

CIA INSPECTION INC.

The Latest Advancements in Delayed Coke
Drum Inspection Techniques for Improved
Vessel Performance and Life Extension

Mr. Les Harold
Managing Director
E: lharold@cia-inspection.com
T: +1 281 714 9354



CIA INSPECTION INC. - COMPANY OVERVIEW

- Widely recognized as the world's leading coke drum inspection company
- 22+ years dedicated expertise, 1000+ site inspections, 85 years of collective drum evaluation expertise
- 52+ clients, 100's refinery sites, spanning 25 countries and growing
- Forefront of innovation in coke drum inspection and NDE techniques and continues to set the standards being adopted by the industry worldwide
- Proactive approach (not Reactive) proven to be the most cost effective way to improve operator safety, unit performance, and asset reliability
- Formed strategic partnerships and working relationships with the world's leading service providers to the Petroleum Coking Industry
- Strategic partnership in Brazil



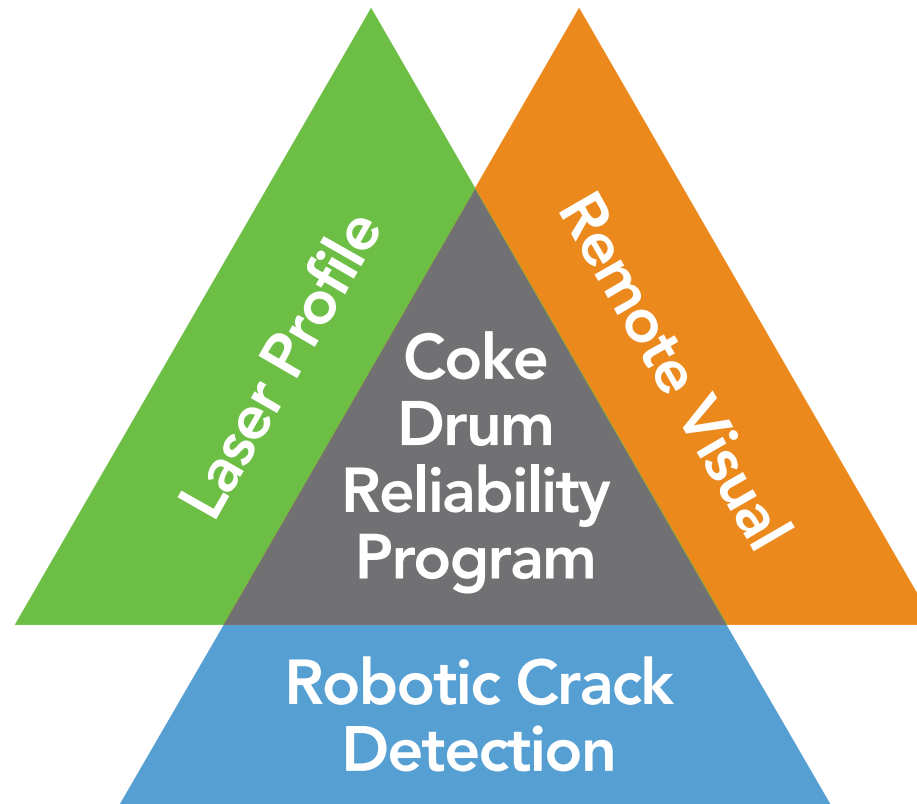
*Coke drum
management
through*
knowledge



COKE DRUM MANAGEMENT THROUGH KNOWLEDGE

Laser Profile:

a remotely deployed, laser-based range imaging tool designed to profile the internal surface of coke drums in order to locate and measure vessel distortions.



Remote Visual:

a state of the art, high definition digital video camera with zoom used to visually inspect the internal surface condition, including the dome, cone and nozzles.

Robotic Crack Detection:

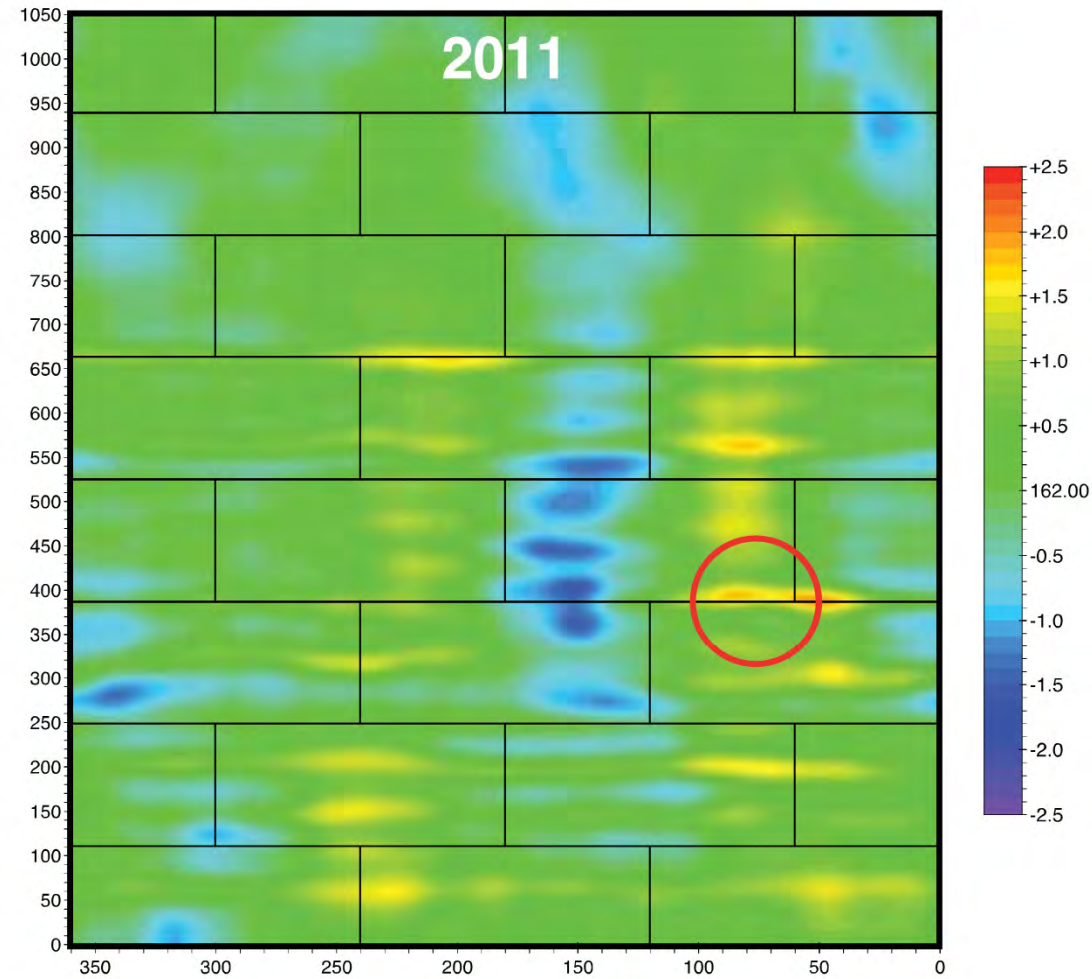
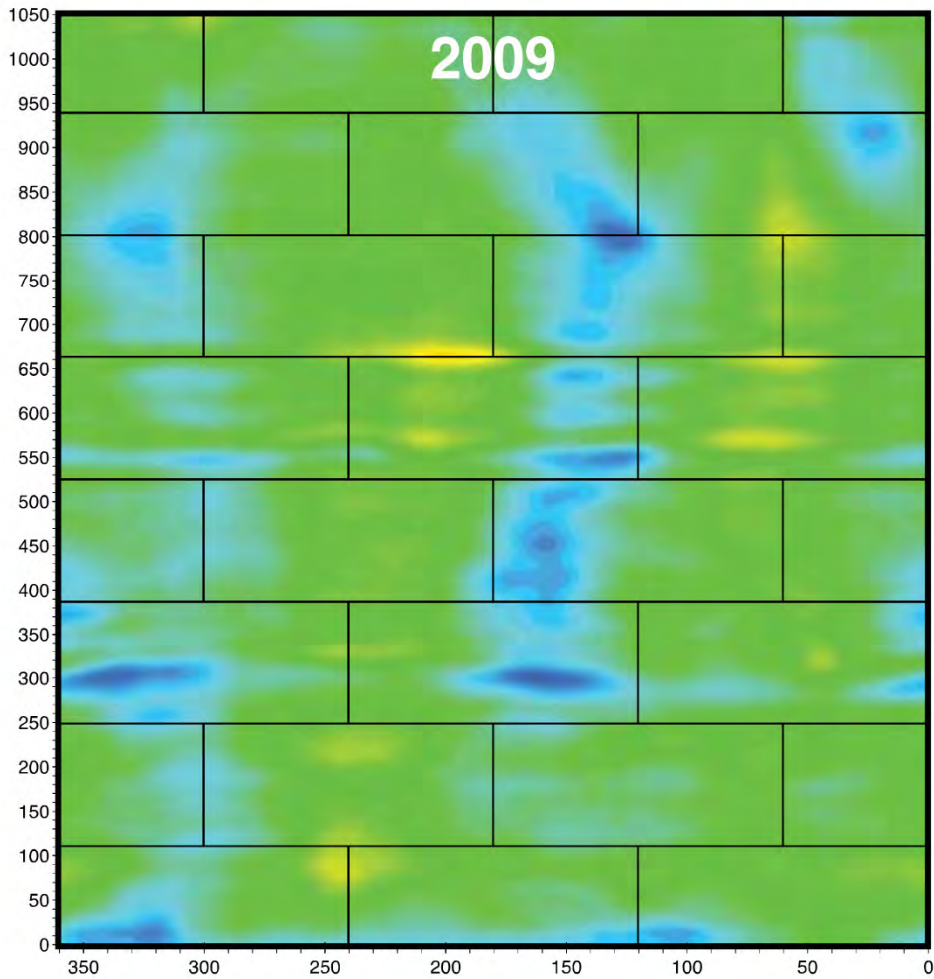
a telescopically deployed robotic crawler equipped with an NDE sensor (ACFM) used to confirm and measure the presence of ID forming cracks.

COKE DRUM MANAGEMENT THROUGH KNOWLEDGE

- **Laser Profiling:**
 - Tracking & Trending
 - Cone & Dome Scanning
 - Thermal Bowing or “Banana Effect”
 - Out of Round Calculations
 - Tangent to Tangent Height
 - Improved Bulge Analysis
 - Data Mining & Predictive Guidance
- **Robotic Crack Detection:**
 - ID crack confirmation and measurement
- **Hi-Definition Digital Remote Visual Inspection**
 - Increased frequency according to engineering analysis
- **Important Partner in any long-term reliability program:**
 - Pre-Turnaround Vessel Assessment
 - Baseline Examinations of New to Service Vessels
 - Packaged Engineering Services
 - Engineering Analysis, FFS, RLA, etc.
 - Health Monitoring System, Strain & Temperature Sensor
 - Weld Repair Strategies
 - External Structural Scanning ⁴

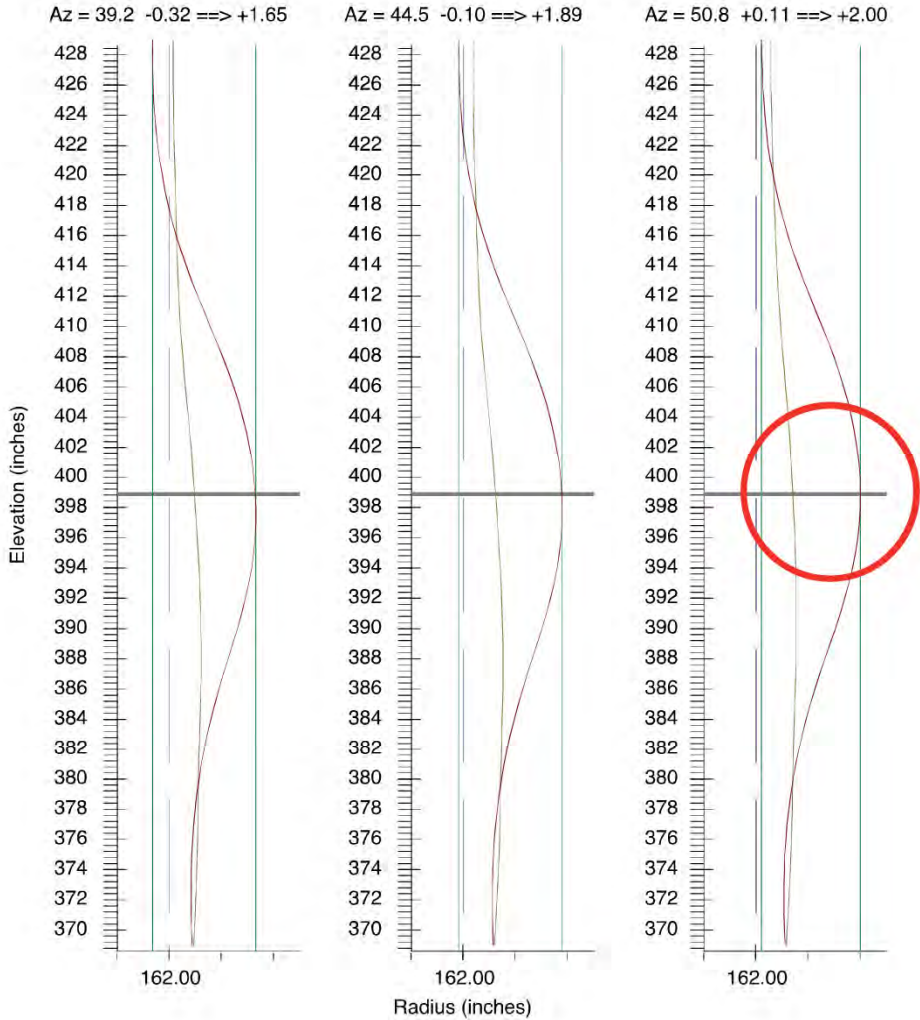
LASER SCANNING - TRACKING & TRENDING

DRUM IMAGE OR BULGE MAPS

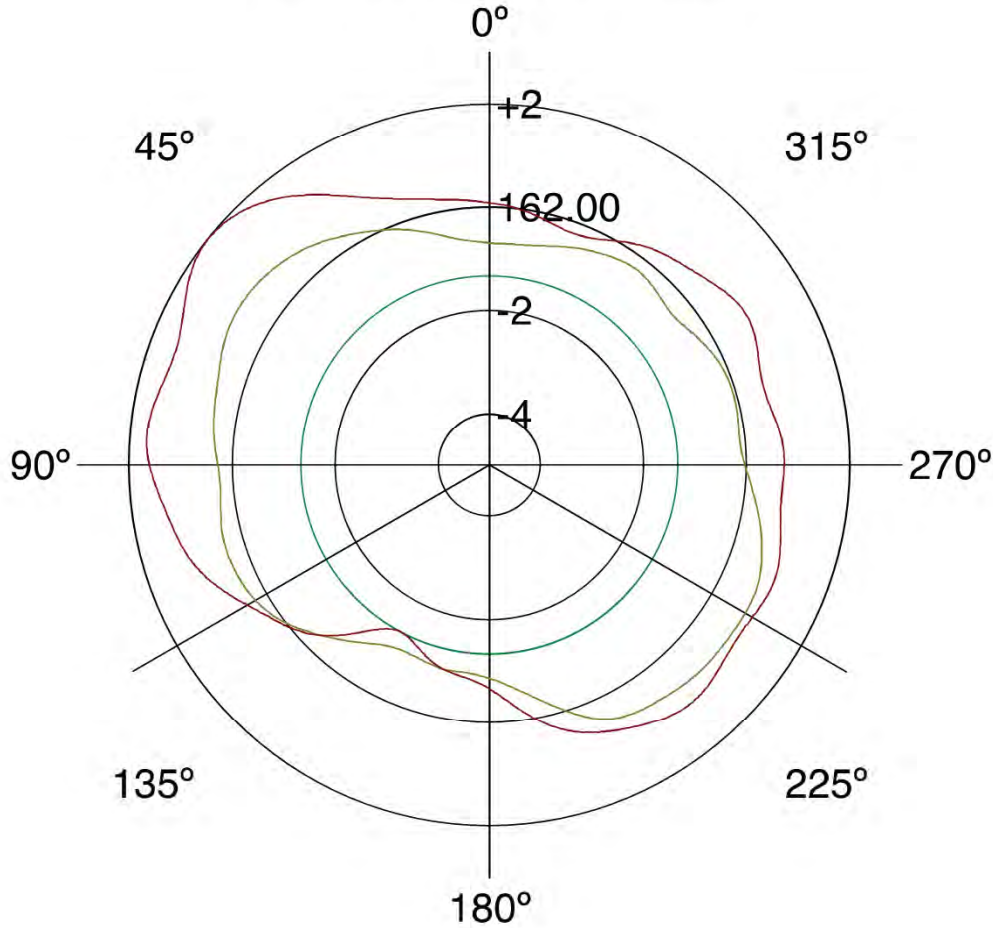


LASER SCANNING - TRACKING & TRENDING

VERTICAL SECTION COMPARISON



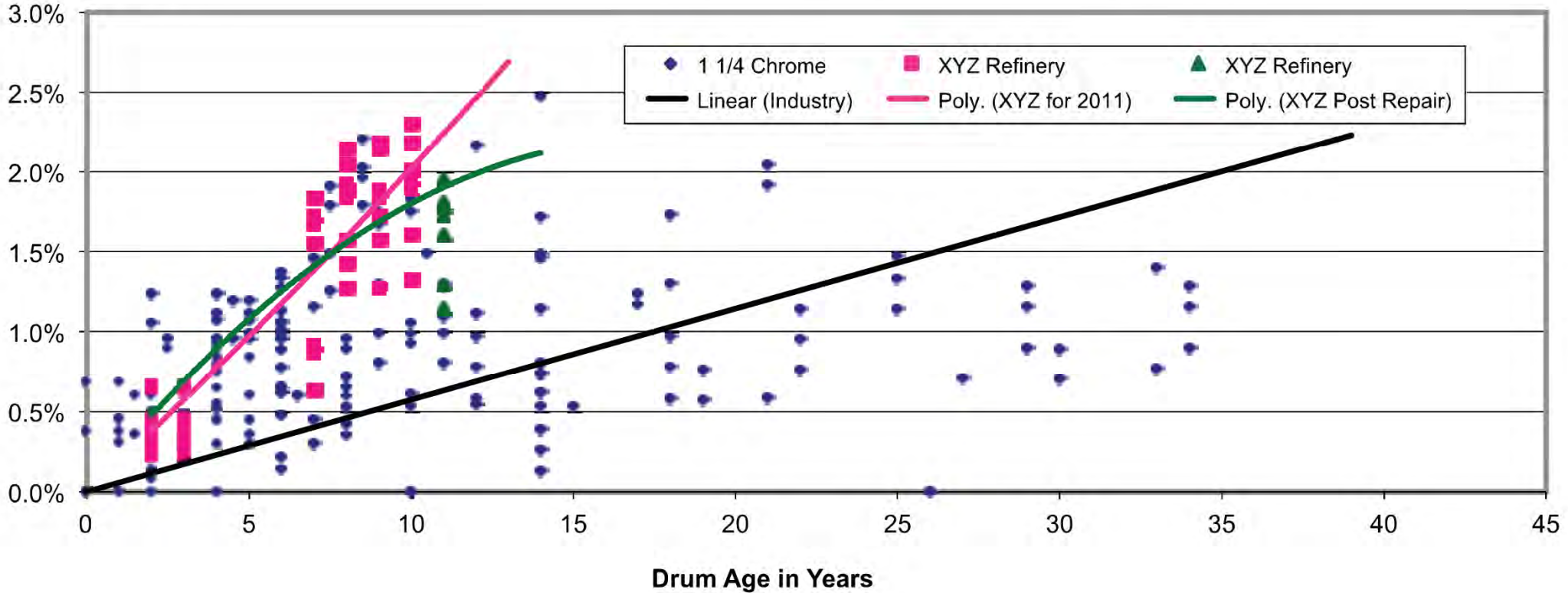
POLAR PLOT COMPARISON ACROSS 4th CIRC WELD



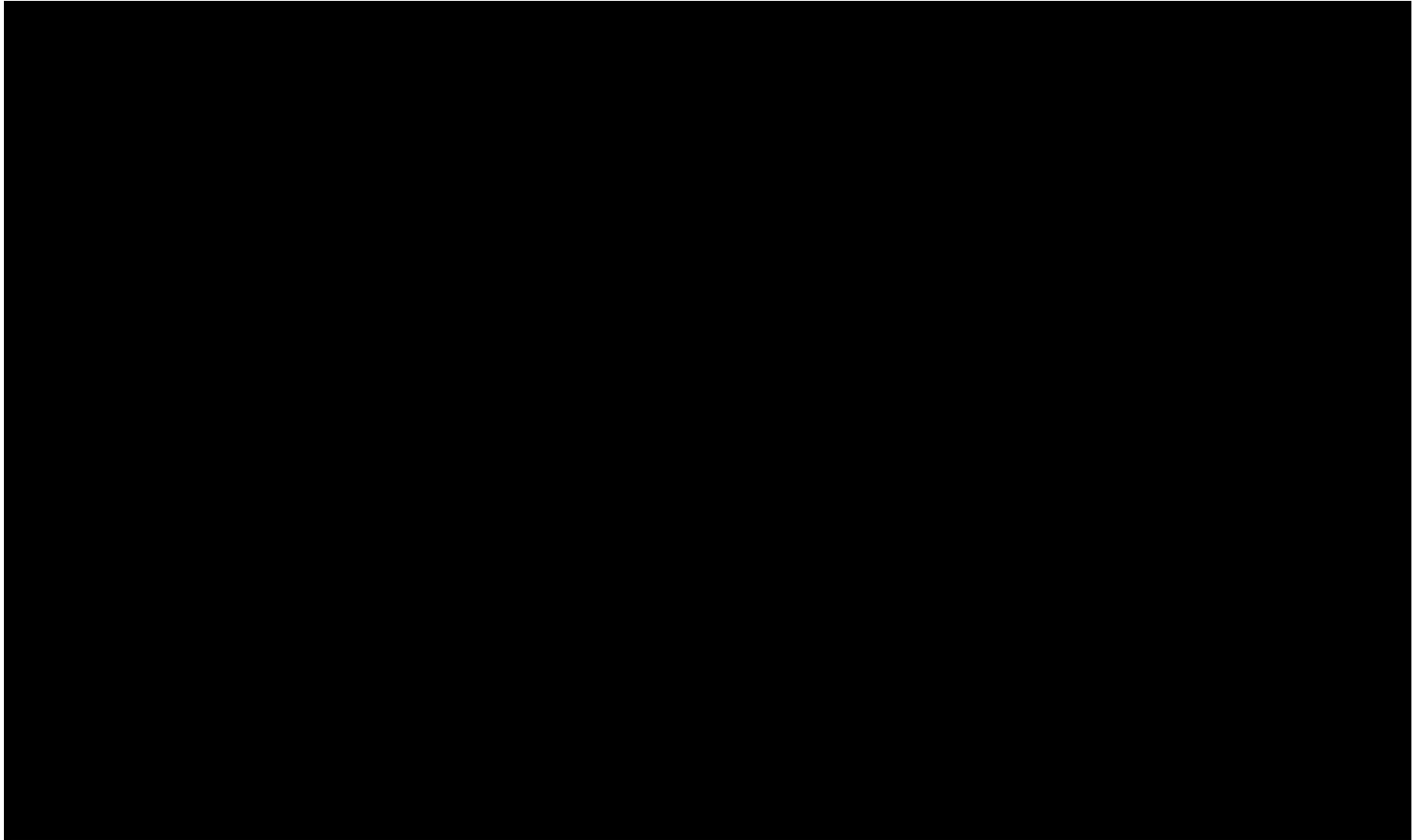
LASER SCANNING – DATA MINING

1 1/4 Chrome Bulge Comparison and Trending

% Radial Growth

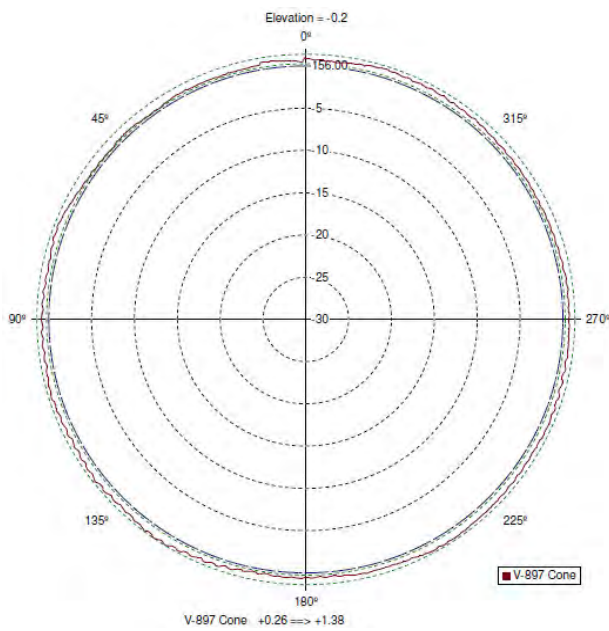


LASER SCANNING – DRUMVIEW

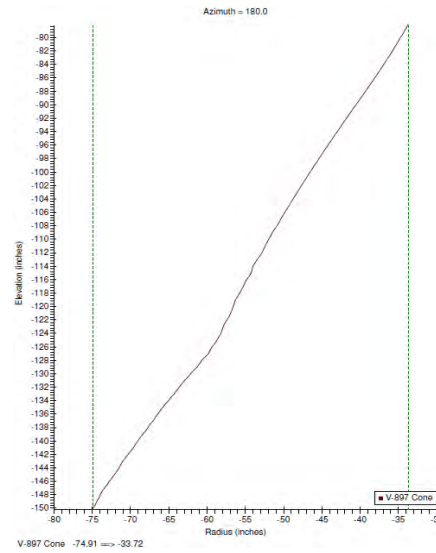


DOMES & CONE SCANNING

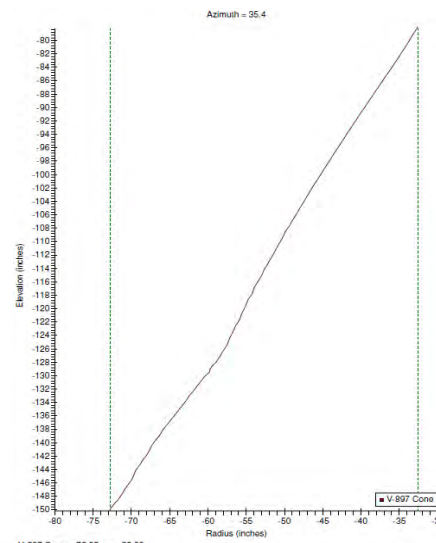
Polar Plot at 0° (Bottom Tangent Line)



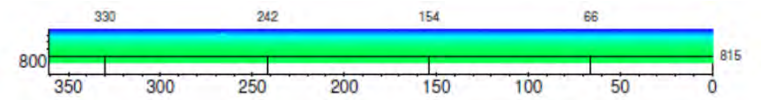
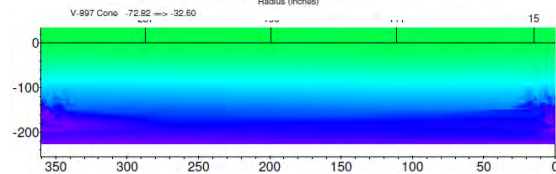
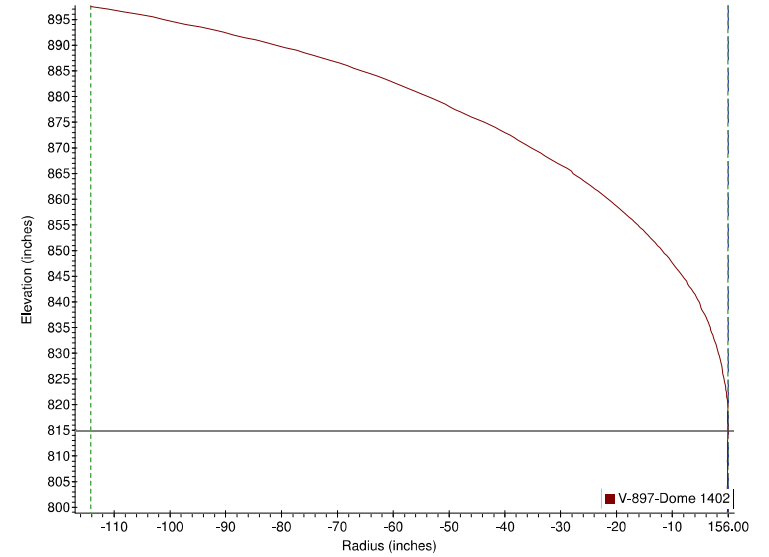
Profile at Cone Join Weld at 180°



Profile at Cone Join Weld at 35°

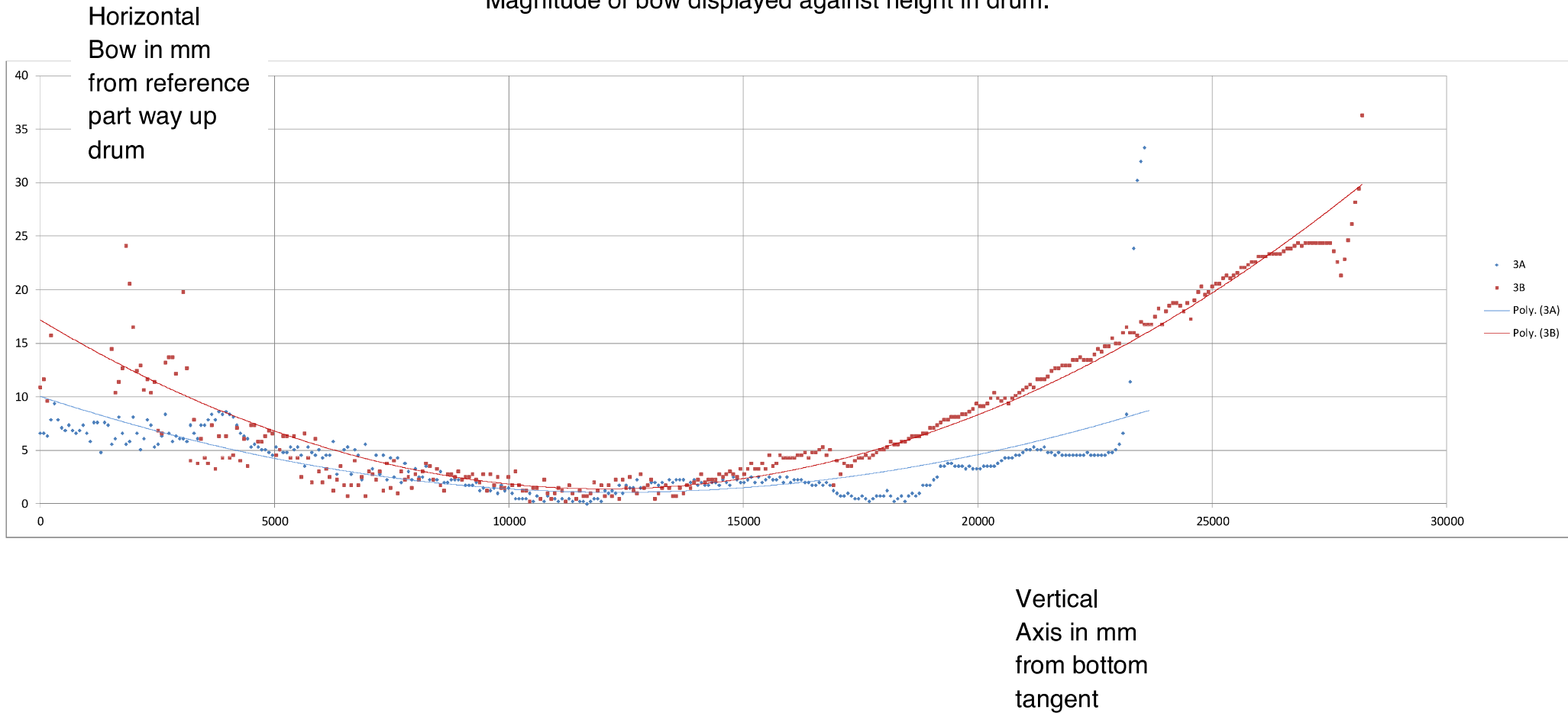


Azimuth = 240.4



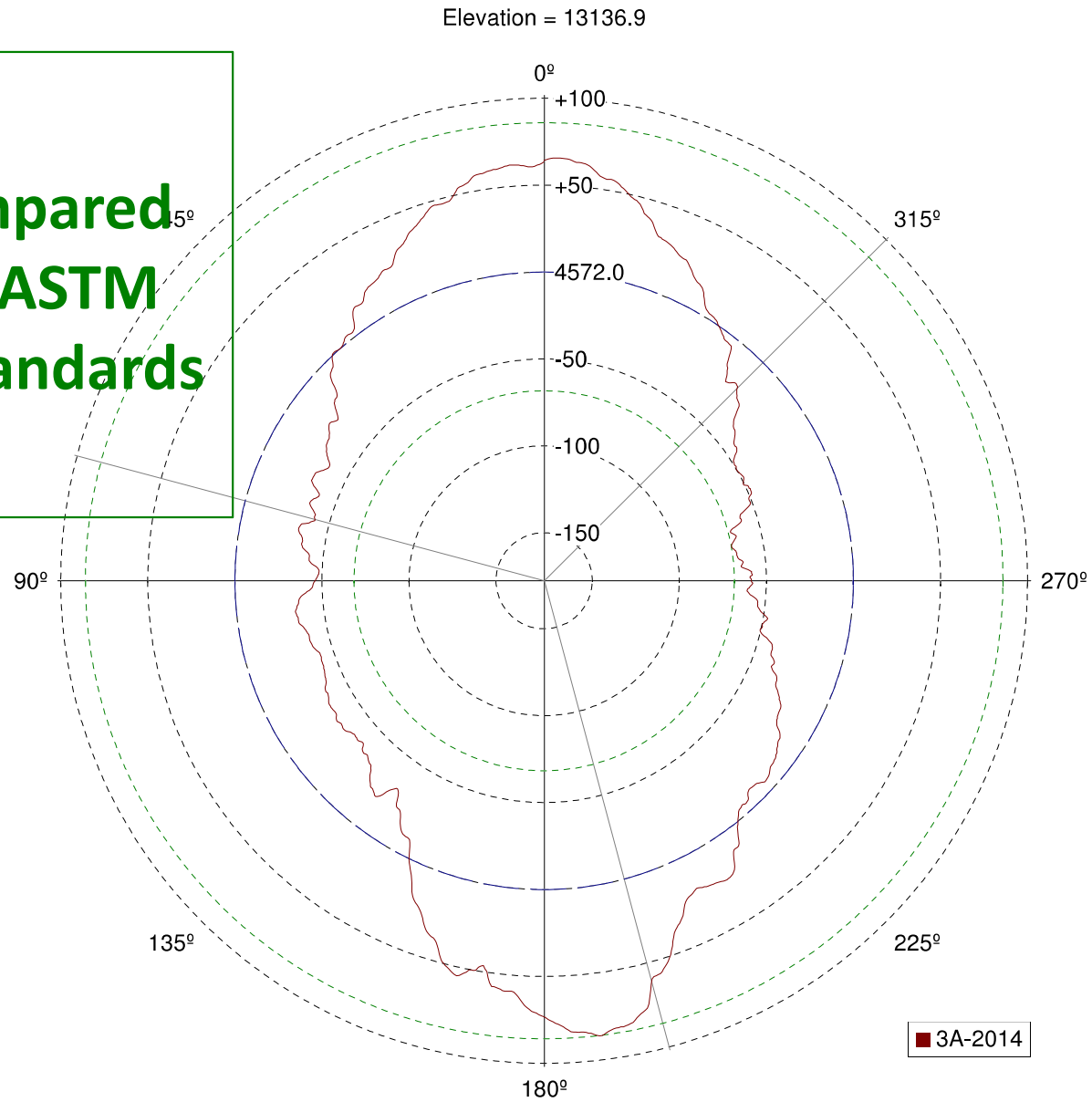
THERMAL BOWING / DRUM BOW

Magnitude of bow displayed against height in drum.



OUT OF ROUNDNESS

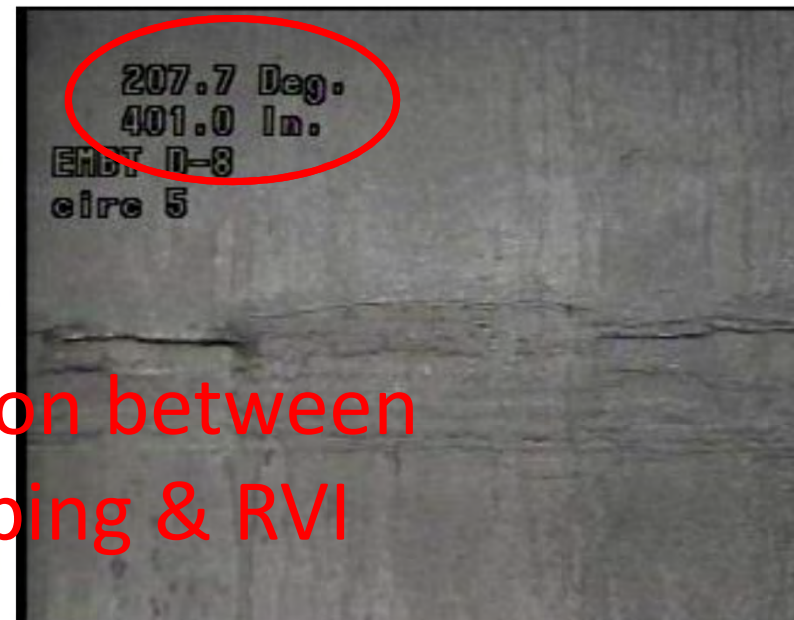
**Findings compared
against API/ASTM
fabrication standards**



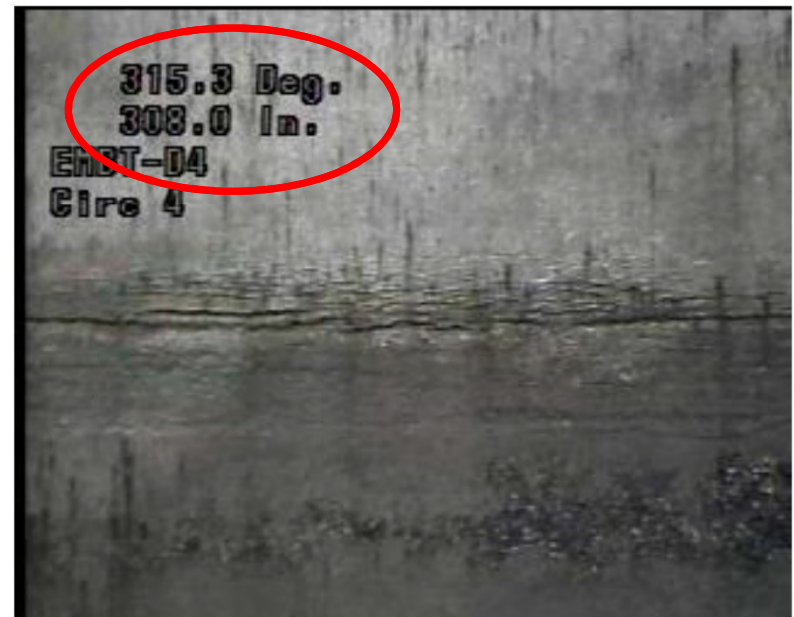
ENGINEERING ASSESSMENTS

- Pleased to have formed strategic partnerships and relationships with the world's leading service providers to the Petroleum Coking Industry
- Integral first-step in any long-term reliability program
- Packaged Engineering Services including:
 - FEA assessments (BSA, PSI)
 - Fitness for Service (FFS) / Remaining Life Assessments (RLA)
 - Others ...
- Working in close collaboration with Engineering providers particularly to improve the value received from the Robotic Crack Detection:
 - Typical procedure is not optimal
 - Provides value add and thorough understanding of vessel condition
 - Immediate results upon completion of the inspection

REMOTE VISUAL INSPECTION & PCTI'S

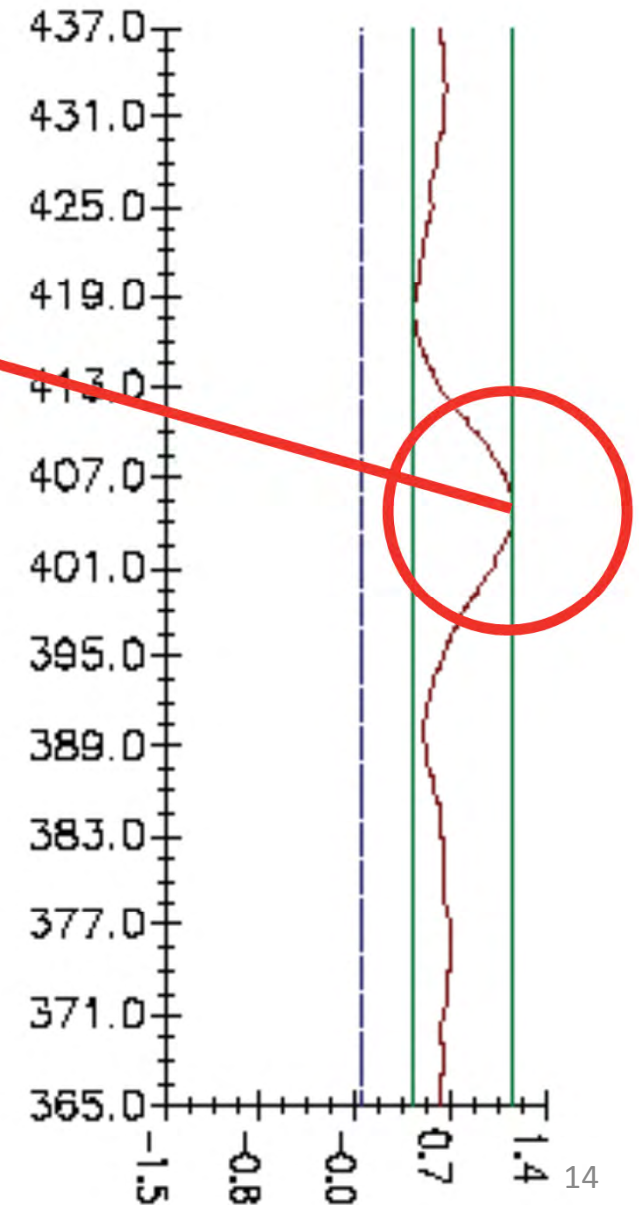


1:1 registration between
Laser Mapping & RVI



CORRELATION TECHNIQUES

IS THIS A CRACK? IF SO HOW DEEP, HOW SERIOUS?



ROBOTIC CRACK DETECTION

Rotary Drive

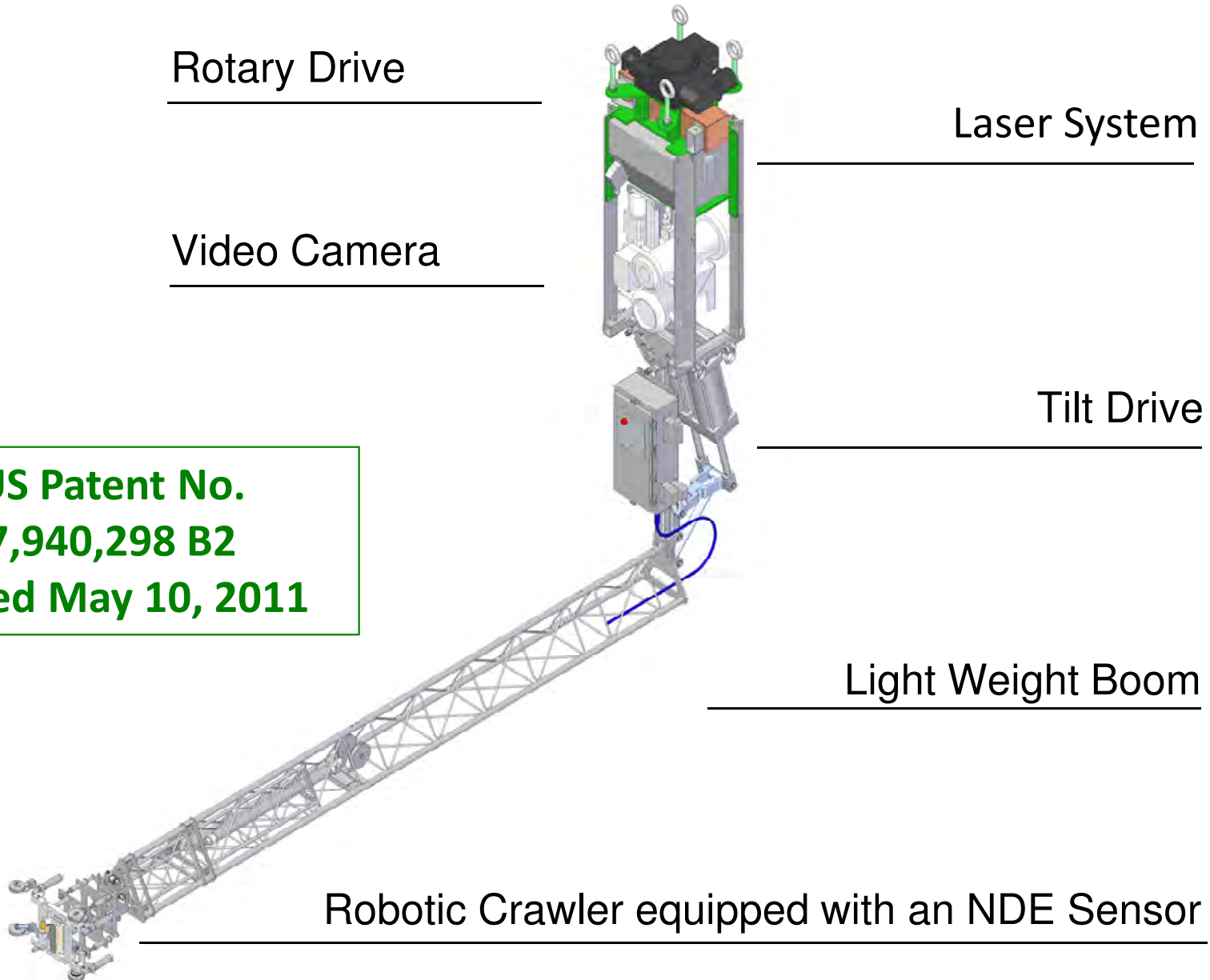
Video Camera

Laser System

Tilt Drive

Light Weight Boom

**US Patent No.
7,940,298 B2
Issued May 10, 2011**



ROBOTIC CRACK DETECTION

BENEFITS:

- Online use, remotely deployed
- Immediate and accurate results
- Rapid scheduling and deployment
- No vessel blinding, scaffolding or surface preparation
- Reduced downtime and cost
- Considered a more cost effective, safe, accurate weld examination strategy in comparison to other UT methods

Proven to work in the coke drum environment!

ROBOTIC CRACK DETECTION - SELECTION CRITERIA

CRITERIA:

Bulge patterns & profiles (sharp, deep distortions)



Location of bulges in close proximity to seam welds



Visual confirmation of crack type indications



Presence of stress cracking sites or "elephant skin"



Distortions occurring across step thickness transition zones



Weld repair zones



Other engineering based techniques (FEA, BSA, PSI, AET)



REASON:

Amplify stress/strain, initiate & propagate bulging-induced cracks

Significant correlation between ID cracking at circumferential welds

Images that appear to have "potential crack type indications"

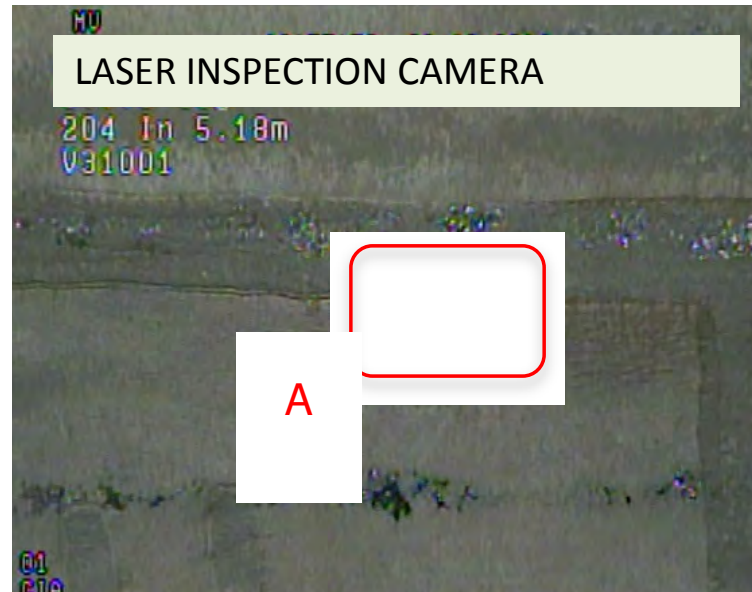
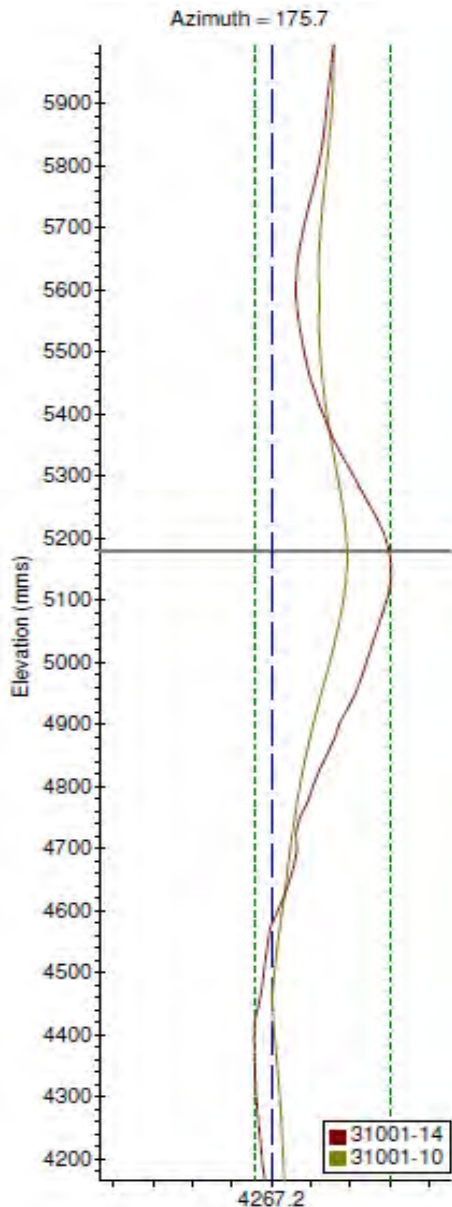
Precursor to more significant crack propagation

Known region of increased stress concentrations

Material mismatch, weld defect, etc.

Compliments service with theoretical and/or other UT approach

ROBOTIC CRACK DETECTION - SELECTION CRITERIA



Notes:

- Bulge growth, ripple pattern forming across the weld seam
- Visual confirmation of crack type indications
- Stress cracking present
- Step-thickness transition in outer shell

Positive Confirmation of Surface Breaking Crack:

length = 110 mm, depth = 3.4 mm

SS410 cladding thickness = 2.8 mm

ROBOTIC CRACK DETECTION – DEPLOYMENT



ROBOTIC CRACK DETECTION - INSPECTION



HI-DEFINITION DIGITAL VIDEO

- Since 1991, CIA has been at the forefront of innovation in non-destructive examination (NDE) techniques for the delayed coking industry
- With recent advances in HDTV and digitally transmitted video, we are capitalizing on these advanced technologies and upgrading our remote visual inspection service
- Currently in operation and schedule is to “roll out” this technology across all inspection units during Q4 2014
- The following images were taken during a recent online inspection and field trial and demonstrate the advantages of this technology:

Once again demonstrates CIA's
innovation and market leadership!

HI-DEFINITION DIGITAL VIDEO



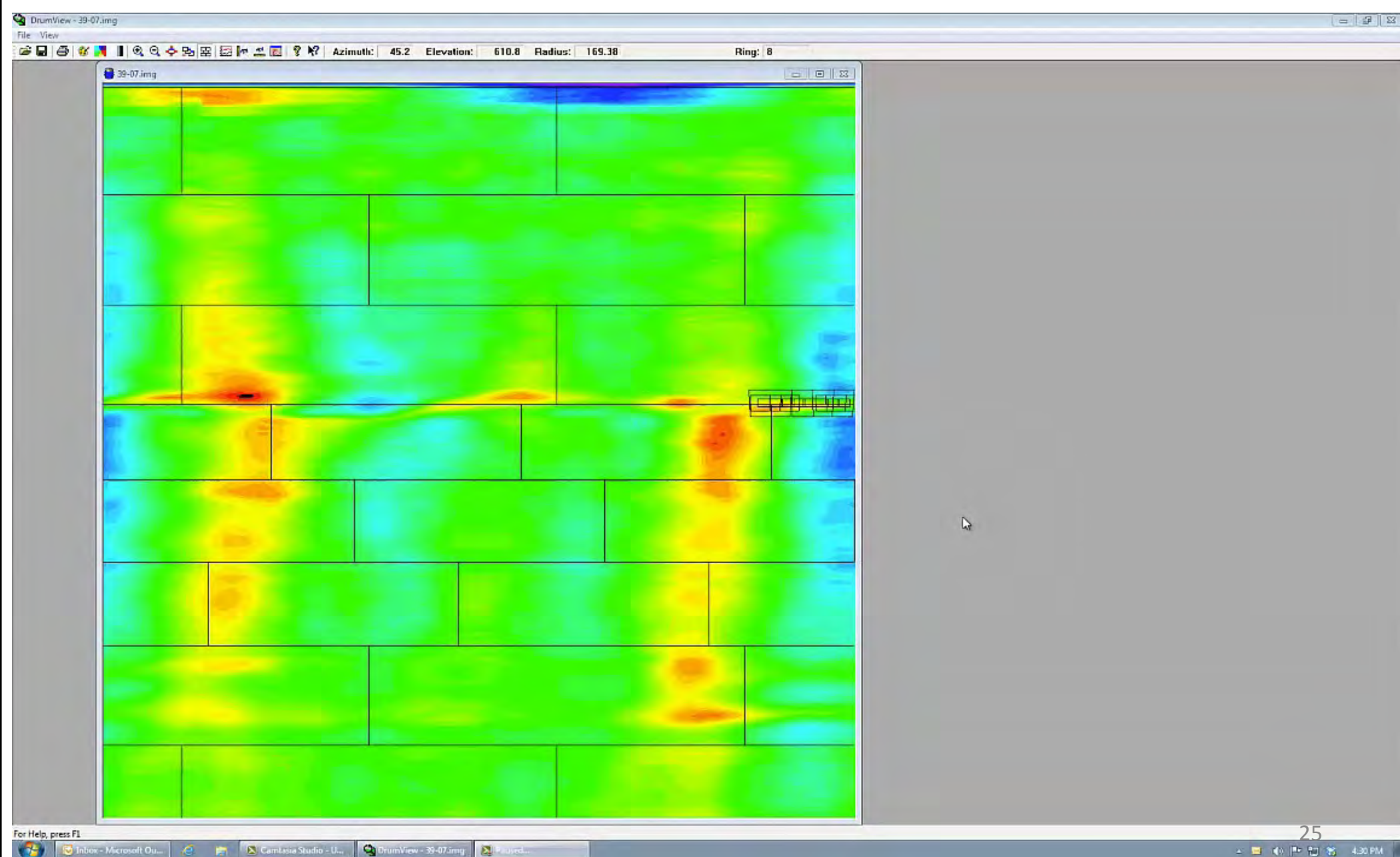
HI-DEFINITION DIGITAL VIDEO



HI-DEFINITION DIGITAL VIDEO

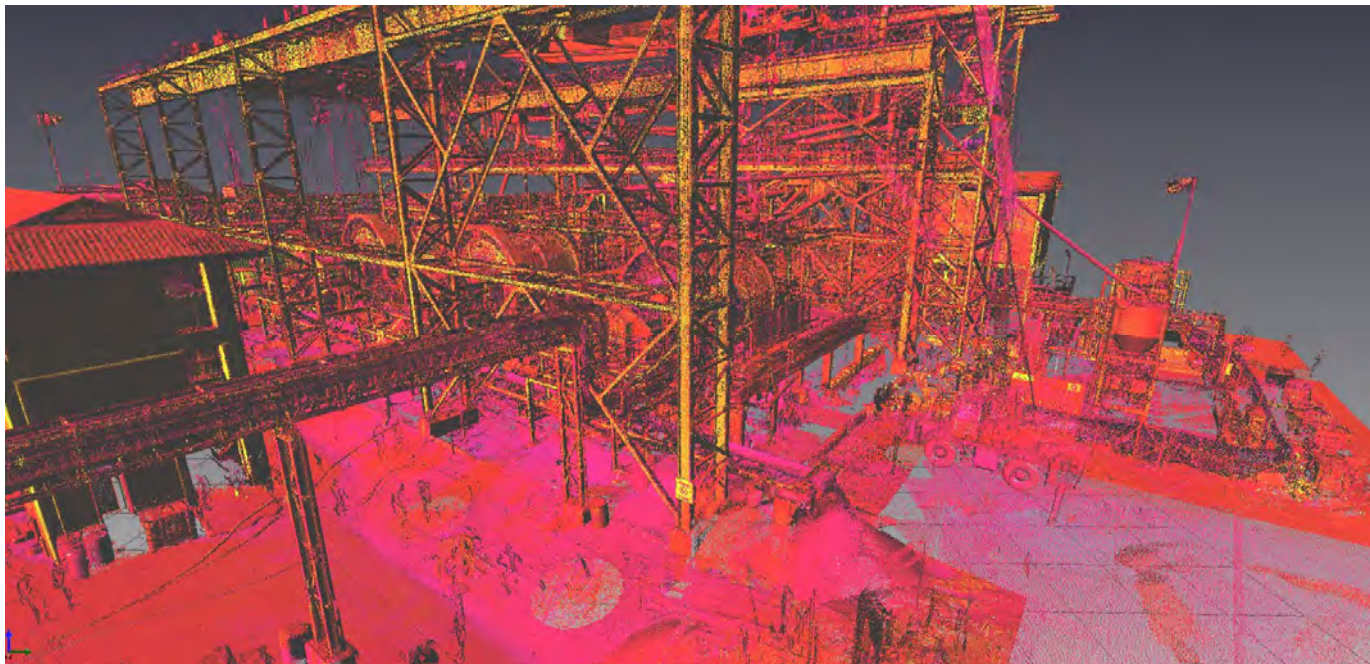


HI-DEFINITION DIGITAL VIDEO



EXTERNAL COKER SCANNING

- Perfect solution for:
 - DrumTilt/Lean - used in combination with drum bowing calculations
 - Retrofits - used in combination with internal cone scanning to assist with BUD projects and retrofits
 - General DCU scanning, Kelly structure verticality, crane rails, etc.



DO NOT RE-INVENT THE WHEEL !!!



CIA INSPECTION INC. - YOUR FULL SERVICE PARTNER

- 22+ years of dedicated expertise with 1000+ site inspections completed for industry's leading refiners,
- Technically superior service, highest quality analysis & reporting and value add service
- ACFM technique is revolutionizing the way drum inspection and weld examination is being employed all across the globe
- Continue to play a lead role in the industry's continued efforts to improve drum reliability and performance
- Safe, accurate and reliable inspection techniques providing partners superior value, service and benefits
- The goal is to be **Proactive** on issues affecting drum integrity rather than being **Reactive** to the resulting problems that are inevitable

Thank you!