The ONYX- Revolution

Angstrom Sciences-
Cylindrical Magnetrons

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BACKGROUND:

- In business for over 20 years
- Comprehensive IP including US Patents on:
  - Profiled Magnets
  - Turbulent water flow
- Complete Cylindrical Cathodes
  - TCO, Reactive, and Metal Applications

For more info . . .
www.angstromsciences.com

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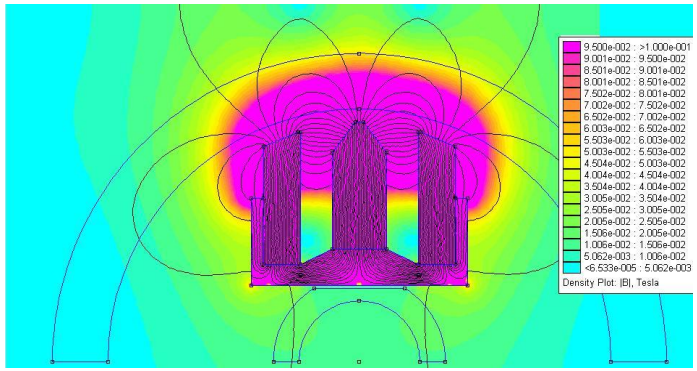
THE SOLUTION: ONYX-REVOLUTION

- 85% or greater bulk target tube utilization
- Highest Vapor Flux Efficiency
- Tunable thickness control

RESULTS:

- Average 20% increase in Dynamic Deposition Rate (DDR)
- Increased *overall* material efficiency
- Best achievable thickness uniformity
- Reduced maintenance and system downtime due to shield cleaning



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THE SOLUTION: ONYX-REVOLUTION

- Advanced profiled Magnetic Design for optimal utilization
  and uniformity
- Gas Integration Options
  - Argon and Reactive gas inputs
- DC, Pulsed DC and MF Power
- Vertical and Horizontal mounting options
- Recommendation for Optimal Uniformity
  - Magnet bar length: 6” overhang on each side of substrate
  - 2”-4” source to substrate

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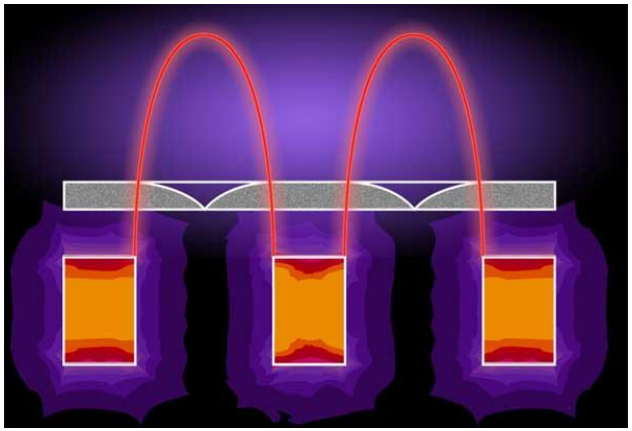
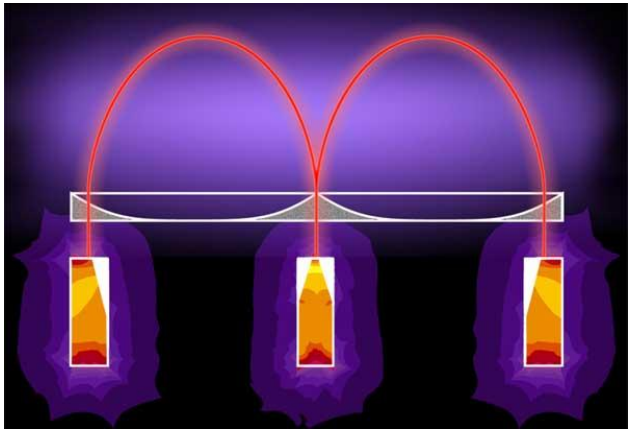
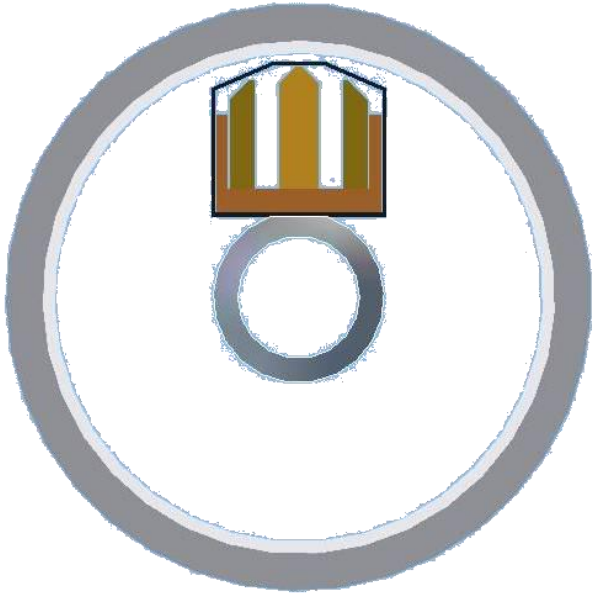
ONYX-REVOLUTION





Magnetics:

Profiled magnets naturally conform to the curvature of cylindrical target; reducing distance between racetracks and increasing field at target surface.



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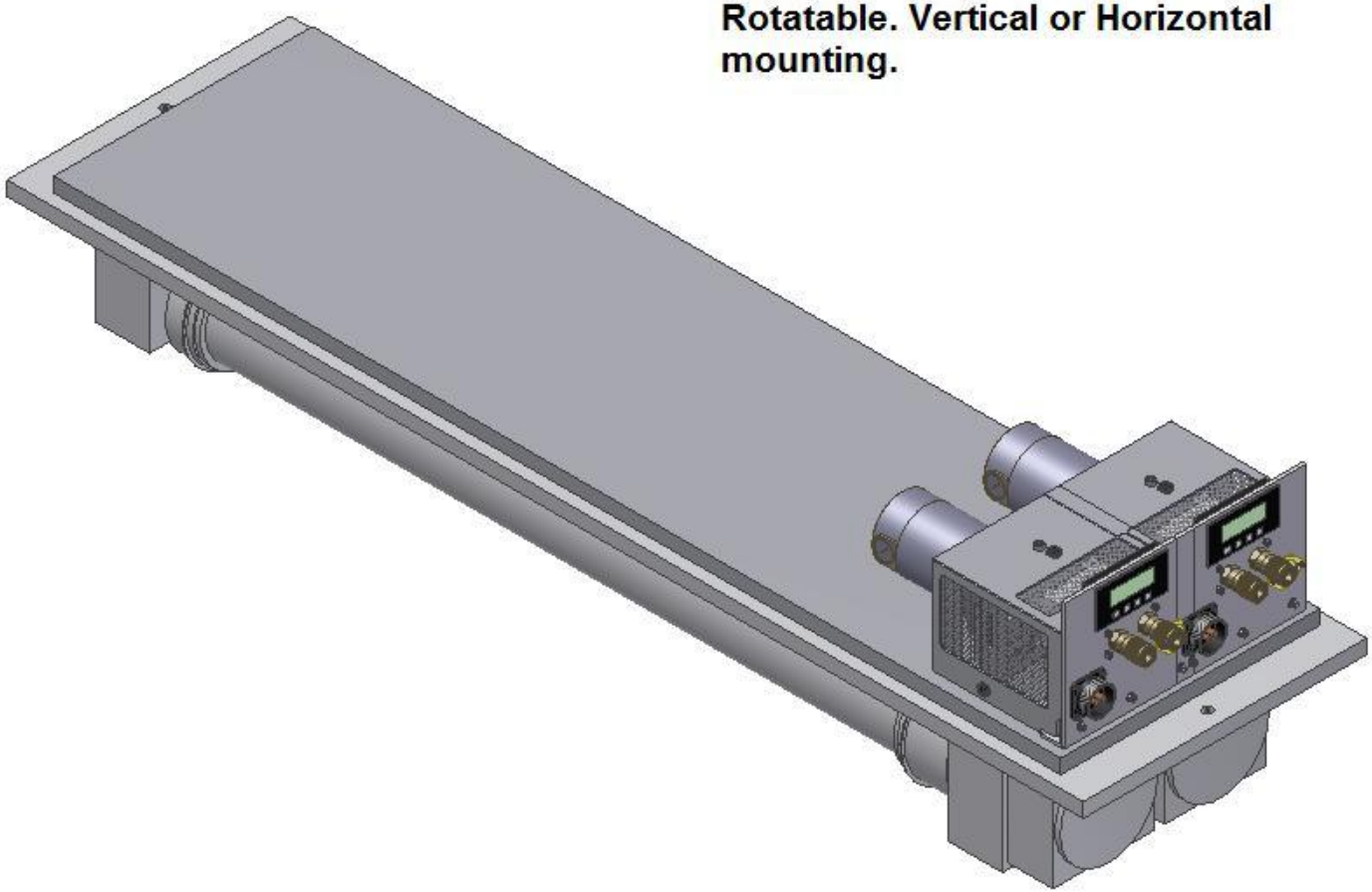
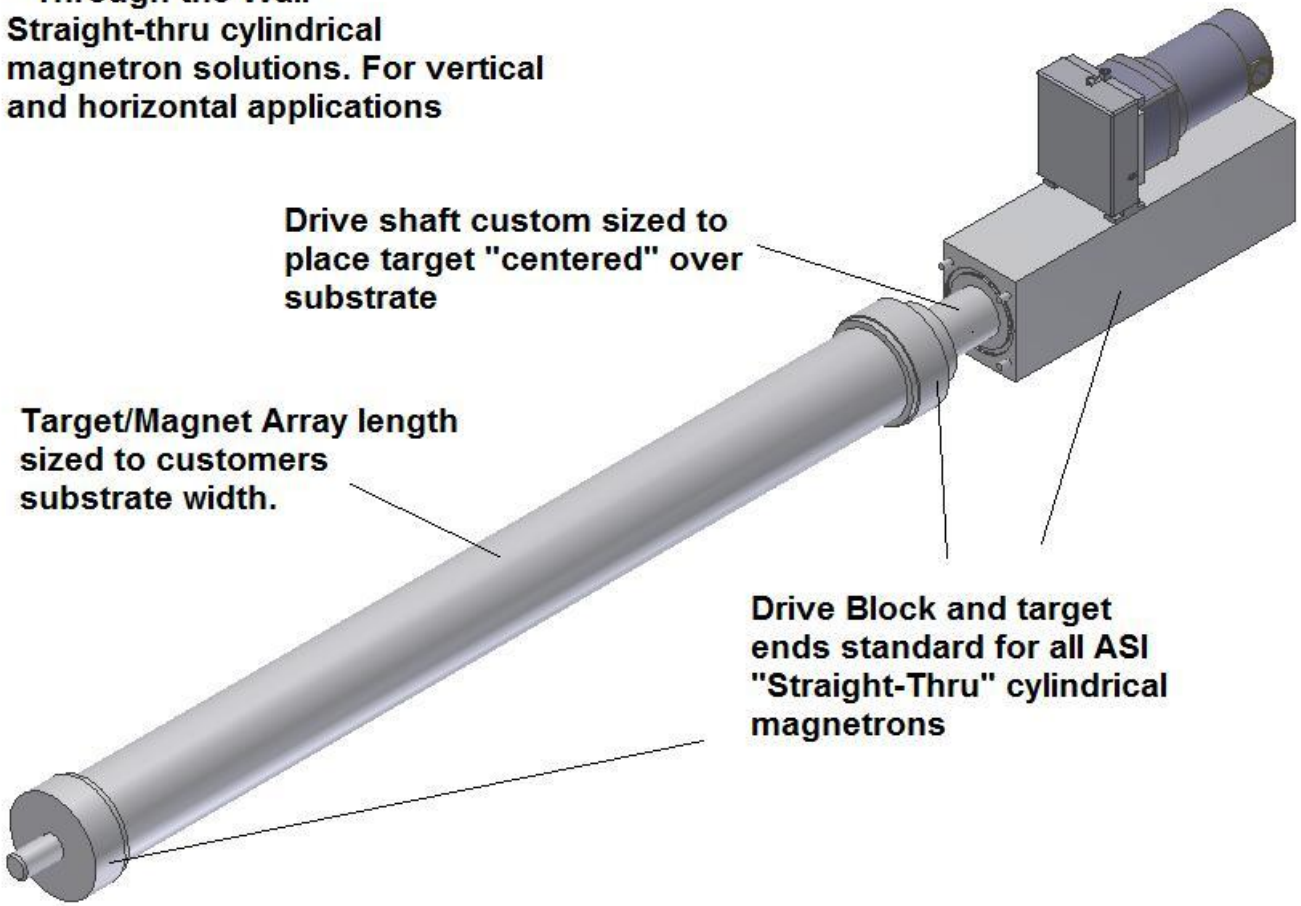
Rotating Cylindrical Magnetron Configurations:

Drop-In / Flange Mount Dual Rotatable. Vertical or Horizontal mounting.



Rotating Cylindrical Magnetron Configurations:

" Through the Wall "
Straight-thru cylindrical magnetron solutions. For vertical and horizontal applications



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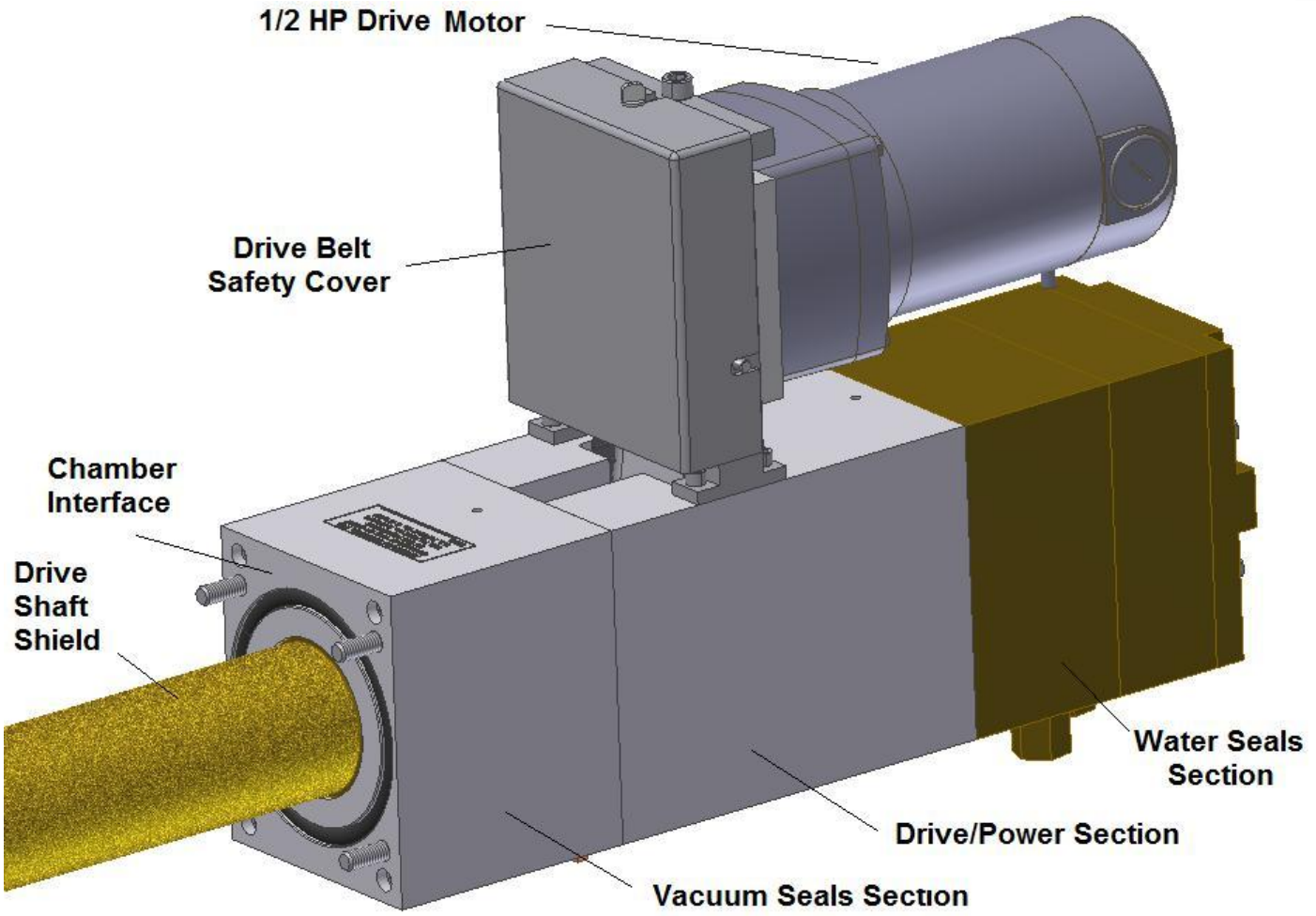
Fundamentals of Cylindrical Cathode Design and Operation

Robust Mechanical Design:

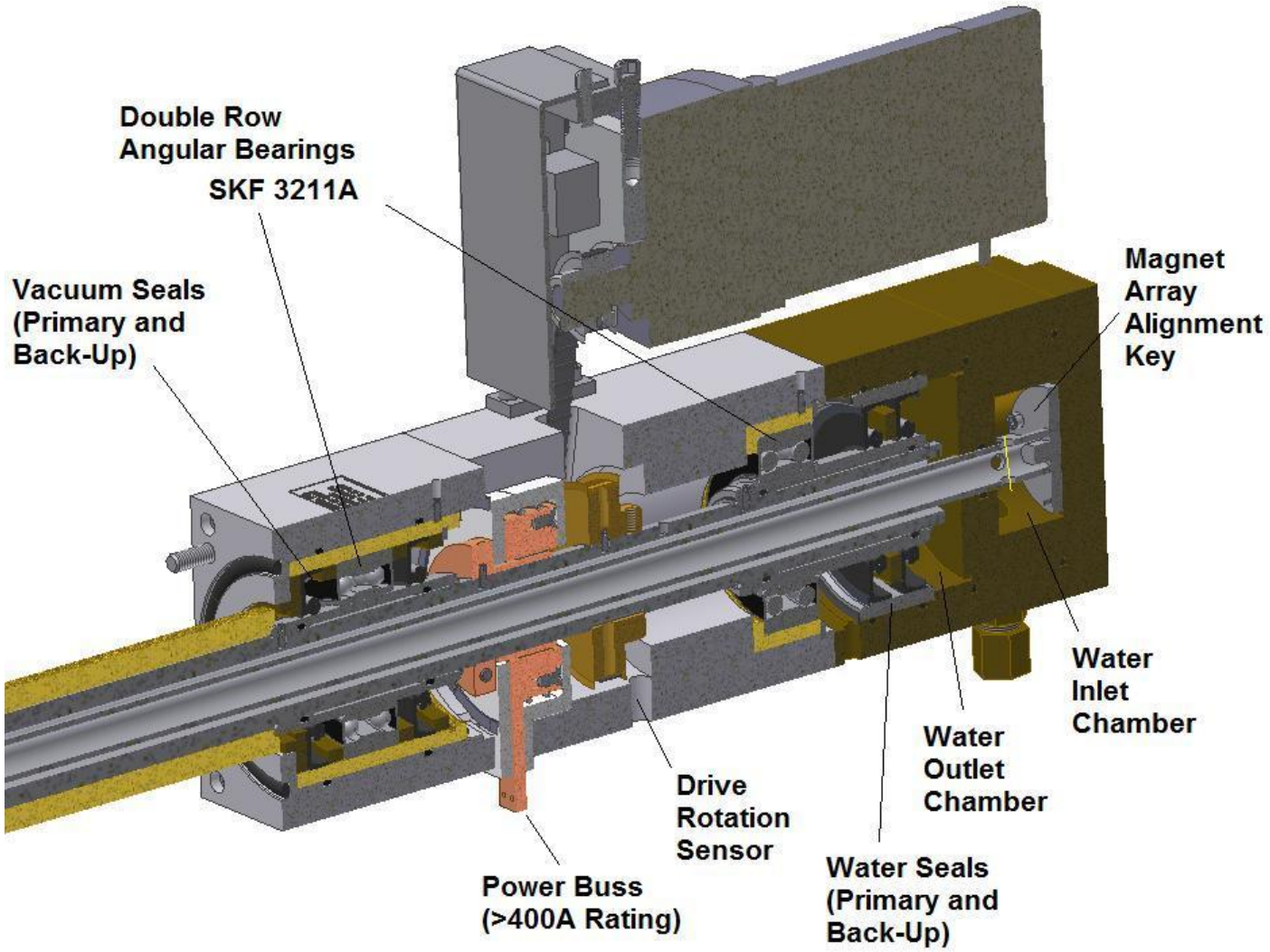
The rotatable cathode must fulfill 3 fundamental operations:

- Dynamically seal air – water - vacuum
- Effectively deliver power to the cathode
- Provide smooth concentric target rotation

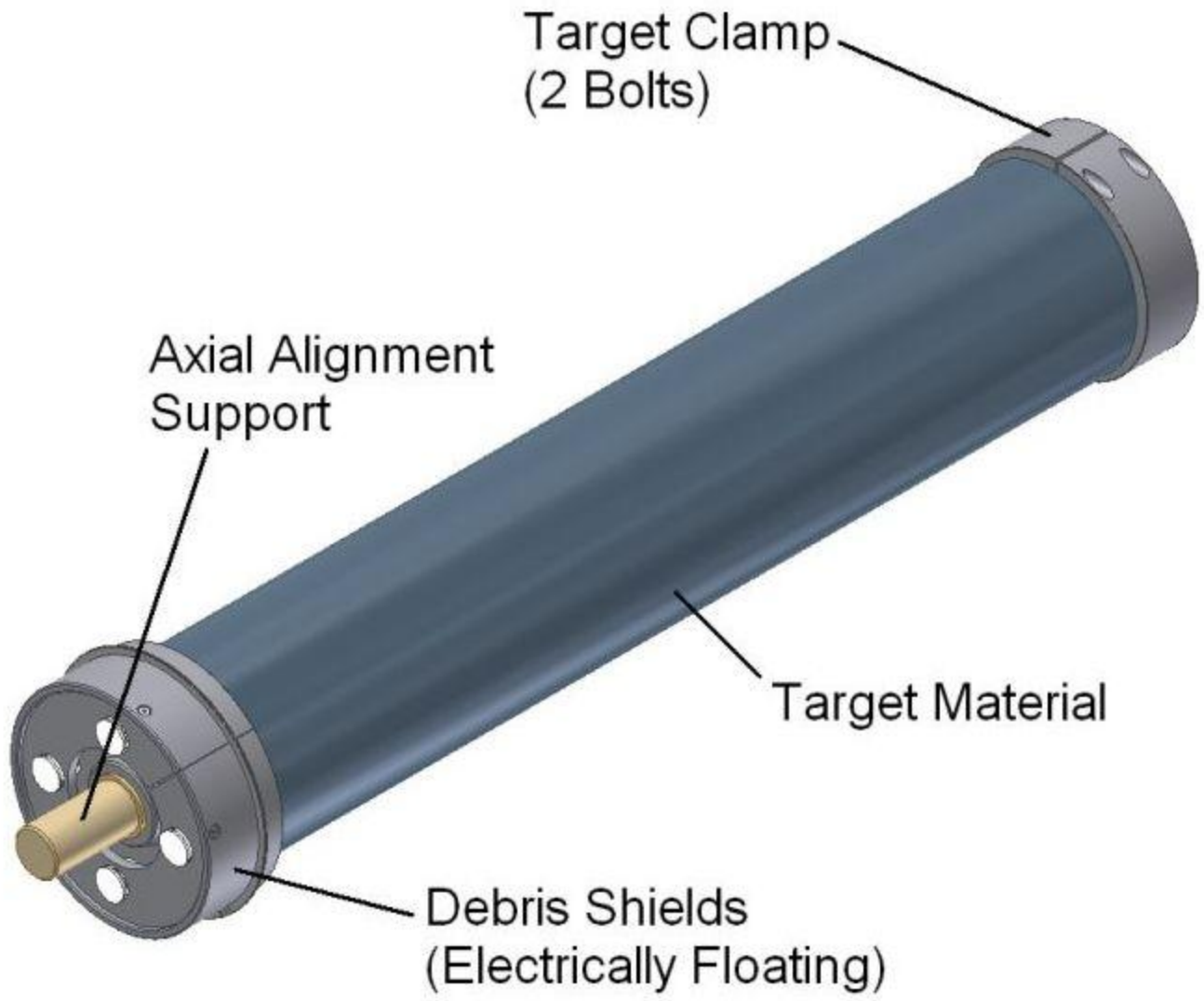
Cathode Drive Overview:



Cathode Drive Overview:



Target Assembly Overview:



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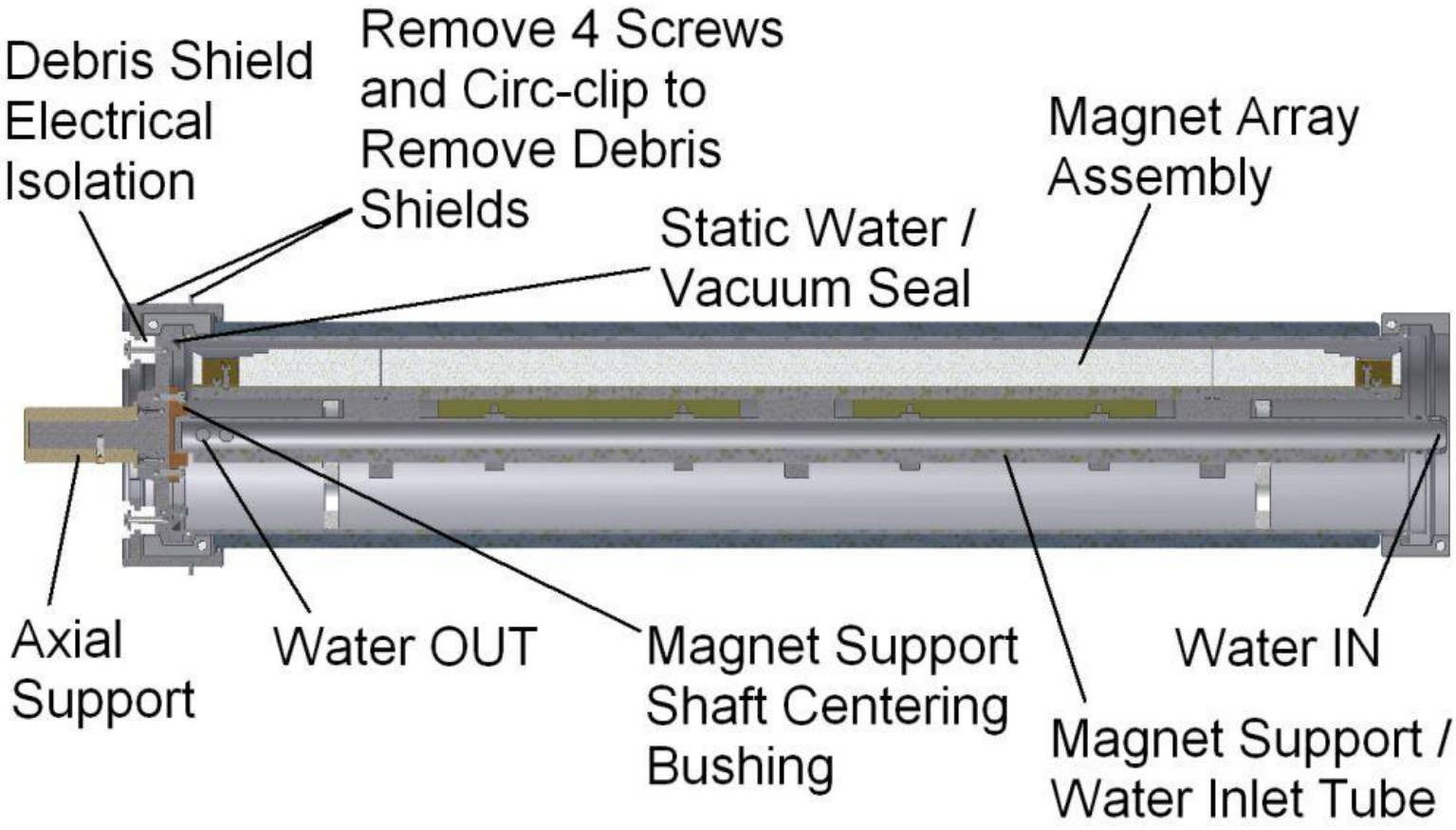
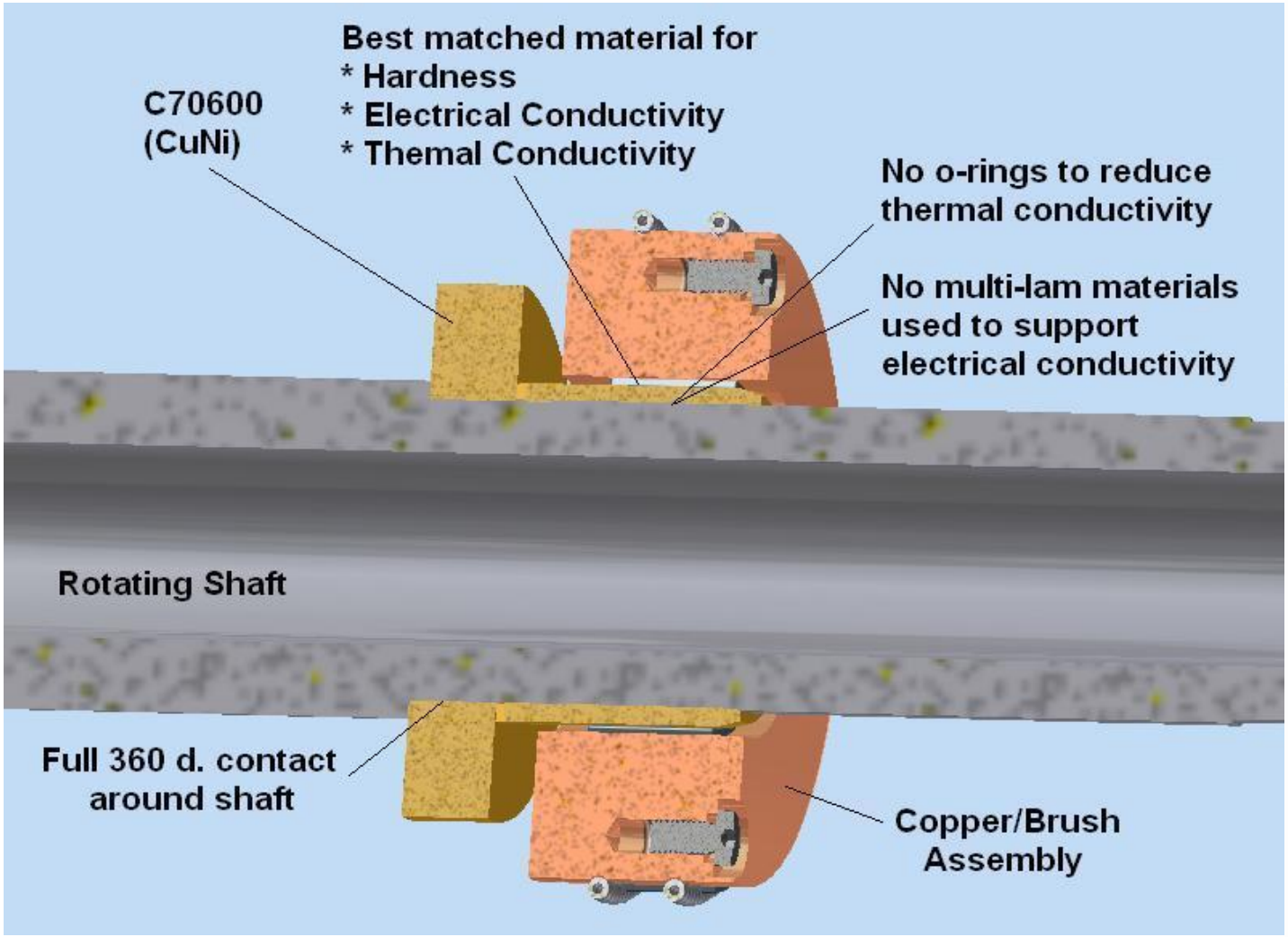


Power Transmission Overview:



Fundamentals of Cylindrical Cathode Design and Operation

Corrosion/Water-resistant Magnet Bars:

- Deep drawn and welded, non-magnetic, stainless steel enclosures
- Epoxy filled to prevent magnet shifting and additional corrosion protection

ANGSTROM ADVANTAGE: MODULAR MAGNET DESIGN

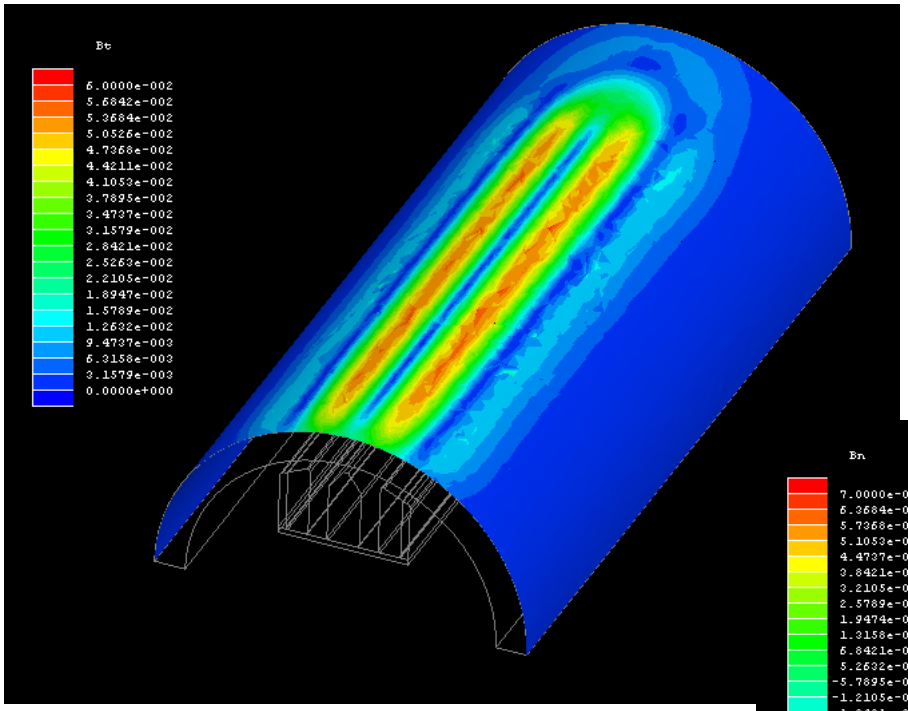
Magnet Assemblies have “interchangeable” turnaround designs that may be manufactured to your specific type of target.

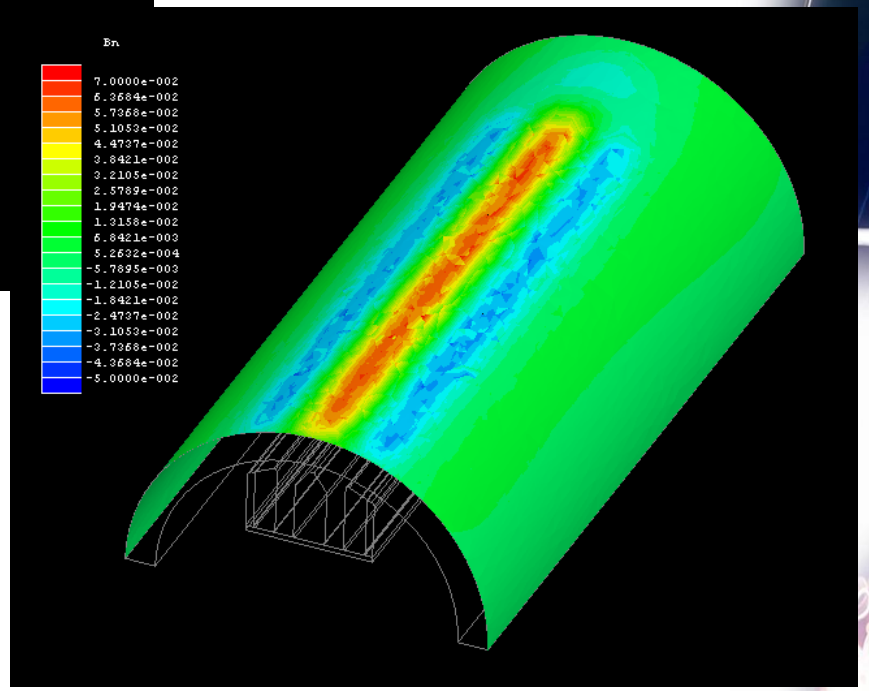
Fundamentals of Cylindrical Cathode Design and Operation

Optimized magnetics:

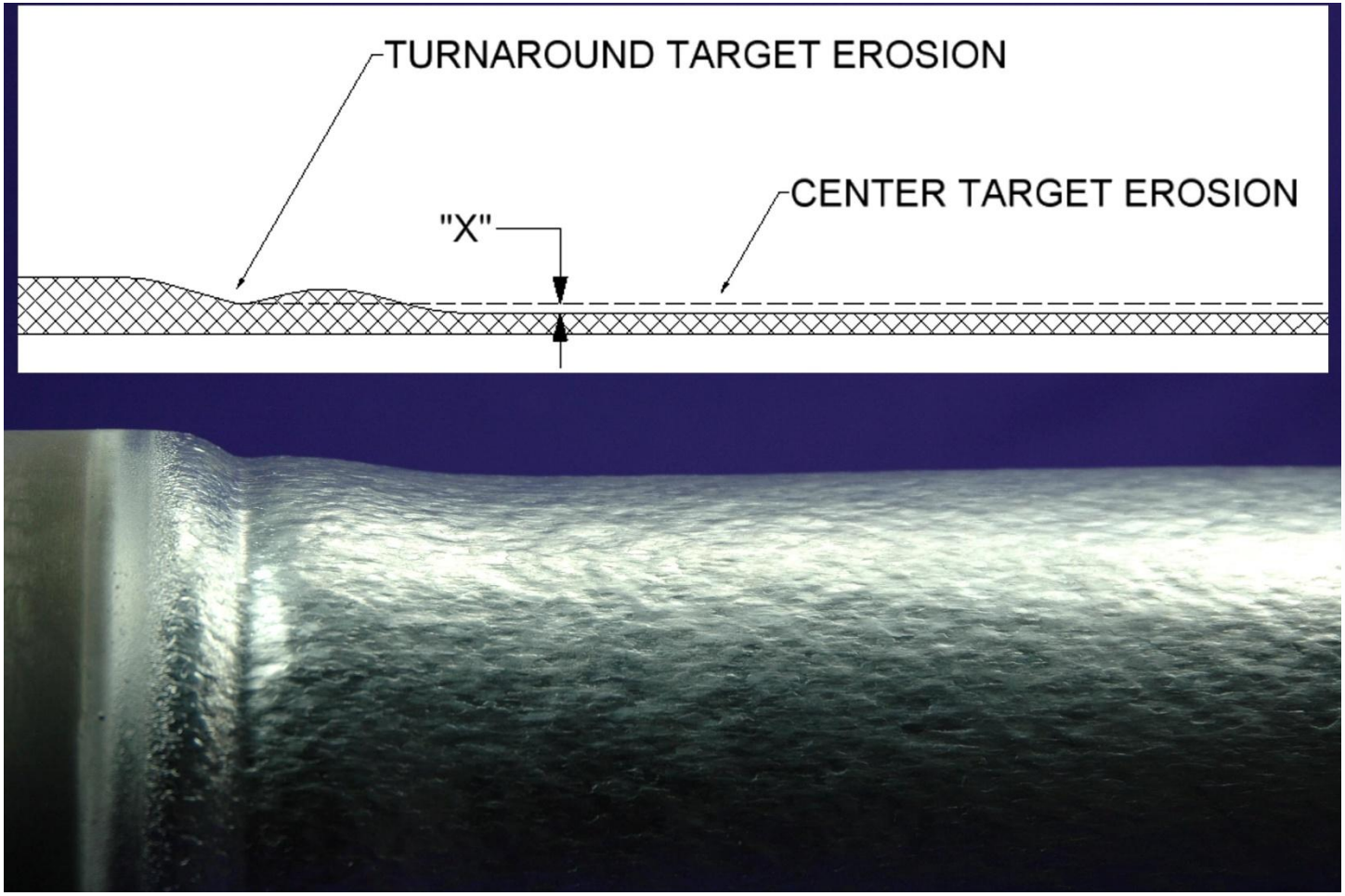
- Modular construction with optimized “turn-arounds” and “straight-away” elements
- Support tube designed to facilitate “tilt” and external shunting for thickness uniformity enhancement
- Minimized distance between adjacent racetracks to enhance “line-source” behavior (Vapor Phase Efficiency)

3D Magnetic Field Modeling for optimized “turn-around” erosion:



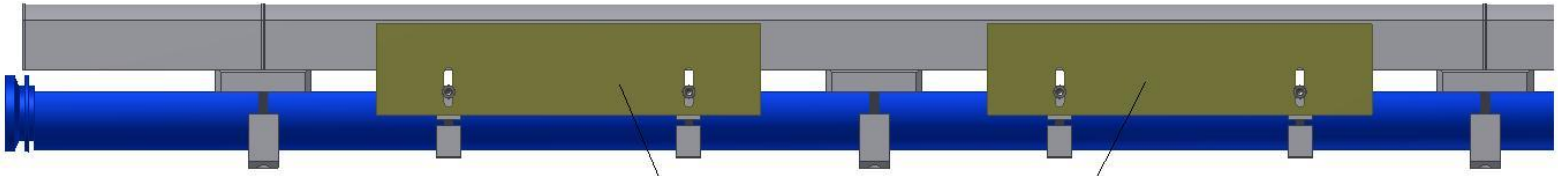


ERODED TARGET: 85%+ BULK TARGET UTILIZATION



Impact of Tilting and Shunting:

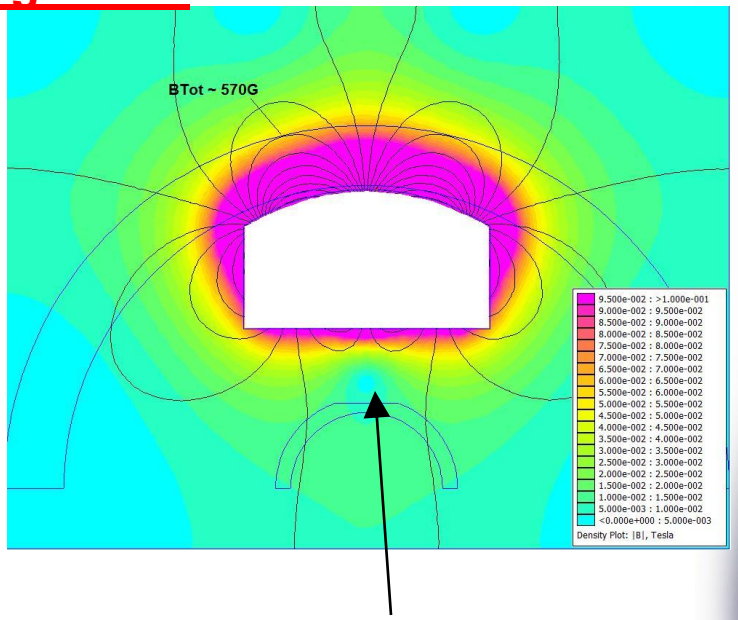
Shims are used for small adjustments due to "local" effects which might be caused by gas flow, anode amplifications, ... Up to 5% changes can be made

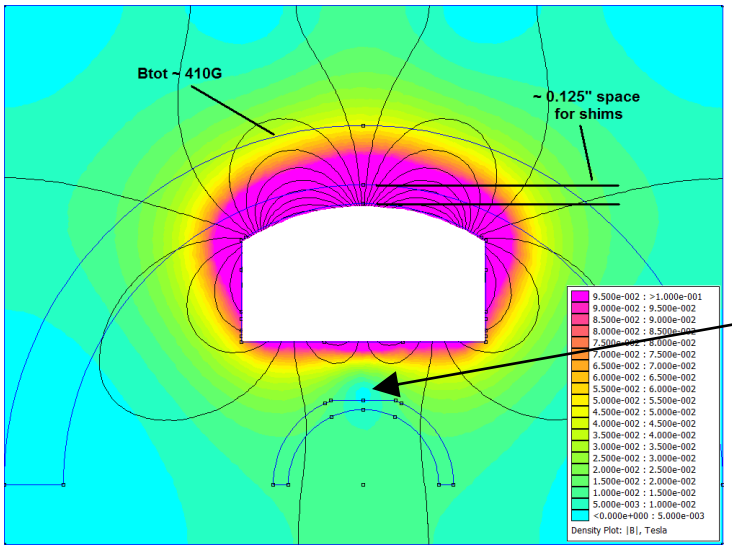


Shunts can be custom trimmed to length, placed anywhere along magnet array length, on 1 or 2 sides of the magnet pack, 1/2" height adjust.

Uniformity Adjustment – Addressing "Tilt":

2D Model (FEMM) of magnet array shows the effects on the magnetic field of inserting spacers.

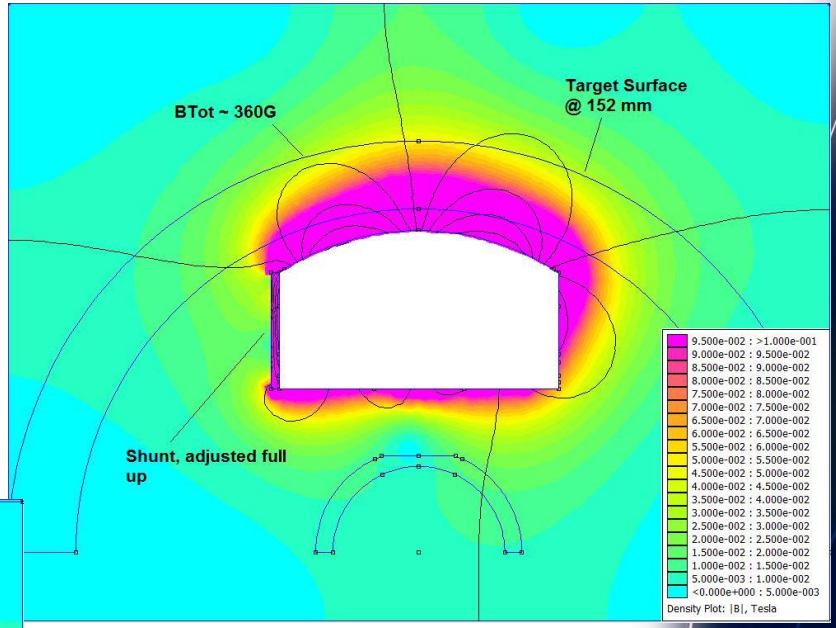


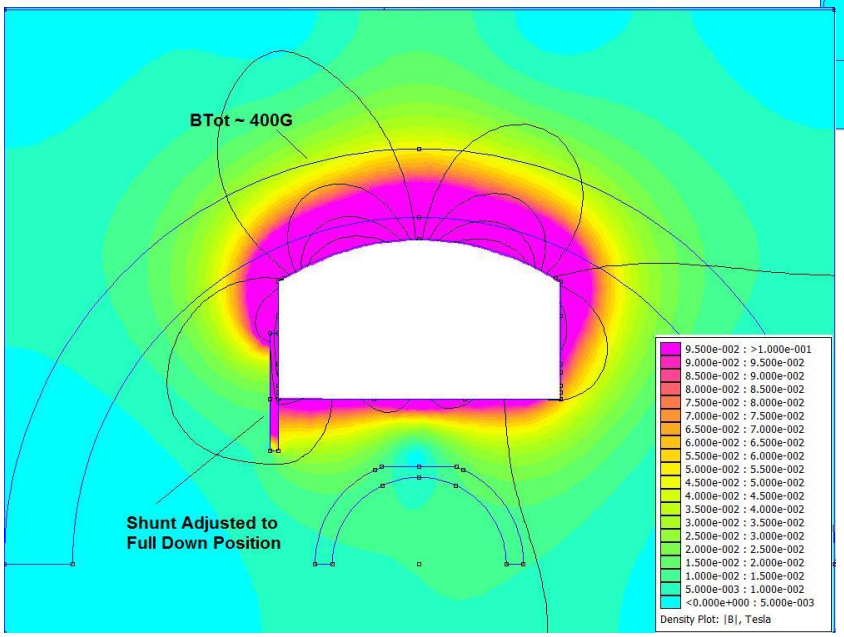


Spacers or mechanical adjustment is used to raise or lower the magnet array at specific locations

Uniformity Adjustment – Addressing "Local" Effects by shunting:

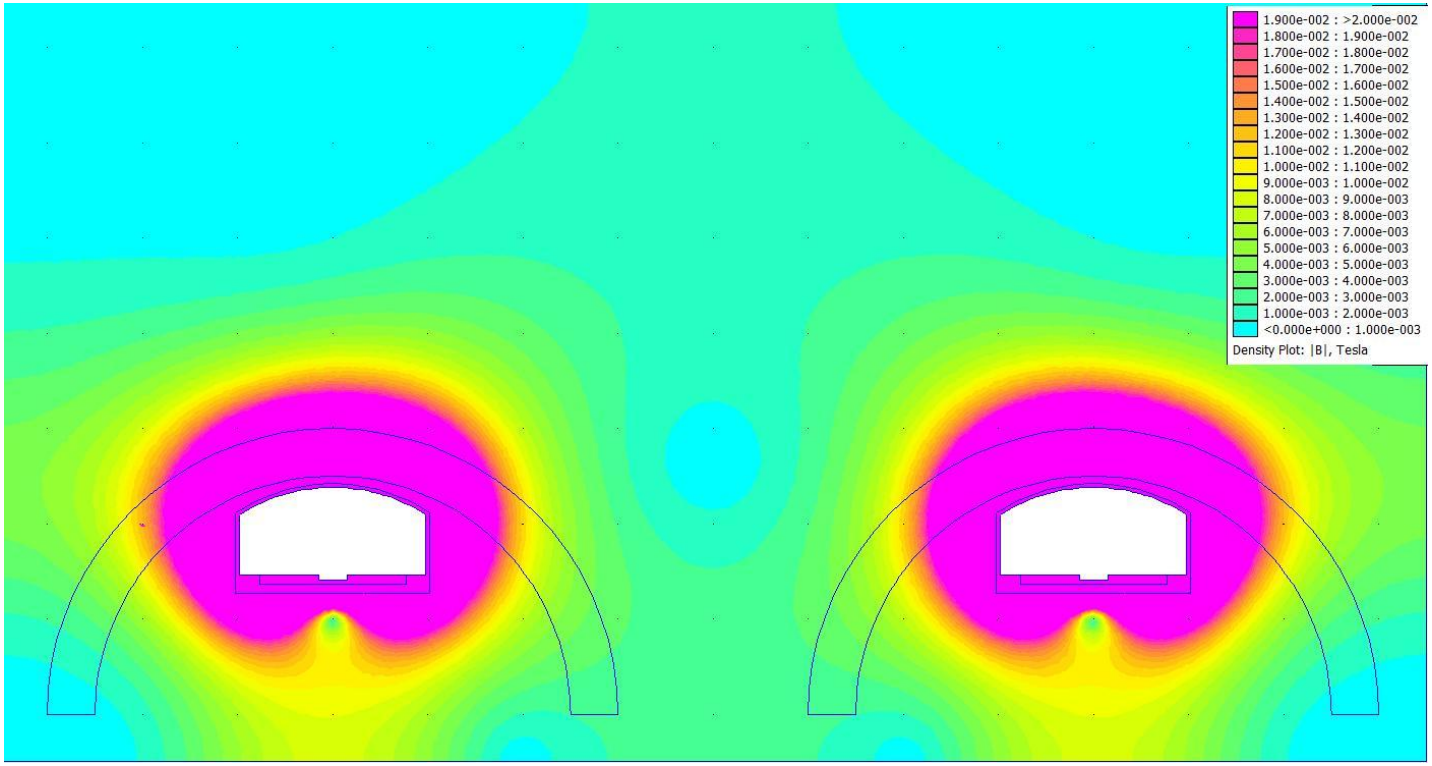
To eliminate "local" uniformity effects, 1 or more shunts may be cut to length and used for tuning over the magnet array length





Depending on the size of the uniformity anomaly, shunts may be used on one or both sides of the magnet array.

Tube to Tube magnetic “cross talk” (203 mm centerline spacing between adjacent target tubes):



The highly concentrated magnetic field at the target surface eliminates any magnetic cross talk between adjacent target tubes in a twin tube configuration

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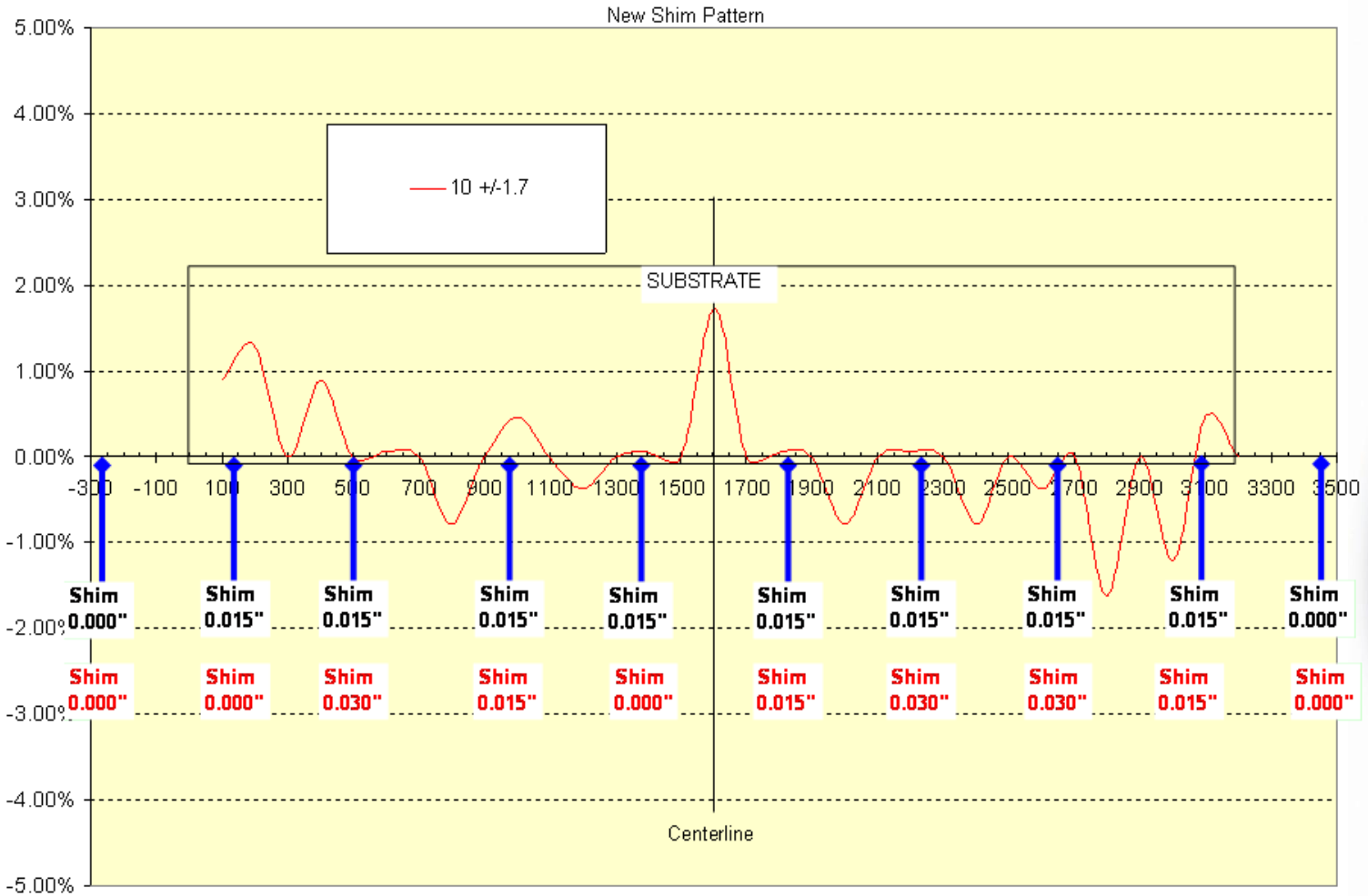


Applying shunting and tilting to optimize thickness distribution < +/- 2.0% on a 3.2 m wide substrate (3.5 m long magnet array)

Vapor Flux Efficiency:

What is V.F.E. --> Vapor Flux Efficiency

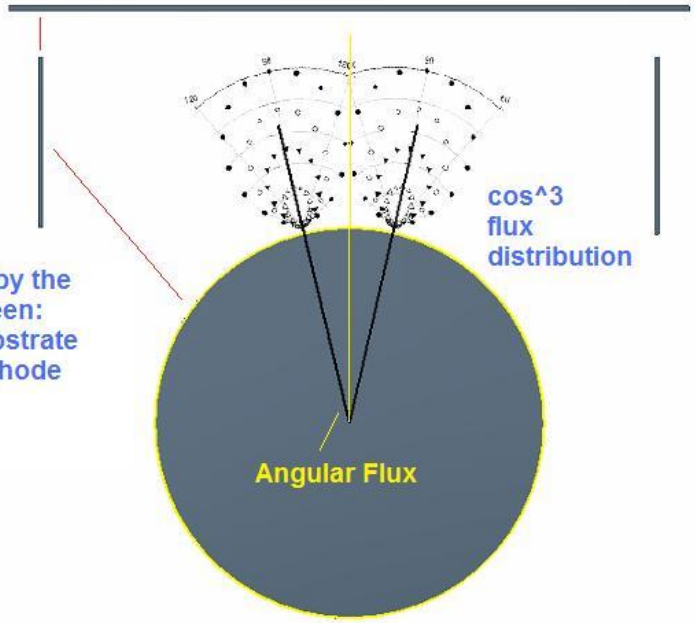
V.F.E. is defined as the amount of material sputtered vs. the amount of material which actually arrives to the substrate

V.F.E. α 1 / shields to cathode distance

V.F.E. α 1 / shields to substrate distance

V.F.E. α 1 / pressure

V.F.E. α 1 / angular flux (+/- 10.5 d.)



ASI uses 85% as a "typical" value

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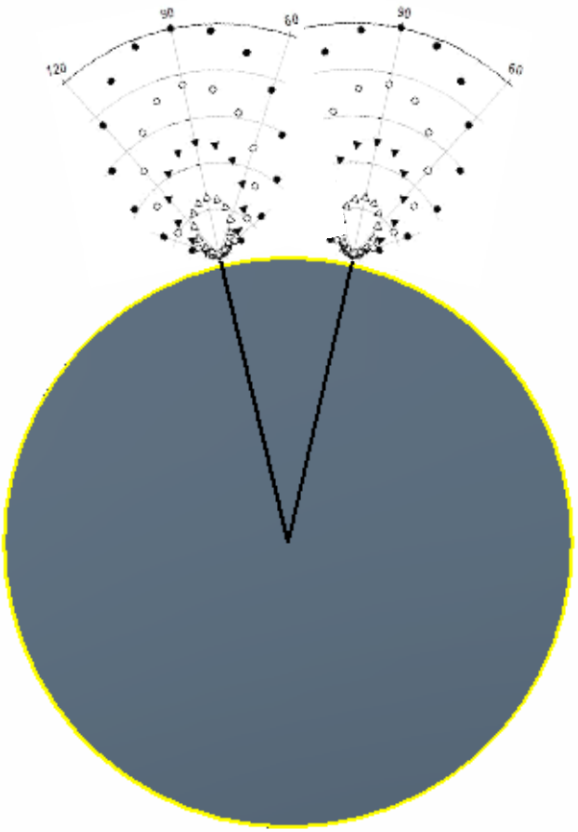
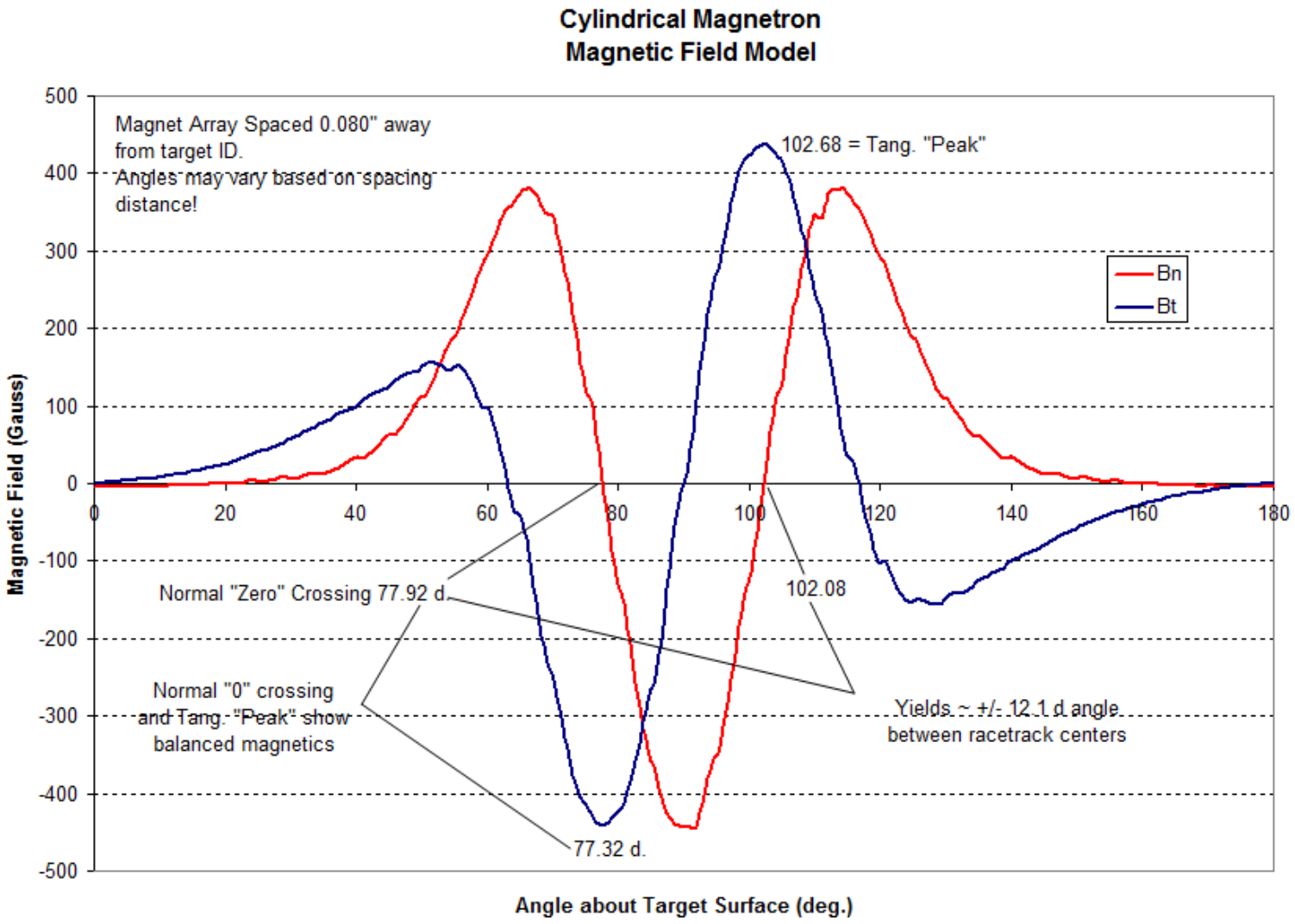


Chamber/Zone Shielding

ASI's patented profiled magnets reduce the distance between the racetracks in comparison to more conventional approaches

More material is directed to the substrate, dramatically reducing build-up on shields and resulting in a cleaner and more stable process that requires les power to achieve a specific deposition rate!


Cylindrical Magnetron
Magnetic Field Model
Magnet Array Spaced 0.080" away from target ID.
Angles may vary based on spacing distance!
102.68 = Tang. "Peak"
Bn
Bt
Normal "Zero" Crossing 77.92 d.
102.08
Normal "0" crossing and Tang. "Peak" show balanced magnetics
Yields ~ +/- 12.1 d angle between racetrack centers
77.32 d.
Magnetic Field (Gauss)
Angle about Target Surface (deg.)
500
400
300
200
100
0
-100
-200
-300
-400
-500
0
20
40
60
80
100
120
140
160
180

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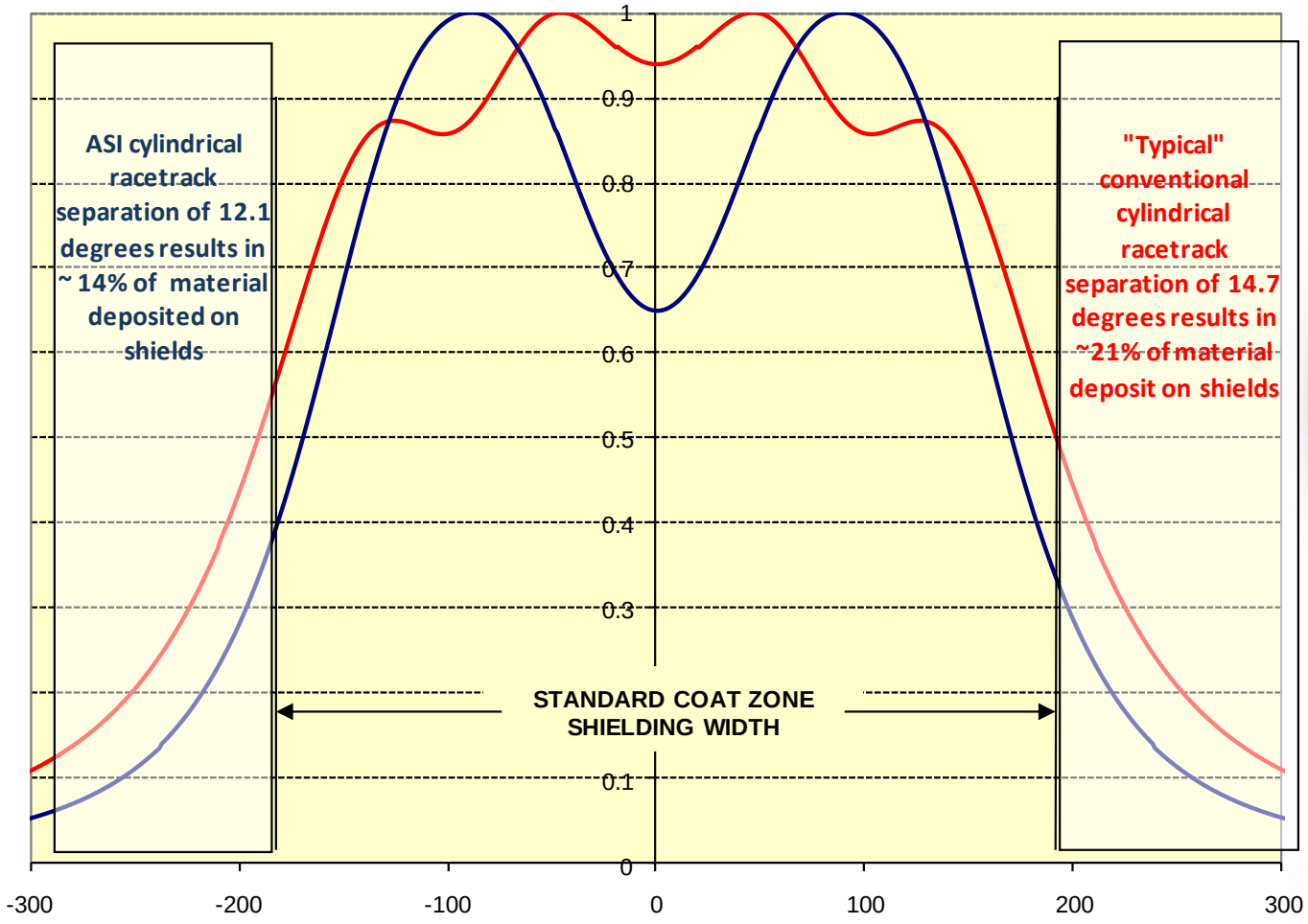
Angstrom Sciences Cylindrical Magnetron Arrays

Normalized Deposition Profile For a Dual Rotatable Magnetron



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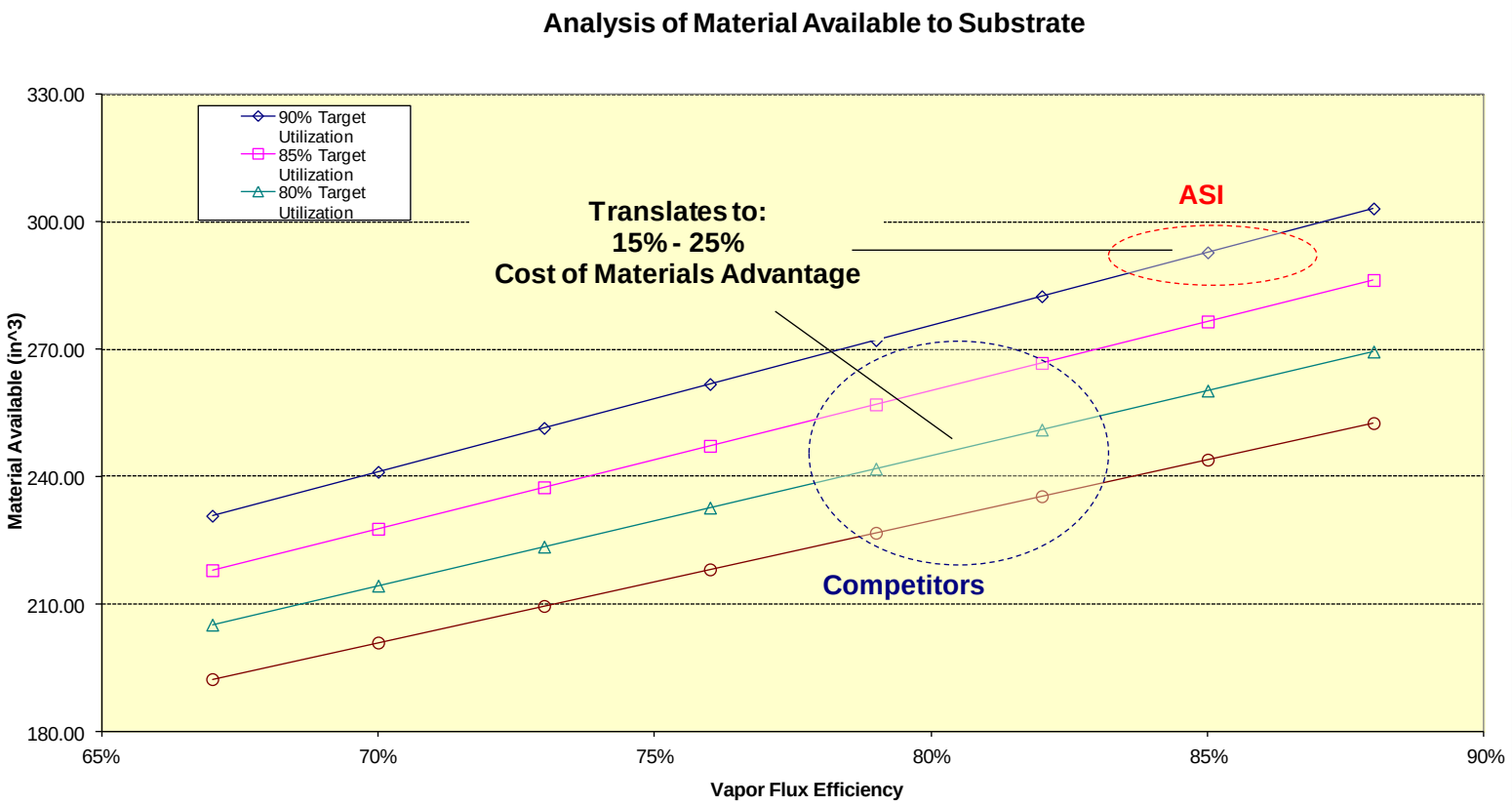
Impact of Vapor Flux Efficiency on "Realized" Materials Utilization:



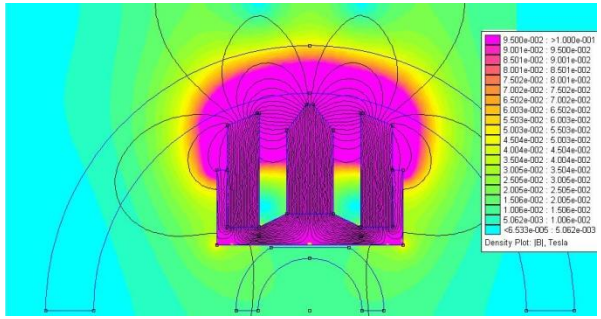
CONCLUSIONS:

Angstrom Sciences has developed cylindrical magnetron technology that embody:

- Robust mechanical and electrical construction
- Corrosion resistant and modular magnet bars
- Optimized magnetics to maximize bulk target erosion and deposited film uniformity
- Profiled magnetics to reduce the separation distance between adjacent racetracks (Vapor Phase Efficiency)

RESULTING IN:

- Average 20% increase in Dynamic Deposition Rate (DDR)
- Increased *overall* material efficiency
- Best achievable thickness uniformity
- Reduced maintenance and system downtime due to shield cleaning



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