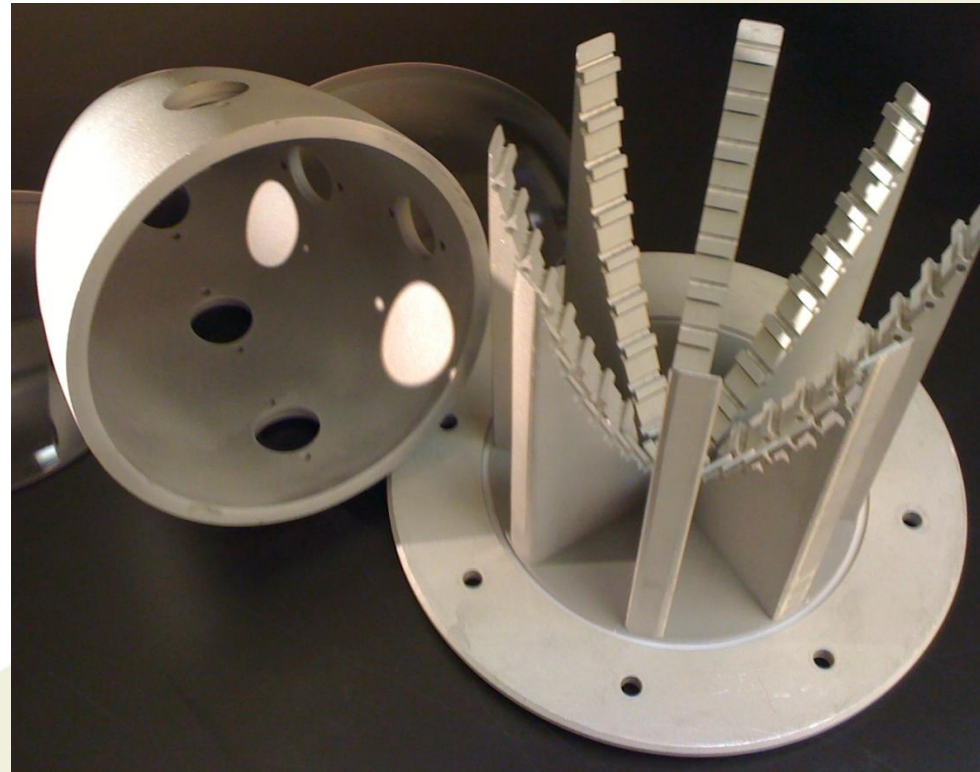


REPORT DOCUMENTATION PAGE				Form Approved OMB No. 0704-0188	
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13. SUPPLEMENTARY NOTES Presented at Mirror Technology Days, Boulder, Colorado, USA, 7-9 June 2010.					
14. ABSTRACT Precision Photonics Corporation has developed a method of applying Ion Beam Sputtered (IBS) MWIR anti-reflective coatings to the interior of a tangent ogive dome. Although IBS has traditionally not been used in this application, it is known that IBS provides the highest density coatings using very hard, durable materials. We achieved a variable coating thickness profile by means of shadow masking coupled with a sophisticated 3 dimensional mathematical model, which optimizes the antireflection performance over a wide range of look angles for an infrared seeker inside the dome. The coating design for this project survives temperatures up to 1000°C.					
15. SUBJECT TERMS mid-wave, infrared, coating, dome, robust, masking, uniformity					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 16	19a. NAME OF RESPONSIBLE PERSON Hans-Peter Dumm
a. REPORT UNCLASSIFIED	b. ABSTRACT UNCLASSIFIED	c. THIS PAGE UNCLASSIFIED			19b. TELEPHONE NUMBER (include area code) 505-853-8397

Thermally Robust IBS Coatings for Deep Concave Surfaces

*Dale Ness, Darrel Pitrat, and
Chris Wood,*

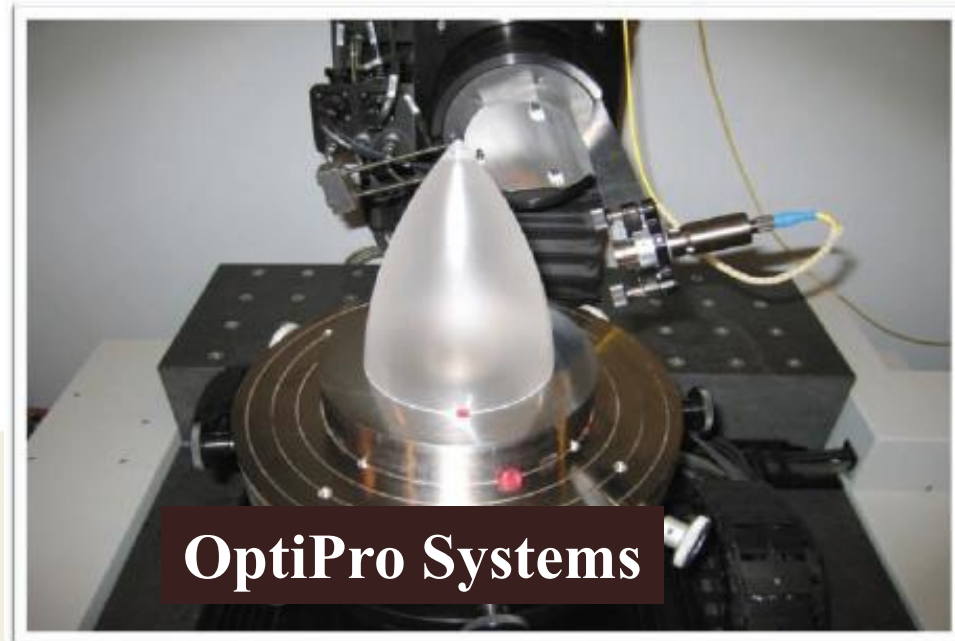
Mark B. Moran, U.S. Navy



This work is supported by the Naval Air Warfare Center Weapons Division, China Lake, under contract N68936-10-C-0020
Distribution A: Approved for Public Release

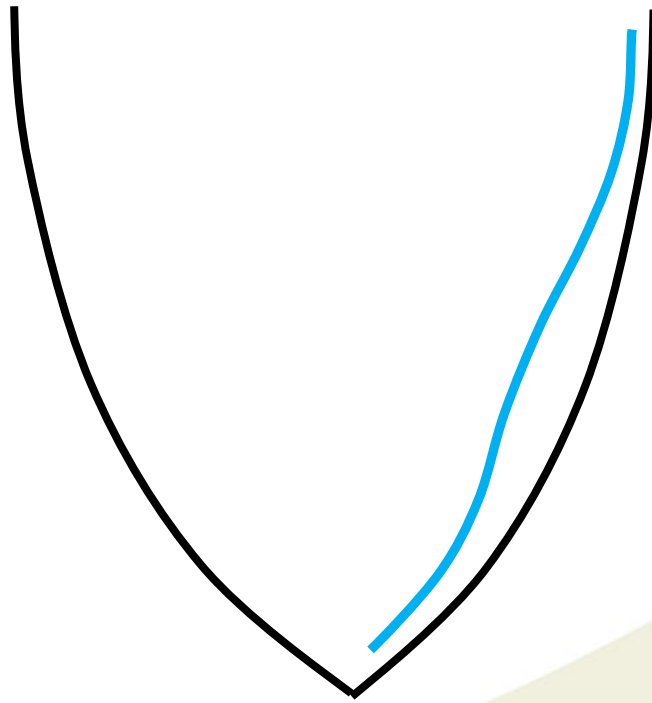
The Challenge

- Dome shape trend: Hemispherical dome → tangent ogive
- Improved aerodynamics:
 - decrease drag, temp., increase range, speed
- Increased durability against rain, etc.
- Increased optical field of regard
- Issues:
 - High temperature operation ($\sim 1000^{\circ}\text{C}$) required
 - more complex optic, more complex coatings necessary
 - Spatially-varying coating profile required in order to optimize AR coating for a wide range of look angles within the dome

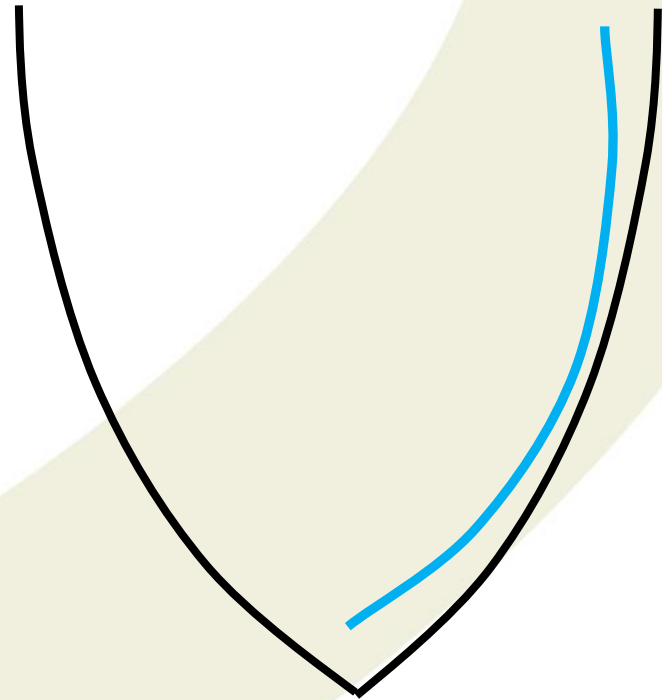


If you just put the dome in a coating chamber...

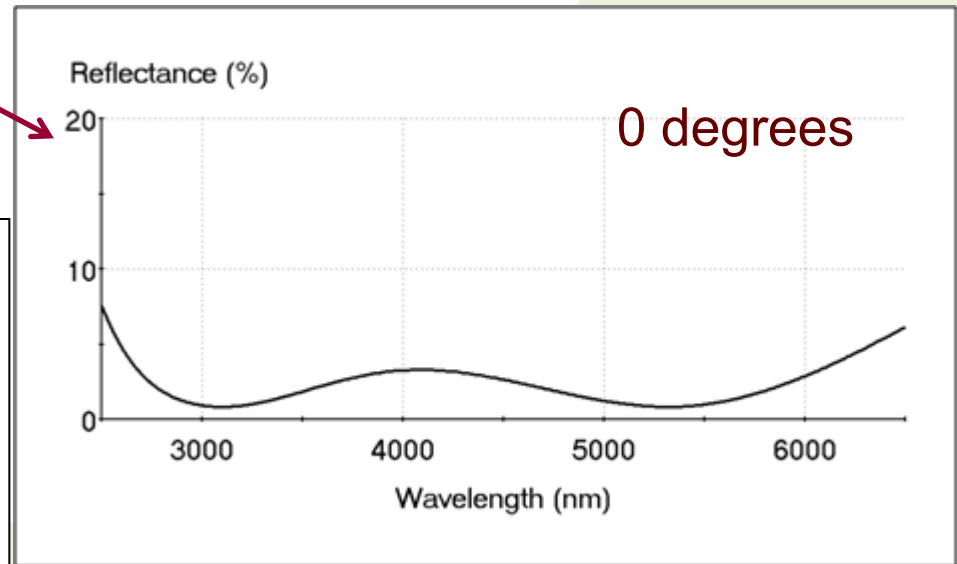
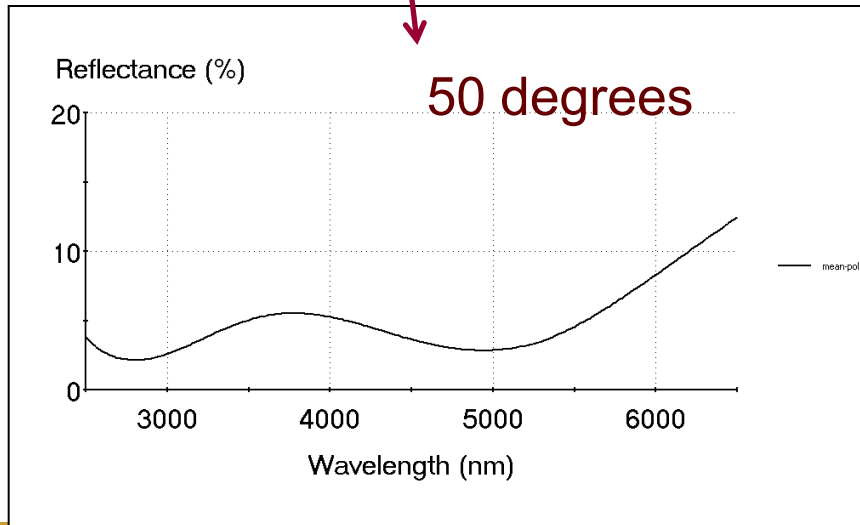
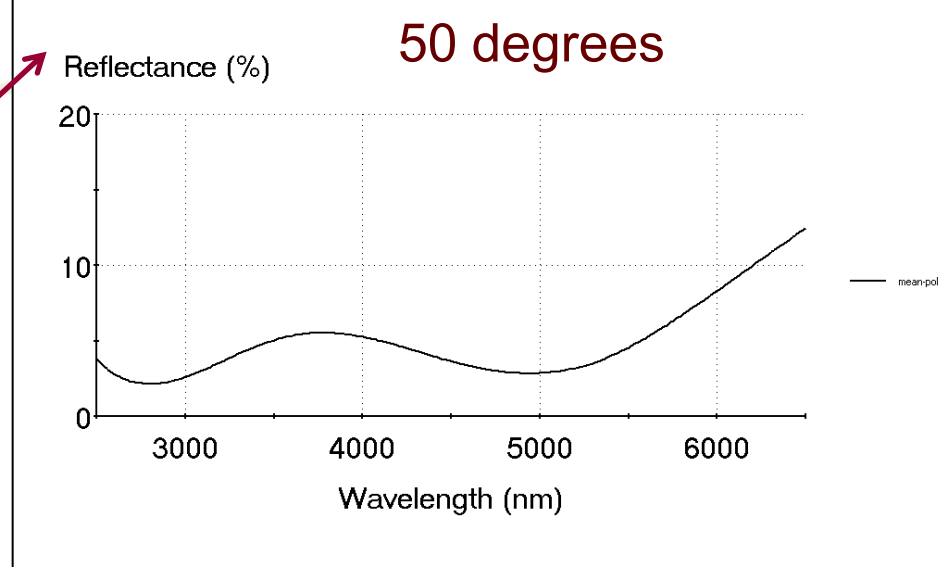
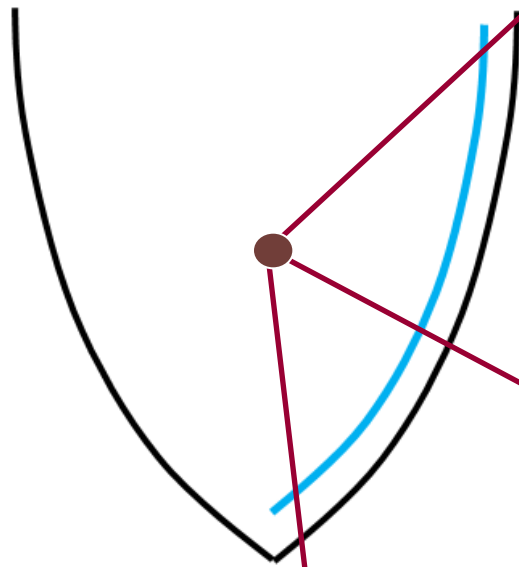
What you get:



What you want:



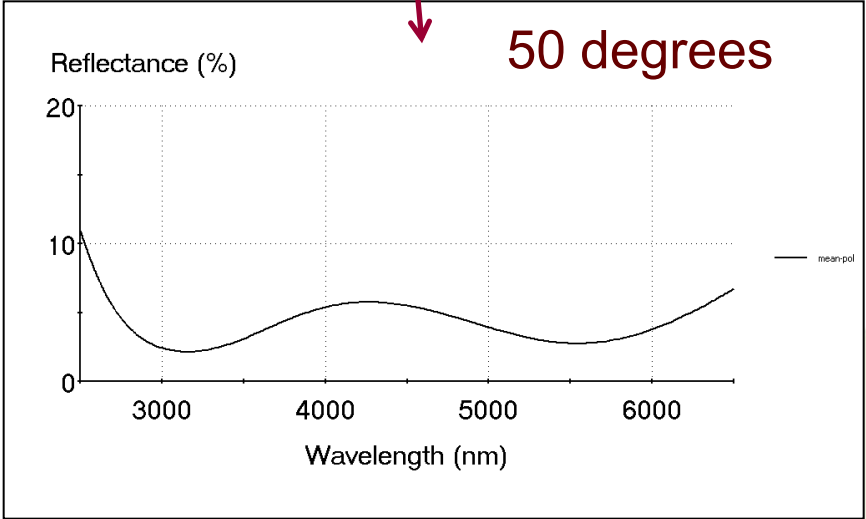
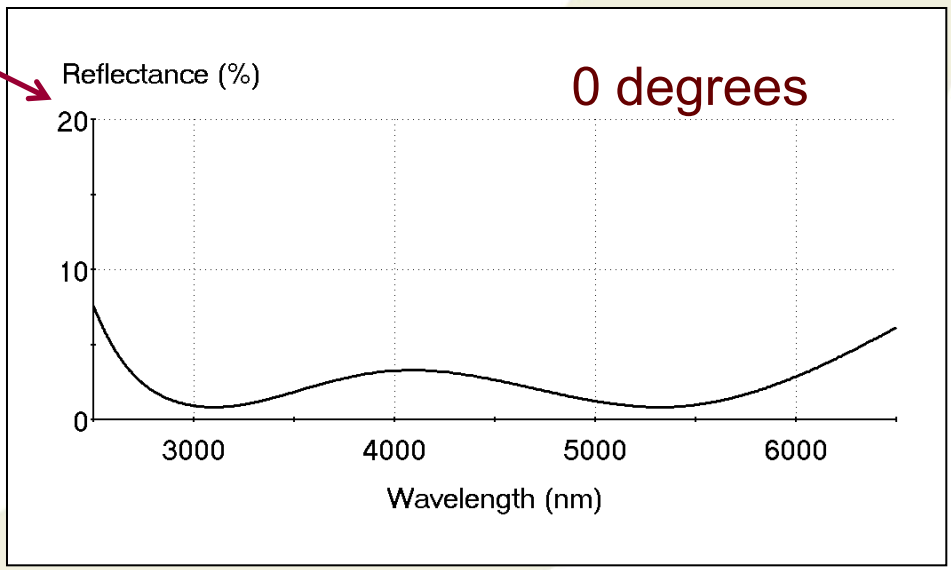
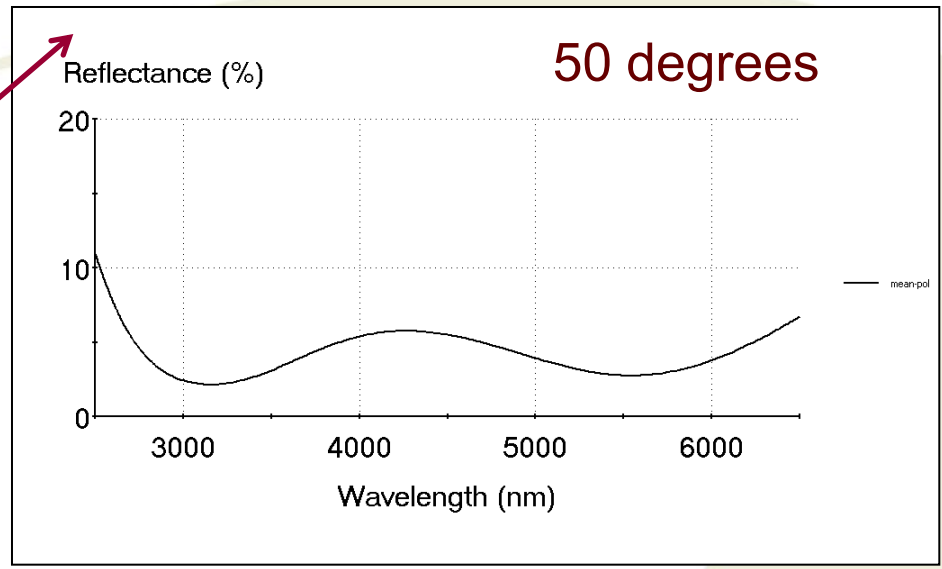
Uniform thickness profile *incorrect*



The coating thickness challenge
(Mean polarization shown)

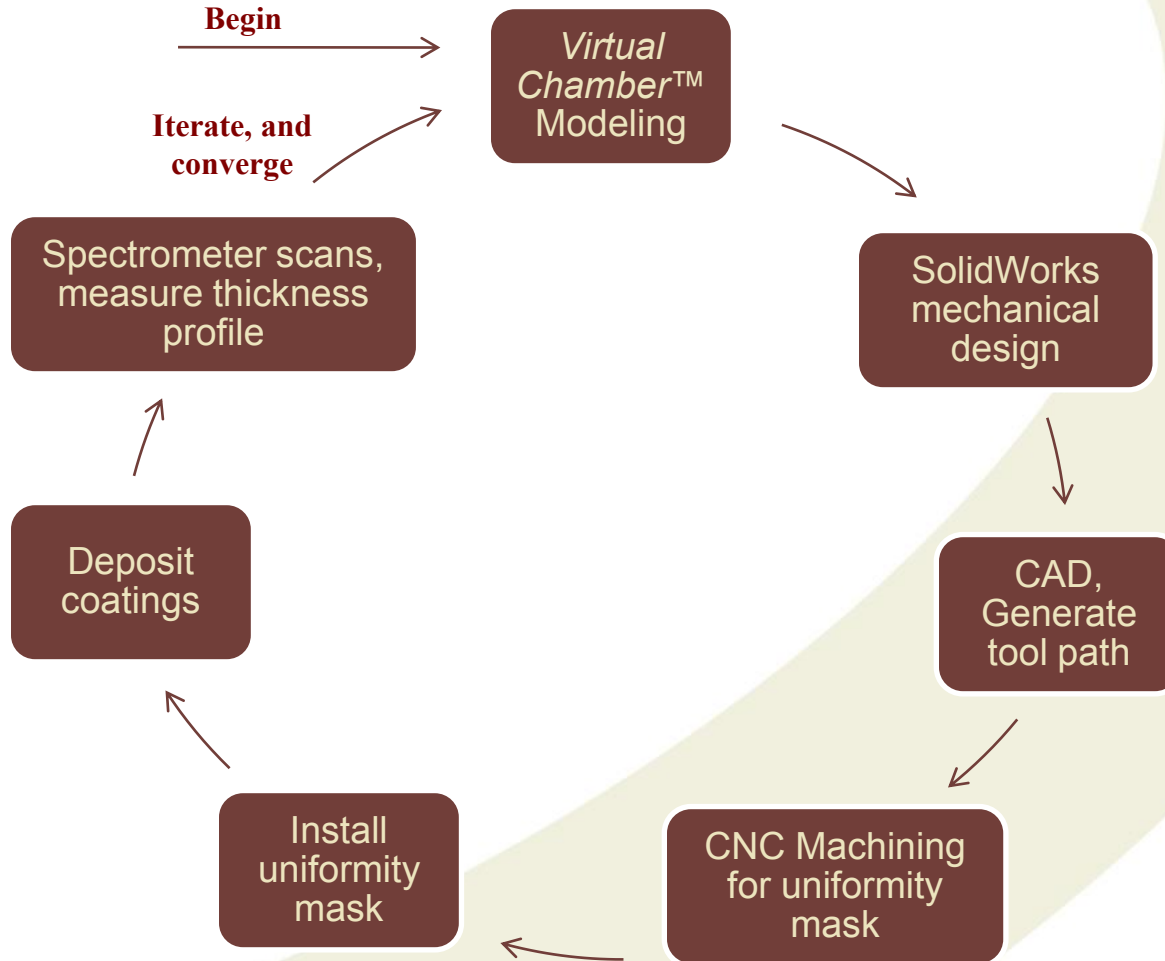
Spatially-varying thickness profile

correct

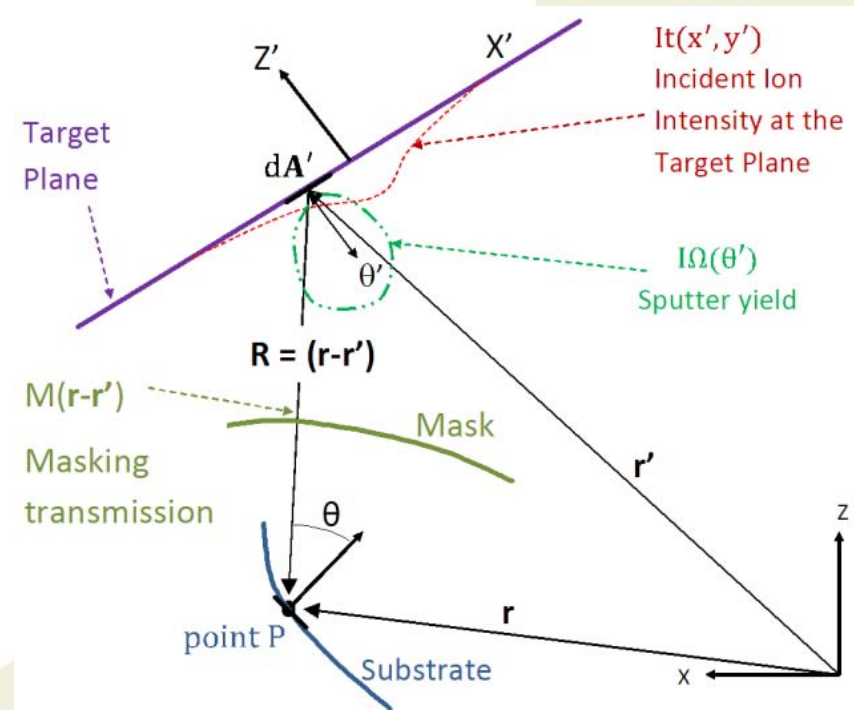
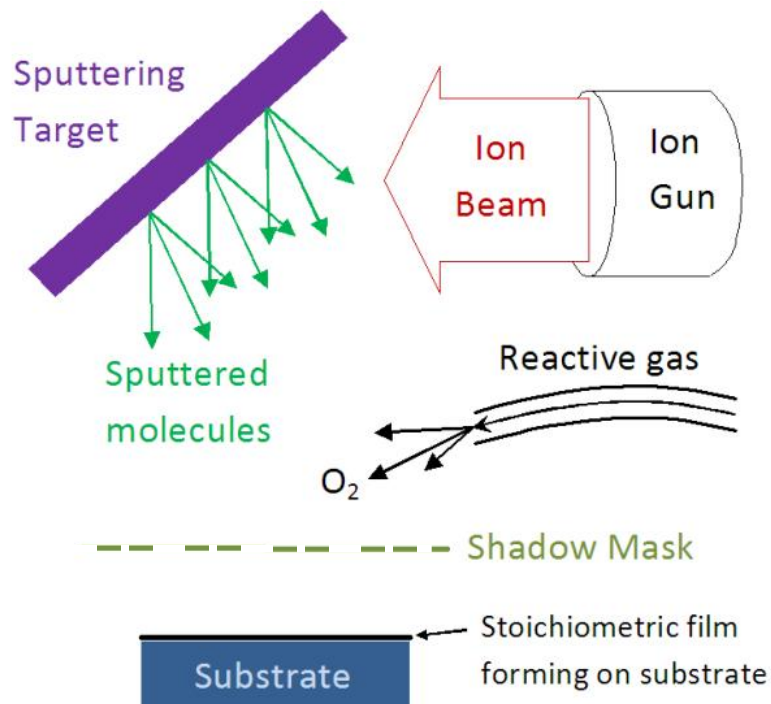


The coating thickness challenge
(Mean polarization shown)

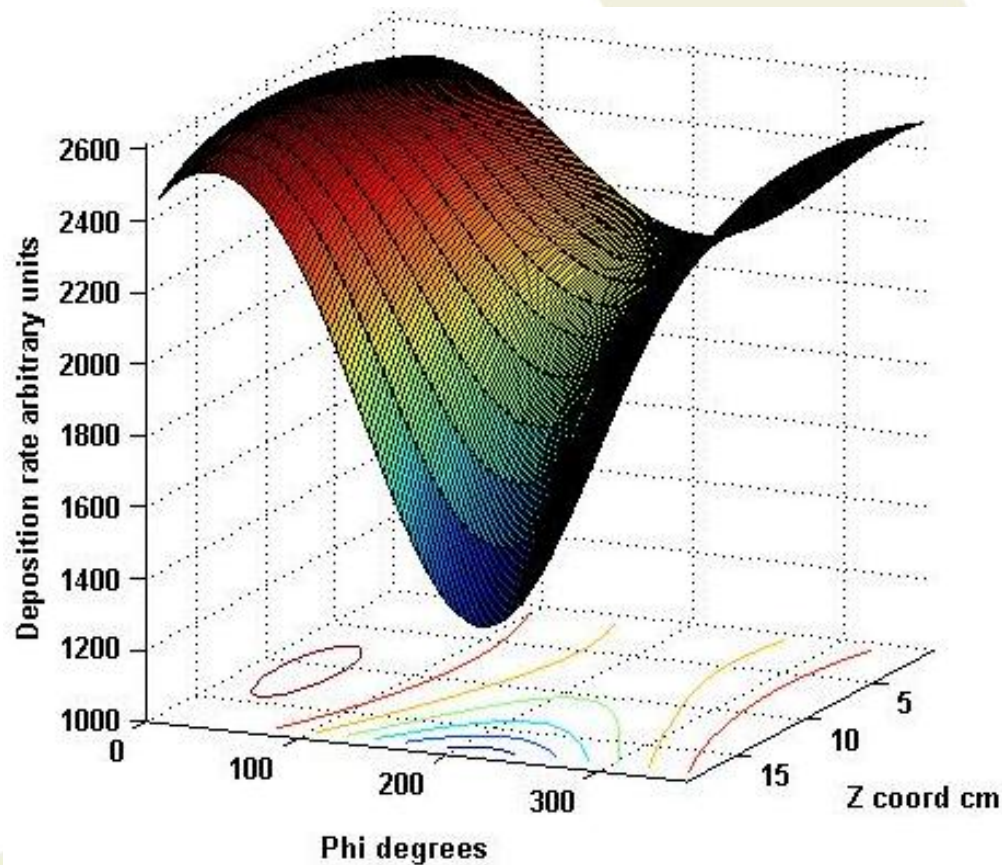
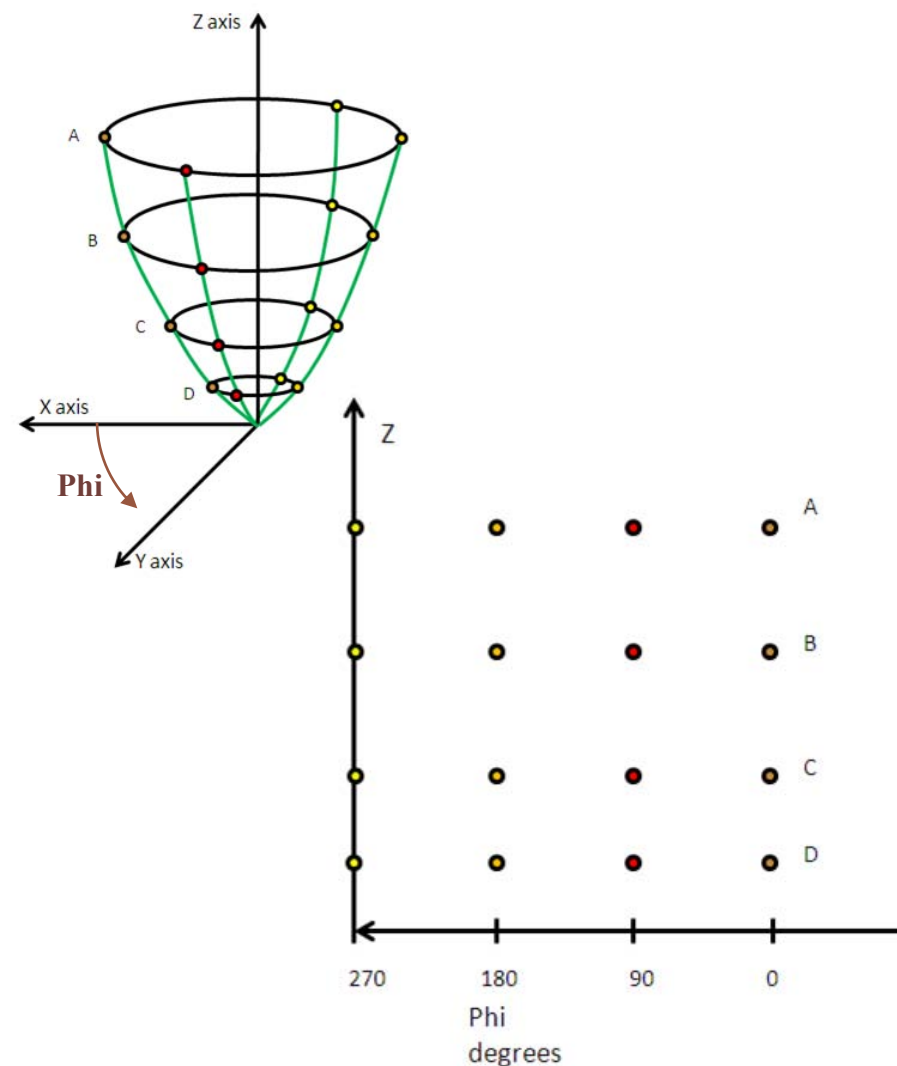
PPC's Solution



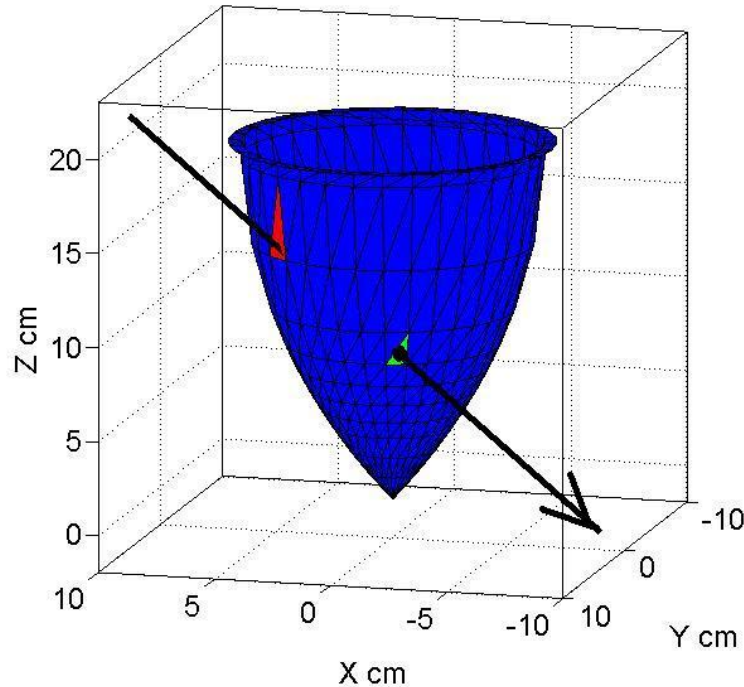
IBS Model: *Virtual Chamber*TM



Virtual Chamber™ → Dome Rate Field



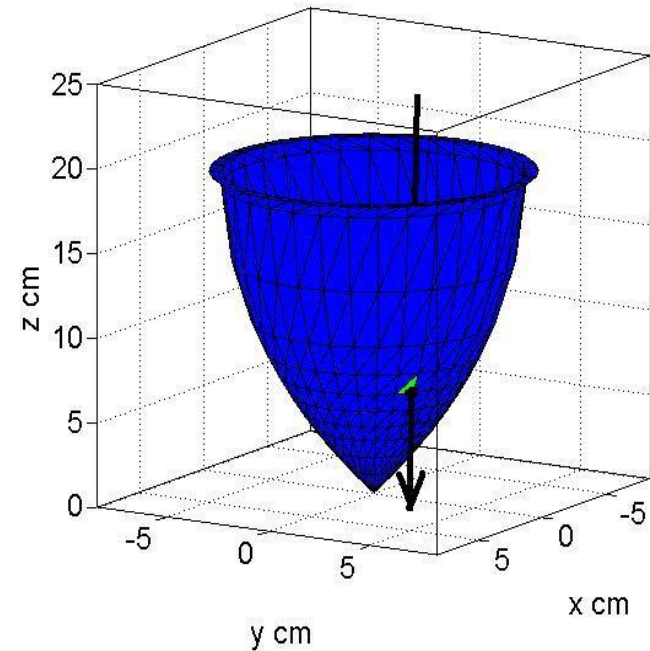
Virtual Chamber™ → Uniformity Masking



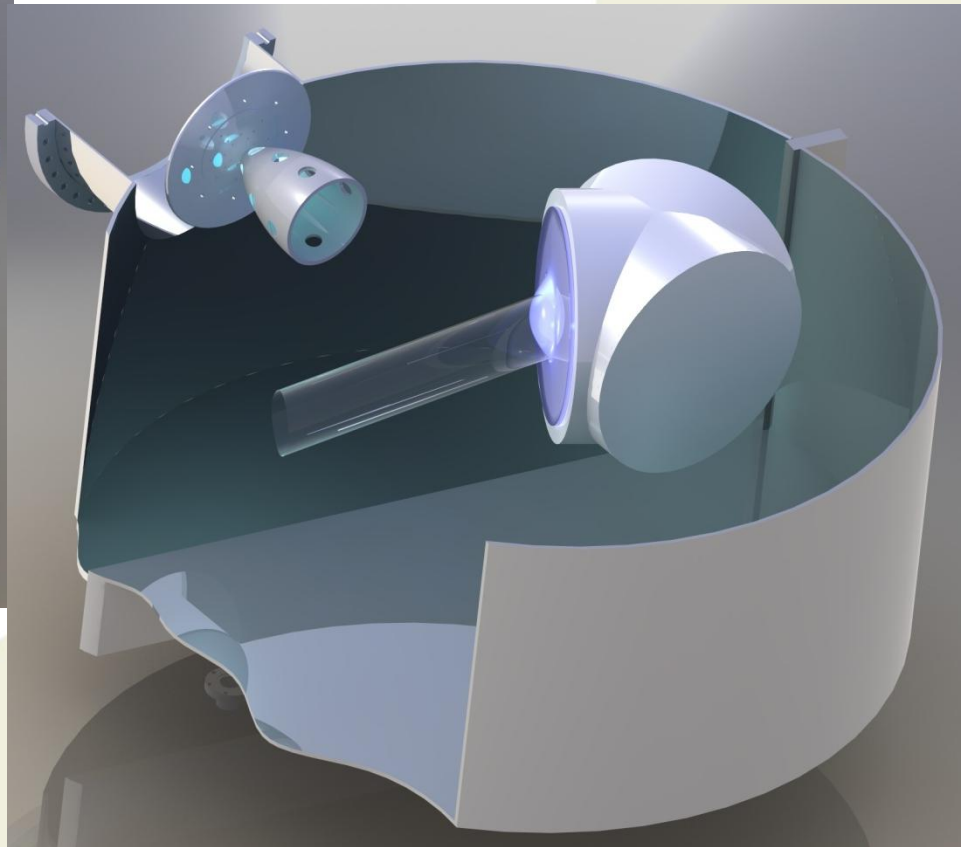
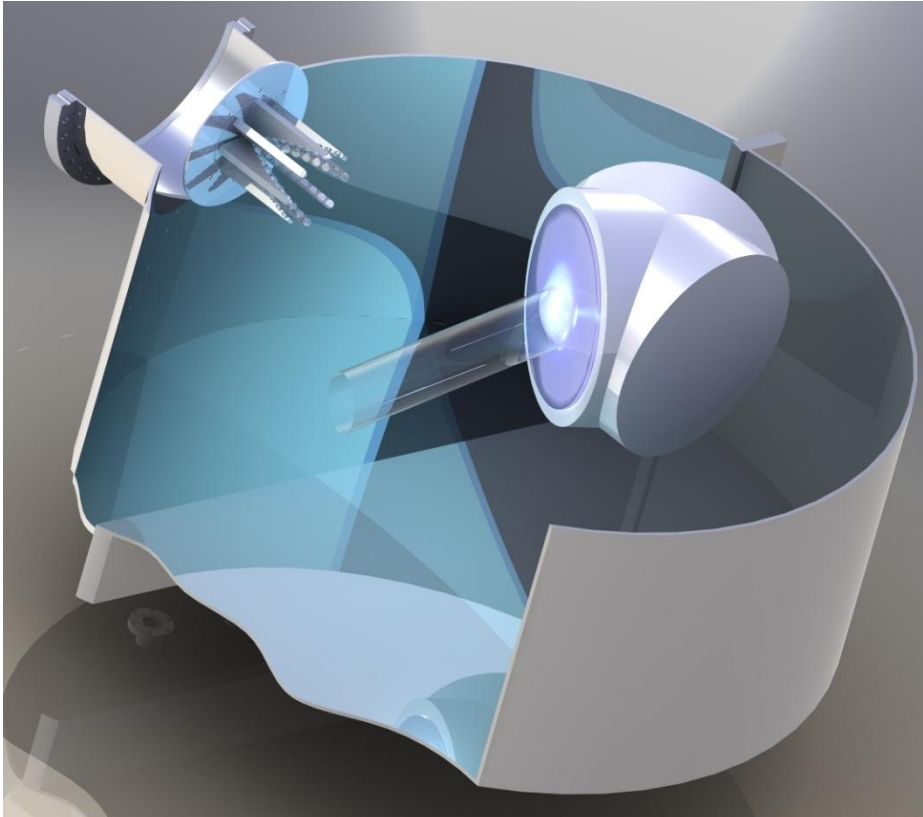
Rays indicate material path from sputtering target to dome surfaces

Goal:

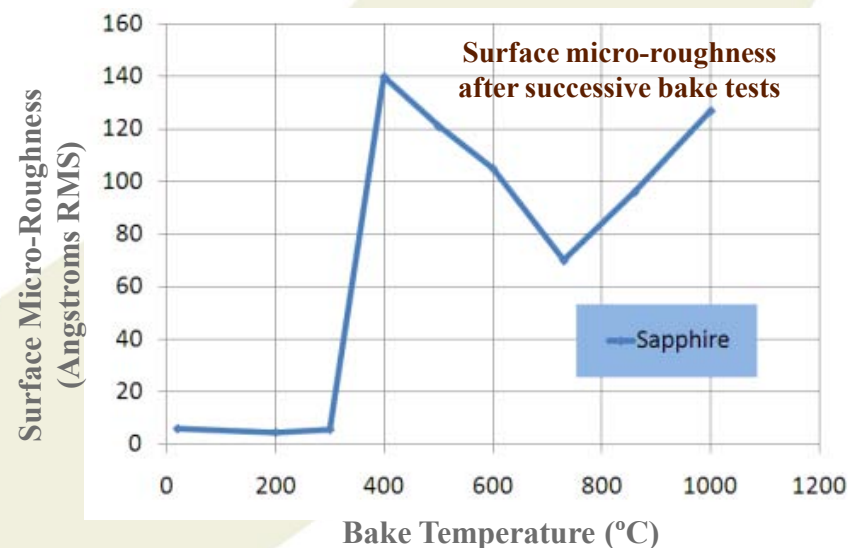
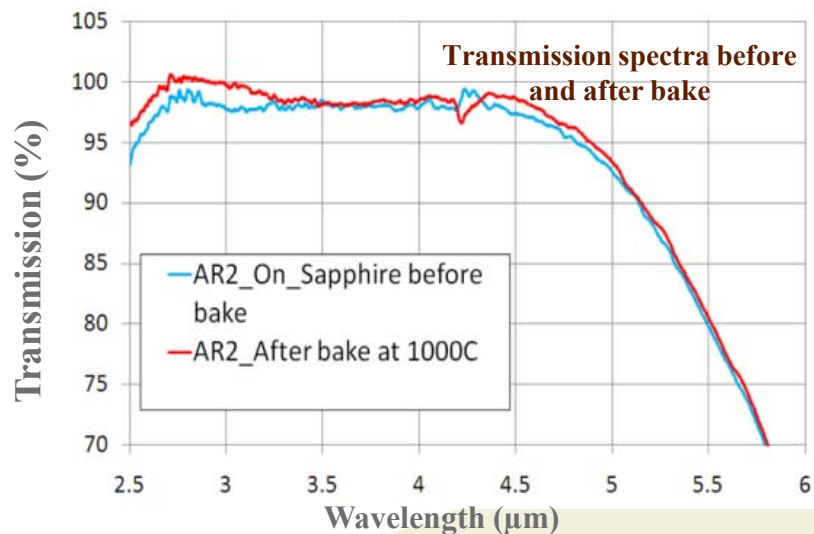
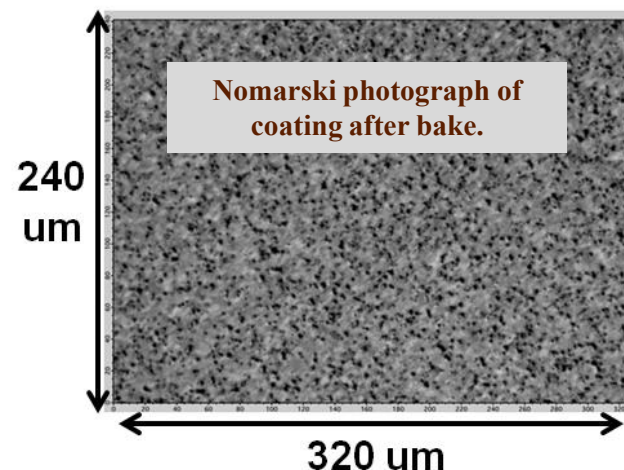
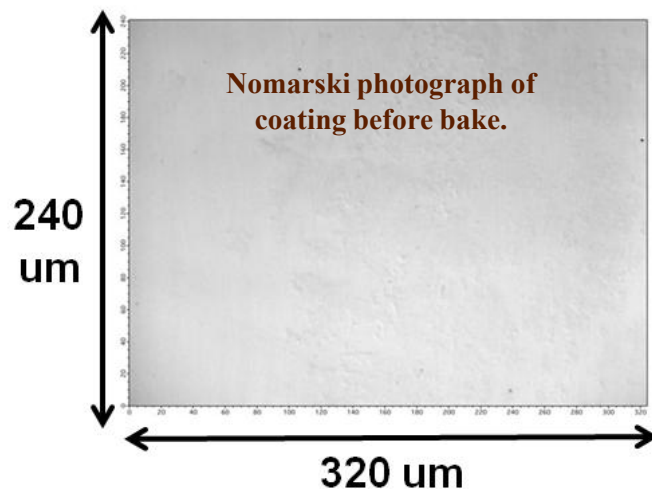
Tailor which 'paths' are allowed to reach the dome surface, as a function of position along the dome interior. Use mechanical masking of sputter distribution to accomplish this



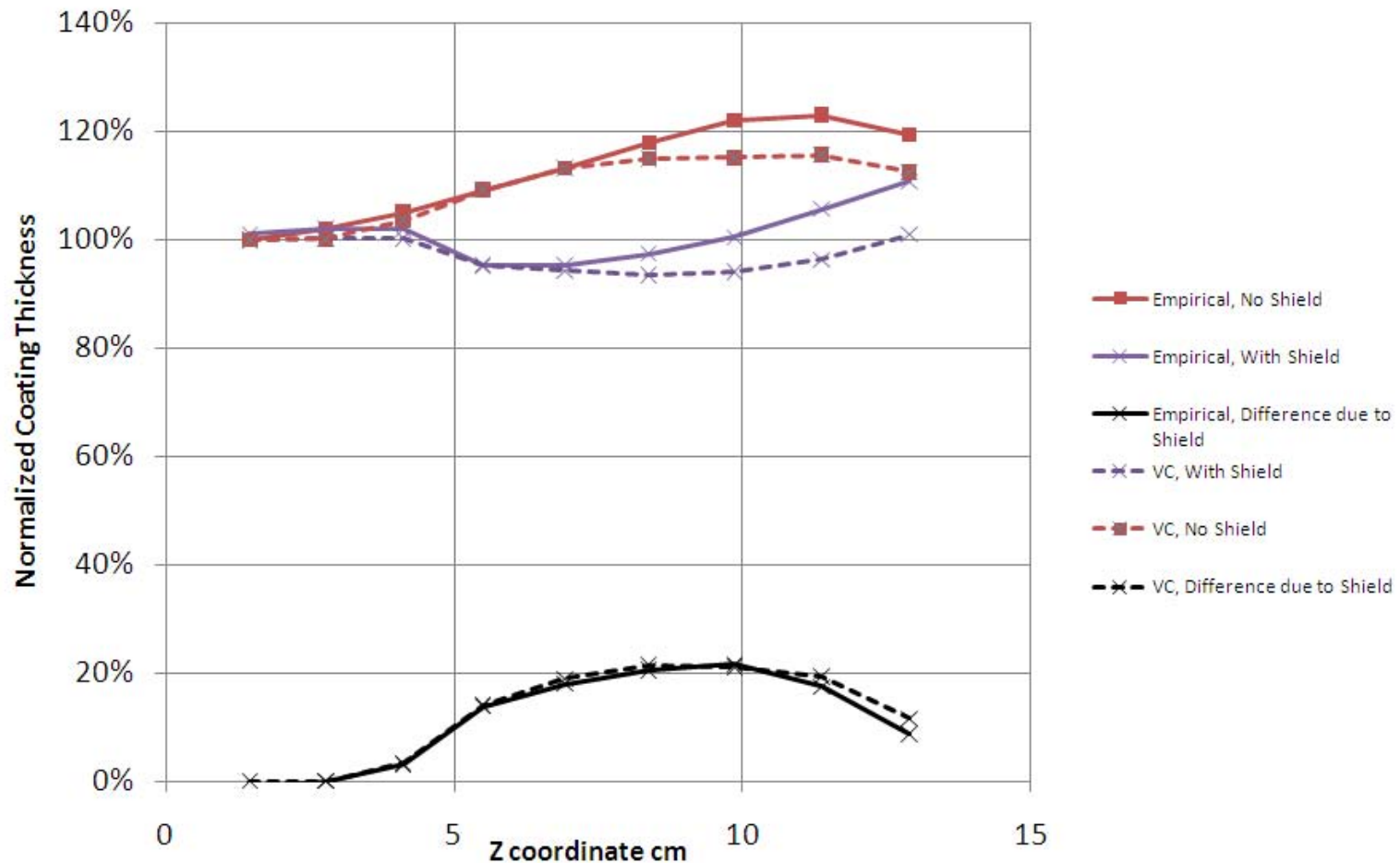
Virtual Chamber™ → SolidWorks



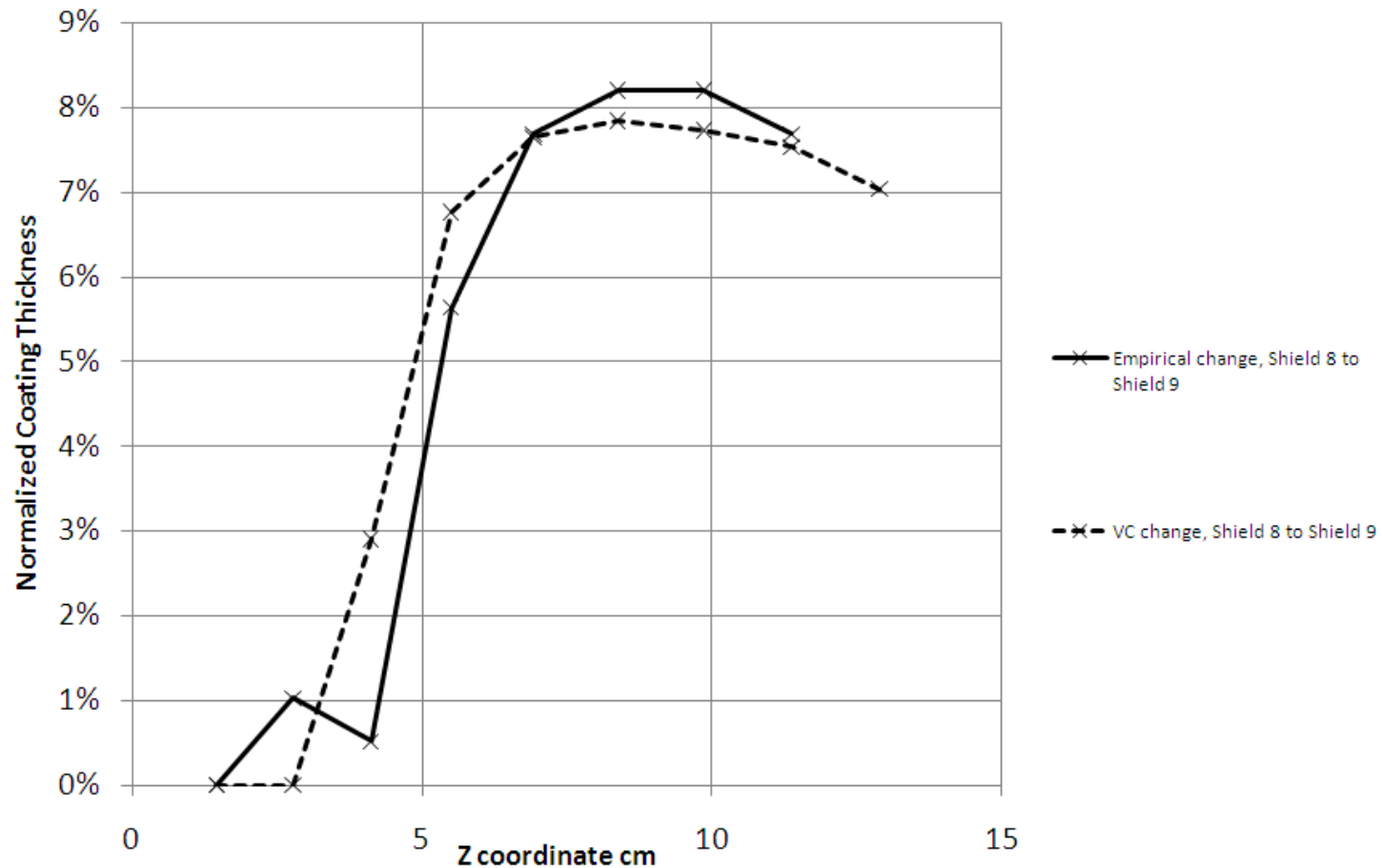
1000°C Operation



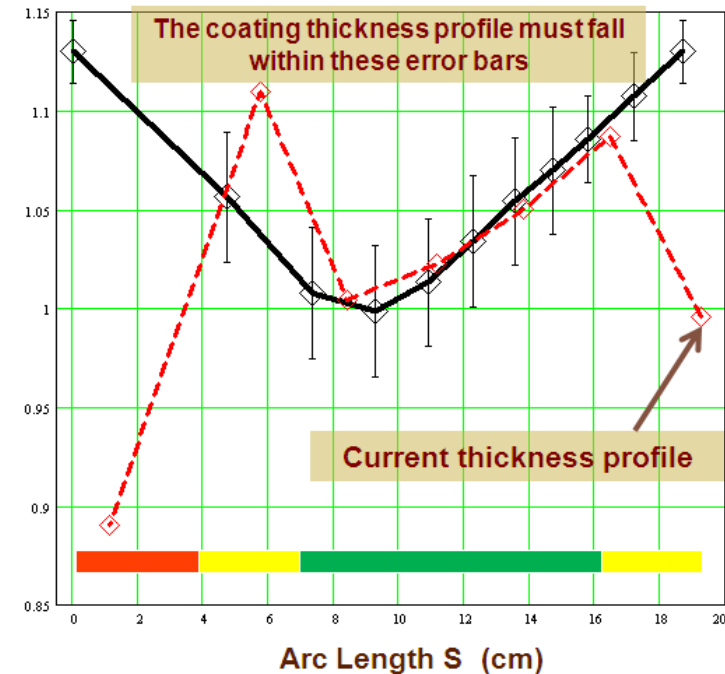
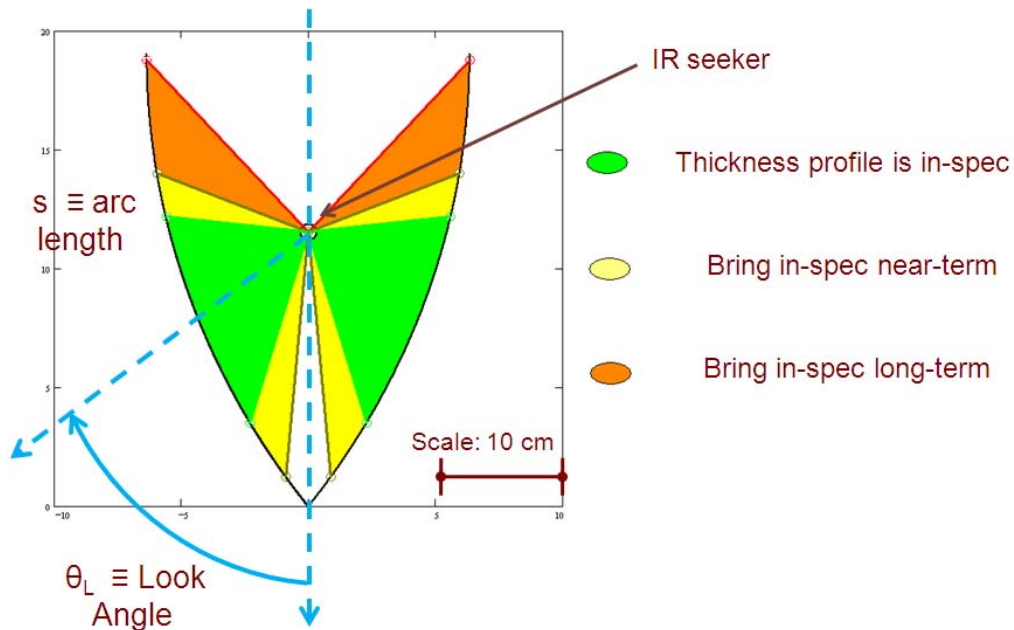
Modeling vs Experiment



Iteration: Old Mask $\rightarrow$ New Mask

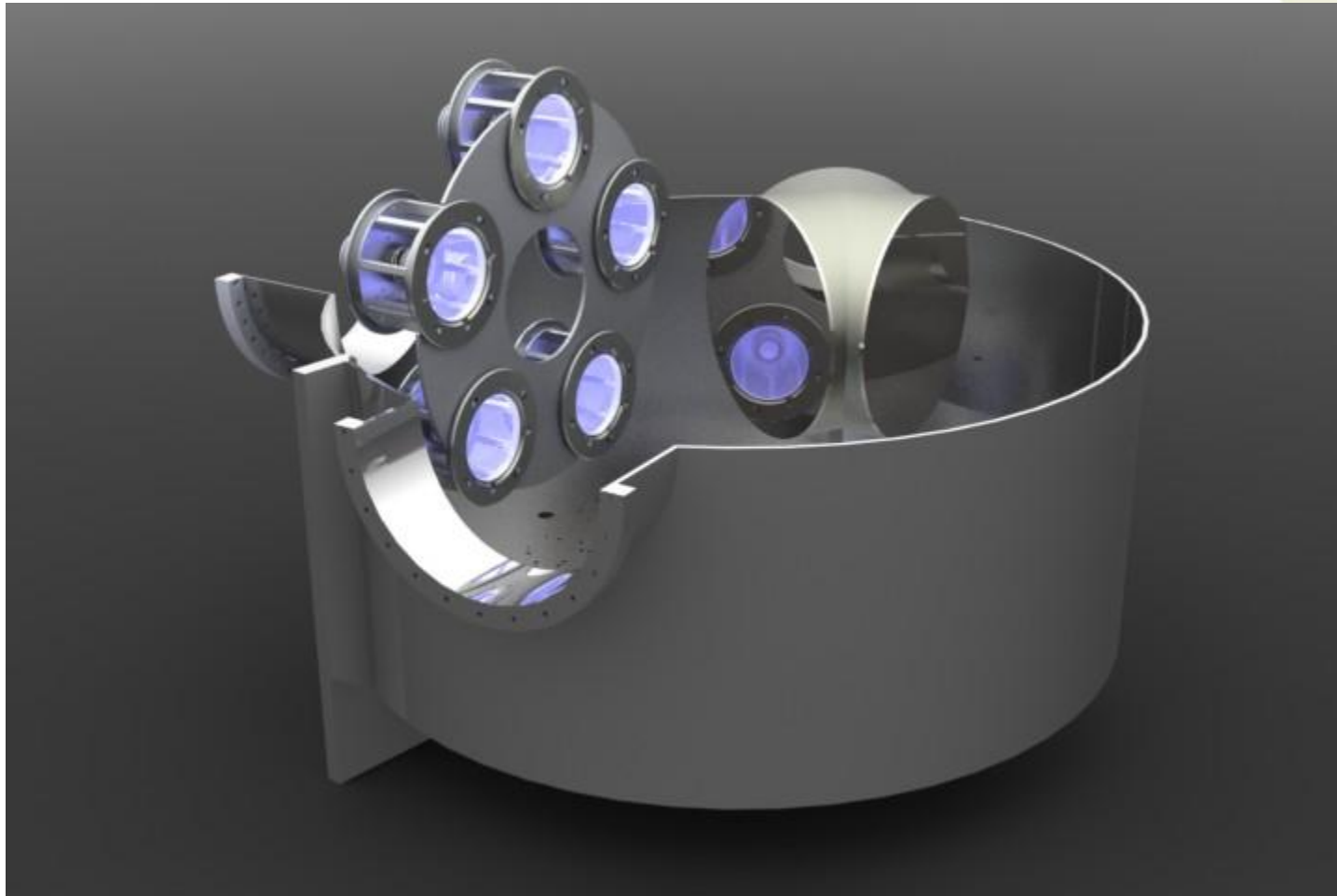


Conclusion and Summary



- Demonstrated a robust AR coating on sapphire that survives exposure to 1000°C
- PPC's *Virtual Chamber*TM model is operational and reliable
- Tooling concept for coating dome interiors works reliably, will be modified for dome exteriors
- Achieved specified coating thickness uniformity over a look angle range of 16° to 96°

Coating Multiple Domes



.....Questions?

Title of Success Story Product/Service

SBIR Company Name
City, State

INNOVATION

Brief description of the new technology/application. (Please try to state what the technology does in a clear, plain-spoken manner.)

ACCOMPLISHMENTS

- ◆ Development stage (e.g., prototype, small production runs, etc.).
- ◆ Significant technical achievements and noteworthy business developments to date.
- ◆ Cumulative private capital investment by firm to date (*if not commercially sensitive*).
- ◆ Other evidence of private-sector commitment.

COMMERCIALIZATION

- ◆ Identify product/service name; trademark name.
- ◆ Indicate number of associated patents, patent applications to date.
- ◆ Brief description of primary target market sectors; distinguish actual from potential market sectors.
- ◆ State if product/service currently being sold or available for sale, by market sector; if not, provide expected entry date into market, by market sector.
- ◆ Cumulative sales revenues to date by market sector (*if not commercially sensitive*).
- ◆ Statement regarding other demonstrated customer interest to date.
- ◆ Other associated cumulative revenues generated to date (e.g., from licensing fees, royalties, sell-off of the technology) (*if not commercially sensitive*).
- ◆ Identify venture structure (e.g., new profit center/business segment within existing firm, spinoff entity, joint venture partnership, other strategic alliance).
- ◆ Identify names of joint venture/strategic alliance partner firms (*if not sensitive*).
- ◆ Describe unique competitive advantage of the new technology, with respect to specific, existing customer needs in each target market sector.



Hollow Cathode Plasma Electron Emitters

GOVERNMENT/SCIENCE APPLICATIONS

- ◆ Brief description of the product service for NASA and other USG applications; distinguish between actual and potential applications.
- ◆ Remaining technological or business development necessary for NASA/USG application.
- ◆ Identify NASA and other USG missions utilizing the product/service; distinguish between actual and potential applications.
- ◆ Statement regarding other demonstrated NASA/USG customer interest to date.
- ◆ NASA and/or other USG Phase III contracts (w/\$ amounts).
- ◆ Estimate of NASA mission/project cost savings due to SBIR innovation/product developed.