Northeast GAS ASSOCIATION

NYSEARCH

Anomaly Detection & Assessment in Natural Gas Pipelines

Current State and Gaps in R&D

US DoT PHMSA 2016 R&D Forum

Working Group #3

Cleveland, OH – November 17, 2016

Dr. George Vradis

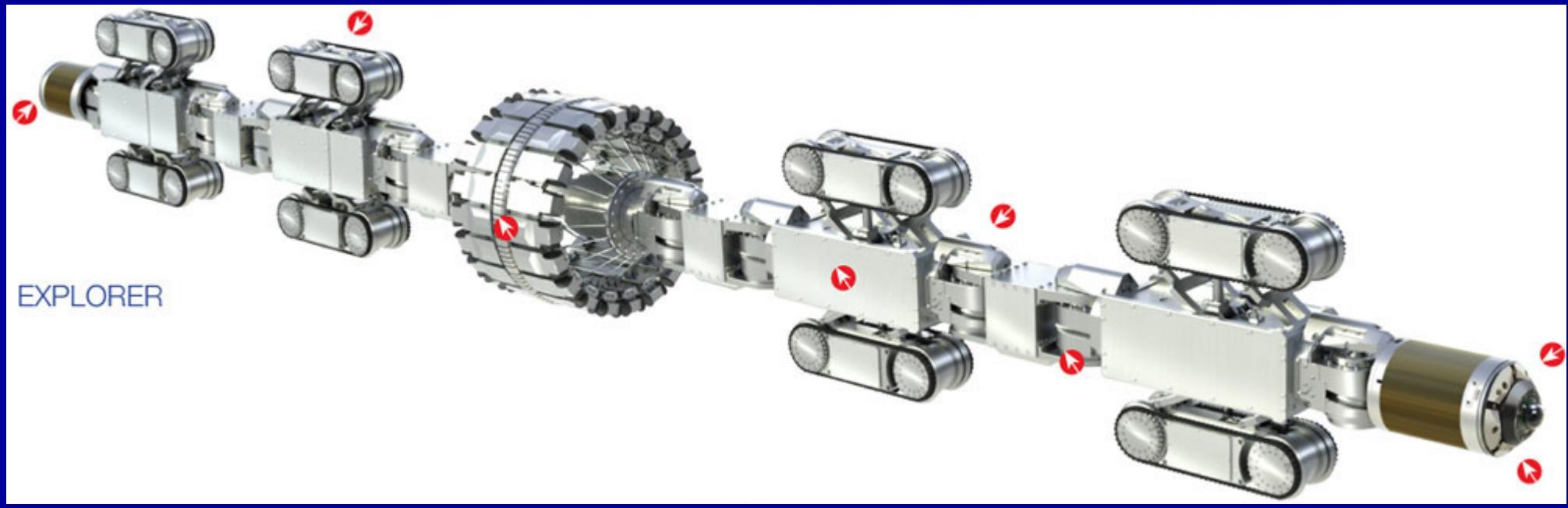
NYSEARCH/Northeast Gas Association

Overall Goals

- Develop technologies for anomaly detection and characterization in unpiggable natural gas pipelines (crossing over to piggables)
  - Use Invodane/Pipetel Technologies Explorer (X) family of robotic systems as the platform for deployment of technologies; developed with PHMSA cofunding since 2004
- Present Priorities: Crack detection, operational efficiencies, material characterization
- Emerging Priorities: Hybrid systems, autonomous systems, plastic pipe in-situ inspection

Platforms

- Explorer 6
- Explorer 10/14
- Explorer 20/26
- Explorer 8
- Explorer 16/18
- Explorer 30/36



Sensors

- RFEC sensor for 1G X6 & 8
- Axial MFL for X6, X8, X10/14, X16/18, X20/26 & X30/36
- Crack sensors
  - Global TMFL/EMAT for X20/26
  - Global EC for X8
  - Seam-weld TMFL/EMAT sensor for X20/26
- Optical Mechanical Damage sensor for X6, X8, X10/14, X16/18, X20/26 & X30/36
- Axial MFL sensor for bends inspection for X20/26
- Hardness tester for materials characterization for X20/26

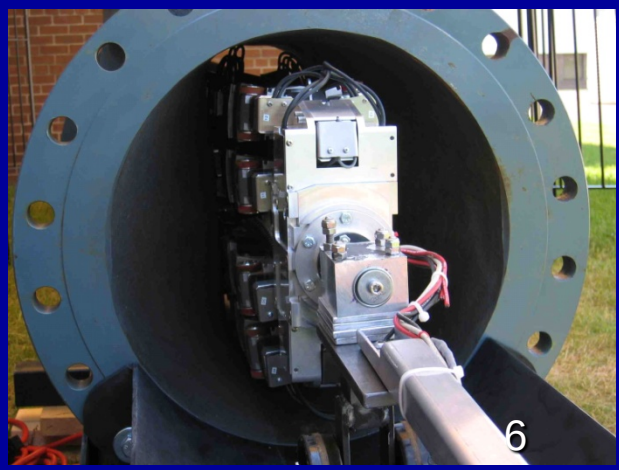
Yellow: commercial, green: under development (available by end of 2017)

Axial MFL Sensor

- Launched, operated and retrieved under live conditions; one pass inspection
- Able to negotiate short radius bends, mitered bend, vertical/inclined segments, plug valves (X20/26 and X30/36)
- Shunting of magnets for feature negotiation
- Bi-directional operation

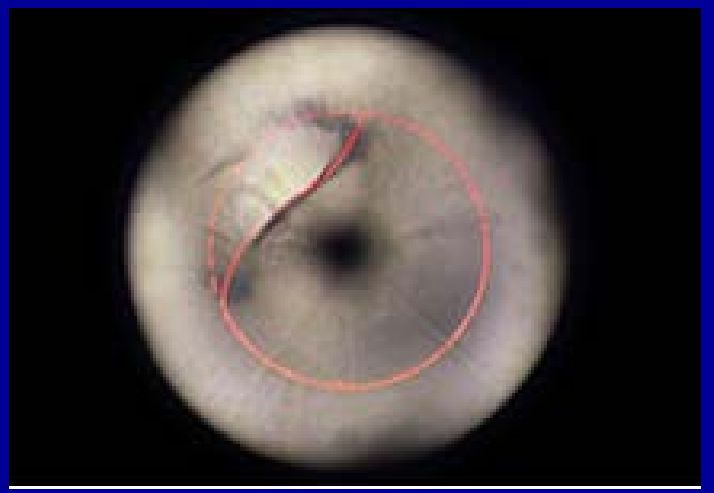
Axial MFL Sensor (continued)

- Successfully deployed hundreds of times over last 5 years.
- Detection capabilities as other state of the art axial MFL tools
- Commercially available through Pipetel on X8, X10/14, X16/18, X20/26 and X30/36



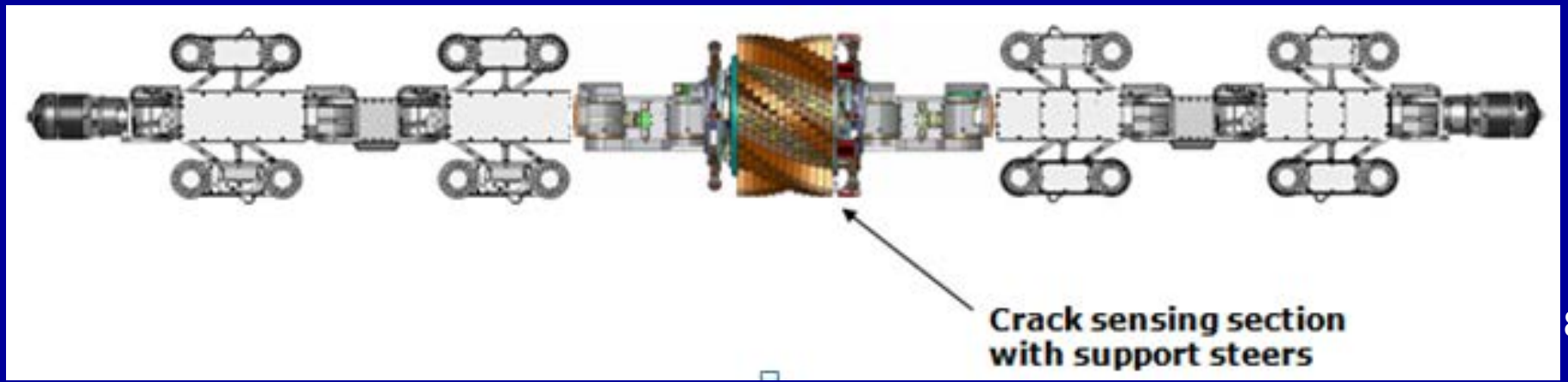
LDS Mechanical Damage Sensor

- Laser based system for detection of dents and ovality
  - Laser system on camera module illuminates the pipe
  - Three high resolution cameras on modified camera module provide the imaging
  - Full 3-D resolution of dents at 25 frames/sec
- Commercially available on all Explore robots



TMFL/EMAT Crack Sensor

- Able to detect cracks and defects in seam welds and base material
- Combination of transverse MFL and EMAT
- Able to negotiate features as axial tool (no plug valve)
- One-pass inspection; single sensor module
- Requires separate run for axial MFL tool
- Due to size, applicable to ≥16” pipes
- To become commercially available on X20/26 in 2017

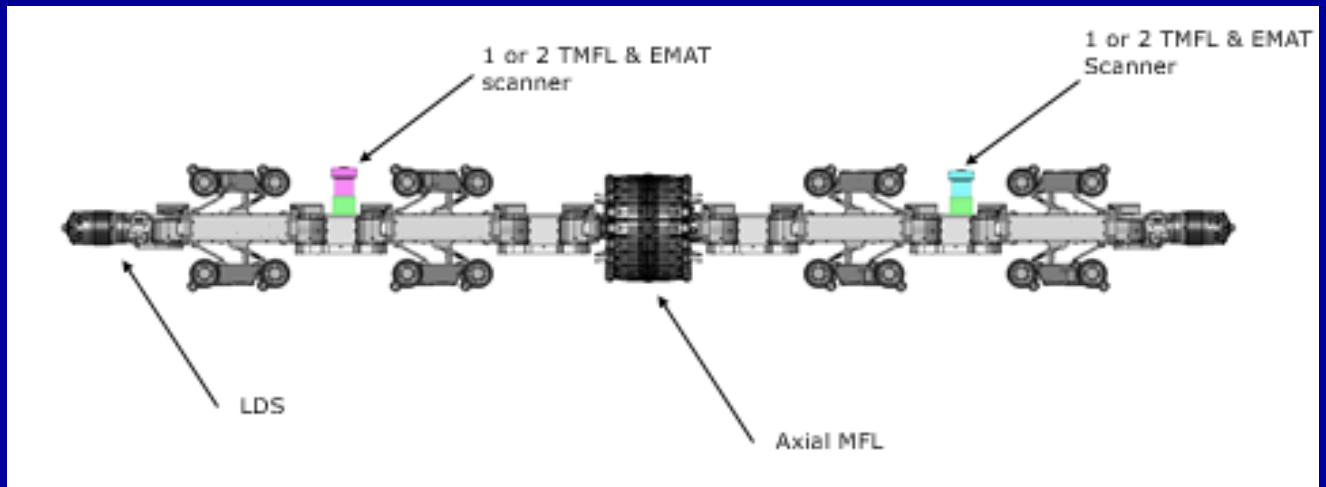


AMR EC Crack Sensor

- Eddy Current based crack sensor (RMD Inc.); single module
- Crack detection in seam welds and base material; originally developed for aircraft inspection
- Requires separate run for axial MFL sensor
- Light and low power consuming; applicable to all pipe sizes
  - Limited to thinner walls
- To become commercially available on X8 in early 2018

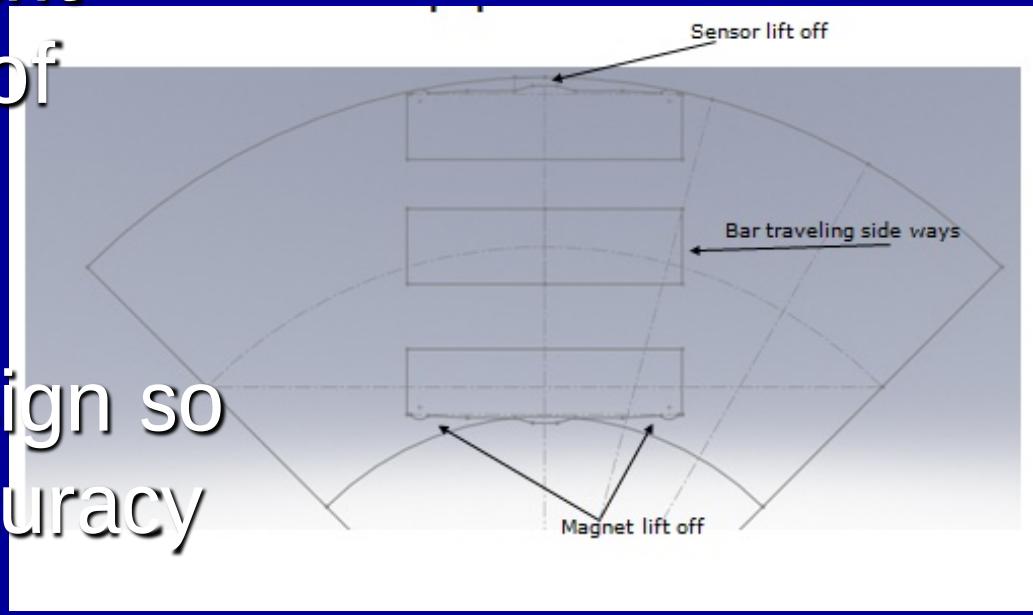
Seam Weld Crack Sensor

- Combination TMFL and EMAT sensor
- Crack detection in seam welds only
  - Sensor probe on steer module
- Run with the axial MFL sensor
  - Allows corrosion and seam weld crack inspection in one run!
- To become commercially available on X20/26 at the end of 2017



Axial MFL Sensor for Bends Inspection

- MFL sensors have inherent limitations in inspecting of bends due to physical constraints
- Modified MFL sensor design so it can provide higher accuracy and detectability
- Commercially available on X20/26; to be commercially available in other Explorer robots over the next two years.



Hardness Tester for Materials Characterization

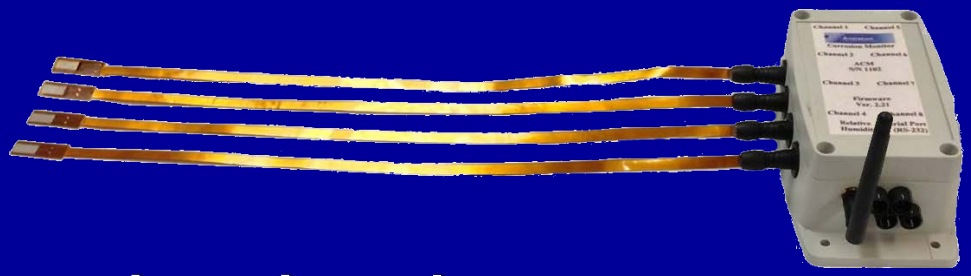
- Develop a hardness testing sensor module to allow materials characterization of pipelines
  - CRTD Vol. 91 provides detailed instructions on how to apply hardness testing to piping in the field using portable hardness testers; reference point is Rockwell B laboratory testing
  - Meet standards for portable devices
- Operated as other Explorer sensors
- System concept:
  - Anchor at area of measurement
  - Prepare surface as needed
  - Carry out multiple measurements at each location
  - Live data processing for data quality determination

Hardness Tester for Materials Characterization (continued)

- Successfully tested in the field in 9/2016
- Allows multiple point measurements of hardness in live pipeline from a single access point
- To be commercially available on X20/26 in early 2017

Corrosion Sensor Array

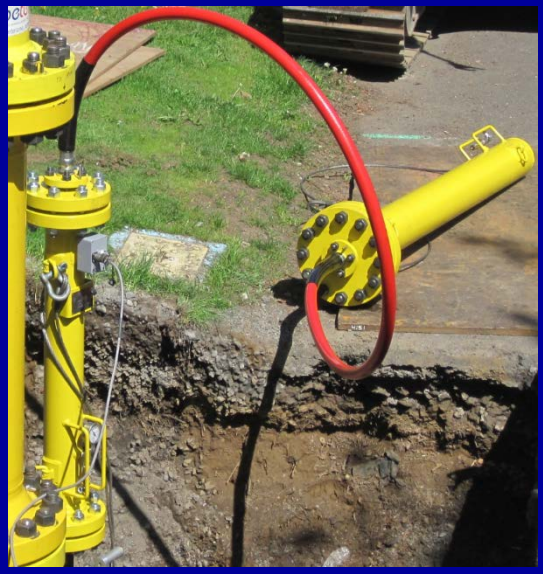
- A real time, validated, structural health monitoring system originally developed for aerospace applications; Analatom Inc., Sunnyvale, CA
- Electrochemical technique; measures corrosion current; very sensitive; measures corrosion at earliest stages
- Type of Corrosion
  - General corrosion – Mass Loss / Surface Loss
  - Inter-granular corrosion
  - Pitting and crevice corrosion
  - Galvanic corrosion



- Pre-commercial system under development
  - Field testing in 2017

Technologies for Enhancing Explorer Operations

- In-line battery recharging
  - Implemented in all Explorer robots
- Unpiggable pipeline cleaning tool
  - Able to remove heavy debris and some liquids in unpiggable pipelines
  - Commercially available on X20/26



THANK YOU

Inquiries to gvradis@northeastgas.org