Spectrometry of heavy ions below 1 MeV/amu with ND and CVDD detectors

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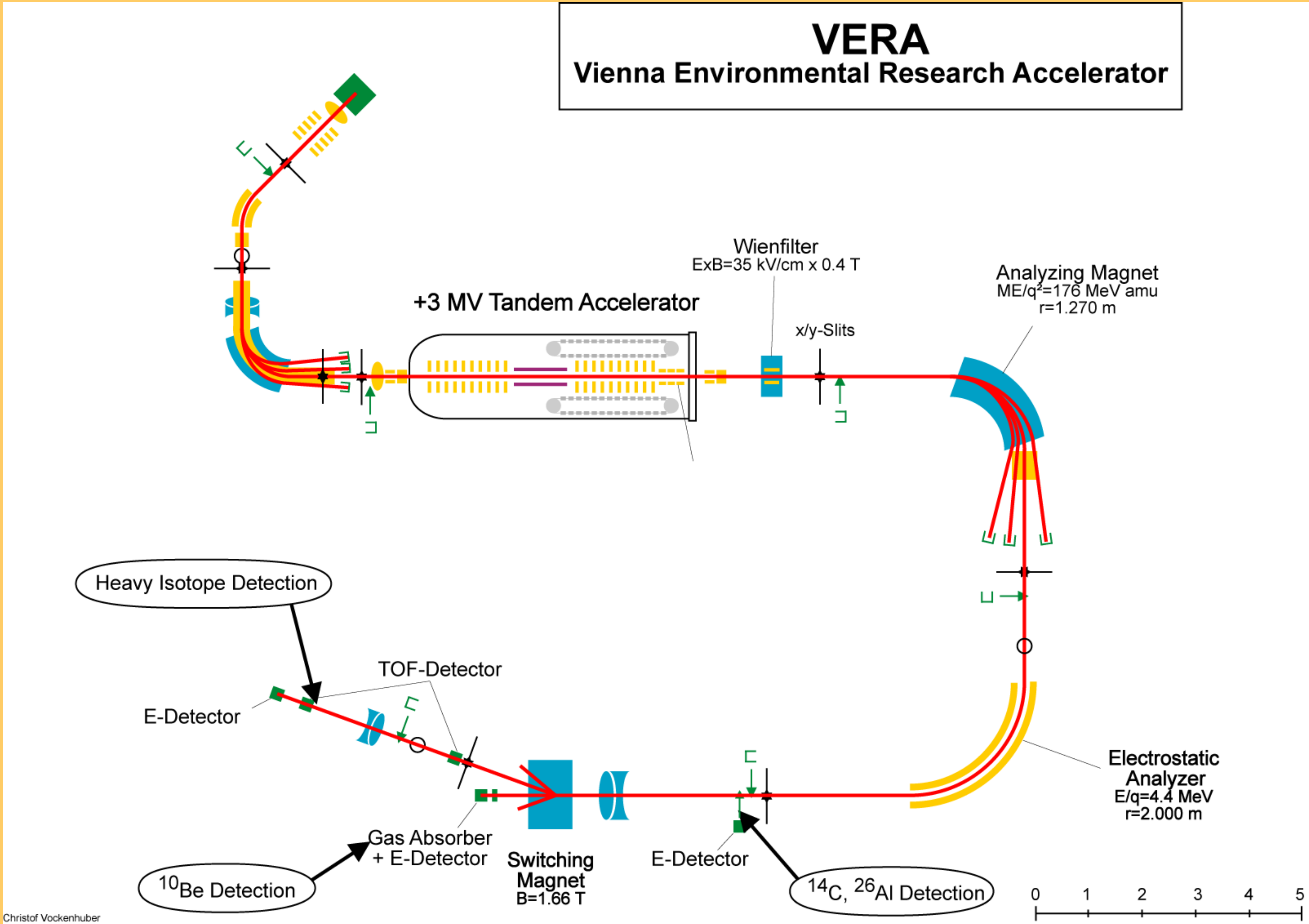


- is a dedicated AMS facilty

Performance of other common detector types for heavy ions below 1 MeV/u

Silicon surface barrier (Si-SB) detectors
- quick radiation damage
- better resolution than DDs
- slower than DDs

Ionization chambers
- resolution better for heavy ions
- no radiation damage
- very slow
- very thin entrance windows needed => small

Specimens investigated

3× Natural Diamond Detectors (NDD)

Provided by V. Liechtenstein from the Kurchatov Institute, Moscow

- Thickness 200 μm
- 1×Aluminum contact (2 μm)
- 1×Carbon contact (10 $\mu g/cm^2$)
- 1×Gold contact (20 $\mu g/cm^2$)

1× Chemical Vapor Deposition Single Crystal Diamond Detector (SC-CVDDD), thickness 320 μm

Provided by E. Berdermann, GSI, Darmstadt

- Thickness 320 μm
- Aluminum contact (100 nm)

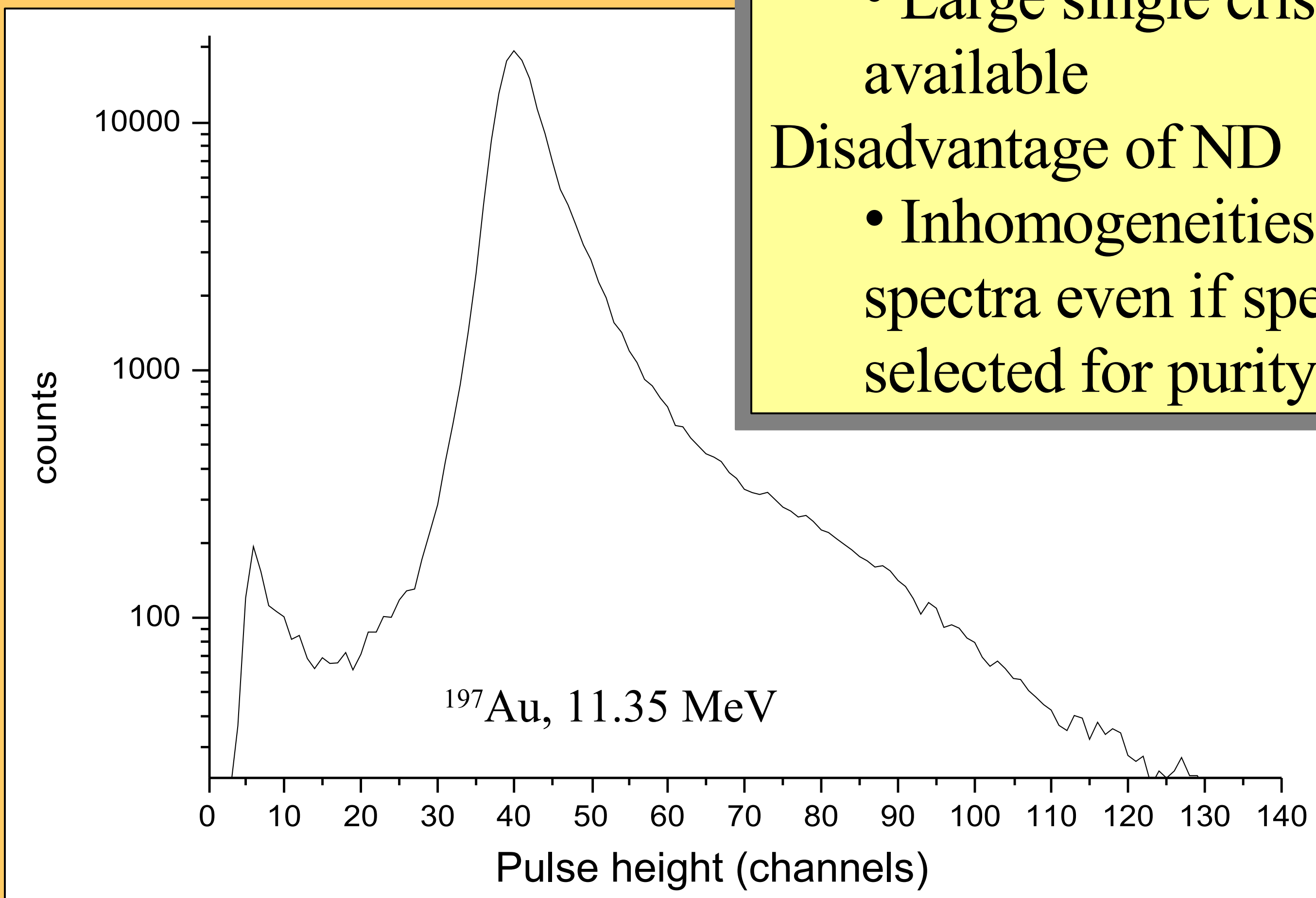
Natural diamond is inhomogenous

Advantage of ND

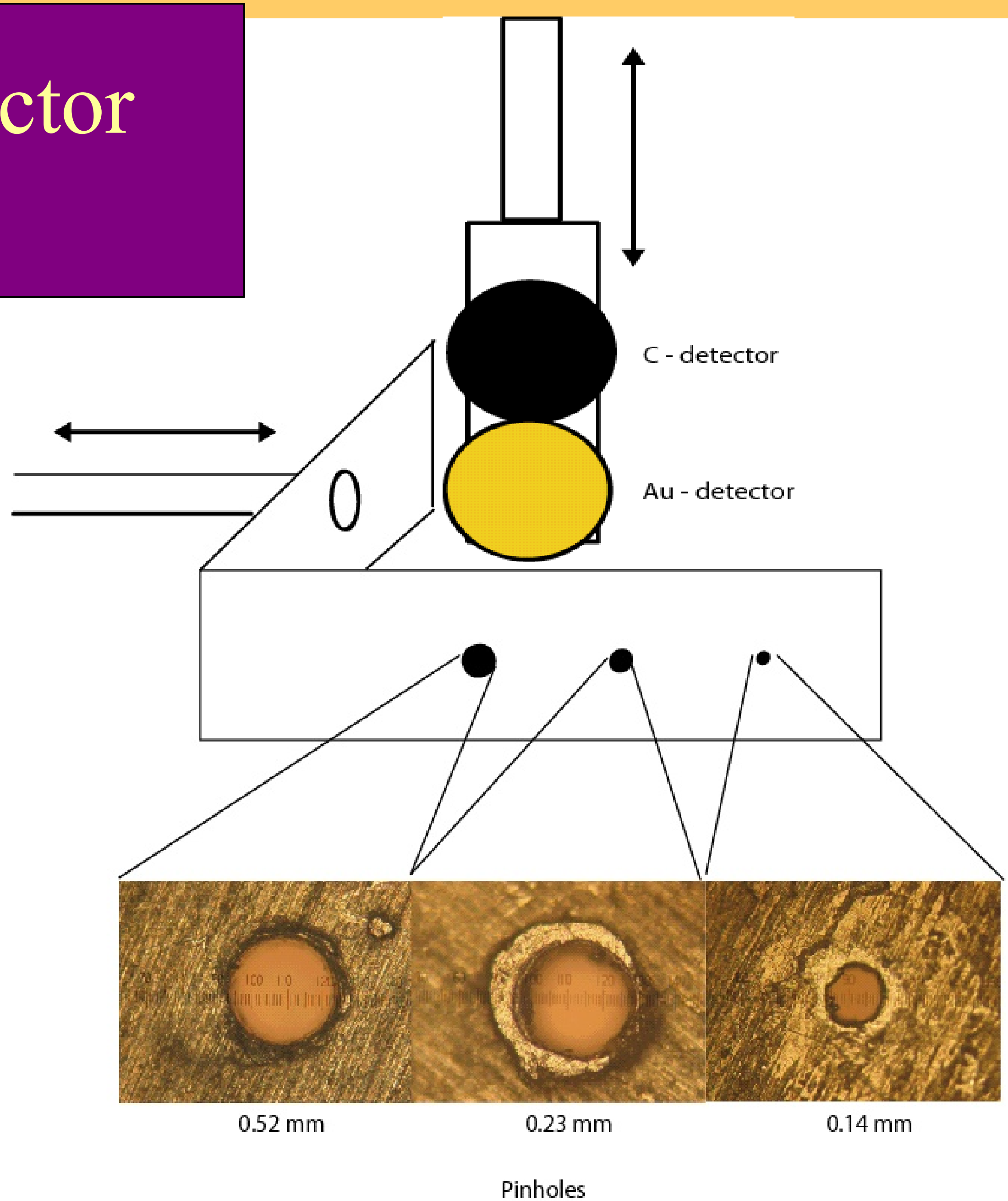
- Large single cristals, readily available

Disadvantage of ND

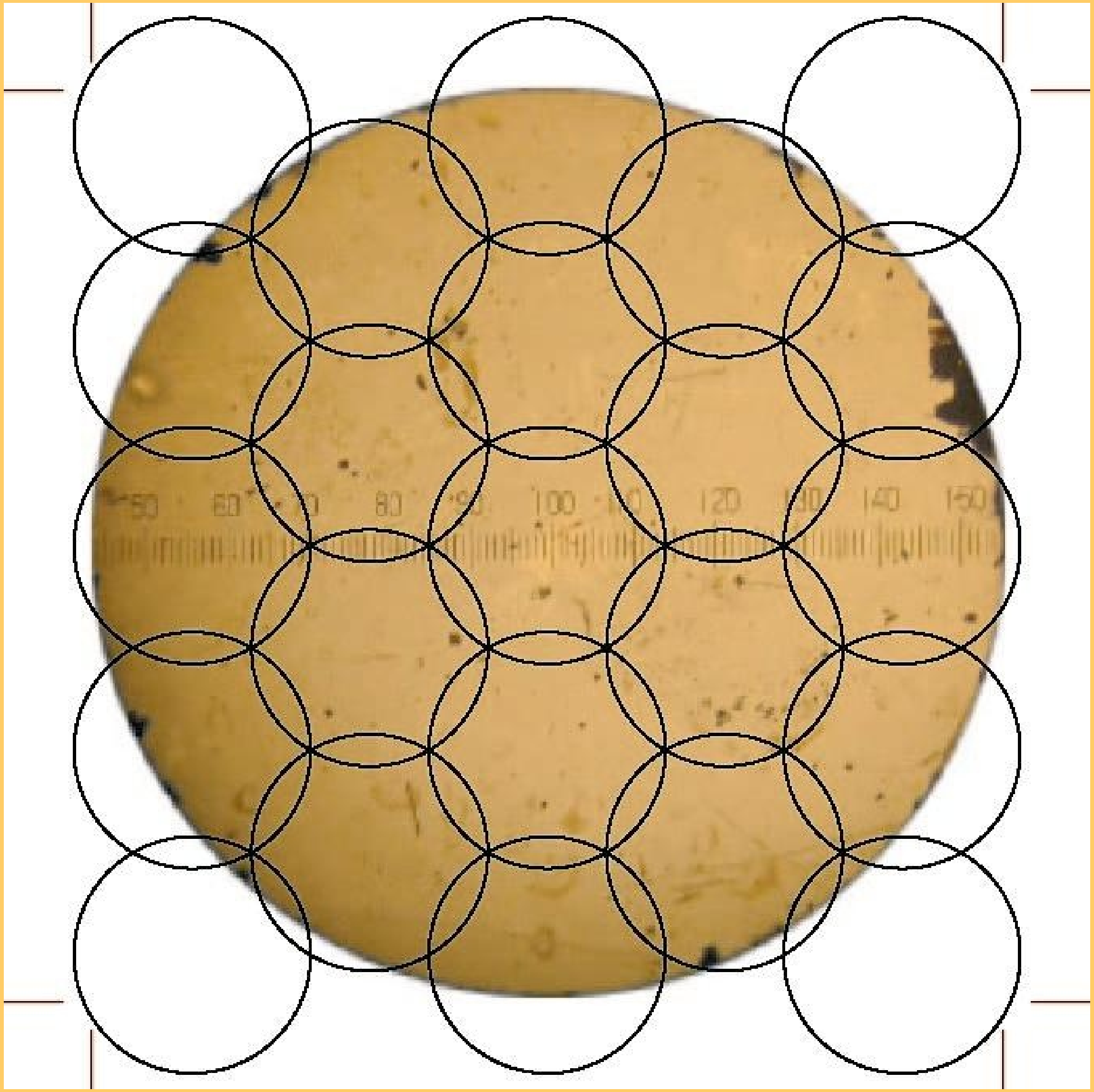
- Inhomogeneities lead to „strange“ spectra even if specimens are hand selected for purity.



Setup for detector mapping

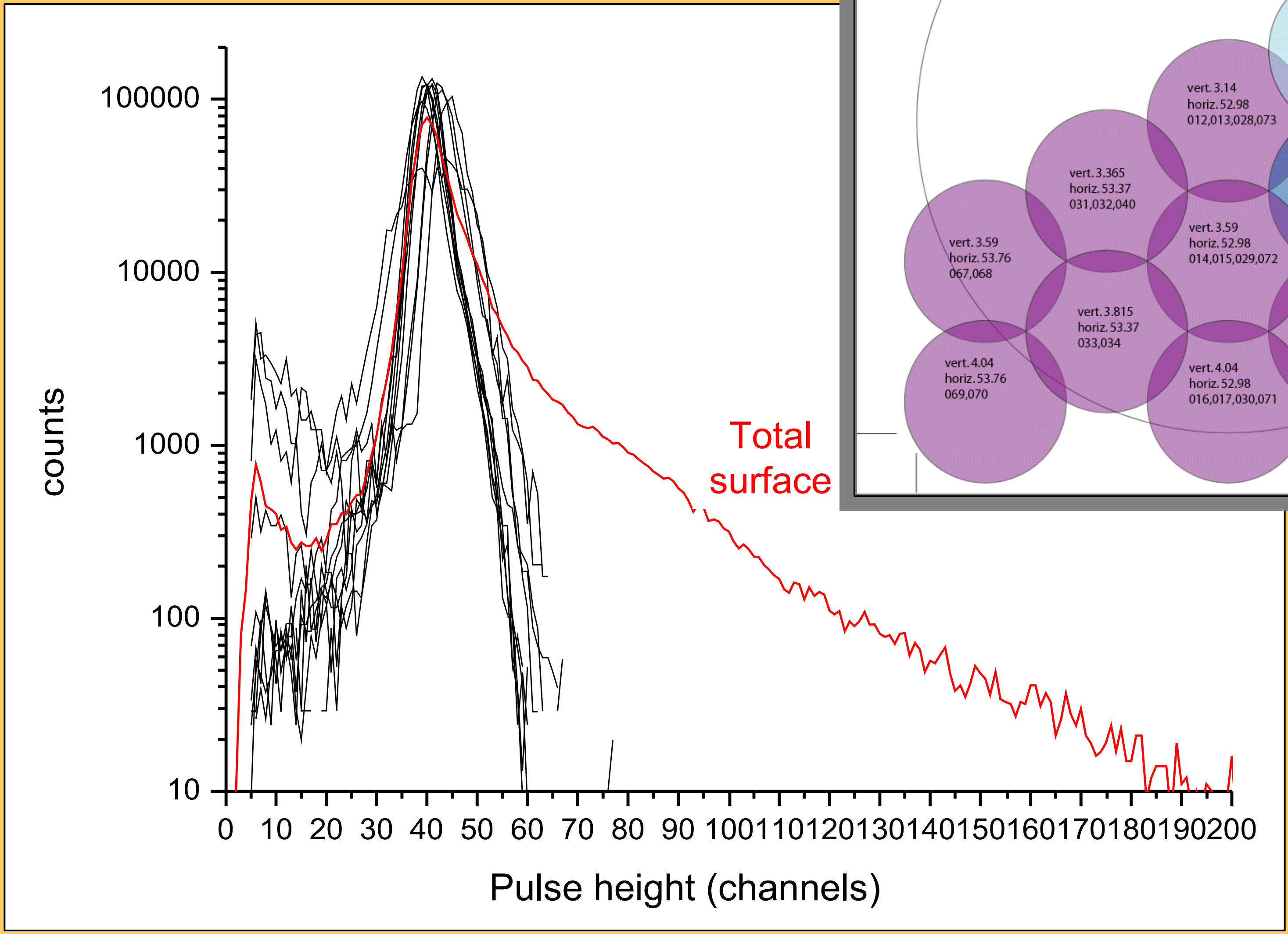


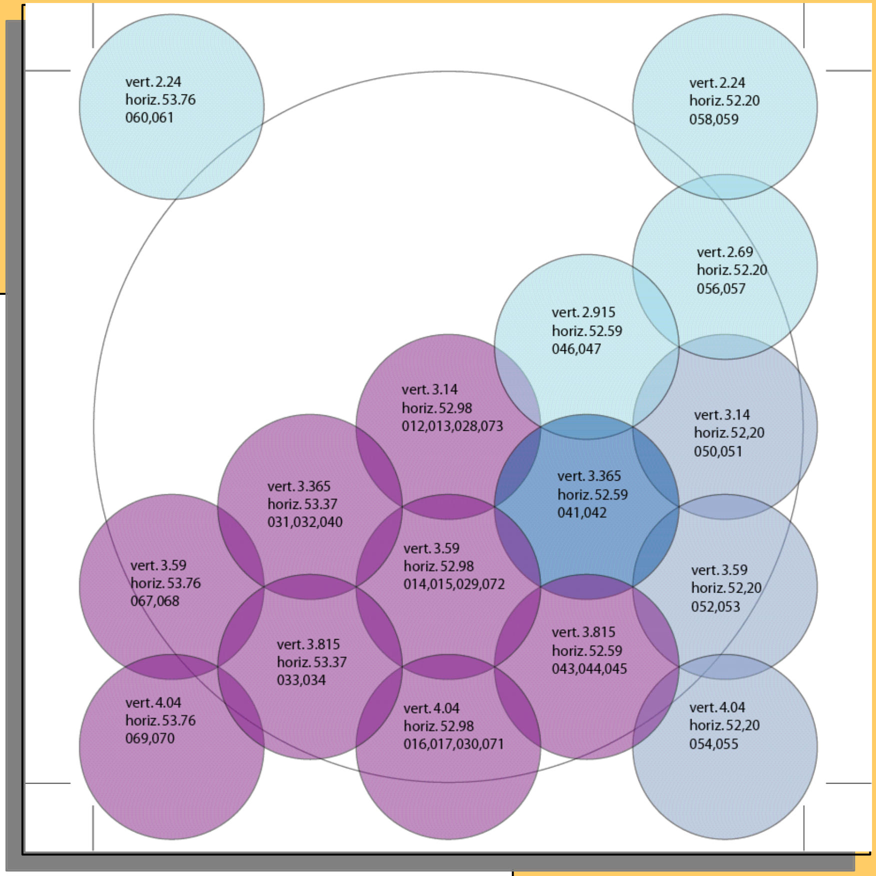
Microscope image of NDD



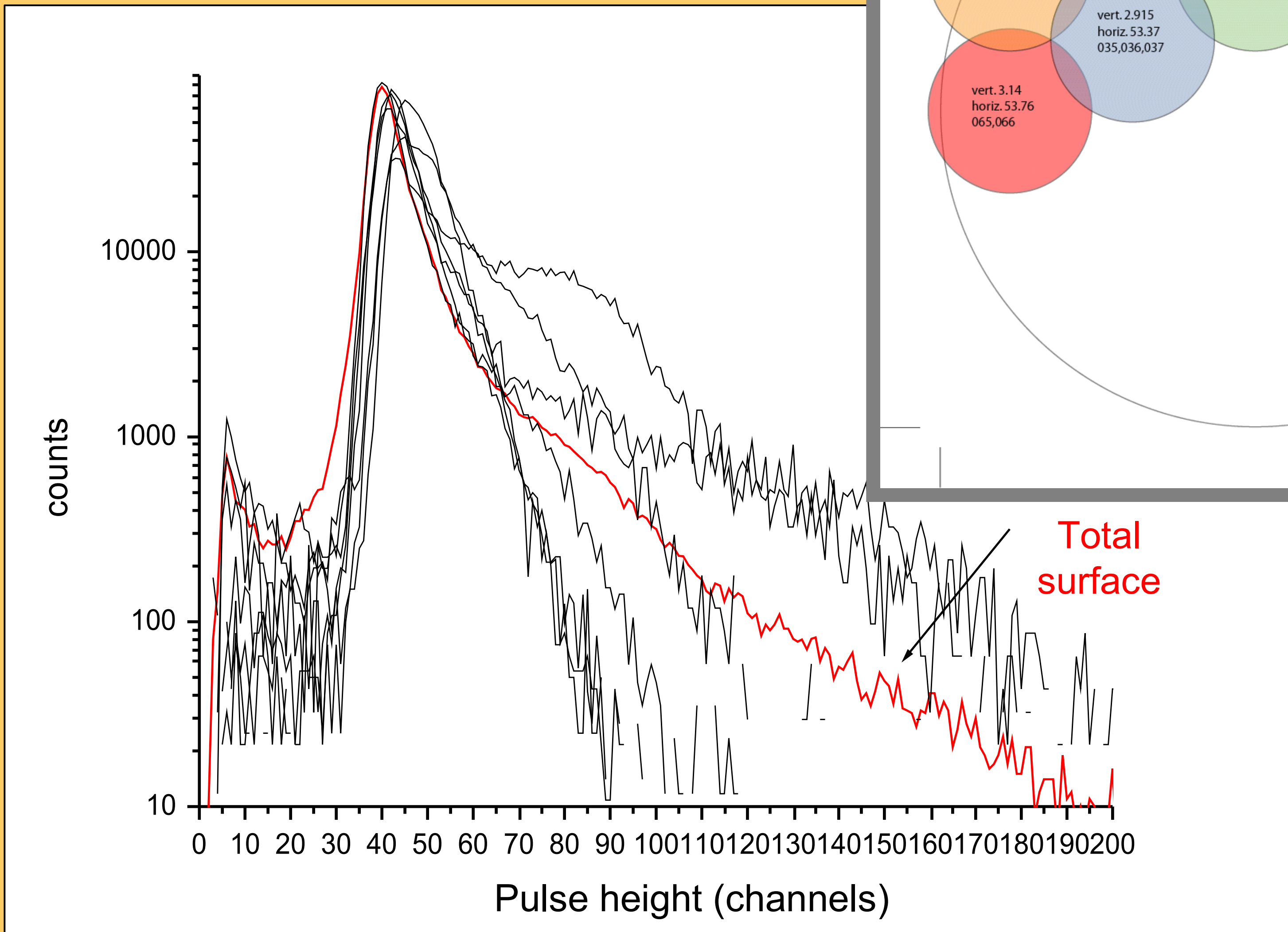
2 mm
diameter

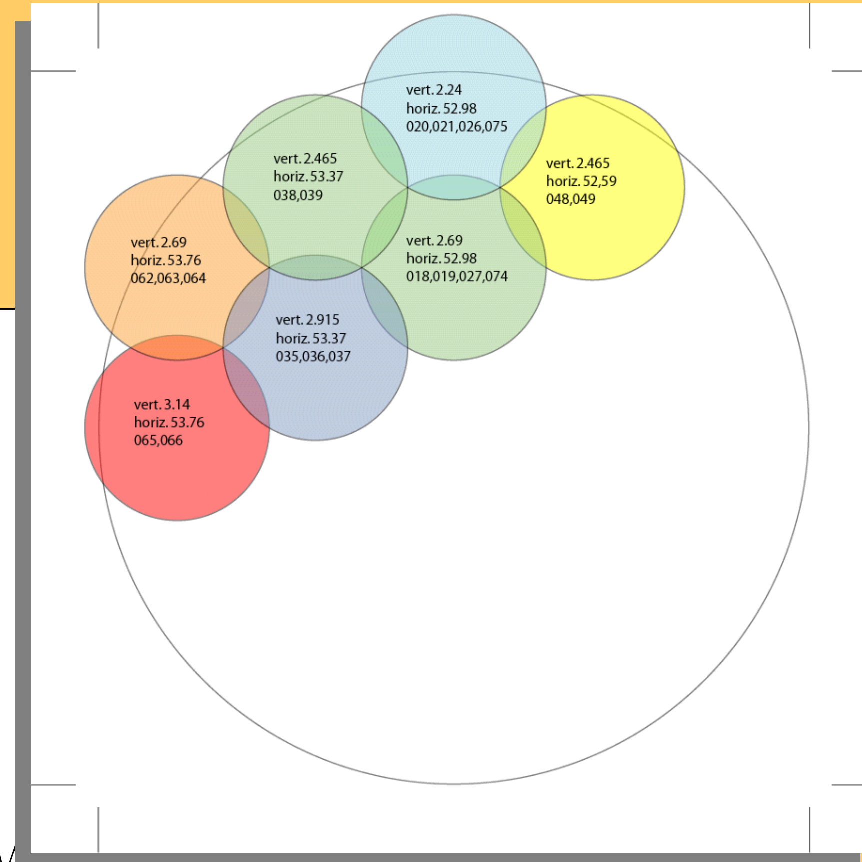
„Good“ regions



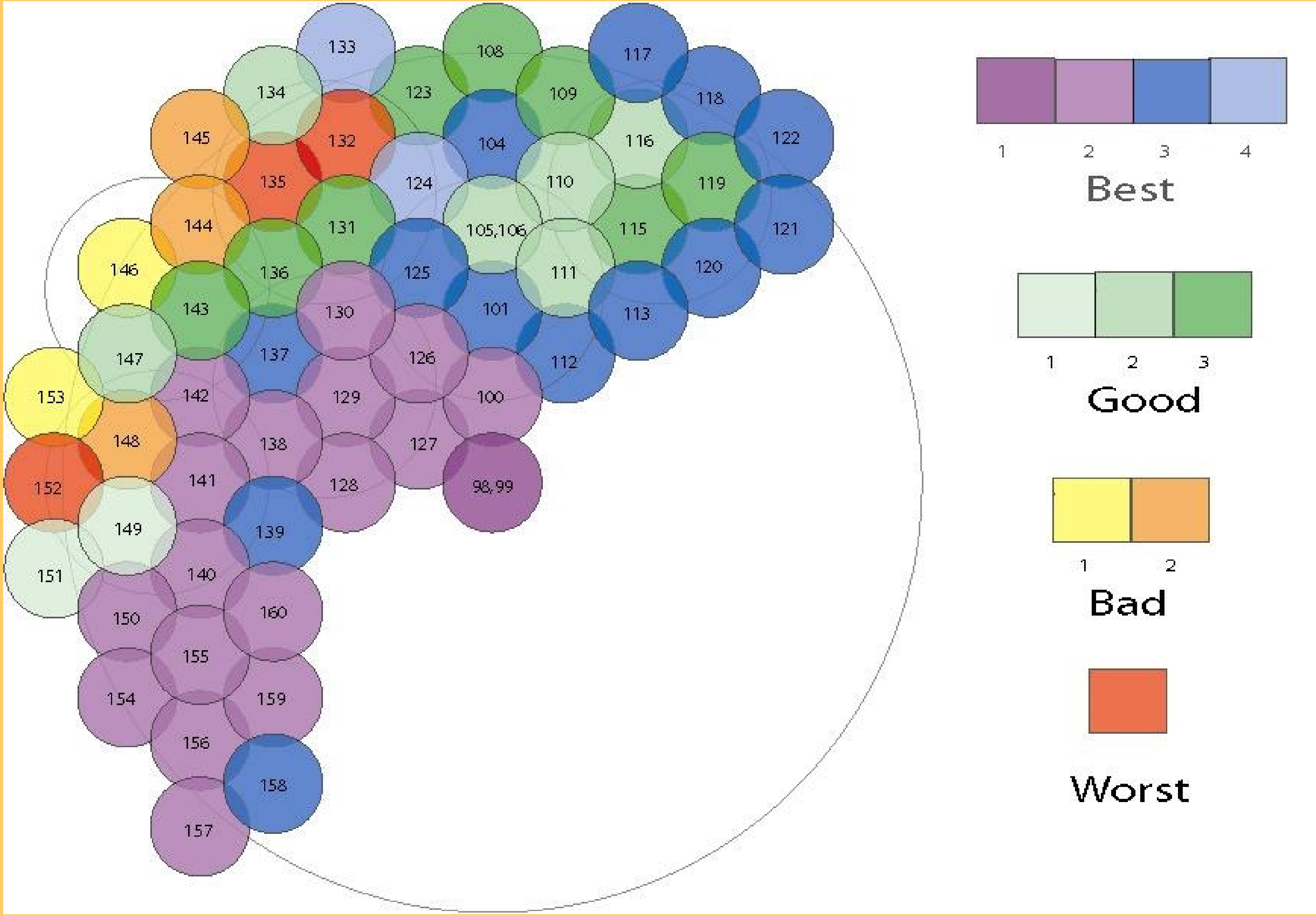


„Bad“ regions

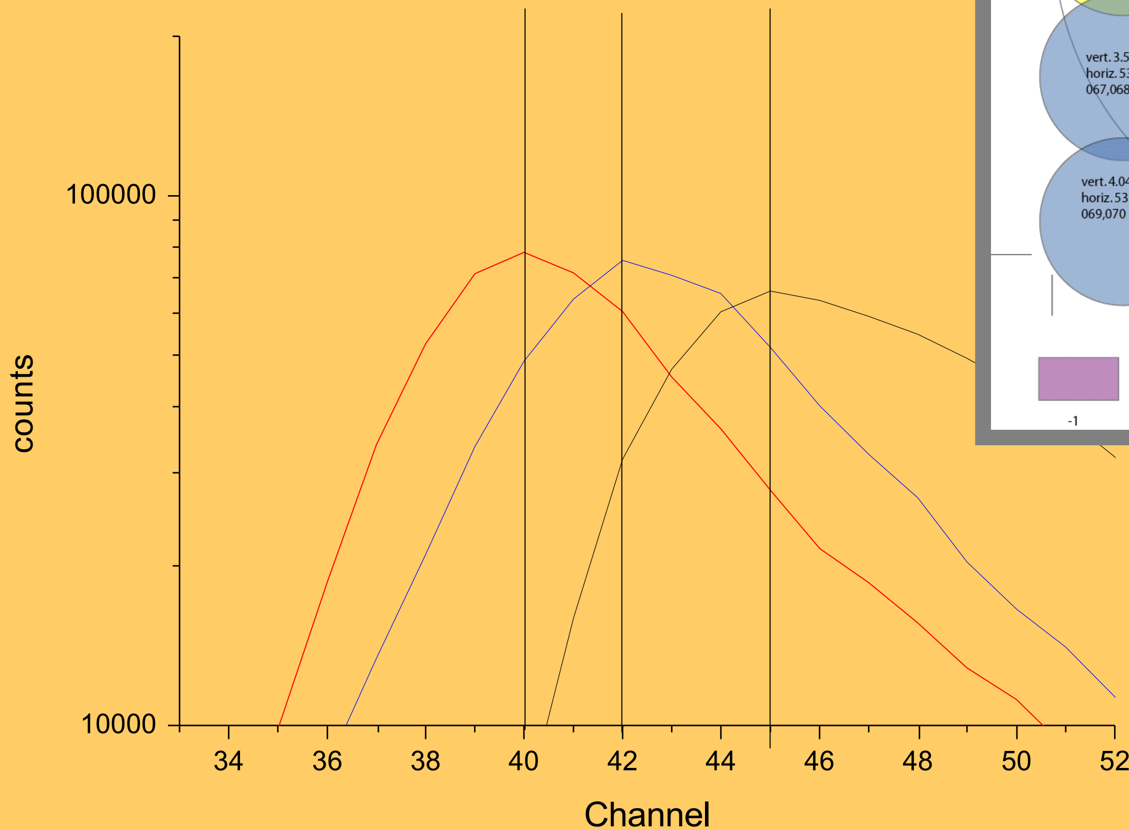

counts
10000
1000
100
10
0 10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200
Pulse height (channels)
Total surface


vert. 2.24
horiz. 52.98
020,021,026,075
vert. 2.465
horiz. 53.37
038,039
vert. 2.465
horiz. 52,59
048,049
vert. 2.69
horiz. 53.76
062,063,064
vert. 2.69
horiz. 52.98
018,019,027,074
vert. 2.915
horiz. 53.37
035,036,037
vert. 3.14
horiz. 53.76
065,066

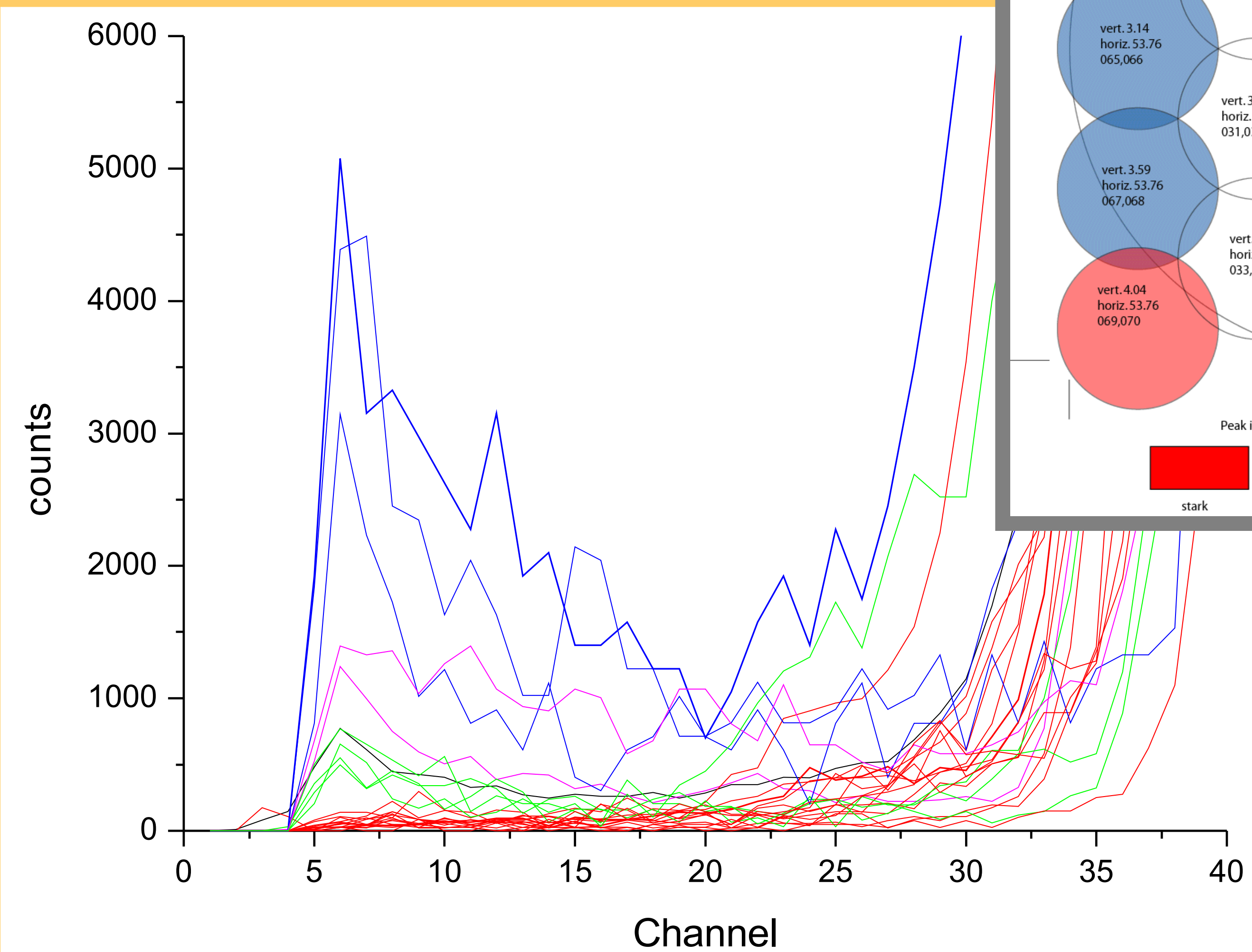
Bad regions at higher spatial resolution



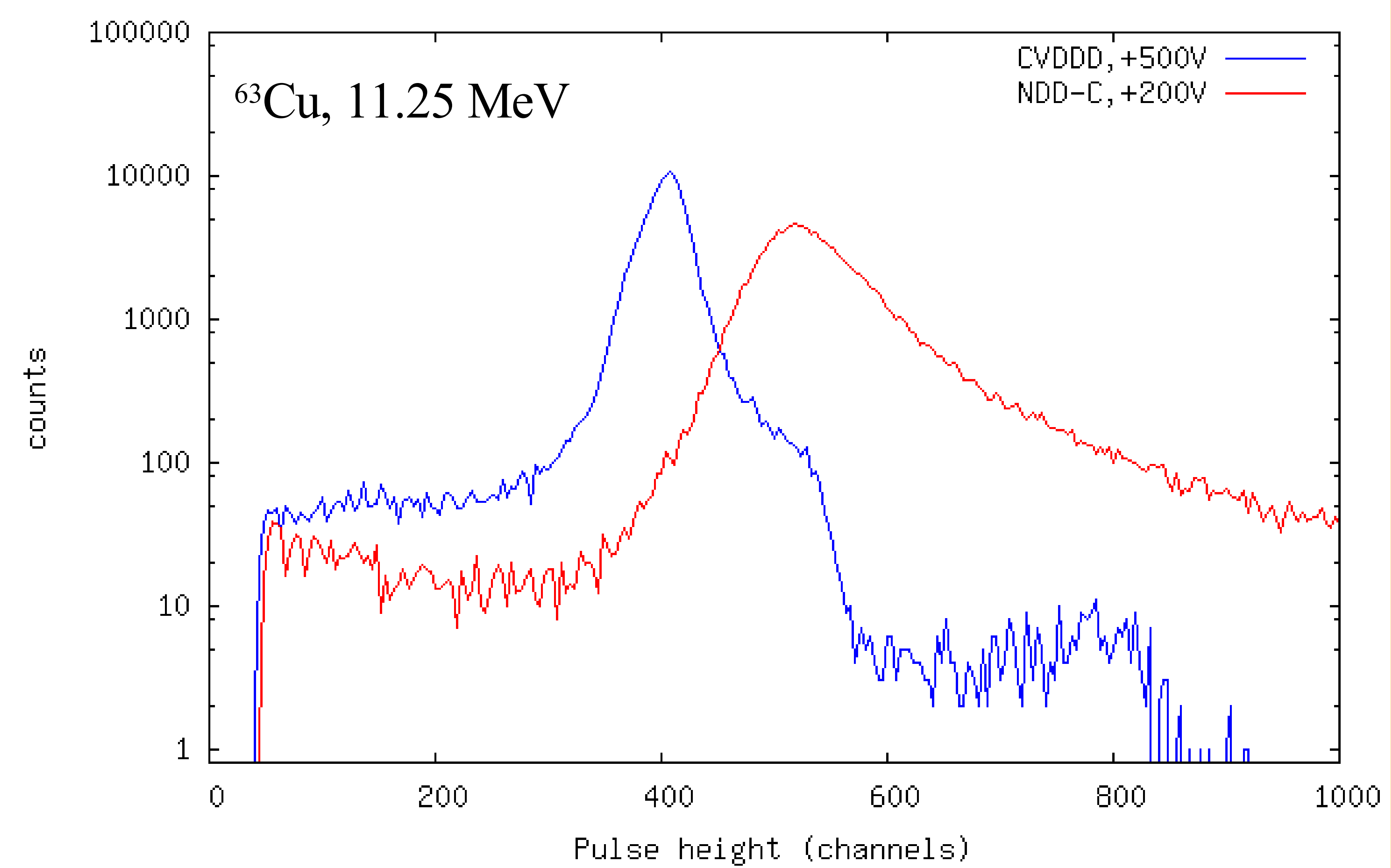
Shift of peak maximum



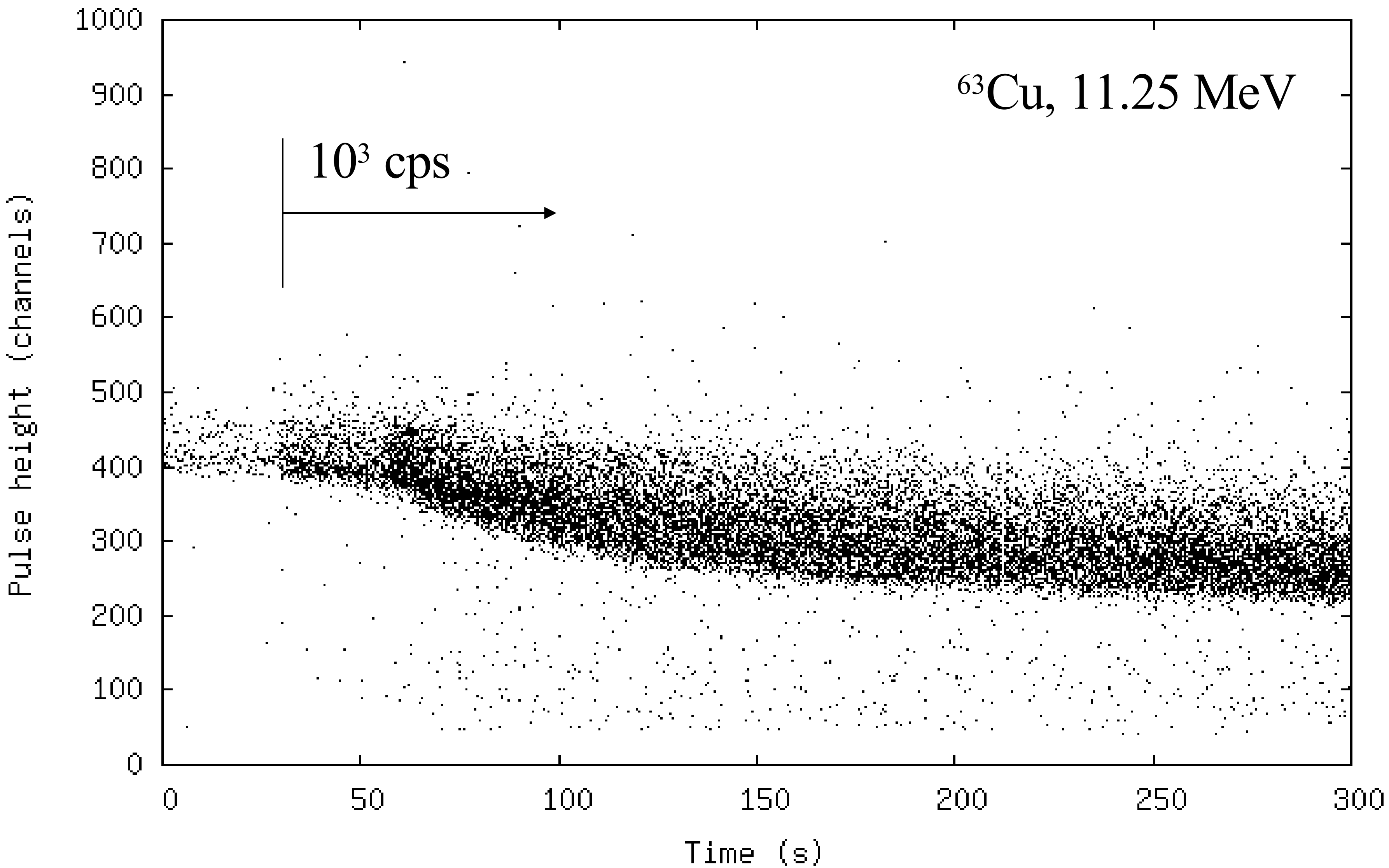
Low energy tails



CVDSCDD vs. NDD



Polarization of CVDSCD



Preparation of NDDs

• Octahedra crystals cut with laser cutting technique along the easiest slicing plates <100> or <110>.

• Polished with synthetic diamond polishing powder (4 microns).

• Cleaning

  • washing with standard potassium dichromate ($K_2Cr_20_7$)-H_2SO_4 solution

  • washing in ammonia solution

  • washing in (high purity) distilled water.

• Selection:

  • measuring the photoconductivity and absorption coefficient for UV to ensure nitrogen concentration below 10^{16} cm^{-3}.

  • overall purity deduced from the carrier lifetimes estimated from photocurrent.

  • measure I-VS curves

  • α-particles

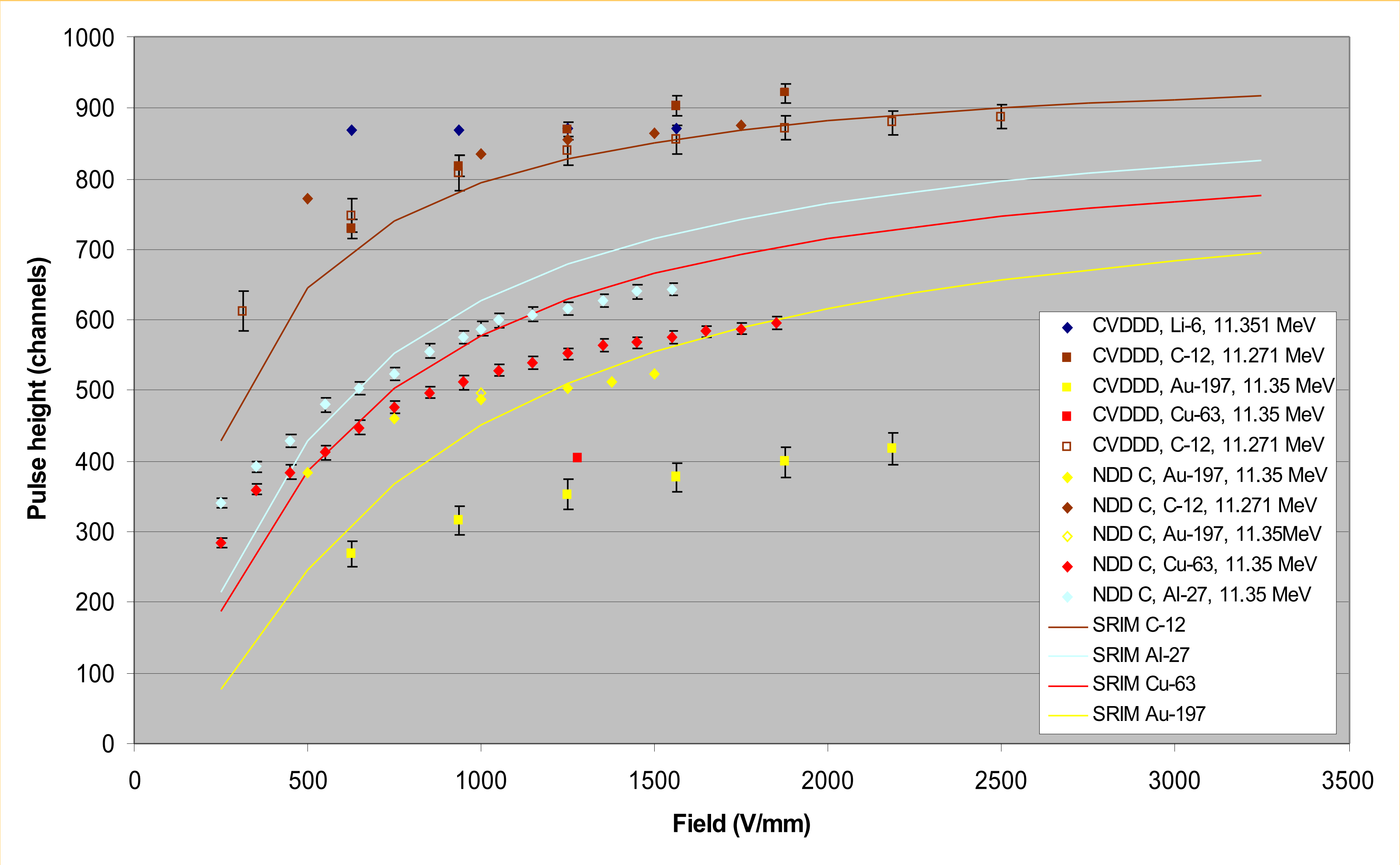
• Formation of contacts: thinnest possible front windows with no care on adhesion and Ohmic properties of the contact films.

  • Au contact (20µg/cm^2): thermally evaporated onto the front surface

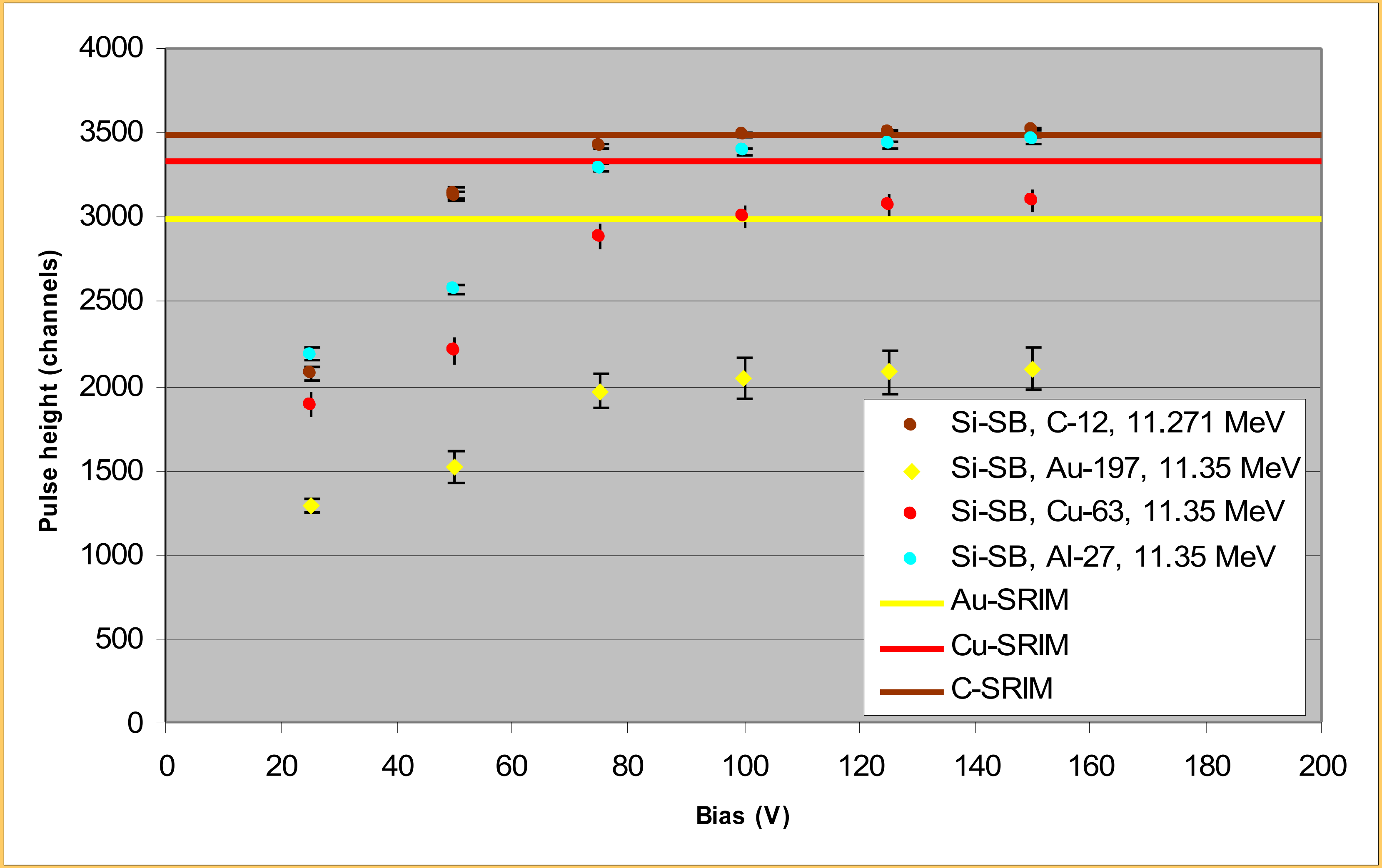
  • Carbon contact (10 µg/cm^2): thermal cracking of methyl iodide (~ 1 mbar) at the surface of the hot sample.

• Ag paste/compound used as backing contacts.

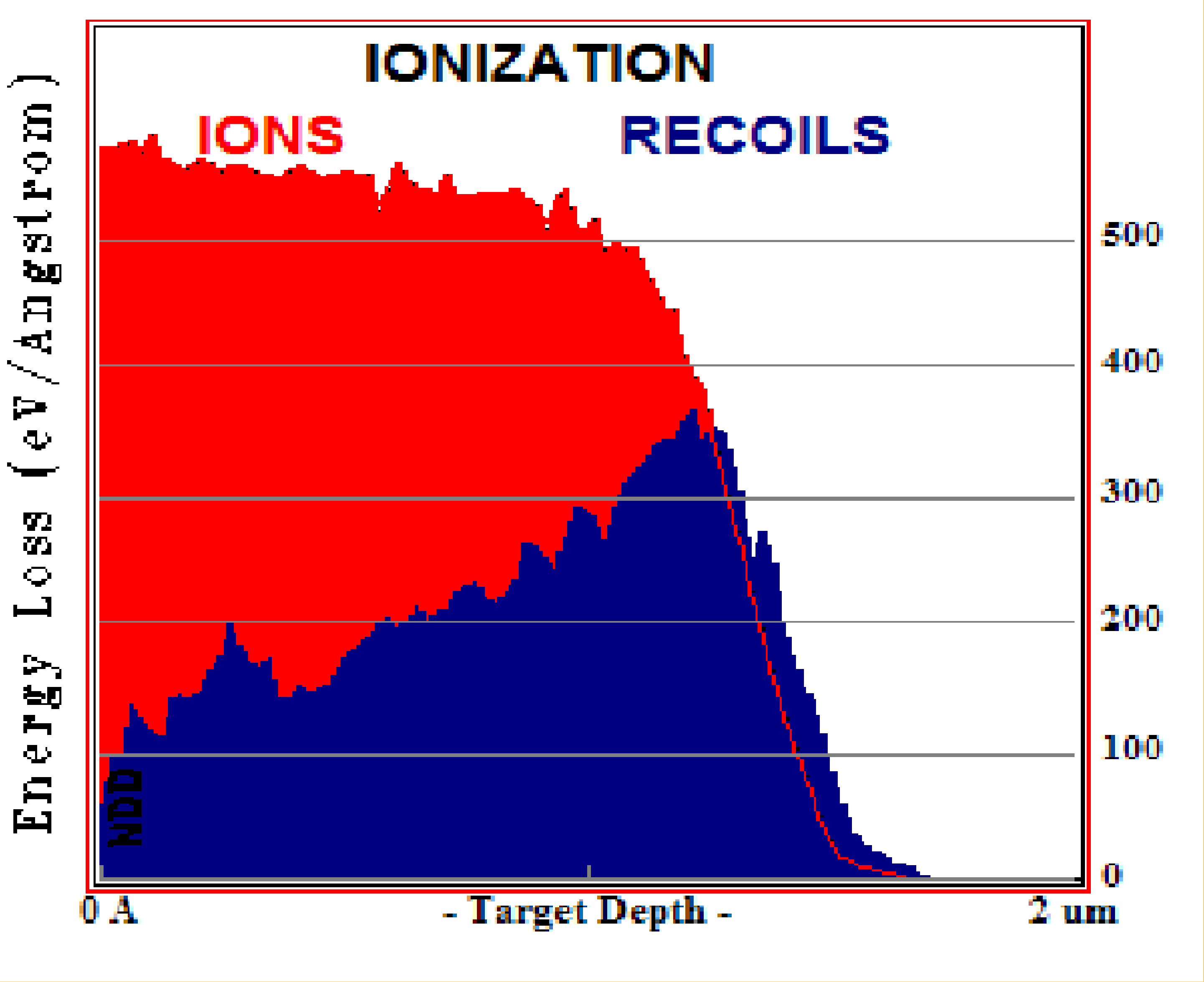
All measurements



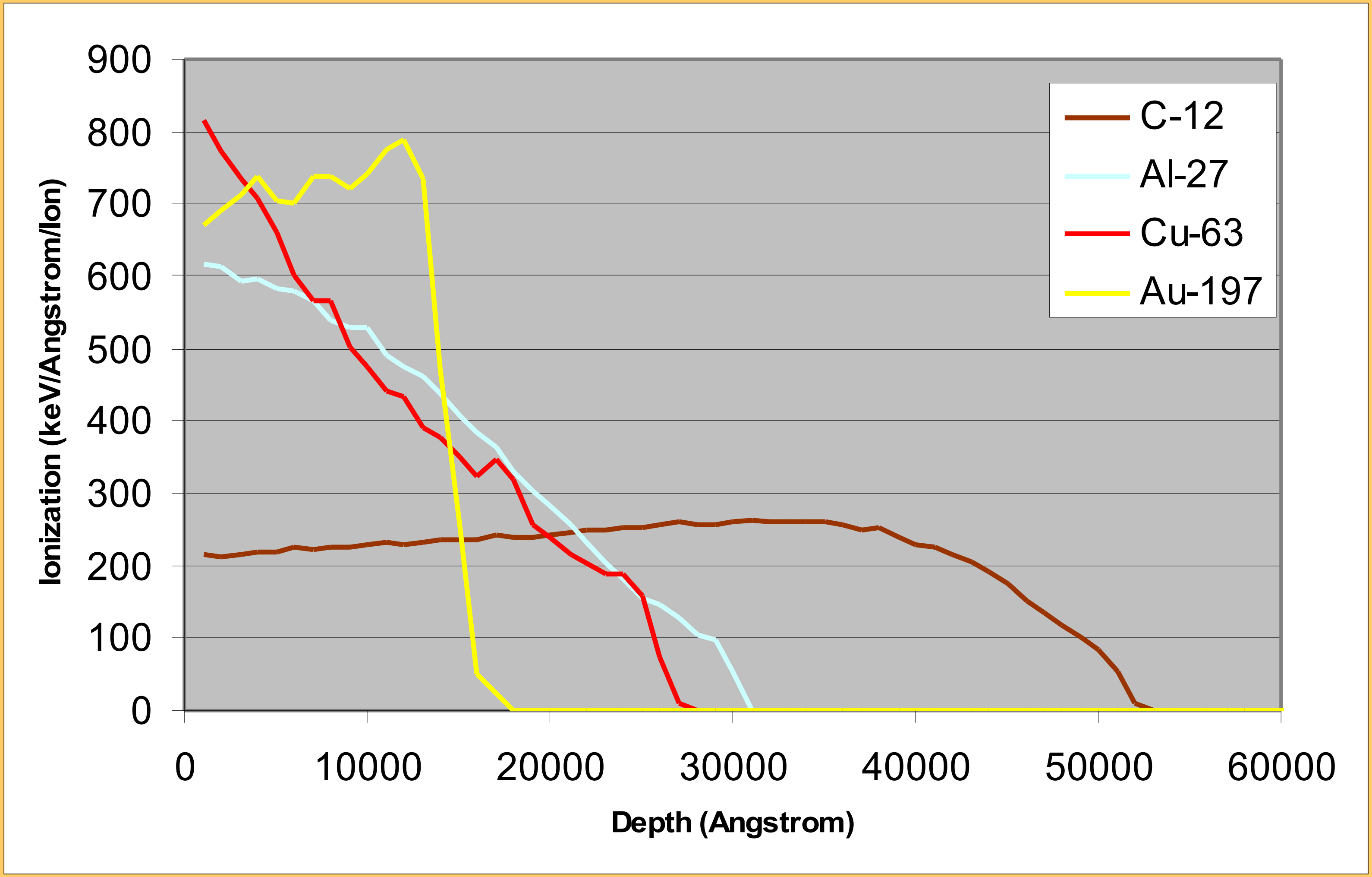
Measurements with Si-SB detector



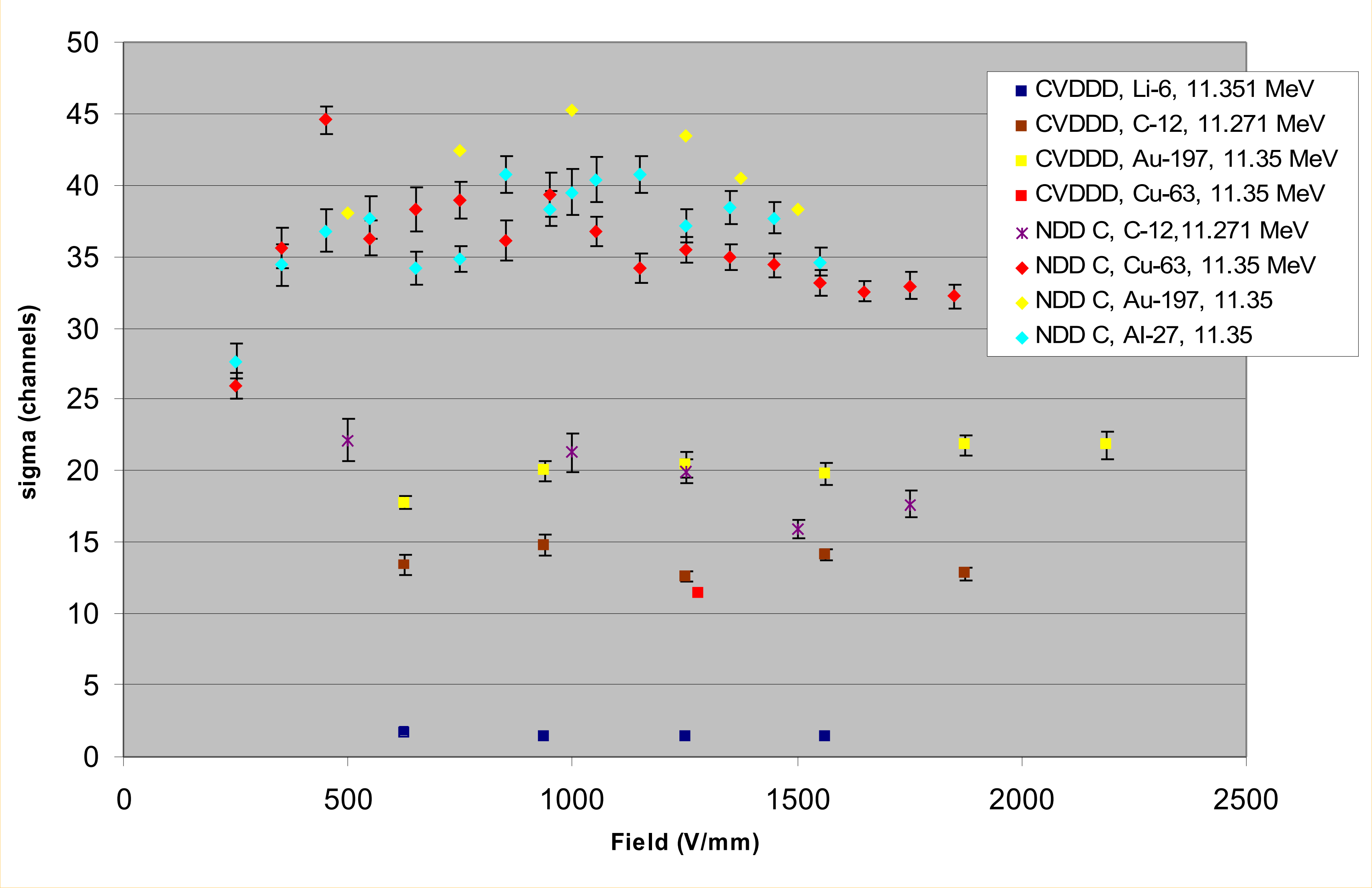
SRIM: ionization by recoils



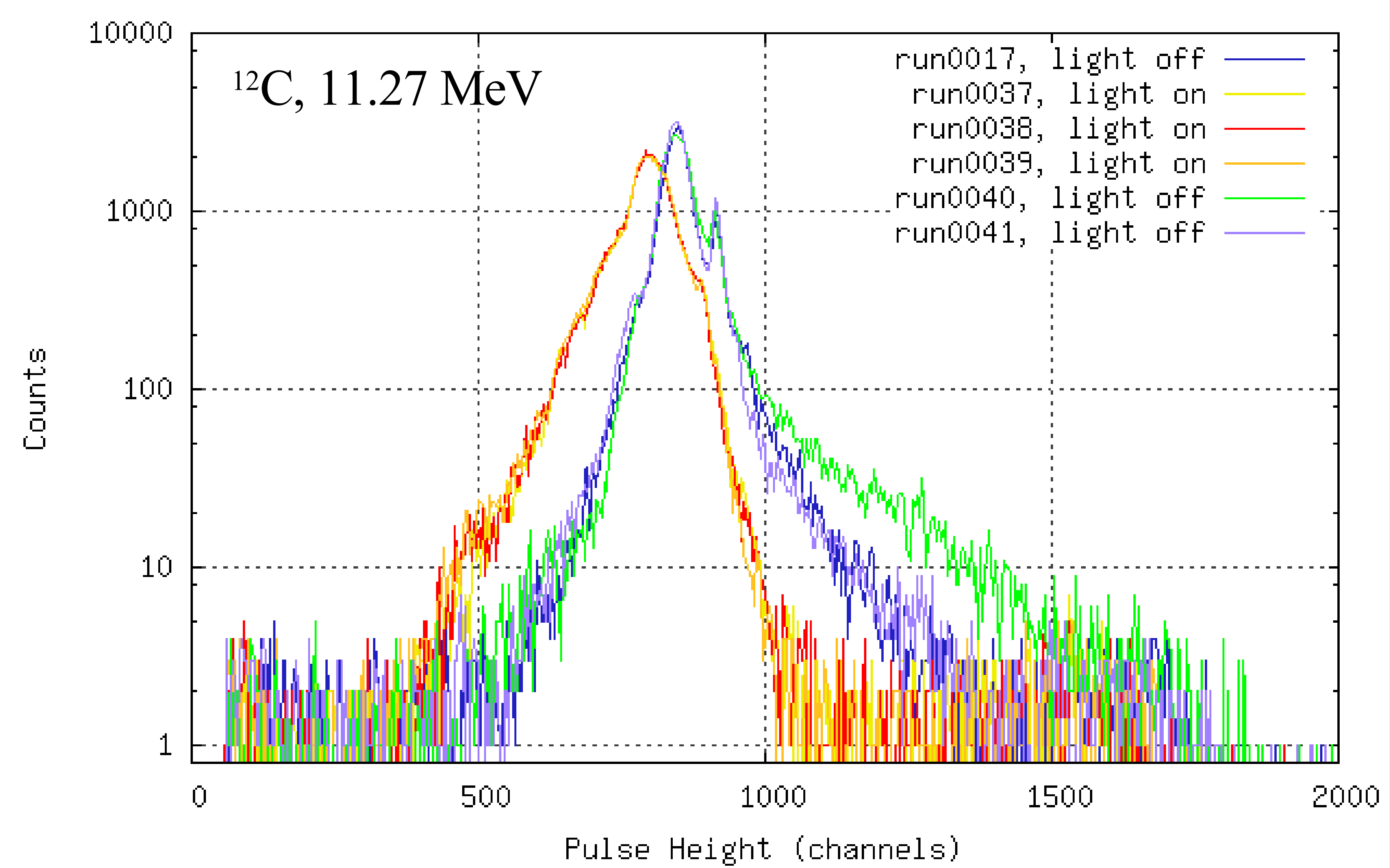
Modelling with SRIM



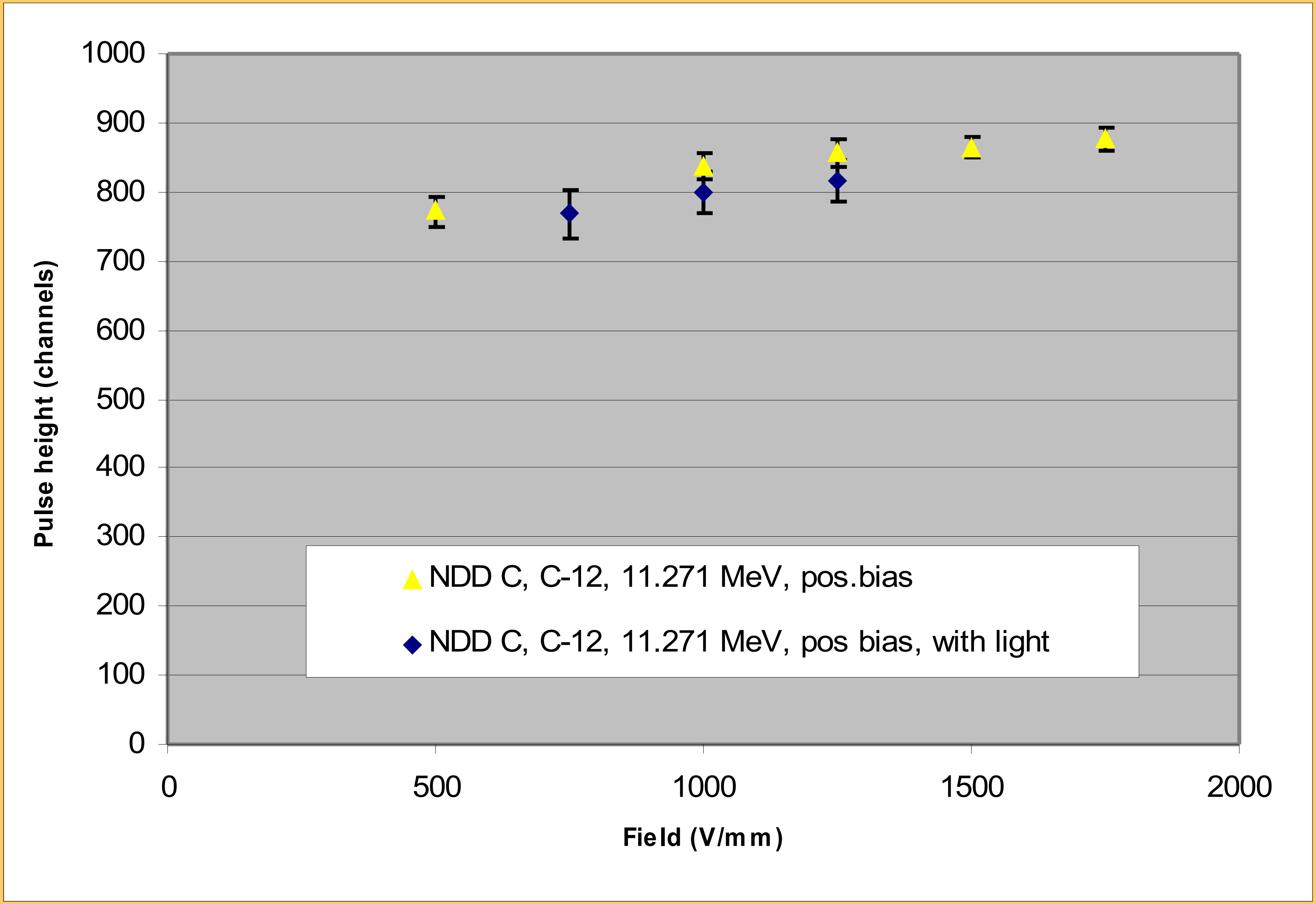
Resolution (standard deviation)



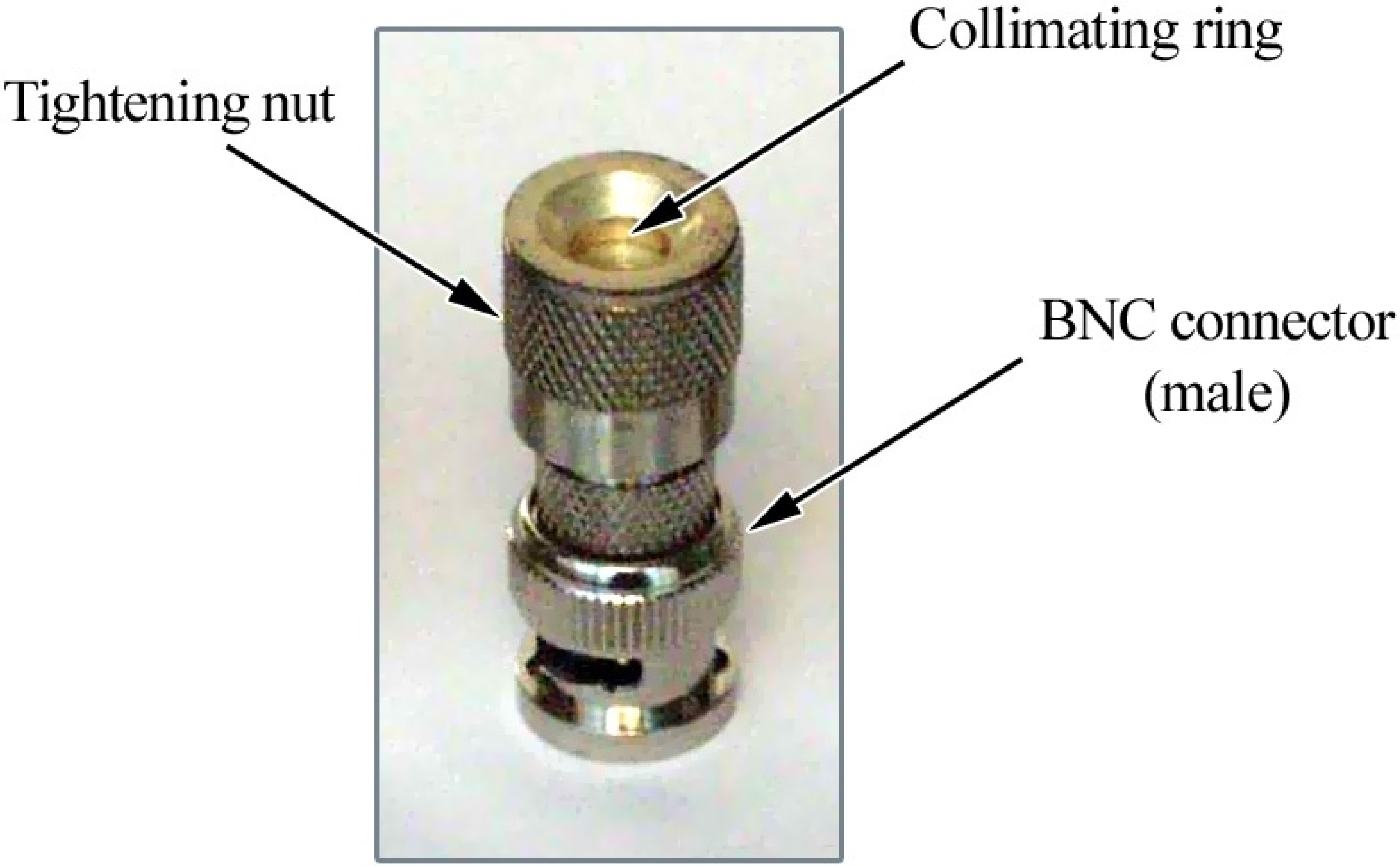
Influence of light



Influence of light



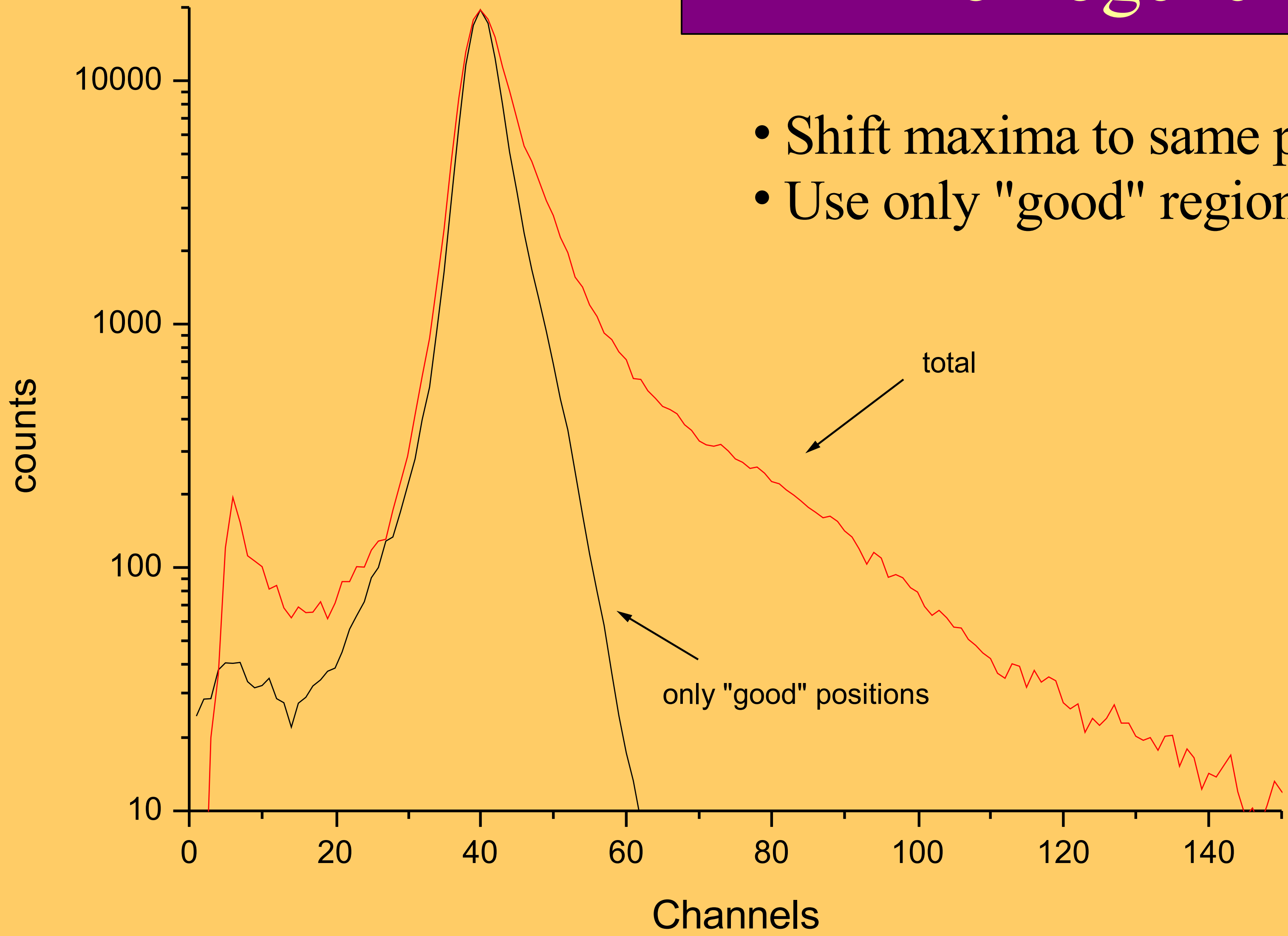
End of presentation



NDD1 assembly as
used at VERA-Lab

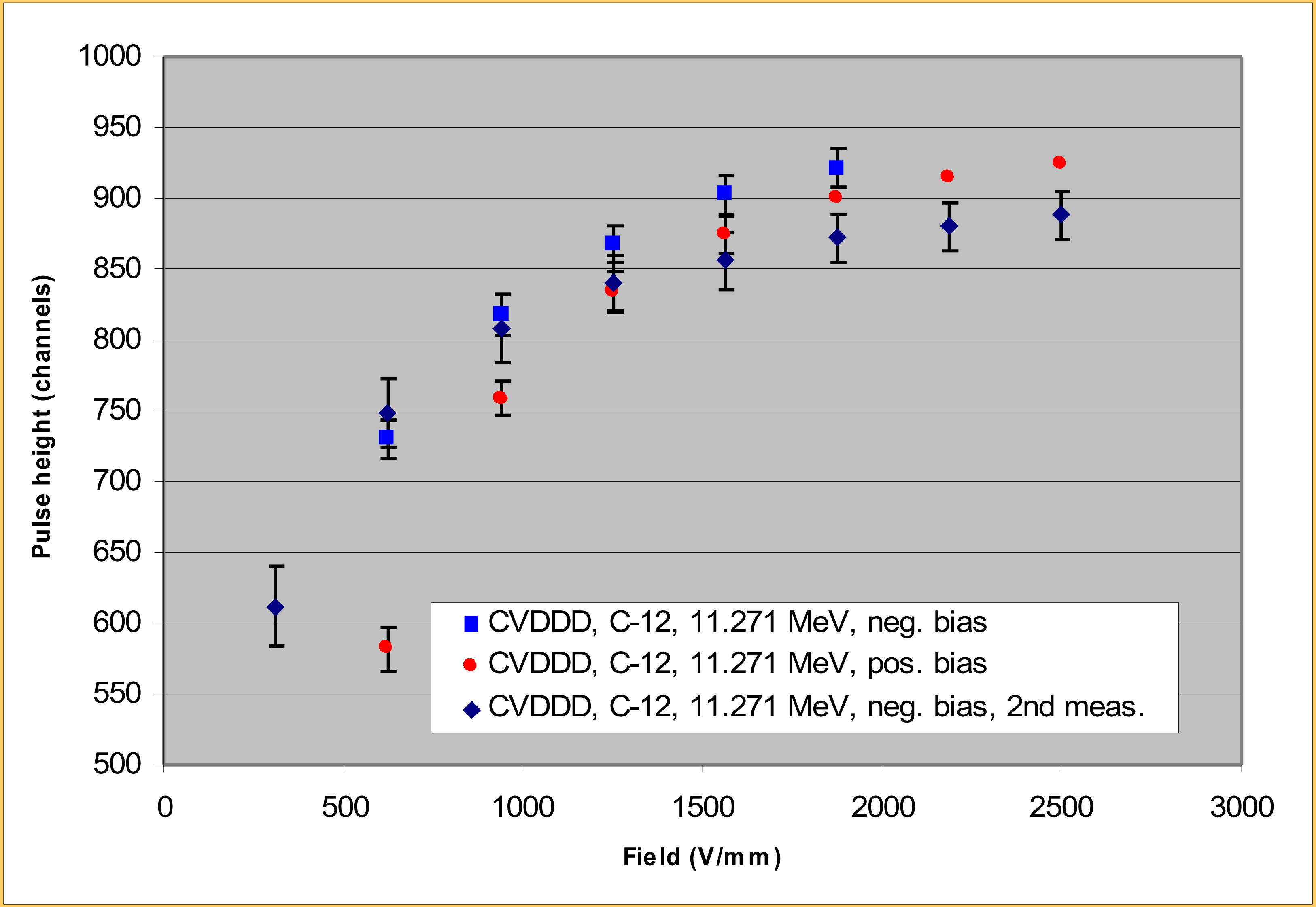
Spectra "corrected" for inhomogeneity

- Shift maxima to same position
- Use only "good" regions



Microscope image of NDD

Influence of bias polarity



Size of bad spots