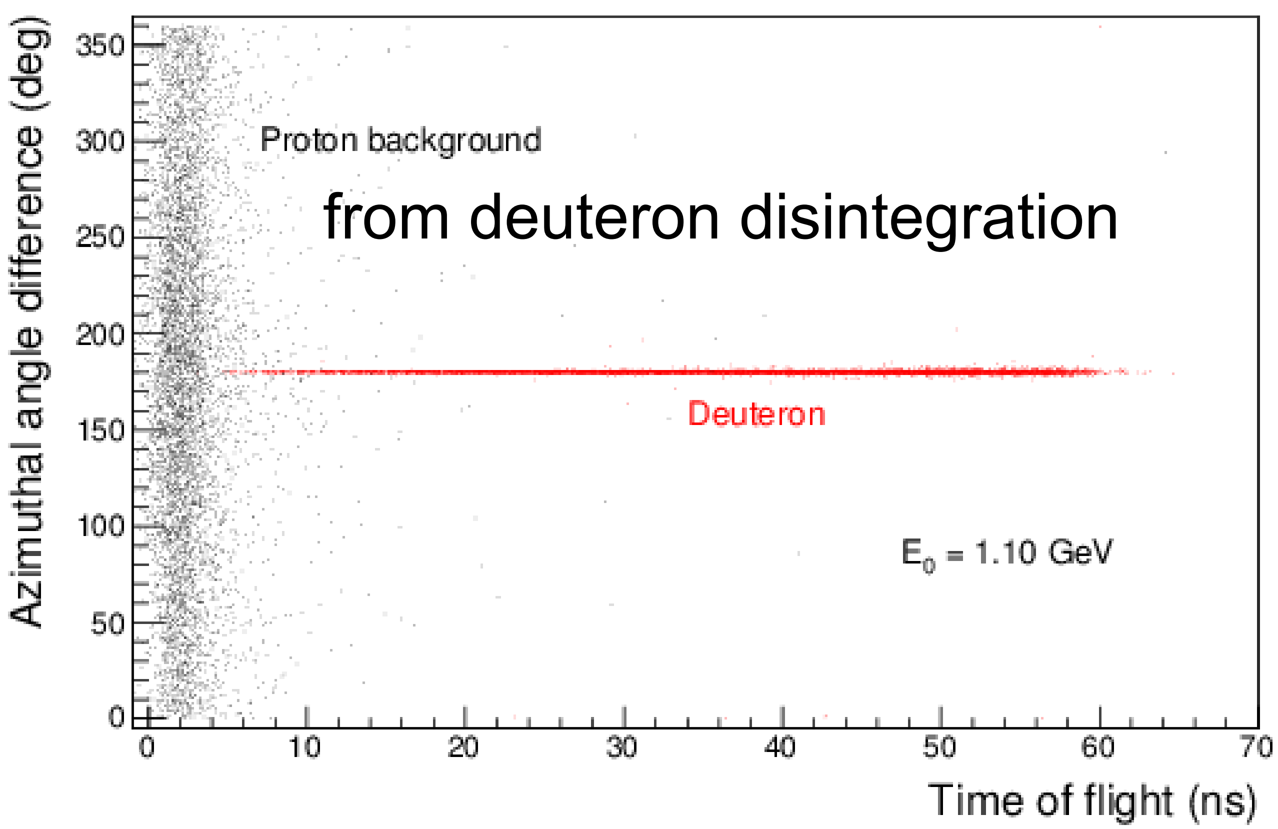
The readout system is identical to the one used by the SVD in CLAS12 and we expect to use electronics from the spare planes of the BST.
The readout is build on FSSR2 ASIC developed and Fermilab.
Each channel of 128 input channel of the FSSR2 chip has a preamplifier, a shaper with adjustable shaping time (50 - 125 ns), a baseline restorer, and a 3-bit ADC.

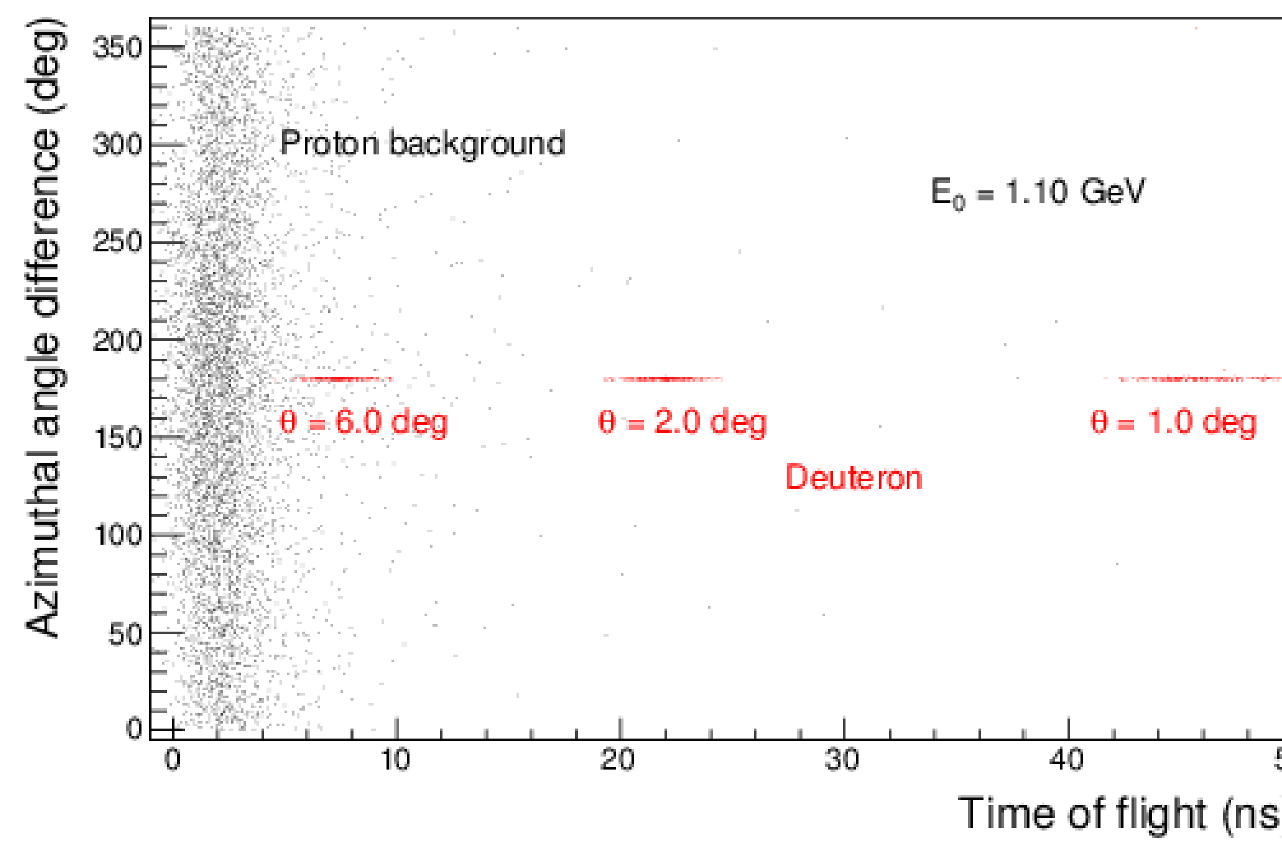
PID @ 1.1 GeV



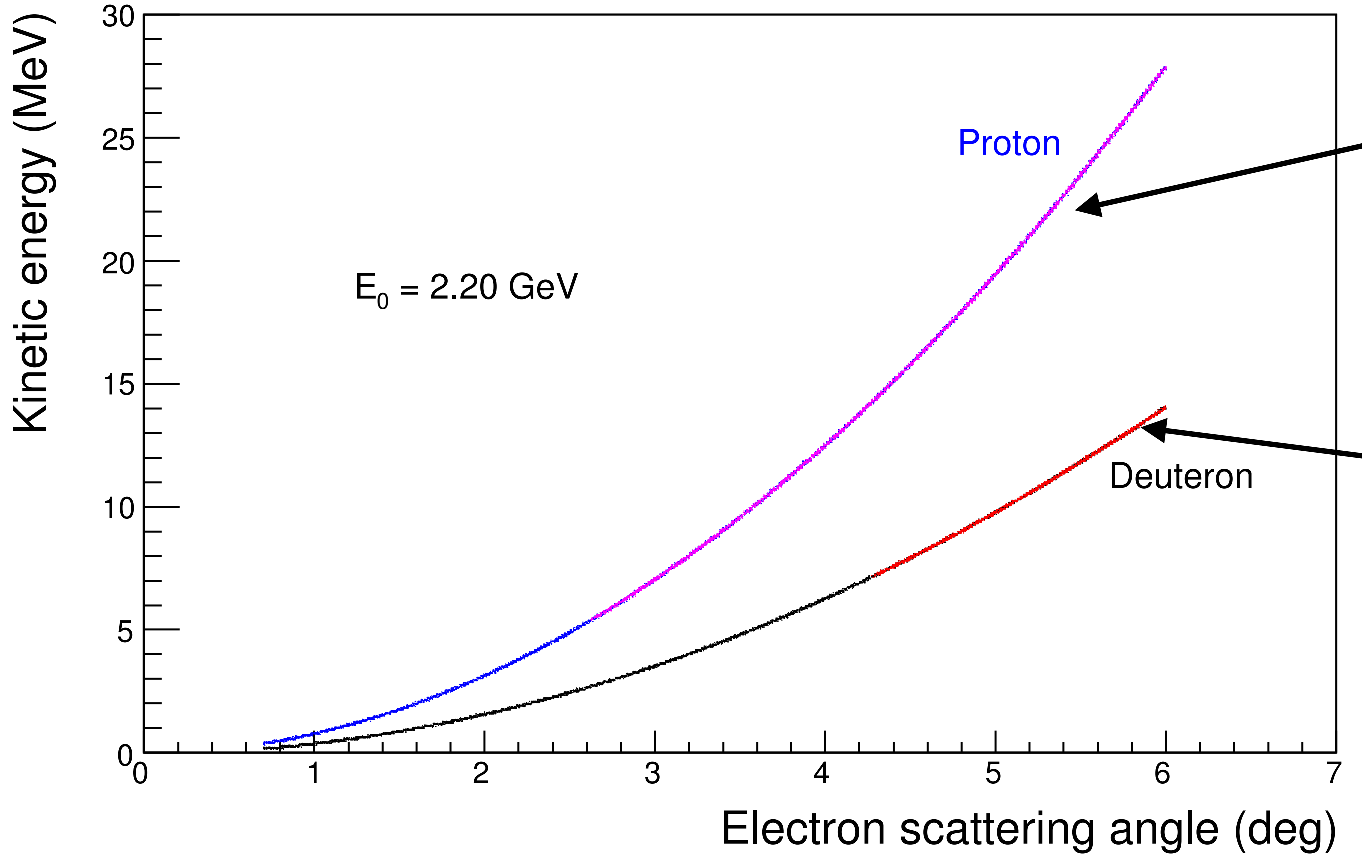
Protons that pass through first layer

For large part of 1.1 GeV the deuterons do not disintegrate, but you still need to detect the deuteron.





PID @ 2.2 GeV

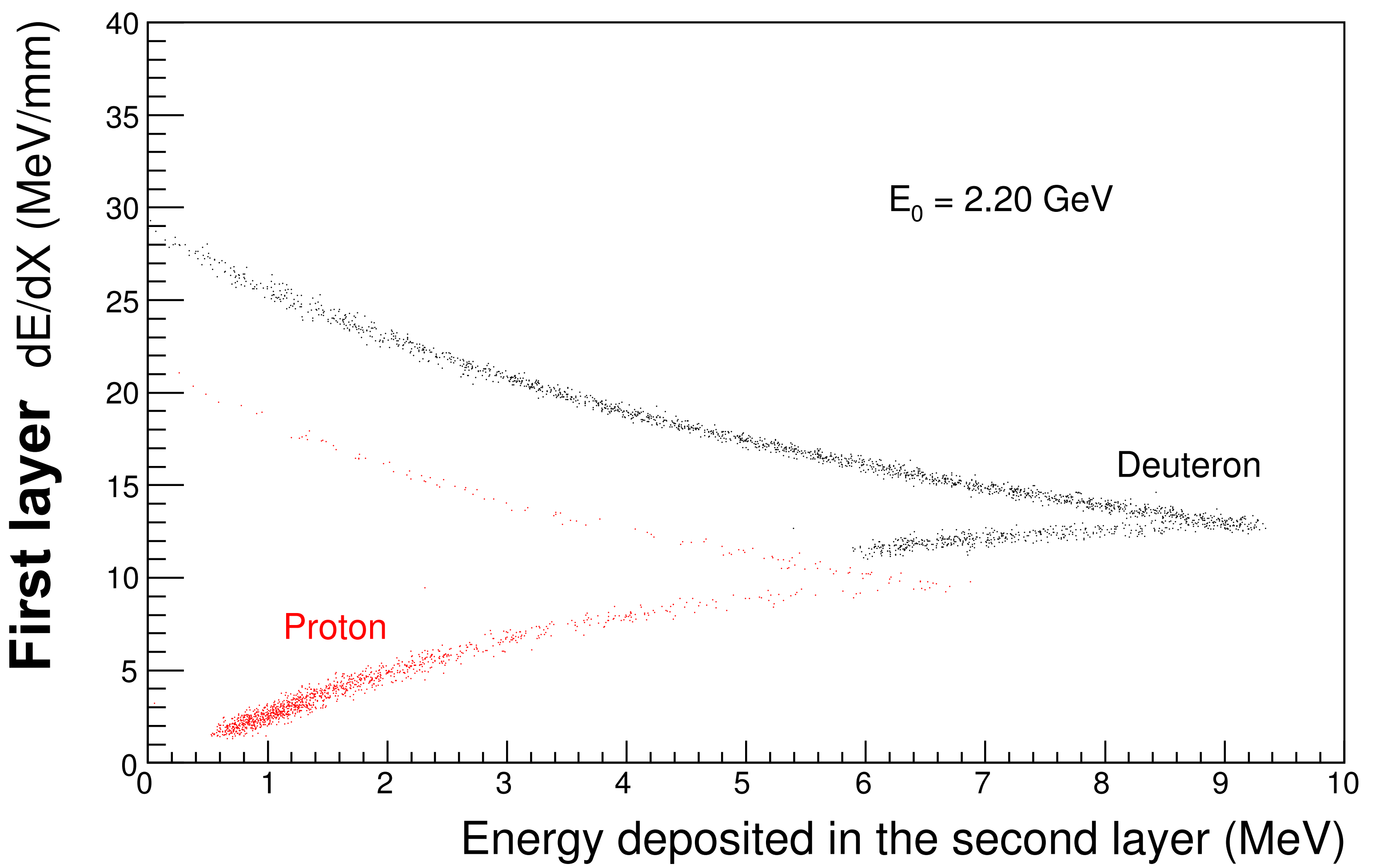


Protons that pass through first layer

Deuterons that pass through first layer

$\Delta\varphi$ vs TOF

will also be used



For large part of 1.1 GeV the deuterons do not disintegrate, but you still need to detect the deuteron. We simulated eD and quasi-elastic scattering to examine this issue.

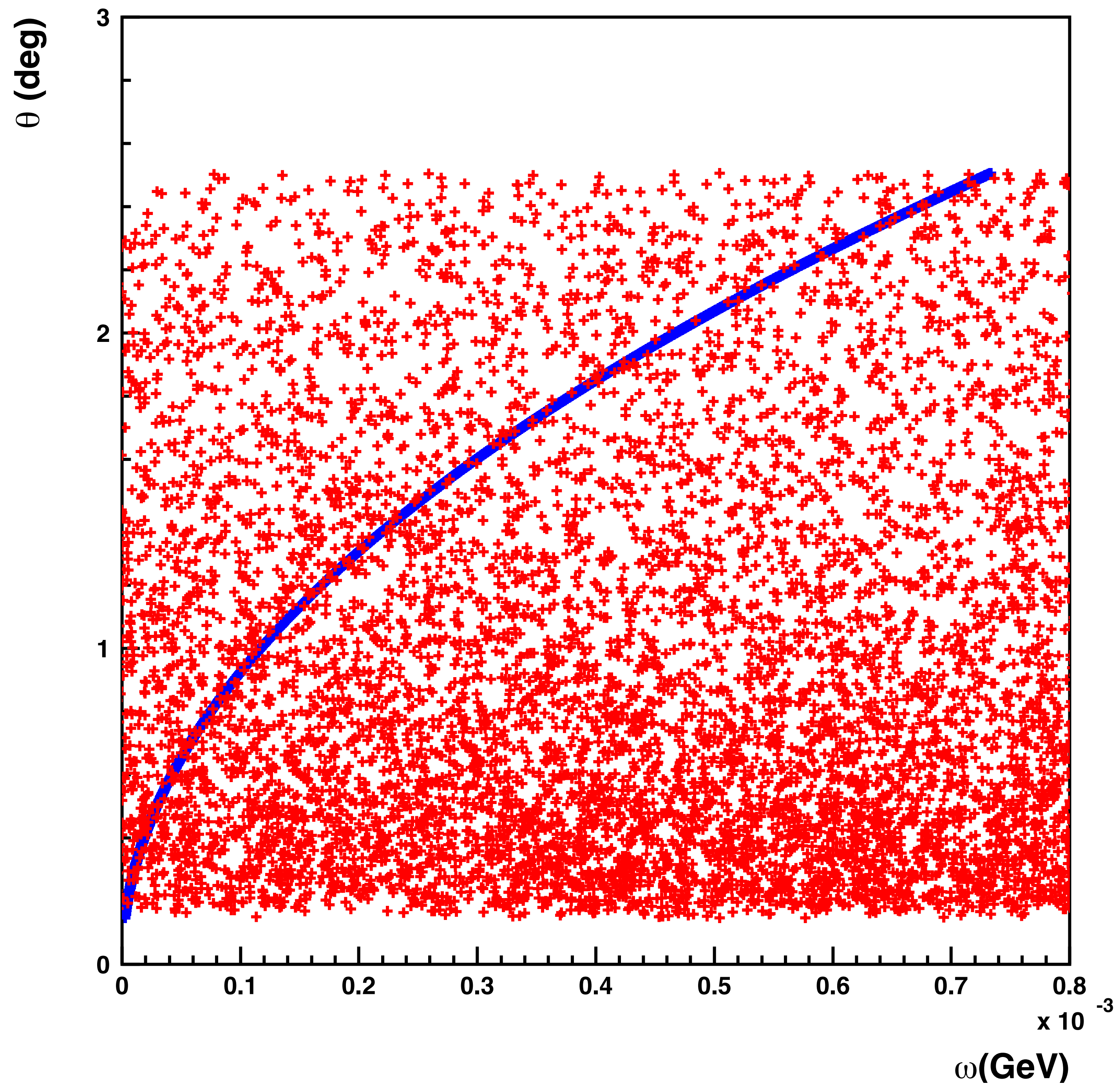
For elastic eD —> eD: $$E' = \frac{E_{beam}}{1 + \frac{2E_{beam}}{M_D}\sin^2\frac{\theta}{2}}$$

Using only E_{beam} and θ: calculate $\omega = E_{beam} - E'$ and plot θ vs ω

For quasi-elastic eD scattering: $$E' = \frac{E_{beam}}{1 + \frac{2E_{beam}}{M_p}\sin^2\frac{\theta}{2}}$$

Using only E_{beam} and θ: calculate $Q^2 = 4EE'\sin^2\theta/2$
use $\omega_{peak} = Q^2/2M_p - 2.2$ and
$\omega_{width} = 2QP_{Fermi}/M_p$
plot θ vs ω

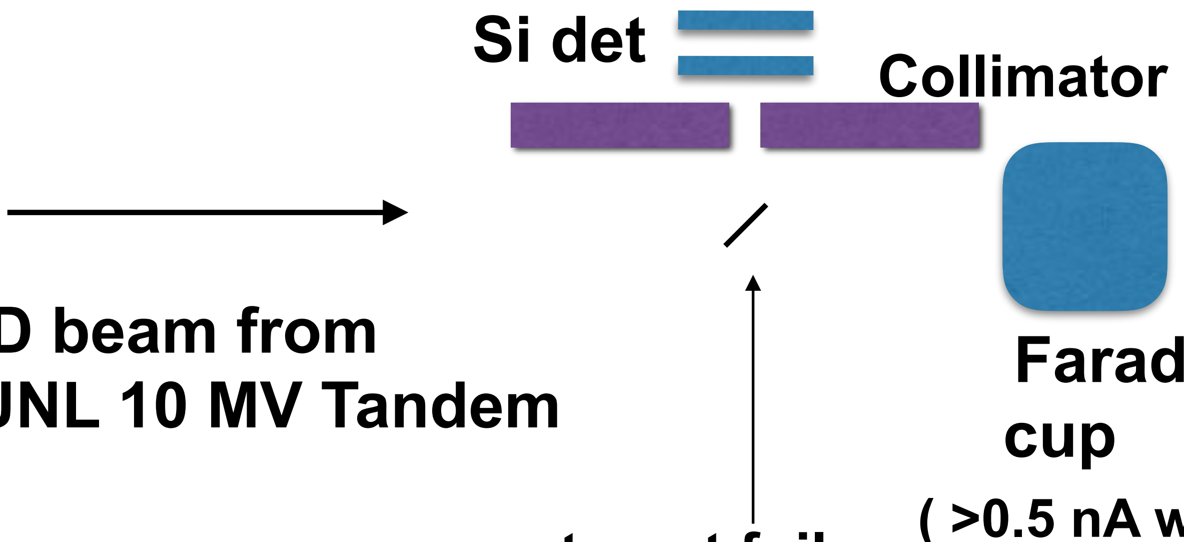
E_{beam} = 1.2 GeV

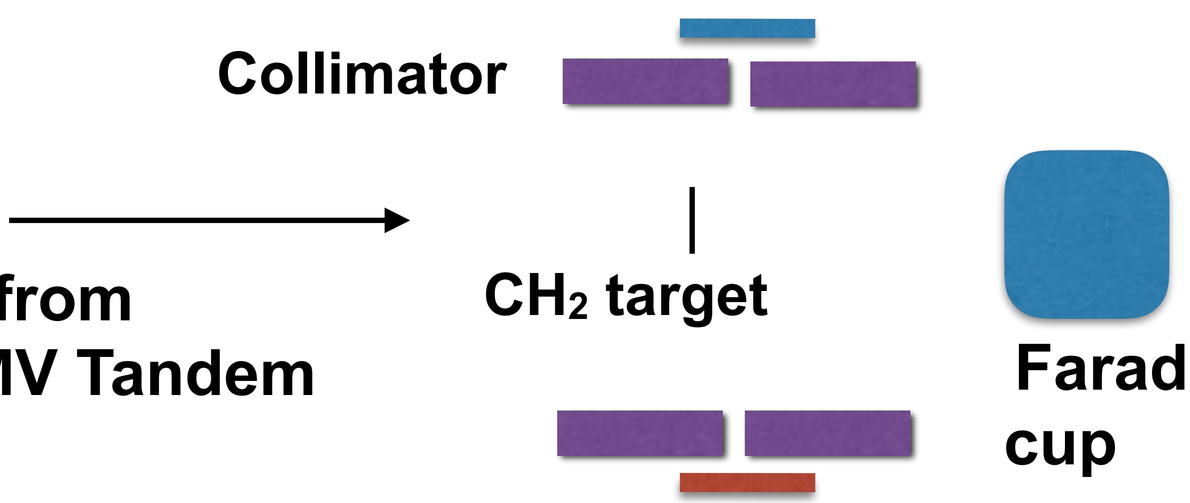


Main PAC issues to address

"It is not clear how the efficiency of this detector for the lowest energy deuterons can be determined and calibrated. Extrapolation from protons or higher energy deuterons leads to systematic errors which cannot be quantified."

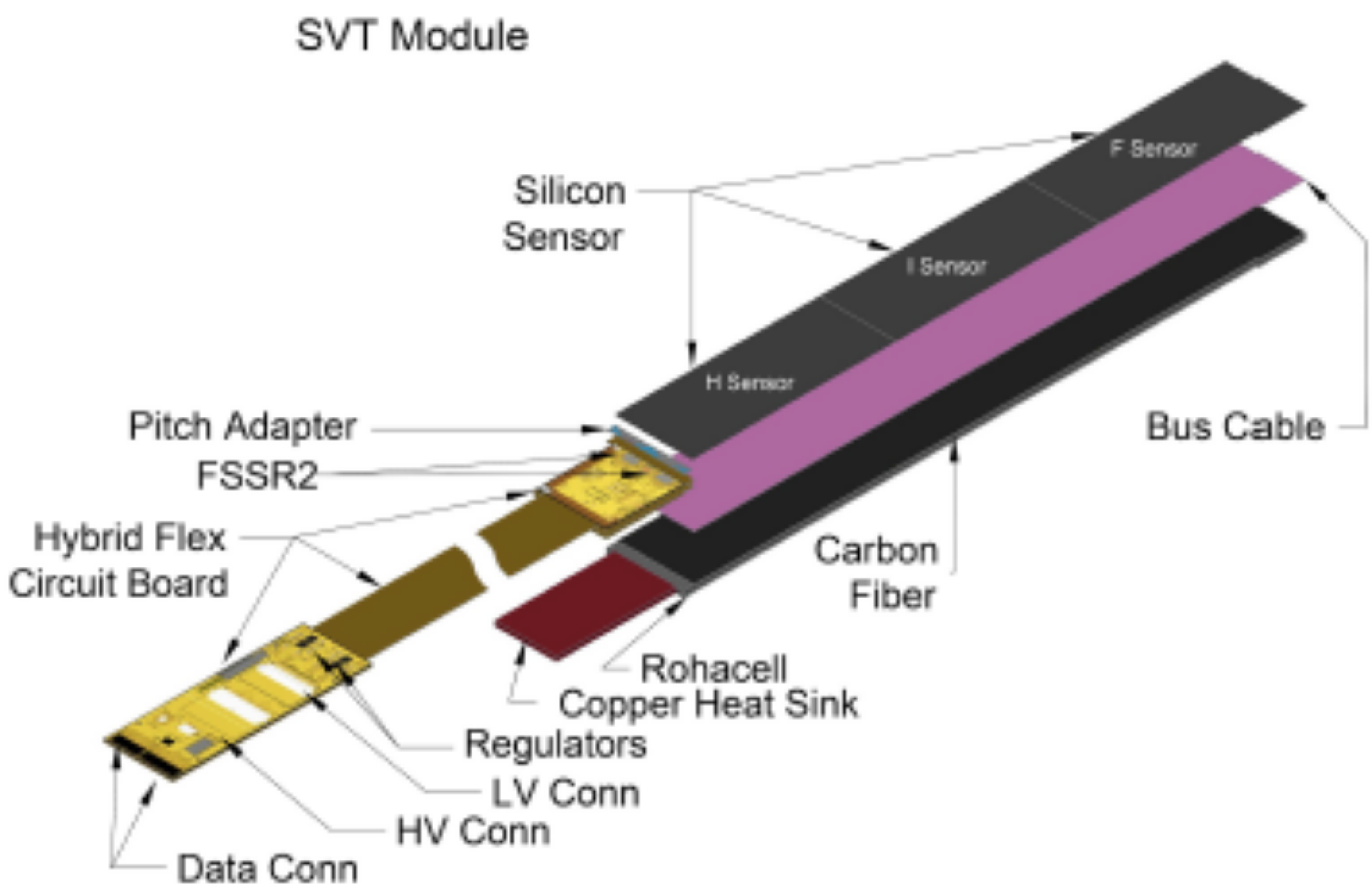
Detector calibration:



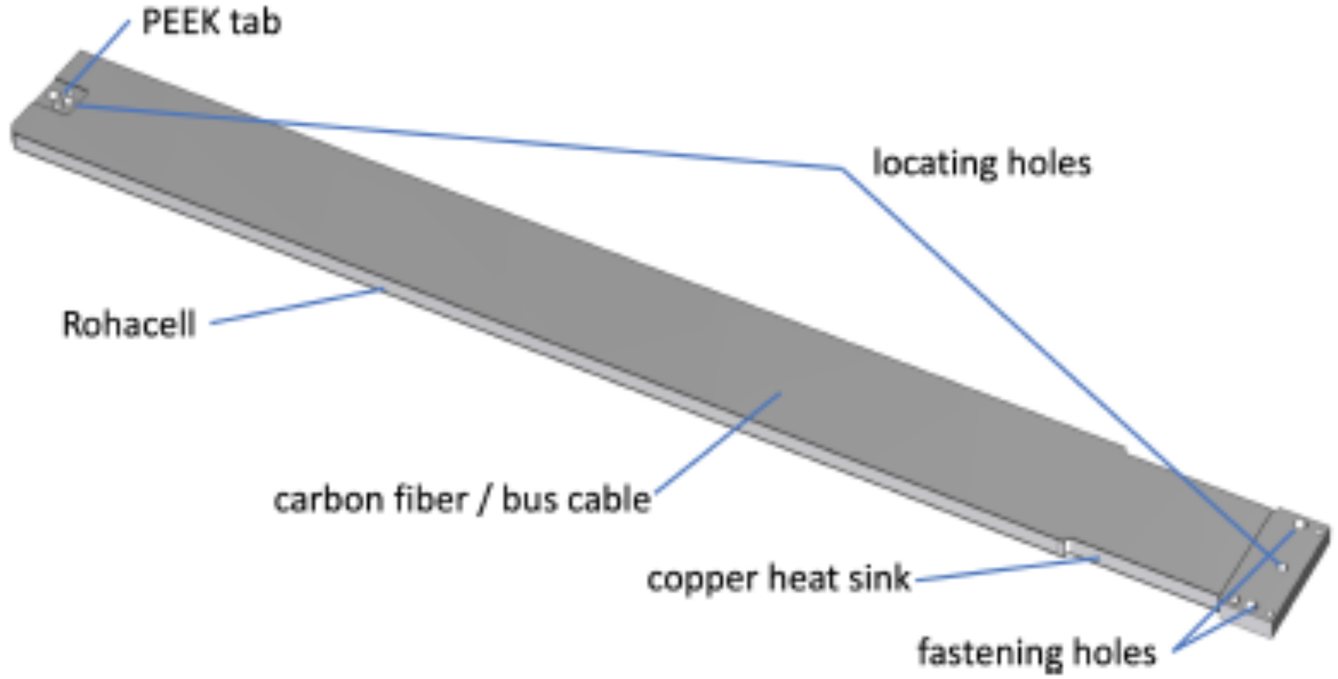


For DRad proposal, we just need to show some preliminary feasibility studies using the simplest scheme with some existing spare detectors

For example using 1 module of the CLAS12 SVT detector

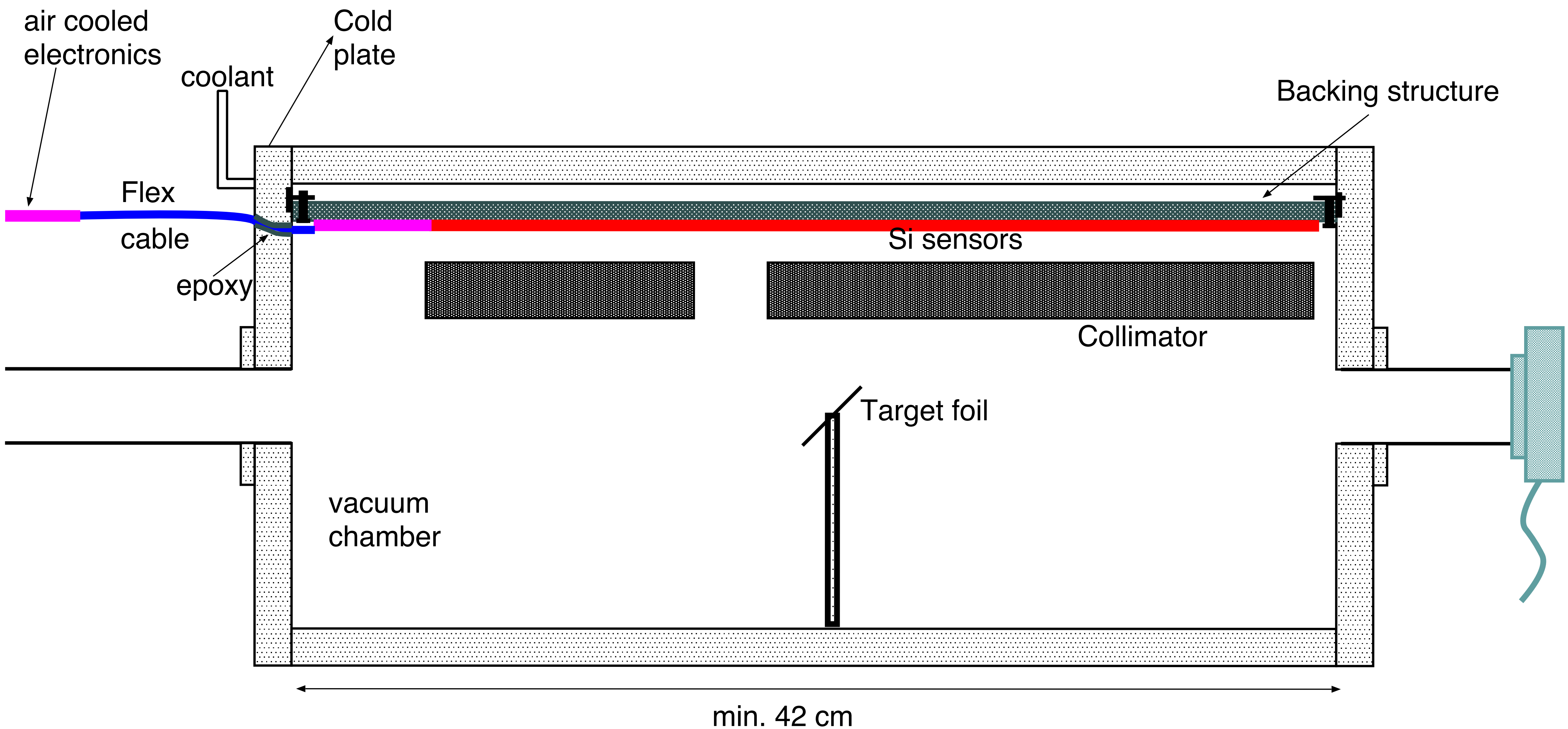


Each SVT module is built on a rigid backing structure that is ~42 cm long.



Therefore the vacuum chamber used in the test must be at least ~42 cm long.

A possible setup for testing the CLAS12 SVT module at TUNL



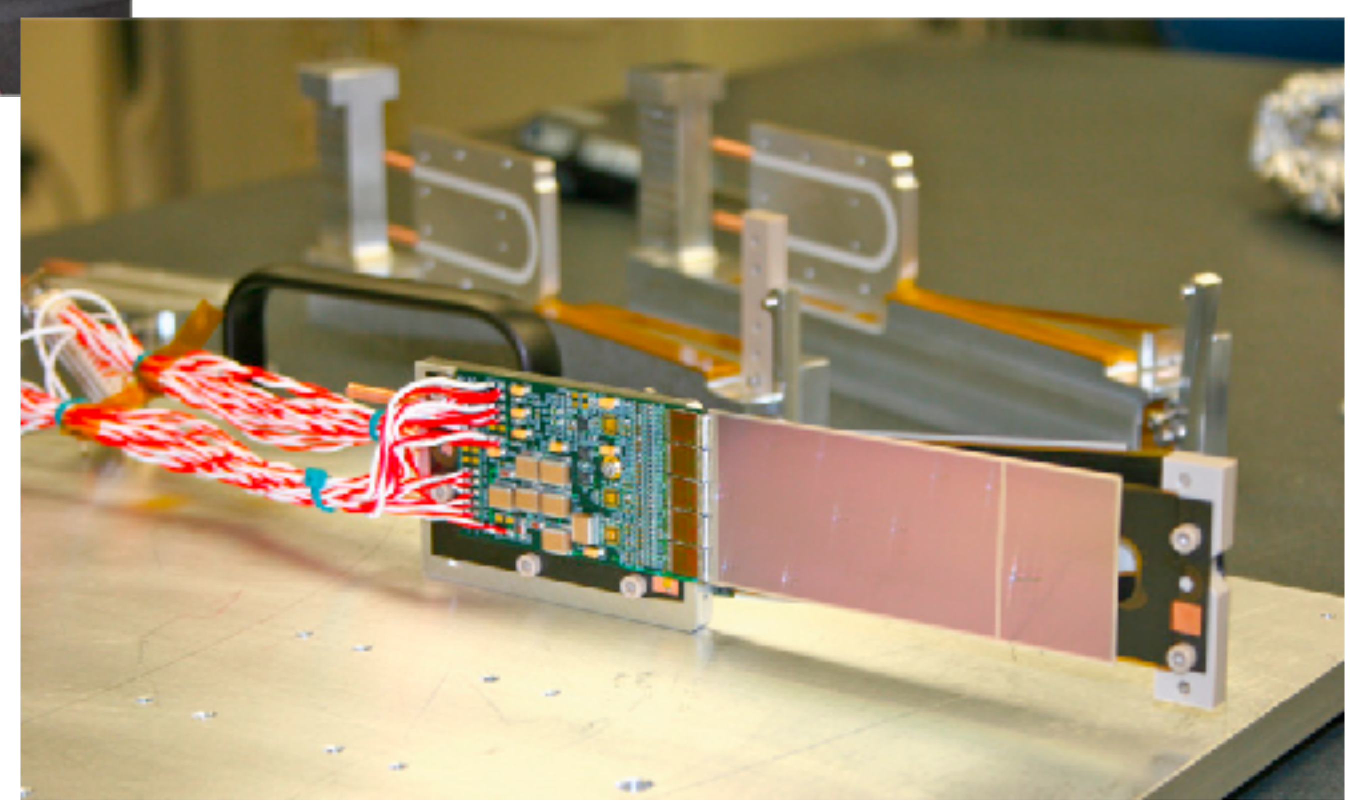
Need a vacuum chamber that is at least 42 cm long and a chiller

Another possibility is to use one spare HPS SVT module

The sensors are 10 cm long so much smaller vacuum chamber needed.

0.7% r.l. radiation budget

Readout based on APV boards which were used in PRad GEMs



Summary

- DRad proposal needs to include a method to calibrate the recoil detector.

- We need to show at least some preliminary data on the chosen scheme.

- There are at least two possible techniques that can use the p/D beam at TUNL to test the efficiency.

- Pick the method which is simpler to implement for the first test

- If using CLAS12 SVT module we will need a more complex setup with a vacuum chamber that is at least 42 cm long.

- Using the HPS SVT module should be easier.