



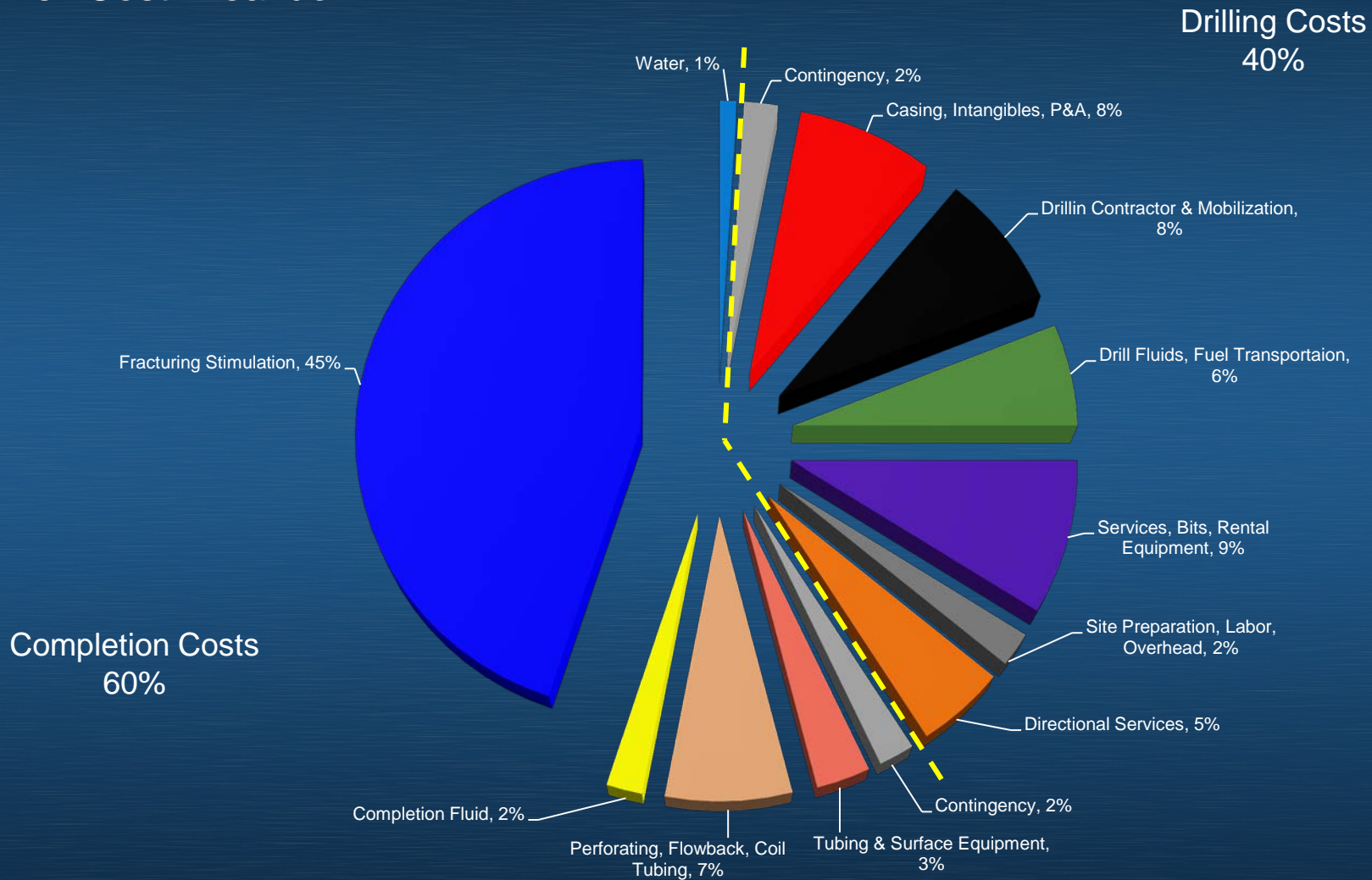
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Well Costs, Completion Costs, & Perforating Costs

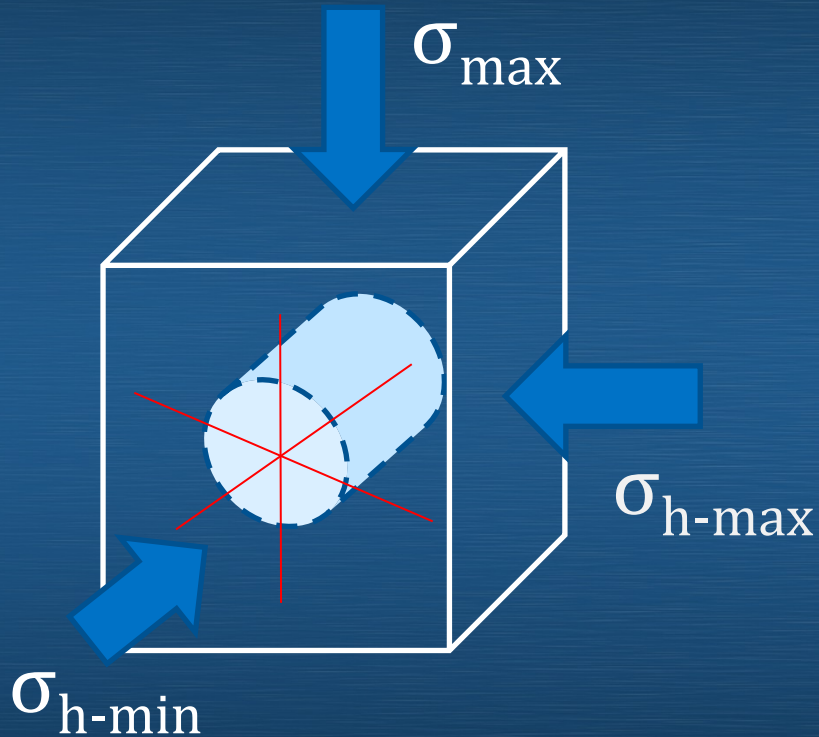
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Well Cost Breakdown



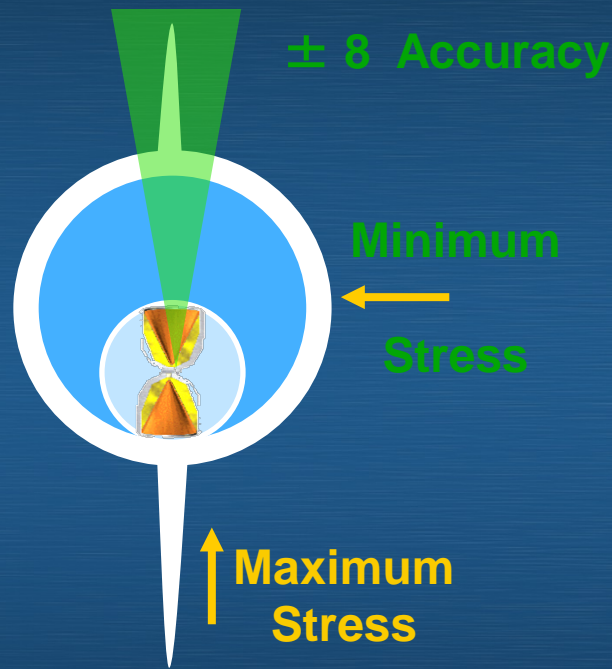
- **SPE 77363**
 - The 180 degree phasing will be the best completion technique for horizontal perforated wells because all the perforations will be oriented in the direction of minimum permeability

- **SPE 166086**
 - Perforations at top and/or bottom of the well may be a better choice than the popular pattern of helical 60 degree perforations

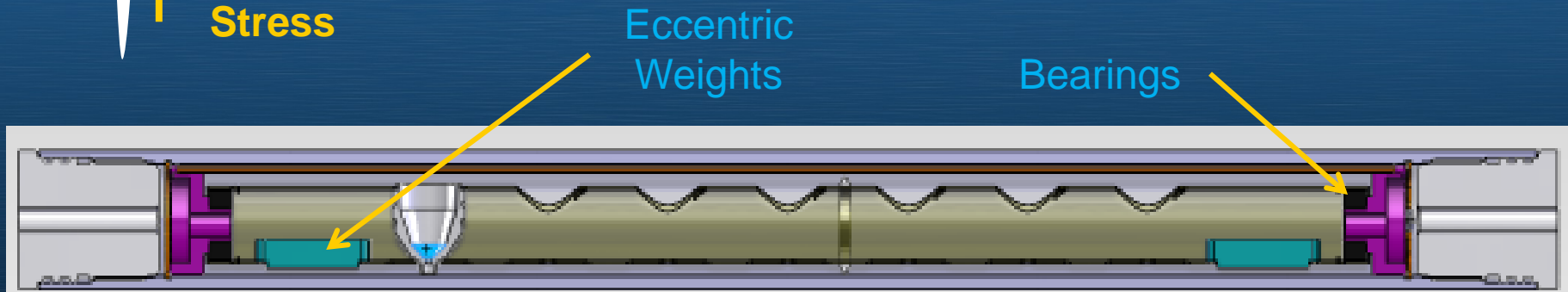


Phasing

- 60 Degree
 - Unknown direction of fracture
 - Scatter gun
- Oriented
 - Known direction of fracture
 - Orient for more penetrations on plane
 - Limit tortuosity
- Wireline orientation requires eccentric weight bars
 - SPE 166369 demonstrated $\pm 62^\circ$ ERROR in a horizontal
- TCP or Coil uses weights with required Swivels and Kick-overs
 - $\pm 31^\circ$ ERROR dependent on sized hardware for casing size



- Positive orientation in deviated well bore
- Accurate shot placement
- Charge tube rotates independent of gun
- Weights orient the charge tube
- Charge orientation not affected by wellbore debris, downhole conditions
- Void of additional down-hole equipment



Oriented Gun Cutaway in Lab

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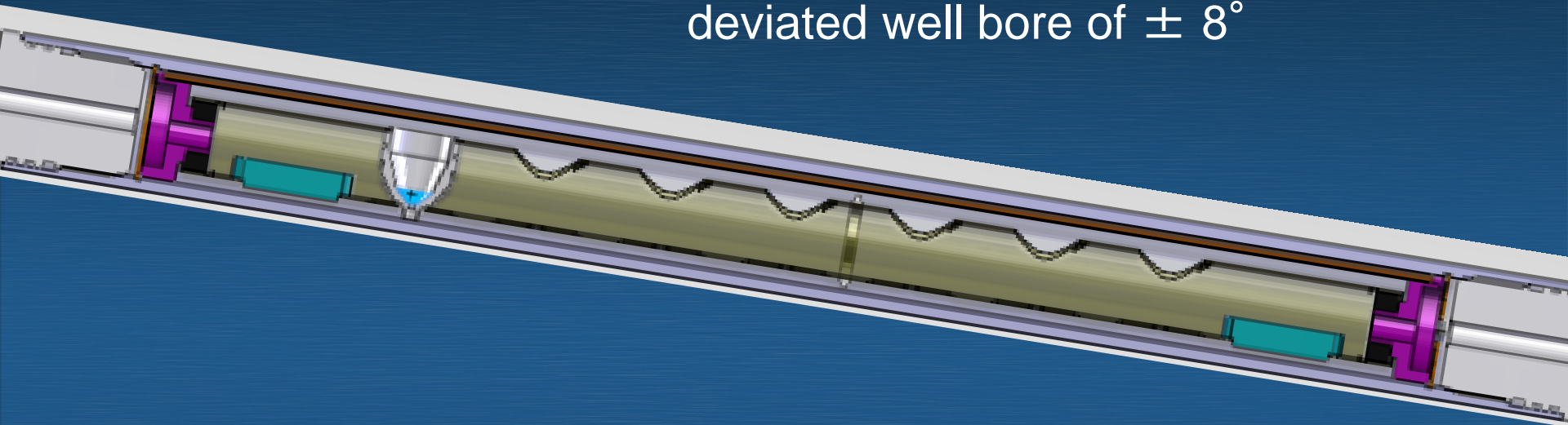
Rocky Mountains-

- Hydraulic fracturing pressure was reduced 2400 psi with same flow rate as similar wells.
- Open perforation flow area calculated 100% of the zero and 180° oriented perforations to be open.

South Texas-

- 18 stages shot successfully with zero & 180° oriented guns.
- Vertically oriented gun effectiveness showed pressure reduction of 600 to 1200 psi during hydraulic fracturing.

- Accurate Shot Placement in the deviated well bore of $\pm 8^\circ$



- Known orientation allows for tighter charge performance
- Increased number of effective holes with more shots on plane and open to flow
- 1500 psi reduced breakdown when compared to 6spf, 60°



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