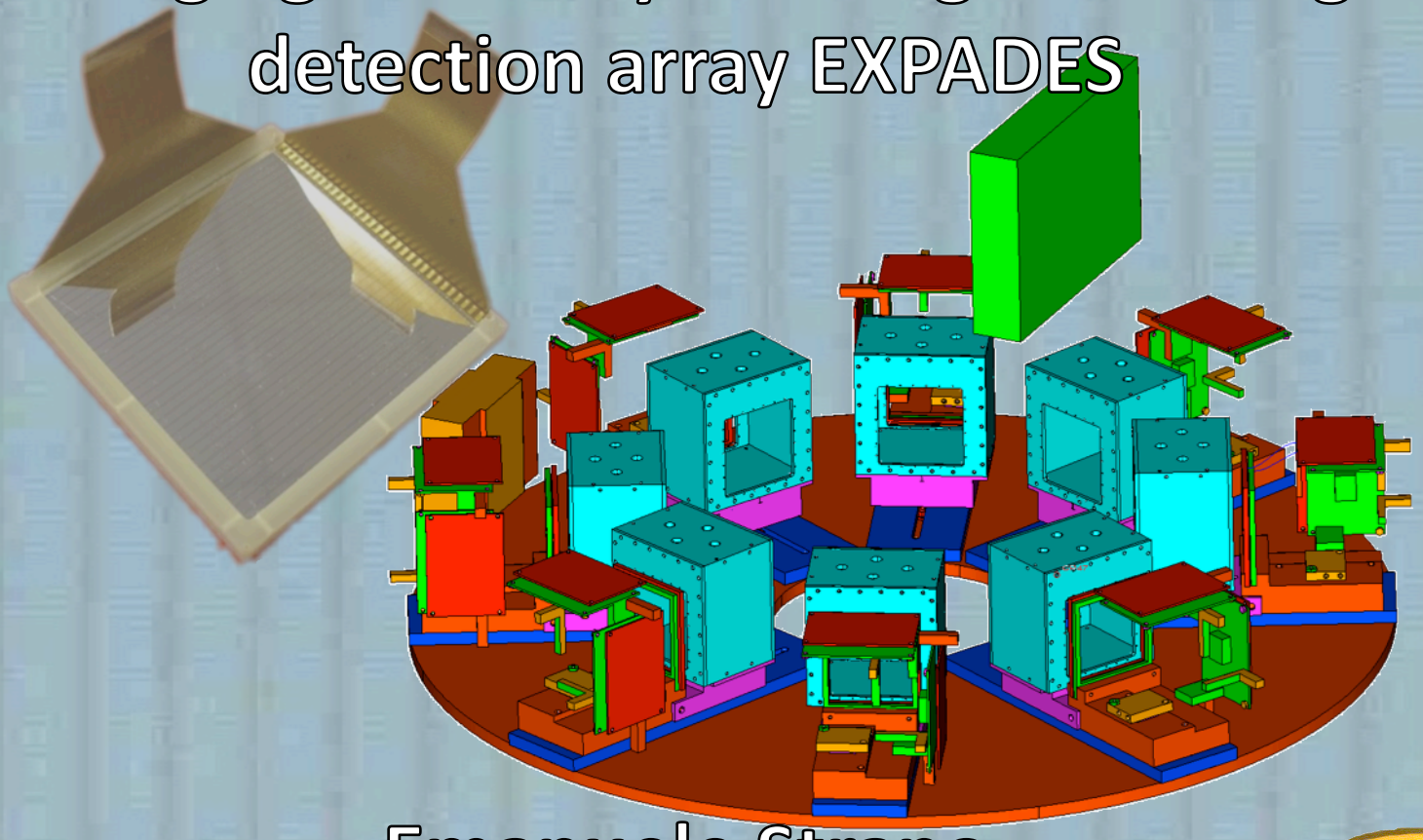
The high granularity and large solid angle detection array EXPADES



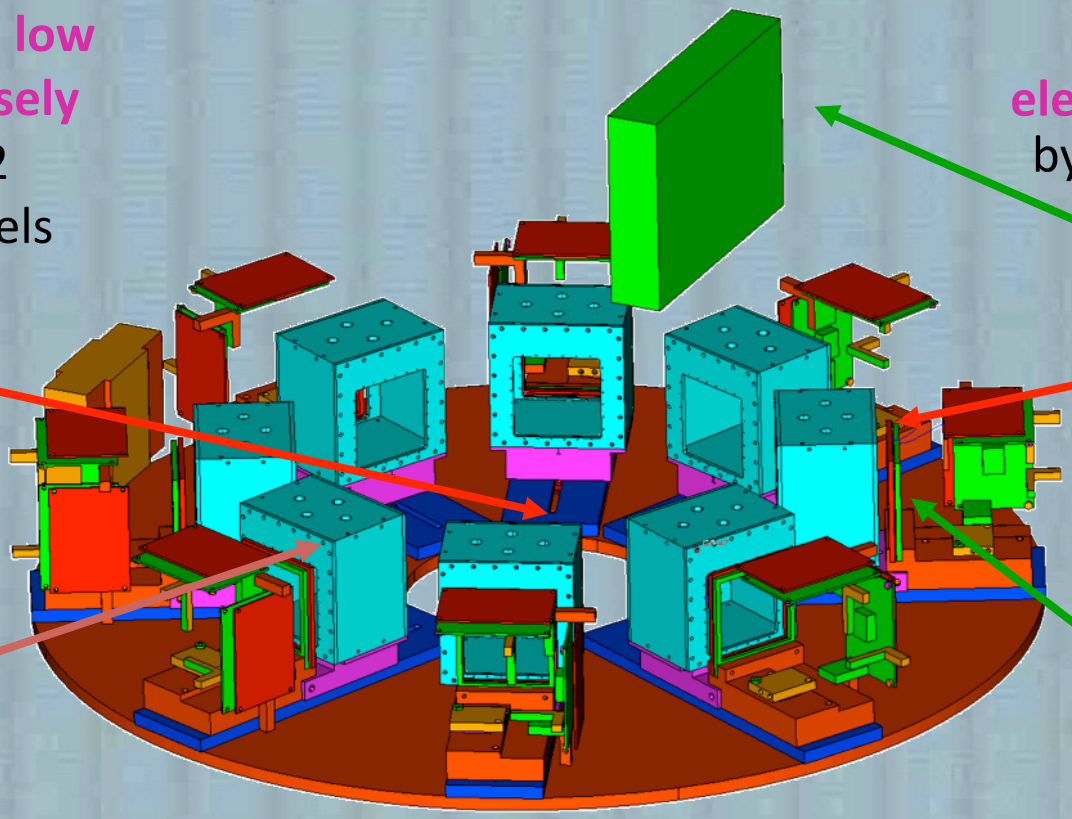
Emanuele Strano

For the EXOTIC collaboration

EXPADES

Especially tailored for experiments with **low intensity** and **loosely bound RIBs**: 8192 2 mm x 2 mm pixels

All **home-made electronics** developed by our collaboration



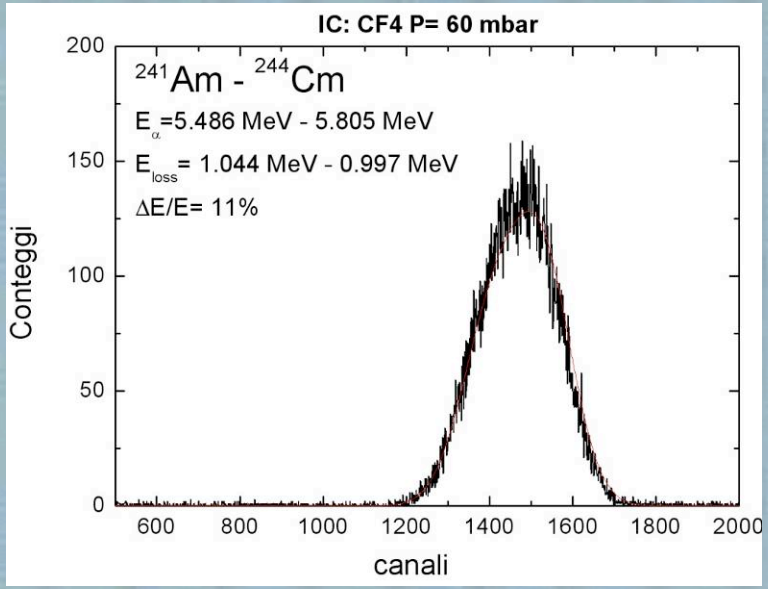
- 8 **Ionization Chambers** (ΔE stage) - **NA**
- 8 **40 µm Silicon** DSSDs 32 x 32 strips (ΔE stage) - **MI**
- 8 **300 µm Silicon** DSSDs 32 x 32 strips (E_{res} stage) - **PD**
- 8 500 µm silicon pads (3rd stage) - **NA**
- Newly dedicated DAQ - **LNL**

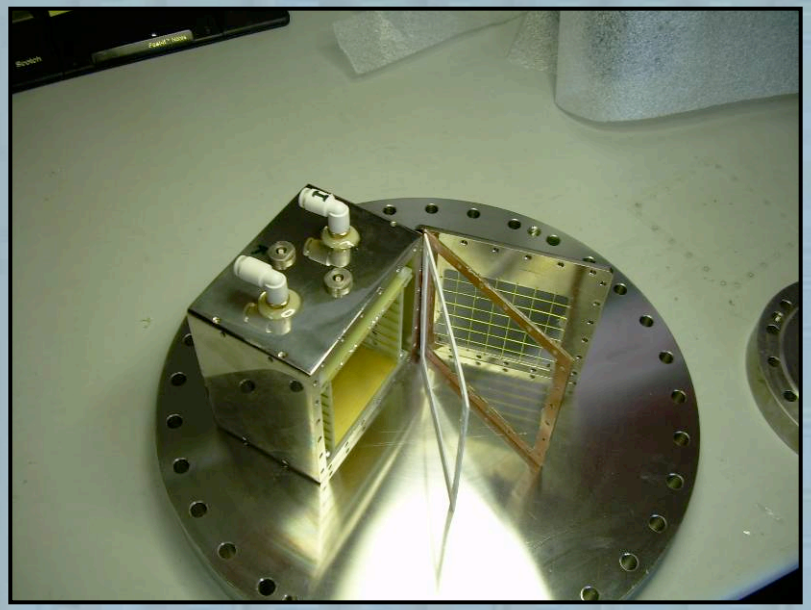
EXPADES – Ionization Chamber (ΔE)

The original project has been **improved** to avoid **gas lackage** from the mylar windows.

The layout is **more modular** (the replacement after a window breaking is a 10'-operation).

An energy resolution **ΔE/E ~ 11%** has been obtained with a mixed ^{241}Am-^{244}Cm α source.





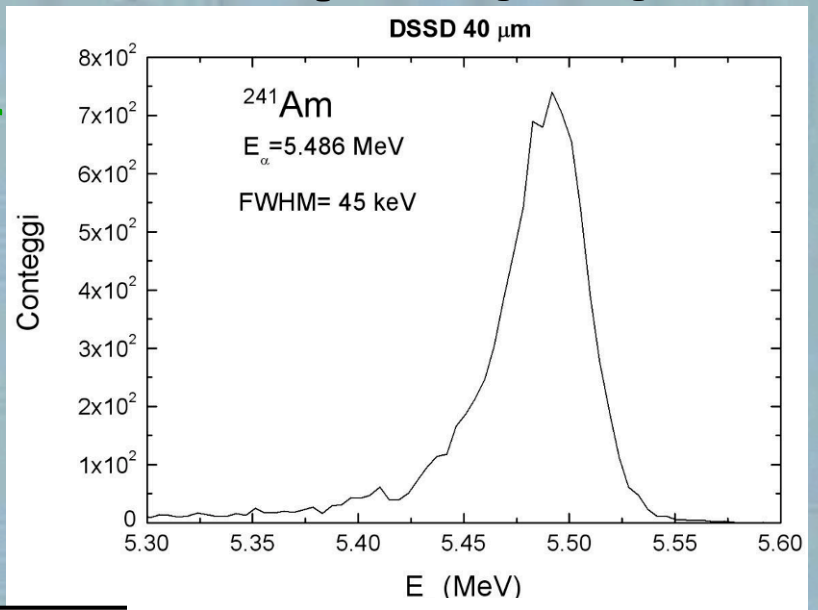
EXPADES – Silicon DSSD 40 μm (ΔE)

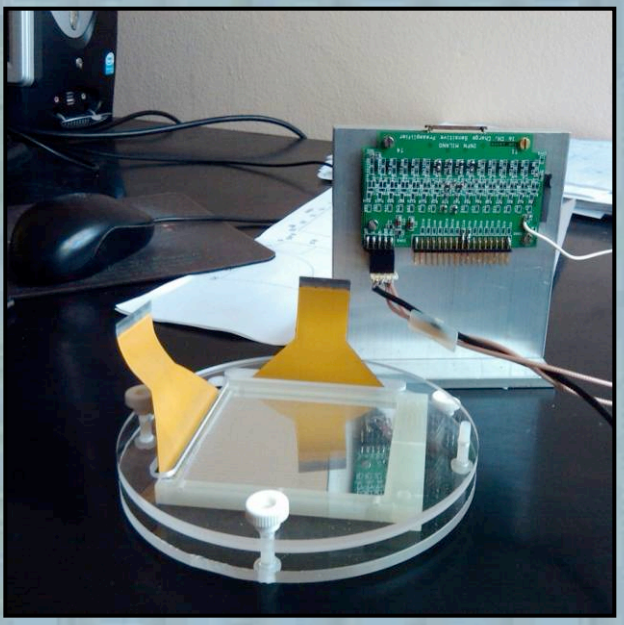
Connected to a **home-made charge preamplifier** and to an **ad-hoc ampliflier+CFD** module.

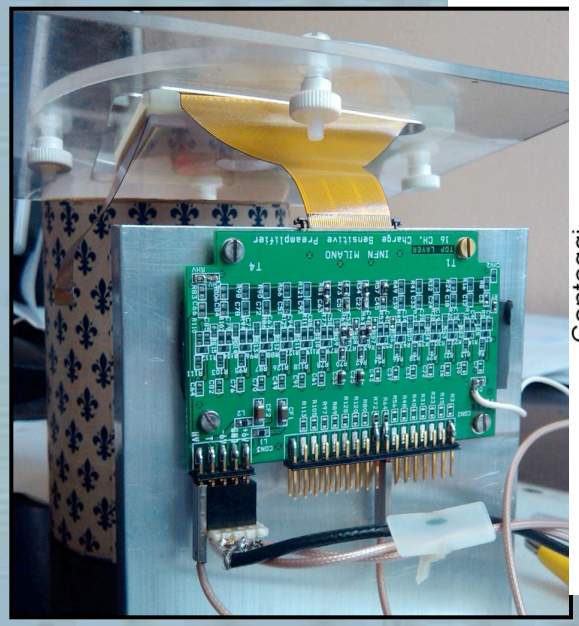
Energy resolution **ΔE/E ~ 0.8% (45 keV)**, with 5.486-MeV α-particles from a ^{241}Am source.

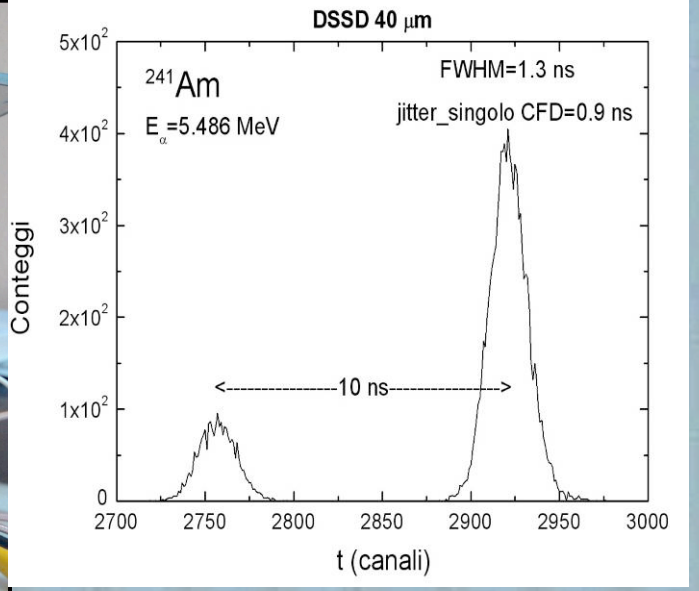
Time Resolution **Δt ~ 0.9 ns** with α-particles,

(Intrinsic) Time Resolution **Δt ~ 85-190 ps** with 500-50 mV and 20 ns rise-time pulses.



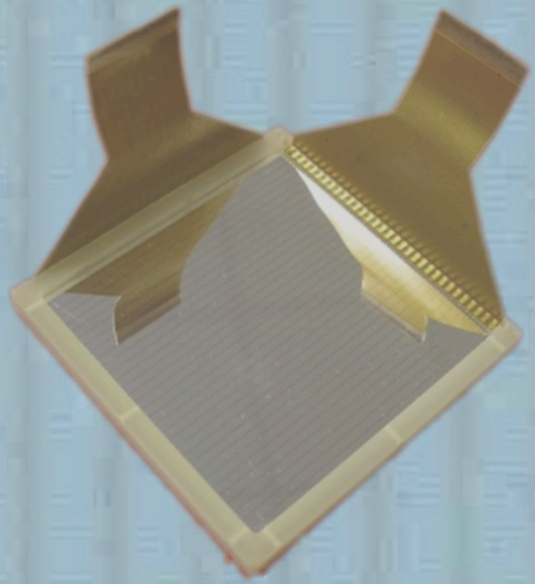


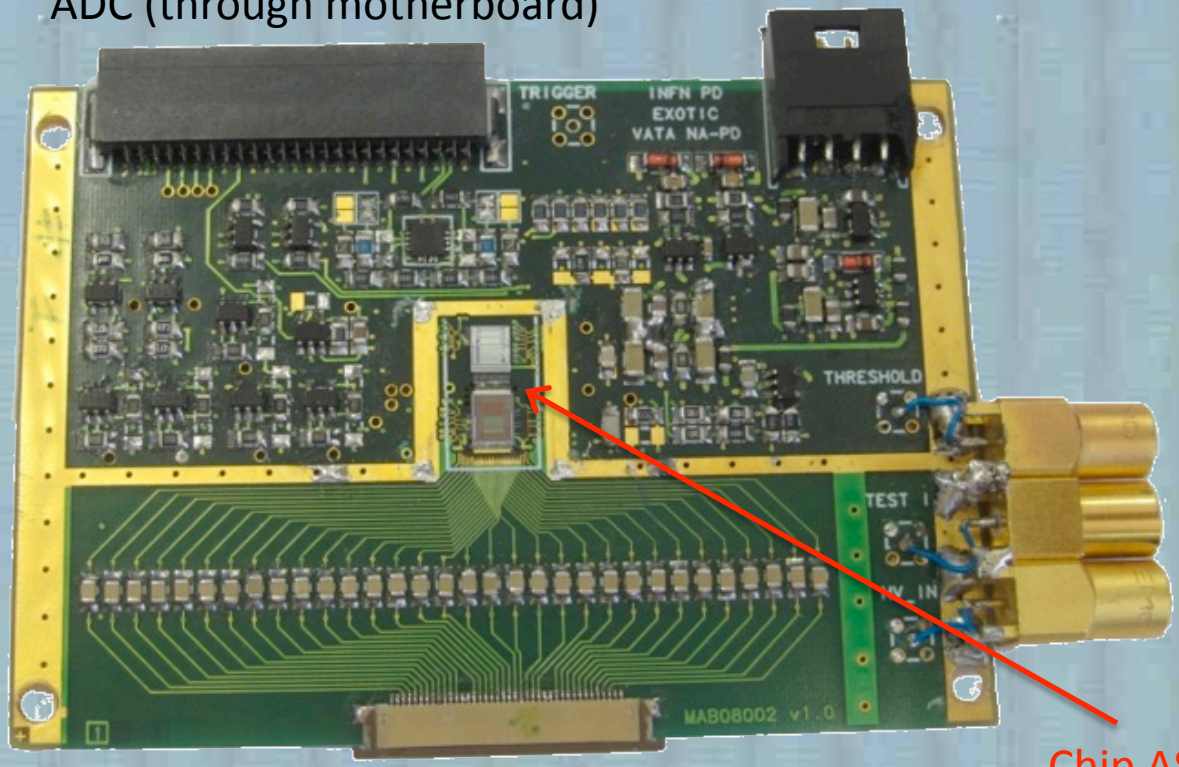




EXPADES – Silicon DSSD 300 µm (E_{res})

Read-out electronics based on **innovative ASIC** chips. One multiplexed signal contains the energy deposit information of 32 strips.





ADC (through motherboard)

Power supply

Threshold

Test in

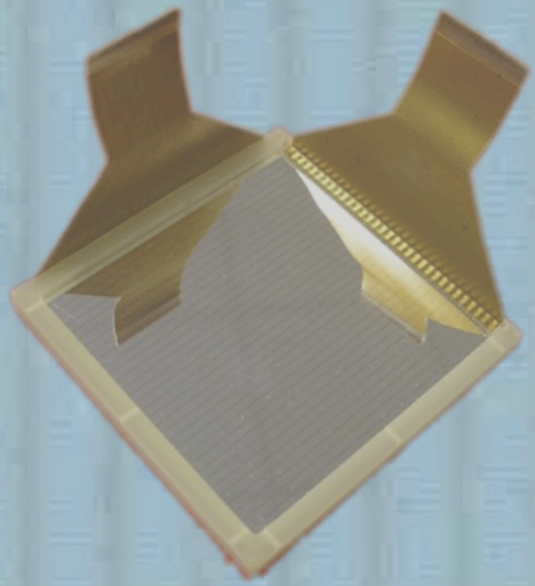
HV supply

Detector

Chip ASIC VA32HDR14.2 and TA32CG3 from IDEAS (Norway)

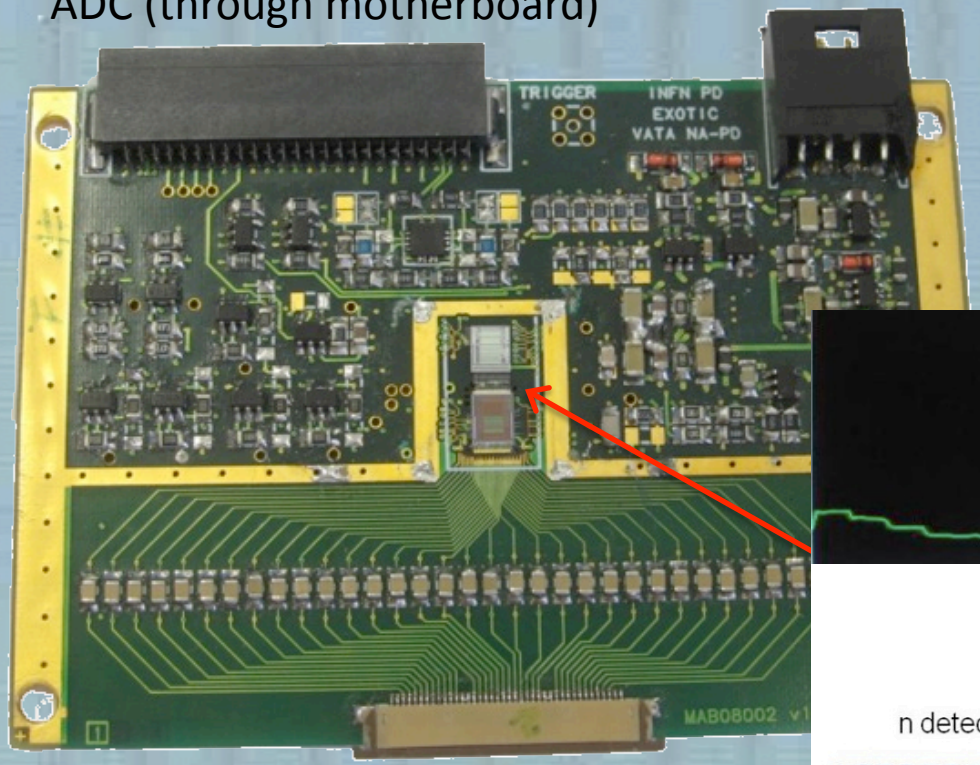
EXPADES – Silicon DSSD 300 µm (E_{res})

Read-out electronics based on **innovative ASIC** chips. One multiplexed signal contains the energy deposit information of 32 strips.

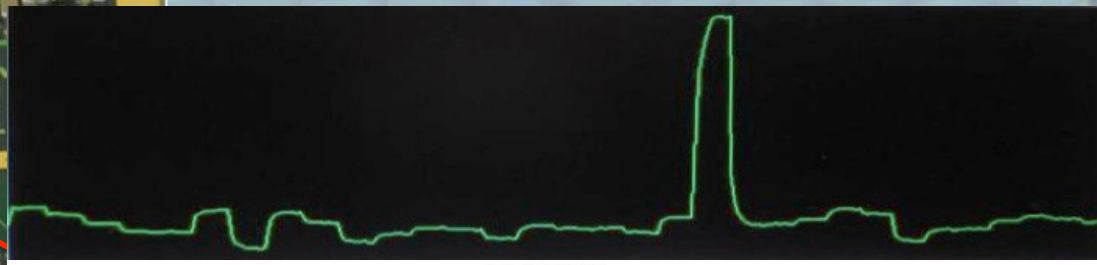


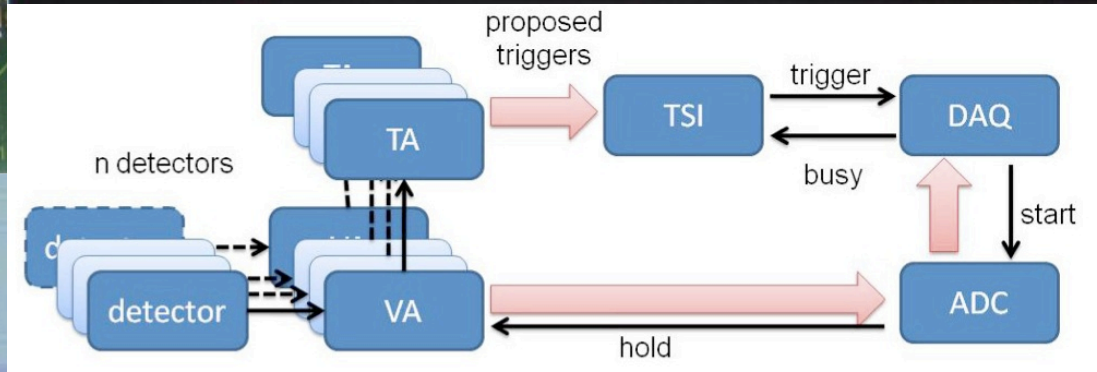
Power supply

ADC (through motherboard)

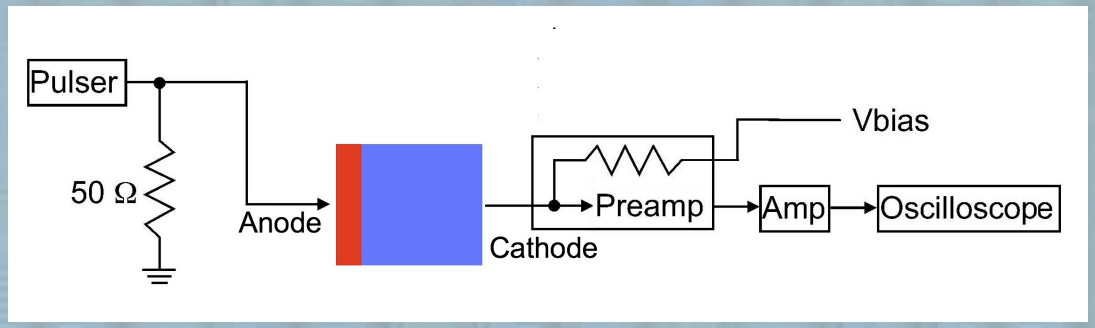


Detector





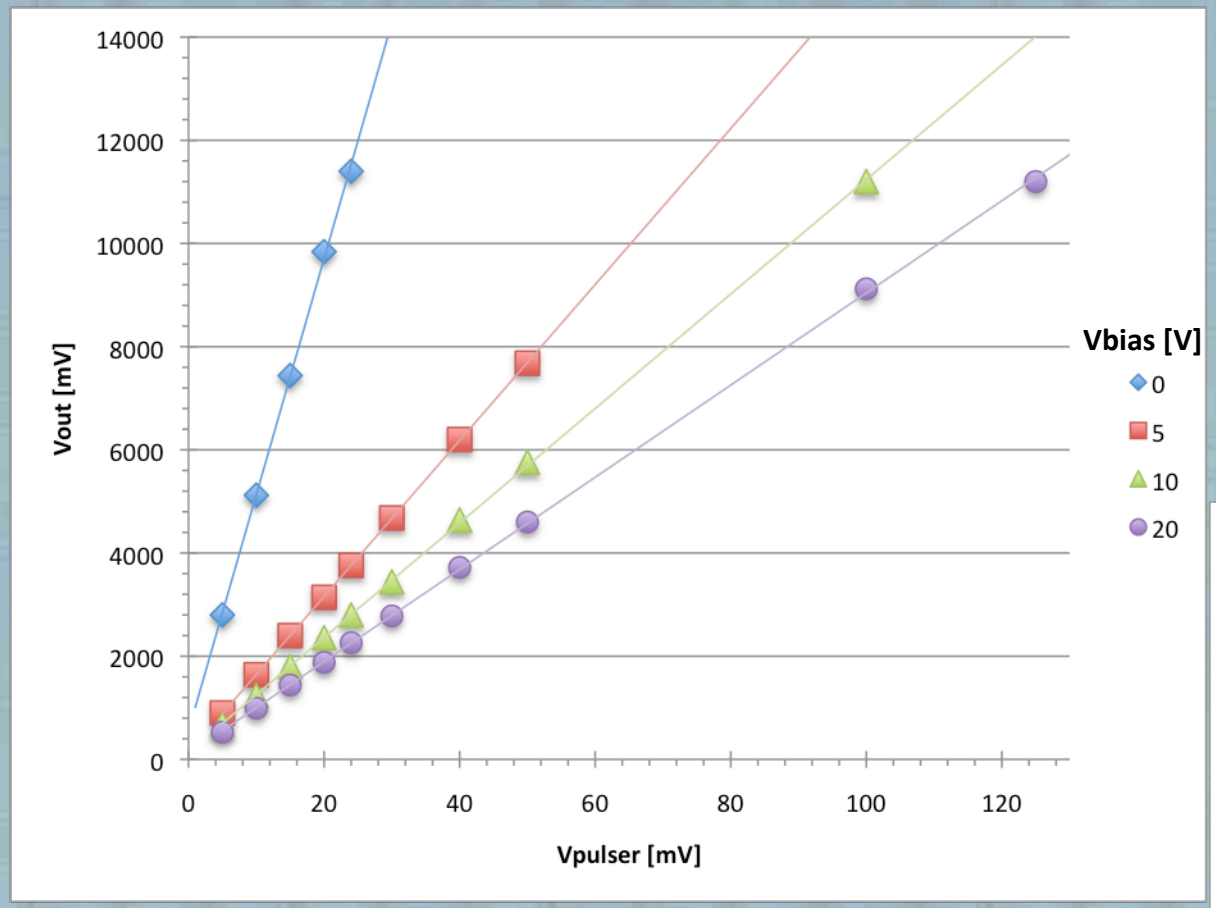
Measuring the capacitance of a detector

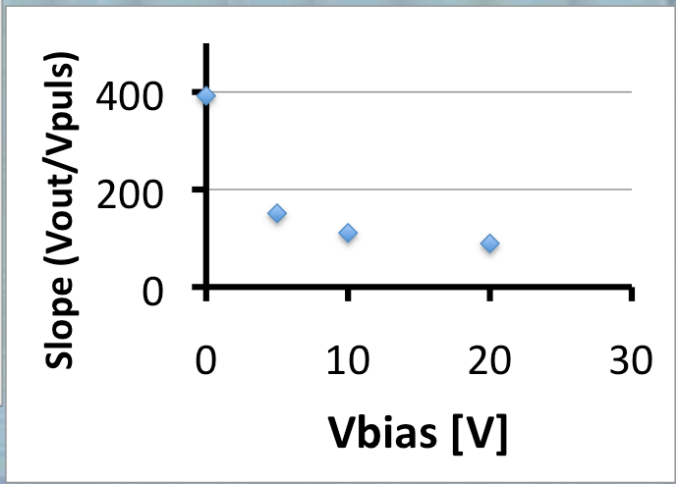


$$C = \frac{Q}{V}$$

Linear relation:
slope ∝ capacitance

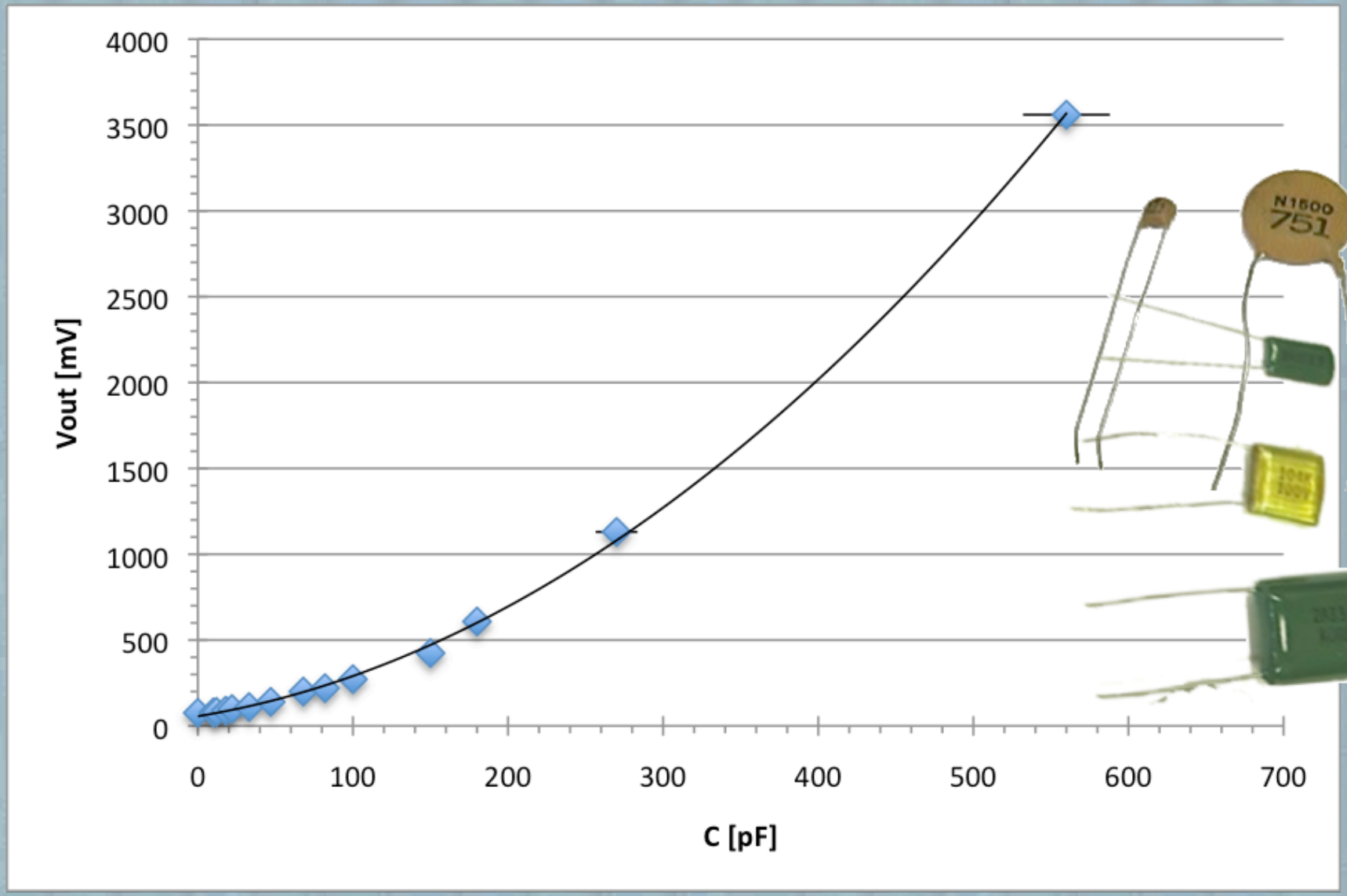
Vpulser choice:
high for low capacitances
low for high capacitances





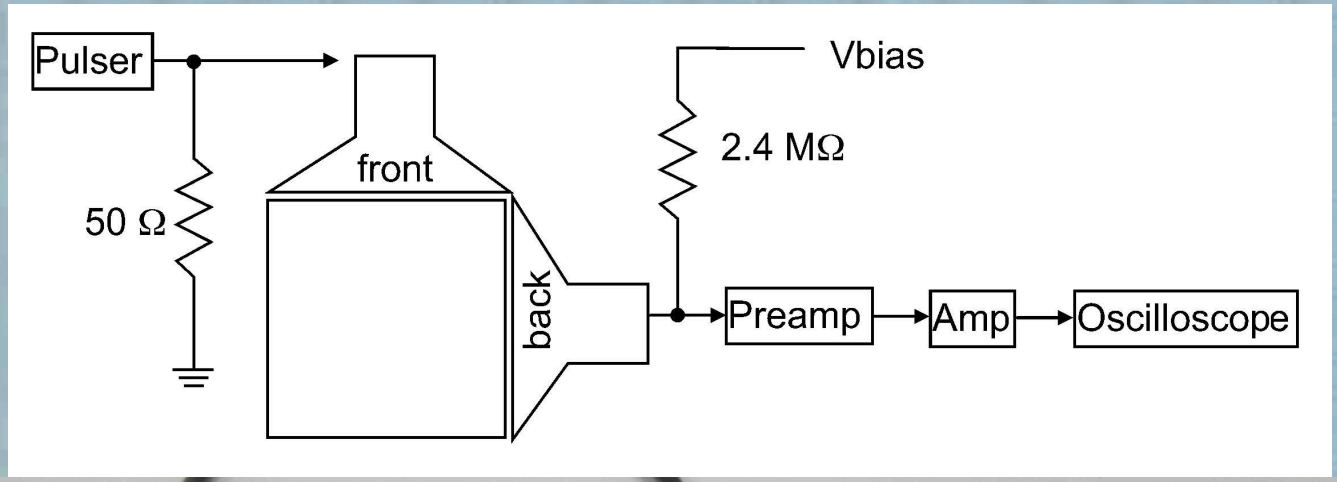
System calibration

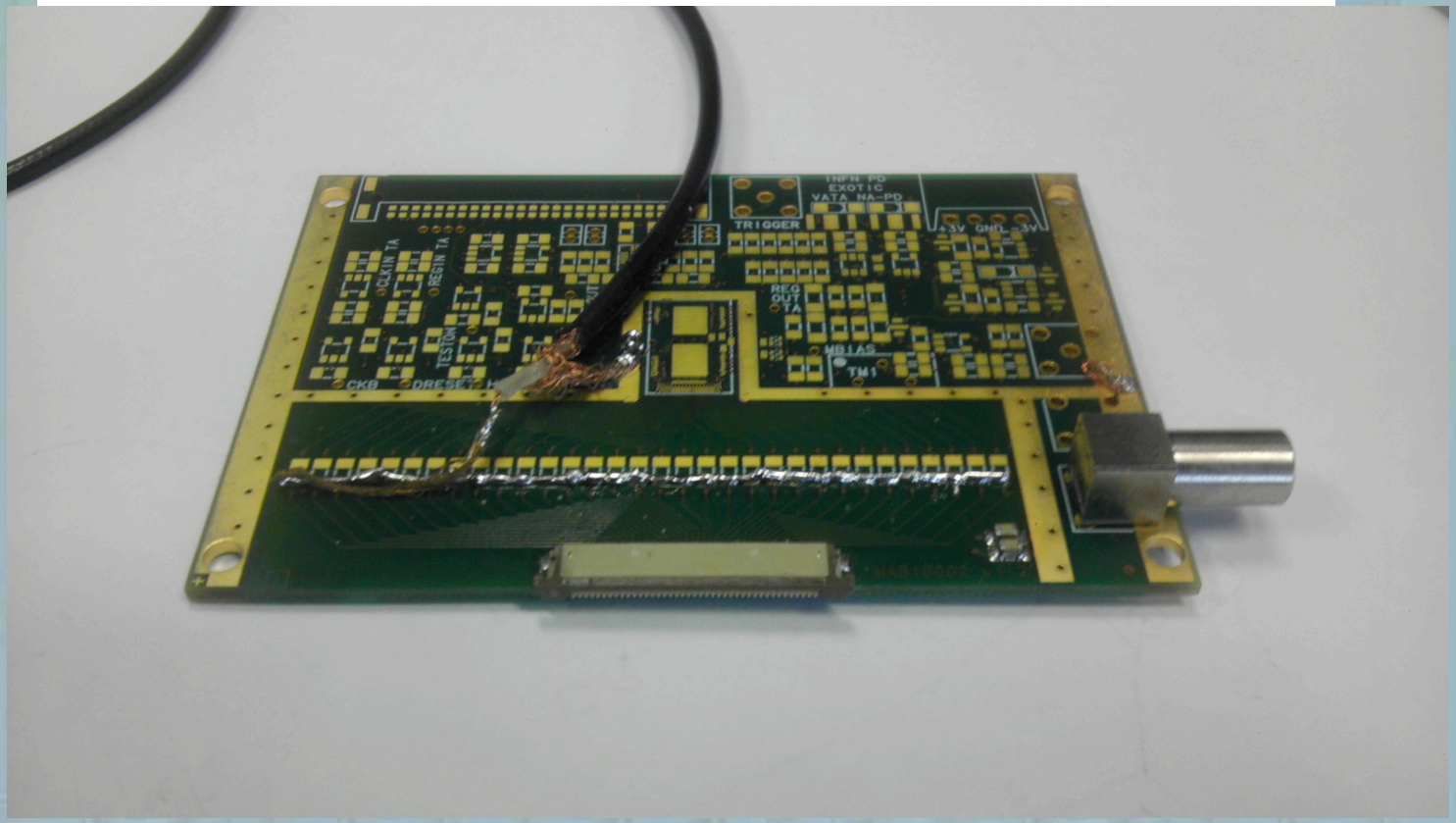
By known capacitances



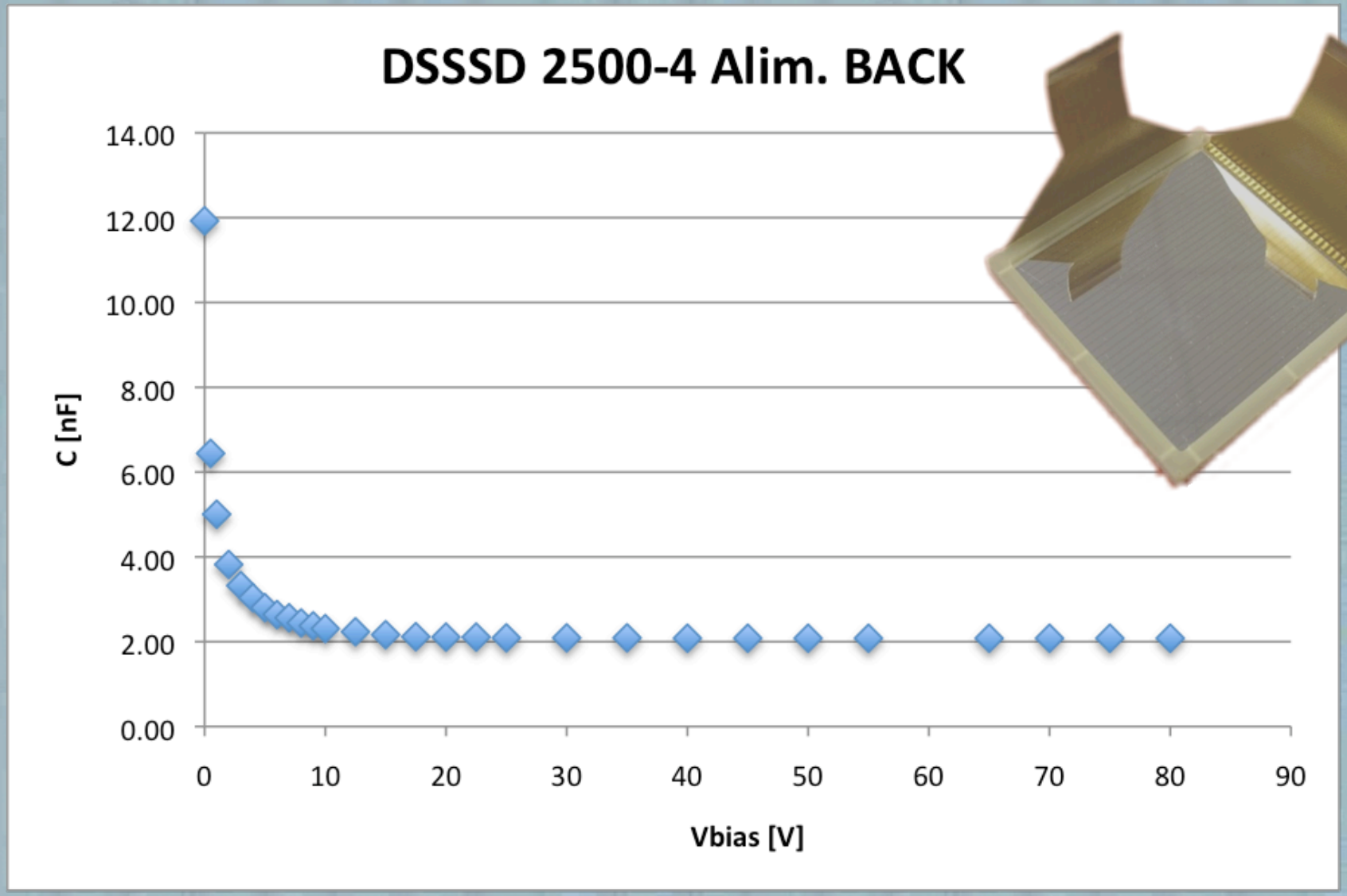
Capacitance of a surface barrier detector

Body capacitance of the 300um DSSSD detector

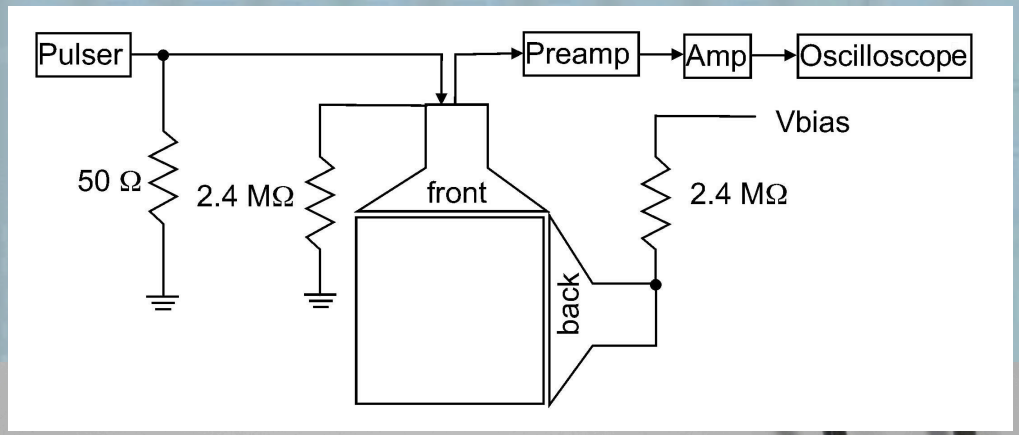


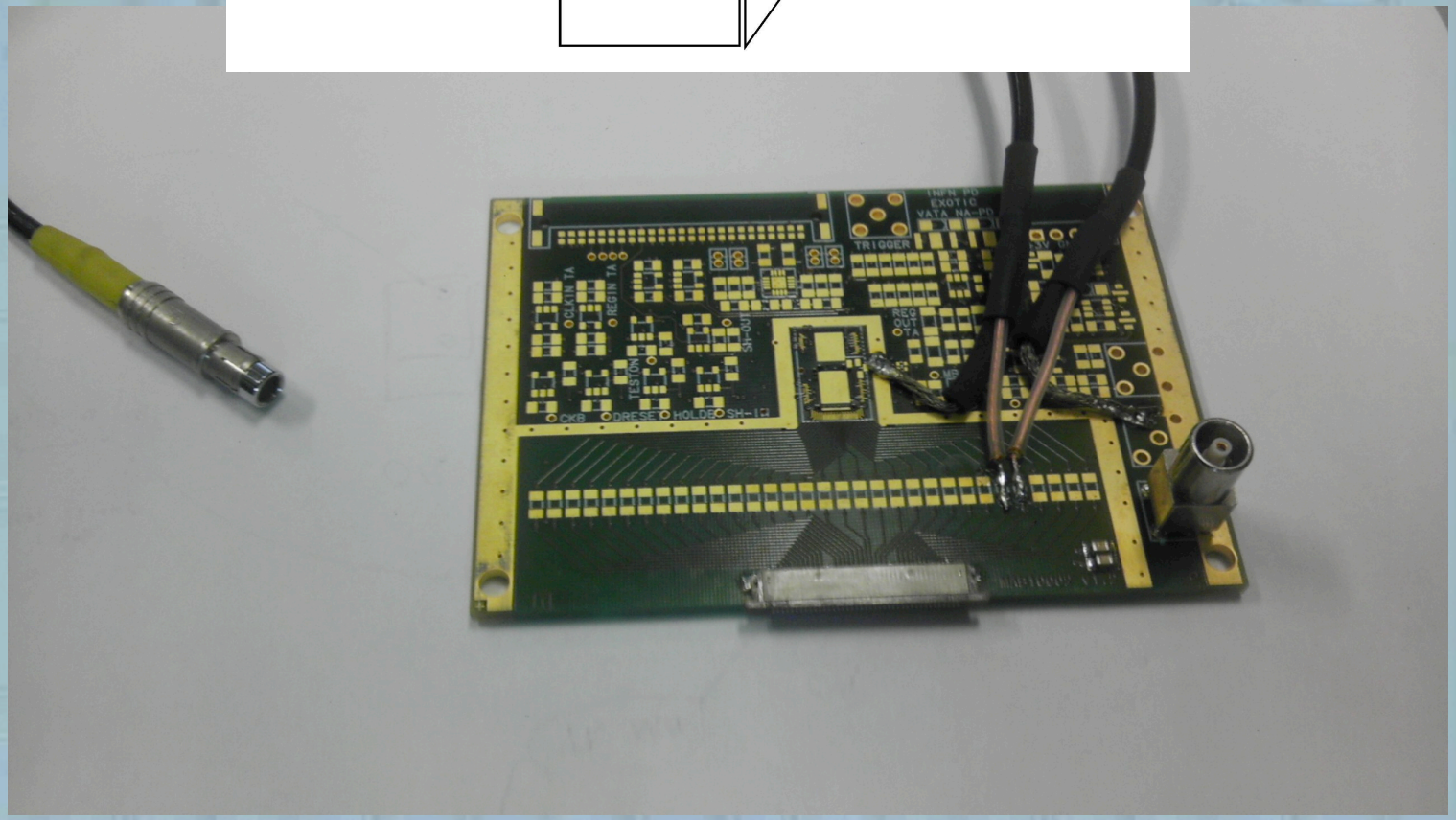


Body capacitance of the 300μm DSSSD detector

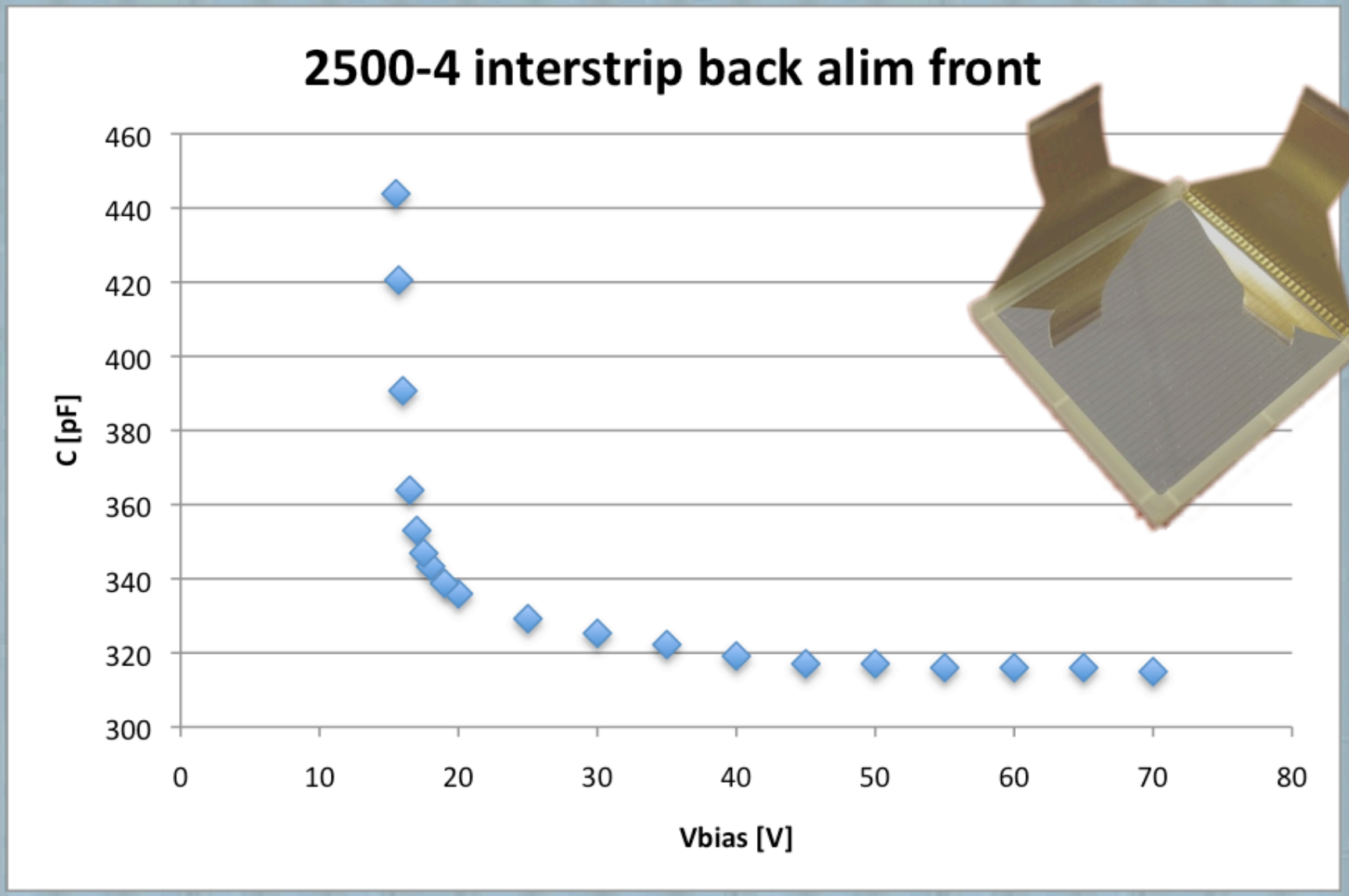


Interstrip capacitance of the 300um DSSSD detector





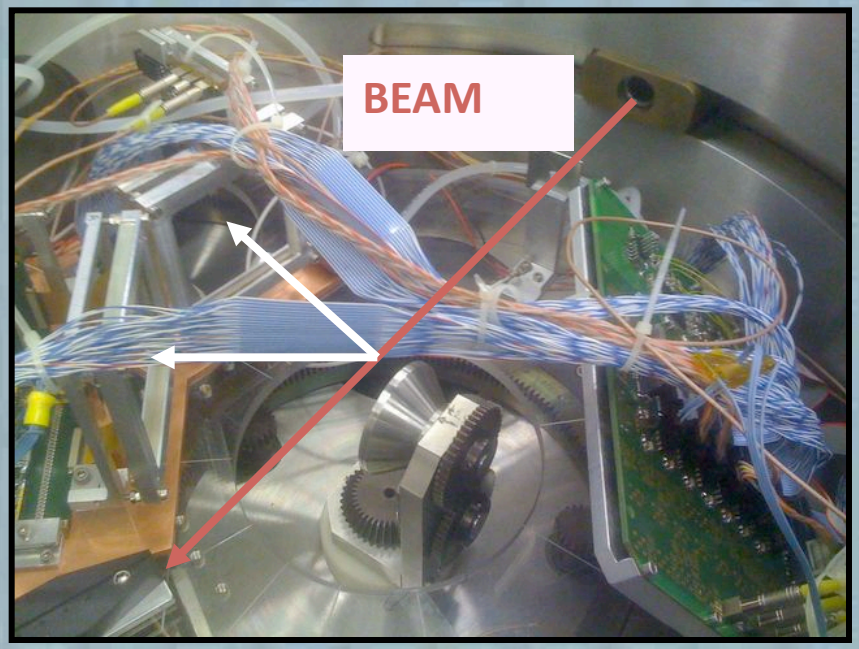
Interstrip capacitance of the 300μm DSSSD detector

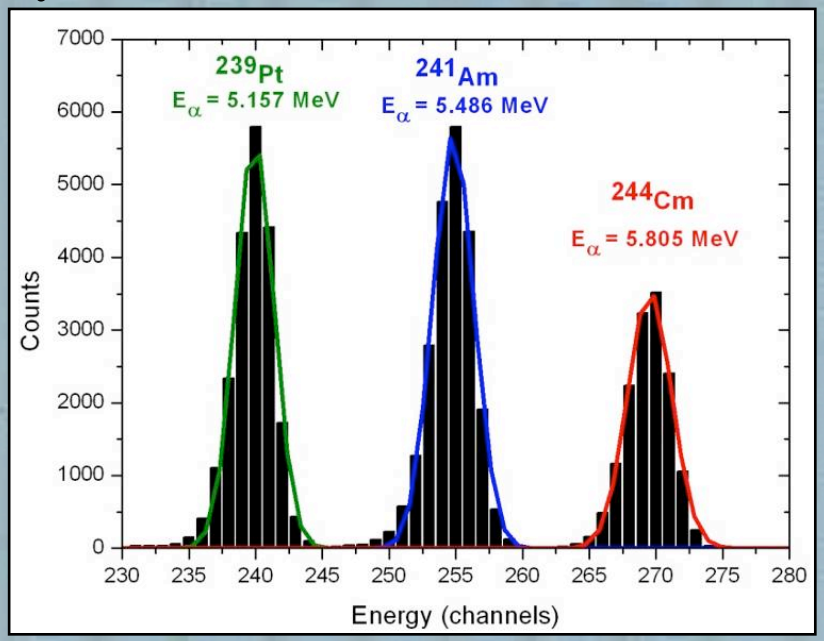


In beam test of the 300μm DSSSD detector

Energy resolution **ΔE/E ~ 1.5 %** (85 keV) for α particles from calibration sources.

Two modules **tested** with **energetic heavy-ions** (^{17}O in the energy range 40-100 MeV) in April 2011.





Primary Beam: $^{17}O^{4+}$

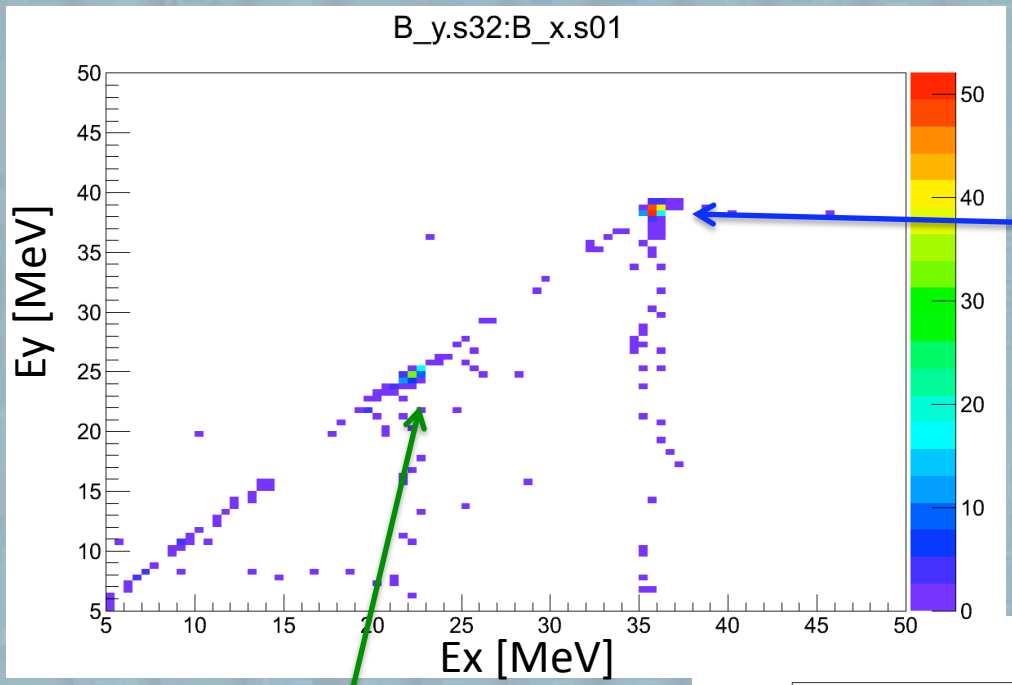
Intensity: 1-4 enA

Energy: **42.5-55 MeV** in **2.5-MeV** steps

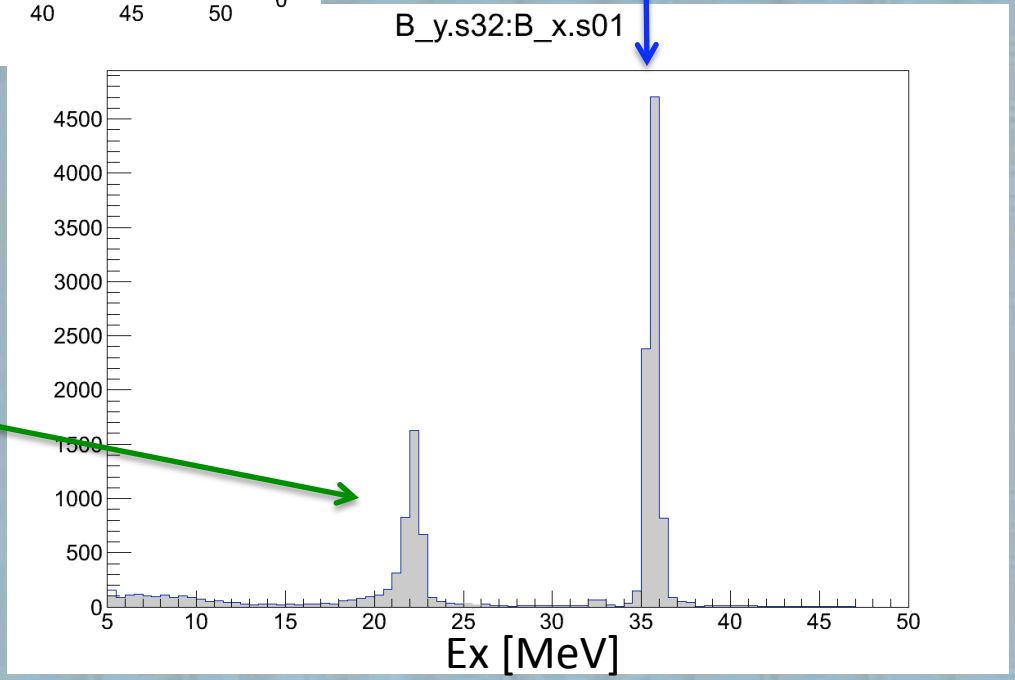
Target: ^{58}Ni+^{208}Pb backing

Pixel by pixel analysis.

In beam test: pixel by pixel analysis



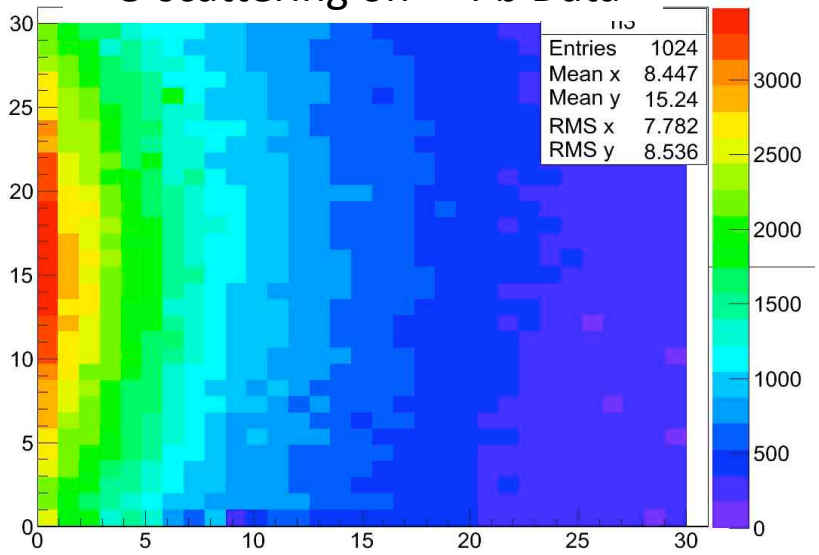
^{208}Pb



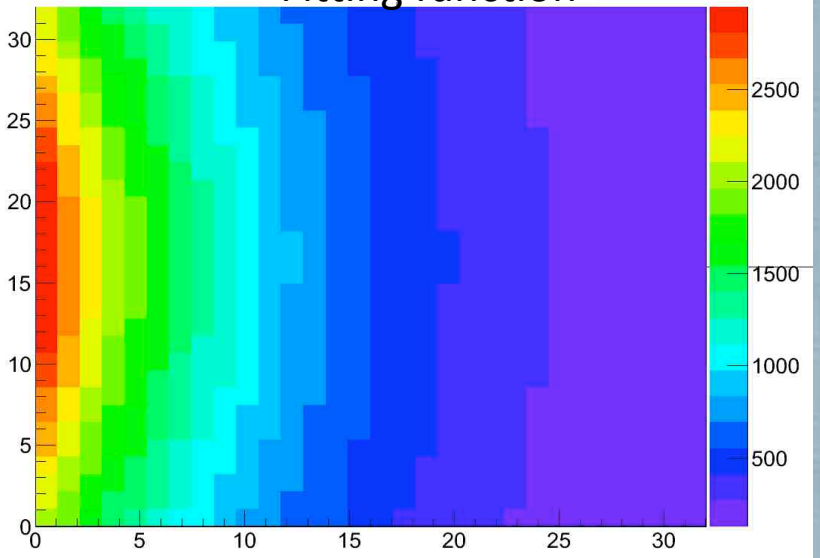
^{58}Ni

In beam test: geometric best-fit

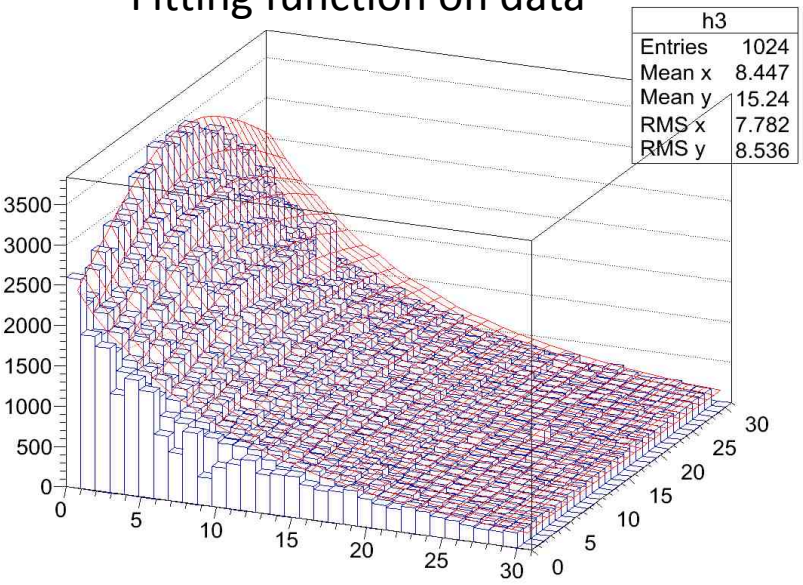
^{17}O scattering on ^{208}Pb Data



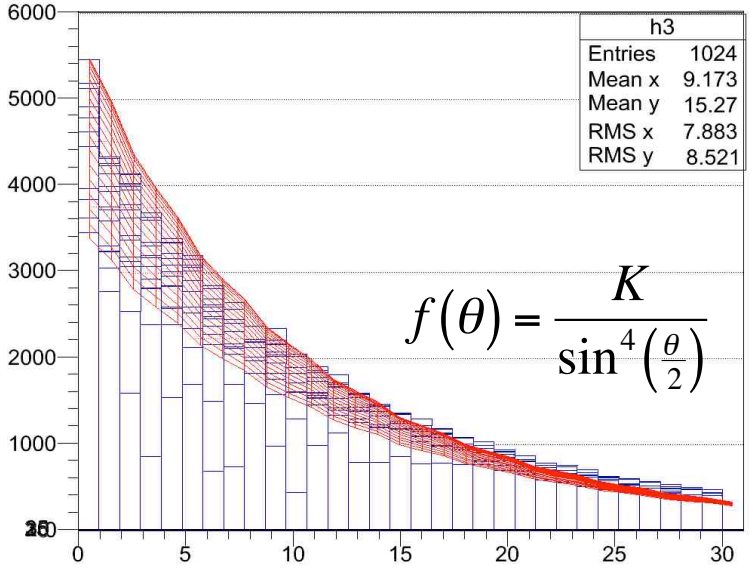
Fitting function



Fitting function on data



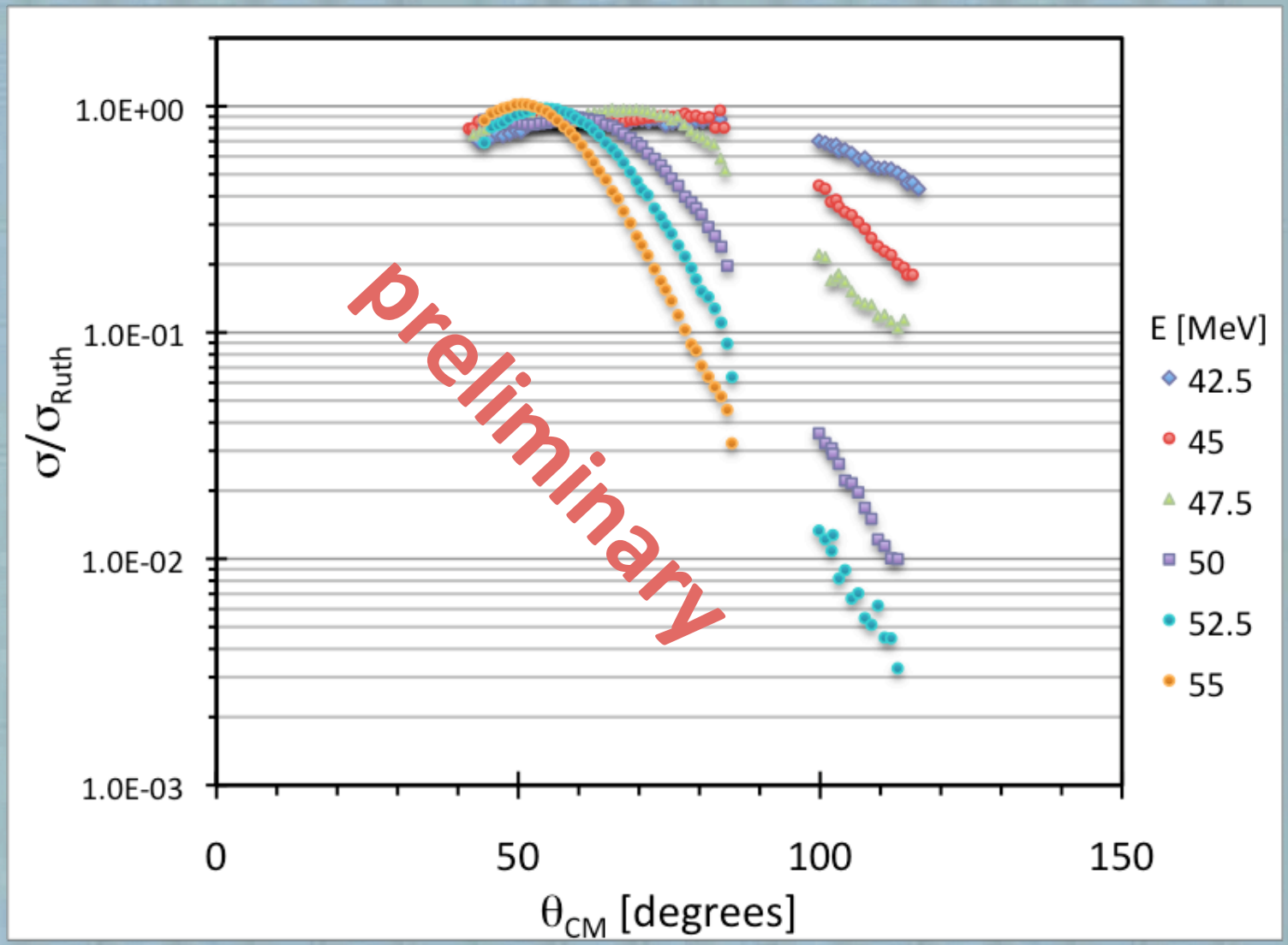
Fitting function on data profile



In beam test: preliminary results

$$\frac{\sigma_{el}^{Ni}}{\sigma_{Ruth}^{Ni}}\left(\theta_{CM}^{Ni}\right) = \frac{\sigma_{Ruth}^{Pb}\left(\theta_{CM}^{Pb}\right)}{N_{el}^{Pb}\left(\theta_{lab}\right)} \frac{N_{el}^{Ni}\left(\theta_{lab}\right)}{\sigma_{Ruth}^{Ni}\left(\theta_{CM}^{Ni}\right)} \frac{\xi_{Pb}}{\xi_{Ni}} \left(\frac{E_{CM}^{Pb}}{E_{CM}^{Ni}}\right)^2$$

Auto-normalization of solid angles and beam current



Conclusions and perspectives

Setup in the final in-beam commissioning phase.

Ionization chambers test with an alpha source $\Delta E \sim 11\%$.

ΔE silicon module test with an alpha source $\Delta E \sim 45$KeV

Capacitance of the 300μm module.

300μm module test with an alpha source $\Delta E \sim 85$KeV.

300μm module in beam test $^{17}O+^{58}Ni$.

- Pixel by pixel analysis
- Scattering on Pb fit
- σ/σ_{Ruth} for ^{17}O scattering on ^{58}Ni

Next: testing the overall capabilities of the three modules in a "in beam" setup

The EXOTIC collaboration: A. Boiano[3], C. Boiano[4], P. Di Meo[3], T. Glodariu[5], J. Grebosz[6], A. Guglielmetti[4,7],M. La Commara[3,8], C. Manea[2], M. Mazzocco[1,2], P. Molini[1,2], M. Nicoletto[2], C. Parascandolo[1,2], L. Parascandolo[3], D. Pierroutsakou[3], C. Signorini[1,2], F. Soramel[1,2], E. Strano[1,2], L. Stroe[5], N. Toniolo[9], D. Torresi[1,2]

[1]Phyics and Astronomy Dept., Padova University, via Marzolo 8, I-35131 Padova
[2]INFN - Sezione di Padova, Via Marzolo 8, 35131 Padova - Italy
[3]INFN - Sezione di Napoli, via Cintia, I-80126, Napoli, Italy.
[4]INFN - Sezione di Milano, Via Celoria 16, Milano, Italy.
[5]NIPNE Măgurele, Bucharest, Romania.
[6]IFJ ul. Radzikowskiego 152 31-342 Krakow, Poland,
[7]Physics Dept., Milano University , via Celoria 16, Milano, Italy.
[8]Physics Dept., Napoli University, via Cintia, I-80126, Napoli, Italy.
[9]INFN - LNL Legnaro (Padova)