



Advanced Energy Consortium

Bureau of Economic Geology
Jackson School of Geosciences
The University of Texas at Austin

John Ullo Consultant (Schlumberger)/AEC



Membership

- BakerHughes
- Shell
- ConocoPhillips
- Halliburton
- Marathon
- Occidental
- BP
- Petrobras
- Schlumberger
- Total

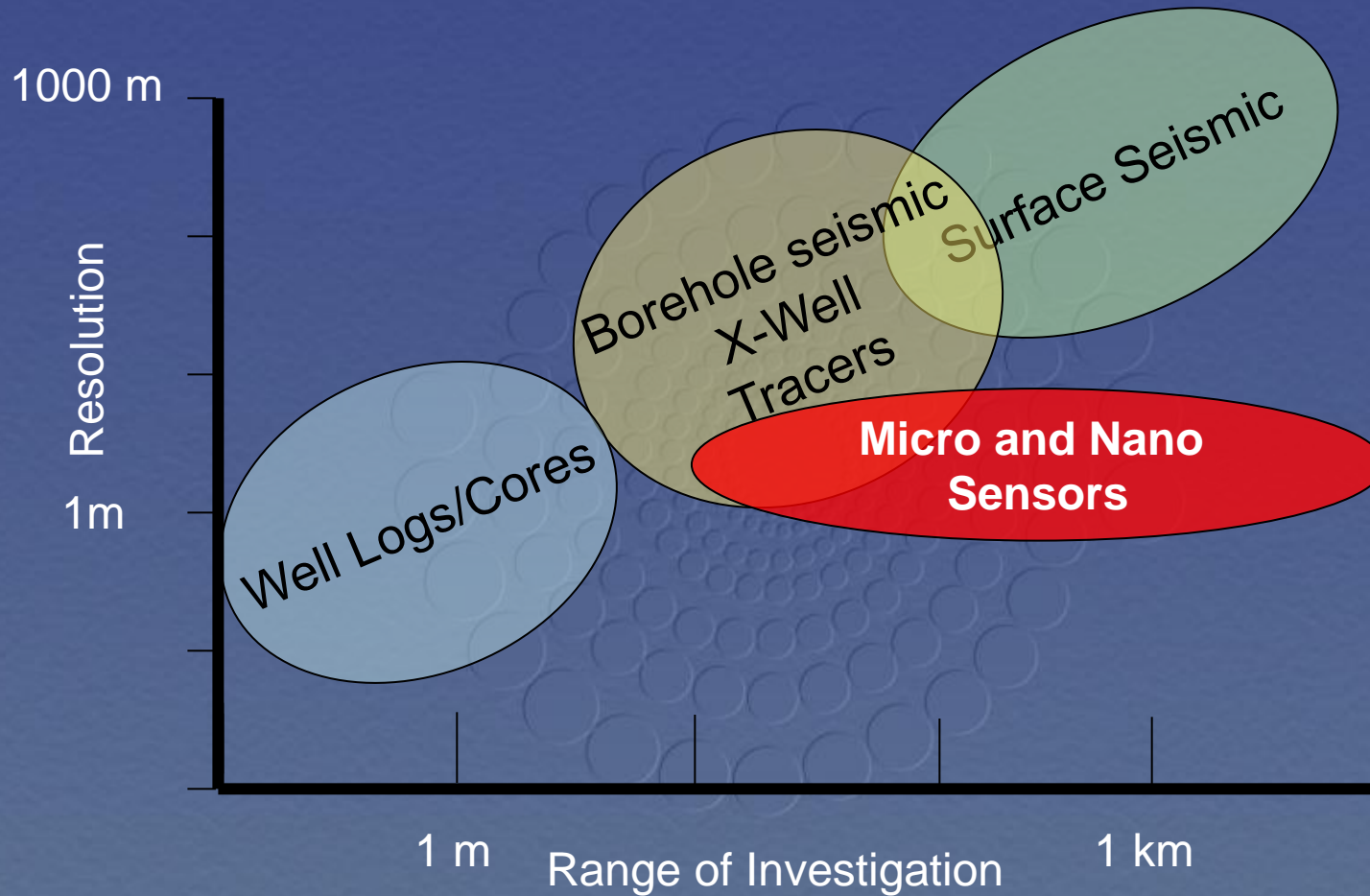


Mission

The AEC will drive pre-competitive research in Micro and Nano Scale Sensors to create through collaboration a positive disruptive change in the upstream oil & gas industry.

Micro – Nano Sensing – Where does it fit in?

“Illumination” beyond the wellbore. Drilling is not the answer.



Energy Landscape

I - Even though renewable sources of energy will assume a greater proportion of energy supply, energy transitions take time

- ~7 % of 2030 Global Energy Demand
- ~20% of 2030 Electricity Demand

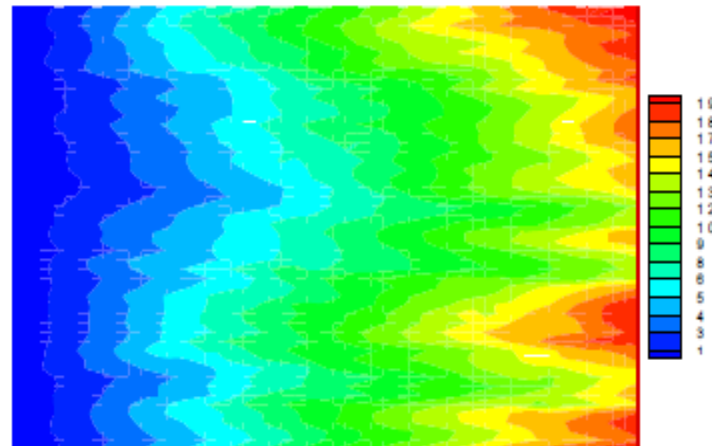
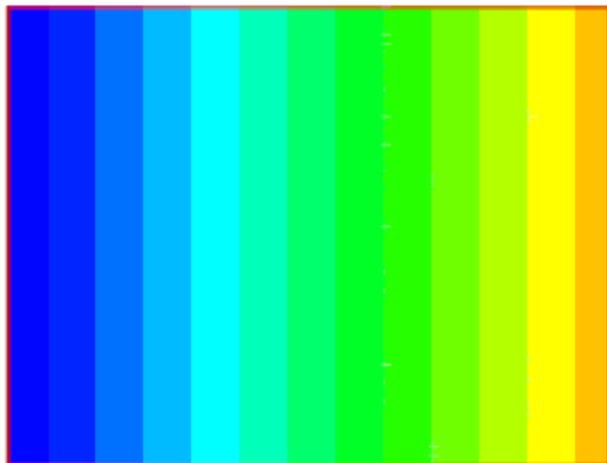
II - Fossil fuels will remain a bridge for some time



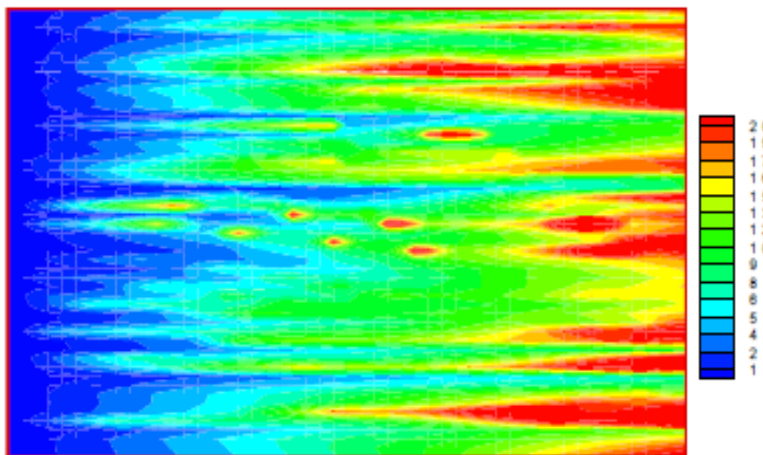
Improved Reservoir Recovery

- The best place to find oil and gas is where you already have found it.
The catch: The easy oil and gas has already come out
- Reservoir recovery factors are typically 35% or less and the average size of new discoveries is only 25% of mid-1960s
- Goal is 60-70% eventual recovery using new technology and practices
- What's the prize? Another trillion BOE

Key Application - Water Flood Recovery

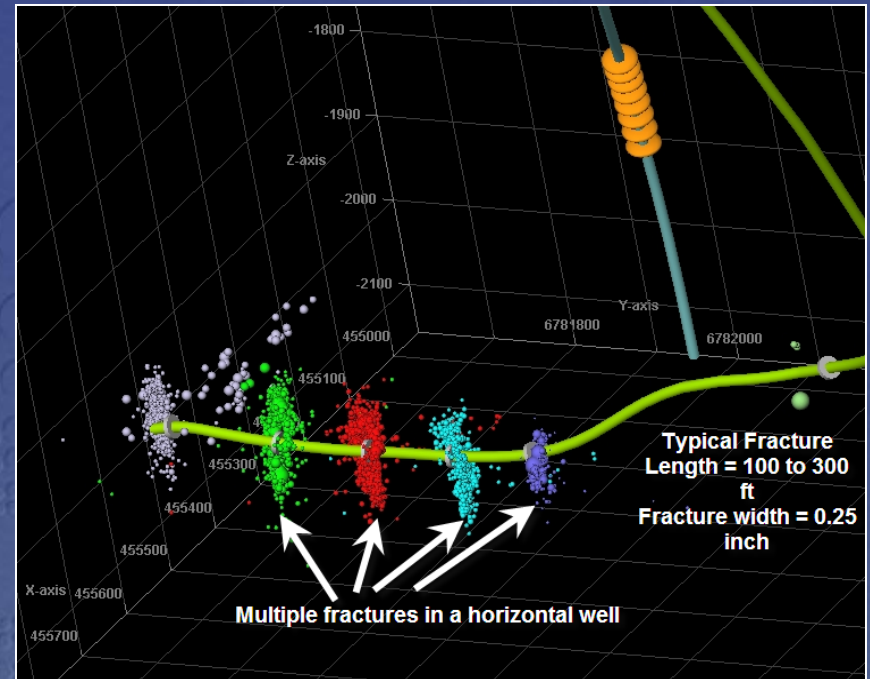
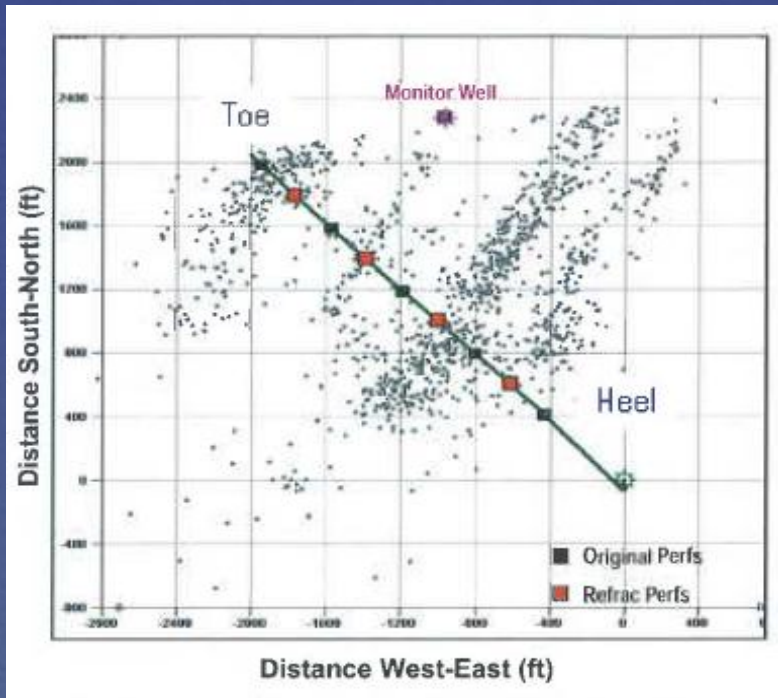


Well # 1



Well # 2

Key Application – Shale Gas Hydraulic Fracturing



Challenges:

Where did the frac go? (Length, height, asymmetry, width, azimuth)

What portion of the frac network actually produces? (actual drainage pattern)

Microseismic mapping is the dominant monitoring capability today

What if we could image the fracturing fluid/proppant in real time?

Shale Gas Resources



Unconventional Gas

North America ~ 8,228 TCF

Proved reserves ~ 2,074 TCF

US consumption ~ 23 TCF (EIA)

AEC Highlights



Research

- **35 Projects**

AEC Publications

- **4 Internal**

AEC –Funded Articles

- **40+ Publications, including conferences**
- **23 Papers for journals**
- **2 held for patent**
- **After 22 months**

Patents

- **Multiple provisionals**
 - **With more under discussion**

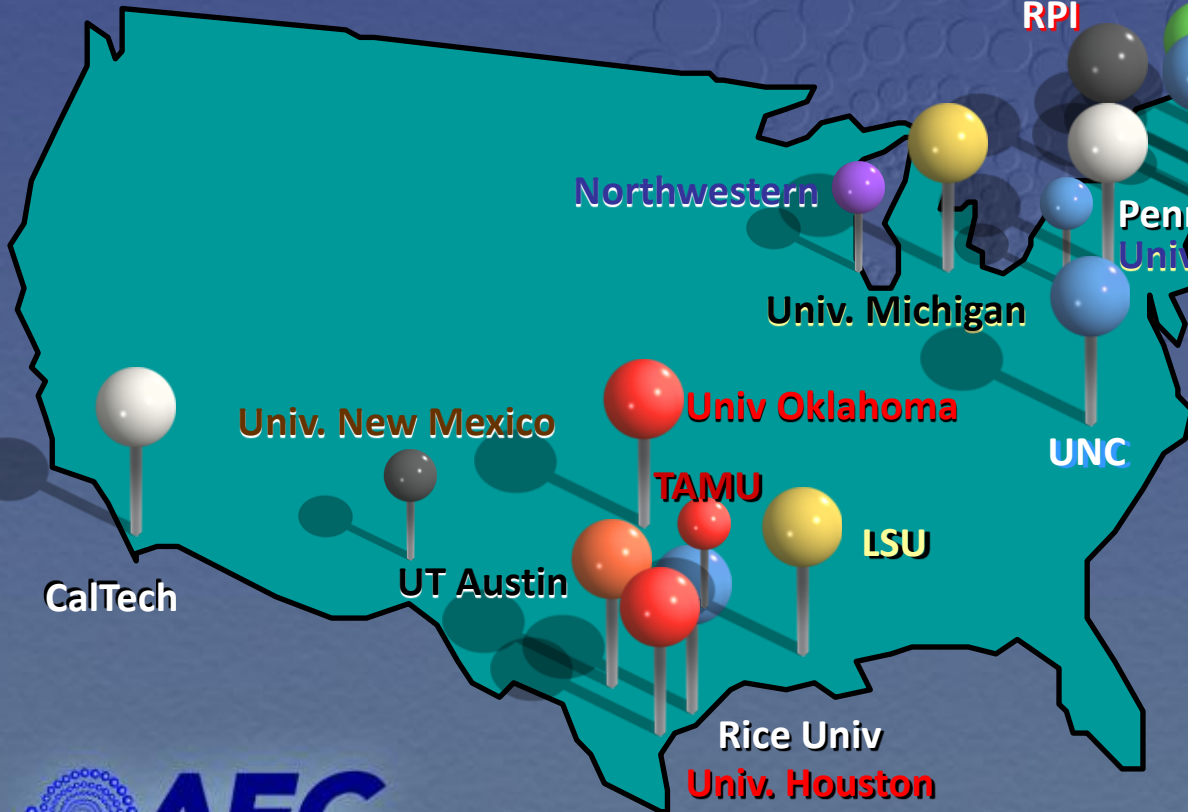
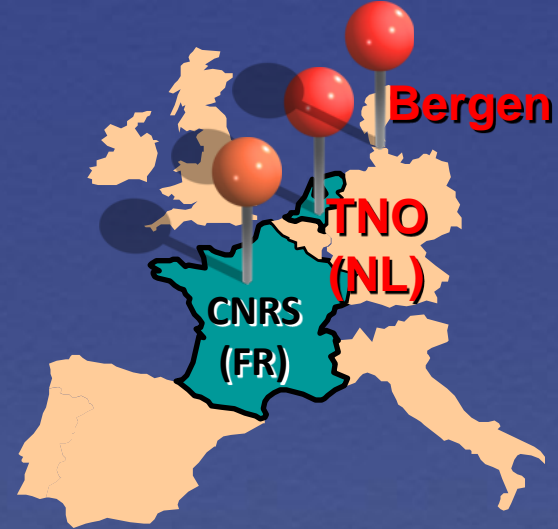
Research Collaborations



Worldwide



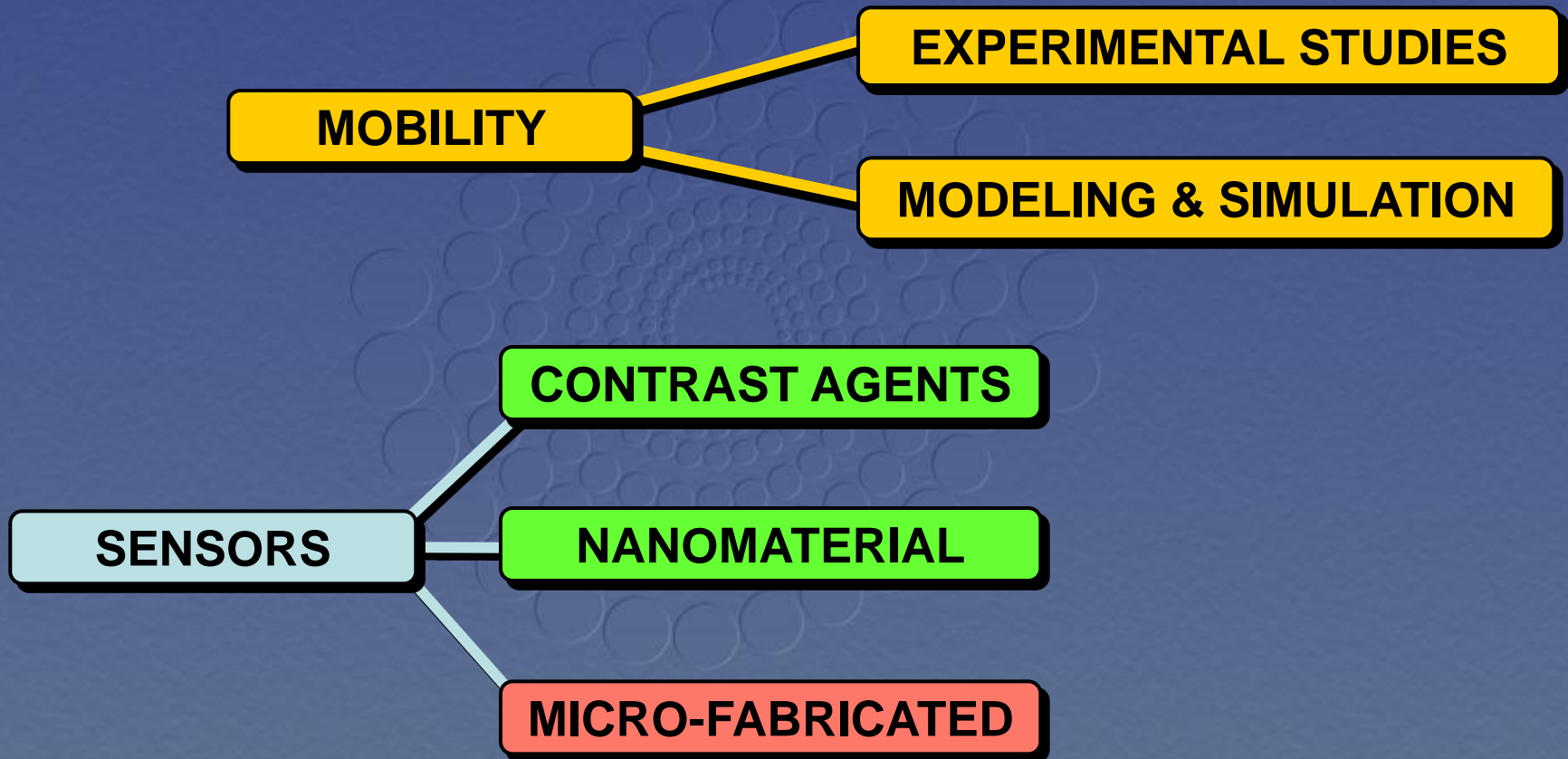
26 Universities
& Research
Institutions



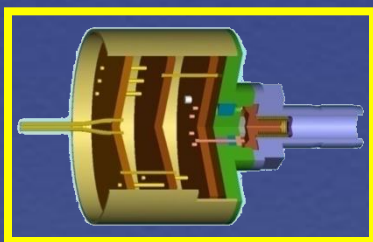
Large Pins = Primaries, Small Pins = Collaborators

ADVANCED ENERGY CONSORTIUM

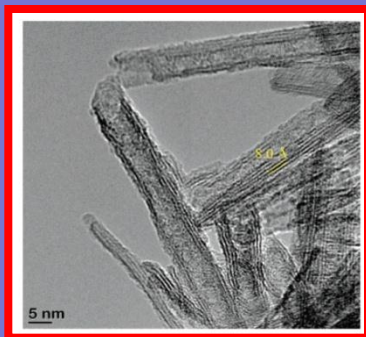
AEC Research Portfolio Taxonomy:



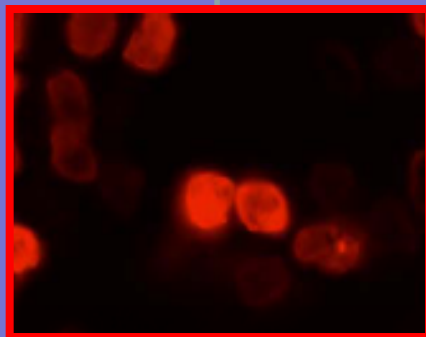
Emerging Devices and Materials



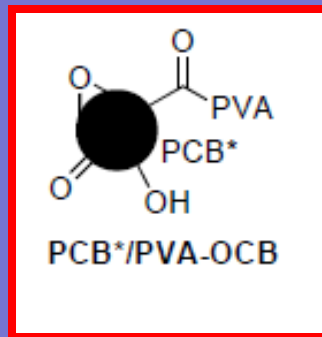
MEMS Pressure



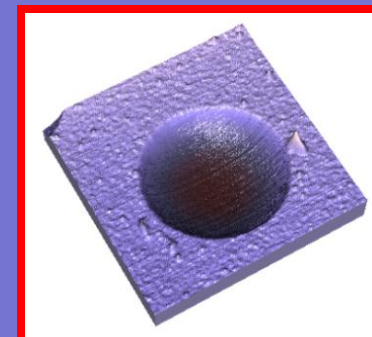
Contrast agents



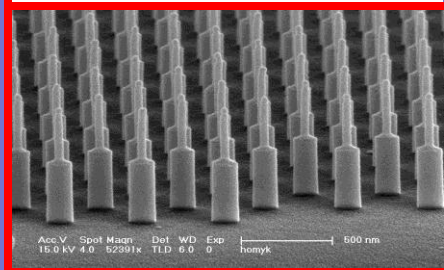
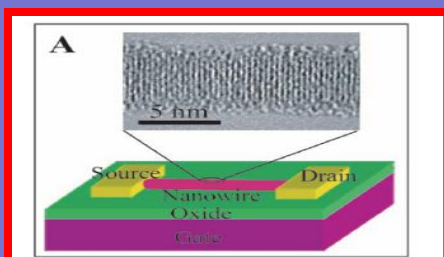
Nanomaterial tracers



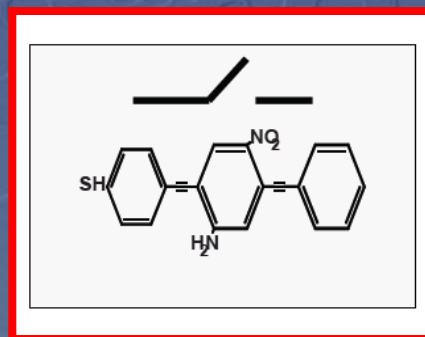
Nanomaterial - hc reporter



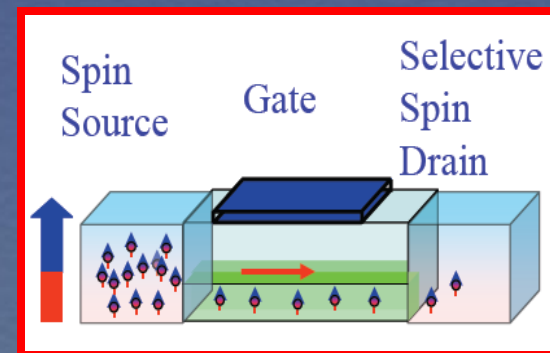
Nanomaterial - graphene pressure



Microfabricated devices - NWs, NTs, QDots



molecular devices



spin devices (no power)

Grand Challenges

- **Mobility:** Enable nanoparticle transport at the km scale in a heterogenous, multi-component, multi-phase subsurface reservoir with harsh temperature and pressure.
- **Remote Communications:** RF strongly attenuated in brine. Antennas must be nanoscale. Desire km range – no known technique yet
- **Geolocation:** Value of information greatly increases when geolocated. Subsurface GPS system not foreseen
- **System Miniaturization:** 10 to 1 cubic microns, integrated sensor package
- **Synthesis & Manufacturing:** Scalability to needed production quantities

AEC Value Proposition

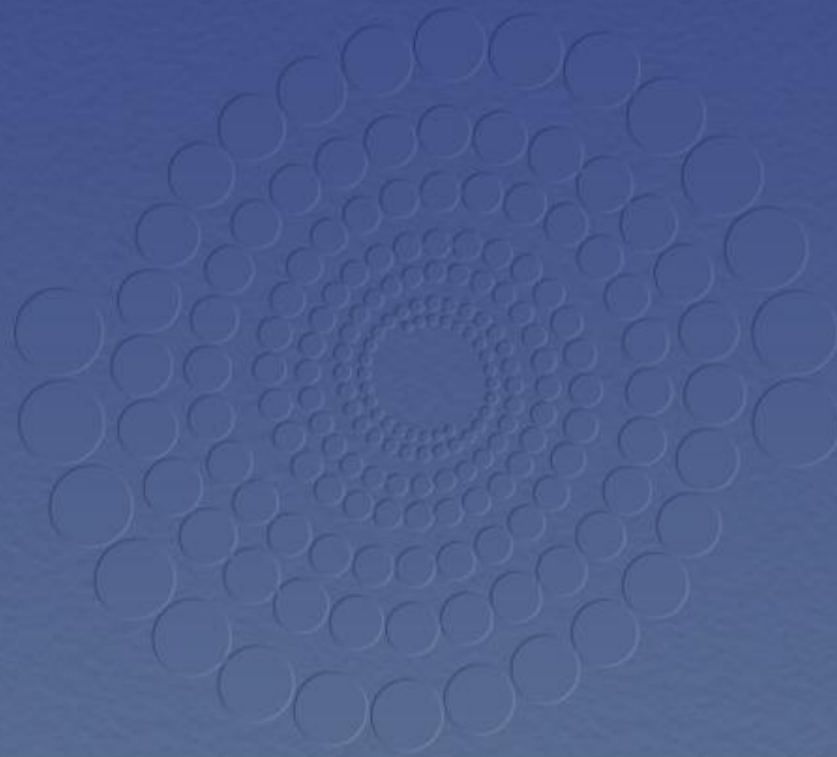
Leverage research investments a factor of ten and more

Acceleration of progress up a steep learning curve through mentors and collaborators

Avoid capital investment of expensive equipment

Direct engagement with selection, content and direction of research

Training future researchers



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