

# Status of Barrel DIRC prototype bars quality tests

**Grzegorz Kalicy**

GSI, Darmstadt  
Goethe Universität Frankfurt

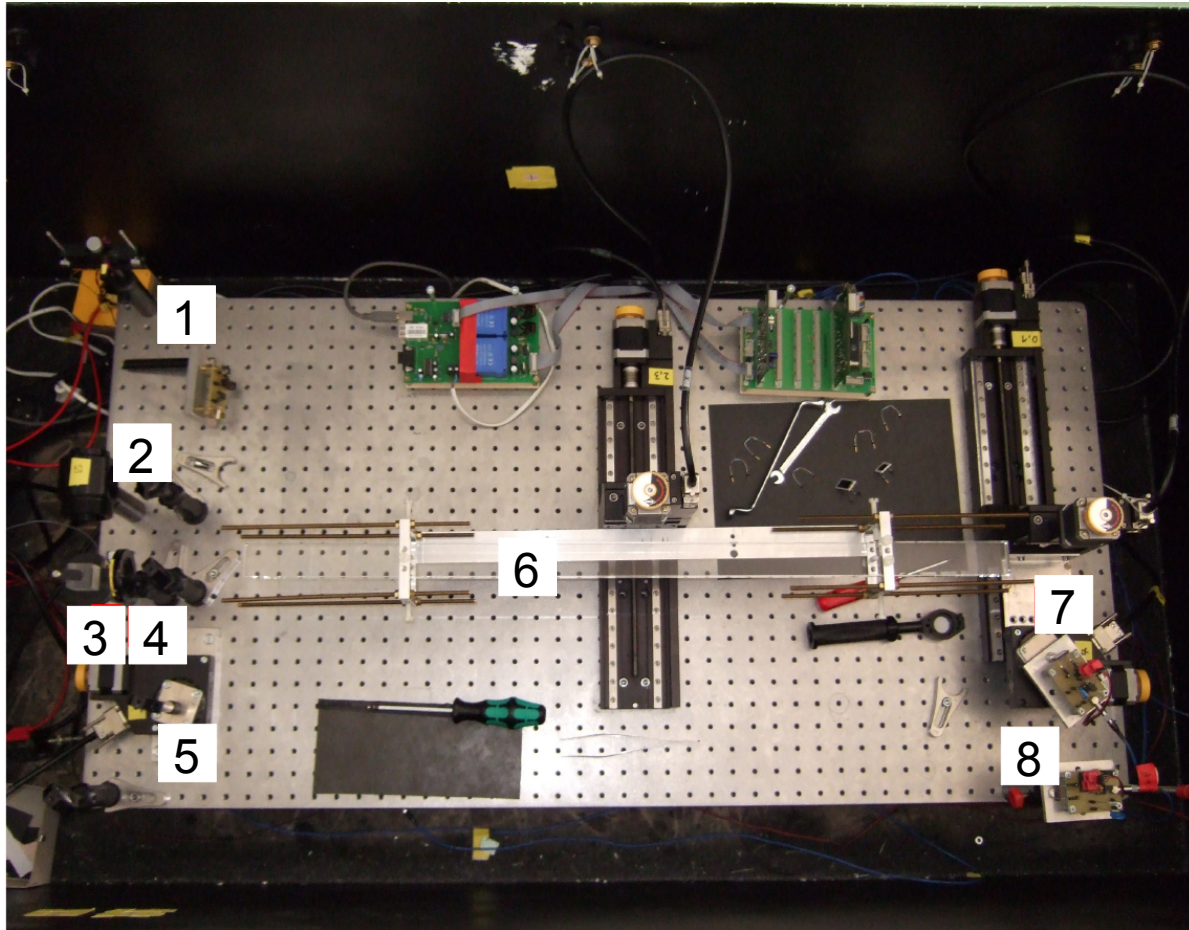
**PANDA Collaboration Meeting  
at GSI**

14 March 2011

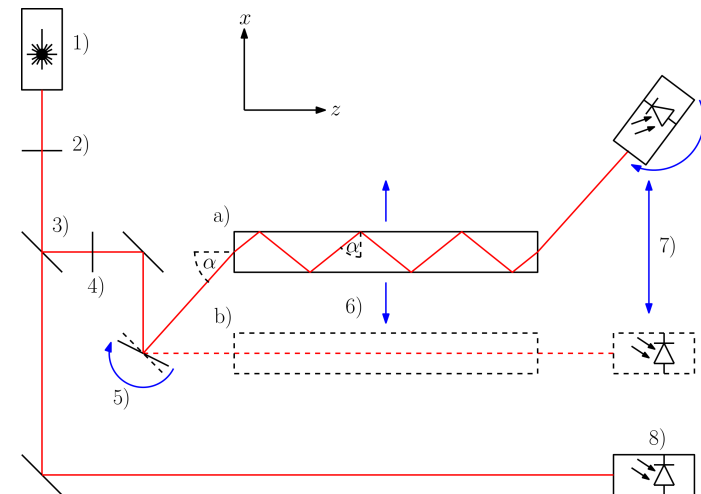
Roland Hohler, Klaus Peters, Georg Schepers, Carsten Schwarz,  
Jochen Schwiening



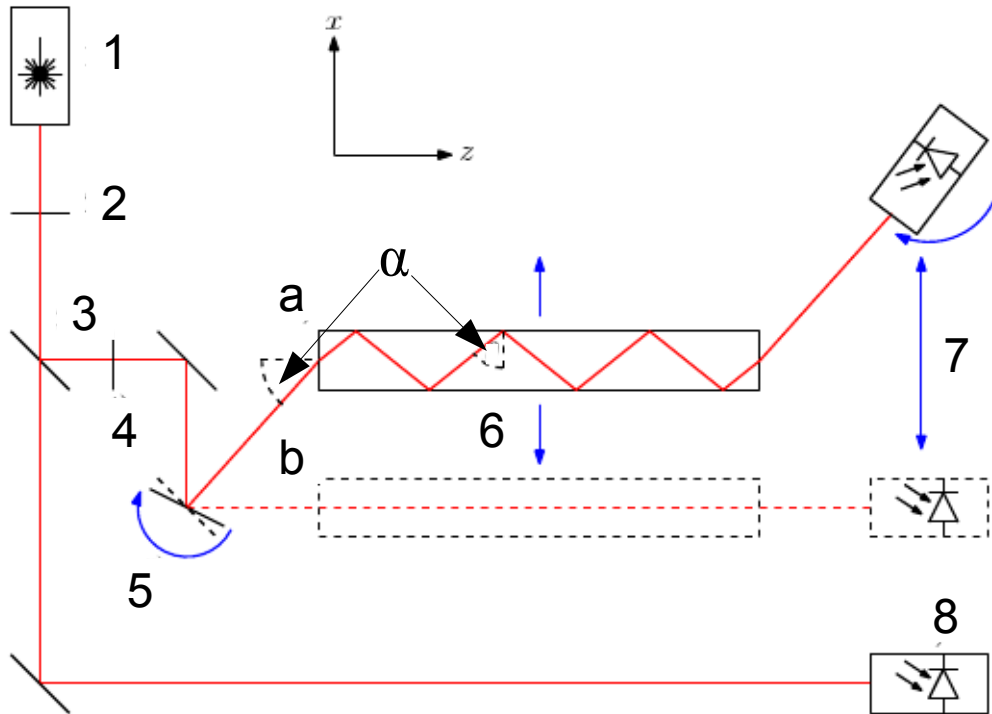
# Radiator Quality Test Motion-controlled scanning setup



- 1) Laser (405, 532, 635 nm)
- 2) Polarizer
- 3) Beam splitter
- 4) Diaphragm
- 5) Brewster mirror
- 6) Bar on x, y stage
- 7) Value Diode
- 8) Reference Diode



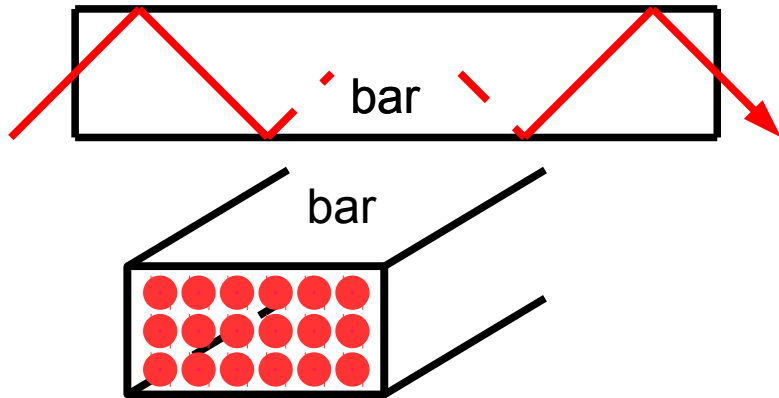
# Radiator Quality Test Procedure



- 1) Laser (405, 532, 635 nm)
- 2) Polarizer
- 3) Beam splitter
- 4) Diaphragm
- 5) Brewster mirror
- 6) Bar on x, y stage
- 7) Value Diode
- 8) Reference Diode

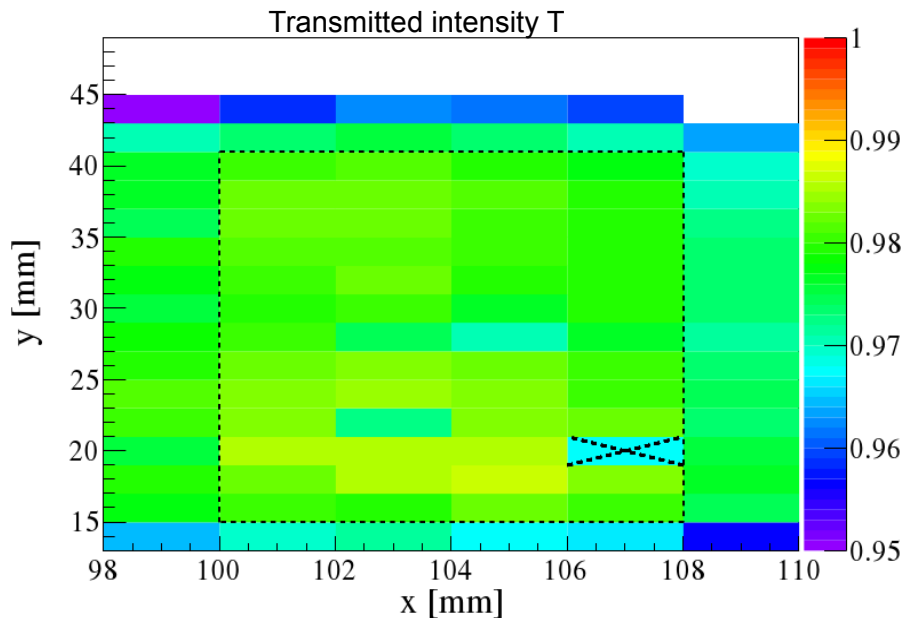
- *Measurements at multiple laser wavelengths of transmitted intensity  $T$  (Normalization by reference intensity).*
- *Determine attenuation length  $\Lambda$  by aiming laser down length of bar.*

# Radiator Quality Test Procedure

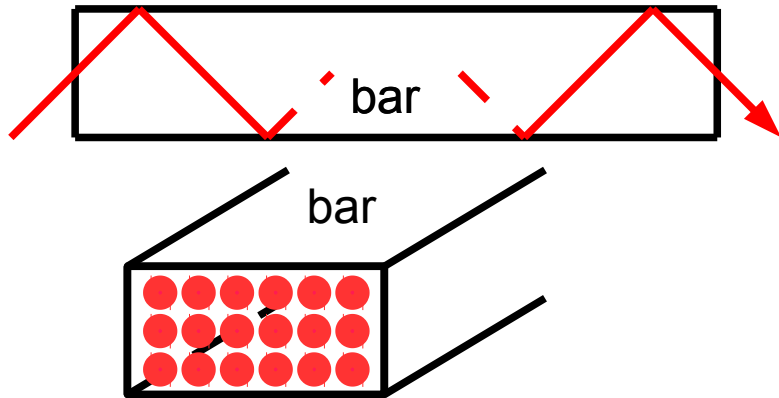


- **Determine coefficient of total internal reflection  $R$**  by bouncing laser off bar surfaces at Brewster angle.
- For 80 cm long bar 30/31 internal reflections from bar faces or 14/15 from bar sides.
- For 30 cm long bar 12 internal reflections from bar faces or 6 from bar sides.
- Calculate  $R$  from **mean transmitted intensity  $T$** :

$$T = R^N \cdot \exp\left(-\frac{L}{\Lambda}\right)$$



# Radiator Quality Test Procedure

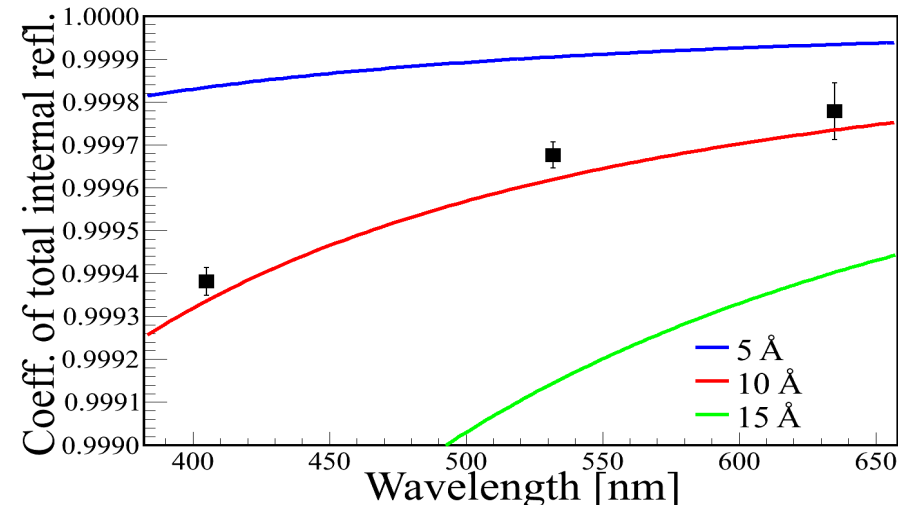


$$T = R^N \cdot \exp\left(-\frac{L}{\Lambda}\right)$$

- Calculate **surface roughness**  $\sigma$  from  $R$  using **scalar theory of scattering**:

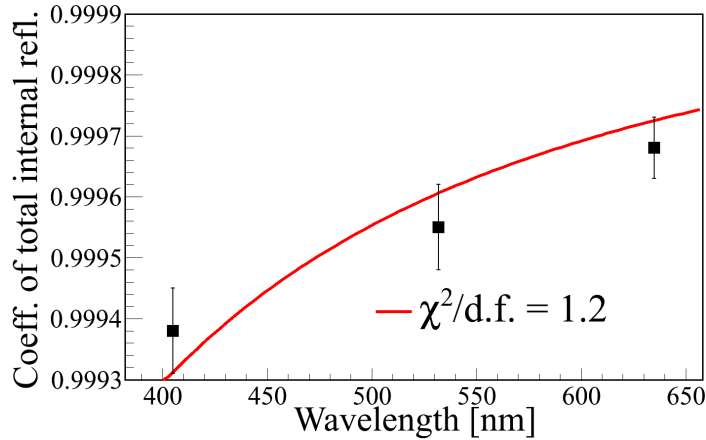
$$R = 1 - \left( \frac{4\pi \cdot \sigma \cdot n \cdot \cos \alpha}{\lambda} \right)^2 \quad \text{for } \sigma \ll \lambda$$

- **Cleaning procedure** (large impact on results).
- **Systematics** (bar uniformity, mirror rotation, laser halo, diode uniformity, etc).
- Determine quality of surface finish with **few Å accuracy**.
- Check agreement with production specifications.

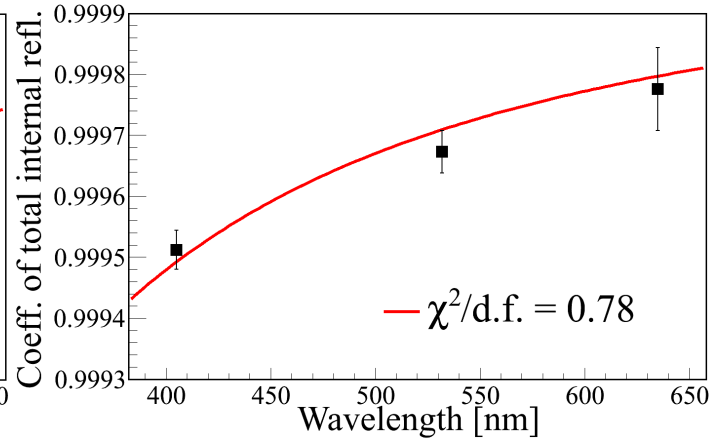


# Radiator Quality Test Results: Schott Lithotec, 80cm bar

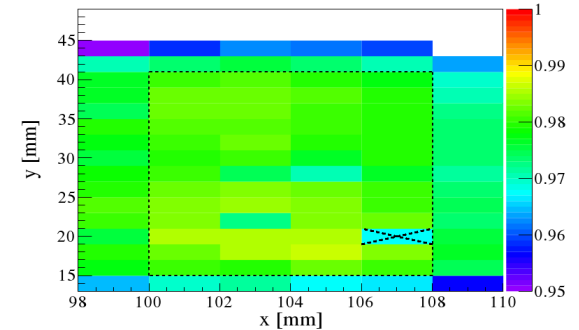
## 15 Reflections



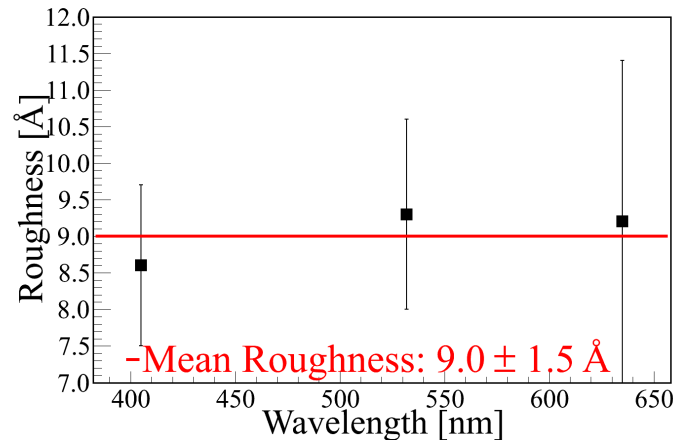
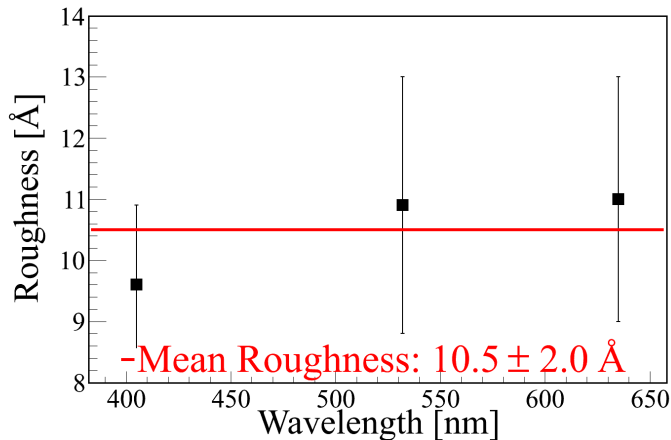
## 31 Reflections



Transmitted intensity T

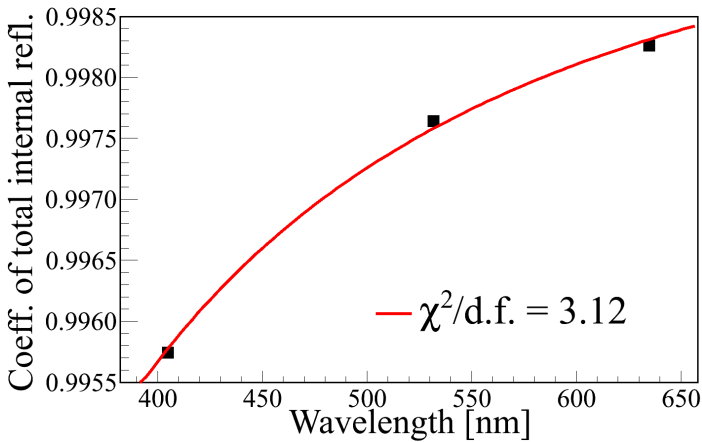


- Results consistent with the specifications.
- *Good agreement with scalar theory of scattering.*
- *Pitch polishing - similar to method used in BABAR is able to produce bars with very good surface polish.*
- *Not an option since Lithotec shuts down.*

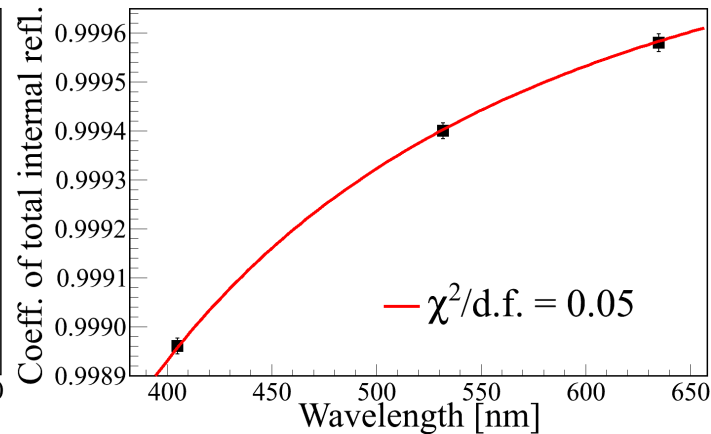


# Radiator Quality Test Results: Lytkarino LZOS, 30cm bar

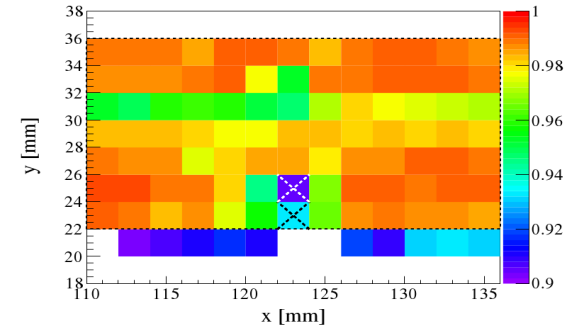
## 6 Reflections



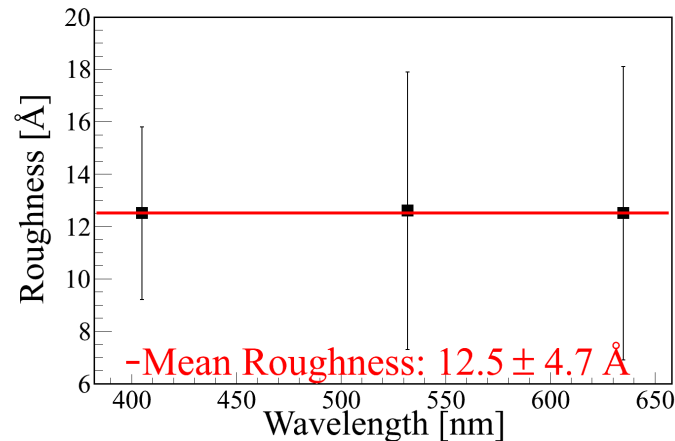
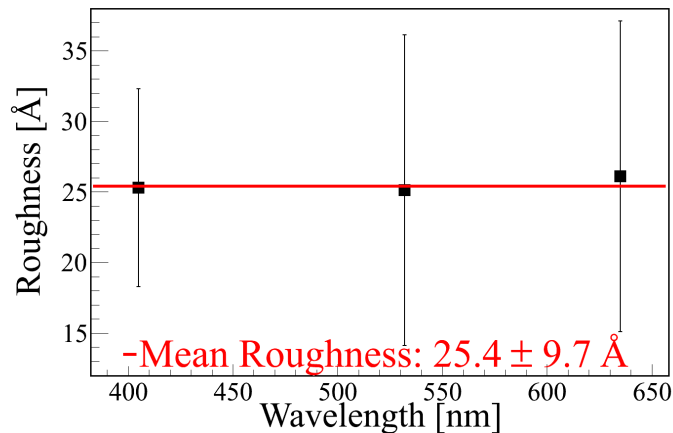
## 12 Reflections



Transmitted intensity T

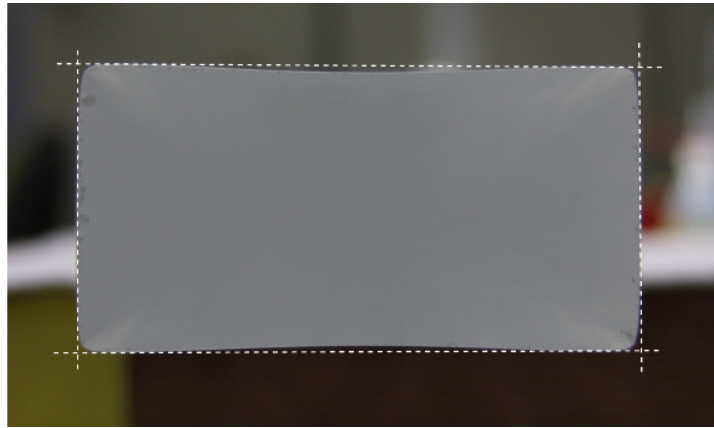


- Results consistent with the specifications.
- *Some bar defects.*
- *Short length of the bar.*
- *New 90cm length prototype bars from LZOS almost done (update on delivery and manufacturer's QA data at April DIRC workshop)*

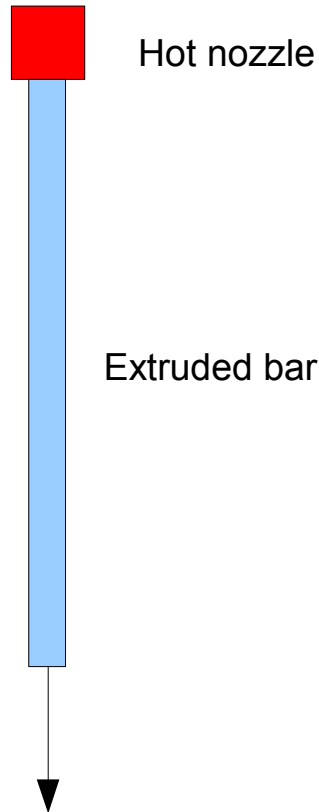
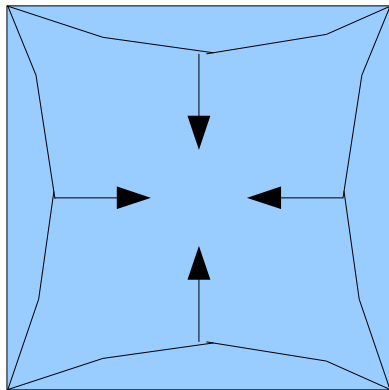




# Radiator Quality Test Results: *Heraeus bars*



**Bar cross section**



*Tested inexpensive alternative production methods with Heraeus.*

- *Production of the Heraeus bars using extrusion method - lateral sides of the bars are curved.*
- *Surface melting of ground bars – better, but surface roughness still not sufficient for PANDA DIRC.*
- *Several bars with different production parameters checked (temperature, feed-through speed).*
- *Heraeus production methods cannot reach so far requirements for optical properties of radiators (bar shape, surface roughness).*



# Summary & Outlook

---

- **Motion-controlled setup** to study optical properties of Cherenkov radiators for the PANDA Barrel DIRC and determine quality of surface finish with few Å accuracy.
- **Tested prototype bars** from several manufacturers.
- **Measured internal reflection coefficients** with multiple wavelengths → **consistent with the scalar theory**.
- **Measured surface roughness** in agreement with the specification.
- “Shift change” - knowledge transfer from Roland Hohler.
- **Dark Room** almost ready (Improvement of automation and stability of the setup).
- Expand wavelength range using a UV-laser (266 nm).
- Testing bars from **additional vendors**:  
**Zeiss**: 8 bars ordered by Mainz, prototype process, expect delivery Sep/Oct (833mm length)  
**InSync Inc.**: received 5 bars, BaBar-DIRC process (1225mm length)

# Backup

---

