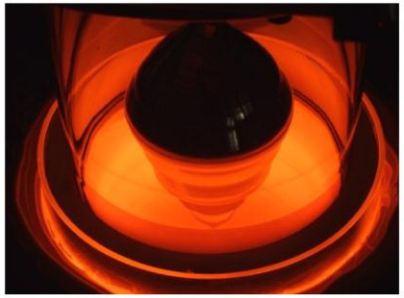
# Growth of large diameter high-purity germanium crystals for Nuclear Physics research



DE-SC0004256

**Presented by Ethan Hull , PHDS Co.**
Richard Pehl, PI

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**Collaboration with C.J. Lister at U. Mass Lowell**

- Large diameter germanium crystal scaling arguments
- Last year we demonstrated 90-mm diameter commercially viable HPGe wafers
  - Significant commercial success through GeGI
- This year 90 mm → 140 m diameter siege
- Technical Program
  - Growth of very large germanium crystals
  - **Demonstration of fully depleted operating 140-mm diameter HPGe detectors**
  - Complete 140 mm diameter NPX-M prototype detector system
  - Remaining crystal challenges

## MPGe

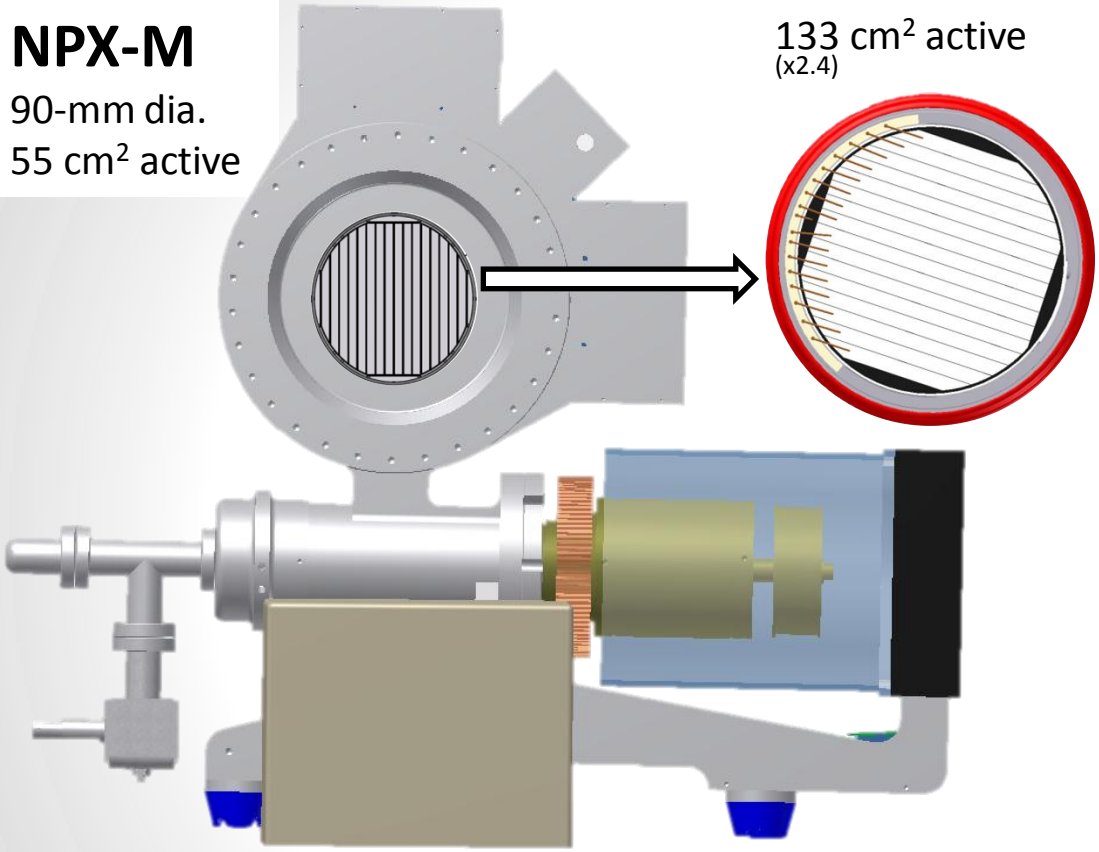
140-mm dia.

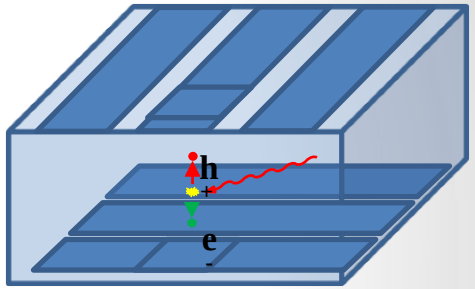
133 $cm^2$ active
(x2.4)

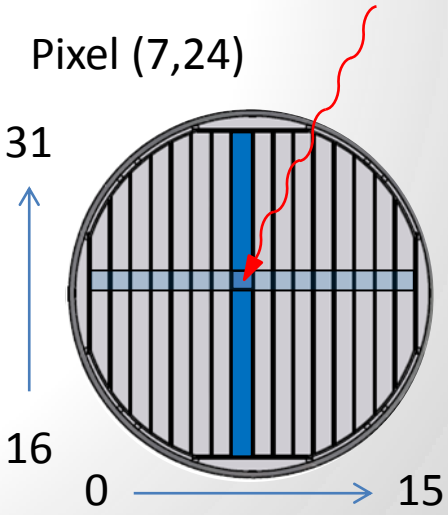
## NPX-M

90-mm dia.

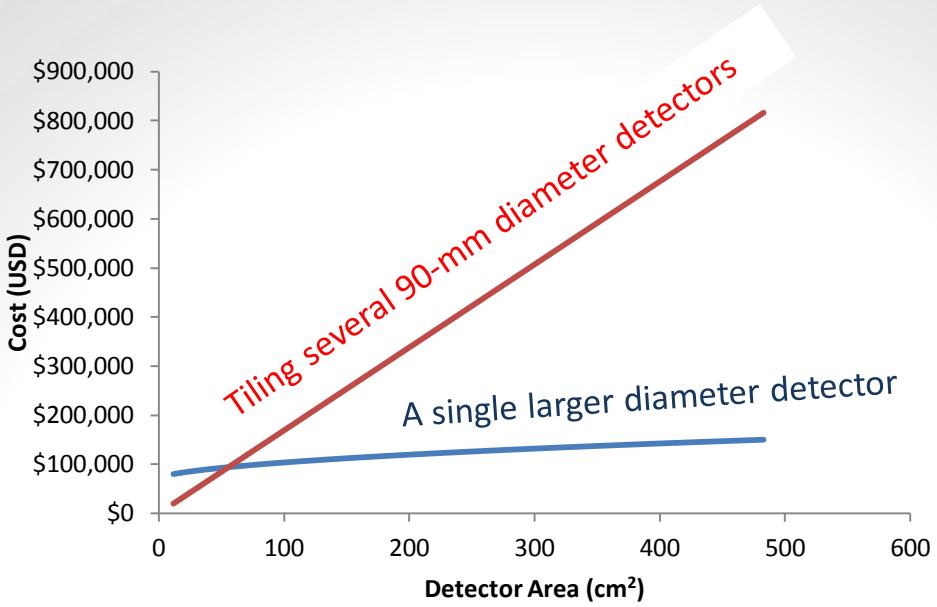
55 $cm^2$ active



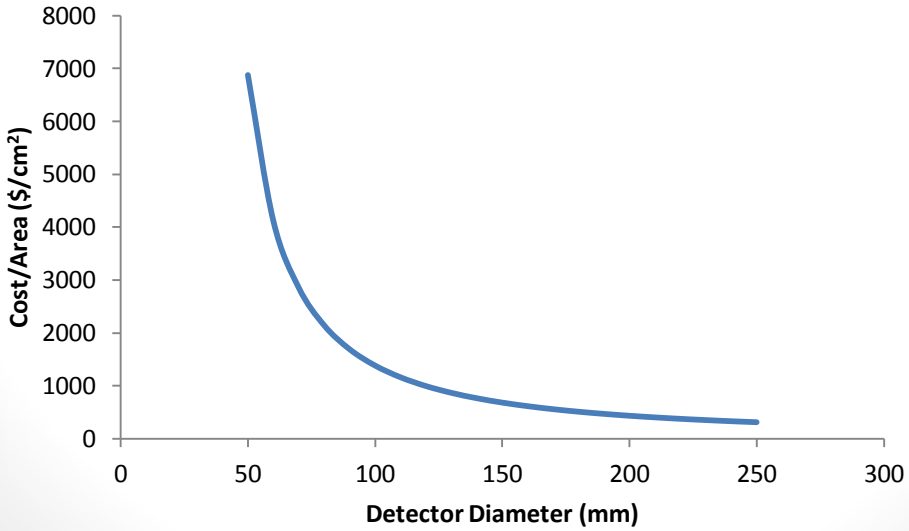



$N^2$ pixels from 2N strips (channels)
Because there are 2 signs of charge

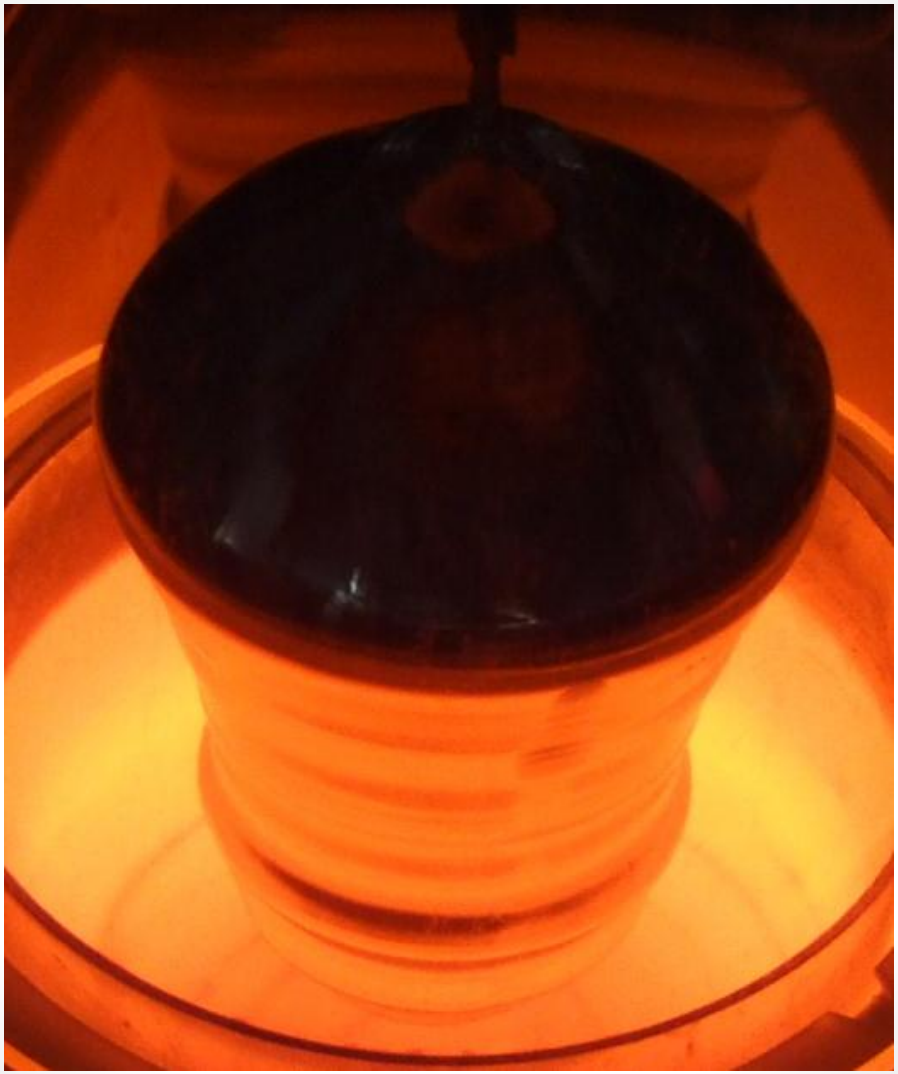



**Larger crystals**



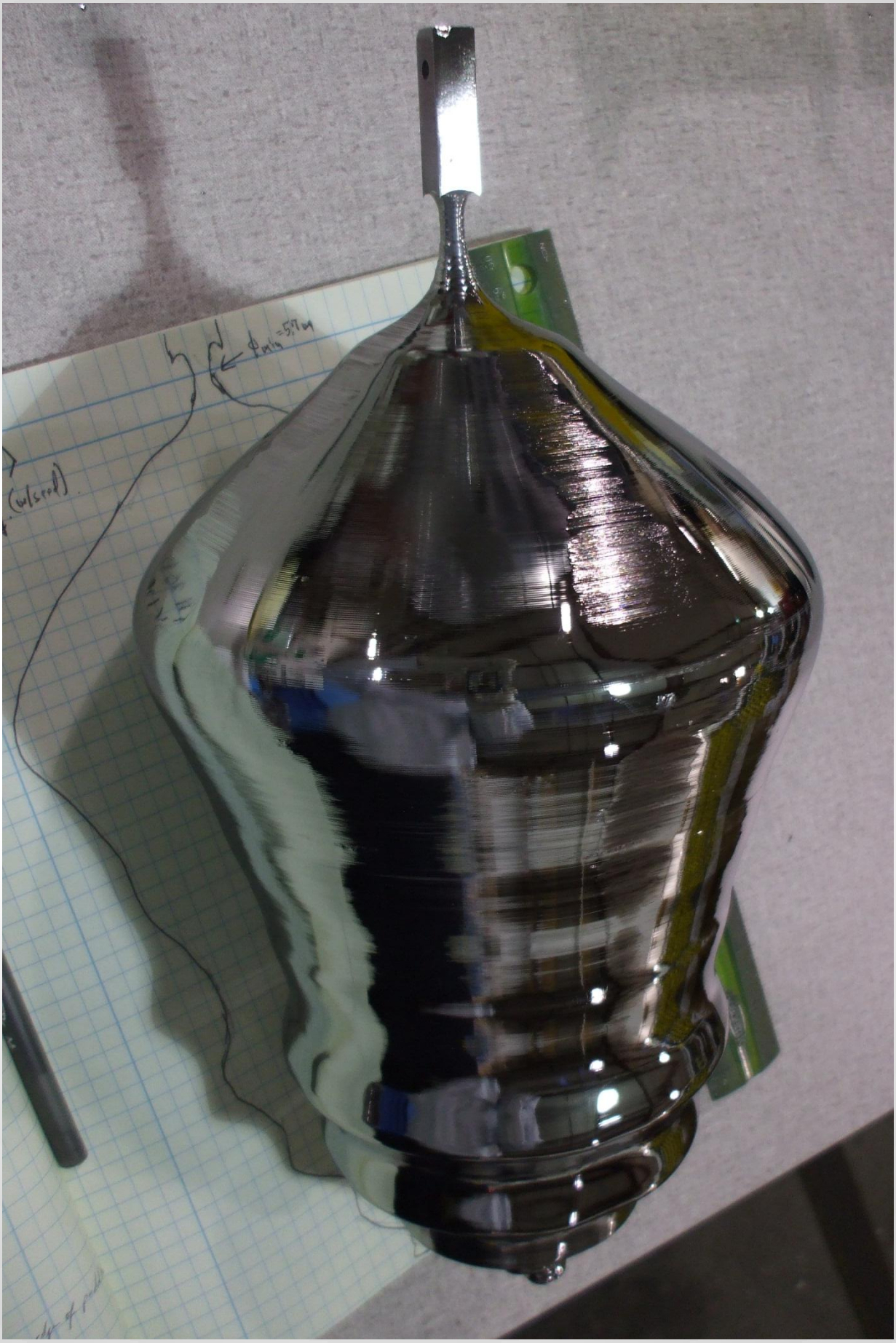

**2 signs of charge (pixels from strip)**

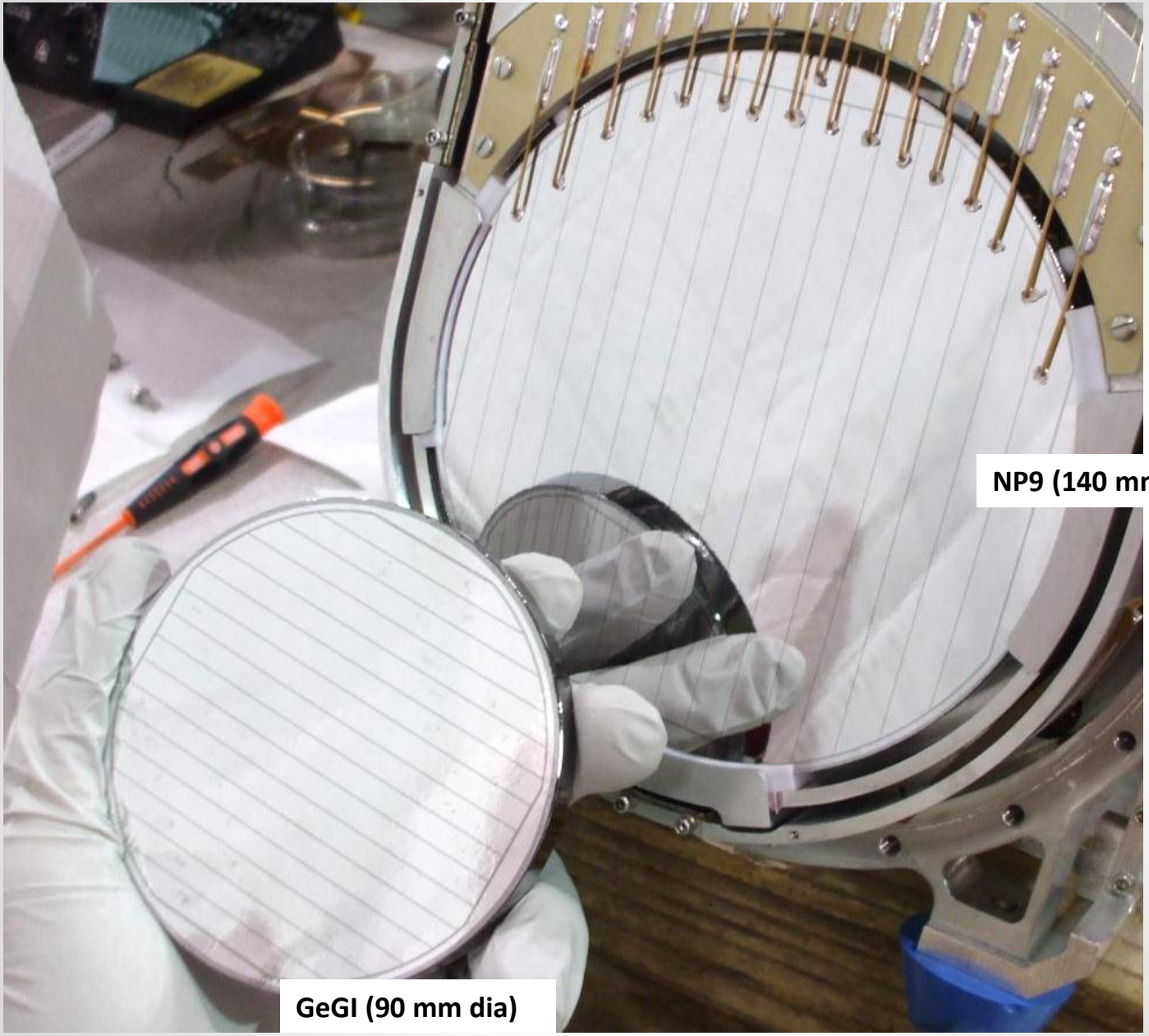
So we strive to grow larger diameter crystals……

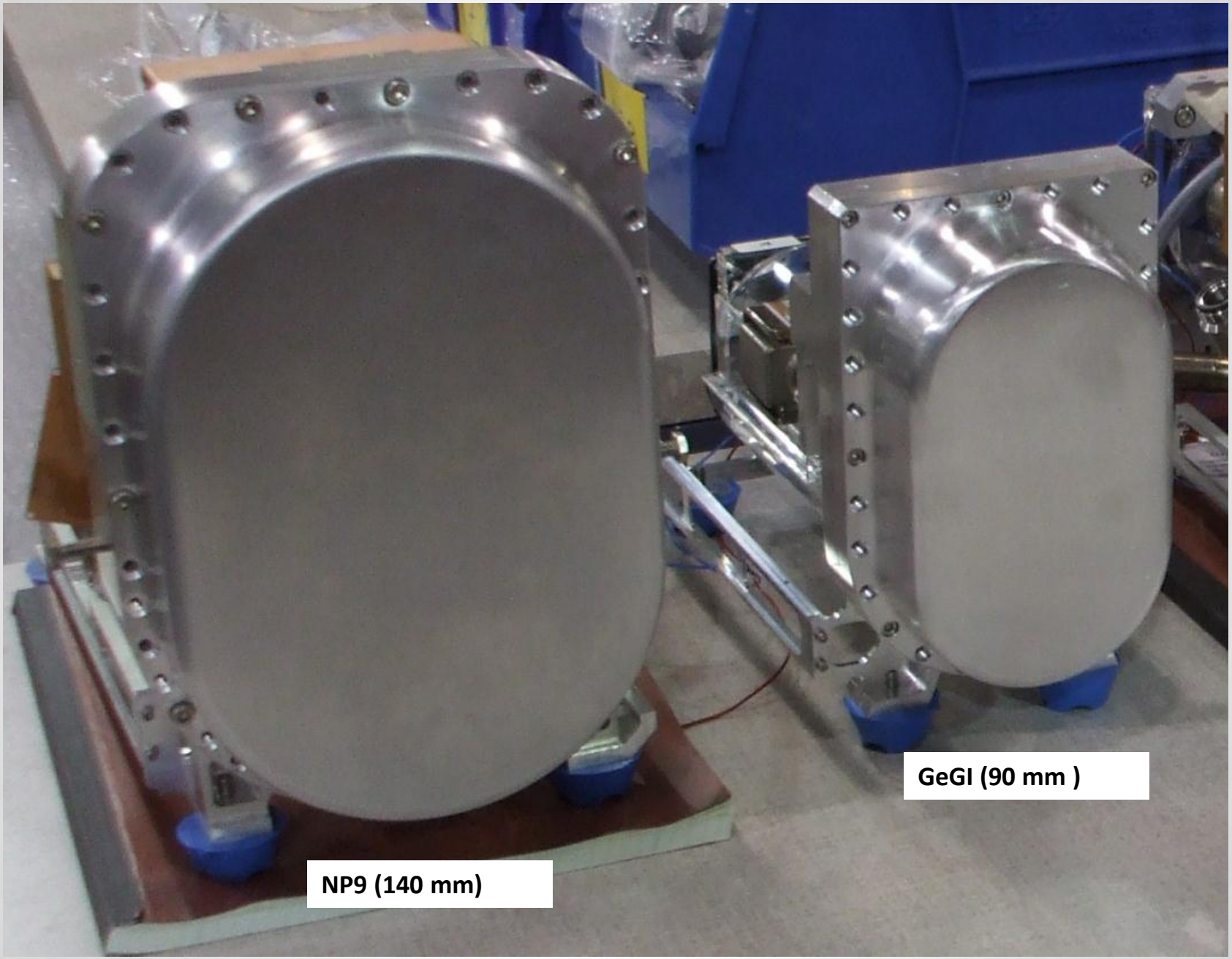


**16.2 kg HPGe Crystal**

168 mm max



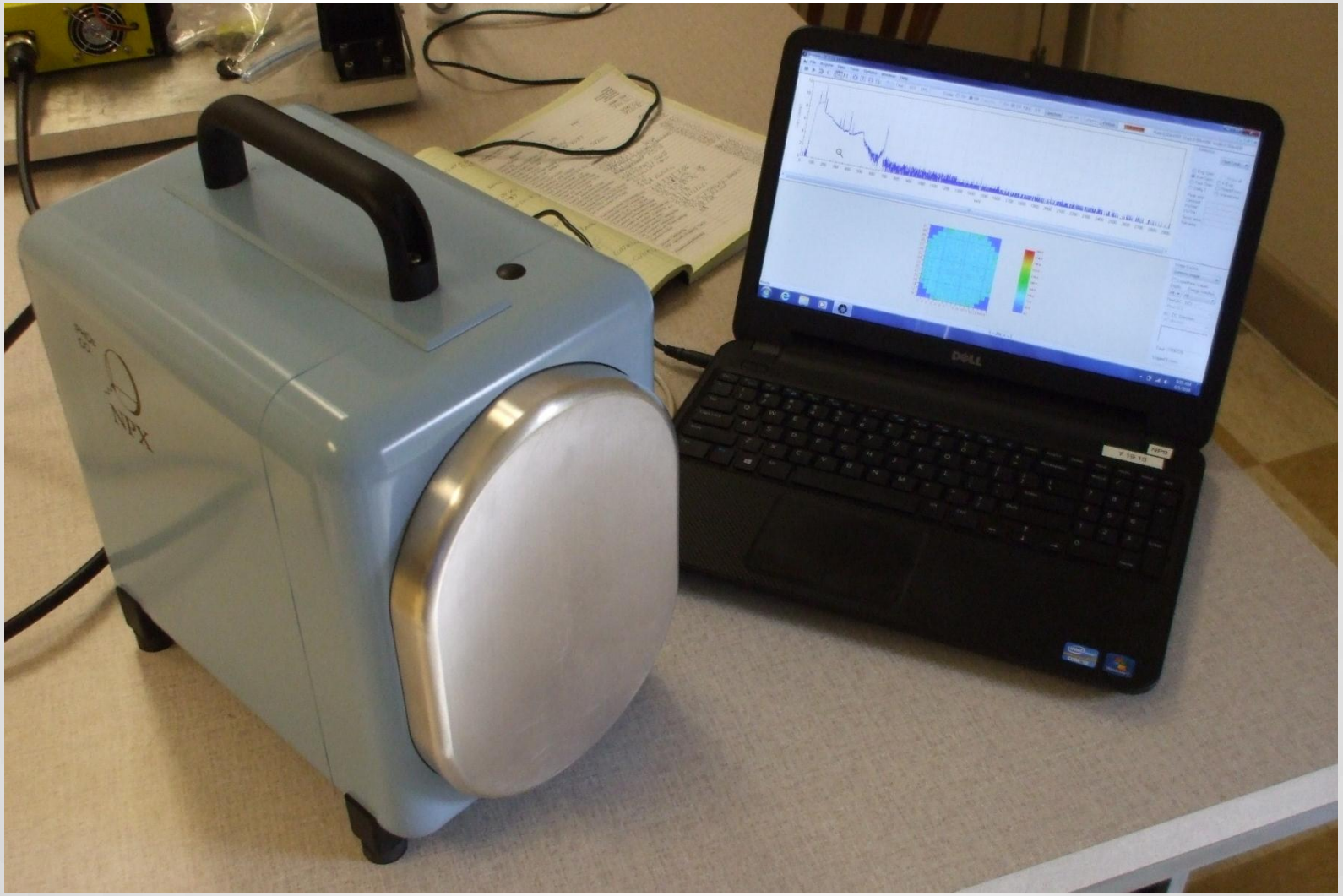

NP9 (140 mm)
GeGI (90 mm dia)

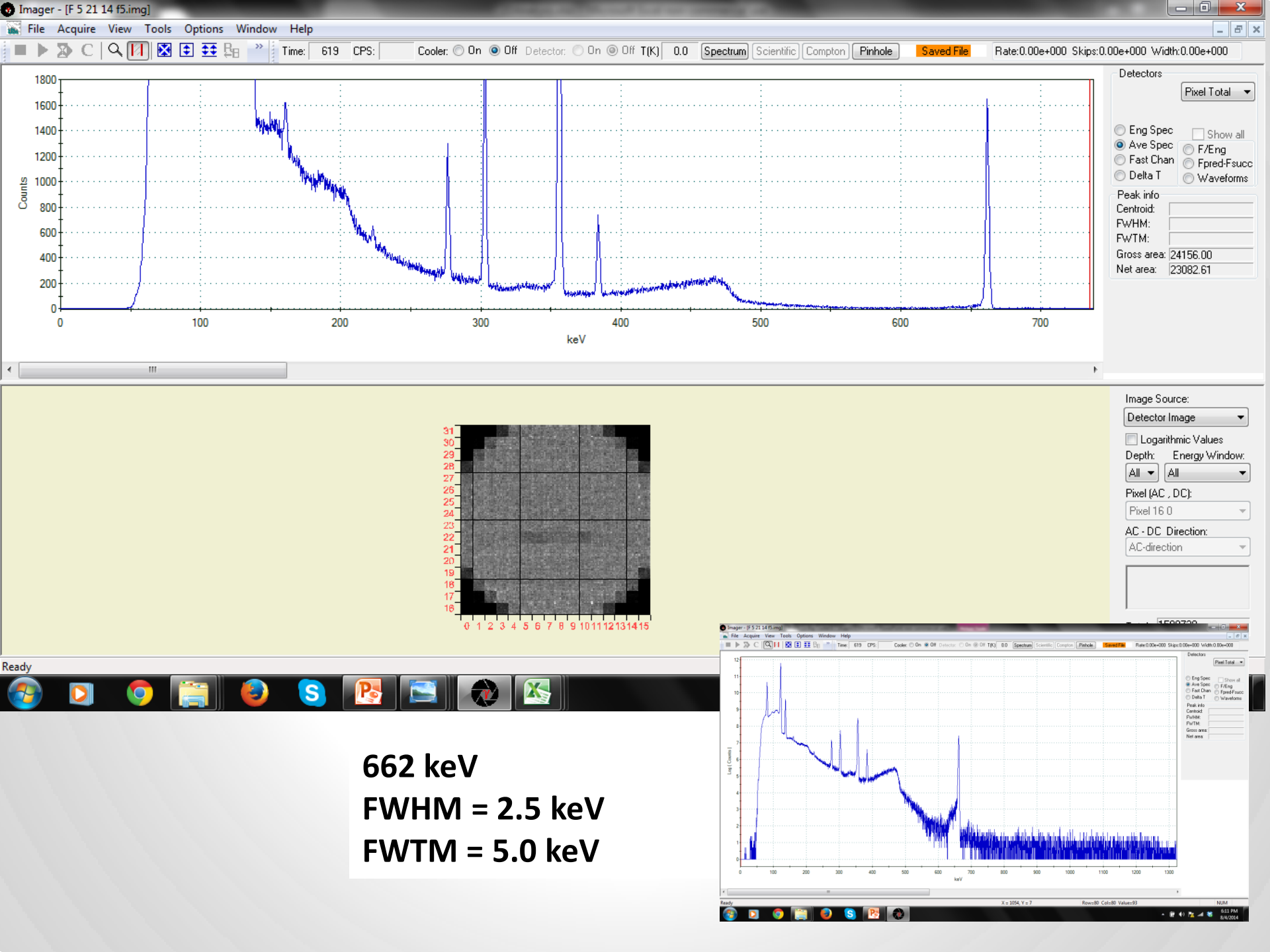

GeGI (90 mm )
NP9 (140 mm)

**NP9 Prototype detector system**

140-mm diameter S4, C2 – $2.0 \times 10^{10}$ /cm$^3$

$V_{depl}$ = + 1150 V and $V_{op}$ = +1400 V





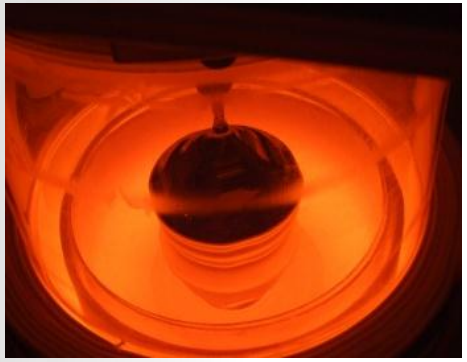

**662 keV**

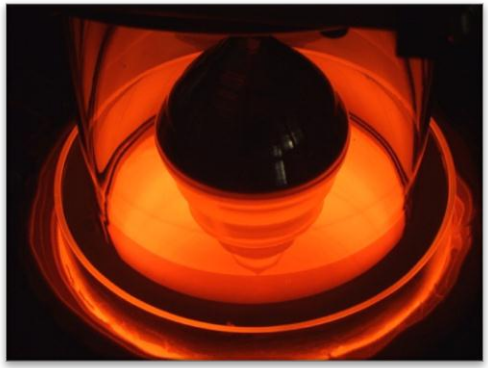
**FWHM = 2.5 keV**

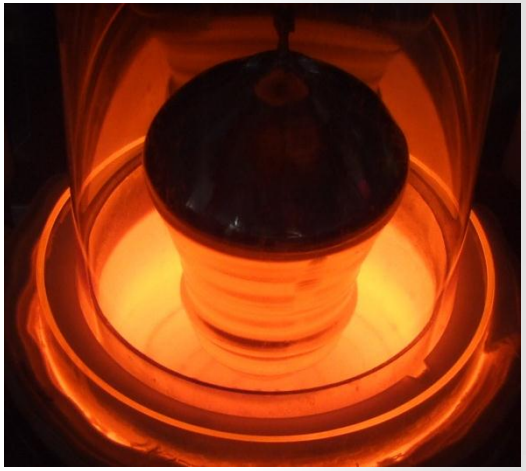
**FWTM = 5.0 keV**

# Big crystal Phase II SBIR program

- All about increasing diameter
  - Phase II: 40 mm to 140 mm HPGe
- Impurity concentration and segregation analysis system
  - Aluminum-Si ion exchange
- Commercially successful 90-mm diameter HPGe (GeGI)!!







## Remaining challenges

→ 140 mm diameter prototype detector function!!

- Charge collection issues -- crystallography
- Yield

Interesting physical process – rocks to software