



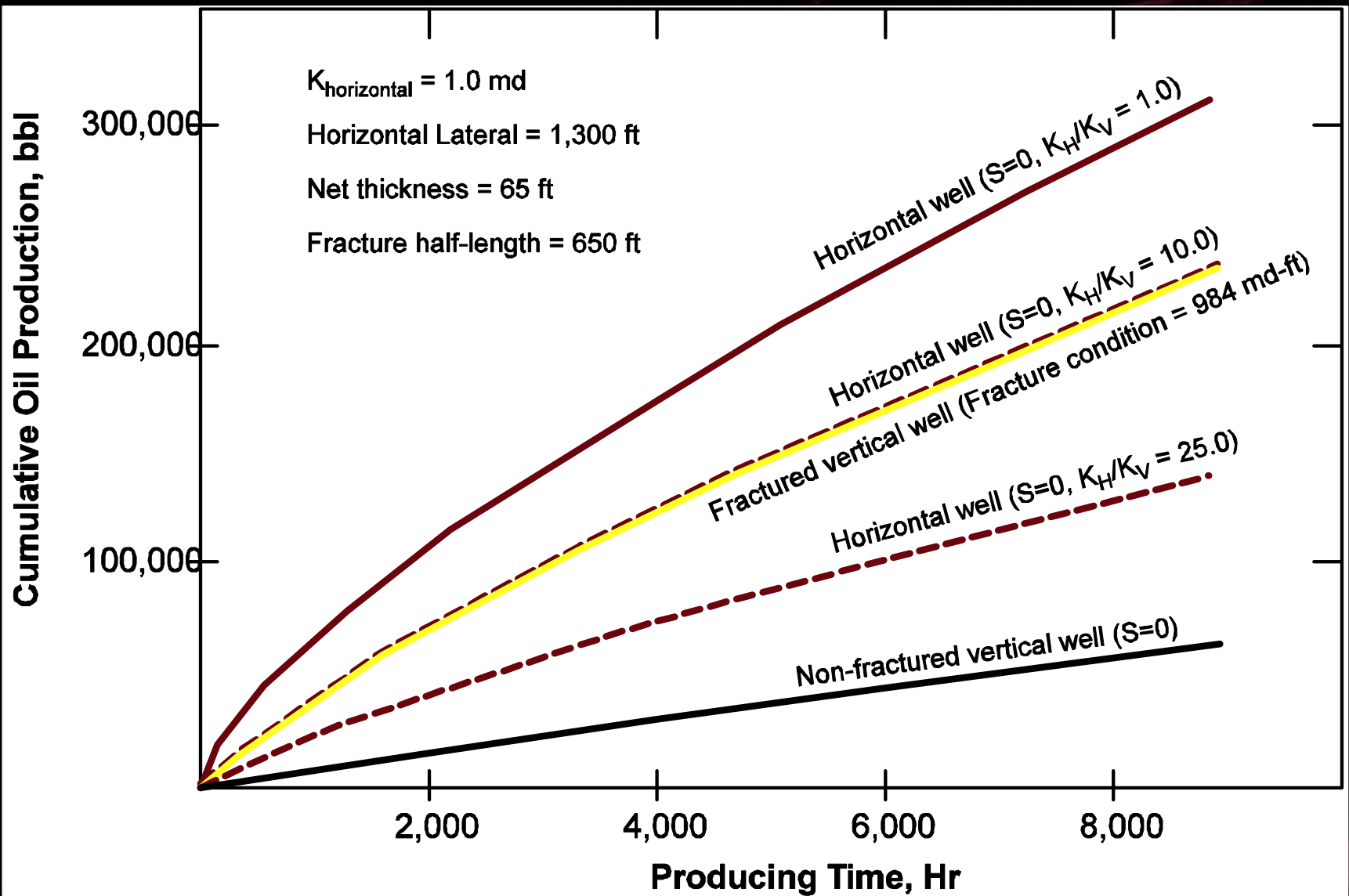
Horizontal Well Stimulation

**WILLISTON BASIN PETROLEUM
CONFERENCE MAY 01, 2007**

HALLIBURTON

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Why Stimulate a Horizontal Well ?



Horizontal Well Simulation Options

- **Open Hole**
 - SurgiFrac Technique
 - Swellable Packers – Frac Ports
 - Mechanical Packers – Frac Ports
 - Hail Mary Frac
- **Cased Hole**
 - Cobra Max - Abrasive perf / Frac / Sand Plugs
 - Perforated Limited Entry
 - Perf and Plug

Effect of Drainage Area Change by Multiple Fractures in Horizontal Wells

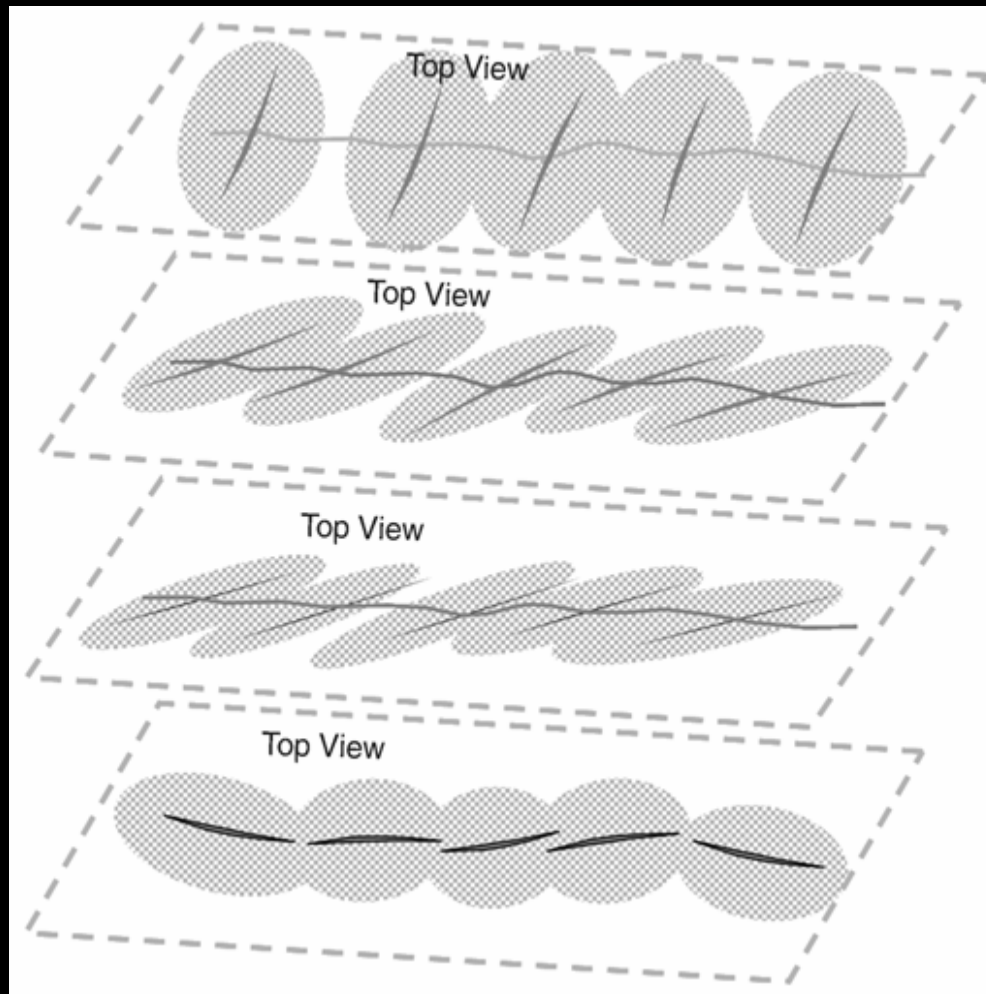
**Effective
Drainage**

~80%

~55%

~45%

~50%



**Achievable
Conductivity**

Good

Fair

Fair

Good-VG

The Fractured “Horizontal Well”

What did Owens, Cipolla, Abass, El Raba, Abou-Sayed, and others teach us back in the late 80’s and early 90’s?

We set out to achieve this...

...but we may achieve this:

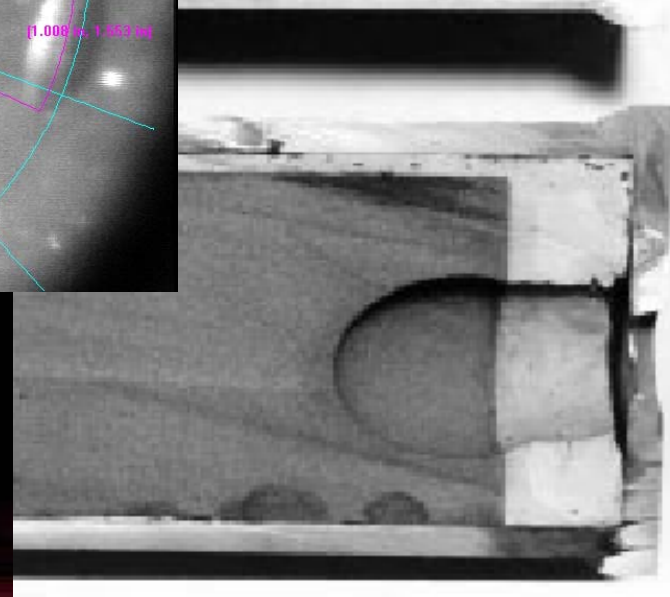
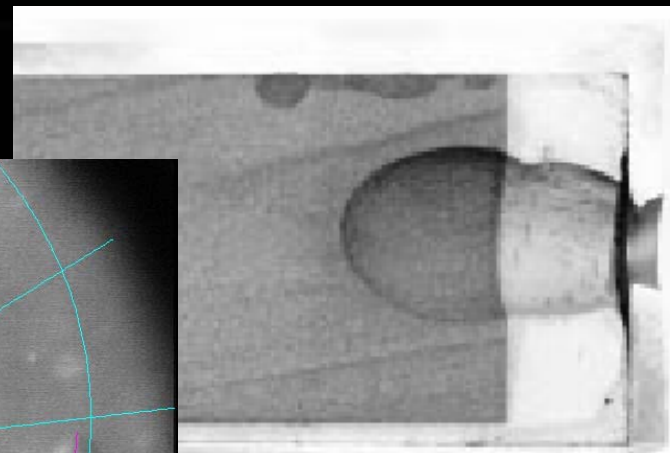
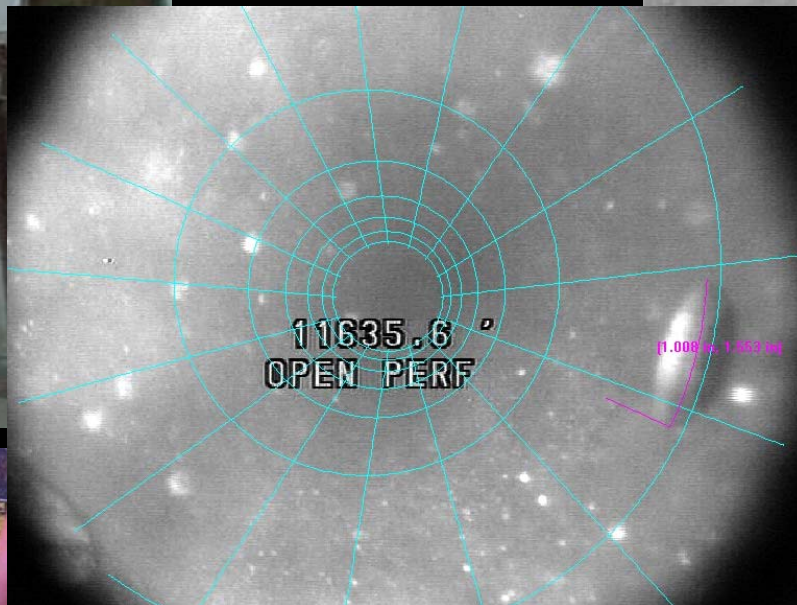
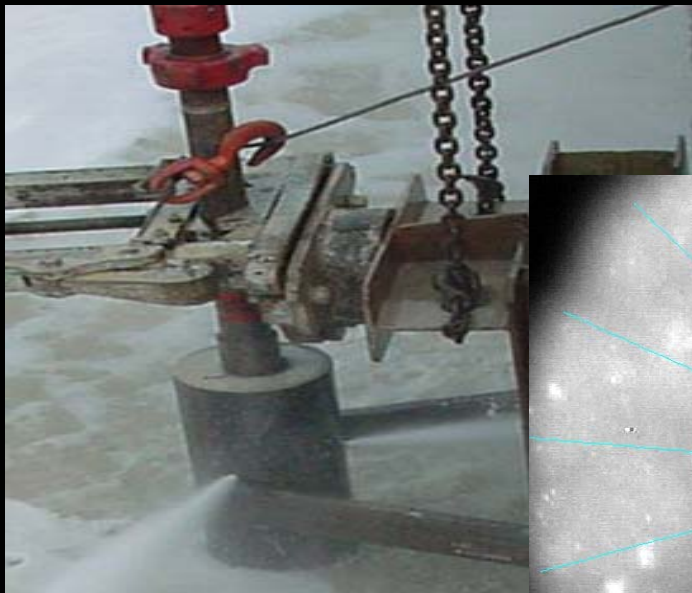


CobraMax® H Process

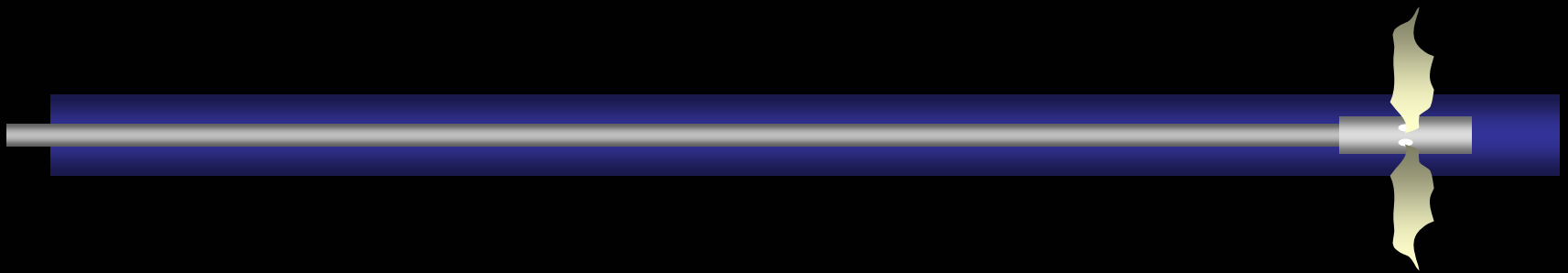
- Cased Hole Application
- Hydrajet Perforation
- Aggressive Frac Schedules
- Isolate Intervals with Sand Plugs



Hydra-Jet Perforating

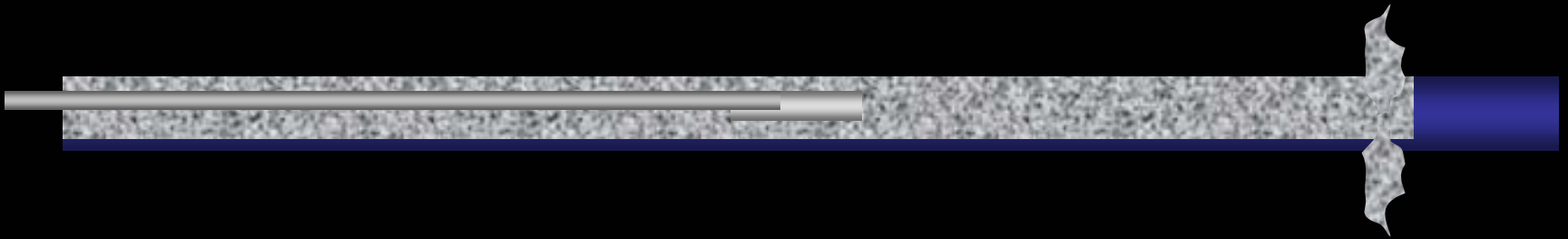


CobraMax H process



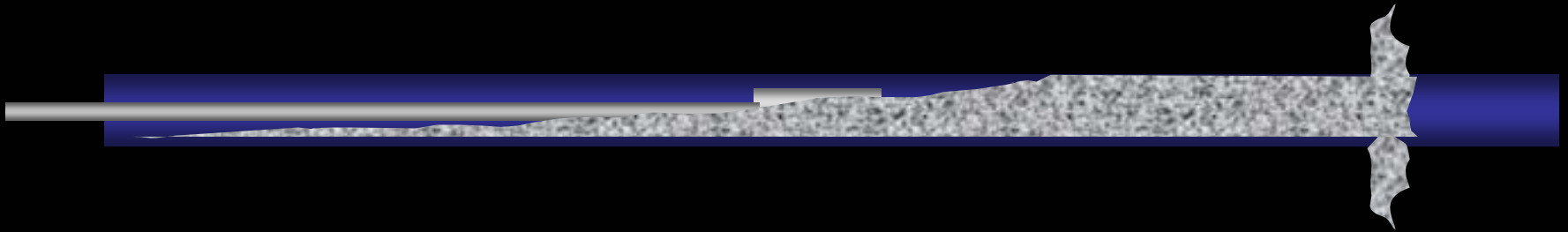
**Move Tool to Lower-most Target, Hydra - Jet Perfs,
Initiate Frac**

CobraMax H process



Pump Frac Down Annulus, and move coil to next target

CobraMax H process



Pump sand plug into place, and repeat process for next targets ... Wash out excess proppant as a final cleanout stage

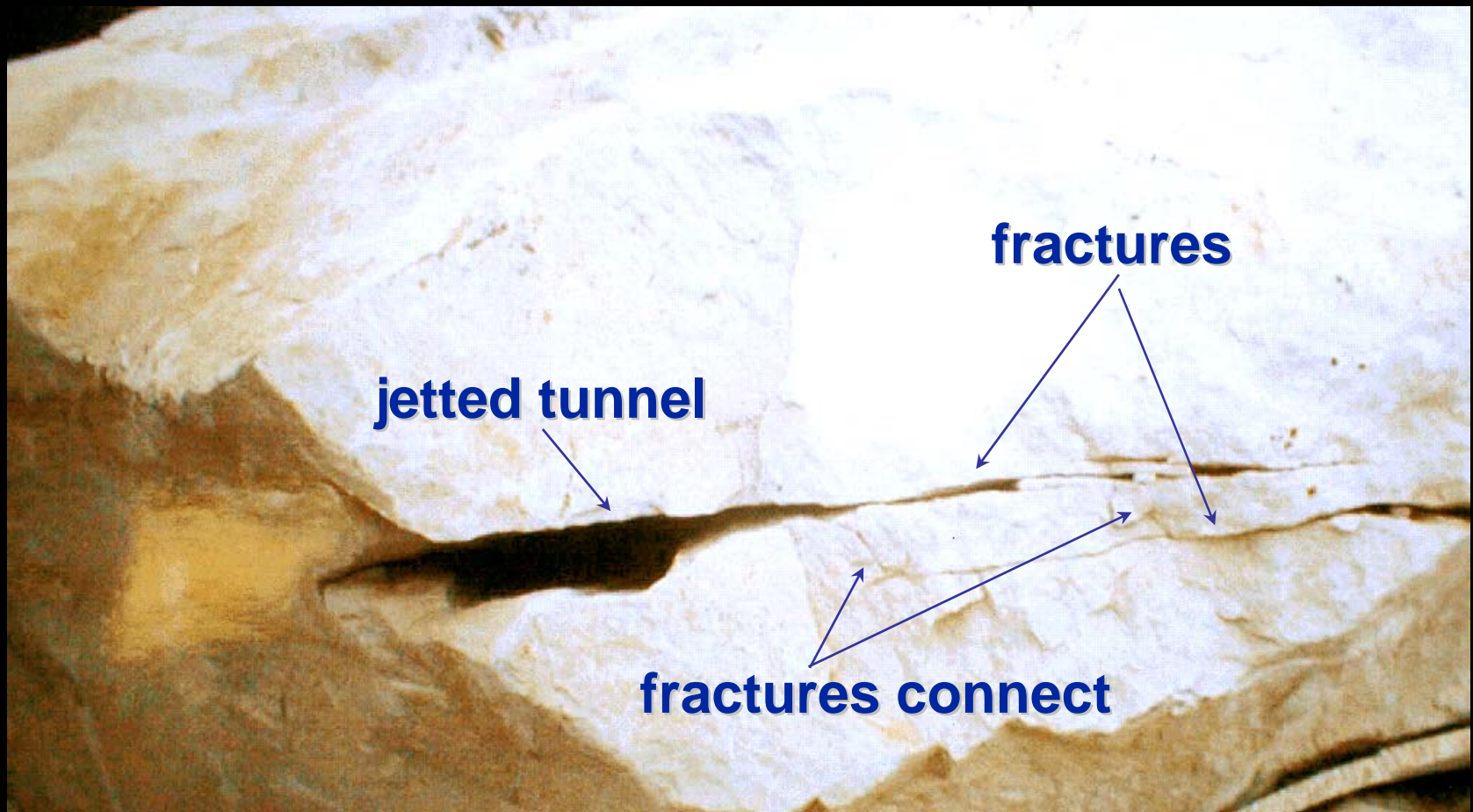
CobraMax H process

- **Over 100 wells completed globally with this process (Vertical and Horizontal) in 2006**
- **3 SPE papers on process**
 - 97004
 - 101840
 - 106052
- **Used on a four well horizontal project in Canada.**
 - Over 2000 tonnes of proppant placed.
 - Excellent production response.

SurgiFrac

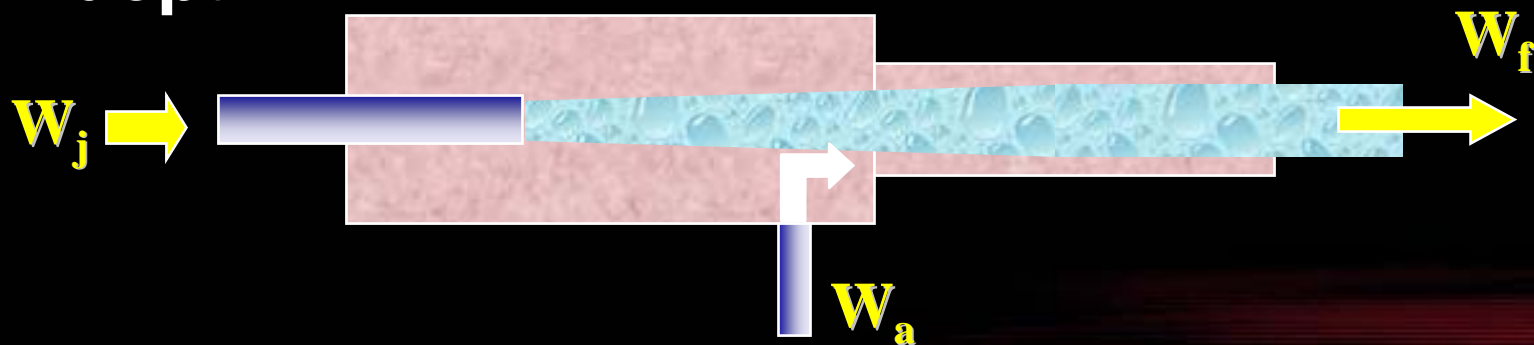
- **SurgiFrac is a method to “Surgically” place hydraulic fracture treatments in a horizontal open hole using:**
 - **Abrasive Perforating Technology**
 - **Bernoulli Effect**
 - **Conventional Fracturing Technology**
 - **Coiled Tubing Delivery**

Long Perforations After Fracturing



Bernoulli Effect

- Creates a low pressure region in the well bore from high pressure jetting.
- Creates a high pressure region in the perforation tunnel from stagnation pressure.
- The combination of these two phenomena selectively initiate a fracture at the jetting depth.

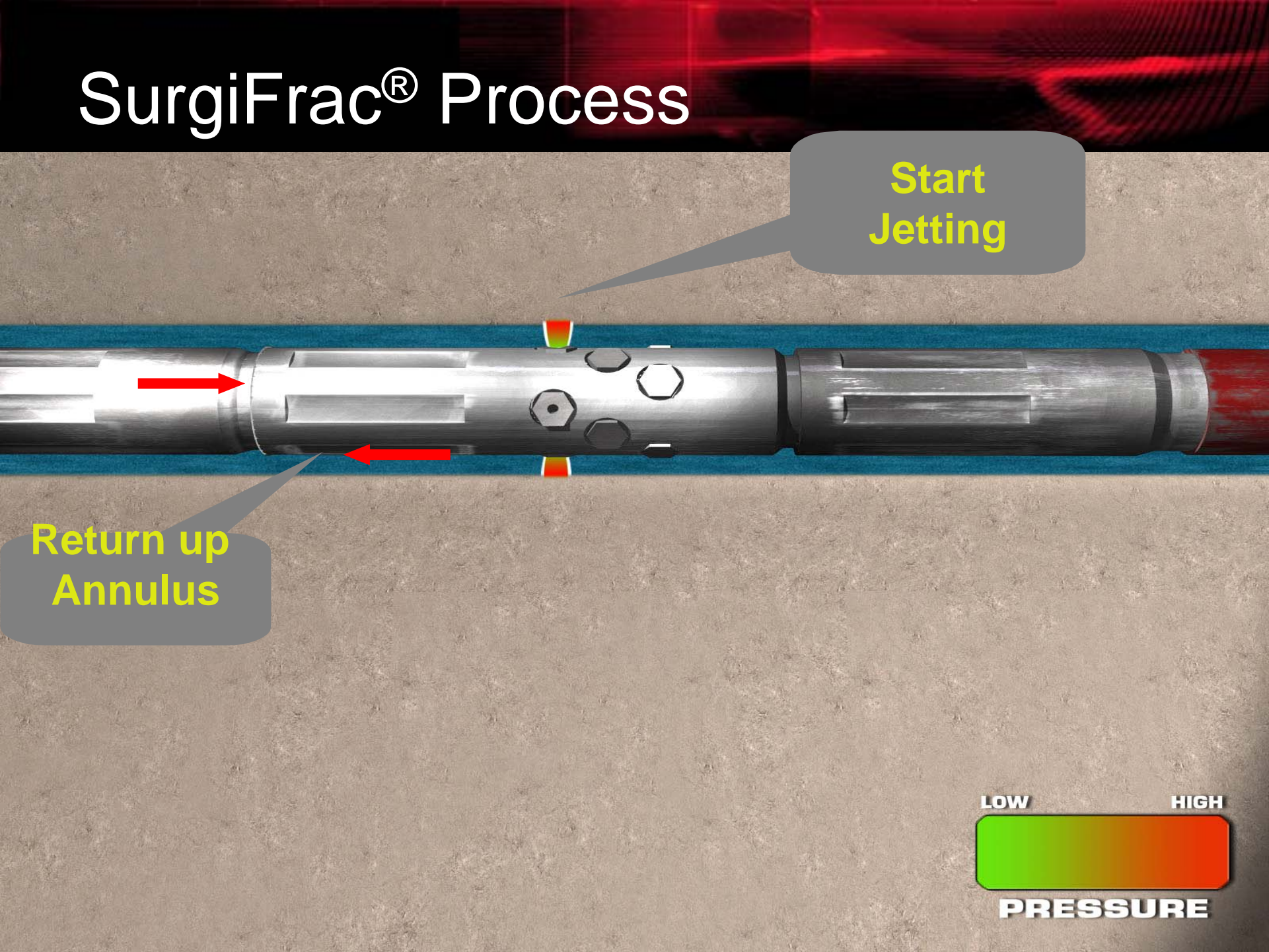


SurgiFrac[®] Process

Start
Jetting

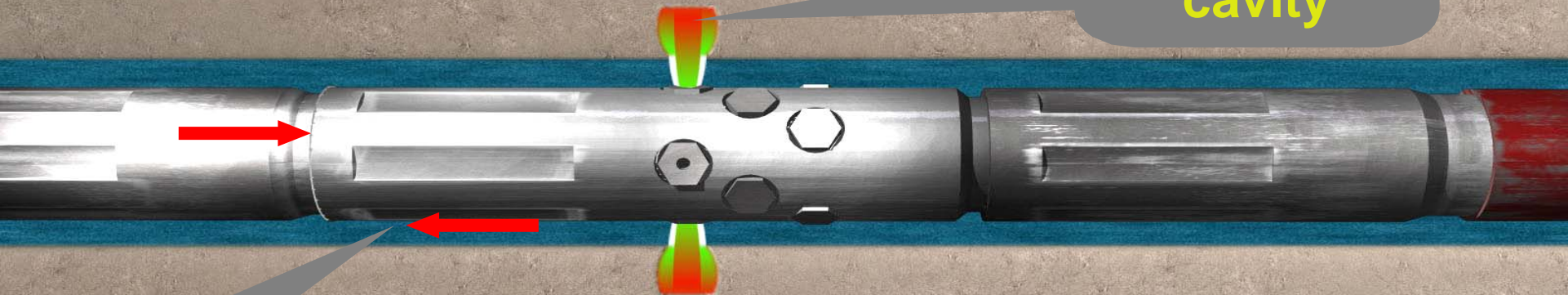
Return up
Annulus

LOW HIGH
PRESSURE



SurgiFrac[®] Process

Sandpill hits
and creates
cavity



Annulus
pressure is
~1-2 MPa
below FIP

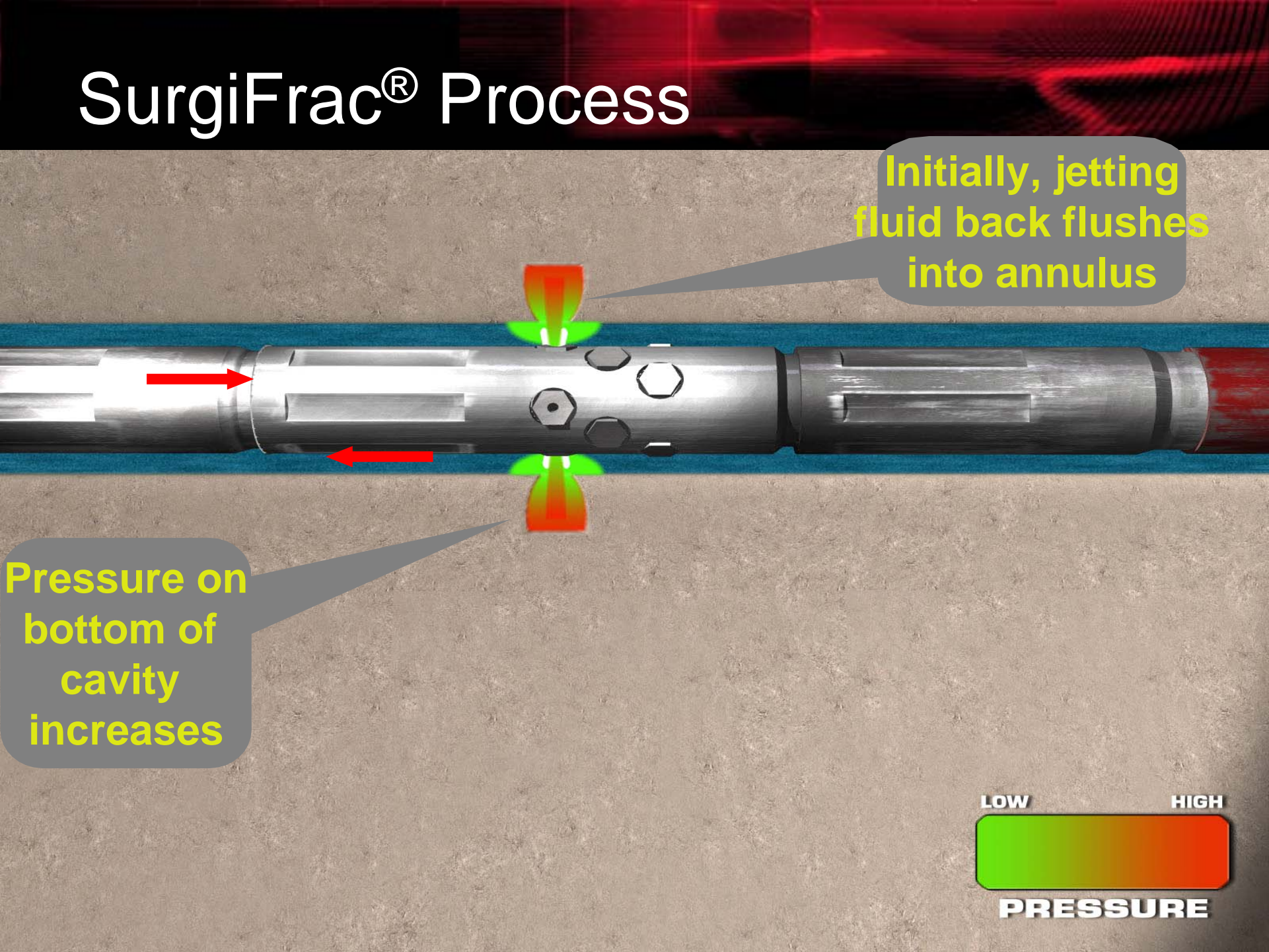
LOW HIGH
PRESSURE

SurgiFrac[®] Process

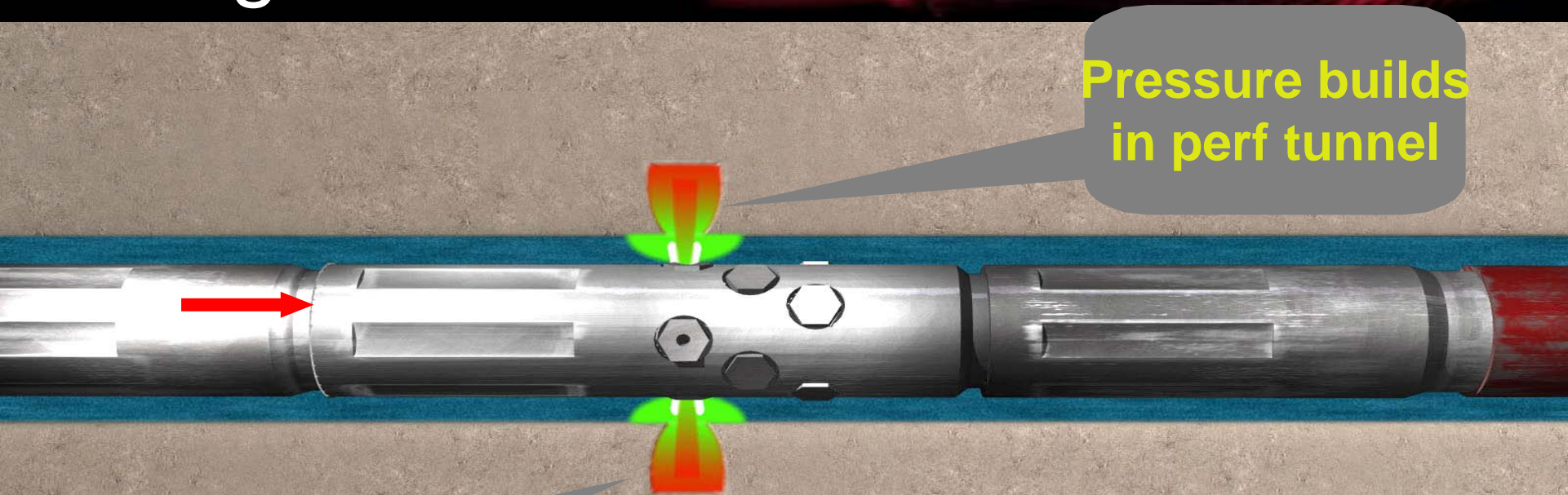
Initially, jetting fluid back flushes into annulus

Pressure on bottom of cavity increases

LOW HIGH
PRESSURE



SurgiFrac[®] Process



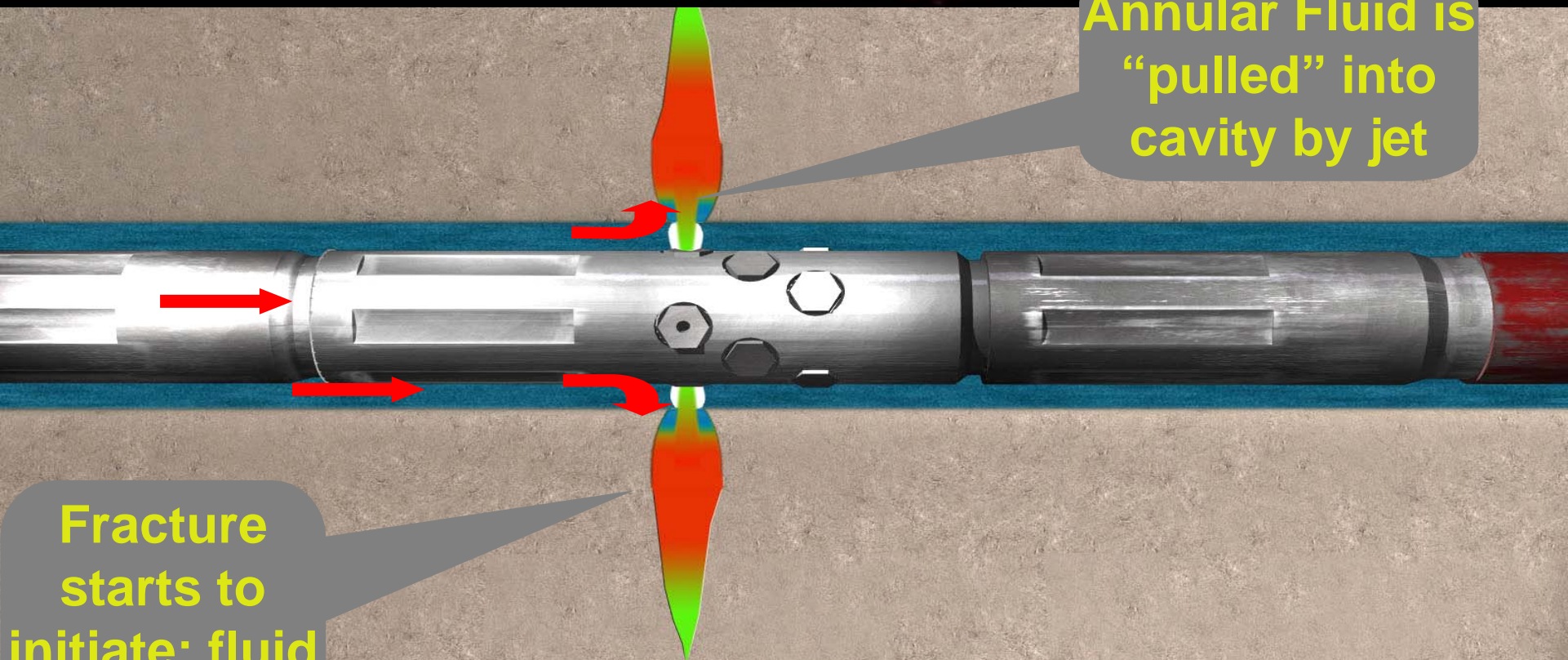
Pressure builds in perf tunnel

Shut in Annulus



SurgiFrac[®] Process

Annular Fluid is
“pulled” into
cavity by jet



Fracture
starts to
initiate; fluid
can enter
formation

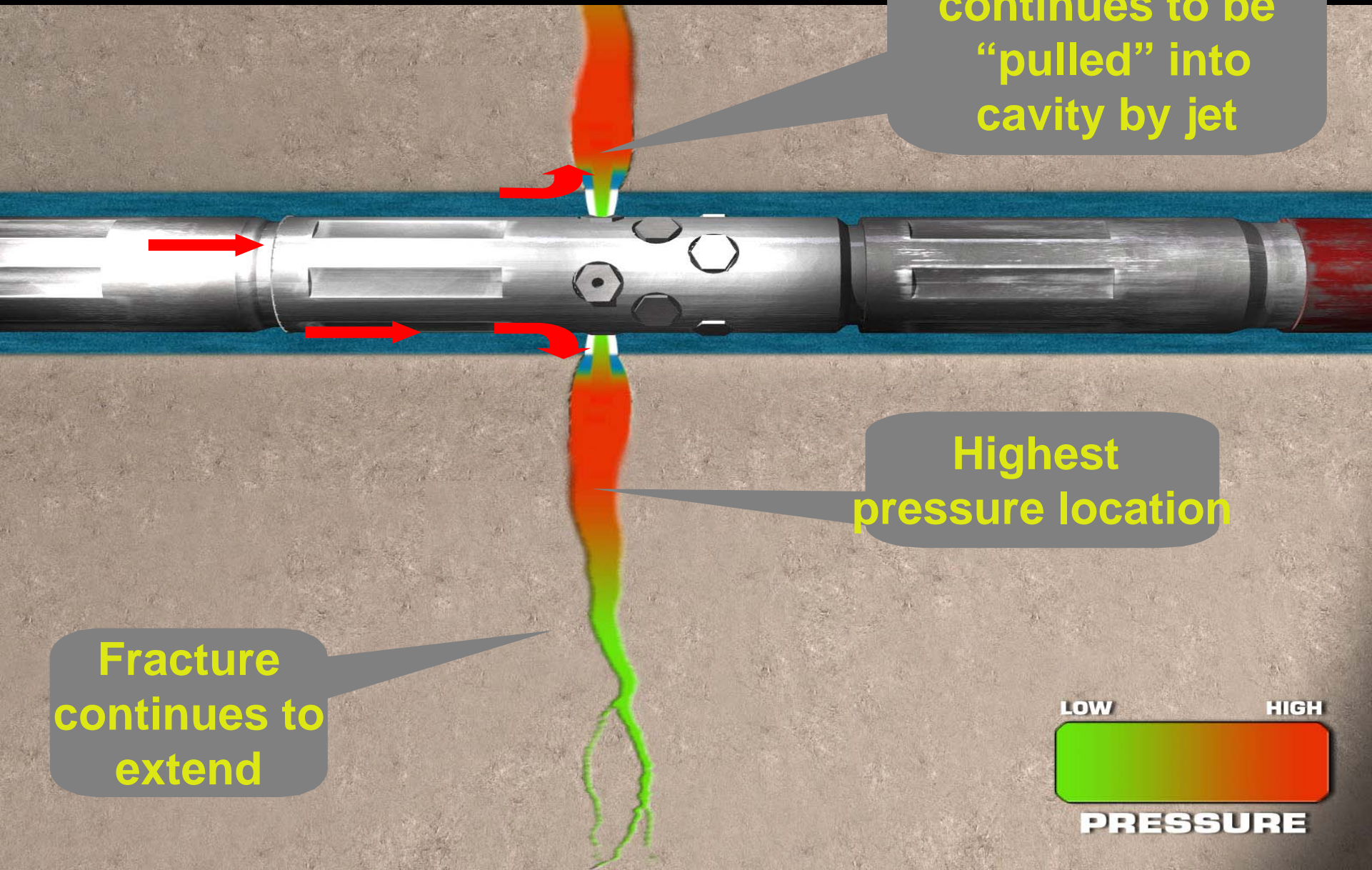


SurgiFrac[®] Process

Annular fluid continues to be "pulled" into cavity by jet

Highest pressure location

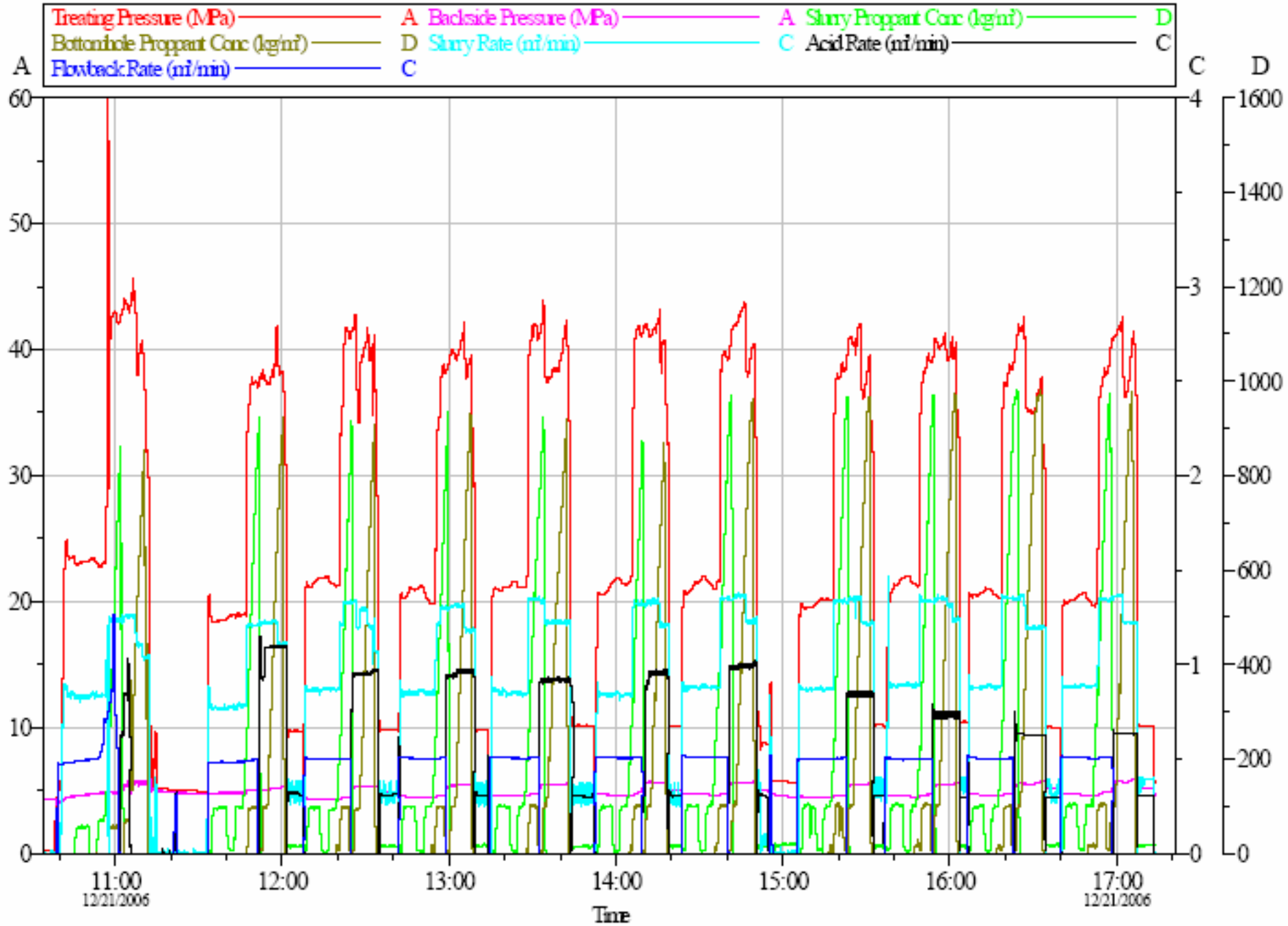
Fracture continues to extend



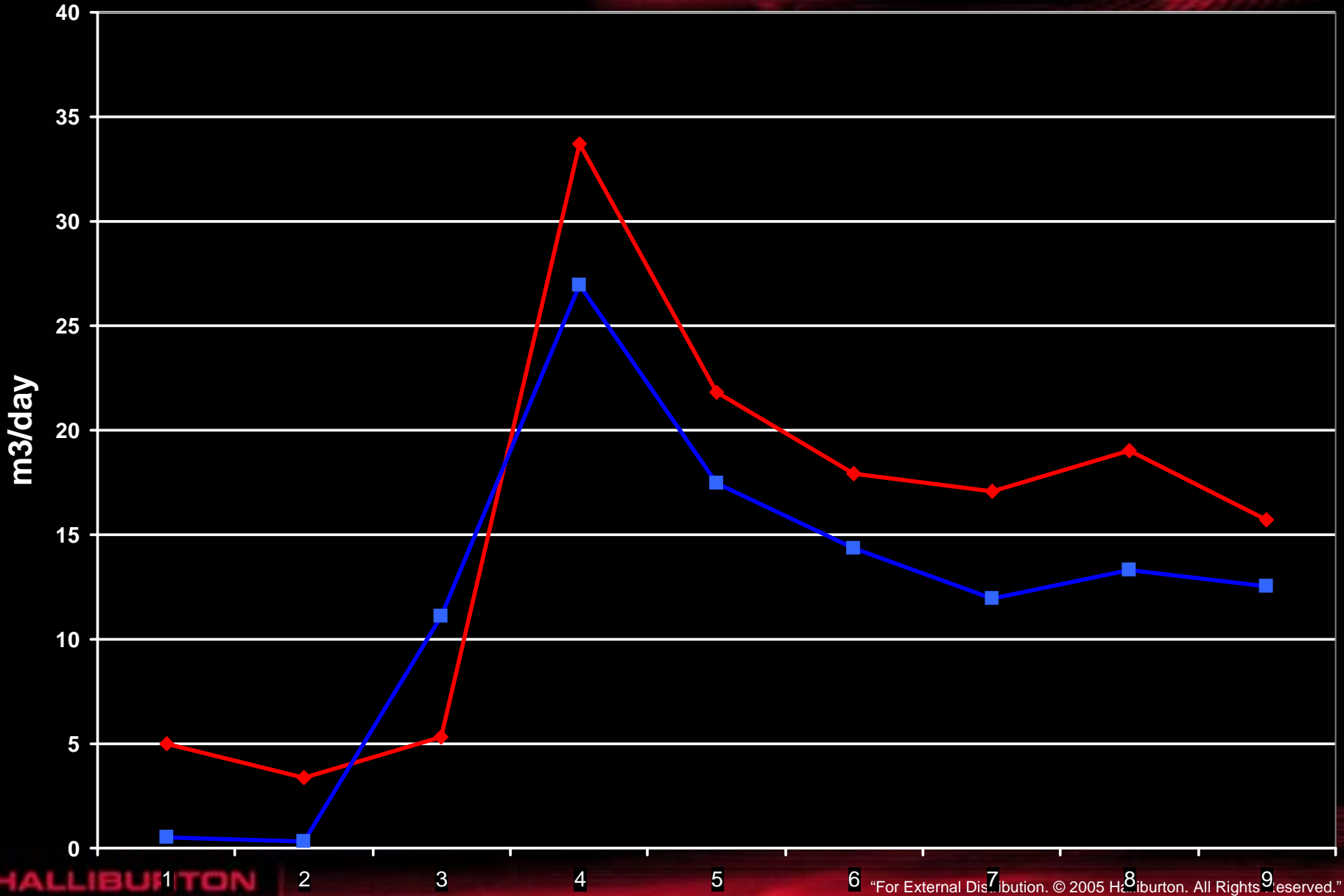
SurgiFrac in SE Saskatchewan

Process is demonstrating Value

- **2001 – 1 Well**
- **2005 – 9 Wells**
- **2006 – 75 Wells**
 - **Using 73 mm Coiled Tubing to depths of 3000 m.**
 - **80 – 100 tonnes of proppant per well.**



SurgiFrac Results



SURGIFRAC

