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

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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
NPX-M
90-mm dia.
55 cm² active

MPGe
140-mm dia.
133 cm² active
(x2.4)

N^2 pixels from 2N strips (channels)
Because there are 2 signs of charge
So we strive to grow larger diameter crystals....
16.2 kg HPGe Crystal

168 mm max
NP9 (140 mm)

GeGl (90 mm)
NP9 Prototype detector system
140-mm diameter S4, C2 – $2.0 \times 10^{10}$ /cm³
$V_{\text{depl}} = +1150$ V and $V_{\text{op}} = +1400$ 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