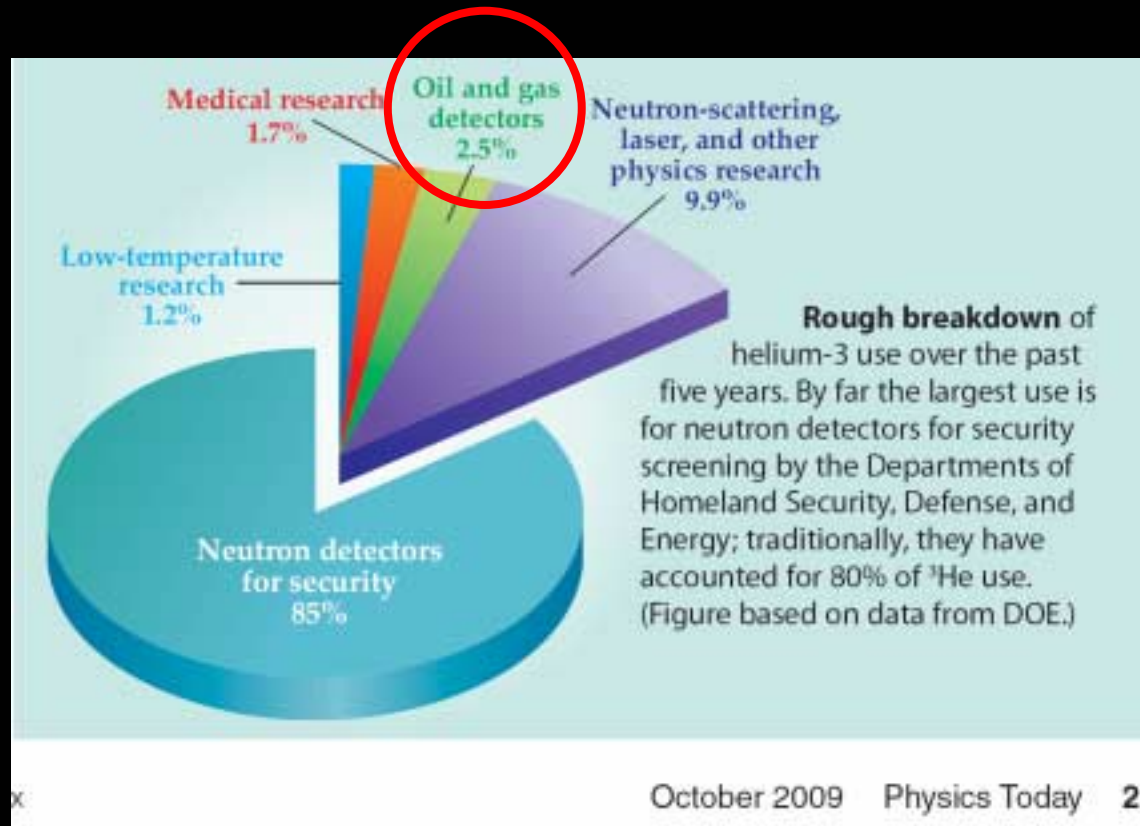


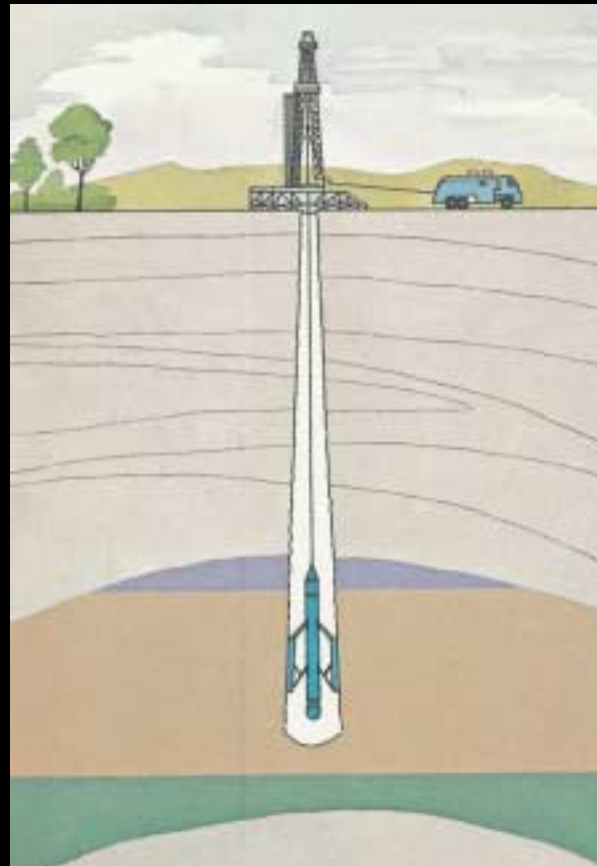
^3He Usage in the Oil Well Logging Industry



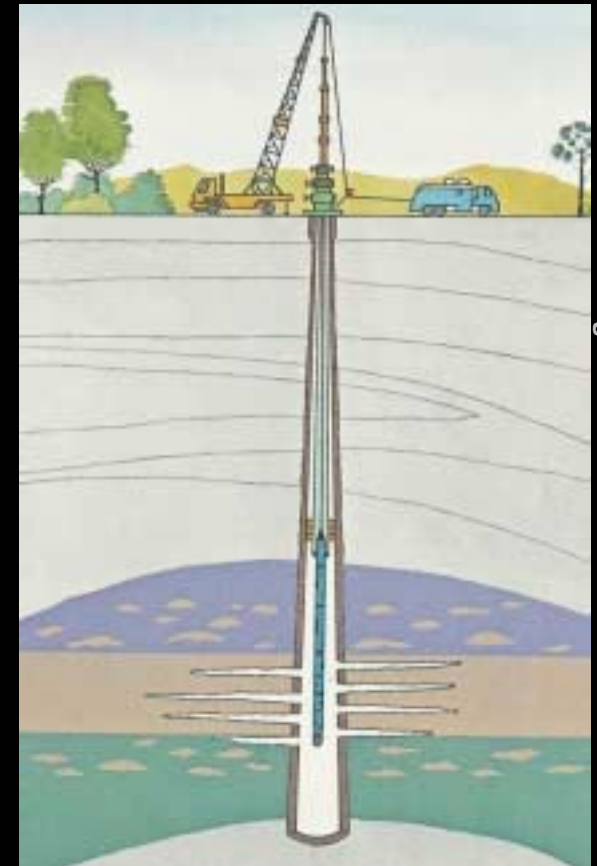
Well Logging Activities



Logging-While-Drilling

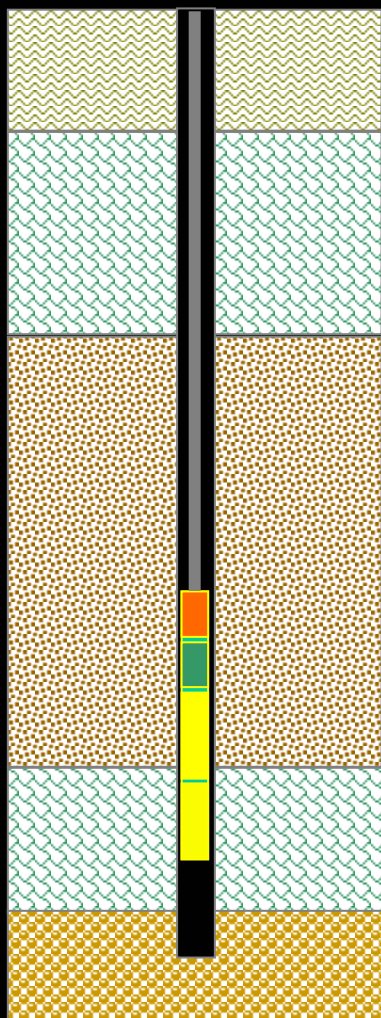


Open-Hole Logging



Cased-Hole Logging

Measurements Respond to the Earth Formation Properties

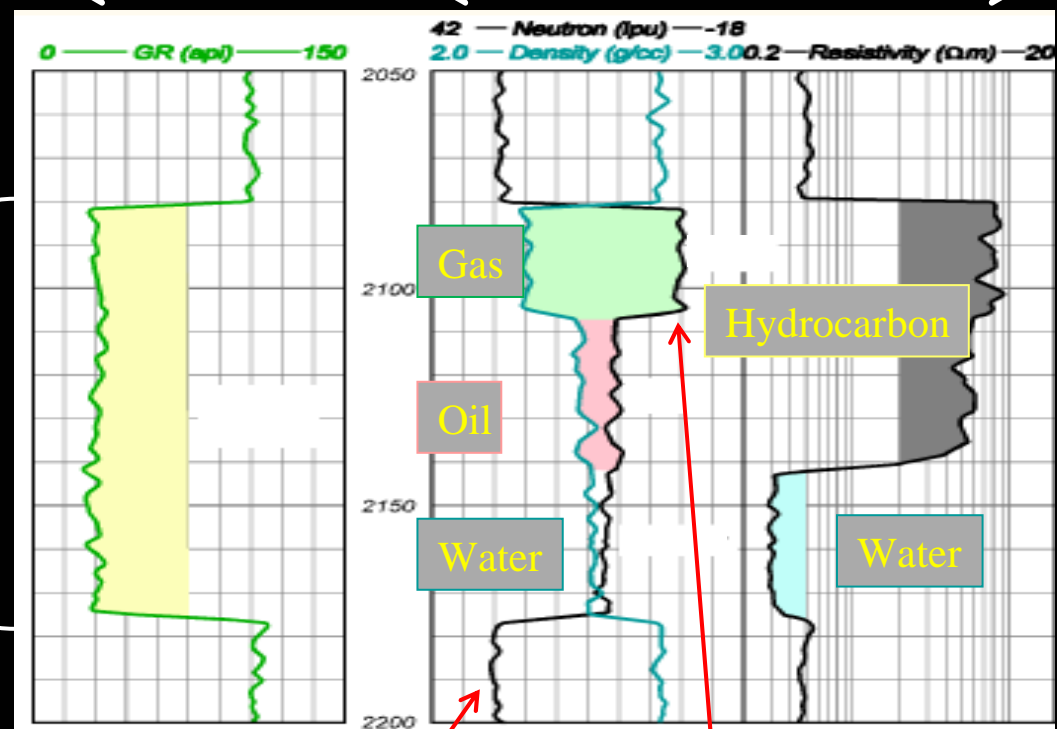


Low
Gamma
Ray:
Potential
Reservoir

Reservoir quality
increases

H increases
 ϕ increases

Oil or gas



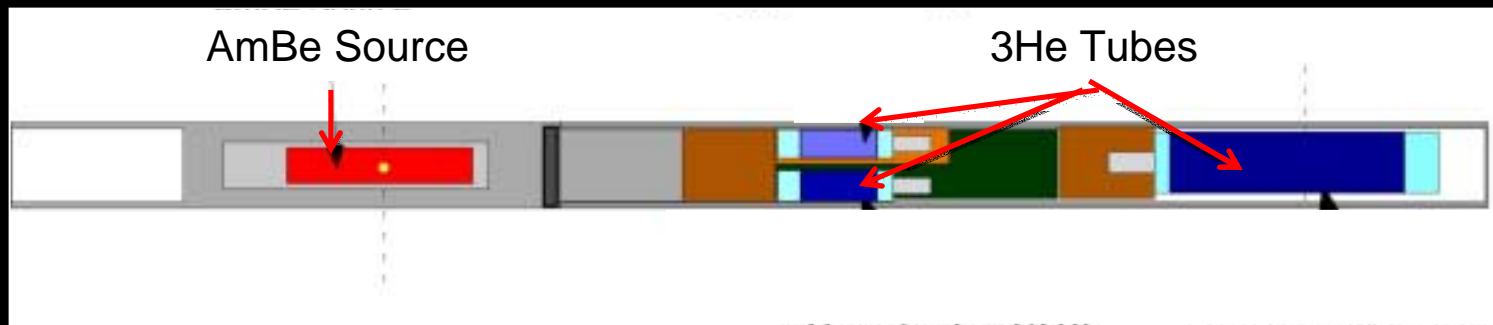
Excess H, poor
rock quality

Very low H,
GAS

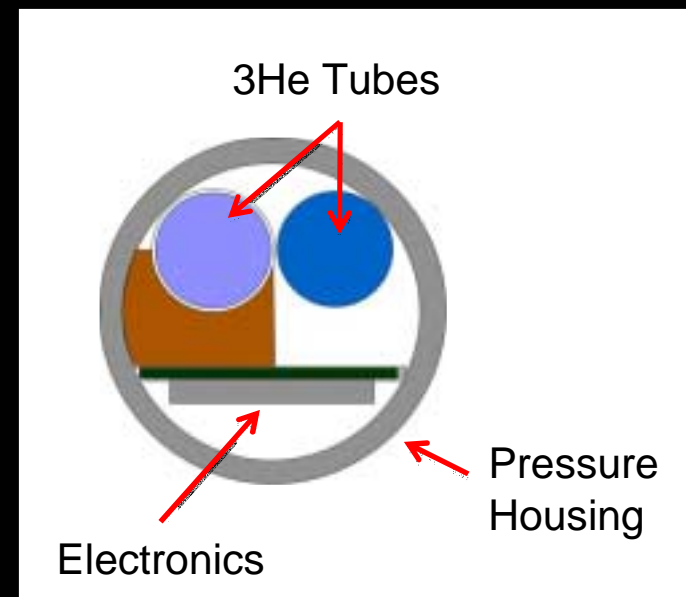
Schlumberger Public

Neutron Measurement is Primary Gas Indicator

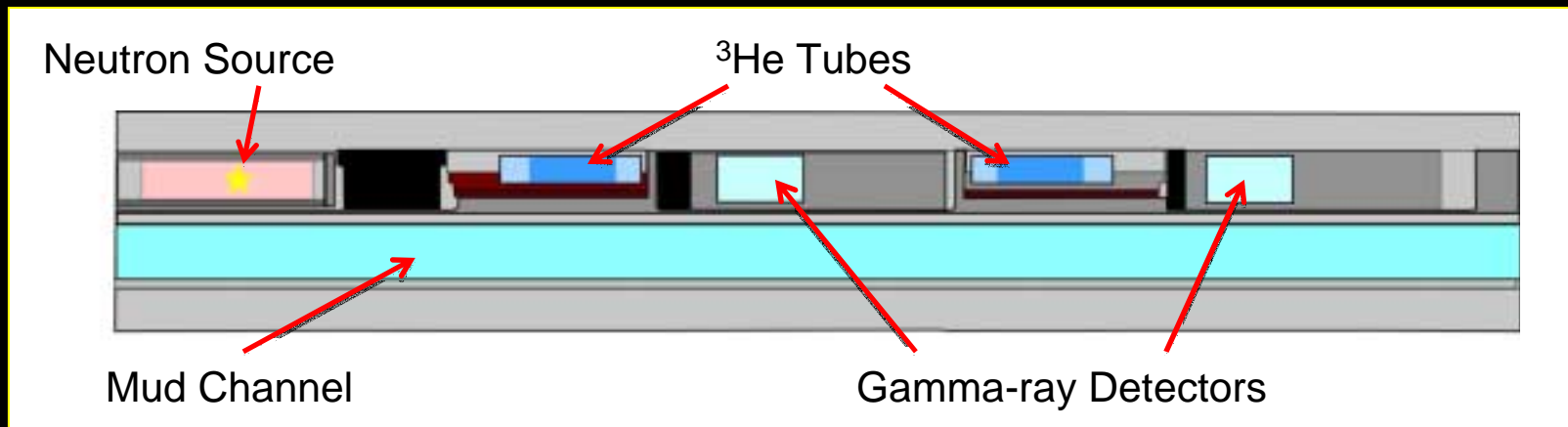
Wireline Tool



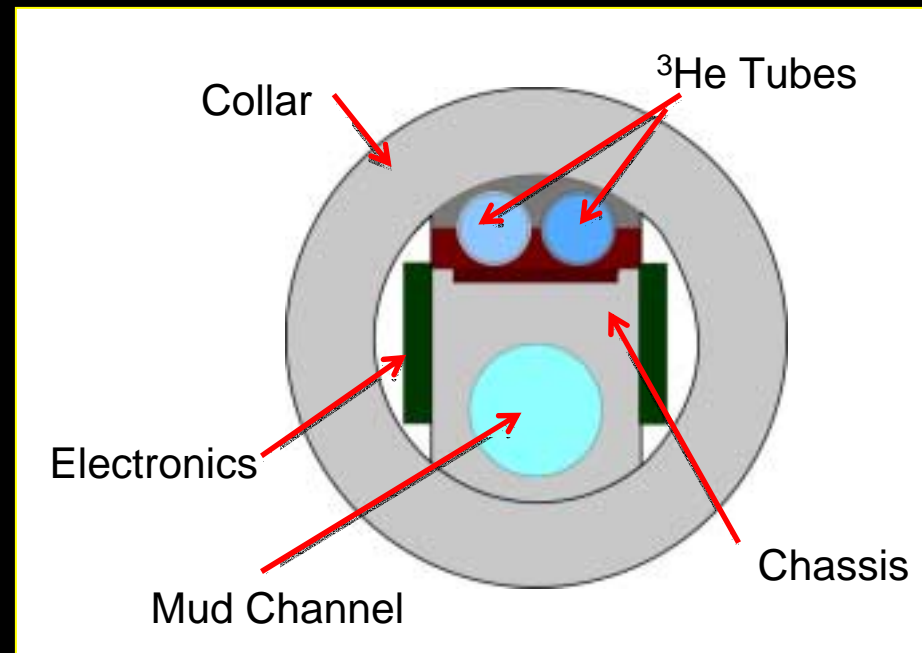
- High Temperature
- Tight Geometry
- 1 sec. Meas. Time
- Medium Shock
- Medium Vibration



Logging-While-Drilling Tool



- High Shock
- High Vibration
- High Temperature
- Tight Geometry
- 30-60 sec. Meas. Time



Measurement Environment

- Short Measurement Times
- High Temperature
- High Pressure
- Small Packages
- Geometry

	Typical Measurement Time (s)	Max Temperature (°C)	Shock & Vibration (g's)	Tool Diameter (in).
Logging While Drilling	9 - 60	150 - 200	1000's	4-8 but hole in center
Open-Hole Logging	0.5 - 1	150 - 200 *260	100's	2.4 - 3.6 - 4.5
Cased-Hole	0.5 - 9	150 - 200 *260	100's	1.7 - 2.4

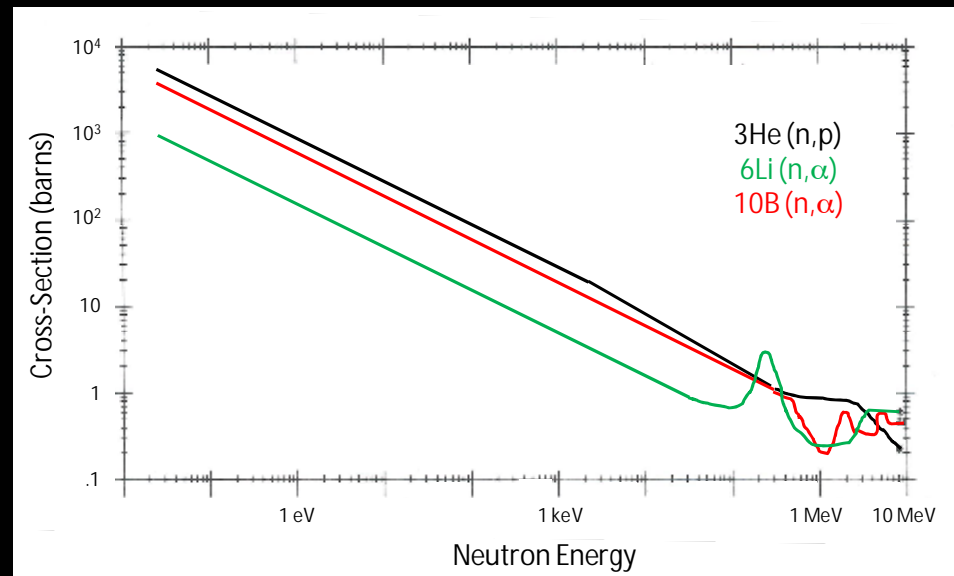
* Dewar Applications

Replacement Technology is Very Difficult

- Reliable at High Temperature
- Reliable with High Shock & Vibration
- Reliable Gamma Discrimination versus Temperature
- Need High Detector Efficiency
 - Replacing 10-20 atm ^3He tubes
- Needs to be compact
 - Room for PMT's?

Replacement Issues

- Detector Efficiency
 - Countrate is key to logging speed
 - Currently 1800 – 3600 feet/hour
 - Minimize Time in Well – Reduces Rig Time Cost, up to \$1M/day
 - Surface vs Volume sensitivity
 - Larger Detector is not an option
- No Drop in Replacement
 - Change of tool response
 - New tool designs required
 - 7 year tool design cycle
 - Multiple tools – 12 years
 - \$100M+ cost



Financial & Strategic Impact

- Financial Impact
 - Rig Time – Direct Cost of Service
 - Can be as high as \$1M/day
 - Oil Production Infrastructure Decisions - \$1-2B
 - Oil, Gas, & Water Processing
 - Transportation Costs
- Strategic & Financial
 - Securing Future Domestic Oil & Gas Reserves
 - Oil Reserves Calculations
 - Gas-Shale Evaluations

