



Cryo test results of SiC/Cf/CNT and directly polishable reaction bonded SiC mirrors

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Mirror tech days

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Background



NASA SBIR Phase I contract NNX12CF47P

Carbon Nanotubes (CNTs) and Carbon Fiber Reinforced SiC Optical Components

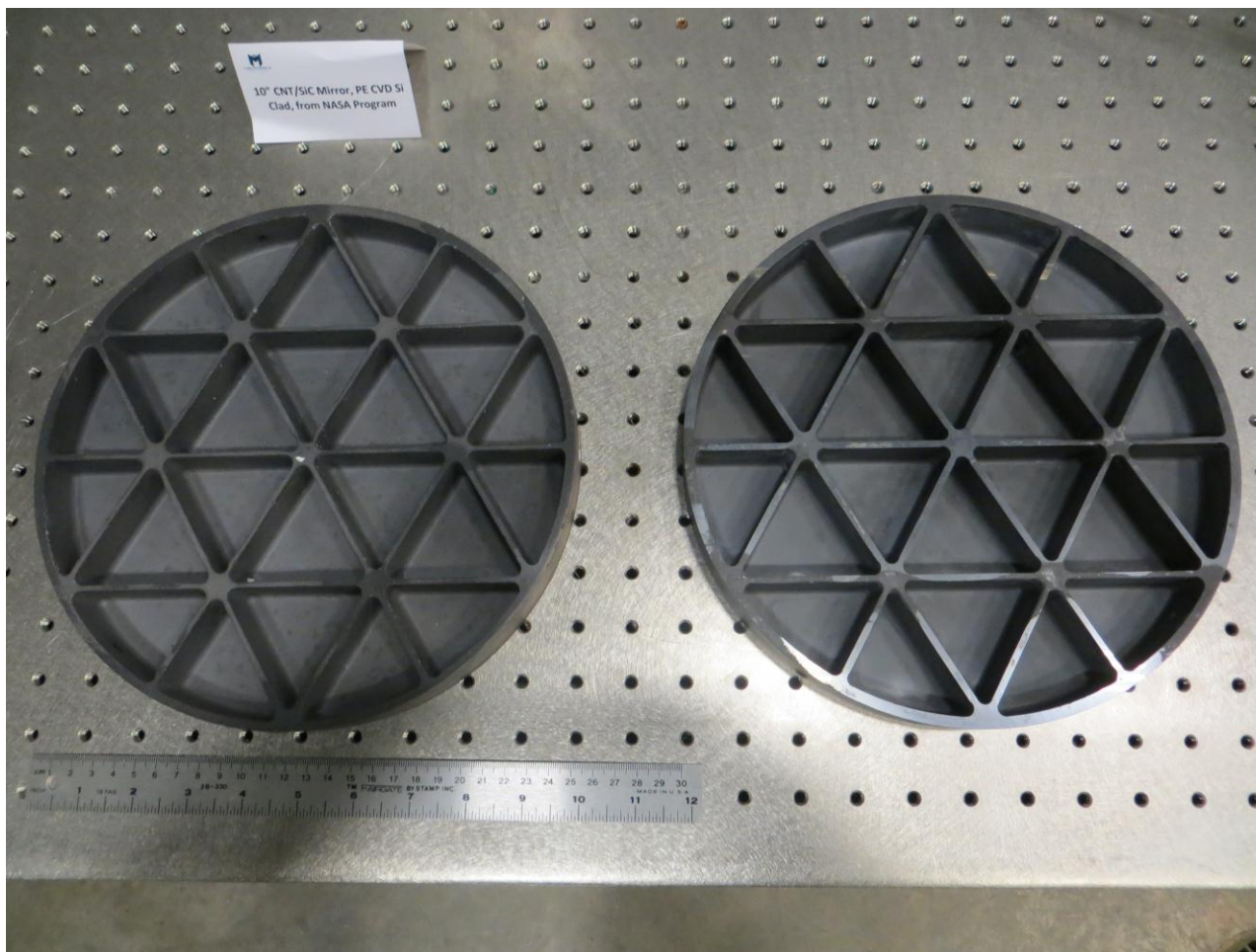
NASA SBIR Subtopic S2.04 “Advanced Optical Components”

Vendor: M Cubed Technologies, Inc., Newark, DE

PI: Prashant Karandikar



SiC/Cf/CNT and polishable RB SiC mirrors



Diameter: 0.25 meter; ROC: 2.5 meters



Objectives



Measure optical performance from 290° to 30° Kelvin.

Perform 2nd cryo cycles for repeatability.

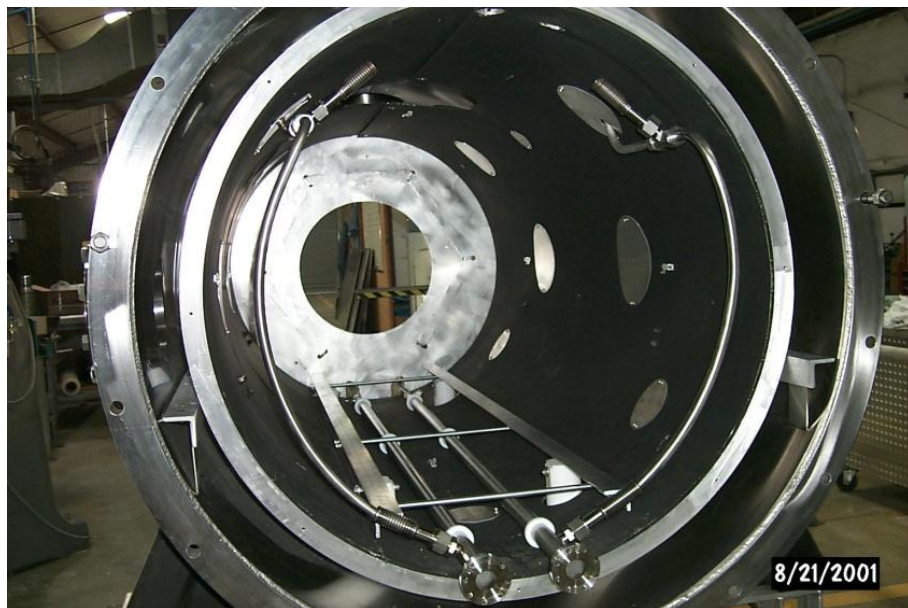
Compare results for both mirrors.



1x3 m optical test chamber

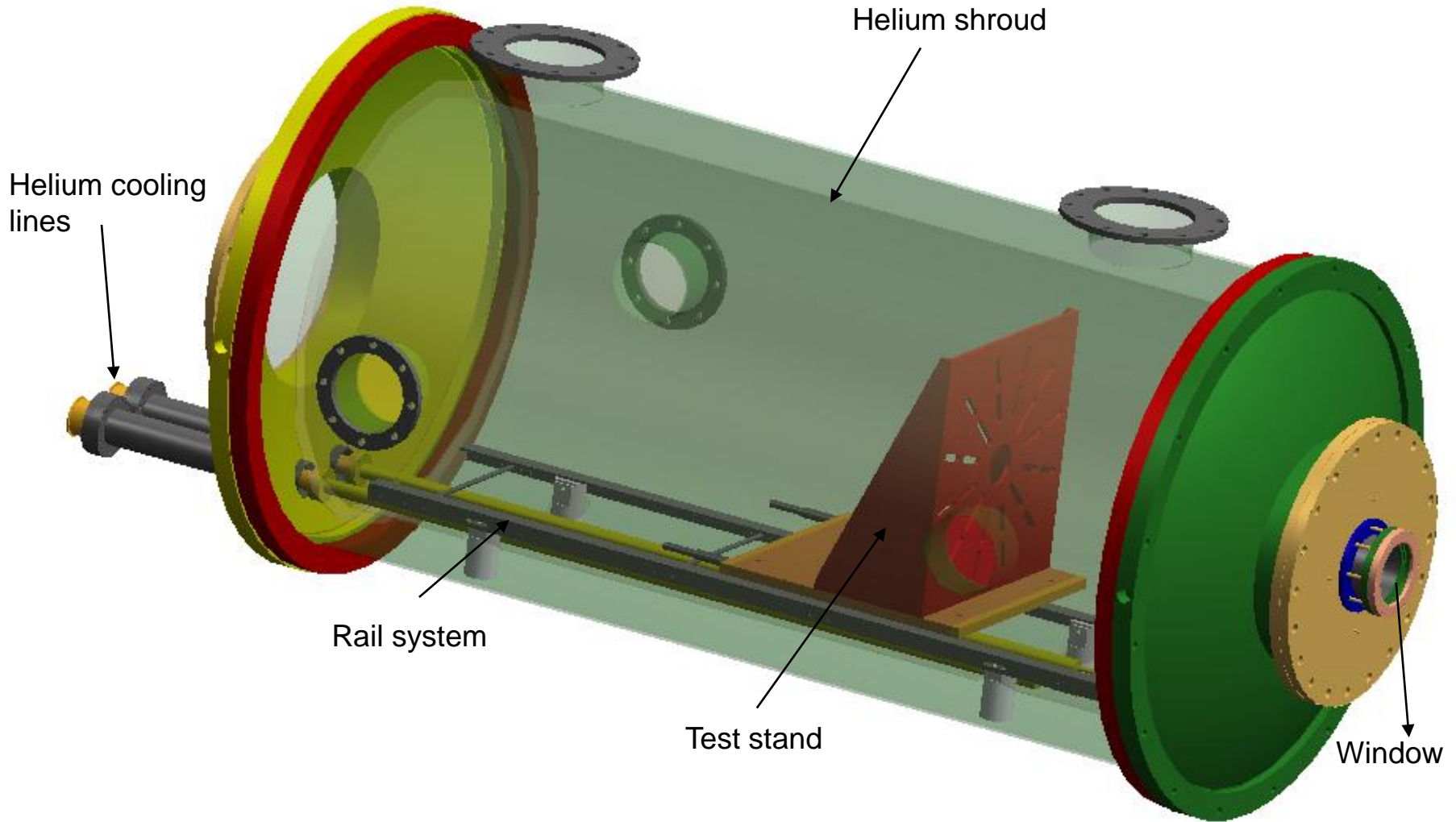


Vacuum chamber: 1x3 m cylinder with helium shroud.
Optical view port: BK7 window; 150 mm dia. clear aperture.
Chamber pressure: < 5 E-6 Torr
Temperature excursion: 293, 30, 60, 90, 130, 190, 260, 293K; 2 cycles.

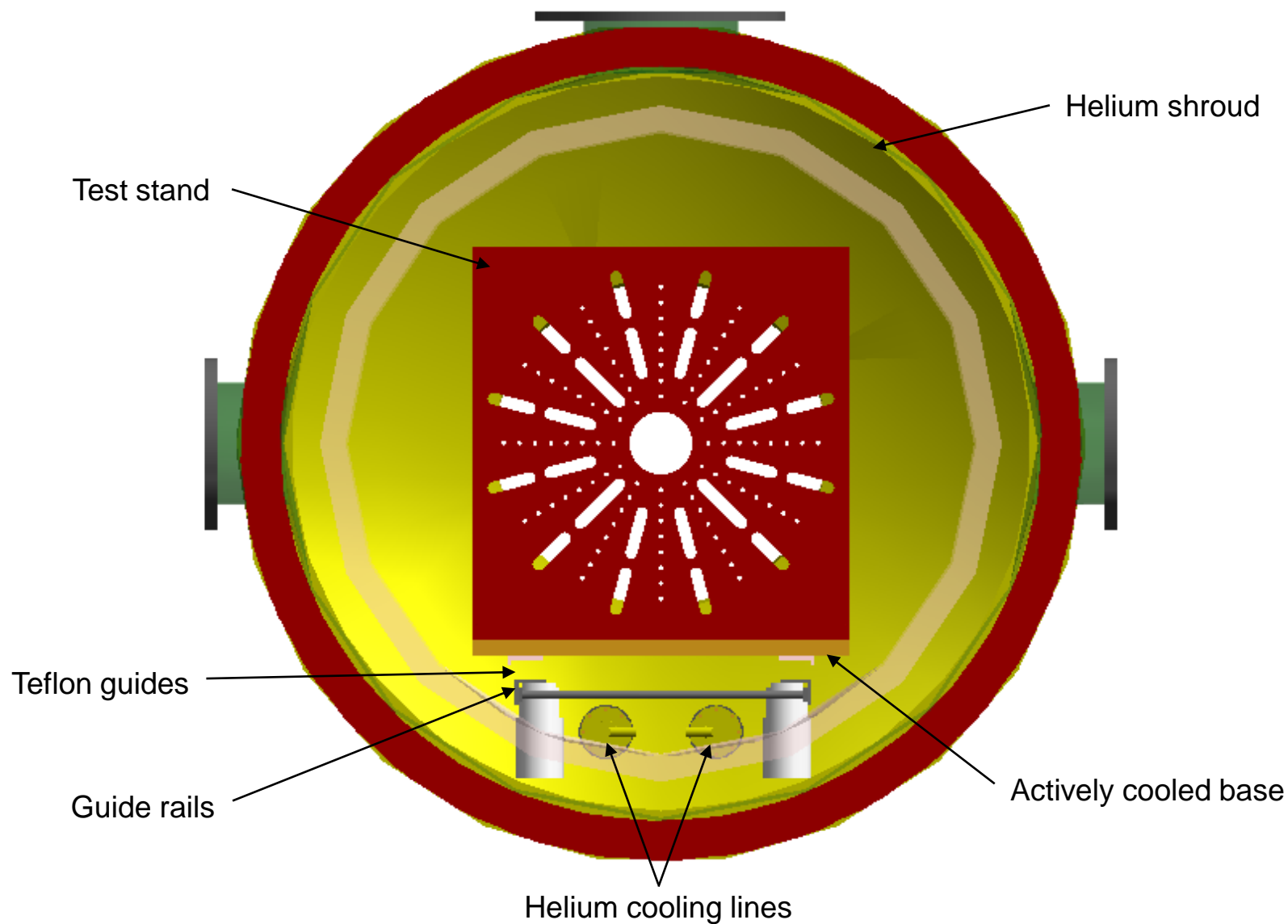




Side view of cryogenic chamber

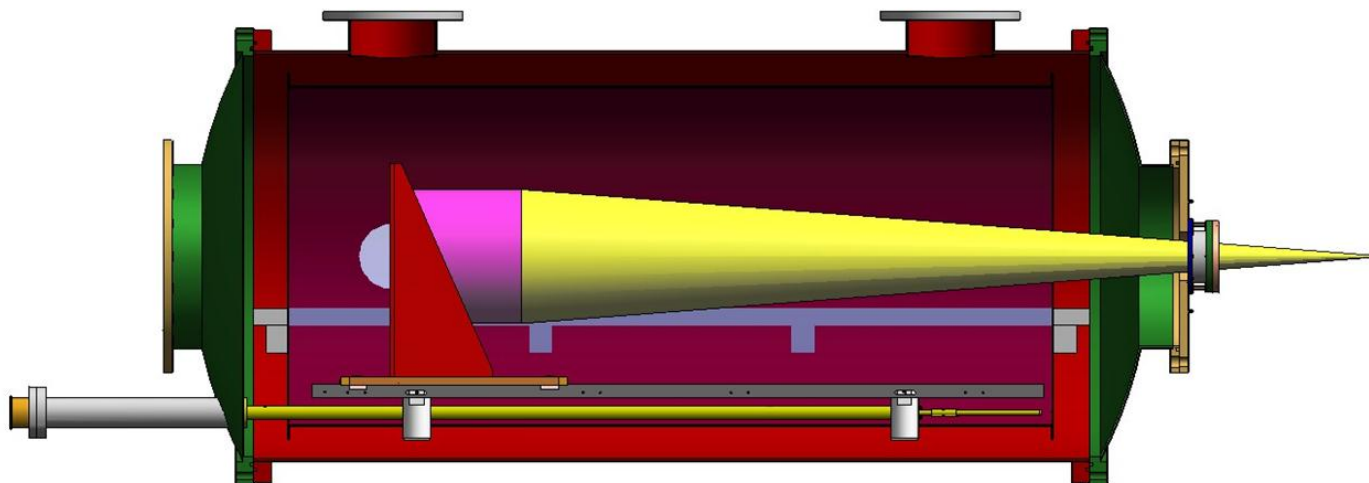


Front view of cryogenic chamber





Mirror in chamber



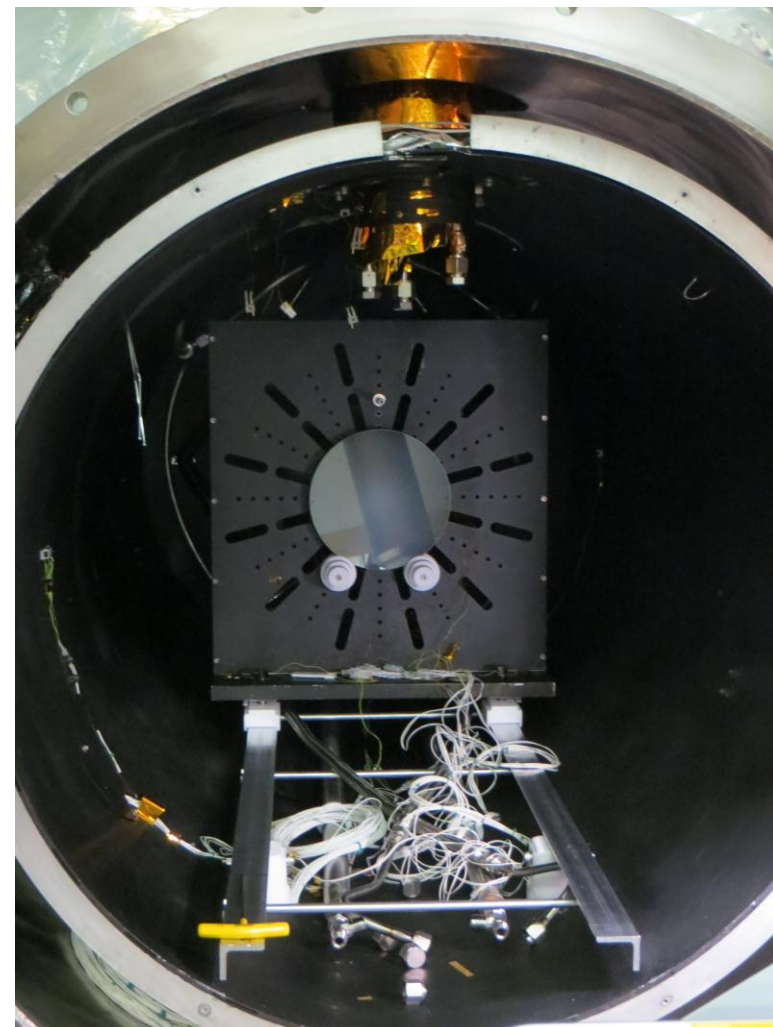
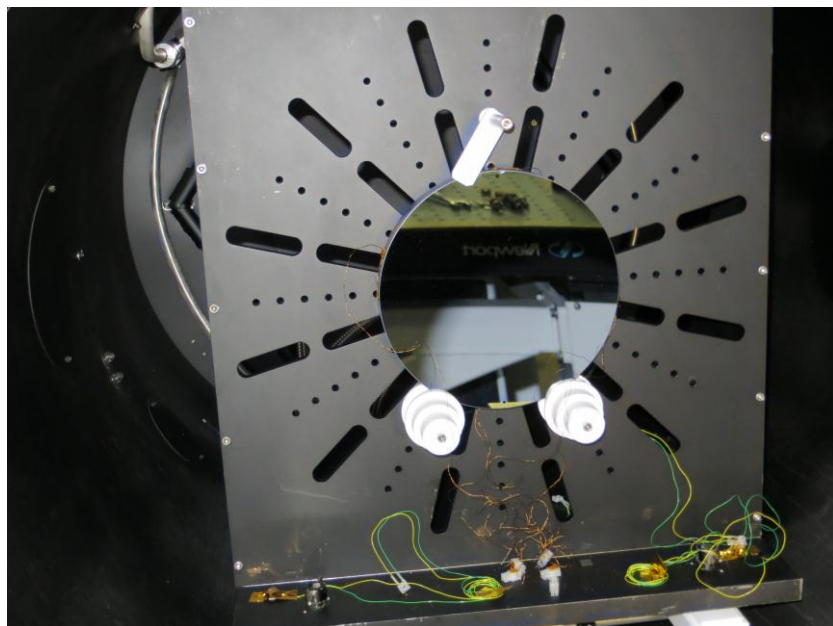
← 2.5 meters →
ROC



PhaseCam 5010 interferometer

- 1954 x 1967 pixels
- Effective array: 977 x 983 pixels
- diverger: f/6; R/10 mirror
- PV uncalibrated accuracy: 15 nm
- RMS uncalibrated accuracy: 3 nm
- PV repeatability: 0.24 nm
- RMS repeatability: 0.05 nm
- PV precision: 2.64 nm
- RMS precision: 0.51 nm

Mirror installed with temperature sensors





Measurement process



Evacuate chamber to 10-5 Torr.

Align the interferometer for minimum defocus, power, and tilt.

Baseline optical measurement at ambient temperature $\sim 293^\circ$.

Set Helium refrigerator to 20°K for 30° measurements with minimum gradient.

Optical measurements at 30, 60, 90, 130, 190, 260, and ambient.

2 cryo cycles.

Optical data evaluated for central 92% pupil.



SiC/Cf/CNT mirror



Temp	293°K	262°K	215	165	130	60	35
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27 nm rms

32

174

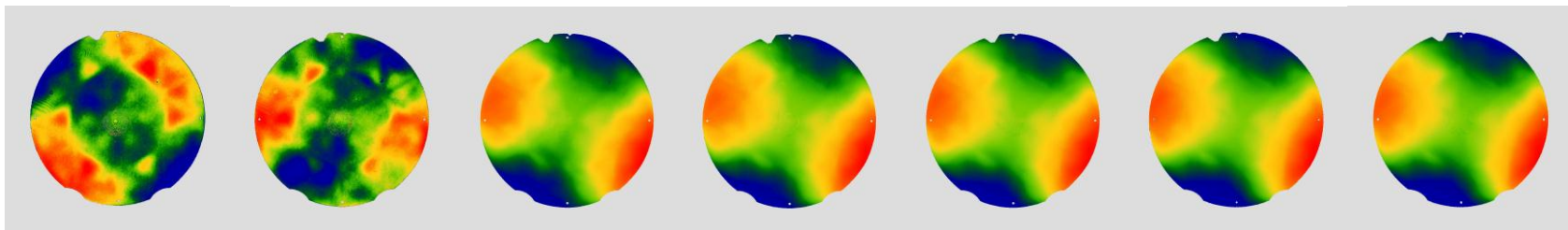
343

478

701

692

1st cycle



289°K
85 nm rms

255
20

221
107

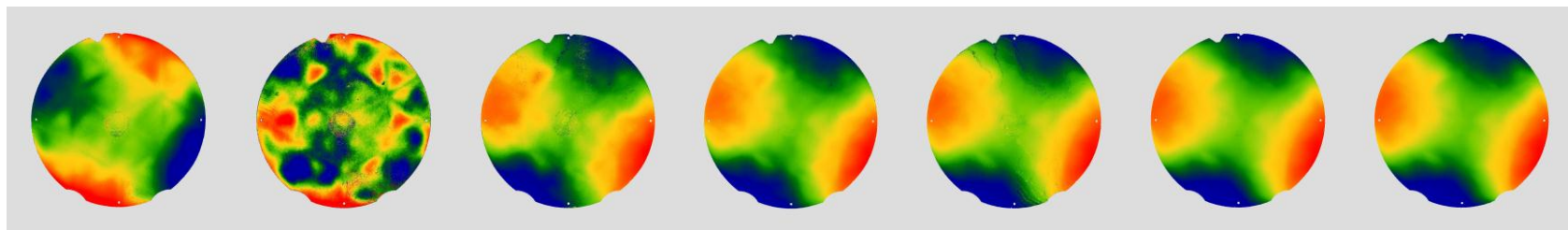
190
192

132
412

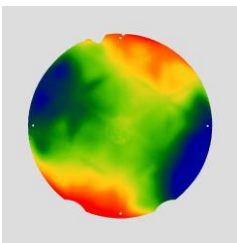
75
611

24
638

2nd cycle

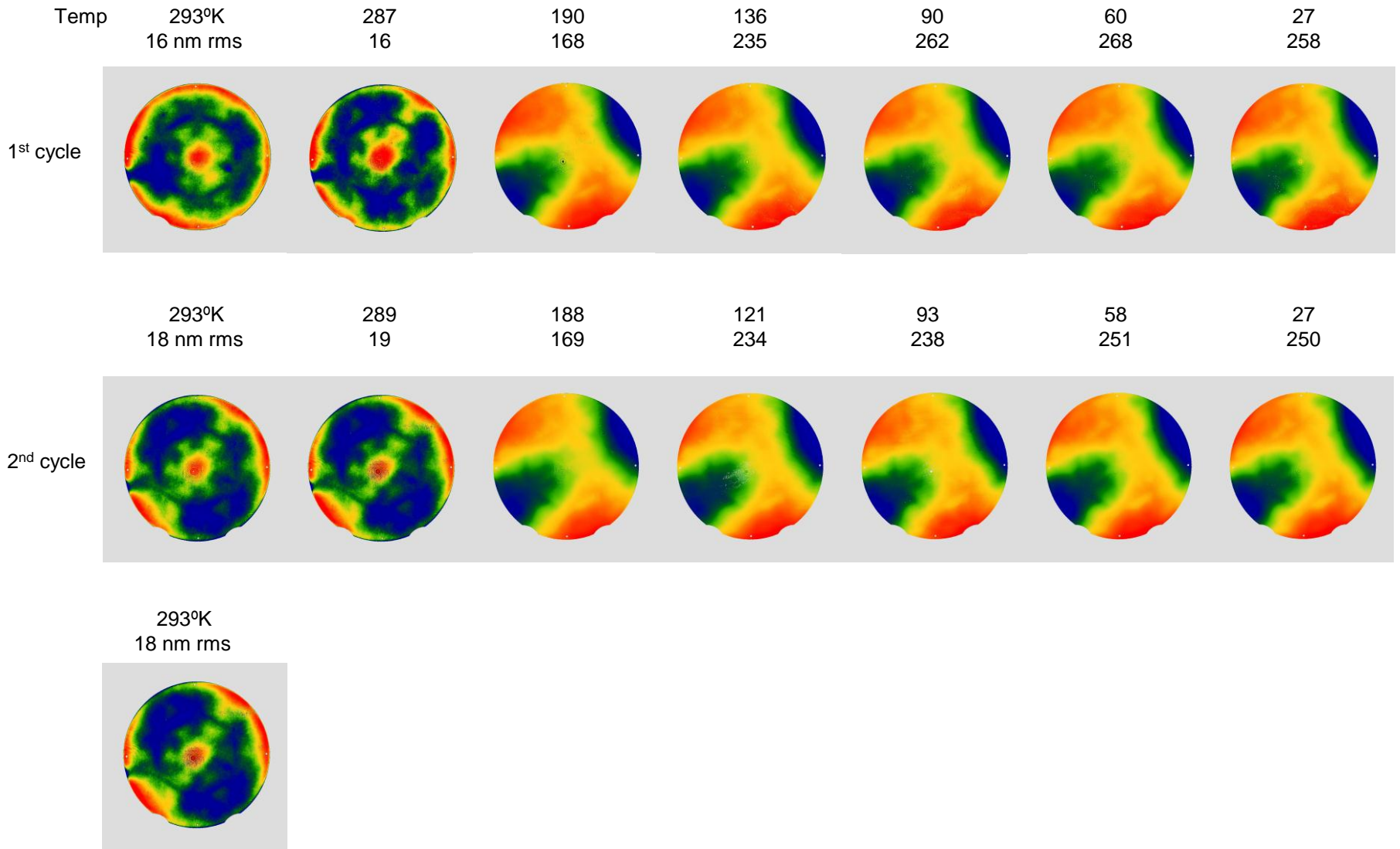


290°K
120 nm rms





Directly Polishable RB SiC





Observations



Directly polishable RB SiC mirror performed better than the SiC/Cf/CNT SiC mirror.

Good repeatability for the directly polishable RB SiC mirror.

SiC/Cf/CNT SiC performed better after 1st cryo cycle.

The PECVD Si coating on the SiC/Cf/CNT SiC mirror could be causing the deformation at cryo temperatures.



Thank you



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