

Advanced Gun Barrel Technologies (AGBT)

76mm Rapid Fire Testing

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Agenda

- AGBT Program Background and status
 - Screening Methodology
 - Current Status
- 76mm Test Planning
- 76mm Rapid Fire Testing
- 76mm Test Results
- AGBT Path Forward
- Questions

Future Naval Capabilities Program

Objectives

- Identify & develop Gun Barrel Technologies that enable upgrades to existing barrel capabilities for Naval gun propulsion missions
 - *Increased Gun Barrel Erosion & Fatigue Life*
 - *Improved Gun Barrel Thermal and Ballistic Performance*
 - *Reduced Life Cycle Cost*

Payoffs

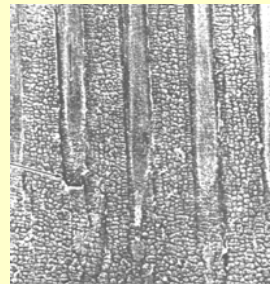
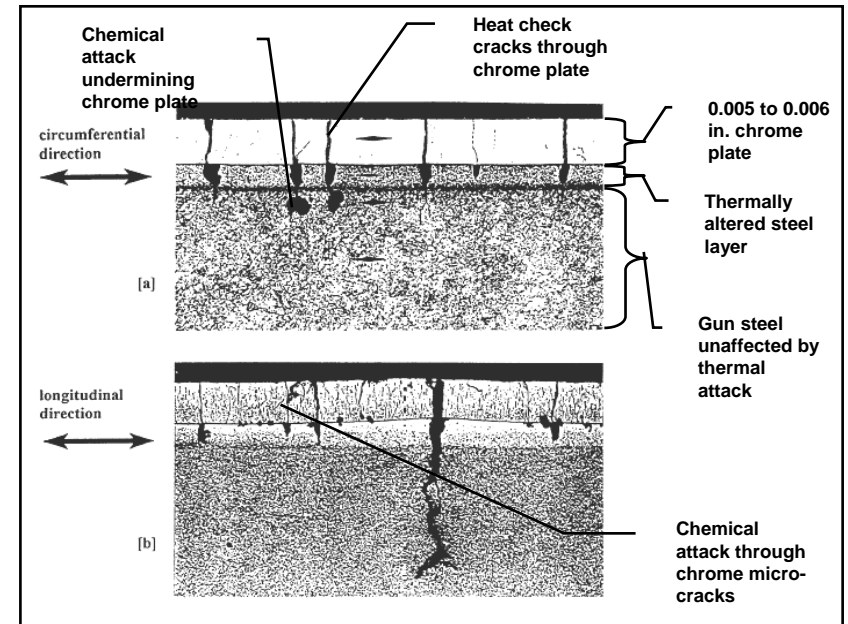
- Increased Gun System Availability
- Improved Ballistic Capability (Higher KE for increased range)
- Lower Life Cycle Cost

Transition

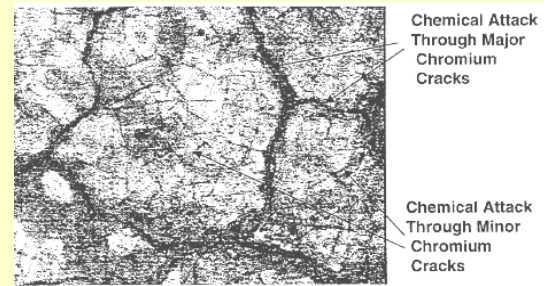
- Develop/Demonstrate Improved Barrel Life and Ballistic performance over AGS Baseline for Transition into Future DD(X) Flights

Root Problem: Chrome Plated Barrel Wear and Erosion

- Gun firing thermal loads generate heat check cracks
- Chrome plating is thermally and chemically attacked until it strips off and exposes the substrate
- Heat check cracks expose steel substrate to chemical attack from combustion gases
- Substrate steel is thermally altered by extreme high temperature spike from gun firing
- Steel substrate is rapidly eroded from aggressive chemical attack at high temperature



Borescope view of heat checks at origin of rifling



Microscopic view of bore surface after electro-chemical removal of chrome plate

Technical Approach

Advanced Gun Barrel Technology Detailed Approach

- Application to small sample
- Low cost gun firing test
- Proof of concept demo

Technology Assessment

- Electroless Nickel-Boron
- Sputtering
- Explosive Cladding
- CED
- EPVD
- Free Form Fabrication

45mm Screening Evaluations

45mm Laboratory Gun Fixture

- Six technologies evaluated
- Hand loaded lab fixture
- Single shot testing

- Application to large sample
- Complex geometry
- Integrate with production
- High rate of fire gun test
- Proof of technology demo

Subscale Competition/Demo

- Explosive Cladding
- EPVD Coating
- Chrome Plating

76mm Gun Tests

MK75 76mm Naval Gun

- Two technologies evaluated
- Fielded gun mount
- Chrome baseline comparison

- Application in full scale
- Most difficult application
- Most expensive testing platform
- Production quality process
- Transition requirements demo



- One technology transitioned

FY03	FY04	FY05	FY06	FY07	FY08
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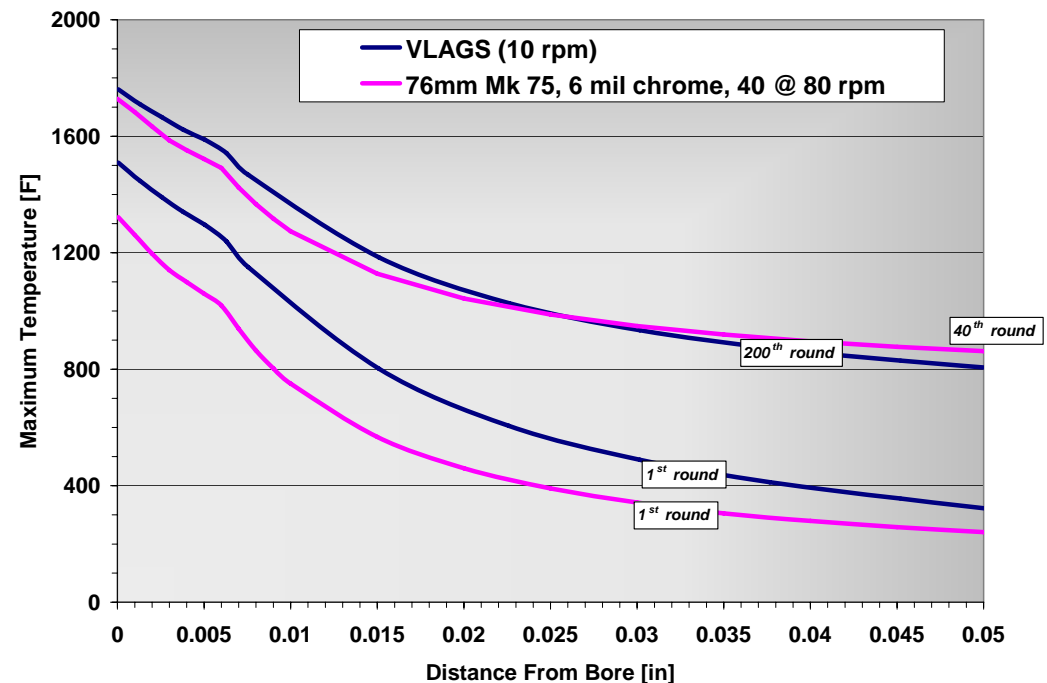
76mm Test Planning

Test Approach:

- Test philosophy is to maintain traceability to the objective AGS gun barrel High Rate of Fire environment.
- Parameters of the objective environment to be matched:
 - Thermal profile through coating and near bore
 - Best match of temperature effects and thermal stress
 - Chemical environment of propellant with bore
 - Best match of chemical attack on bore surface
 - Mechanical stresses
 - Best match of stresses in coating and at interface
- 76mm Test barrel liners produced at BAE Systems OEM barrel production facility in Louisville, KY.

76mm Test Planning

- 76mm platform selected for close match to the AGS environment
- Advanced technology prototype gun barrel assemblies will be fired at high rates to determine robustness of bore surface
- Historical 76mm service records indicated that measurable wear and erosion would occur within 400 rounds fired.
- Adhesion of bore surface material and erosion resistance will be recorded using laser bore mapping technology
- A chrome plated barrel liner will be subjected to the same test protocol to establish a baseline with existing technology



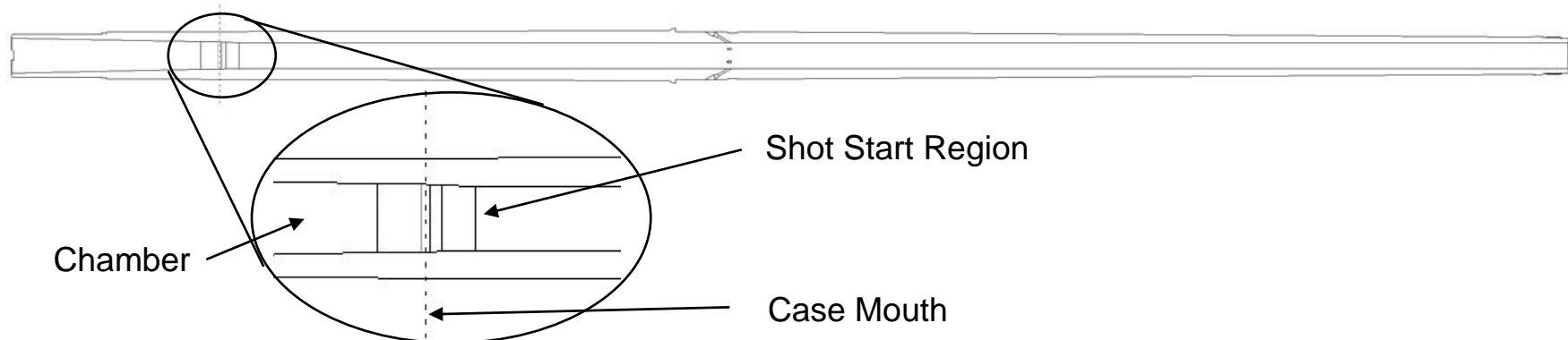
- 80 shots fired through each liner between inspections
 - Two 40 round bursts separated with 15 minute cool-down.
 - Burst duration chosen for best match to AGS thermal profile, and to minimize impact of potential stoppages.
- Minimal stoppages were incurred
 - Gun maintainers on hand to keep mount working smoothly
- 400 rounds total fired through each liner.



76mm Rapid Fire Test Results

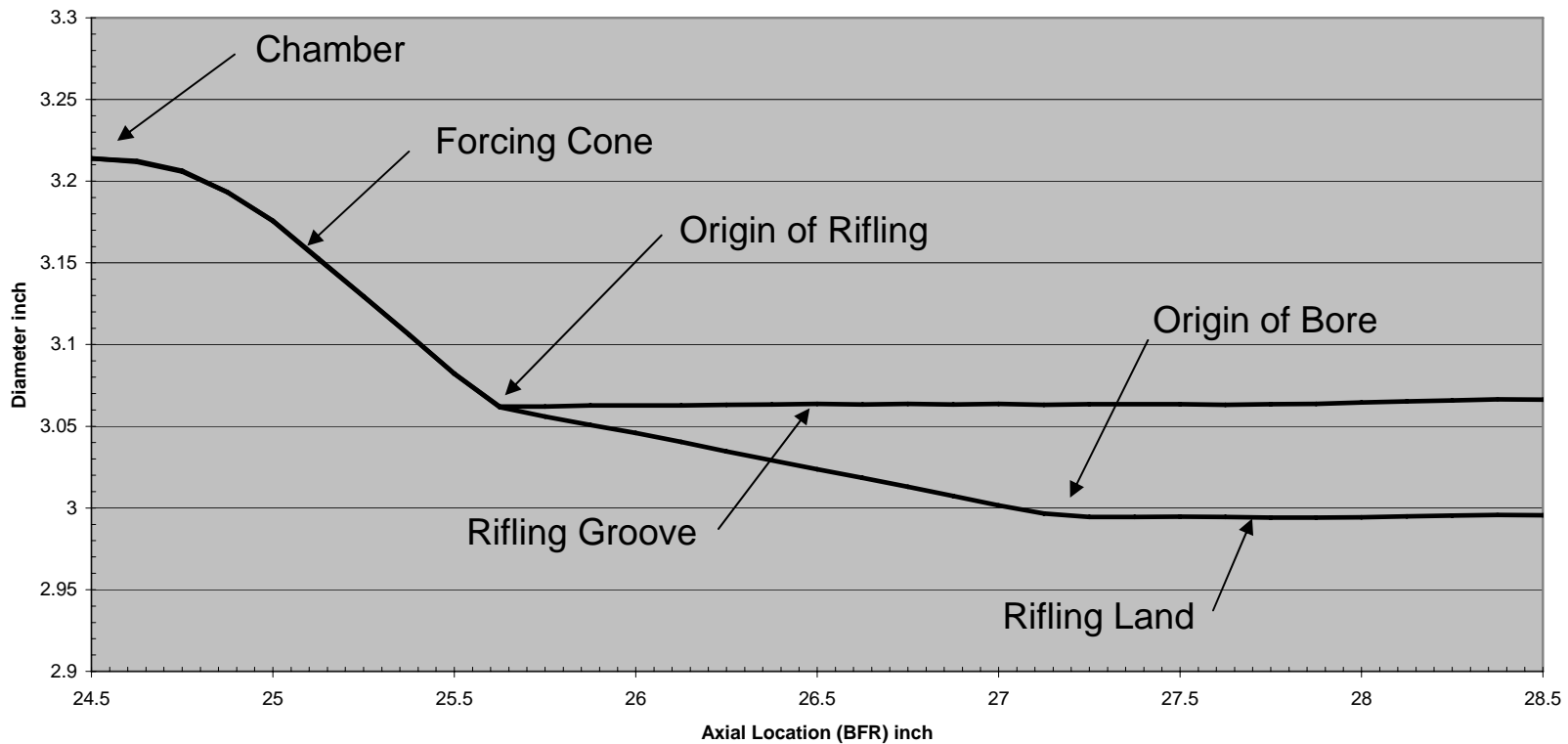
- Rapid fire testing of competing technologies will be complete this summer
- The following results will examine the performance of the Chrome Baseline liner only.

- Liners were inspected after every 80 rounds.
- Liners were thoroughly cleaned, and laser bore mapped
- The most notable erosion/wear was at the shot start region.



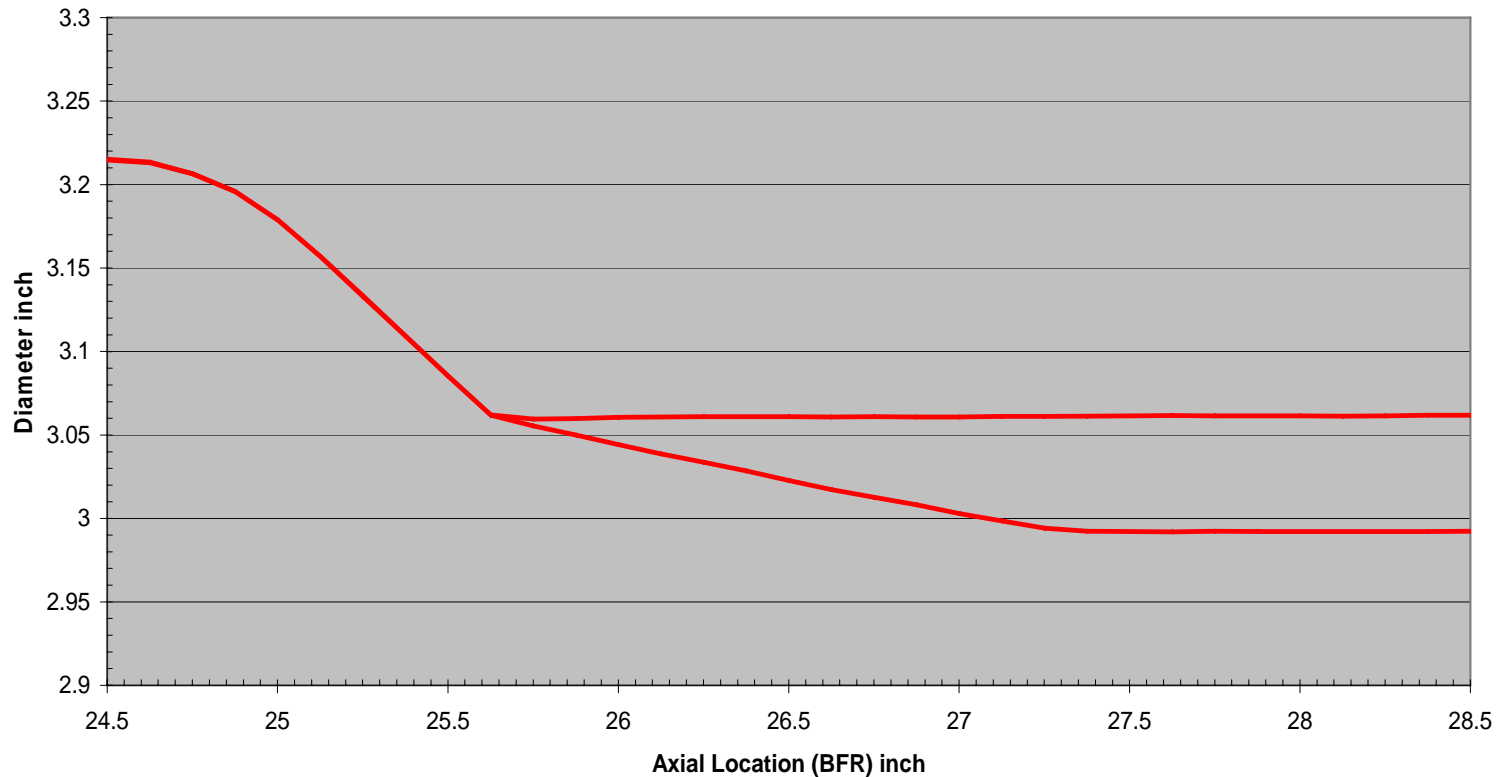
- Chrome liner, Proof shots only

Chrome Wear and Erosion Progression



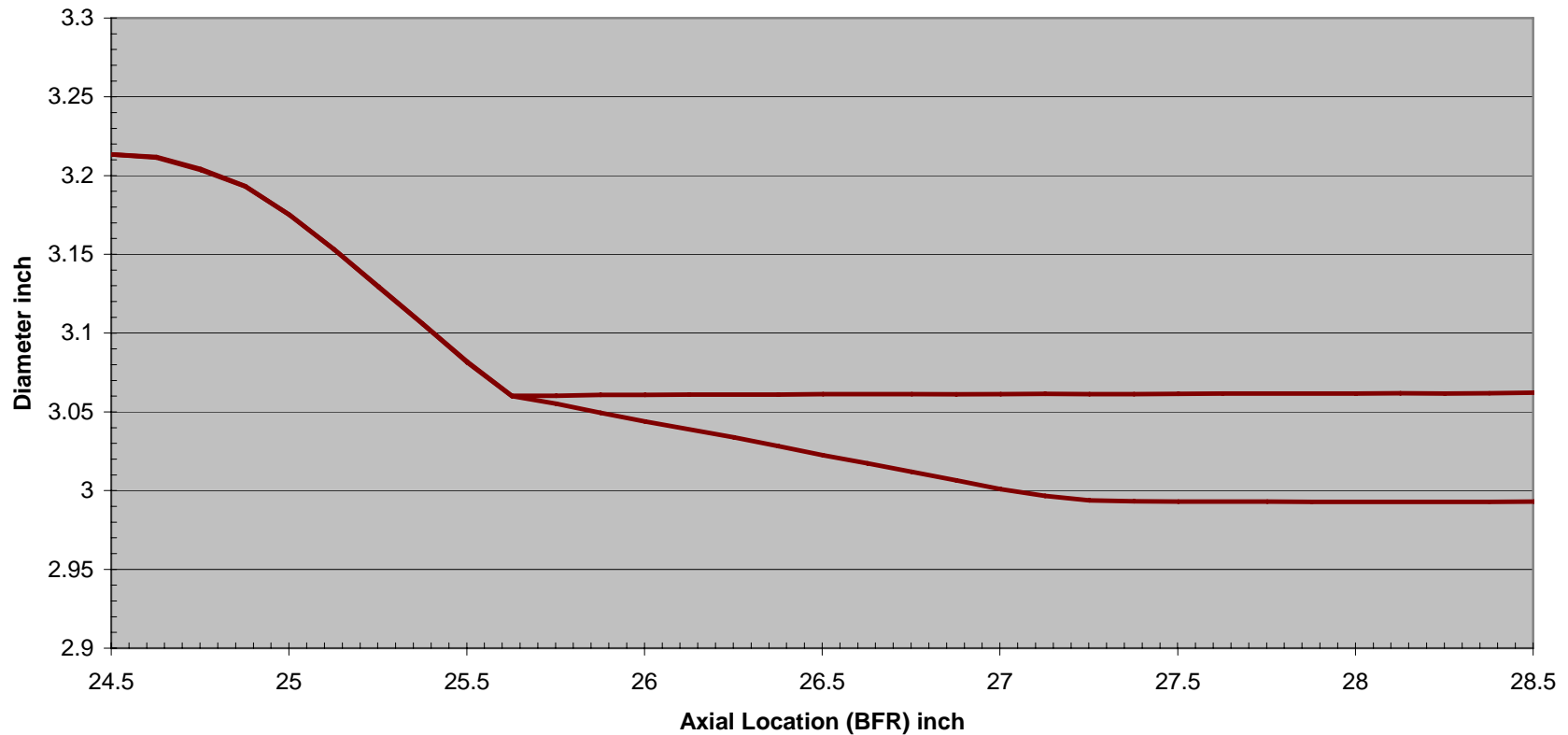
- Chrome liner, after 80 shots

Chrome Wear and Erosion Progression



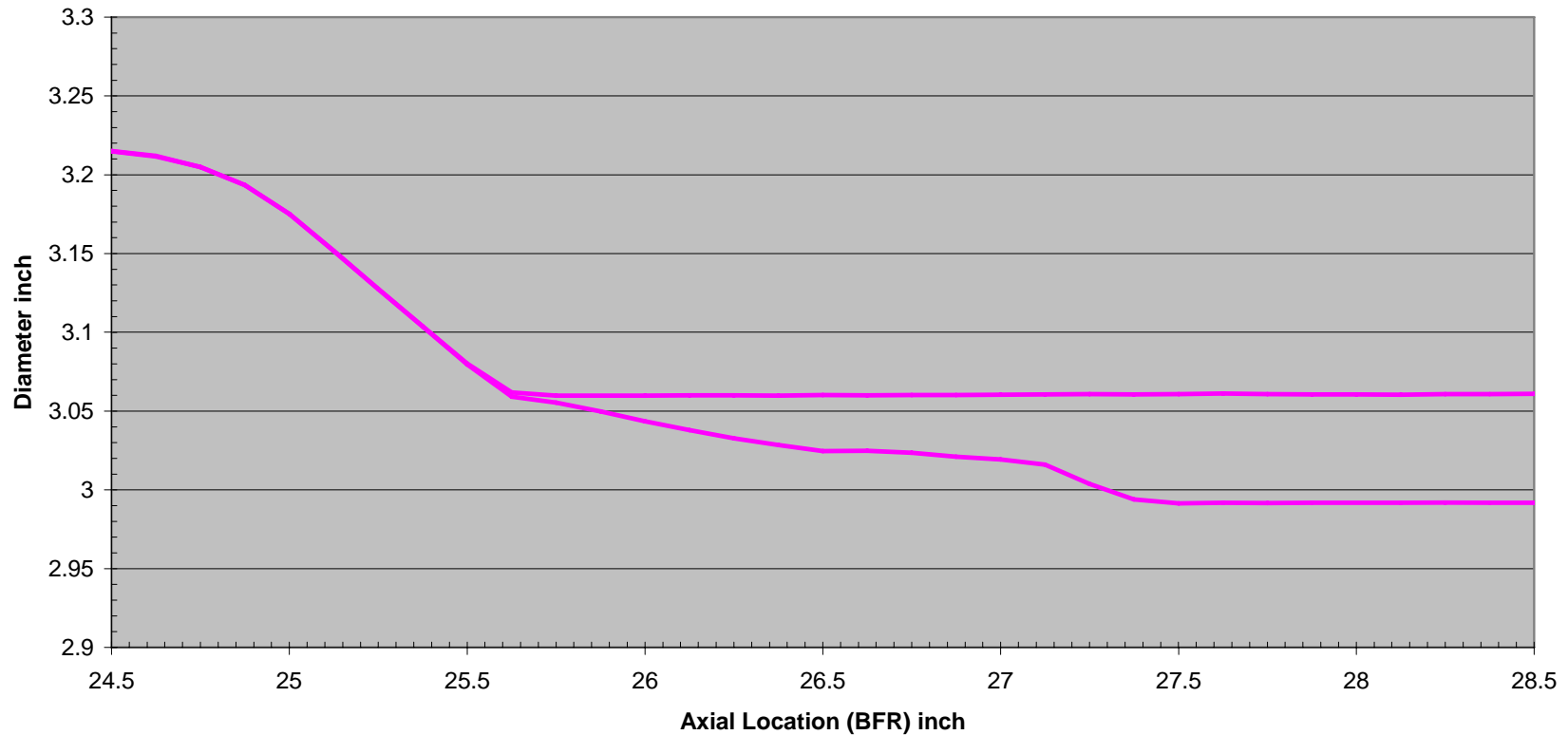
- Chrome liner, after 160 shots

Chrome Wear and Erosion Progression



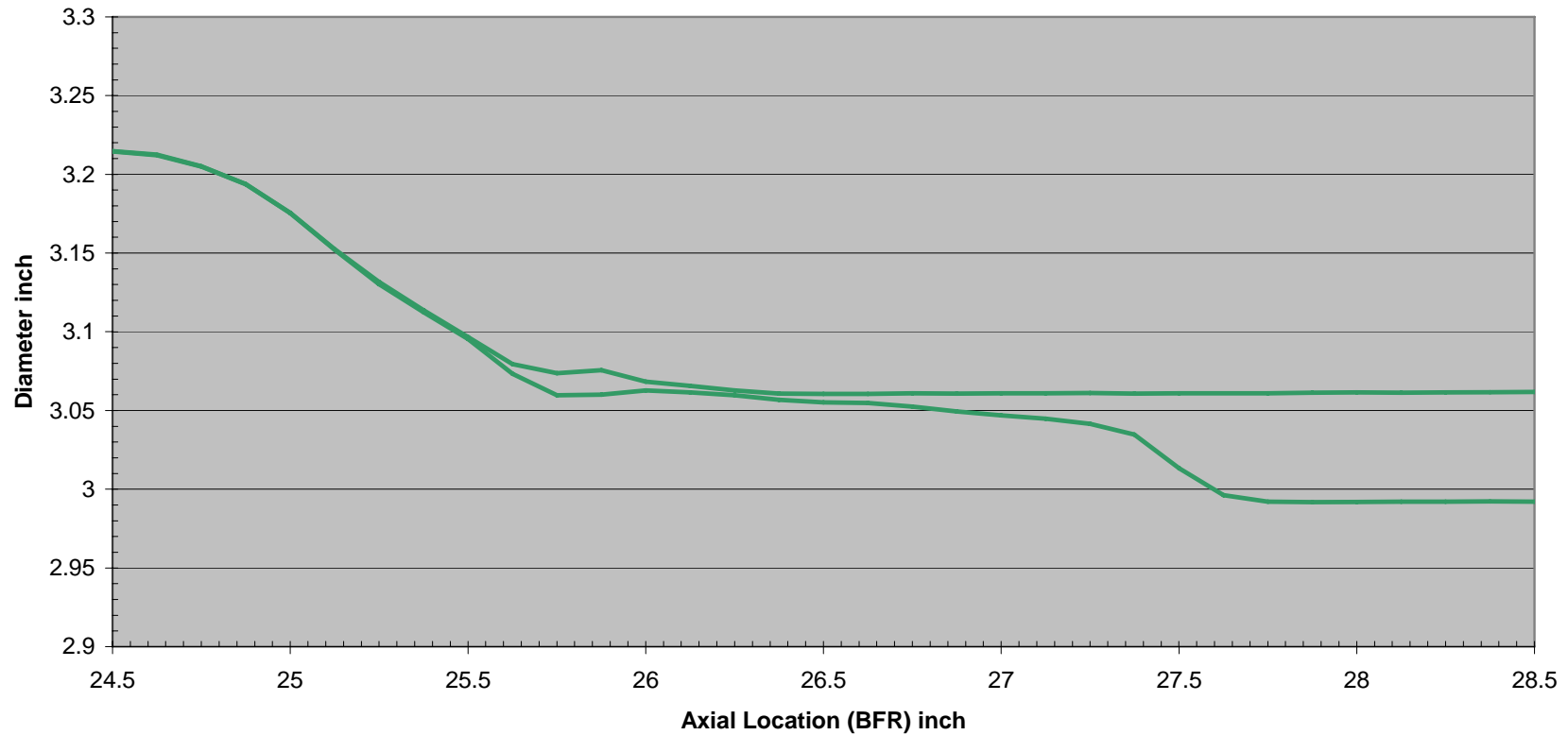
- Chrome liner, after 240 shots

Chrome Wear and Erosion Progression

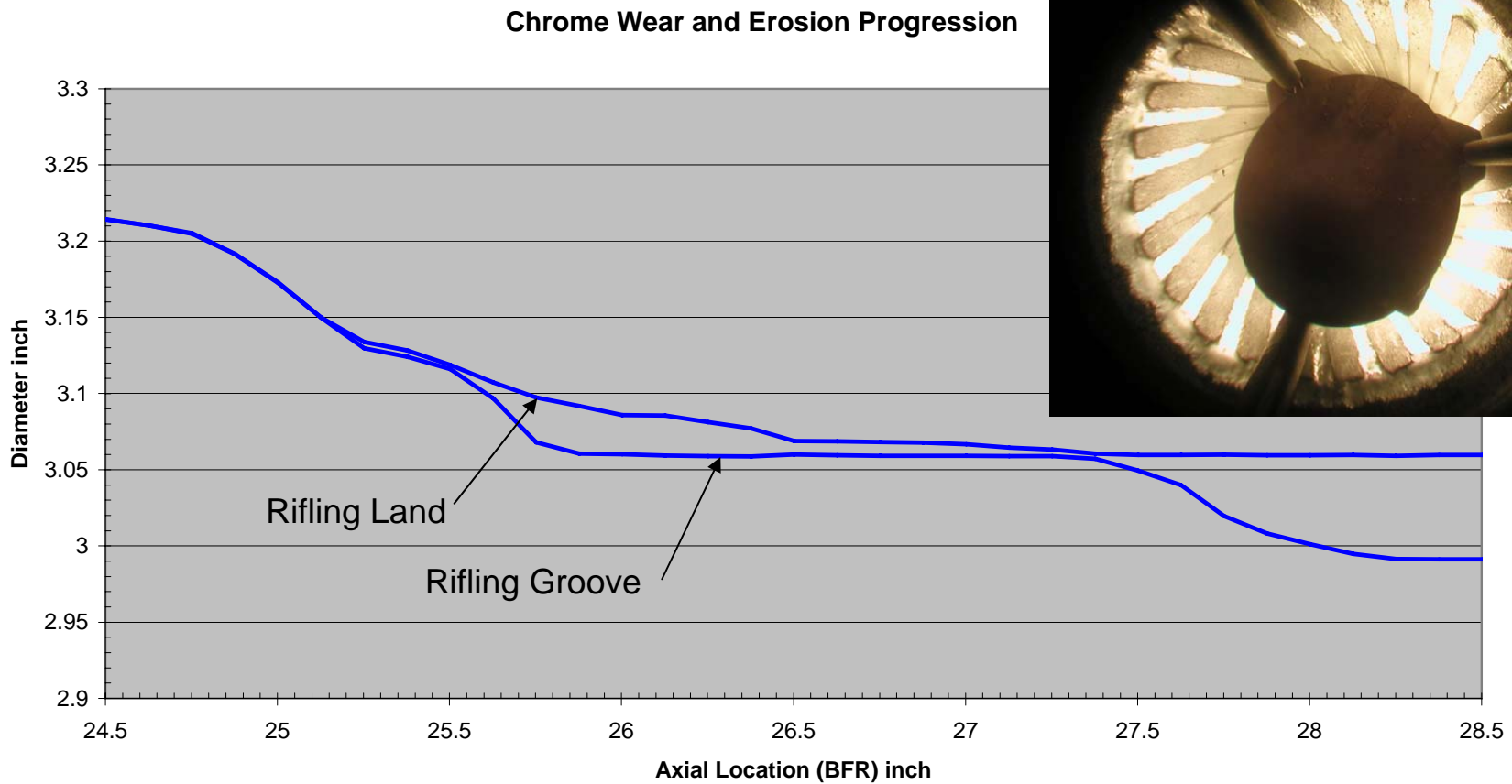


- Chrome liner, after 320 shots

Chrome Wear and Erosion Progression

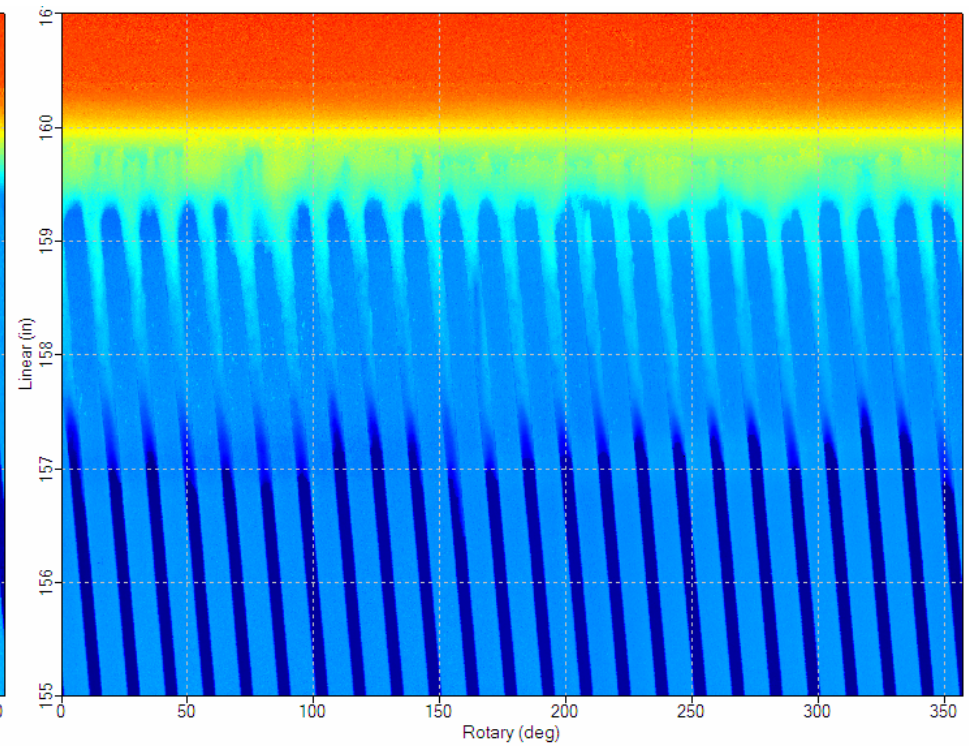
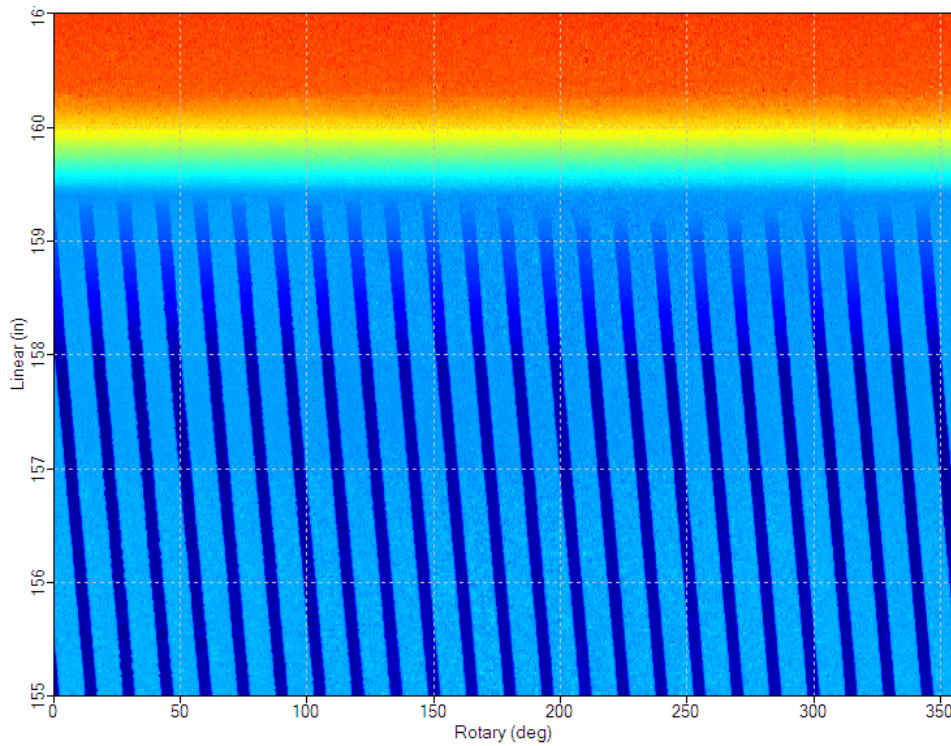


- Chrome liner, after 400 shots



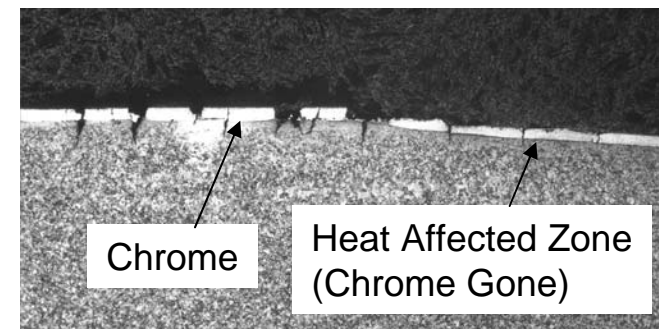
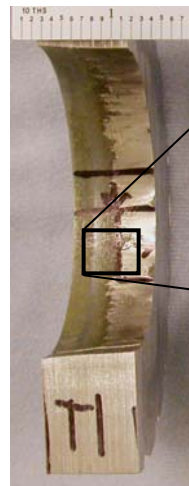
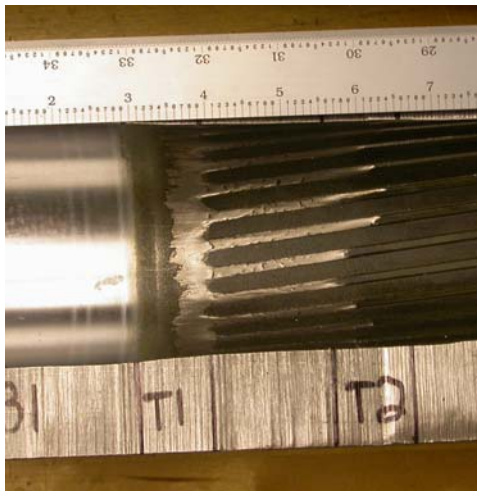
76mm Rapid Fire Test Results

- Laser Bore Mapping images of Chrome liner new, and after 400 rounds.
 - Note, depth of lands has progressed deeper than grooves.

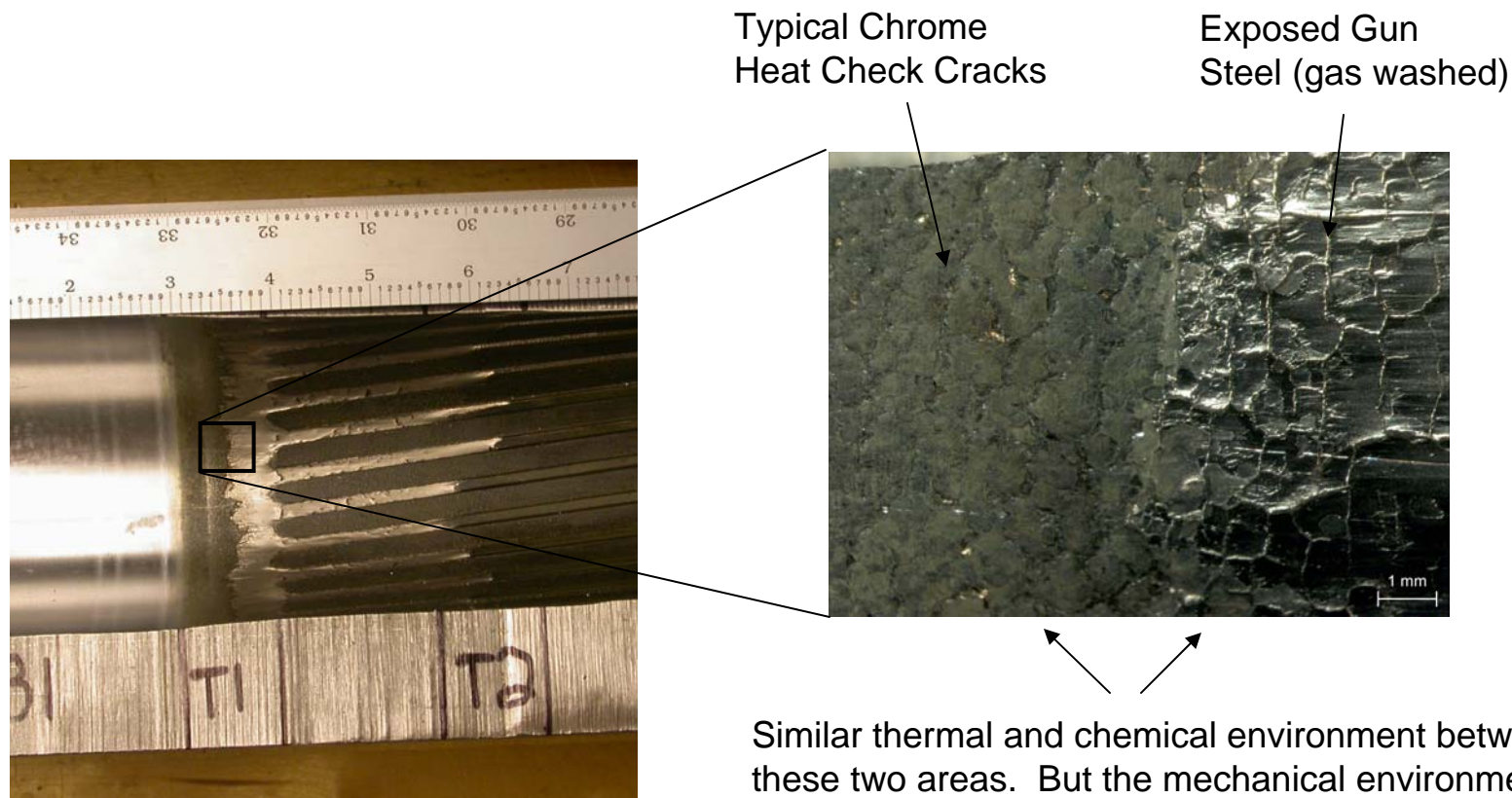


76mm Rapid Fire Test Results

- Micrographic analysis.
 - Surface and axial section view of chrome loss transition area in forcing cone region.



- Noteworthy observation
 - Effect of projectile induced mechanical loads



Similar thermal and chemical environment between these two areas. But the mechanical environment is dramatically different. The area to the right was subject to the physical impact of the projectiles, as well as the additional radial strain caused by the engraving of the rotating band.

- 76mm HRF Testing of Competing Technologies will be completed summer 2007.
- Winning technology will be selected for development into 155mm AGS barrel design.
- 155mm AGS barrel will be tested to demonstrate compliance with AGS transition requirements
 - 50% improvement in life
 - Reduction in life cycle cost
- If compliant with transition criteria, the Advanced Gun Barrel Technology will transition to the acquisition program for insertion into DDG 1000

Questions

