

ELECTROMAGNETIC WELL LOGS SIMULATED WITH COMSOL® RF MODULE ON A CLUSTER

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*Drilling & Production Group HFE-EMS,
Schlumberger*

COMSOL
CONFERENCE
2014 BOSTON



Schlumberger

Author's Profile



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Masters in Computer Science, University of New Mexico
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Systems Program Manager



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Masters in Computational Science and Engineering, GATECH
3 years in Schlumberger, Software Engineer, Production Group

Octo

2

Agenda

- Project Overview and Background
- Project Scope and Problem Definition
- COMSOL model design
- Solution and Results
- Business Value and Benefits
- Conclusion and Acknowledgements



Project Overview and Background

October 15, 2014

4



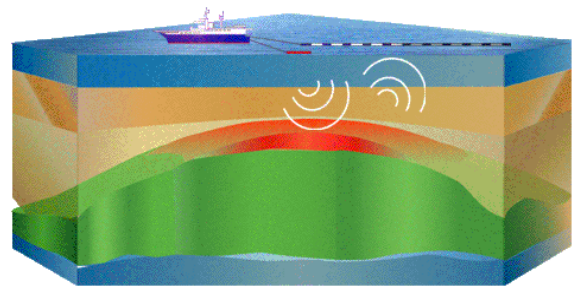
Schlumberger

Schlumberger - Oilfield Operation

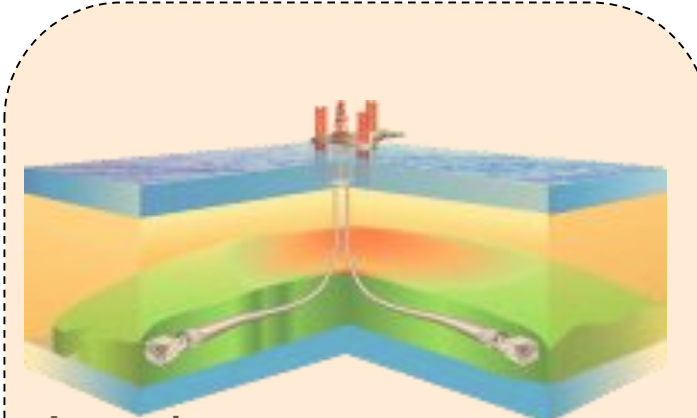
Houston Formation Evaluation



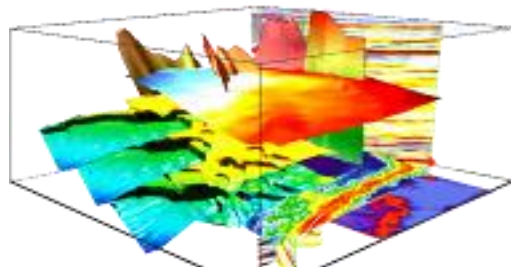
**Schlumberger Solutions:
Integrated Project Management**



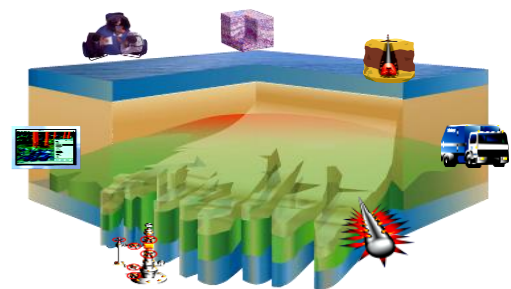
Defining: WesternGeco



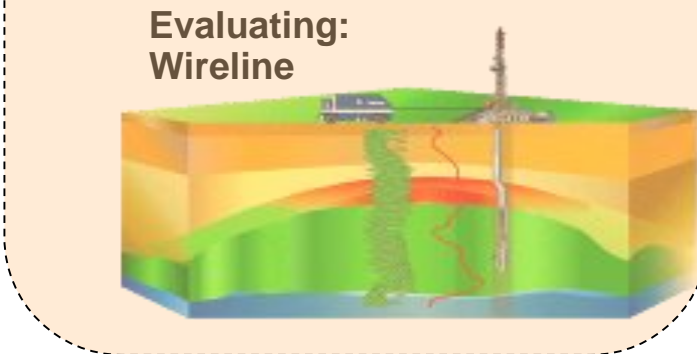
**Accessing:
Drilling & Measurements**



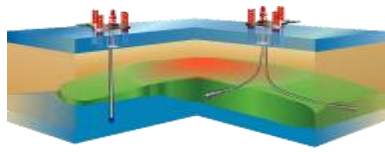
**The Digital Oilfield:
Schlumberger Information
Systems**



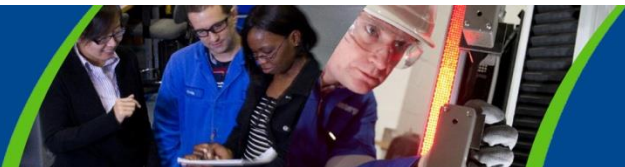
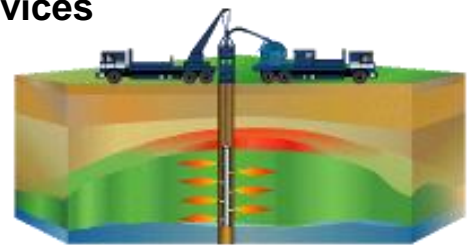
**Optimizing:
Well Services**



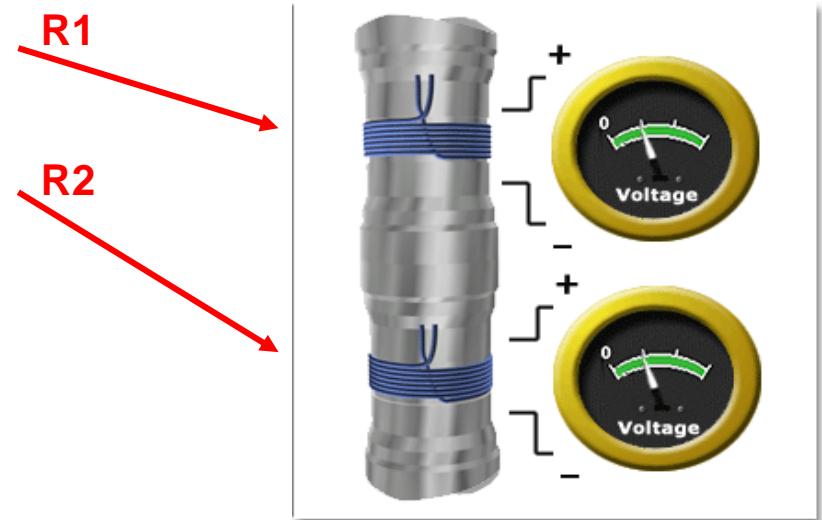
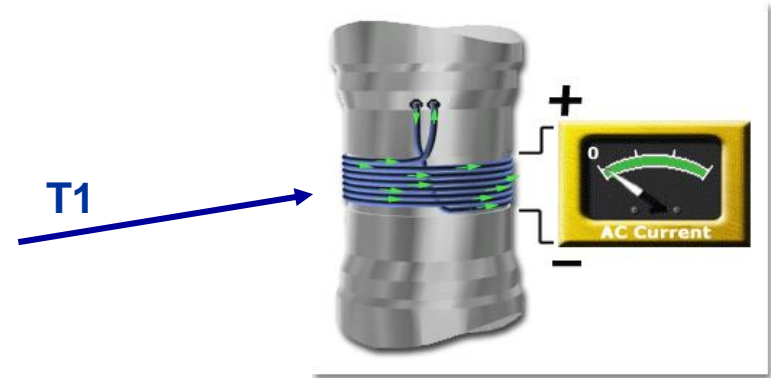
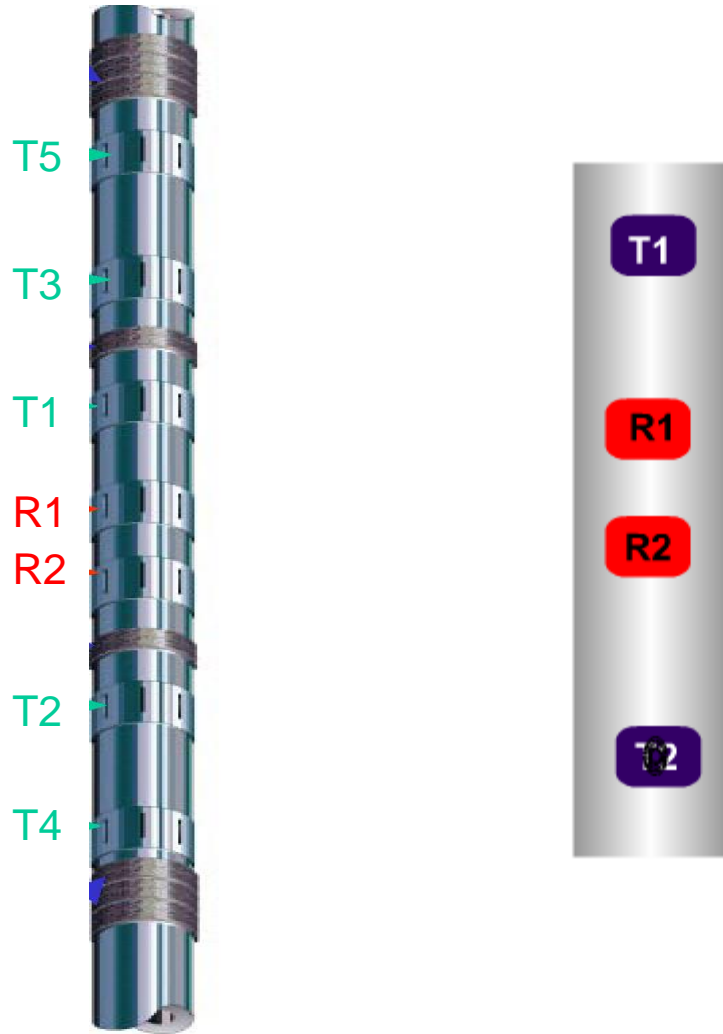
**Evaluating:
Wireline**



**Producing:
Well Completions &
Production,
Artificial Lift**



Electromagnetic Tool



Project Scope and Problem Definition

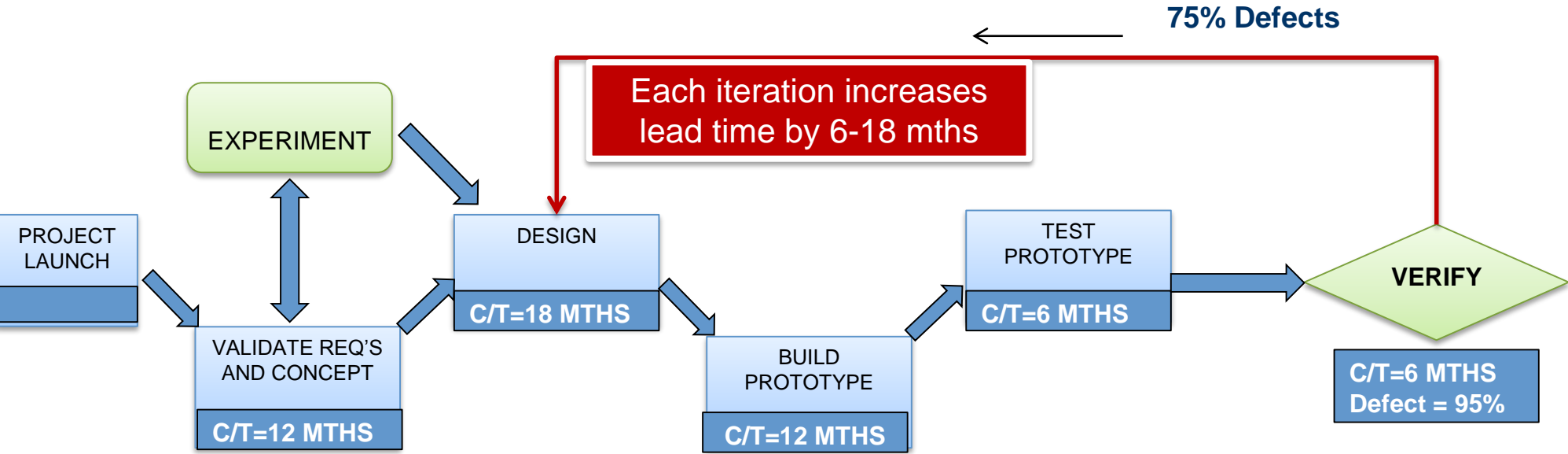
October 15, 2014

7

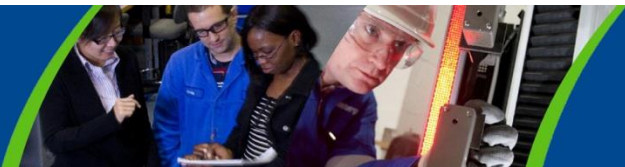


Schlumberger

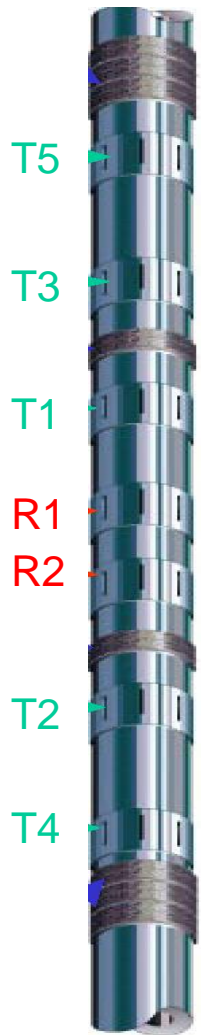
New Product Development Cycle



Total time to Commercialize from Engineering to Manufacturing ~ 6 years



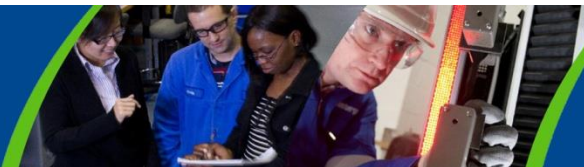
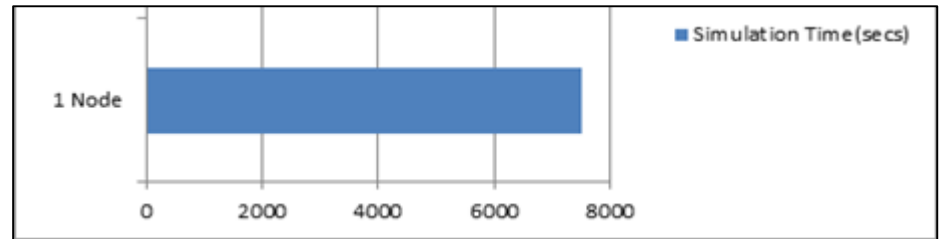
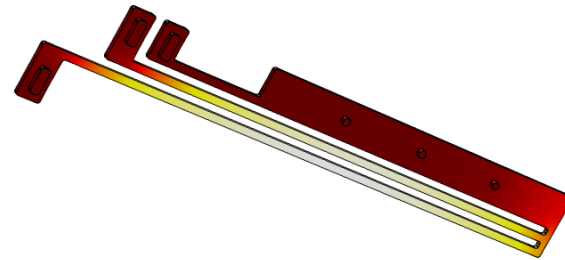
Identifying bottlenecks in the model



Day 1 {5,5.5...8}
 Day 2 {8.5,9...12}
 Day 3 {12.5,13...15}



PARAMETRIC SWEEP
 distance -T3 and T5
 range[5,15,0.5]



Modeling in COMSOL®

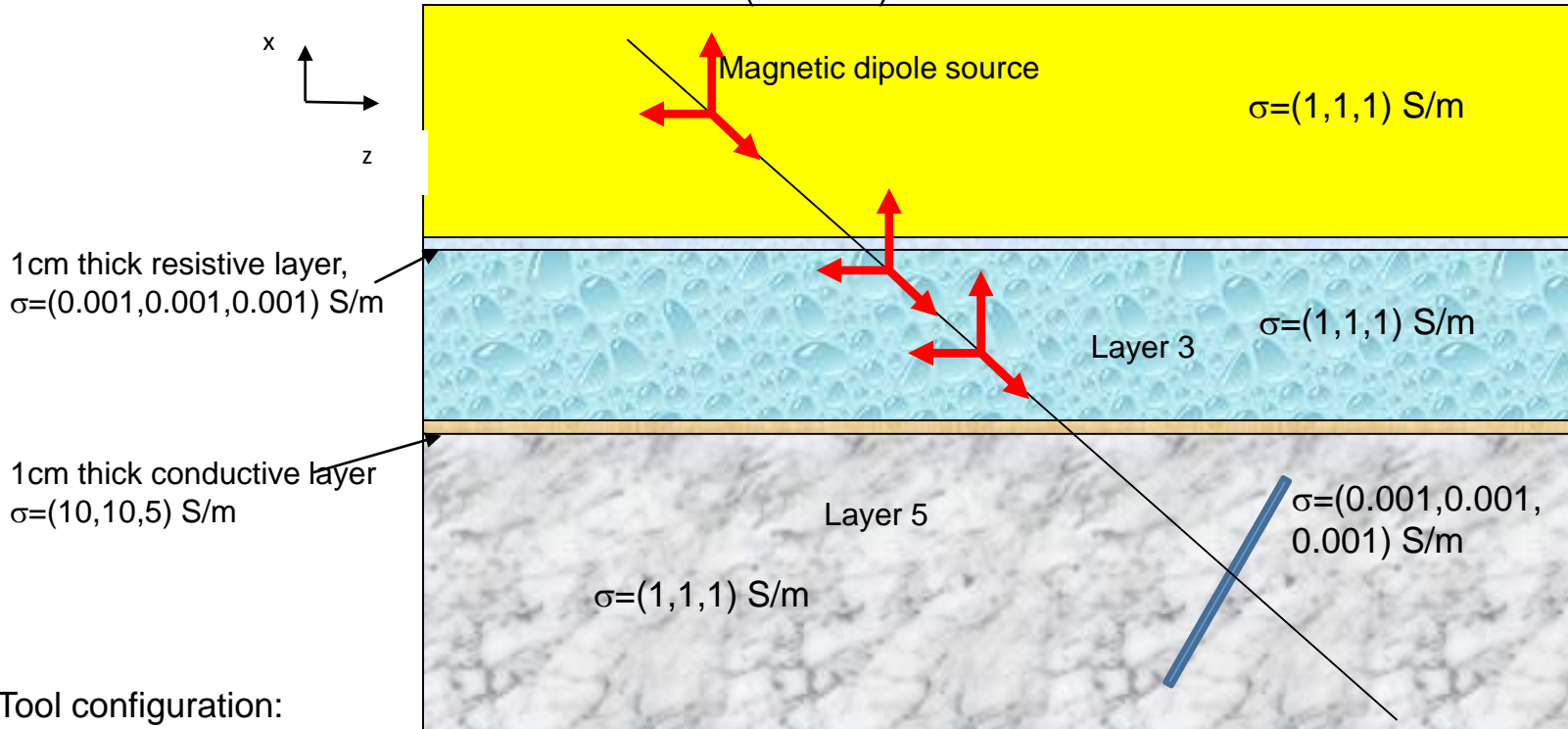
Courtesy – Tina , Gerald, Gong Li and Keli Sun

Senior Modeling Engineers and Research Scientist , HFE , Schlumberger



Fracture in layered formation: triaxial sensor response

1D 5 layer model contains one thin conductive and one resistive layer, with an additional finite size resistive fracture (0.1x1x2)m



Tool configuration:

Triaxial transmitter T and receiver R1 and R2

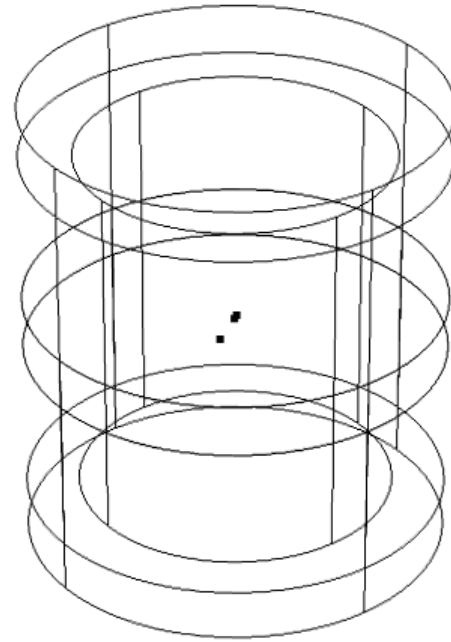
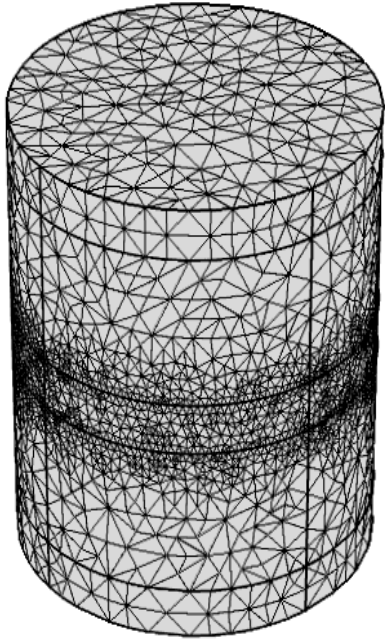
T at (0,0,0), R1 at (0,0,37"), R2 at (0,0,43")

Frequency: 100kHz, 2MHz

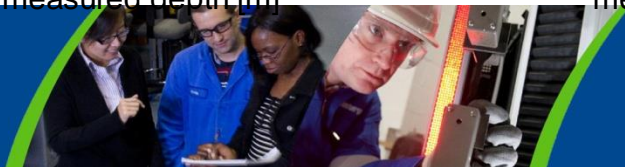
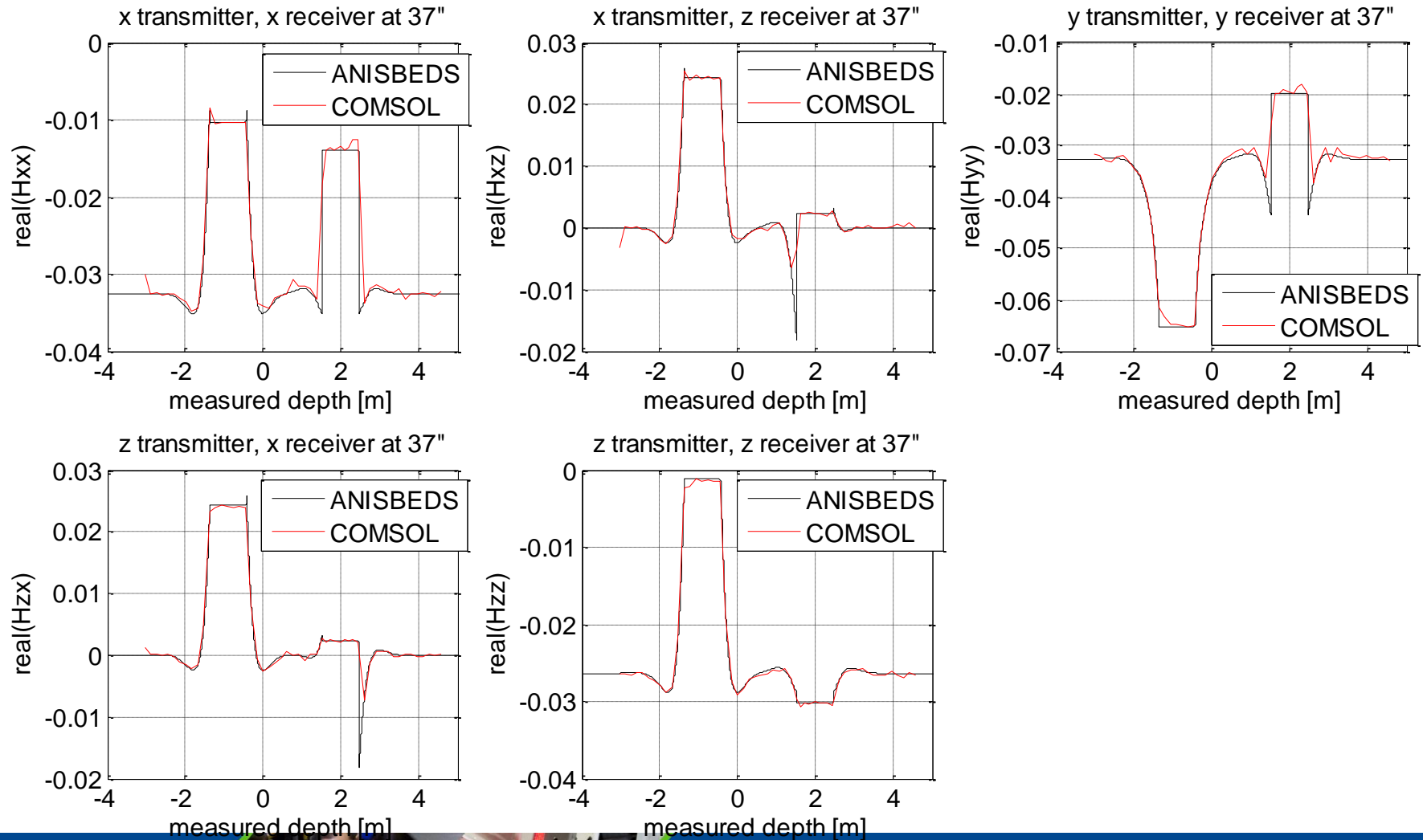
Well trajectory: 45 degree inclination straight line



3D Triaxial Model in COMSOL 4.3a



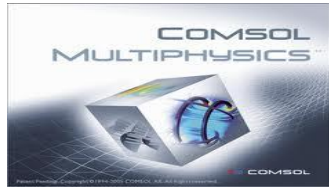
COMSOL modeling results compared with ANISBEDS (2 MHz) for benchmark example



Implement Comsol on Cluster 4.3b



2XCPU (Intel Sandybridge)[each 10 cores] so total 20 cores. 96GB RAM, 1.2TB local scratch space[hard drive], 1GbEthernet connection/Infiniband



Attended WORKSHOP

Negotiated and Acquired CLUSTER LICENSE

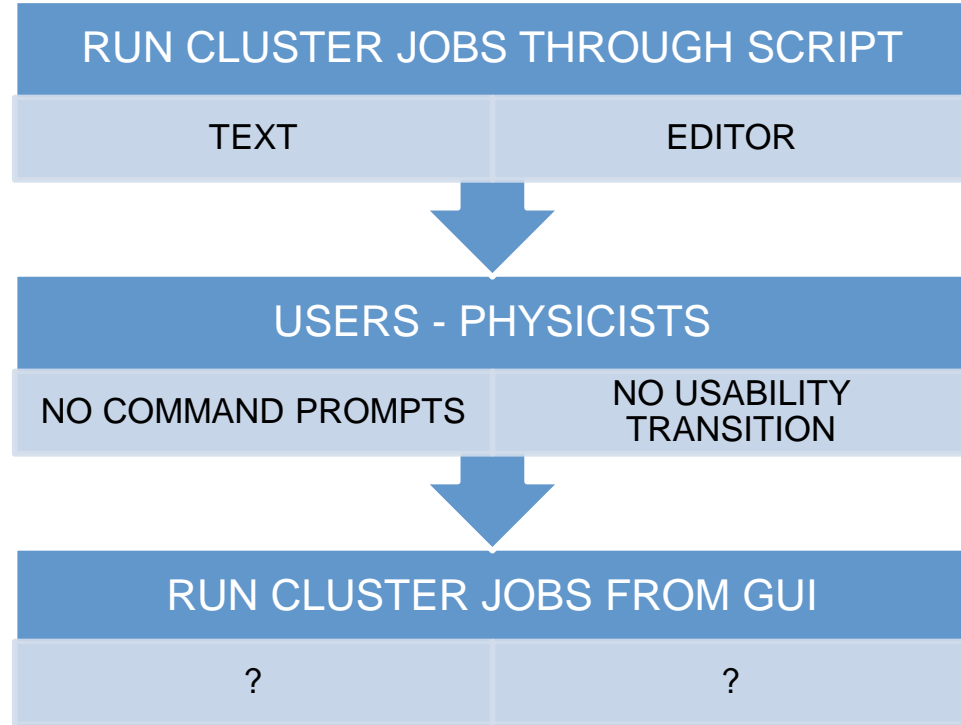
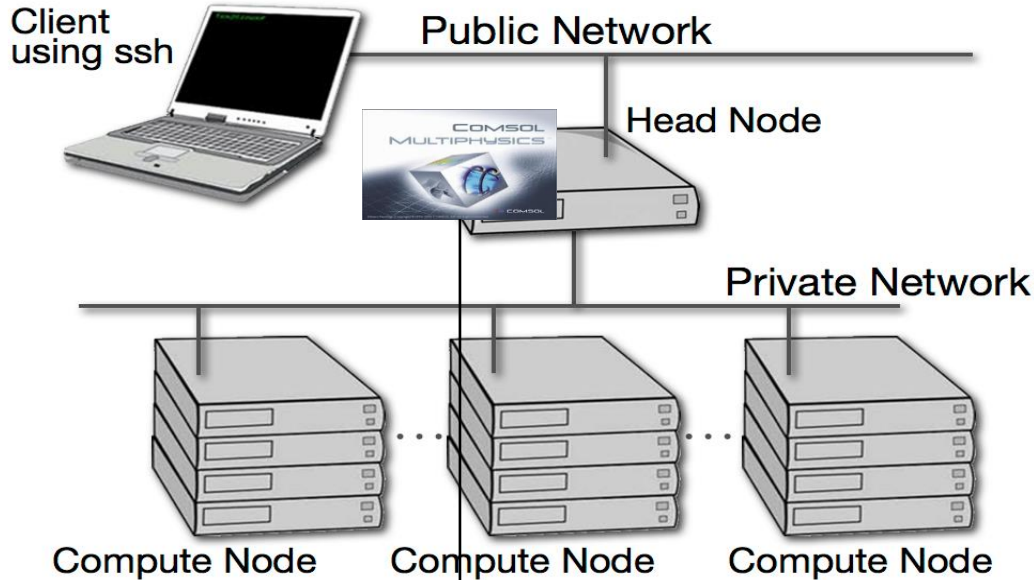
Deployed Comsol on cluster CLUSTER ADMIN



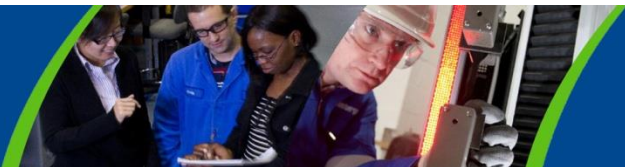
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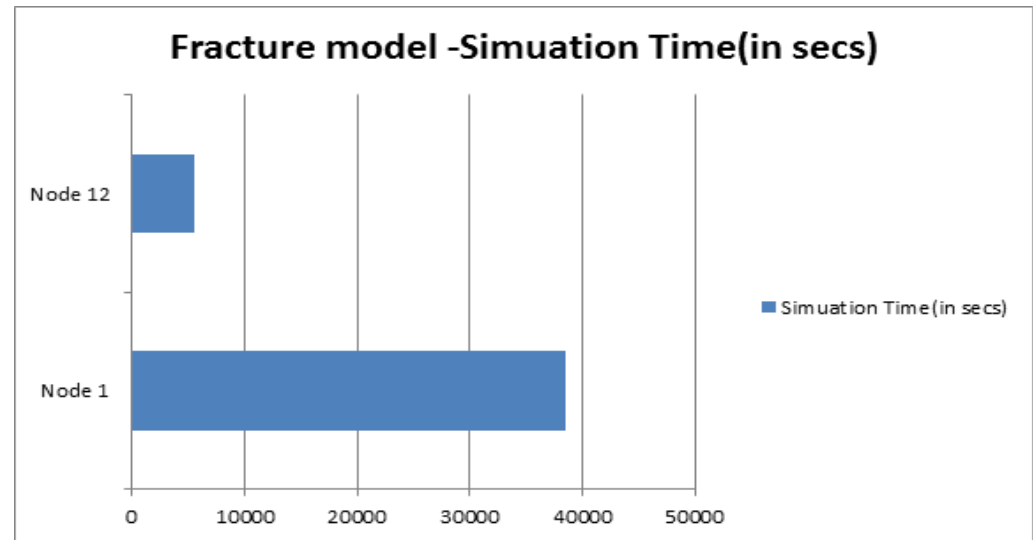
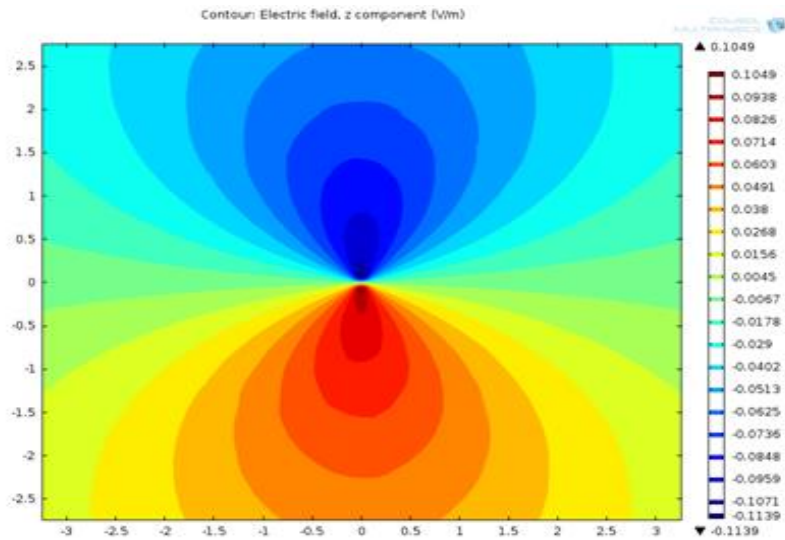
Best Practice for running COMSOL



Wrapper script –GUI invokes the scheduler on cluster



Results - Benchmark Model



Model Size : 4,999,804 Degrees of Freedom

Memory : 33 GB/28GB

Solver : Linear

Parametric

Sweep : direction[1,2,3]

depth measured – 12 points

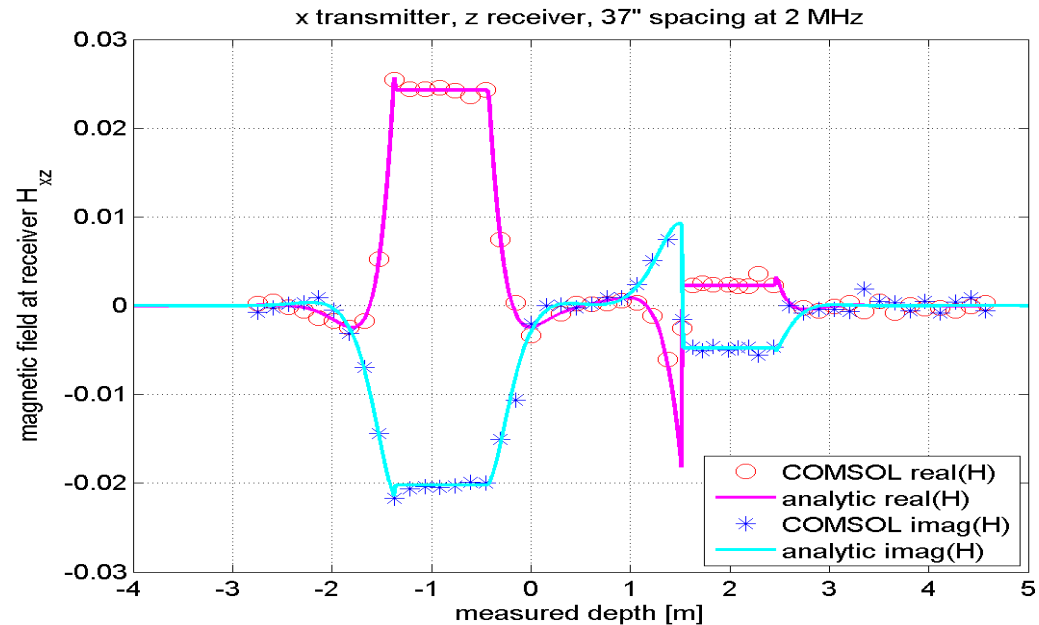
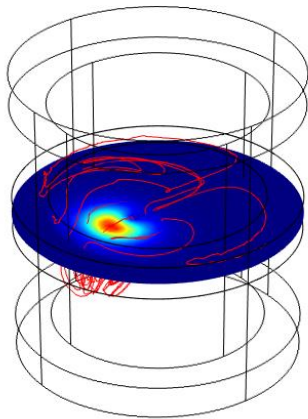
Triaxial induction EM tools
Simulation time – 12 hours
to
1.5 hours

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16

Deliverables

- Report on models taken for performance run explaining distributed parametric sweep and speed-up.
- Guide on implementation of COMSOL on Cluster for Physicists



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Research and Challenges

- Designing models to solve the physicists problems



Deliver better software for Schlumberger

- Nested parametric sweep and cluster license errors
 - 96% Progress on 1 node in 36 hours against 35% on 12 nodes
- Distributed parametric Sweep setting to solvers than parameters
- Memory usage in solver distribution – 12.25/25GB
- Model developed in older version- results mismatch with latest
- Improvements suggestion on submitting bugs

Acknowledgement

Denis Heliot



Jaideva Goswami



**HFE
Global
Métier
Managers**

**Tina Zhao and Gong Li Wang –
Senior Modeling Engineer**

**Keli Sun – Modeling Engineer
Schlumberger**

Jamie Grant – Controller HFE

**Cheryll Manlapaz Vargas– LSS
Site Champion, HFE**

**Fabien Houeto, Project Manager–
Slb**

Chuk – TDAS TL

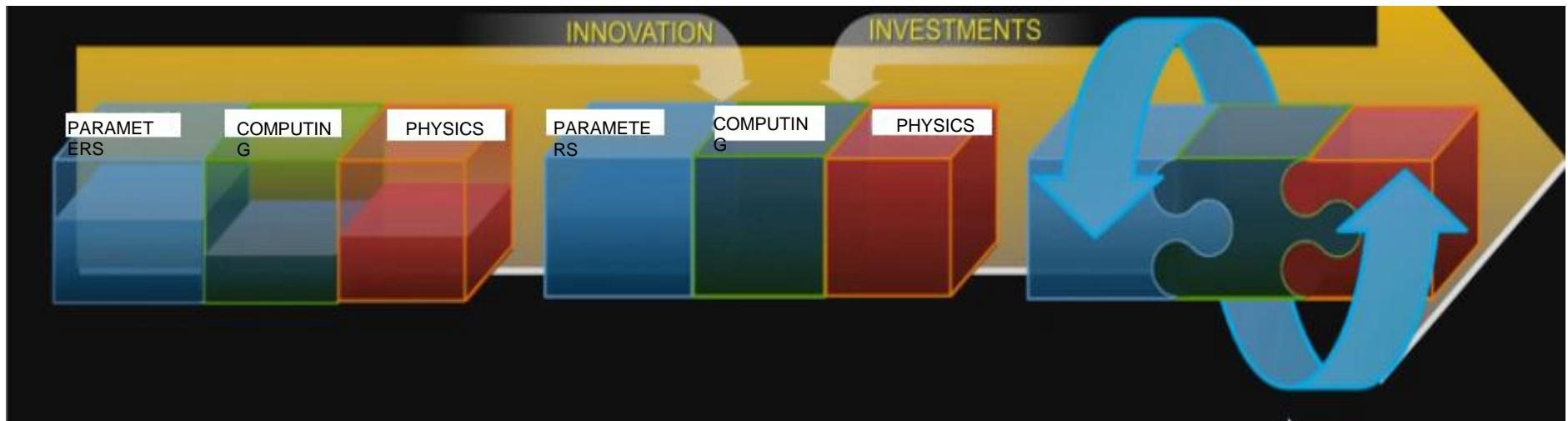
**Linus Anders, David Kan – COMSOL
Support**
Jinlan Huang – COMSOL Conference Chair



Conclusion and Next Steps

Jaideva Goswami and Denis Heliot, HFE Global Métier Managers

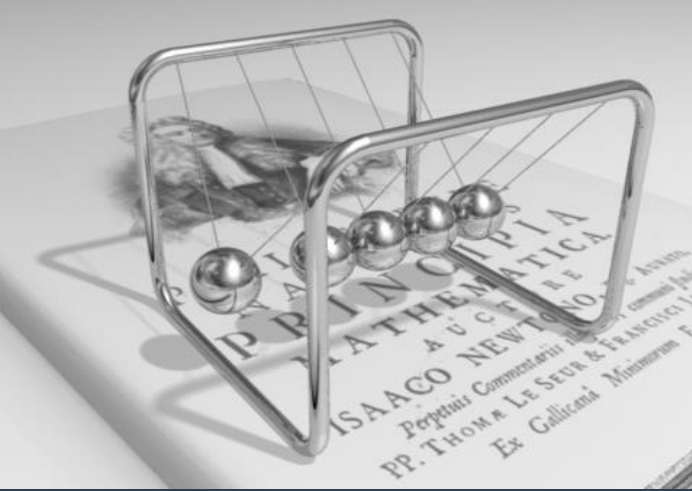
- This is key to delivering a reliable product at lower cost in a timely manner. Your work has demonstrated the feasibility of using HPC to enhance our modeling capabilities. This is in line with our long-term objectives at Research and EMS, and I look forward to its wider implementation.



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20





"If I have seen further, it is only by standing on the shoulders of giants." -Isaac Newton



JAMES CLERK MAXWELL



- Quest entries on field for the tool
- Time to re-design and prototype on failure



- Invest on technology
- Establish collaboration for computing power
- Utilize IT specialists



- Improve Quality
- Save time on faster simulations
- Faster Prototyping
- More time for Modeling



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21

