



**Fabrication of DIRC Radiator Bars and Plates  
at *InSync, Inc.***


**Presented at: DIRC 2017**

**Presented by: Thomas W. Tonnessen**

**August 7, 2017**

# ***InSync, Inc.***

*InSync, Inc.*

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- Our company has been producing high precision optics since 1980
  - Initially as the Bell Aerospace division of Textron, Buffalo, NY
    - Designed and manufactured internally cooled heat exchangers for laser mirrors (FEL, ALPHA, EXCIMER)
  - In 1990 the Rocketdyne division of Rockwell International acquired and moved the facility to Albuquerque, NM
    - Expanded the facility to include synchrotron optics
  - In 1997 the facility was acquired by the Boeing Company
    - Added Cherenkov optics
  - In 2000 the facility became a stand alone company and was renamed to *InSync, Inc.*
  - *InSync, Inc.* is a 16,000 ft<sup>2</sup> (1,500 M<sup>2</sup>) manufacturing facility still at the same Albuquerque, NM location, set-up primarily for High Precision Optics for both small and large quantity



InSync, Inc.

HANDICAPPED  
PARKING  
ONLY



# Facility Capabilities

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- **Processes**

- **Slicing, Grinding, Drilling, Milling, Ultrasonic Machining, CNC Machining, Chemical Anisotropic (Basic) Etching, Isotropic (Acidic) Etching, Bonding, Annealing, Lapping, Polishing, Coating, and Metrology**
- **All processes completed at our facility, only raw material is acquired elsewhere**

- **Materials**

- **Silicon, Silicon Carbide, ULE, Zerodur, Silica, Nickel Plated Metals (GlidCop, Aluminum, etc.), and others**

- **Sizes**

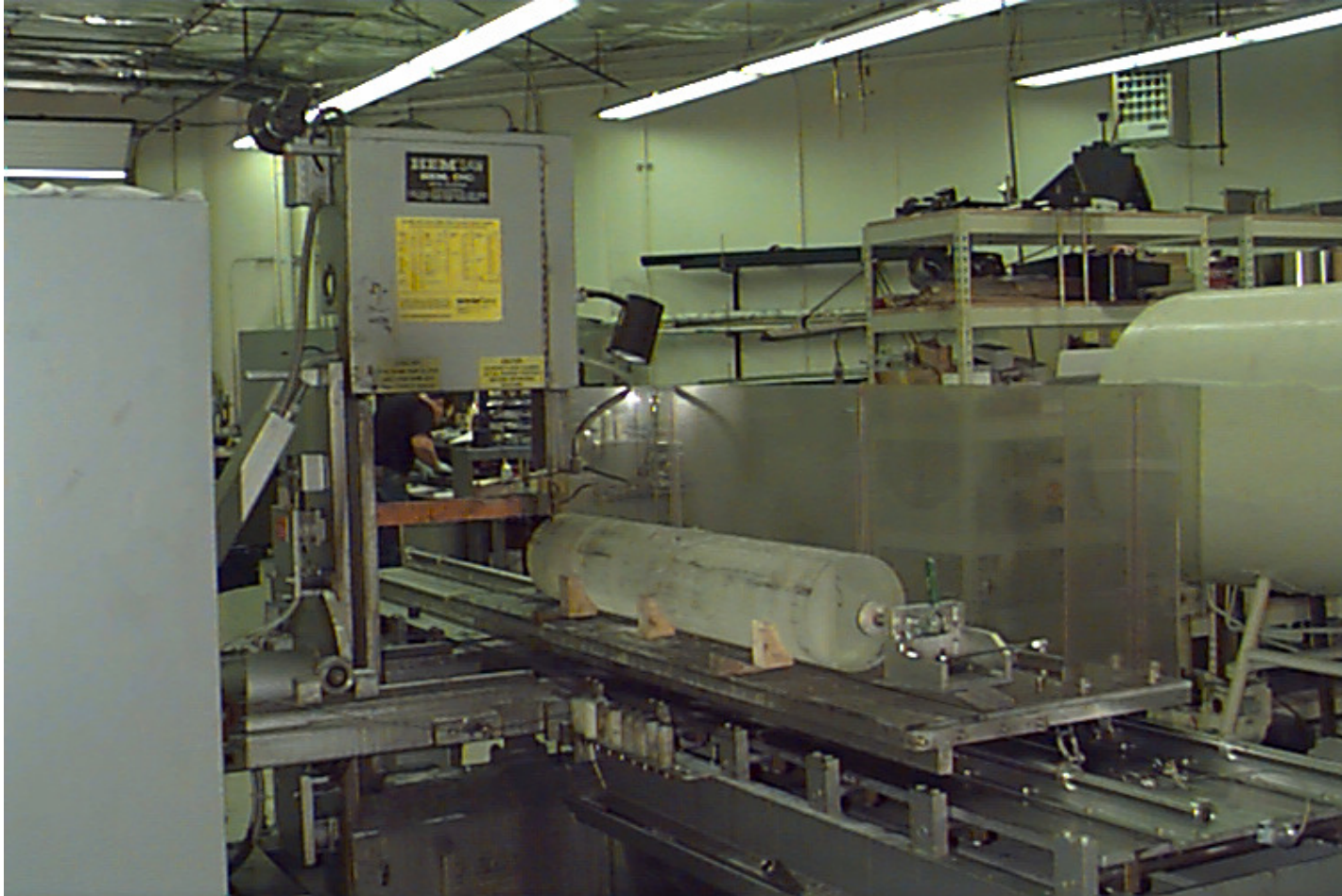
- **Up to 1500mm**

- **Support**

- **Analysis (incl. FEA) and Design (incl. CAD)**

# Sawing

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# Surface Grinders

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# Ultrasonic Impact Grinders

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# CNC Machining

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# Support Equipment for Tooling and Fixturing

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# End Grinding

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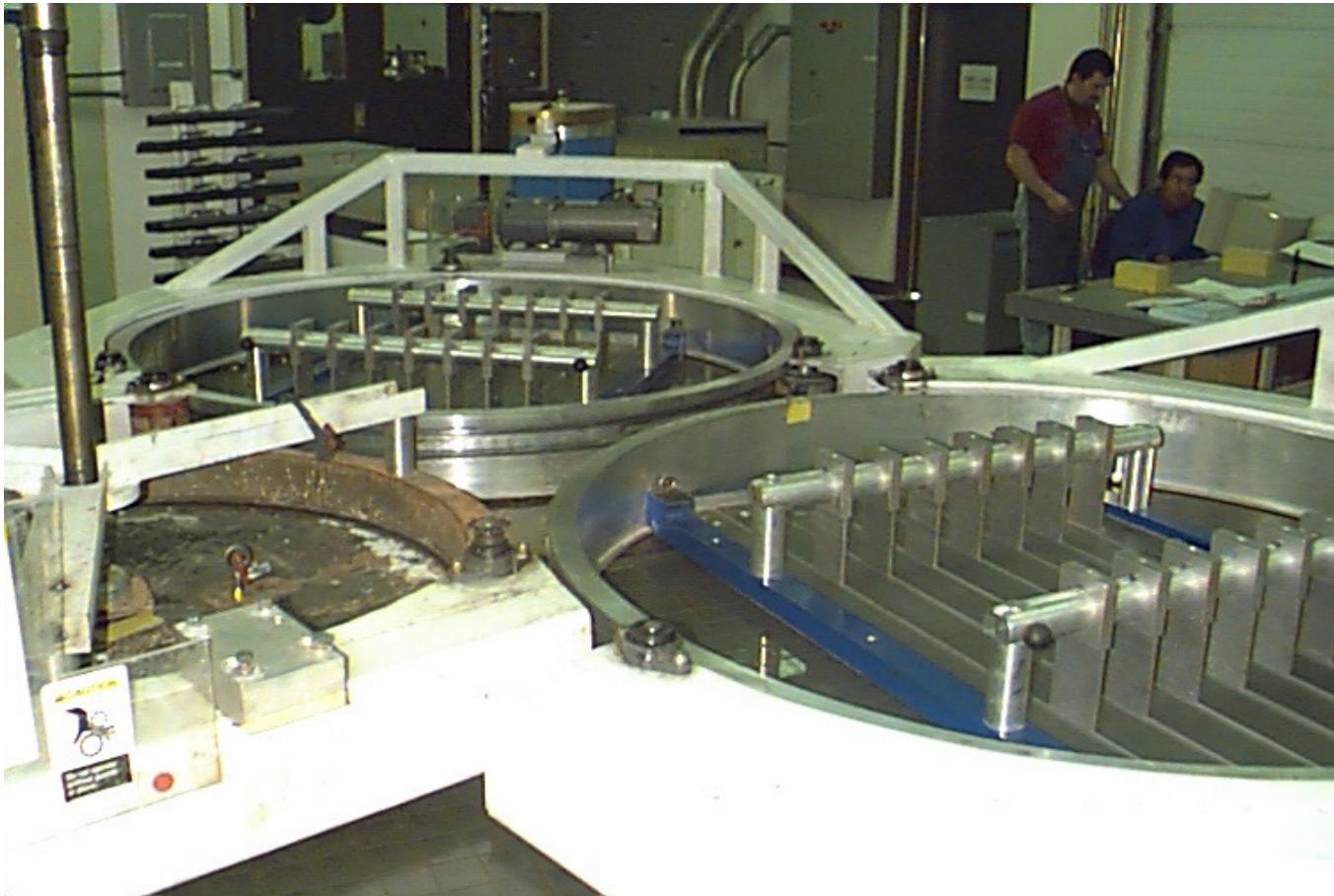
# Furnaces

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# Large Lap (Free Abrasive Grinding) [1500mm Lapping Capacity]

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# 170" (4300mm) Diameter Large Polisher [1500mm Polishing Capacity]

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# 36" (915mm) Diameter Overarm Polisher [Fixtured for End Lapping and Polishing]

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# End Polisher Rotated 90 Degrees for Polishing

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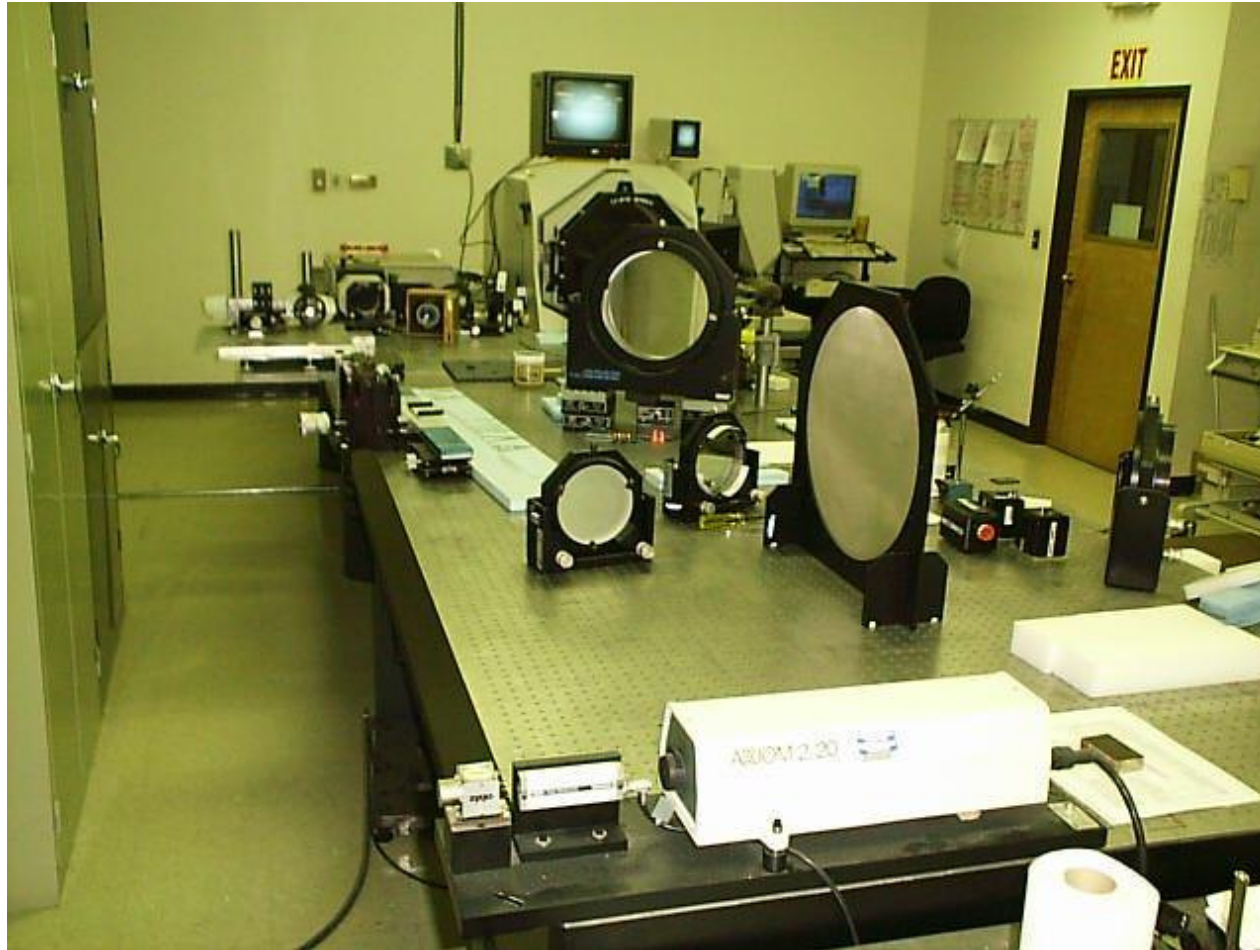
# DC Sputter Coating Machine [1500mm Coating Capacity]

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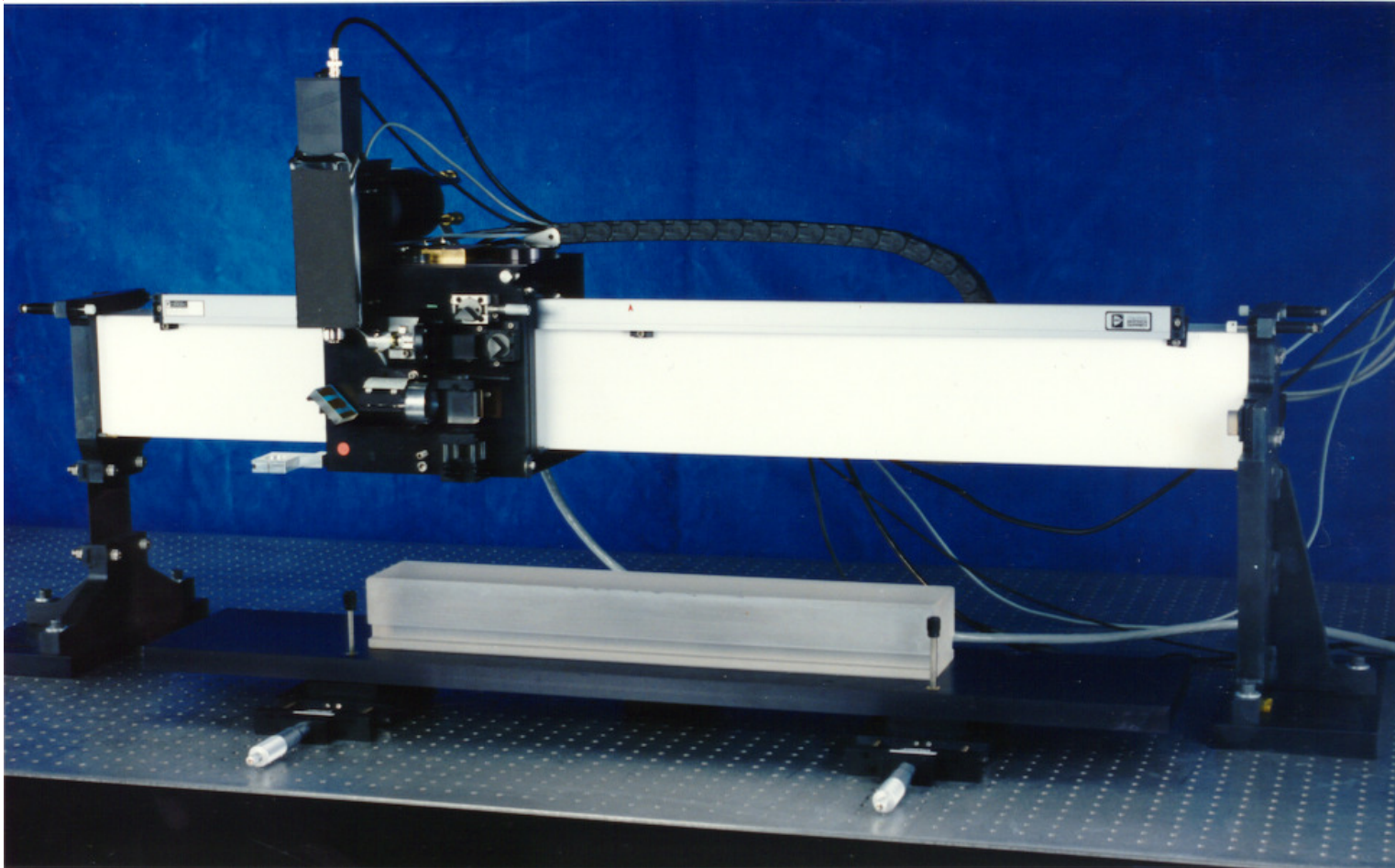
# 4" & 18" Diameter Phase Shifting Interferometers

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# Optical Long Trace Profiler (LTP) [800mm Scan Capacity]

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# Autocollimators/prisms for Angle Measurements

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# Roughness Measuring Interferometer

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# Products

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- **Windows, Mirrors, Gratings, Heat Exchangers, Beam Splitters, Multilayer Optics, Mandrel Optics**
- **Polished Shapes**
  - **Flat, Spherical, Cylinder, and Conical**
- **Designs**
  - **Thin Optics (down to 5mm), Thick Optics, Detail Machined Optics, Internally Cooled Optics**

# 800 mm Long Silicon Flat

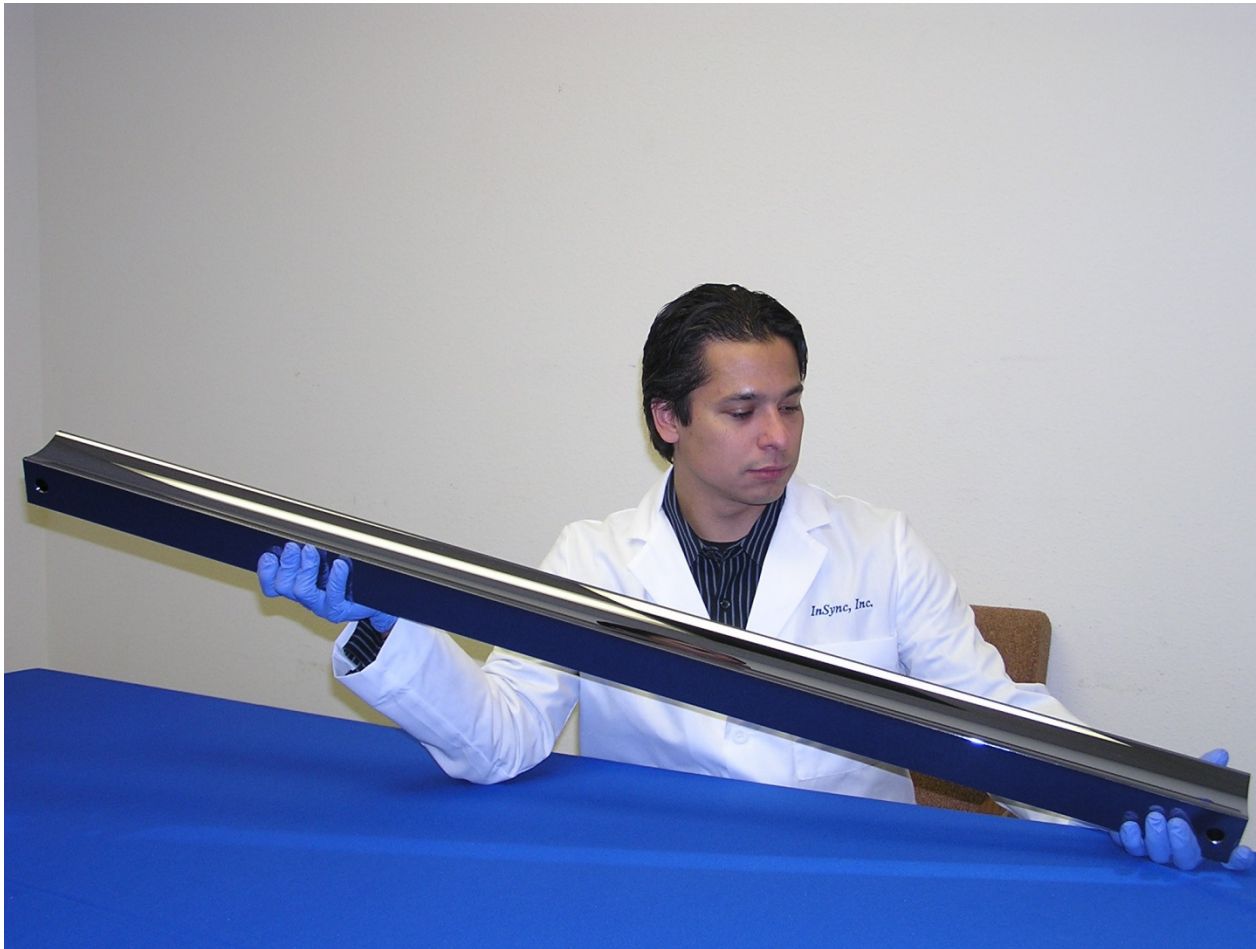
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- 600 mm Long Clear Aperture
- 0.9nm RMS Height Error  
@1mm Resolution over 200mm  
Lengths, Curvature removed

# 1350 mm Long Silicon Sagittal Cylinder

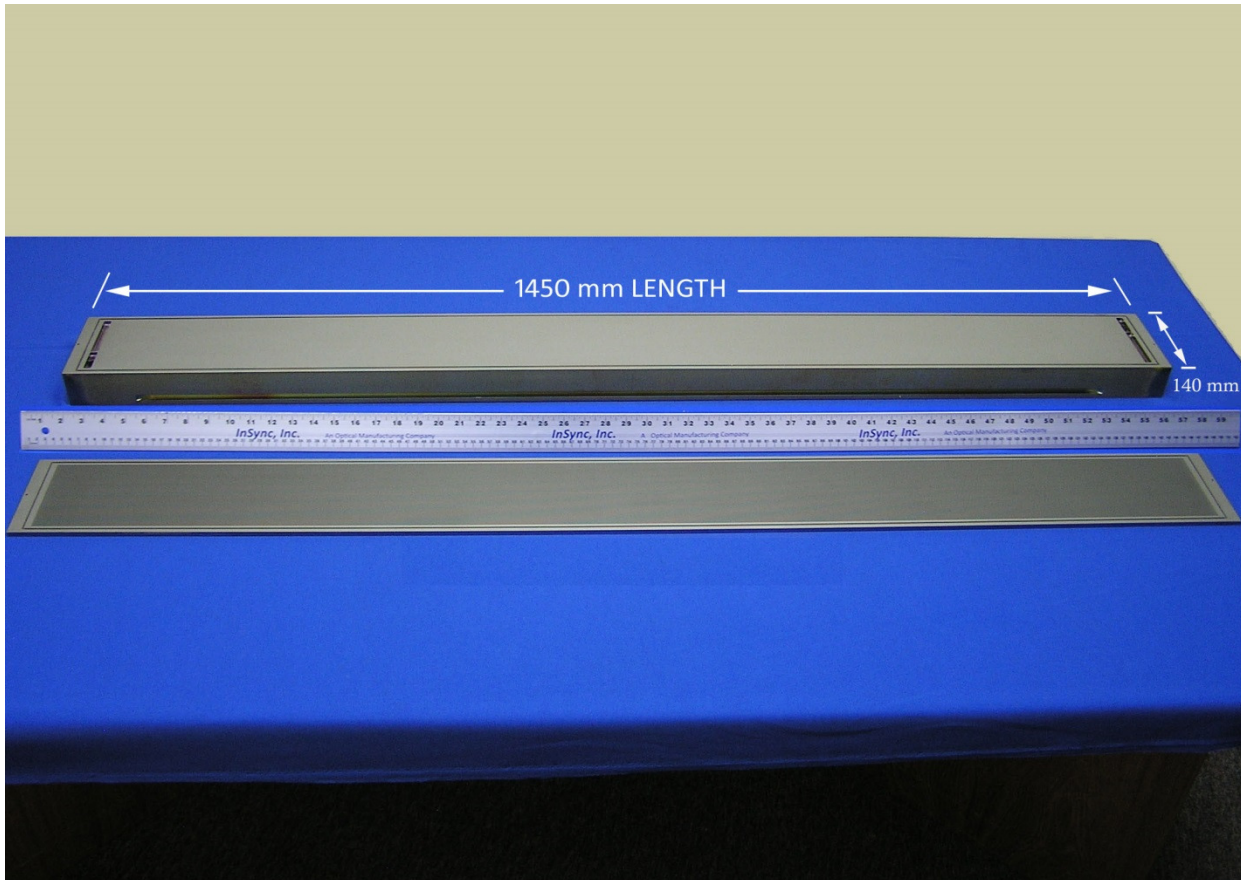
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- 1200 mm Long Clear Aperture
- 0.7  $\mu\text{r}$  RMS Tang. Slope Error
- 2.8  $\text{\AA}$  RMS Roughness

# 1450 mm Long Internally Water Cooled Silicon Flat

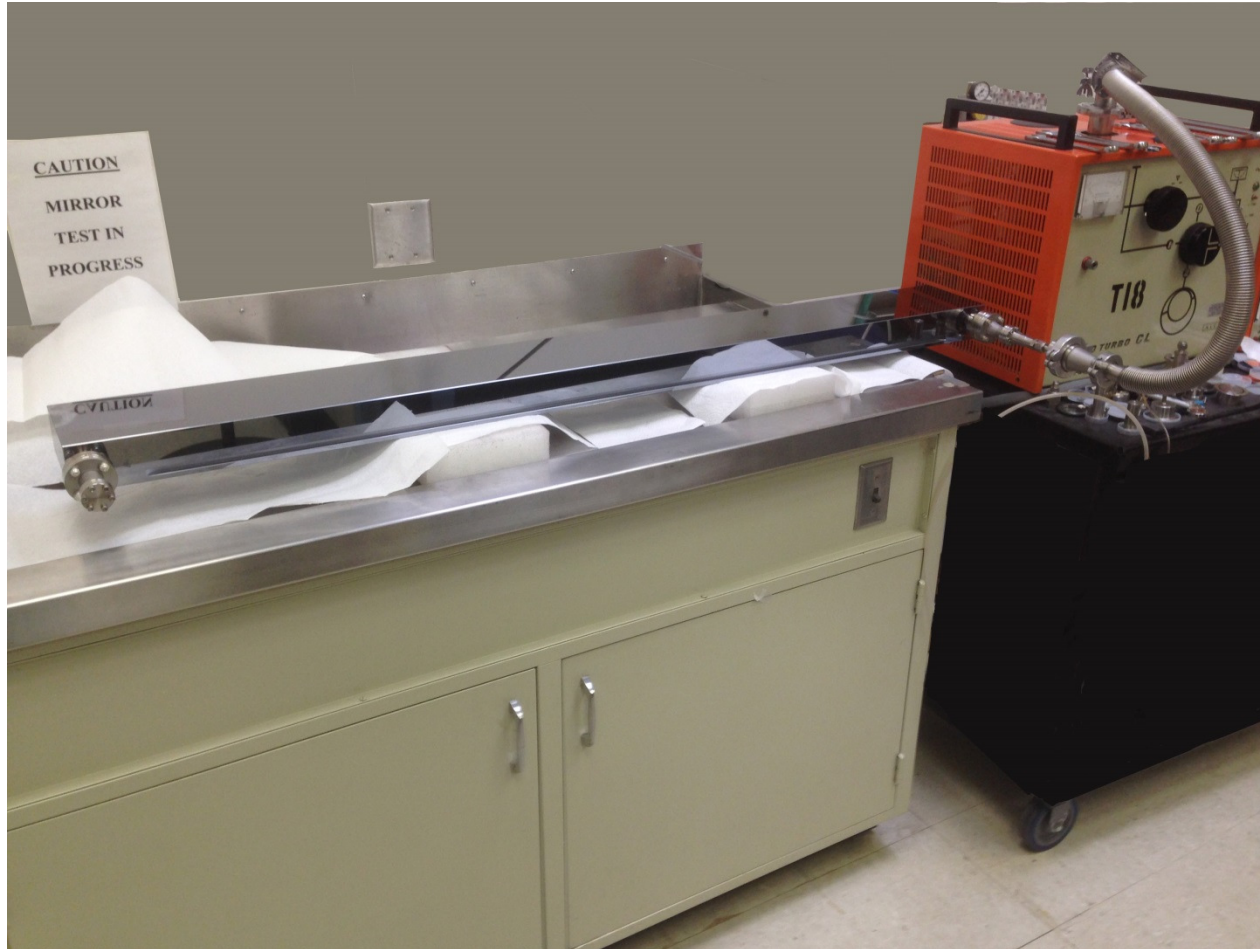
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- 1350 mm Long Clear Aperture  
...and 120mm Wide!
- 0.55  $\mu\text{r}$  RMS Tang. Slope Error
- 0.9  $\text{\AA}$  RMS Roughness

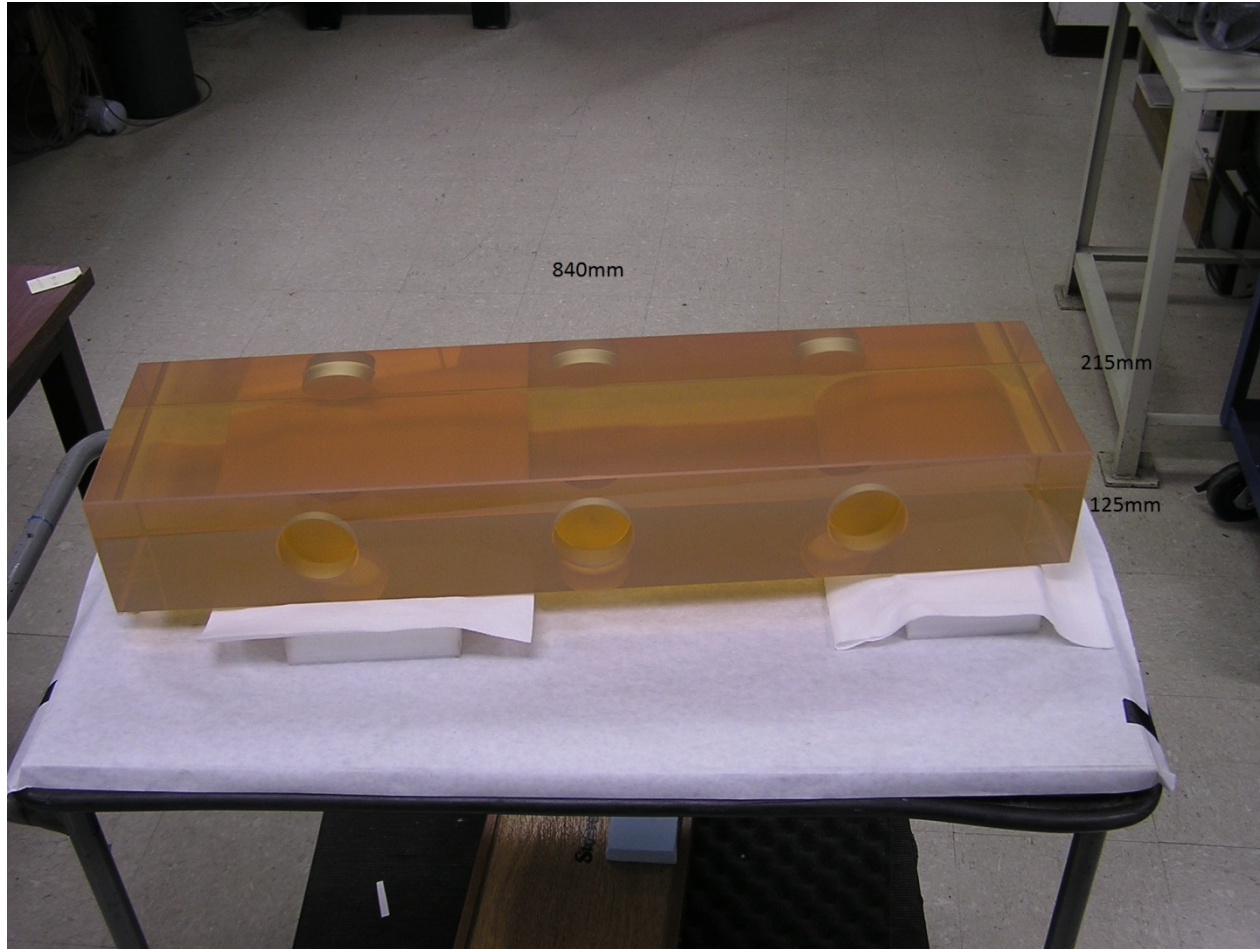
# 1450mm Long Internally Water Cooled Silicon Flat

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# 6 Side Polished Zerodur Glass Ceramic Optic

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# ***InSync, Inc.* Optics Manufactured in Support of DIRC Silica Optics**

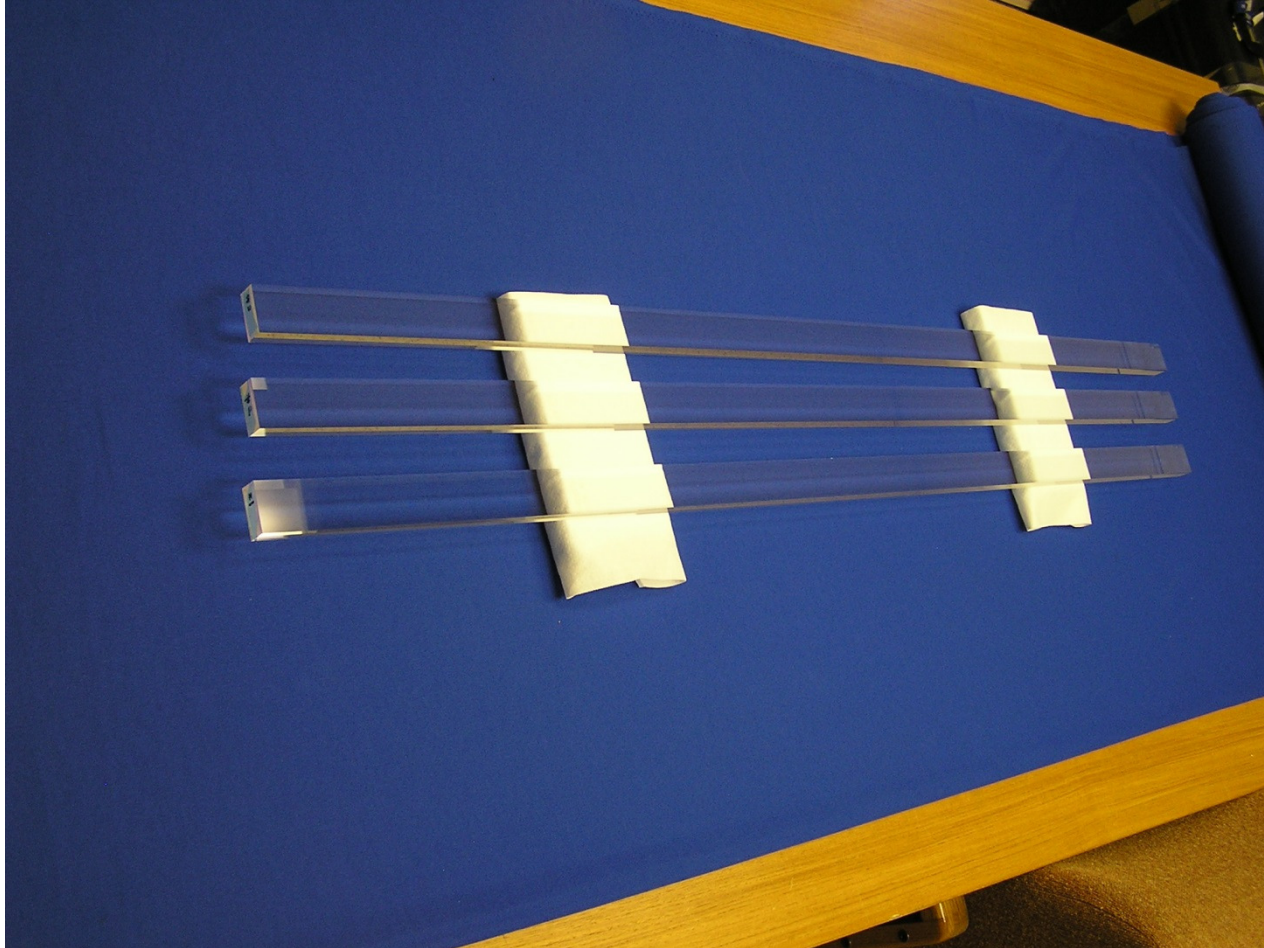
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- **~600 Bars for BaBar in 1999 (1225mm x 35mm x 17.25mm)**
- **1 Bar for PANDA R&D in 2009 (1225mm x 35mm x 17.25mm)**
- **4 Bars for PANDA R&D in 2010 (1200mm x 35mm x 17.25mm)**
- **3 Bars for LHCb TORCH (INFN) R&D in 2011 (200mm x 35mm x 17.25mm)**
- **2 Plates for PANDA R&D in 2012 (1225mm x 175mm x 17mm)**

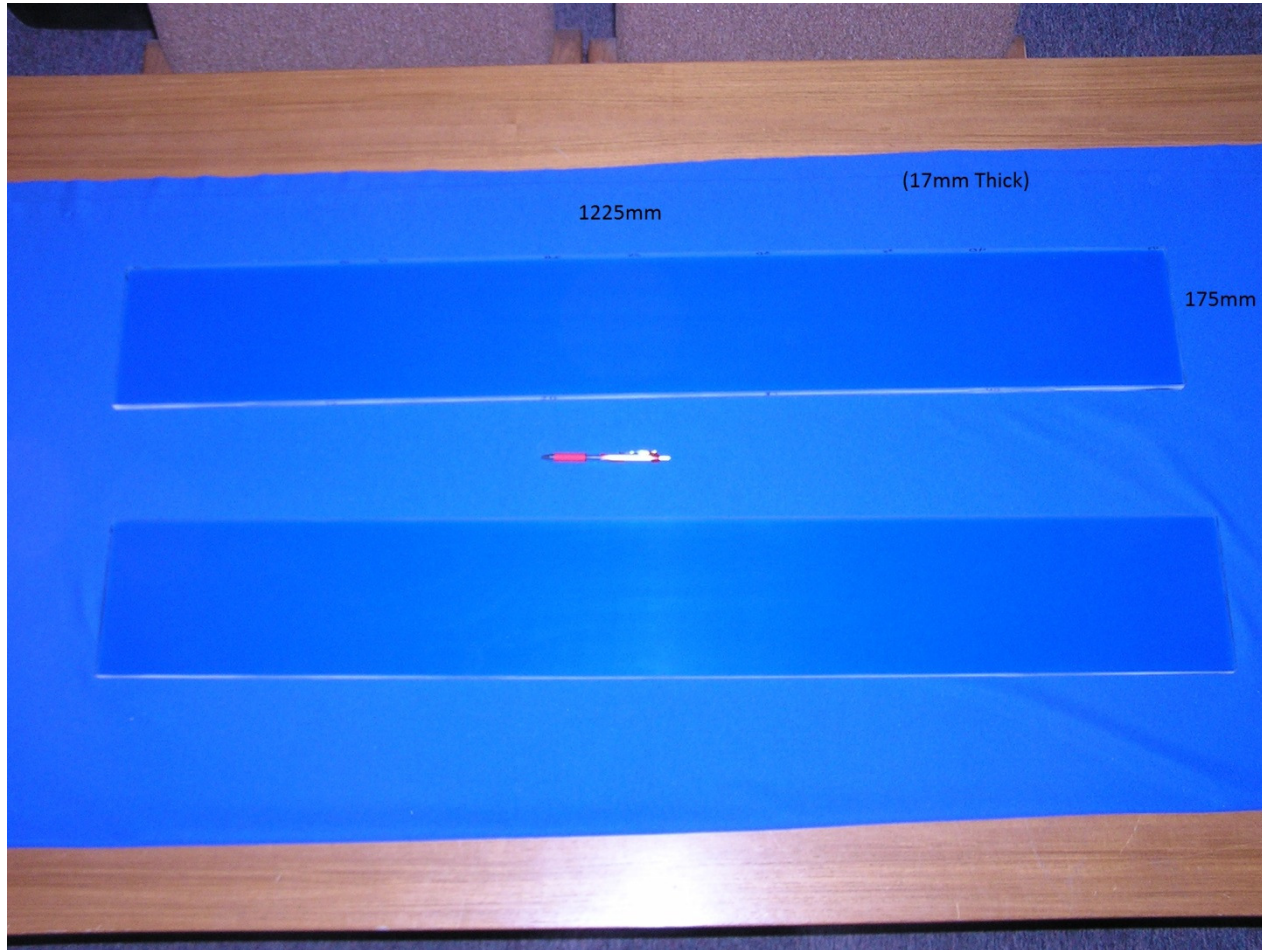
# DIRC Silica Bars for PANDA

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# DIRC Silica Plates for PANDA

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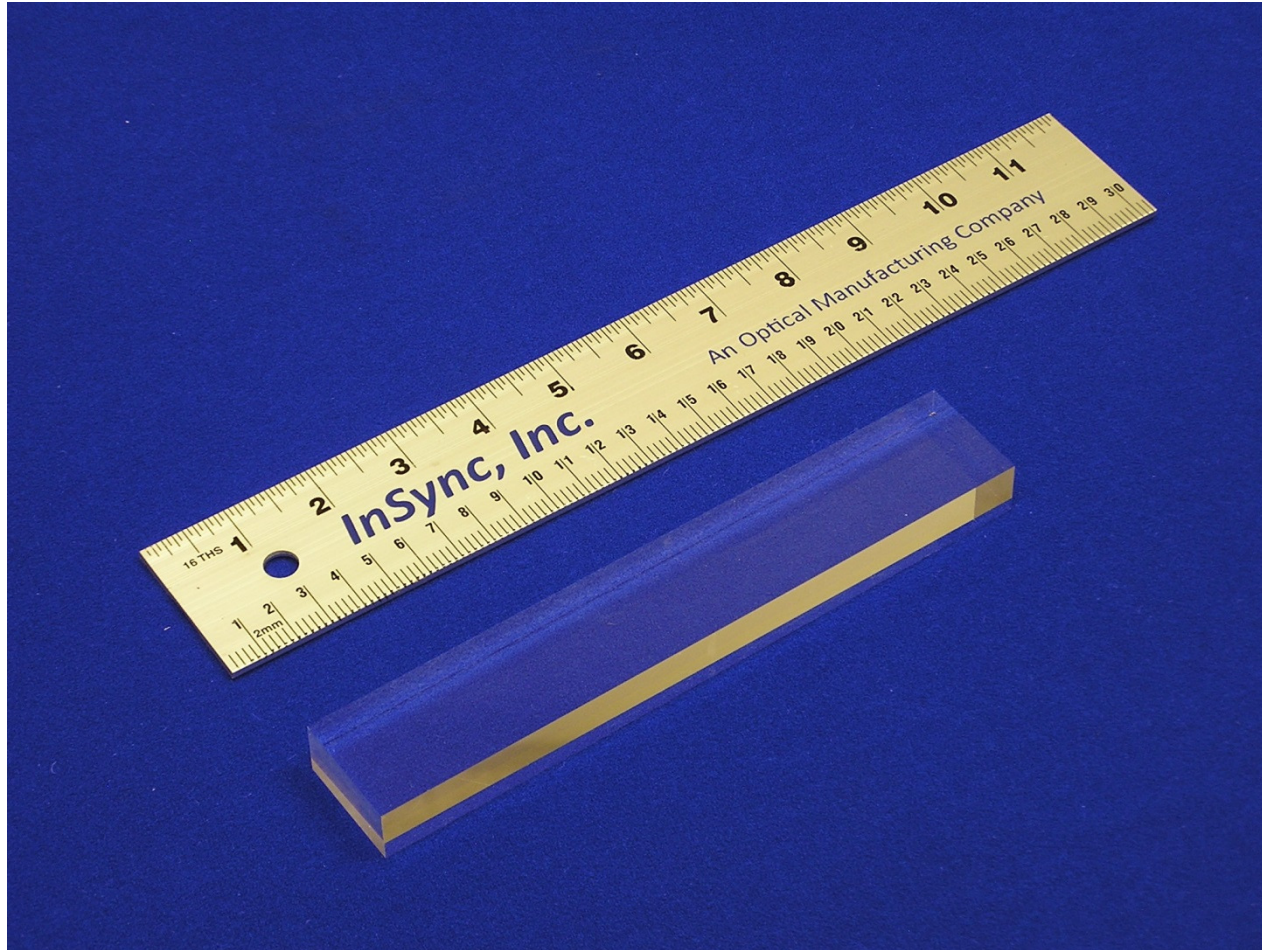
# DIRC Silica Plate for PANDA

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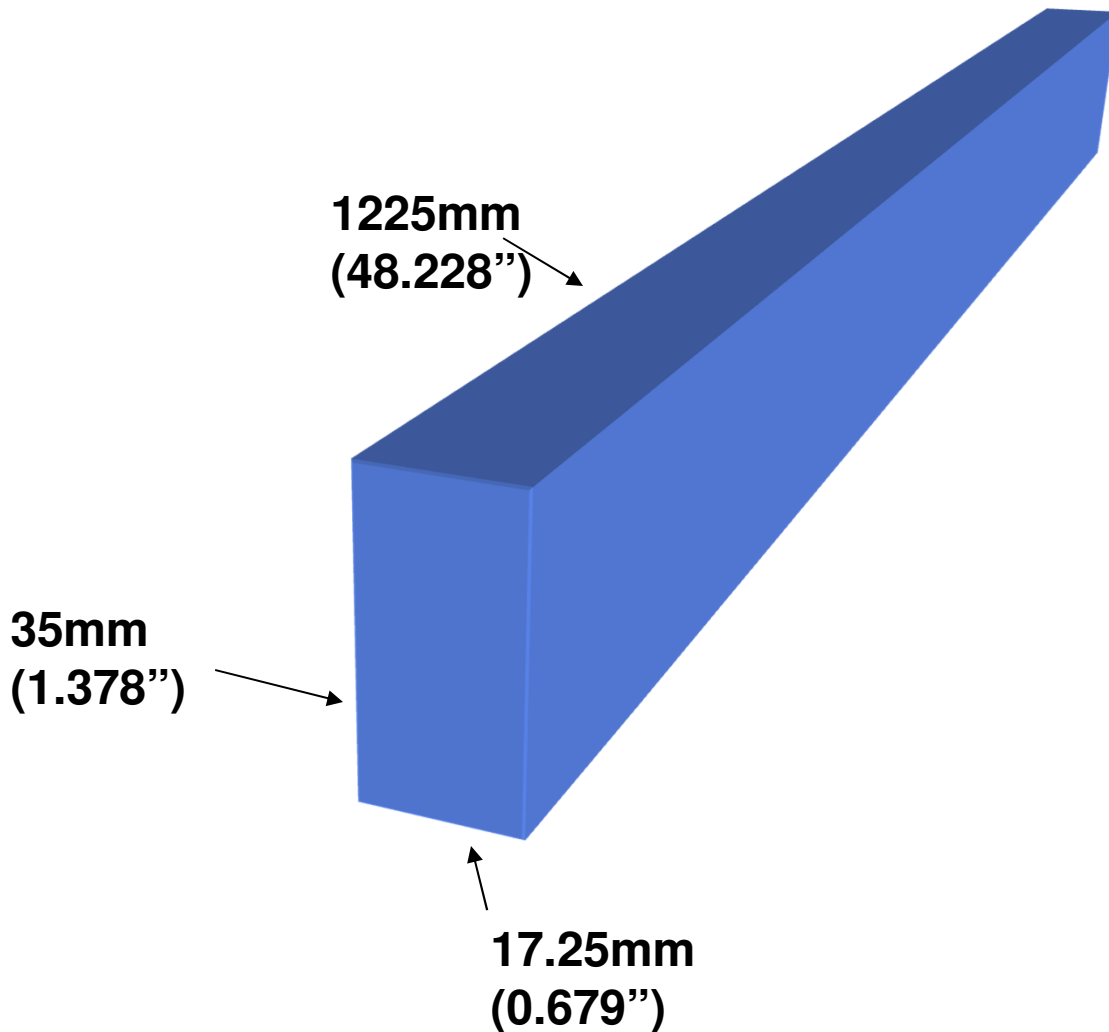
# DIRC Silica Bar for LHCb TORCH (INFN)

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# BaBar Bar Specifications

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## Critical Requirements:

- virtually no chips (5um equivalent chamfer)
- very perpendicular sides to faces (0.25mr)
- very parallel sides (25um TTV)
- all 6 sides polished

# In Closing

*InSync, Inc.*



- **Personnel, machines, tooling, fixturing, measuring, processes, and procedures are all still in place at InSync, Inc. from BaBar bar effort**
- **Based upon our “one of a kind” synchrotron optics and our production BaBar optics, we understand what is needed for each type of effort to produce high quality products in a reasonable time and at a reasonable price**
- **We welcome the opportunity to discuss your optics needs for all of the DIRC facilities**