The University of Texas at Austin
Center for Electromechanics

2016 ADVISORY PANEL
OIL AND GAS

Ray Zowarka
Center for Electromechanics
The University of Texas at Austin
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Applying Electromechanics to the Oil and Gas Fields

- Some existing technologies have run out of steam LITERALLY
- The Navy for many decades has launched aircraft with steam and the technology had reached its limit. The new carrier CVN 78 uses linear induction motor actuators to launch aircraft to fill a need of launching heavier aircraft more efficiently.
- Similarly oil exploration using the vibroseis technique has used hydraulic actuators for many decades to launch waves into the ground. The technology is mature and improvements are incremental at best. Electromechanical actuators provide more force, fidelity and wider frequency band than its predecessor

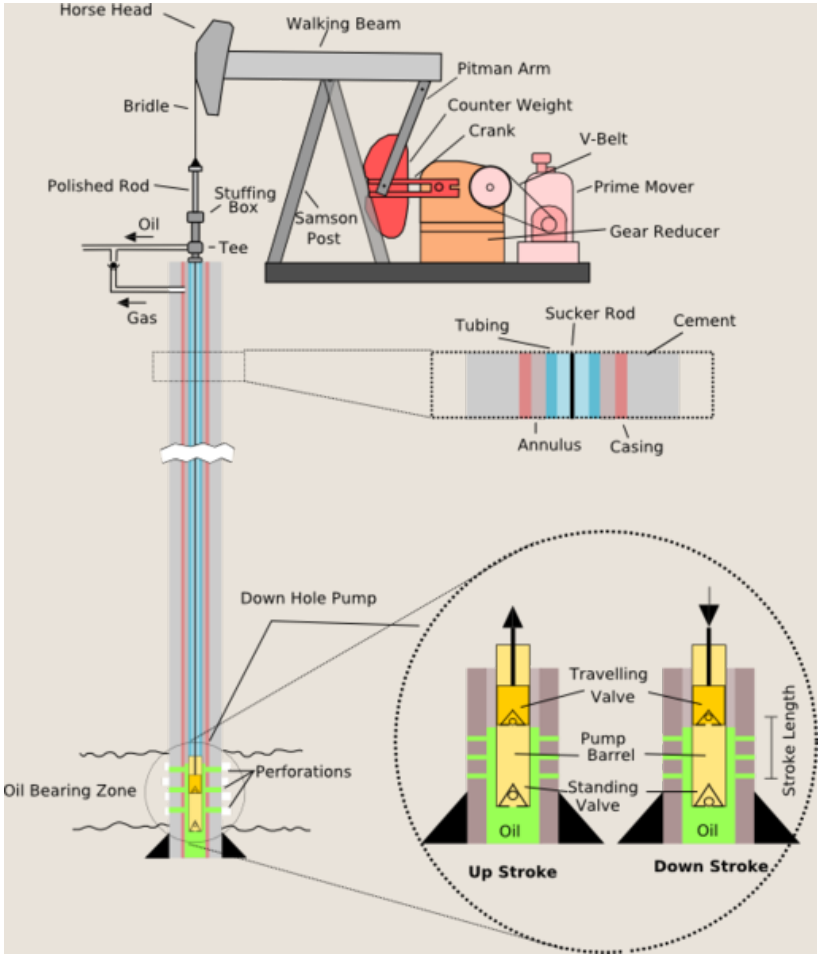
video

EMV operating at 4 Hz frequency

Paraffin Control

- In some oil fields oil recovery is plagued with paraffin formation
- Current techniques use hot oiling to clear paraffin from wells. This is repeated every few months
- Not only is the production time lost in applying the hot oil to the well but the production diminishes between applications.
- Formations damage is caused by hot oiling also reducing well production

Paraffin Deposition is Major Concern and Operating Cost in Oil Wells Worldwide



http://micro-bac.com

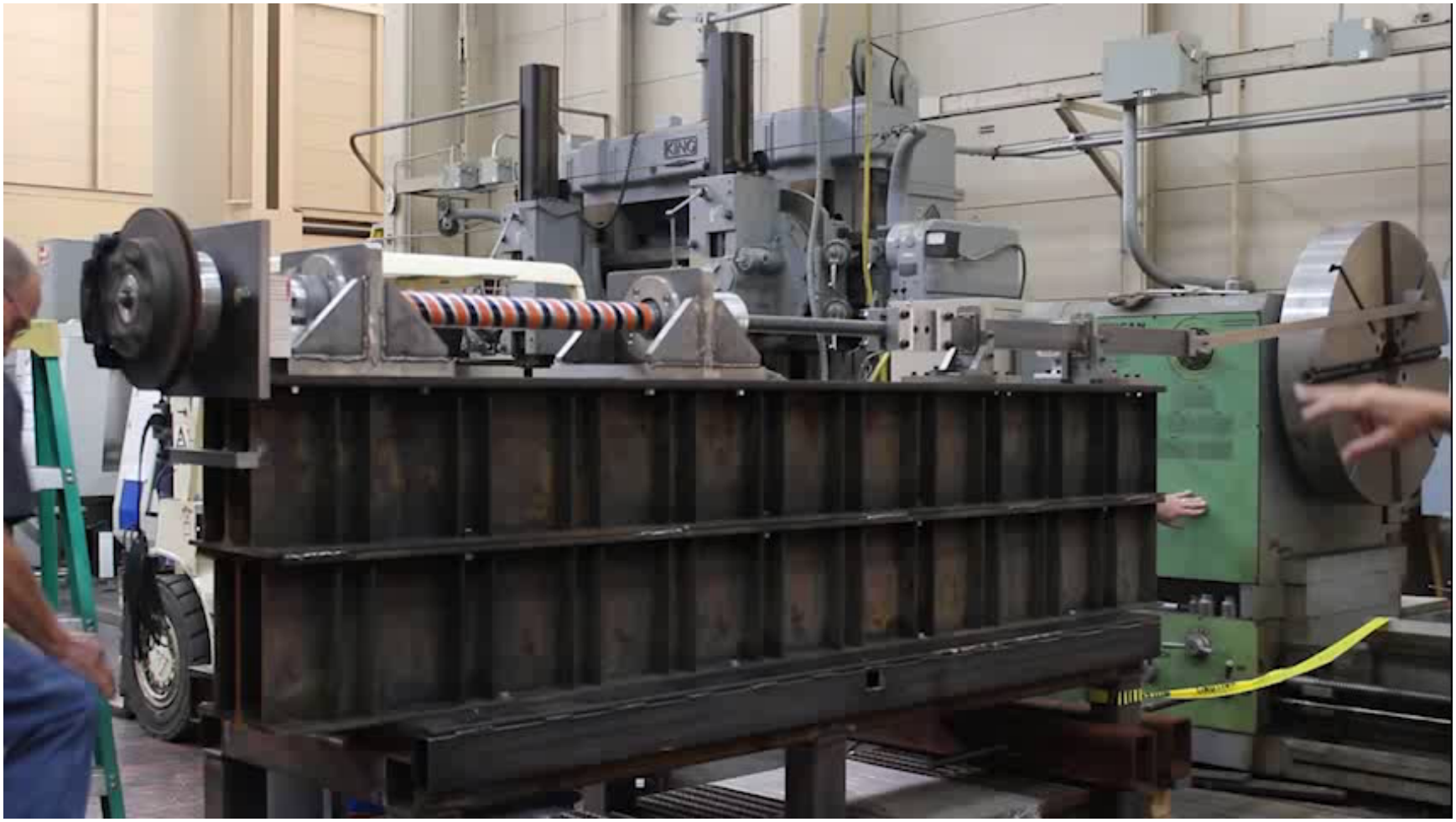
http://www.chemiphase.co.uk

http://en.wikipedia.org/wiki/Pumpjack

Paraffin (cont.)

- Our method uses the power from the primary driver in an artificial lift system (pump jack) to generate heat downhole at the location where the paraffin is forming.
- The heat generation is done using a novel electromagnetic induction heating element that seamlessly integrates into the tubing and pump jack system.

Paraffin video



Homopolar welding of pipeline

- Stick welding is time consuming
- It introduces a heat affected zone in high performance steel that can be non desirable
- Homopolar welding is a solid state resistance welding process that is very rapid, 1 to 2 seconds
- The heat affected zone is small
- The process can be automated

Homopolar Welding video

Artificial lift pumping speed

- Nominal artificial lift parameters are 100” stroke at 6 strokes per minute.
- This is equivalent to an average velocity of 0.5 m/s and a peak velocity of 0.8 m/s (2.6 ft/s)
- Program goal: Perform experiments to evaluate fundamental limit of pumping speed

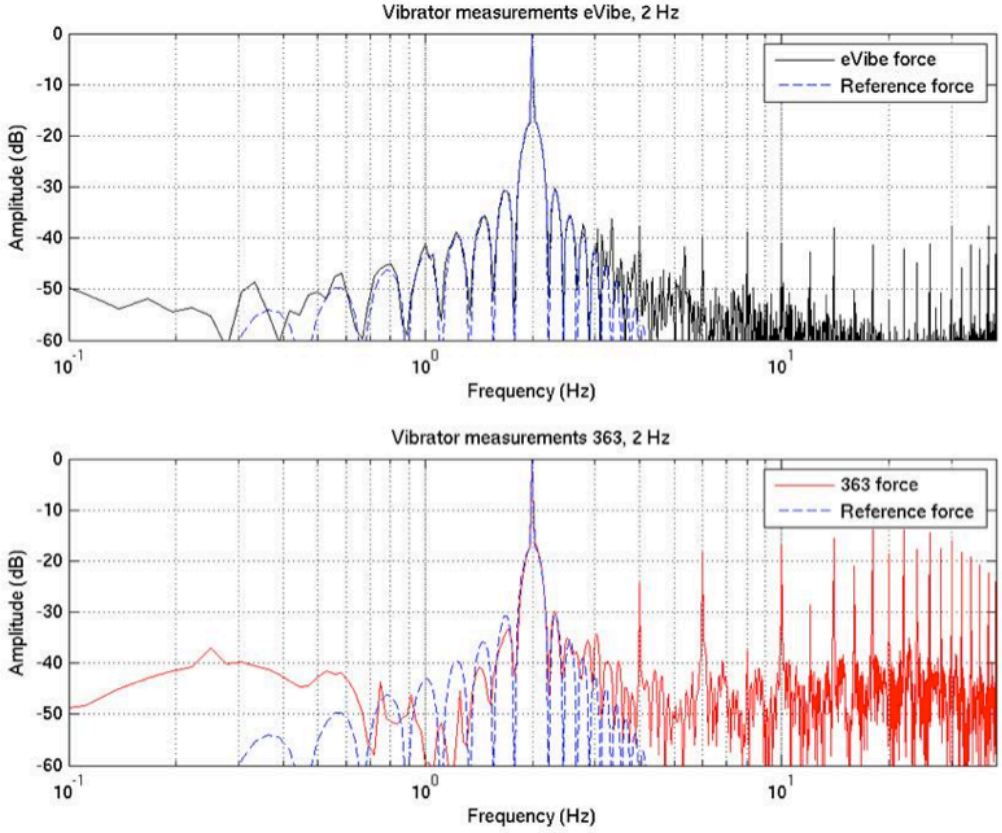
Vibroseis Truck

The EMV was put on a mobile vehicle to take to the field in an evaluation against existing technology

The Electromagnetic Vibrator

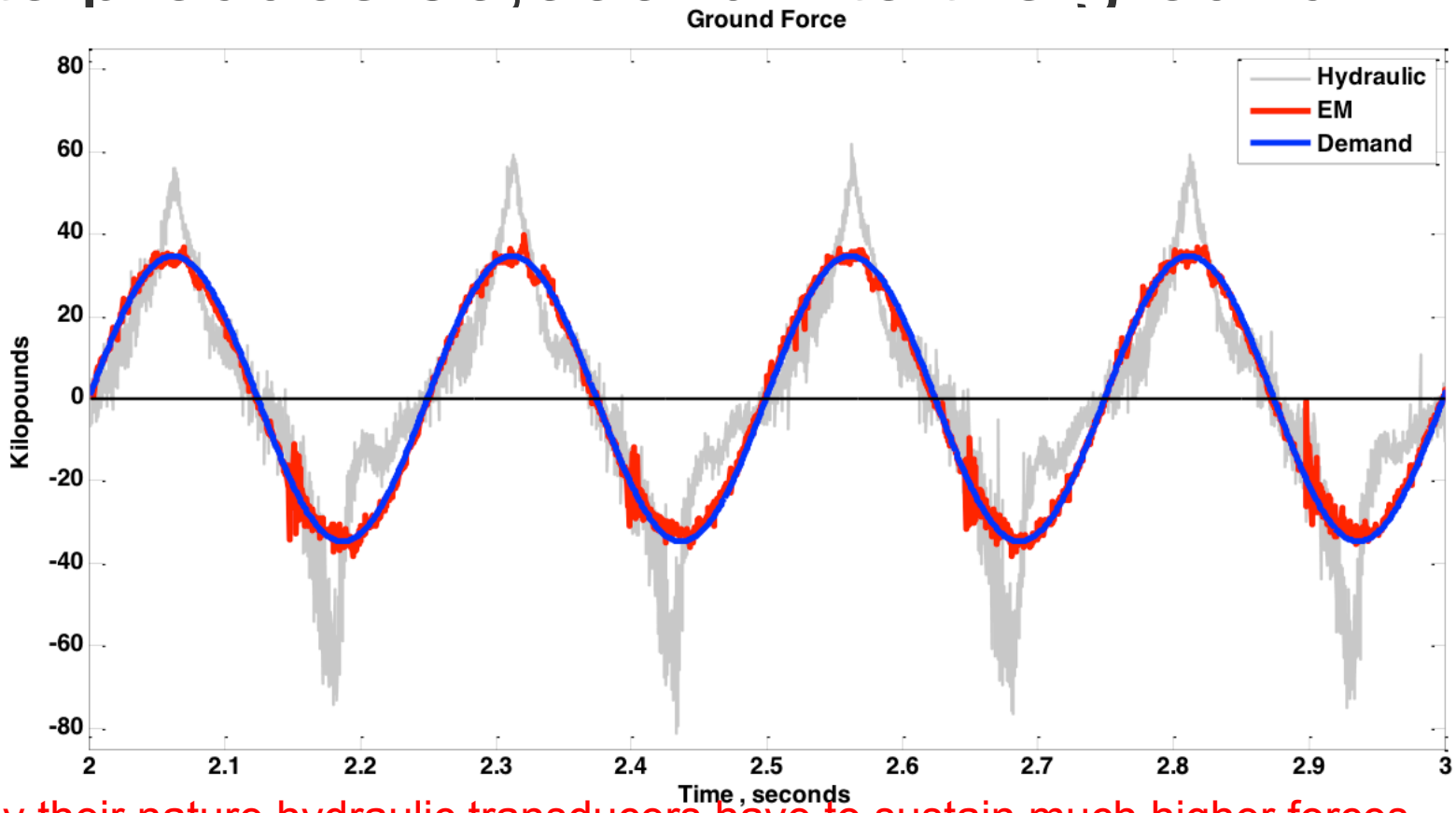
The transducer is a 17,000 lb mass that is levitated and shaken magnetically

Comparison of fidelity of e-vibe and hydraulic vibe at 2 Hz



THD for e-vibe 3% as opposed to 30% for hydraulic vibe

Due to high harmonic content the hydraulic vibe has to peak at 60,000 lb to produce 30,000 lb into the ground



By their nature hydraulic transducers have to sustain much higher forces to propagate fundamental frequency into ground

Paraffin heater

Preventive: The method prevents paraffin from forming. It is much harder to remove paraffin once it is formed.

Efficient: The heating is provided at the location where it is needed. The entire wellbore is not heated.

Simple and non invasive: No electrical wires.
Integrates with existing hardware: Can be screwed into the tubing and the sucker rods.

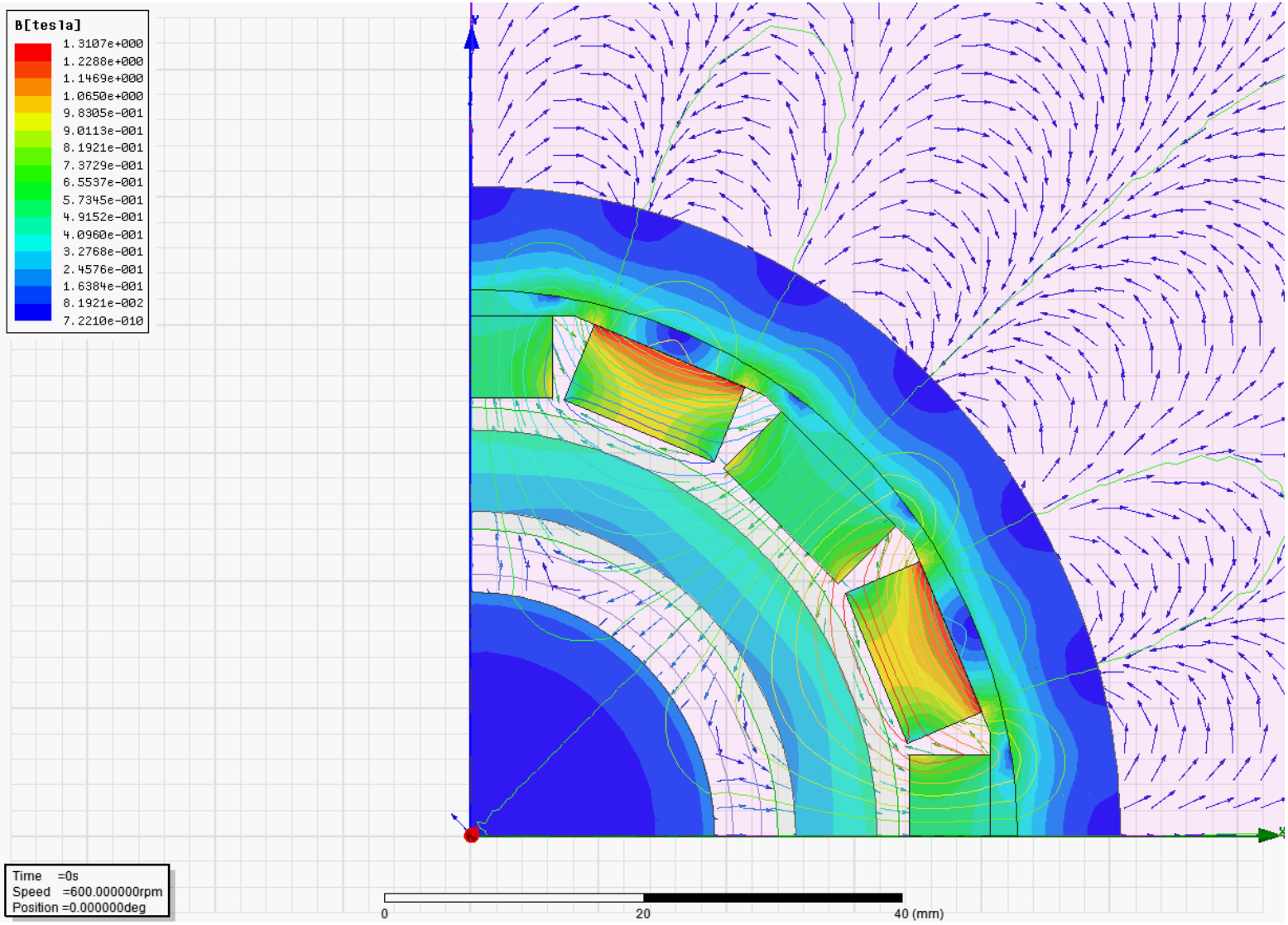
Inexpensive: The incremental cost of the tool is relatively small.

Long life: The device can be replaced or repaired only when the tubing is pulled for a routine maintenance or a workover.

Summary of Current Status

- A prototype device that prevents the formation of paraffin in oil wells has been built and tested.
- The device readily integrates into the existing pump jack hardware without interfering with normal operations.
- The EM and mechanical aspects of the device have been demonstrated in the laboratory
- A provisional patent has been filed on the invention

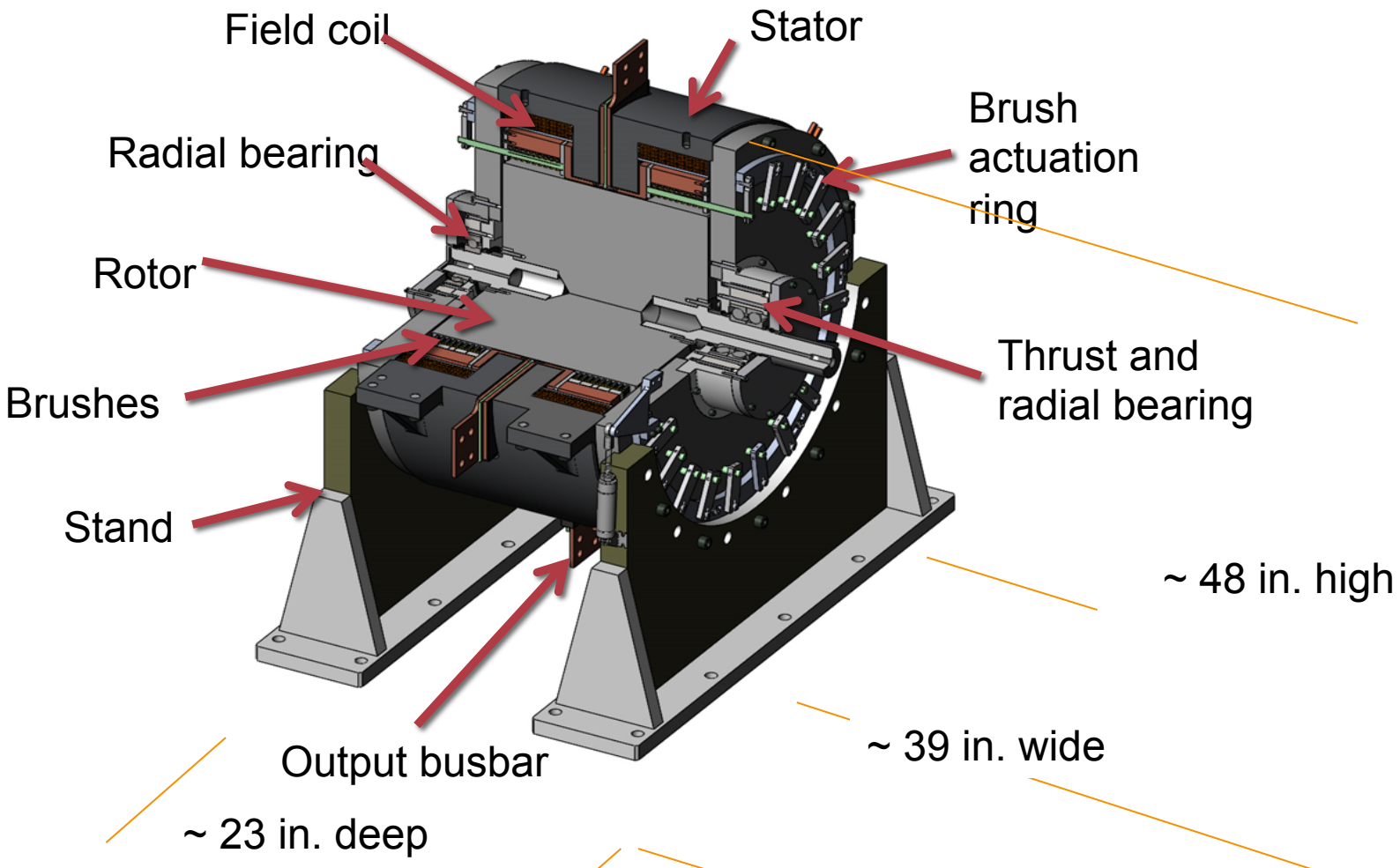
Animation (click on image)



Homopolar Welding

- Current contract involves welding bridge girders for the Department of Transportation
- Past contracts have involved welding oil and gas pipeline, boiling water reactor pipes, heat exchanger tubing
- Other spin off technologies enabled by the pulsed energy store include sintering, billet heating and spot welding

Cross section of Subscale HPG identifying machine components



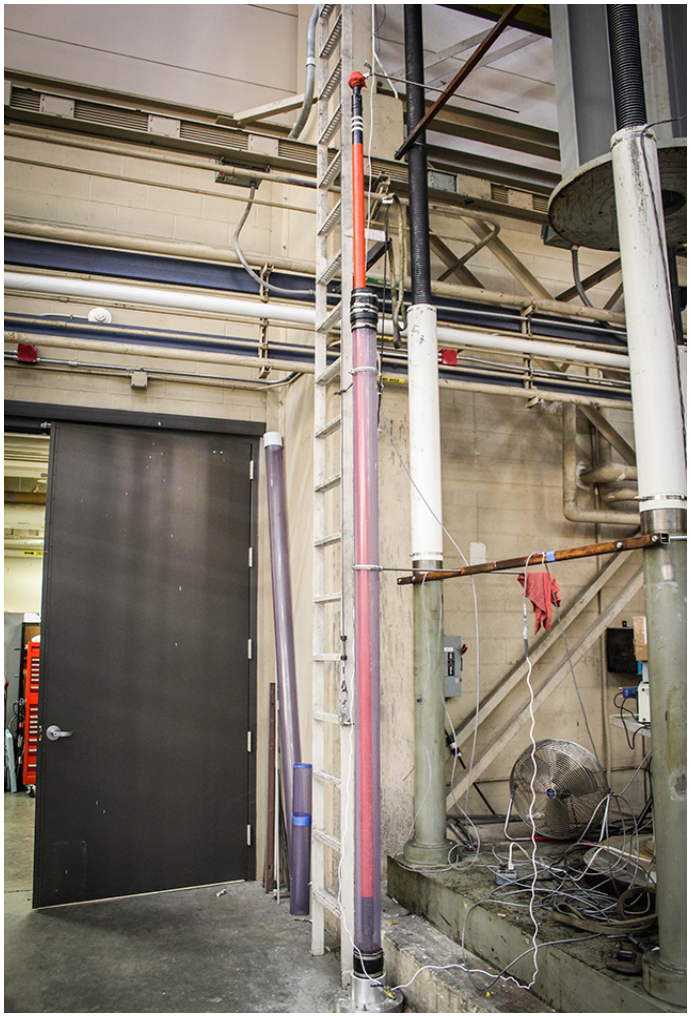
Use advancements in rotating machinery over the last 30 years to realize a low cost HPG with commercialization potential

Industry Day 4/27/16

- Brief the Subscale HPG design to industry and determine if there is interest in commercializing the technology
- Give bridge industry an introduction to the technology
- Give the potential HPG manufacturers process control steps
  - Invite them to send an engineer or technician to witness and document future machine assembly
- Give companies that have expressed an interest in HPG technology insight into the progress to date

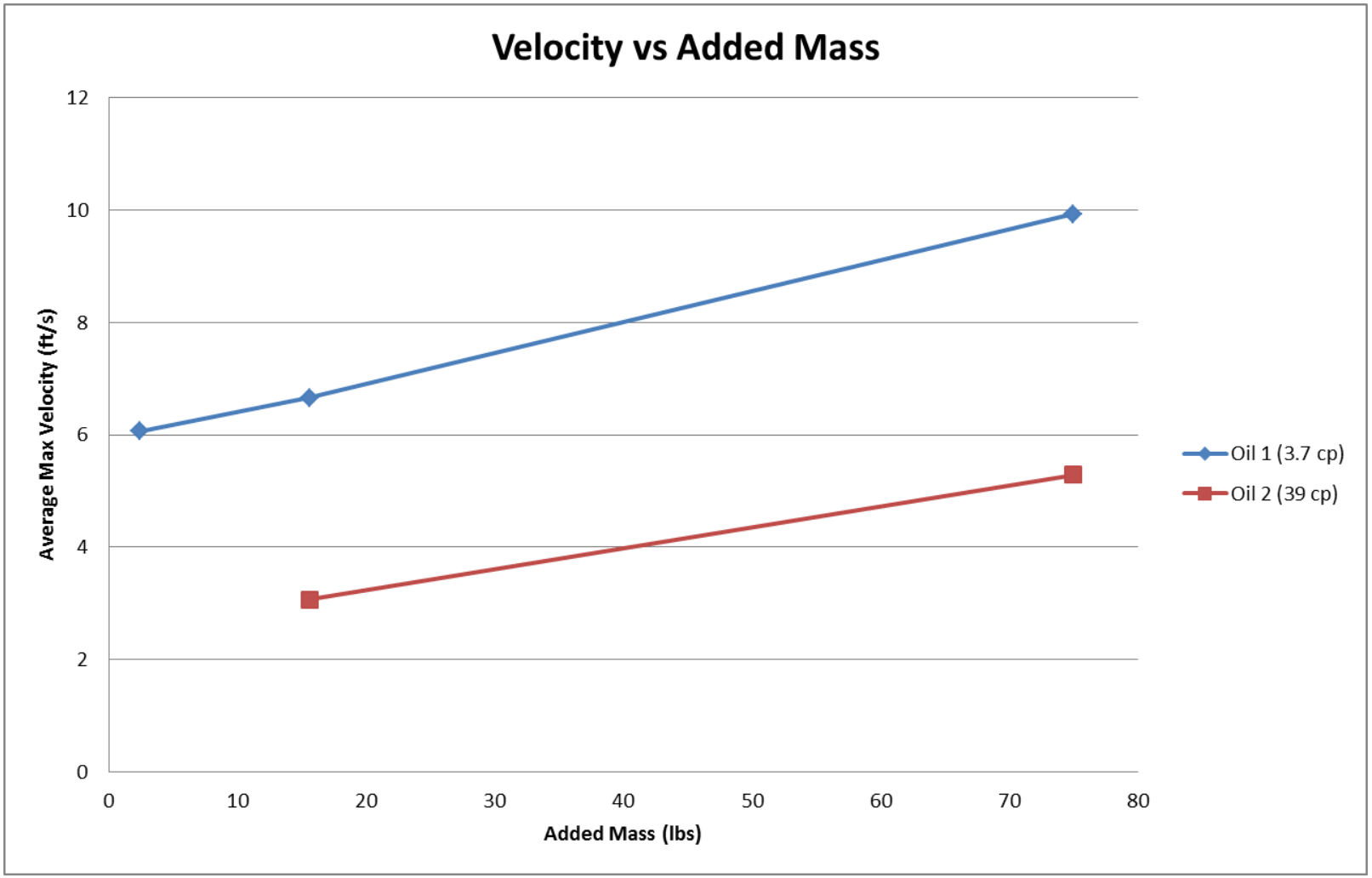
Use the subscale HPG to produce weld coupons for evaluation by the DOT

Pumping speed



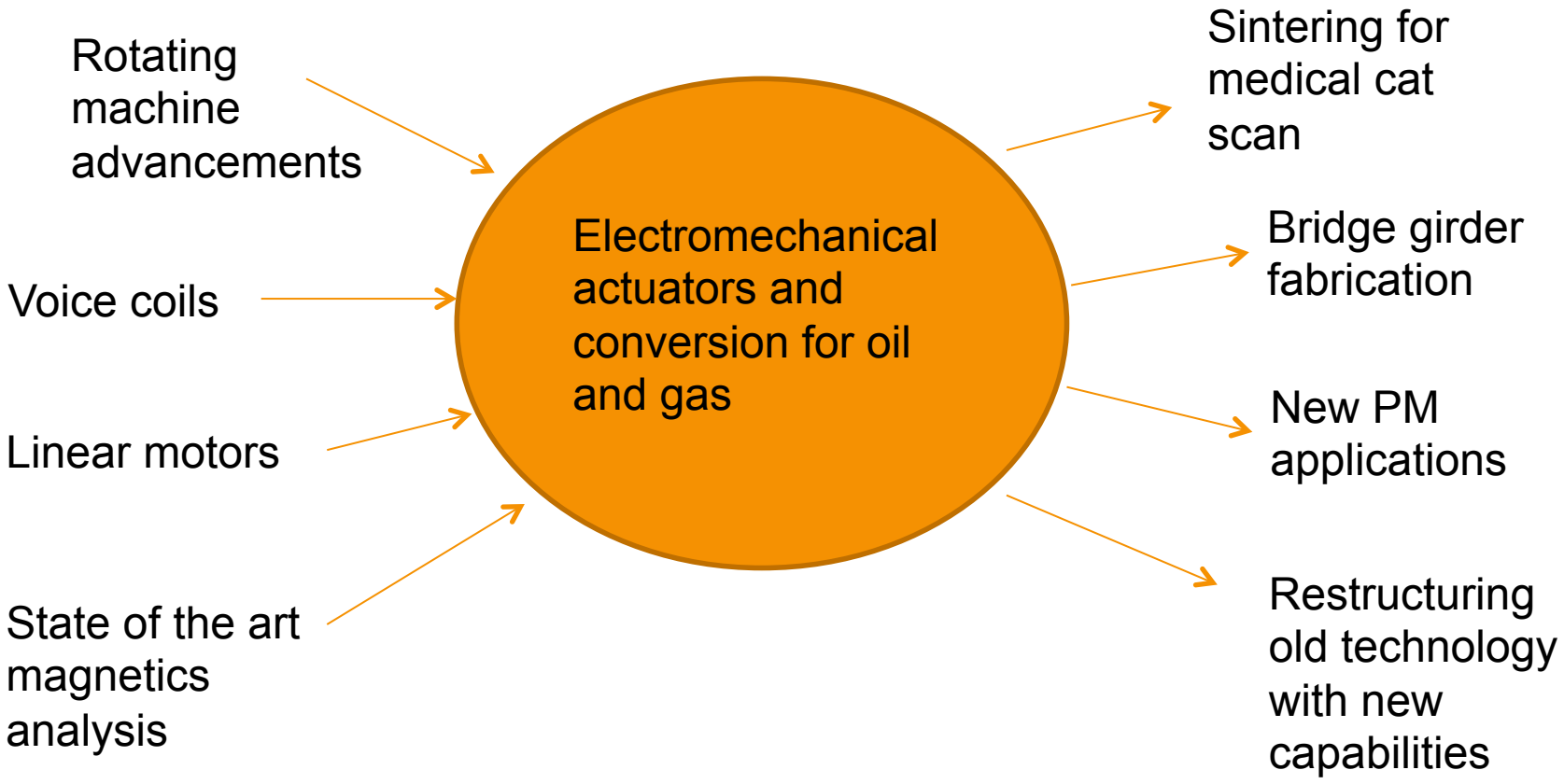
The lift pump was fitted into a surrogate oil well to collect velocity data

Test results – present pumping speed 2.6 ft/s



CEM built experimental equipment and assisted graduate student in collecting data. Petroleum Engineering will develop the rest of the story.

Technology is brought into the program and new technologies emerge



Future Work

- Continue to pursue linear motor actuator for vibroseis
- Commercialize HPG welding
- Commercialize Paraffin Heater – Next step is to install device in operational well in West Texas.
- Continue to pursue partnerships in research with Petroleum Engineering
- Recently received an ARPA-E grant to pursue GENSETS. A 1 kW home power unit utilizing a natural gas turbine and a high speed PM generator