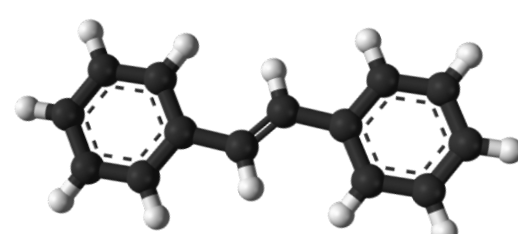


# Commercial Production of Stilbene Scintillation Crystals for Fast Neutron Detection



## Overview

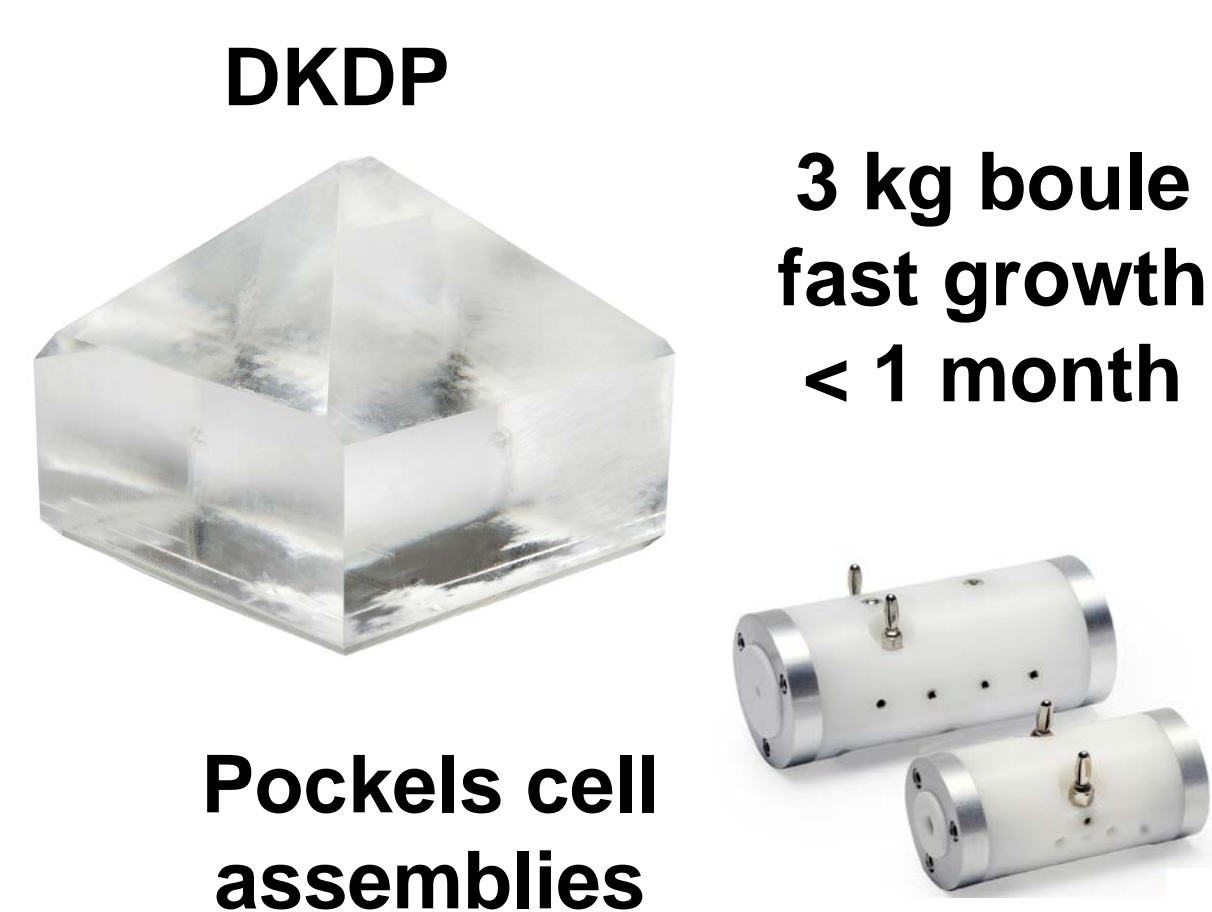
- The organic scintillator trans-stilbene ( $C_{14}H_{12}$ ) has long been recognized as having excellent properties for direct (unmoderated) fast neutron detection in a gamma-ray background.



- Compared with organic liquid and plastic scintillators, stilbene has superior neutron-gamma pulse shape discrimination (PSD) properties.
- Fast neutron counting, spectroscopy, and imaging have applications in medicine, industry, research, defense, and homeland security.
- Stilbene use in these applications has been limited due to low commercial availability of stilbene crystals grown using the traditional method (Bridgman melt growth).

## Organic Solution Growth

- Low-temperature solution crystal growth is an attractive alternative to melt growth.\*
  - scalable process for large, high-yield crystals
  - potential for lower stress, higher quality material
- Comparison to other solution-grown crystals in production at Inrad Optics offers a model for organic scintillators.



## Growth of Large Stilbene

### Challenges:

- Organic solvents attack crystallizer hardware and pump parts.
- Organic solvents are volatile and good seals are required.
- Boules have a tendency to form polycrystalline defects.
- Raw material purity is critical to scintillation performance.\*\*

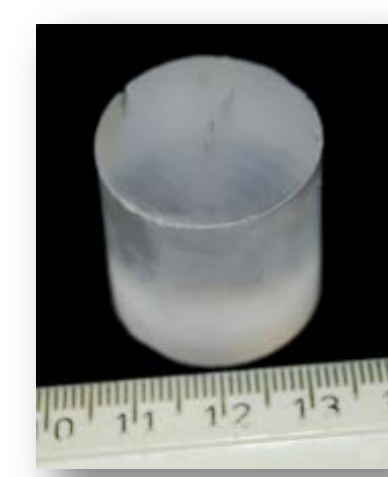
### Progress:

- Size – 4", 1350 g
- Excellent structural quality – x-ray rocking curve FWHM 10-20 asec
- High purity – good transmission characteristics
- Defects avoided by seed holder design modifications.

1.4 kg boule  
4" scale

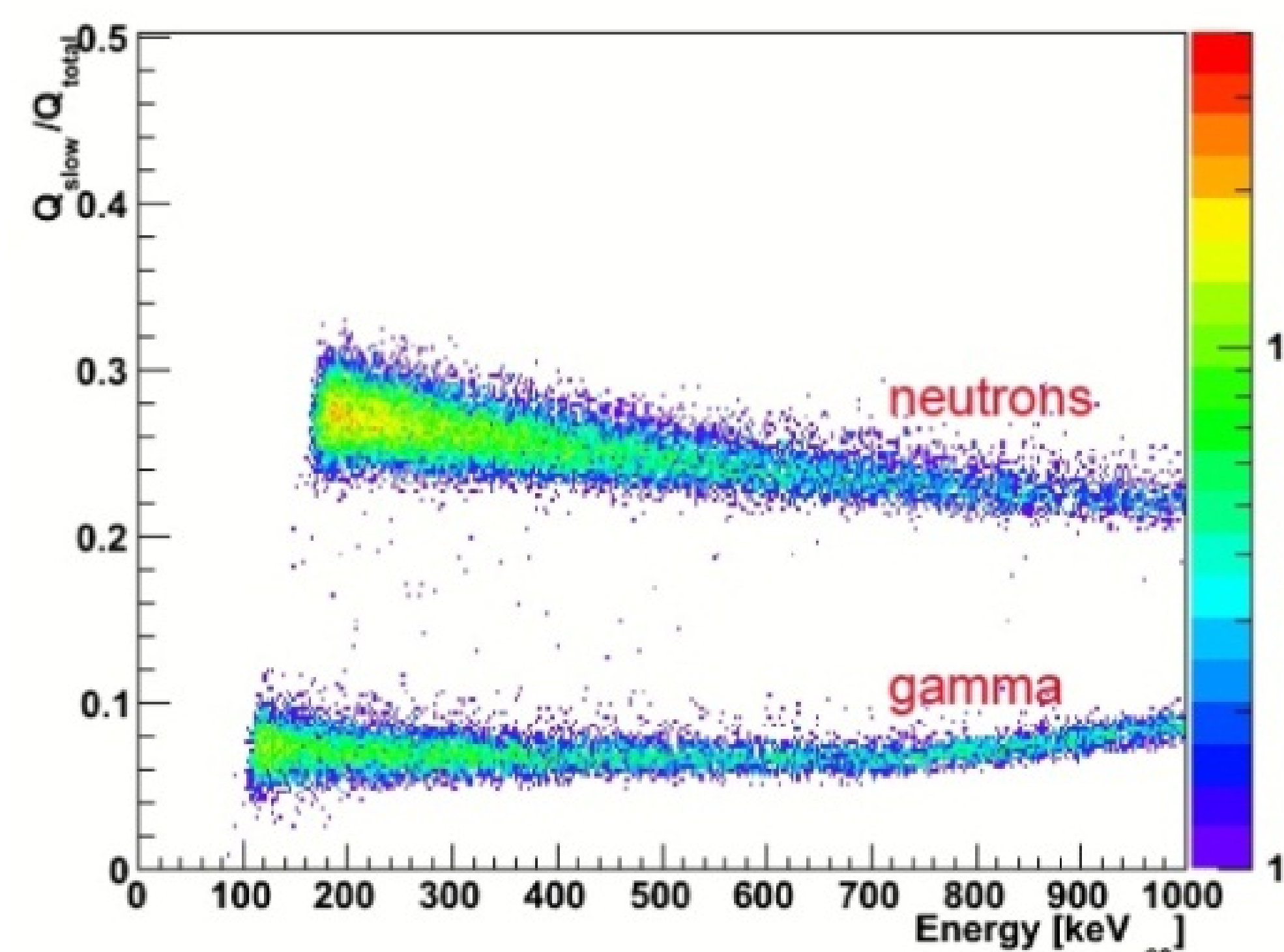


## Characterization



- 1"x1" cylinder
- high purity Inrad Optics stilbene
- characterized at LLNL (courtesy N. Zaitseva)
- unpolished
- some internal defects

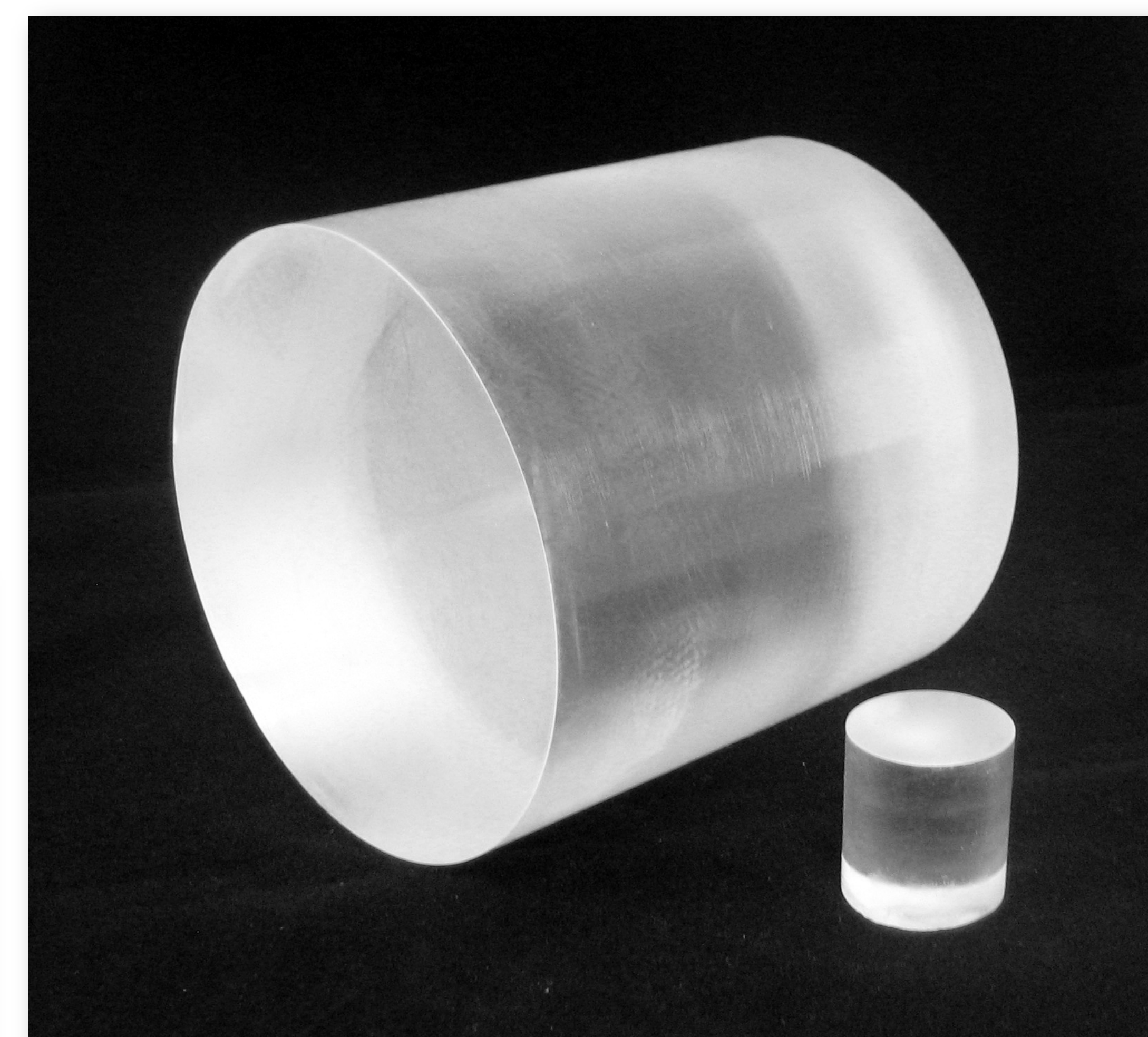
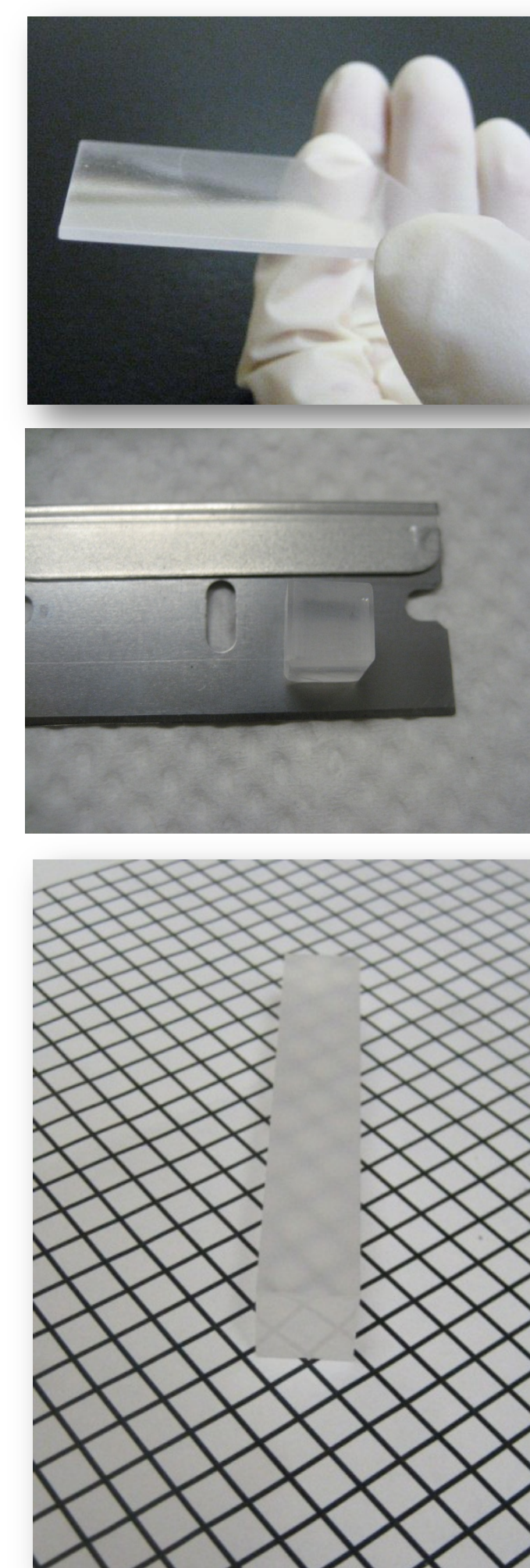
### Pulse shape discrimination ( $^{252}Cf$ )



## Fabrication

- A variety of shapes are needed for neutron-detection applications; geometries fabricated include plates, disks, bars, and cylinders.
- Control over the thermal environment allows fabrication of finished parts without cracks.

### 1"x1" and 4"x4" stilbene



## Conclusions

Solution-grown stilbene is now commercially available from Inrad Optics.

- Excellent material quality
- Fabrication of variety of geometries
- Dimensions up to 4"x4"

\* N. Zaitseva et al., J. Crystal Growth 314 (2011) 163 \*\* L. Carman et al., J. Crystal Growth 368 (2013) 56