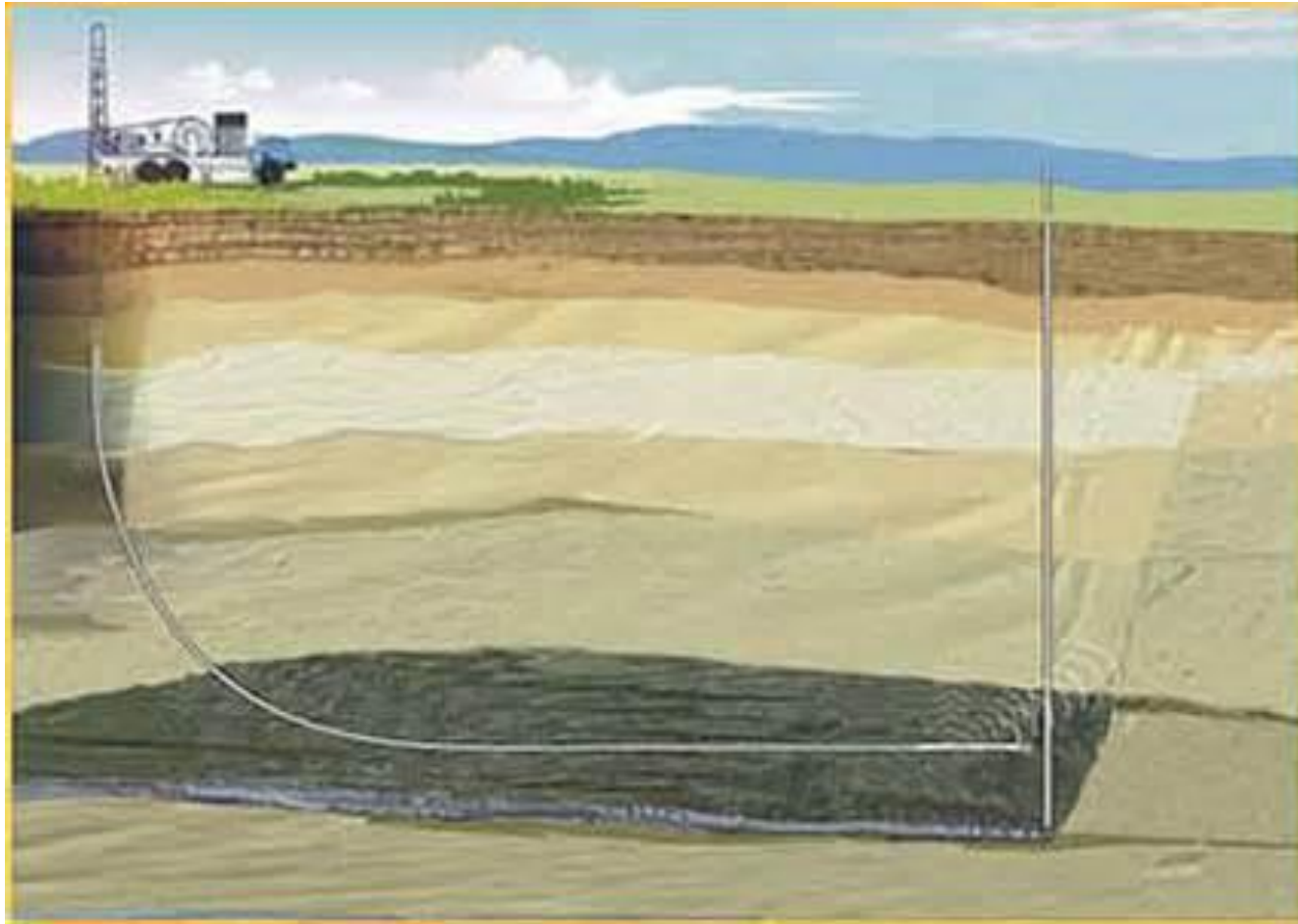




OWEN OIL TOOLS

Penetration not a limiting factor for hydraulic fracturing...

Horizontal Completions

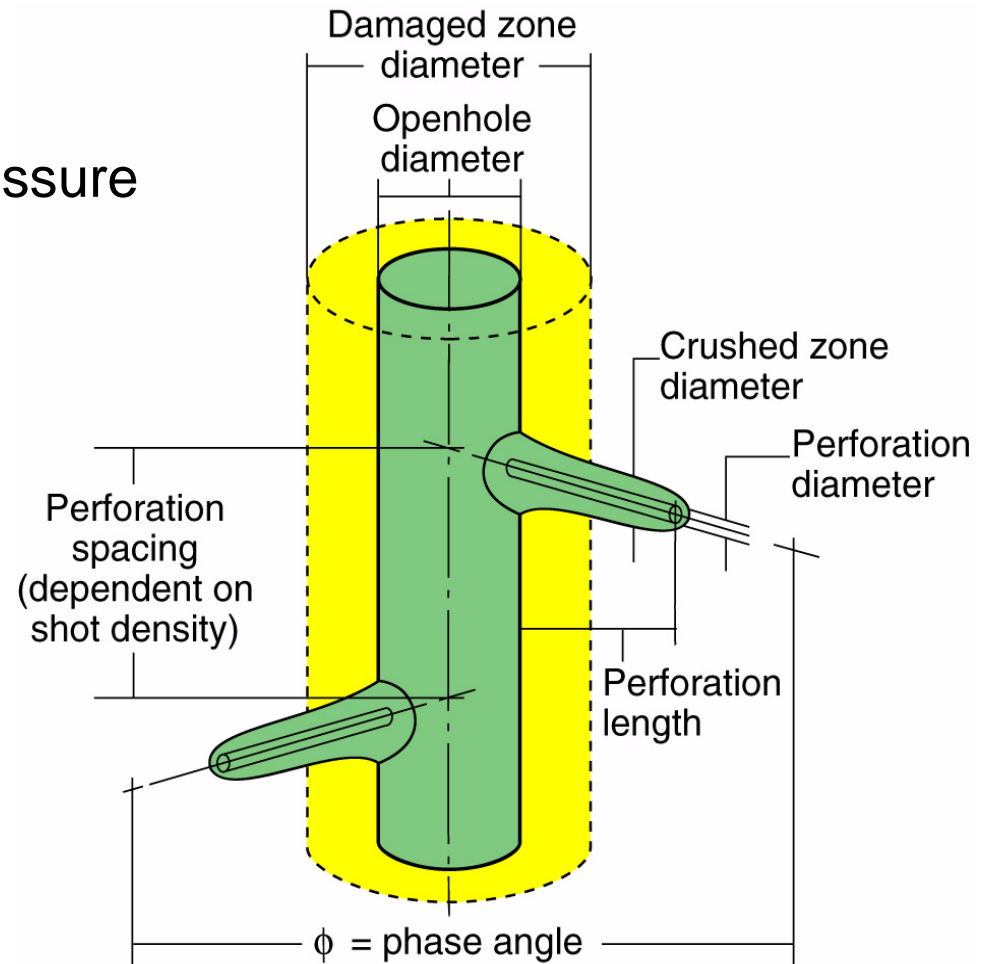




Eagle Ford
Shale

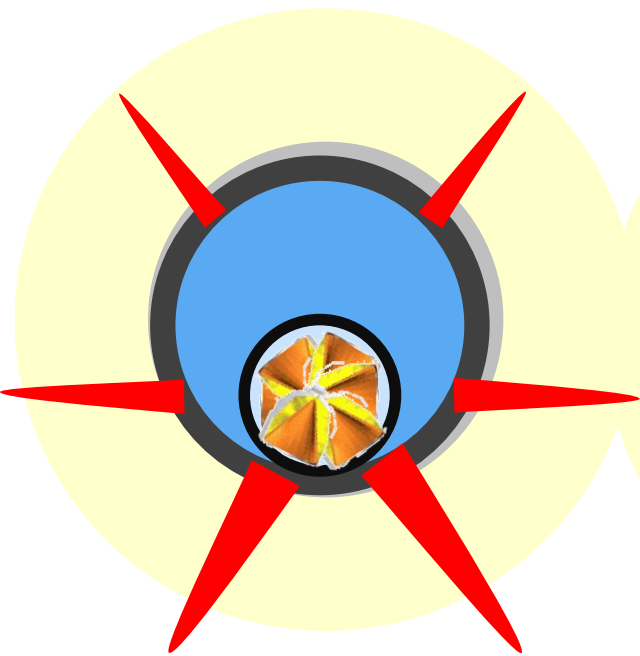
Perforating Choices for Hydraulic Fracture?

- ▶ Hole Size
 - To calculate friction pressure
 - To calculate rate
 - Proppant size
- ▶ Gun Phasing
- ▶ Shot Density
- ▶ Penetration
 - How much?

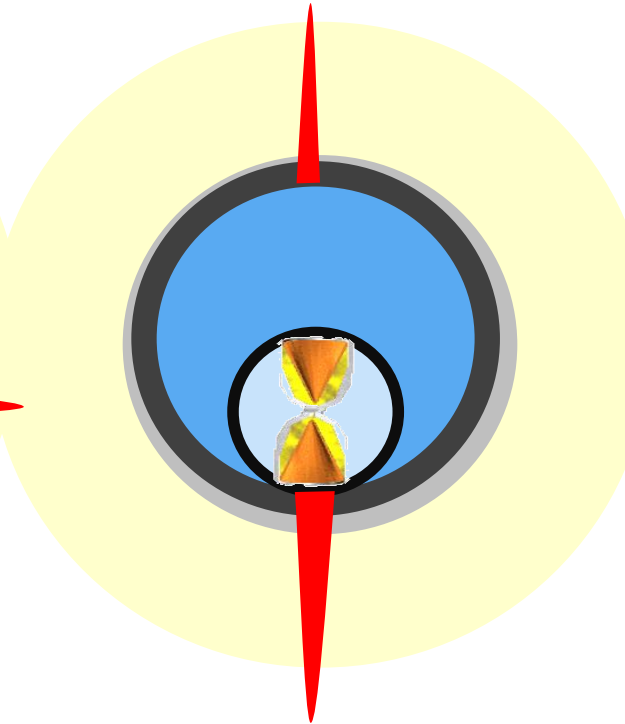


Perforating Choices?

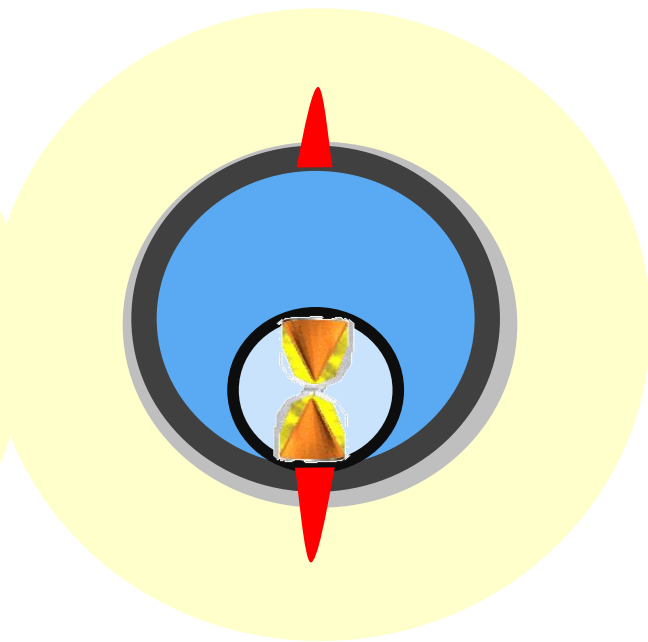
* API Sect I data



EH = 0.37"
Pen* = 35.6"

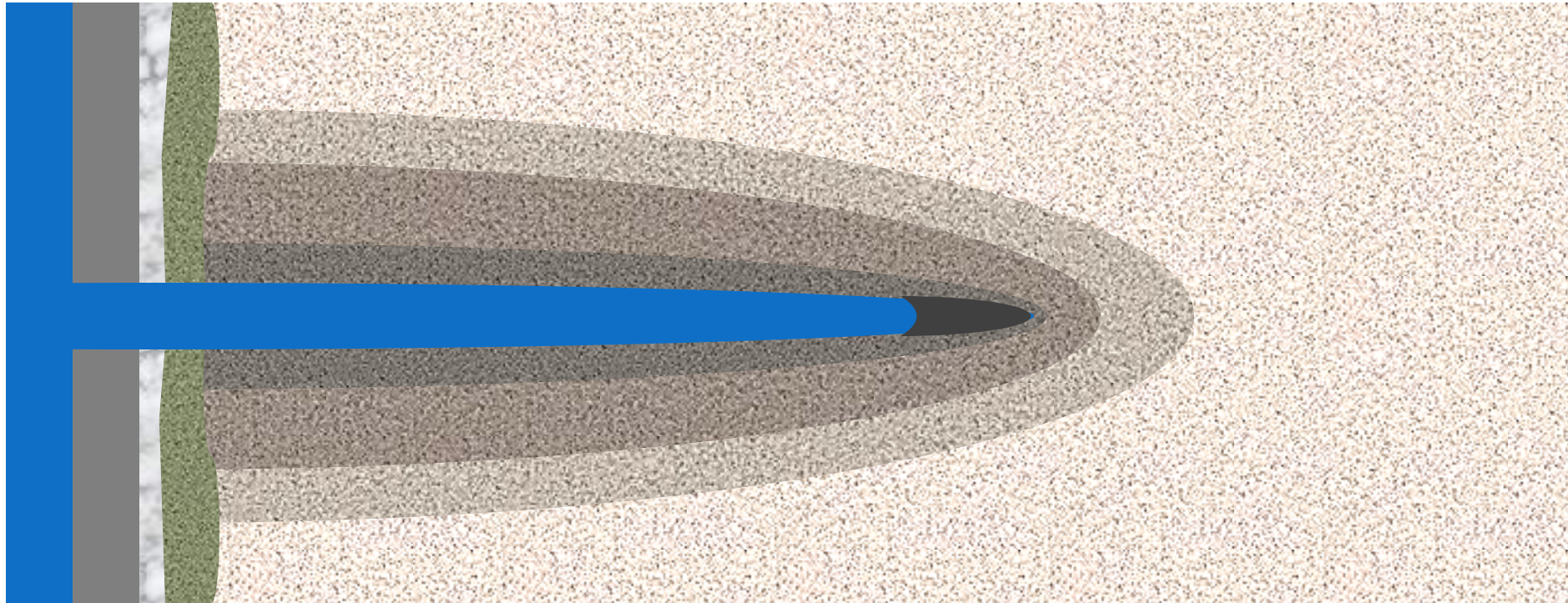


EH = 0.37"
Pen* = 35.6"



EH = 0.43"
Pen* = 2.6"

Where Does the Fracture Initiate?



An Operator Asked,

For a solution requiring

- ▶ 0.45" Entry hole
- ▶ Minimal Formation Penetration
- ▶ 180° Phasing (Preferred Frac Plane at 6 & 12)

Gun/Charge Selection – Step 1

Well Casing = 5.5", 26#/ft, L-80

- ▶ 2 3/4", 3 1/8", 3 3/8" Perforating Guns

Gun Performance Software

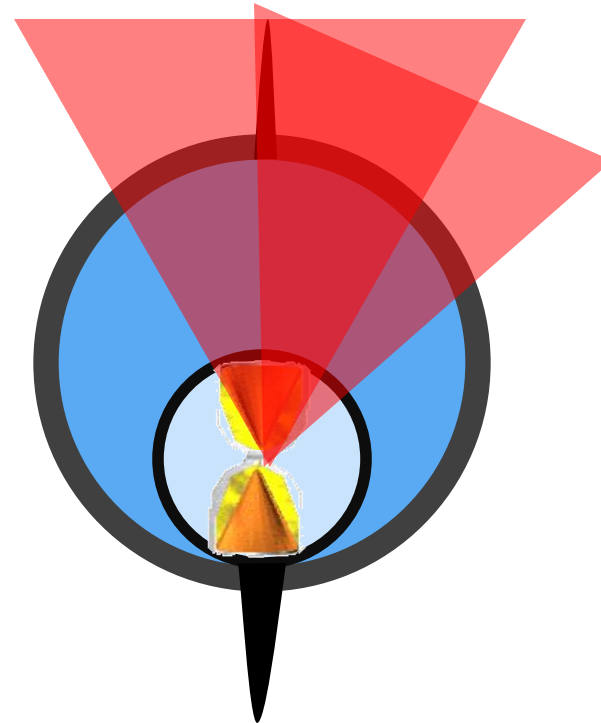
- ▶ Allowed us to narrow down the choices
- ▶ 3 1/8" OD Gun
- ▶ 10 gram Big Hole Charge

Coupon Testing

- ▶ At 6 o'clock, EH = .56" & TTP = 2.75"
- ▶ At 12 o'clock, EH = .30" & TTP = 2.60"

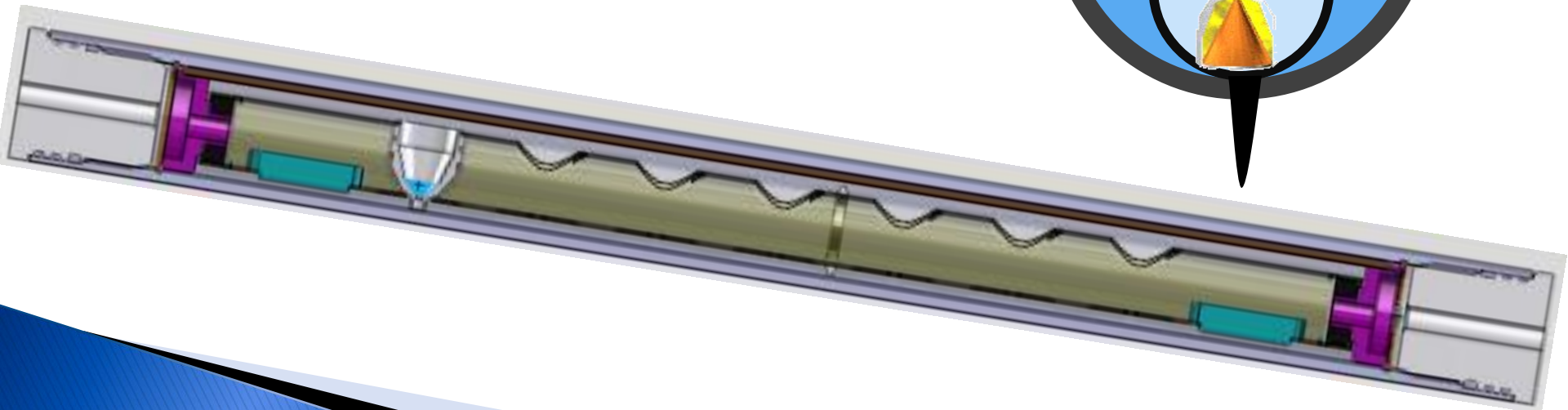
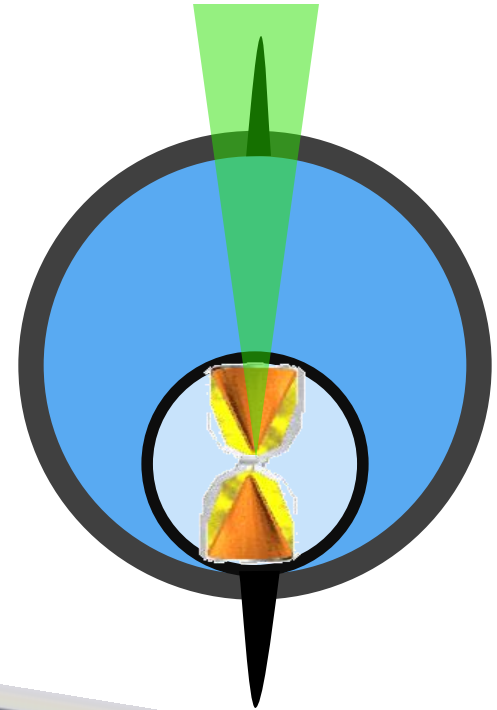
Orientation – Step 2

- Eccentric weight bars
0° – 44° Error in Orientation
- Finned Subs and Swivels
31° Error in Orientation



Orientation – Step 2

- Internally oriented via eccentric weight **8° Error**
- Allows for selective firing
- Patent Pending



Combined Results

- 19 stages of 4 clusters each

1500 psi lower breakdown pressure for Stages 12 & 14 as compared to Stage 13 shot with 60° DP charges



- 12 o'clock shots display common burrs
- 6 o'clock shots show no burrs

Summary

Hydraulic Breakdown and Treating Pressures Reduced when....

- ▶ Perforations oriented in direction of max. stress v. 60 degree
- ▶ Unique orienting gun achieved accurate placement of perforations over conventional orienting techniques
 - Swivels
 - Eccentric weight bars
- ▶ Charges selected on entrance hole performance in actual casing
 - **Penetration was only 2.7” in cement**
 - Explosive weight was 10g v. typical 23 gram