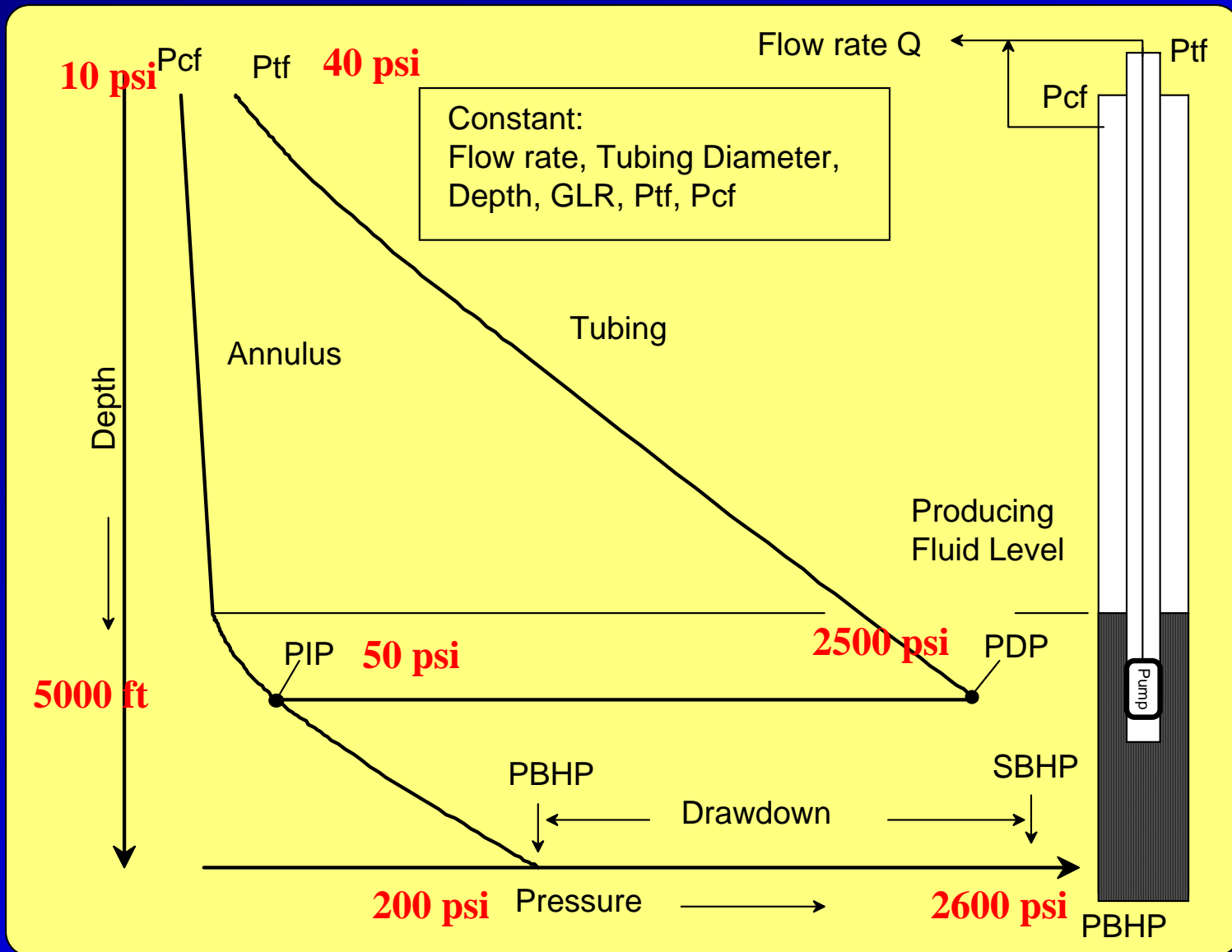


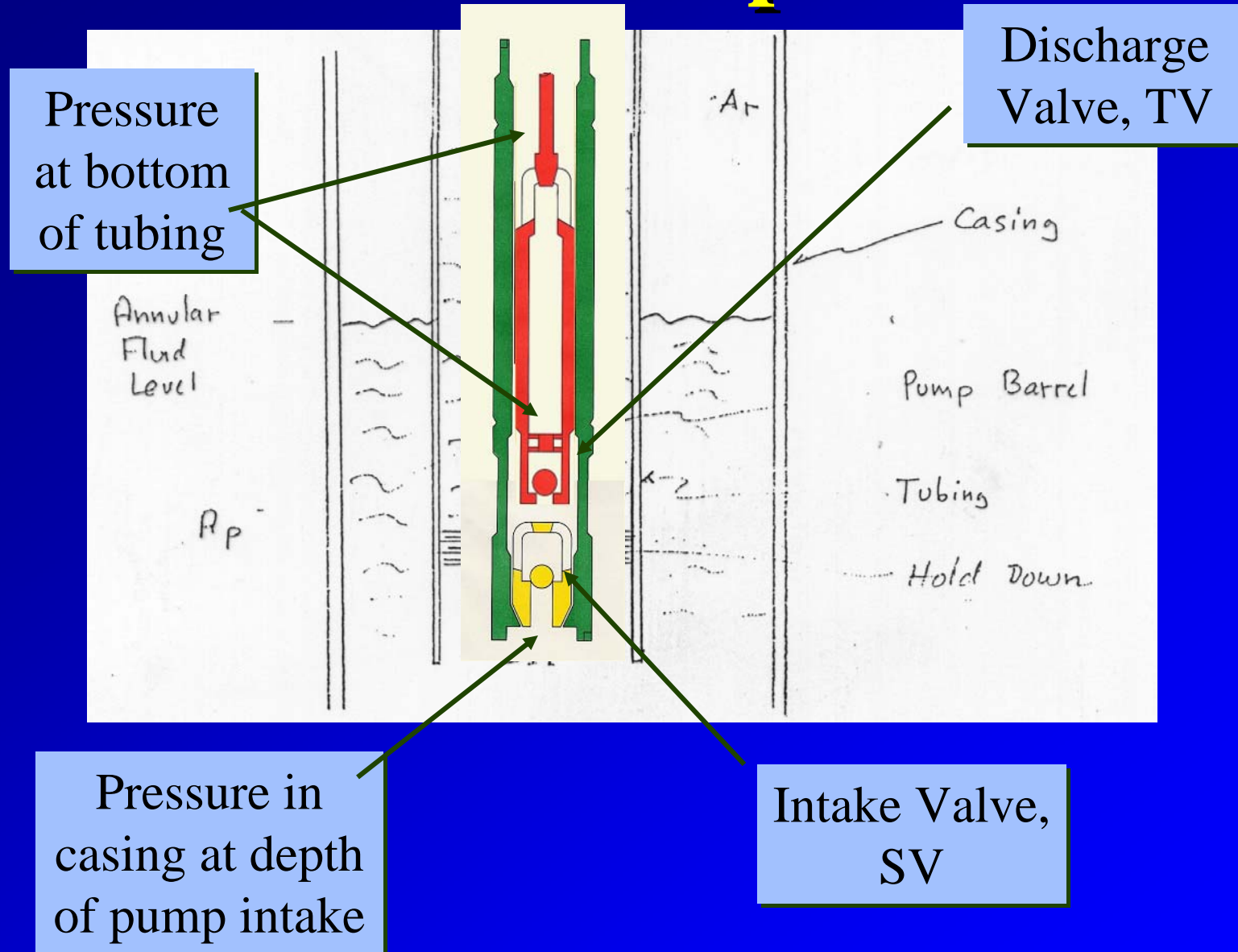
(((ECHOMETER)))

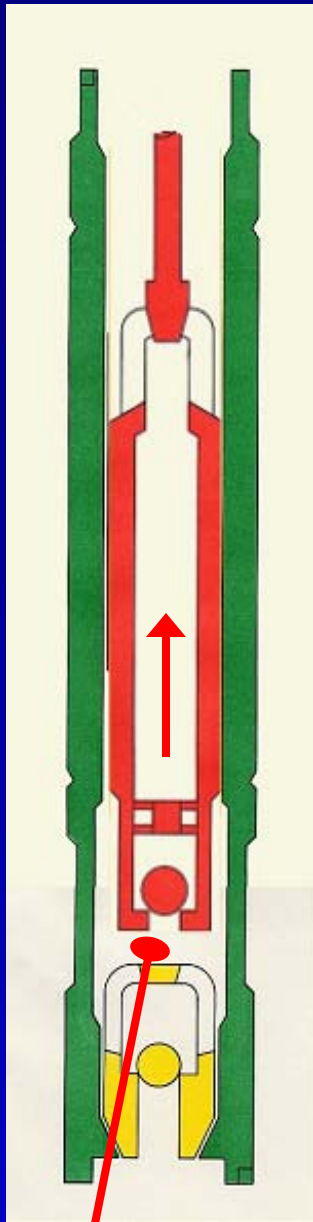
OPERATION OF THE SUCKER ROD PUMP DURING THE PUMPING CYCLE

Pumping System Provides Power to Lift Fluid by Compressing Fluid

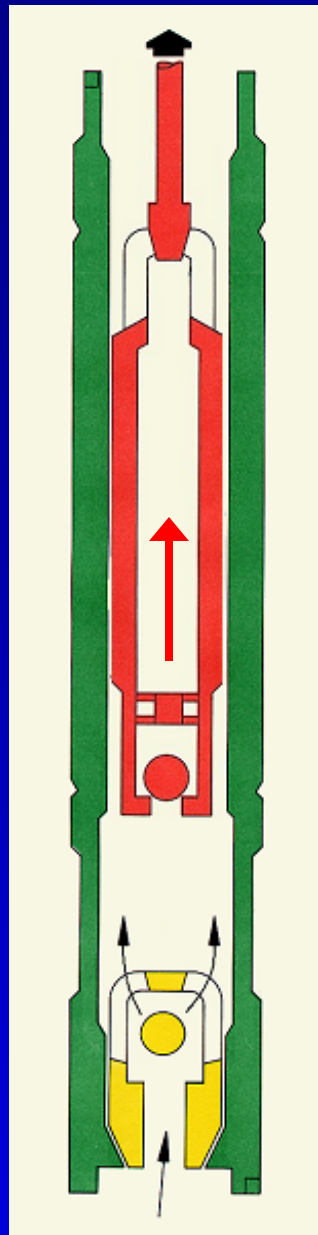


Sucker-Rod Pump

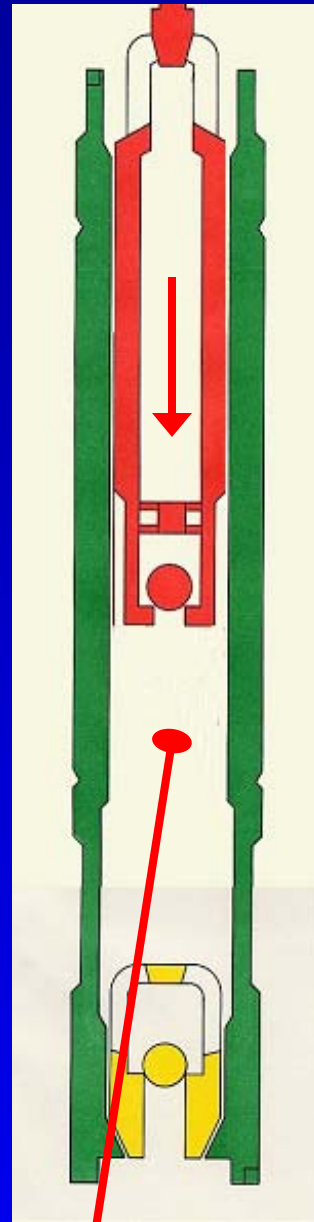




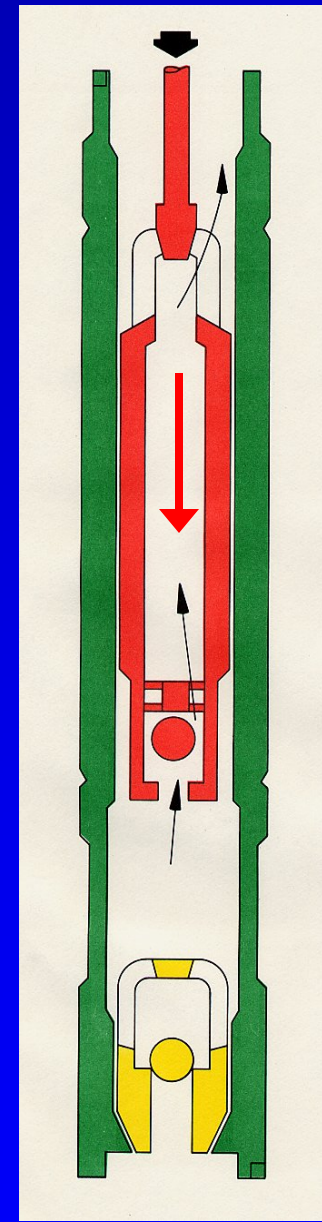
Expansion
A-B



Intake Cycle
B-C



Compression
C-D



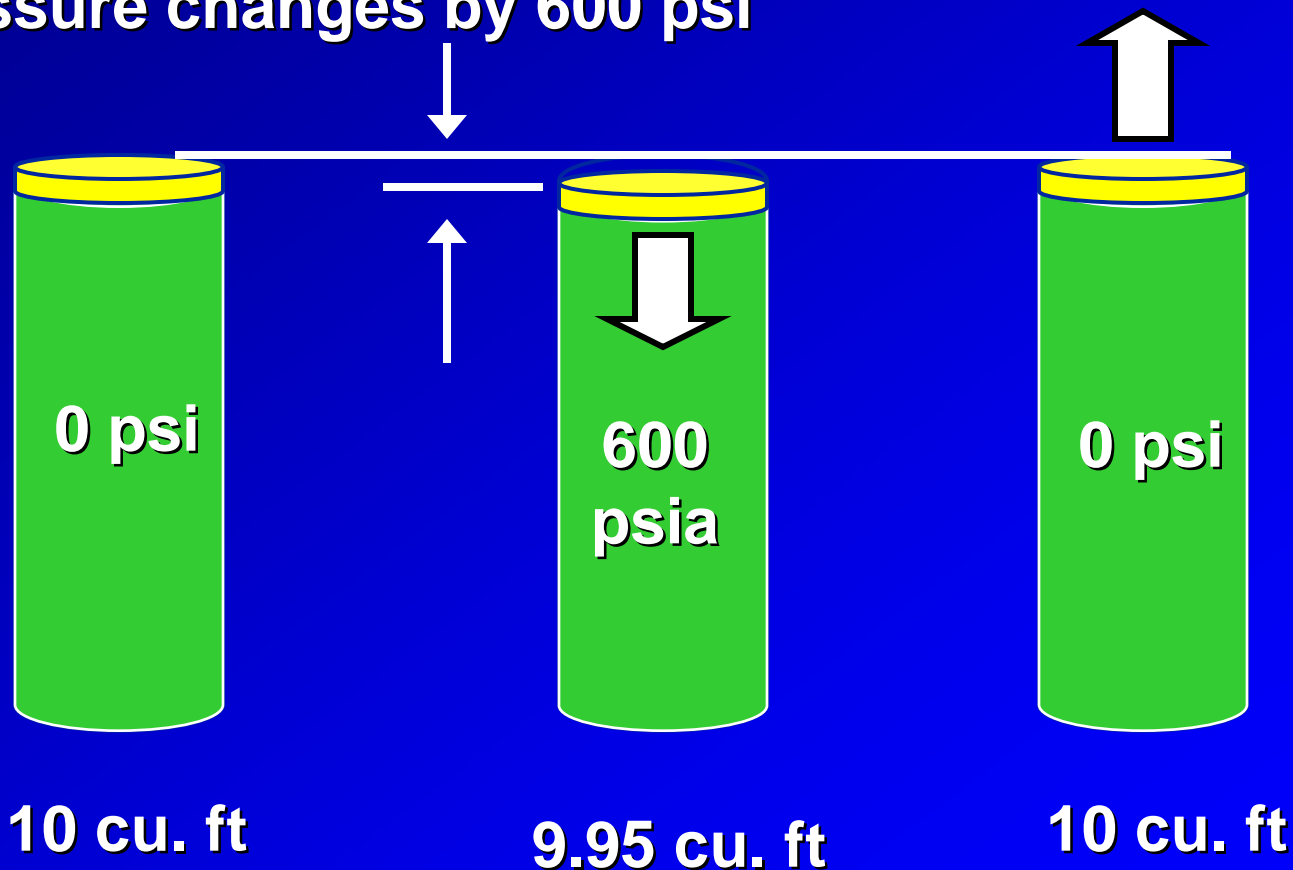
Discharge Cycle
D-A

Basic Mechanism

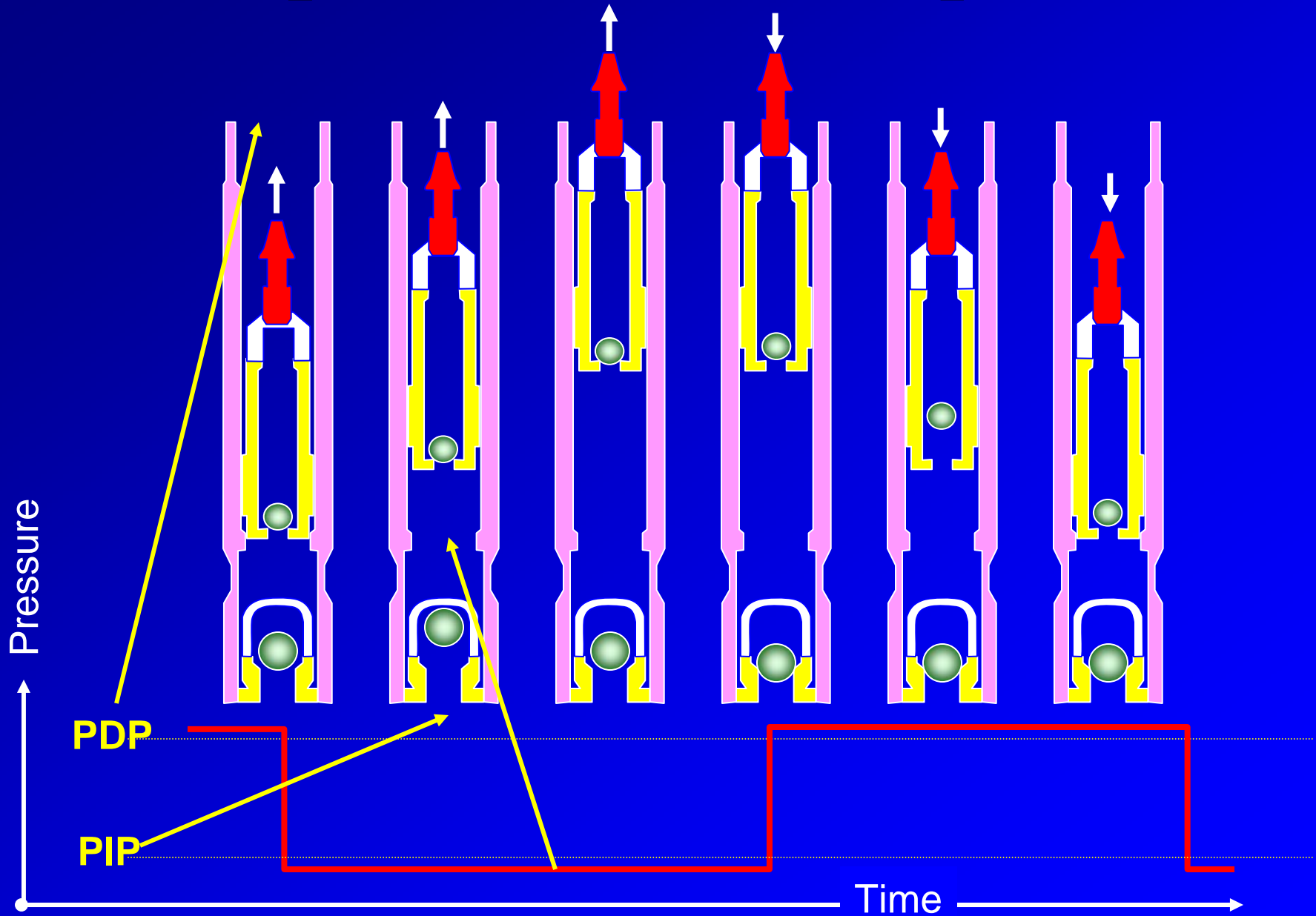
- ◆ Valve opens when pressure below valve **greater** than pressure above valve.
- ◆ Valve closes by flow.
- ◆ Pressure in barrel is a function of plunger travel and compressibility of fluid in barrel.
- ◆ Discharge pressure is pressure at bottom of tubing (PDP)
- ◆ Intake pressure is controlled by casing pressure and fluid column in annulus (PIP)

Compression/Expansion of Oil at Constant Temperature

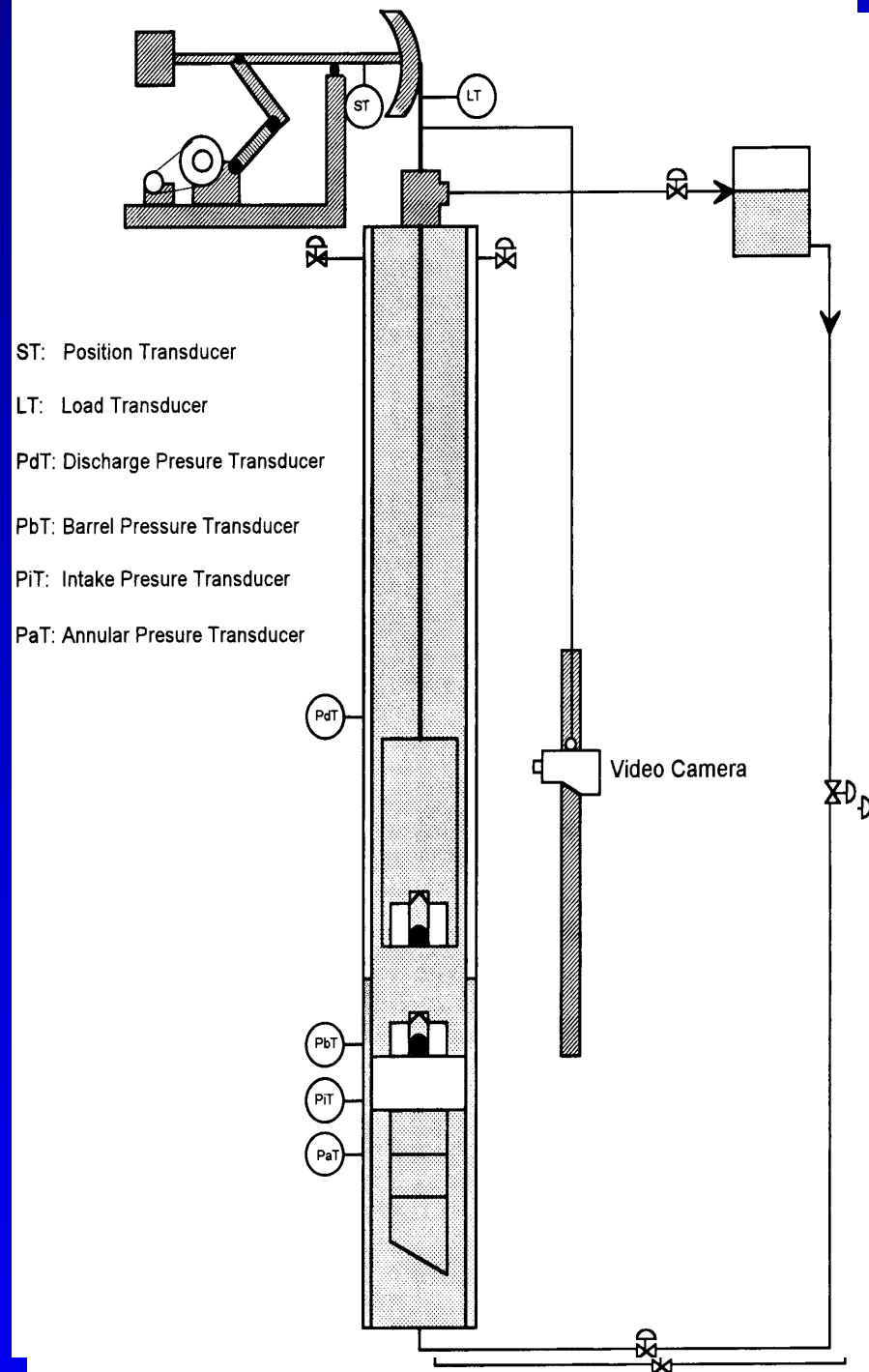
When barrel is full of oil, piston travels down or up by 0.1 inch and pressure changes by 600 psi



Pump Pressure for Liquid

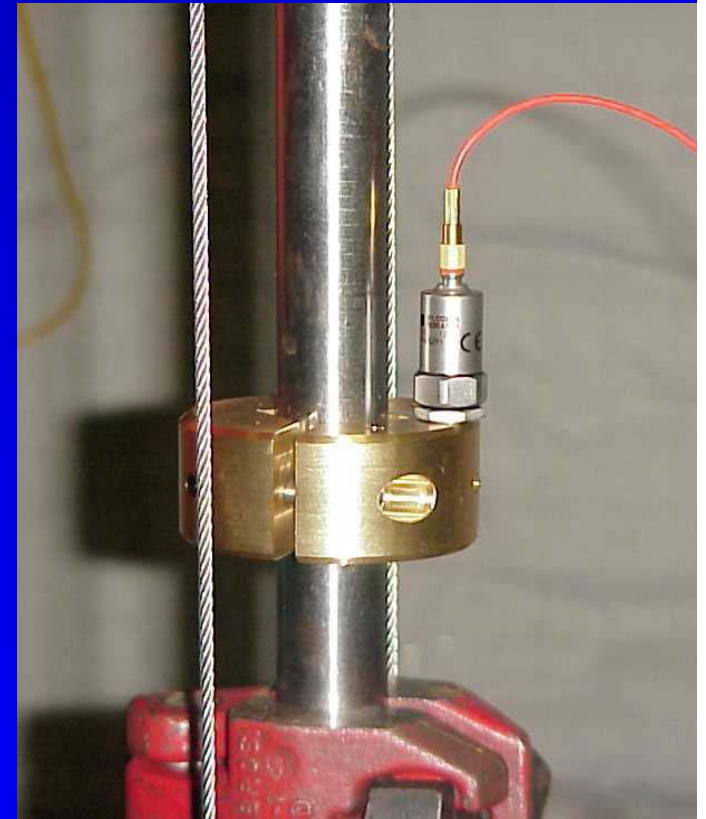


UT Laboratory Instrumented Sucker-rod Pump

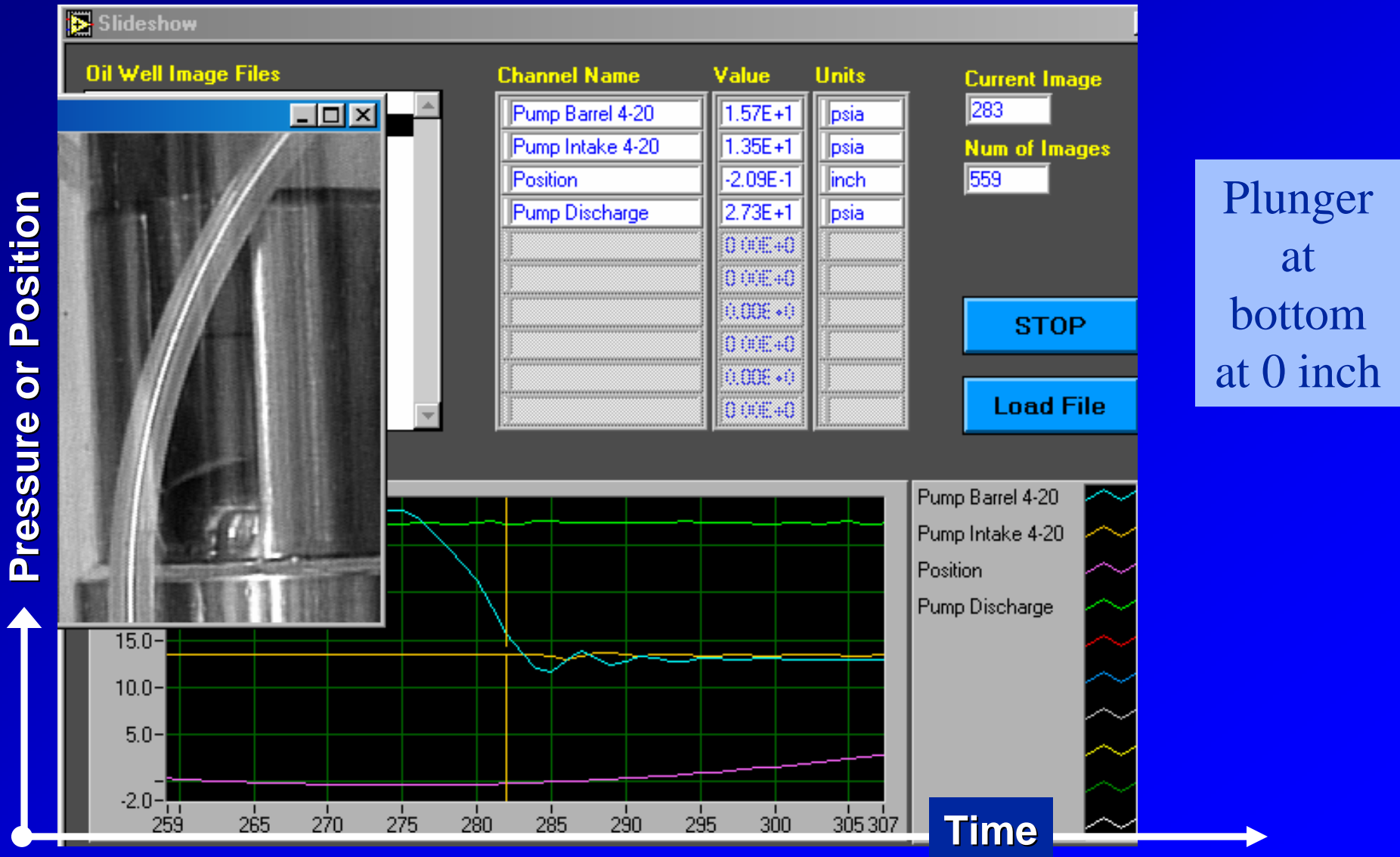


“Sucker Rod Acoustics” in the Lab

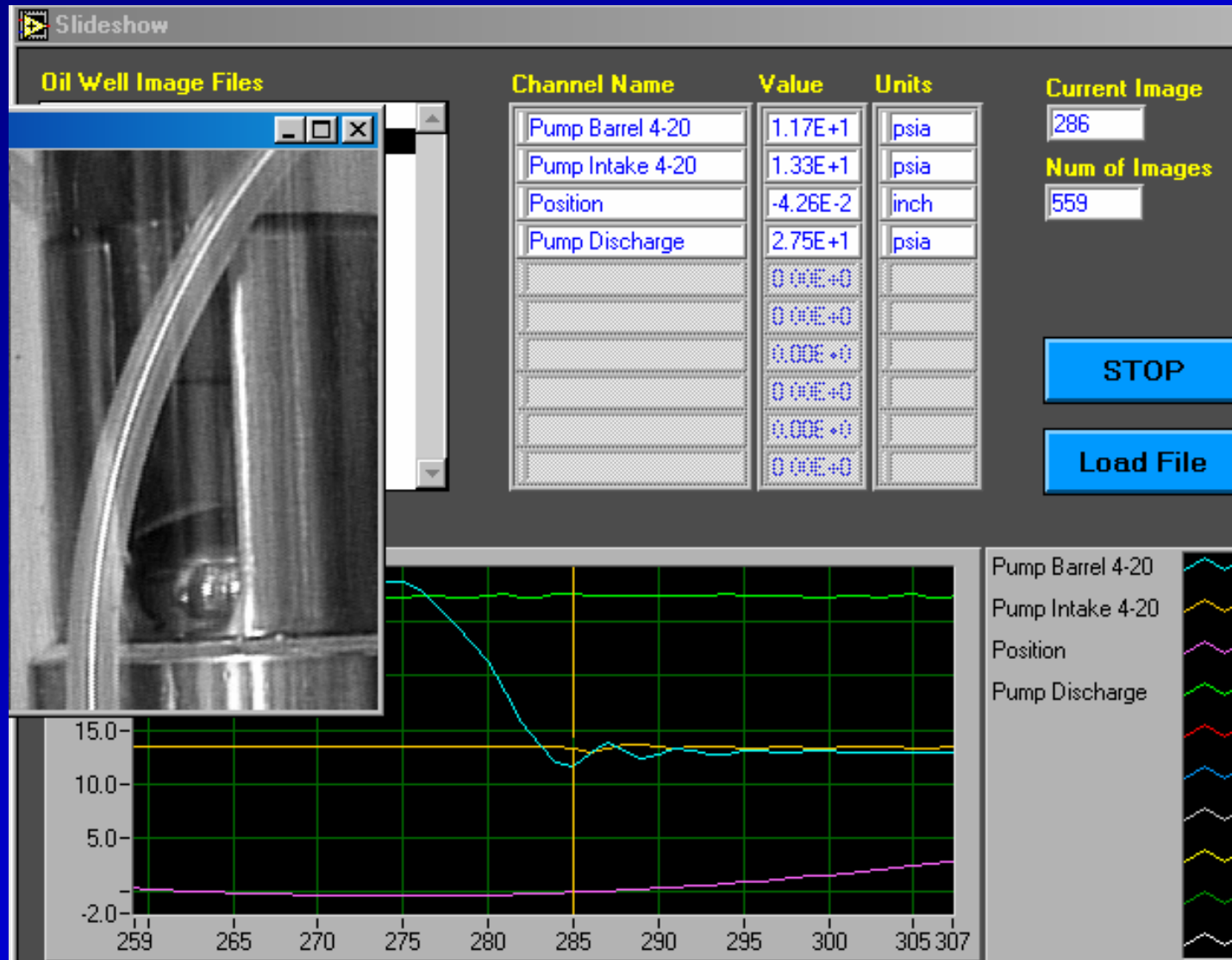
15 SPM Pumped-Off (BV)



Start of Upstroke – SV Closed

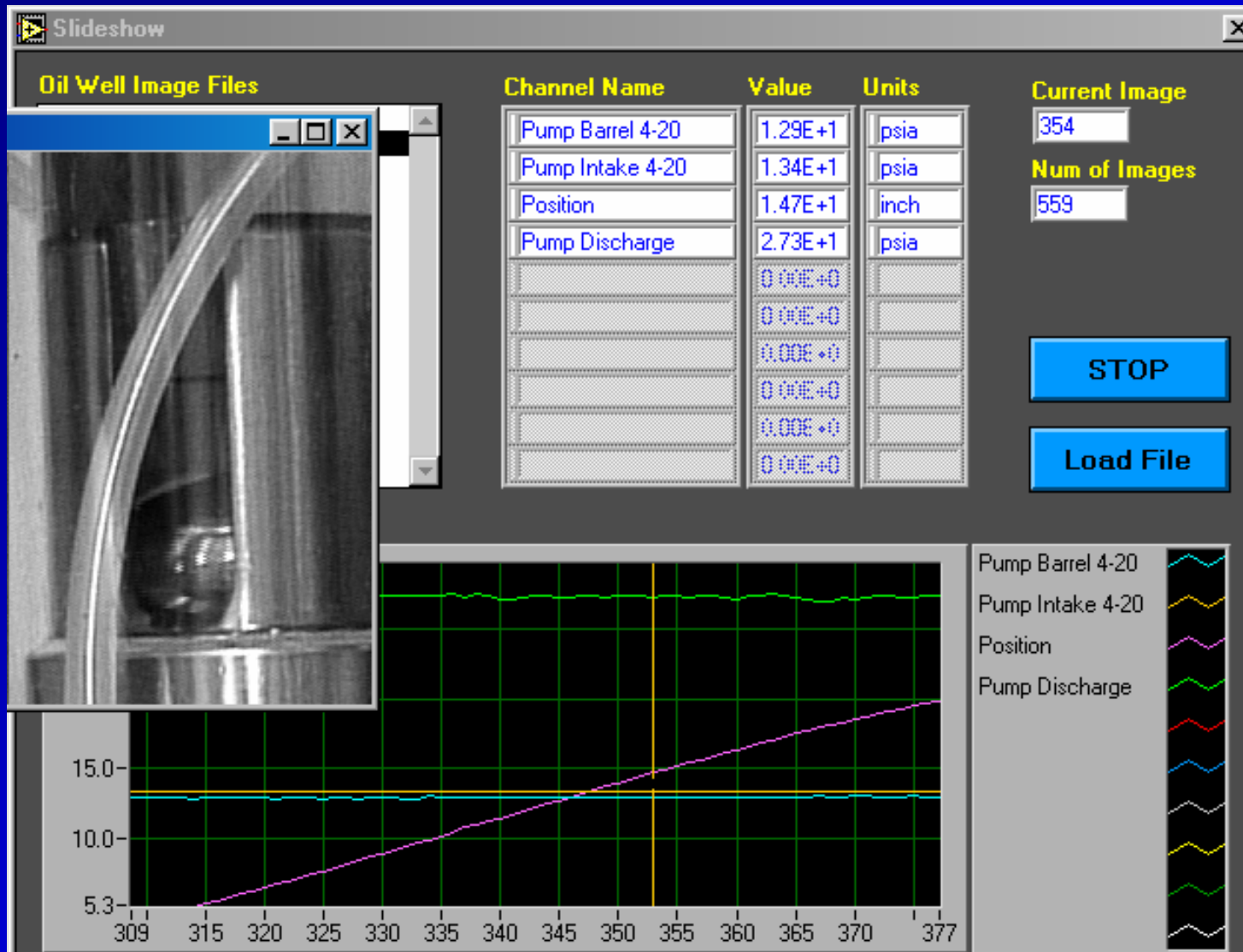


Upstroke – SV Opens



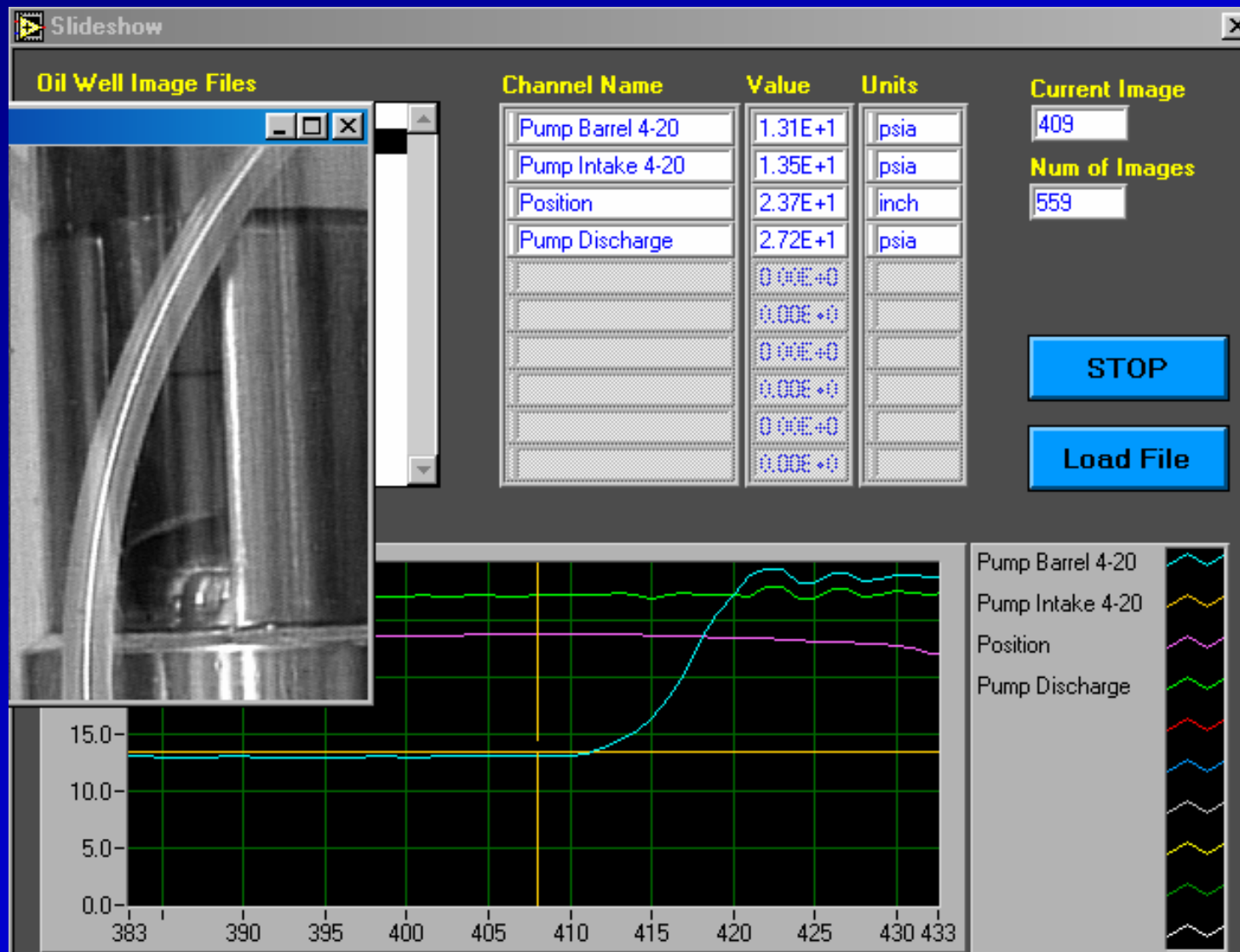
Plunger rising and at 0.1 inch from bottom

Middle of Upstroke – SV Open



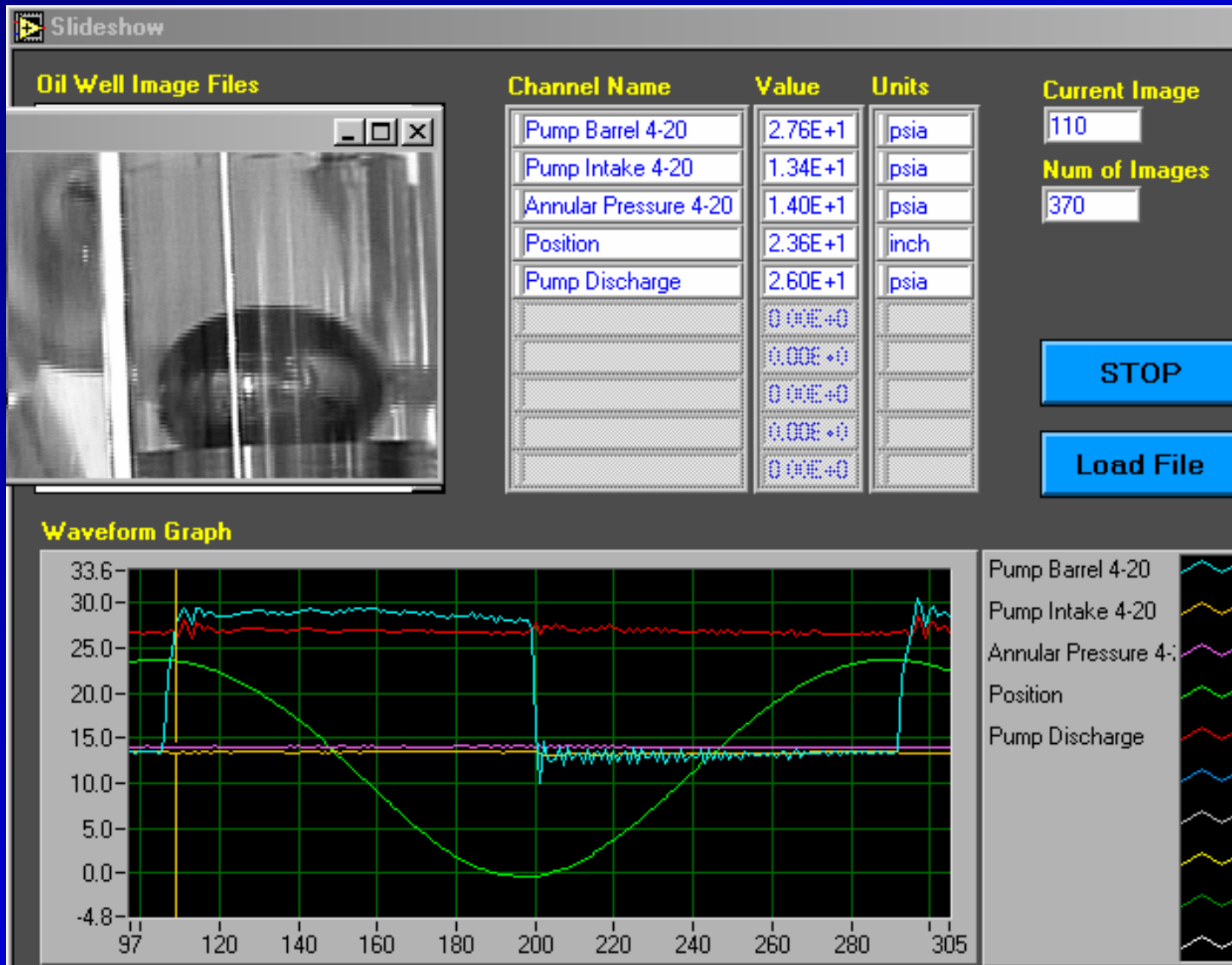
Plunger
Rising
and at
14.7
inch
from
bottom

Top of Upstroke – SV Closed



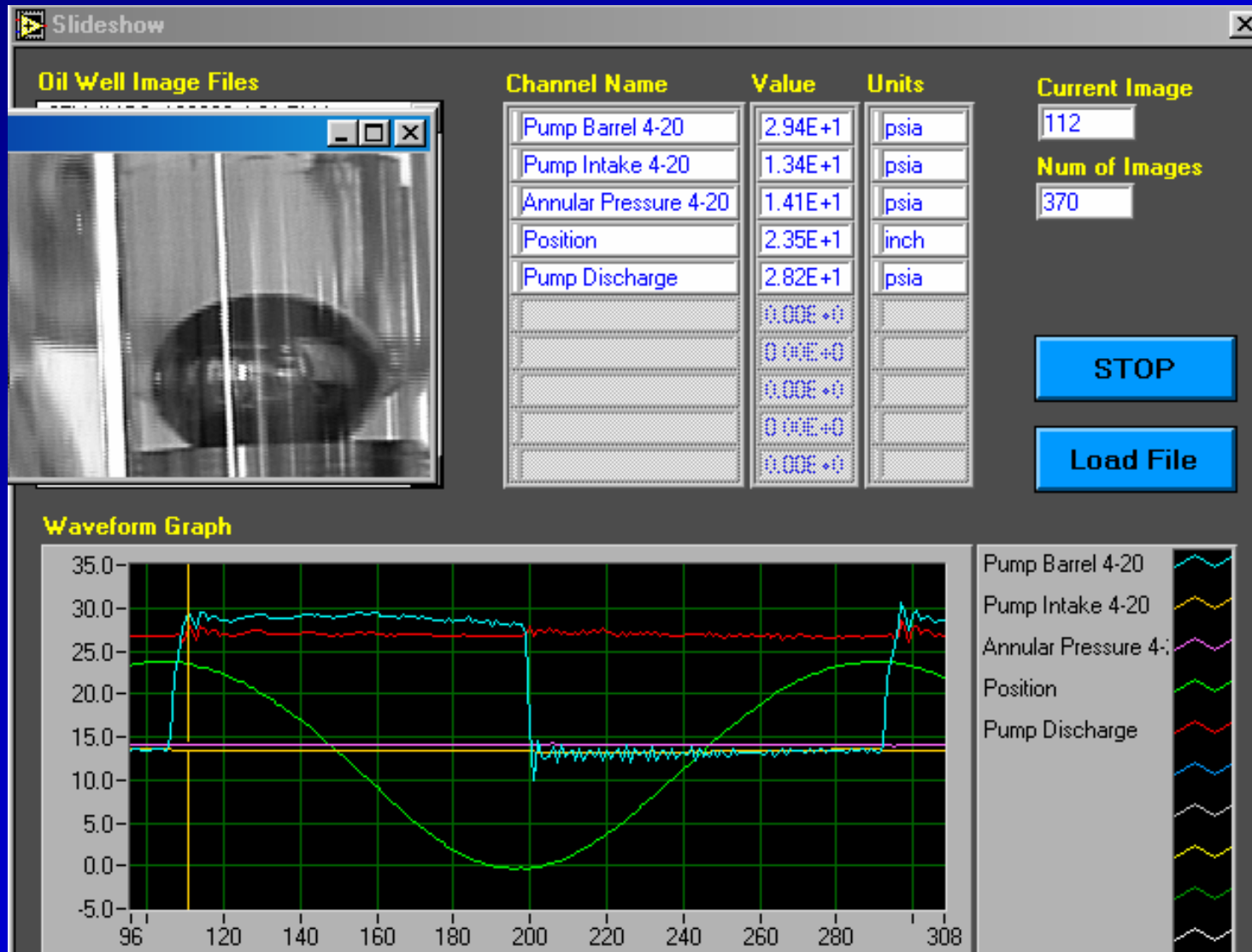
Plunger
at top at
23.7
inch
from
bottom

Start of Downstroke – TV closed



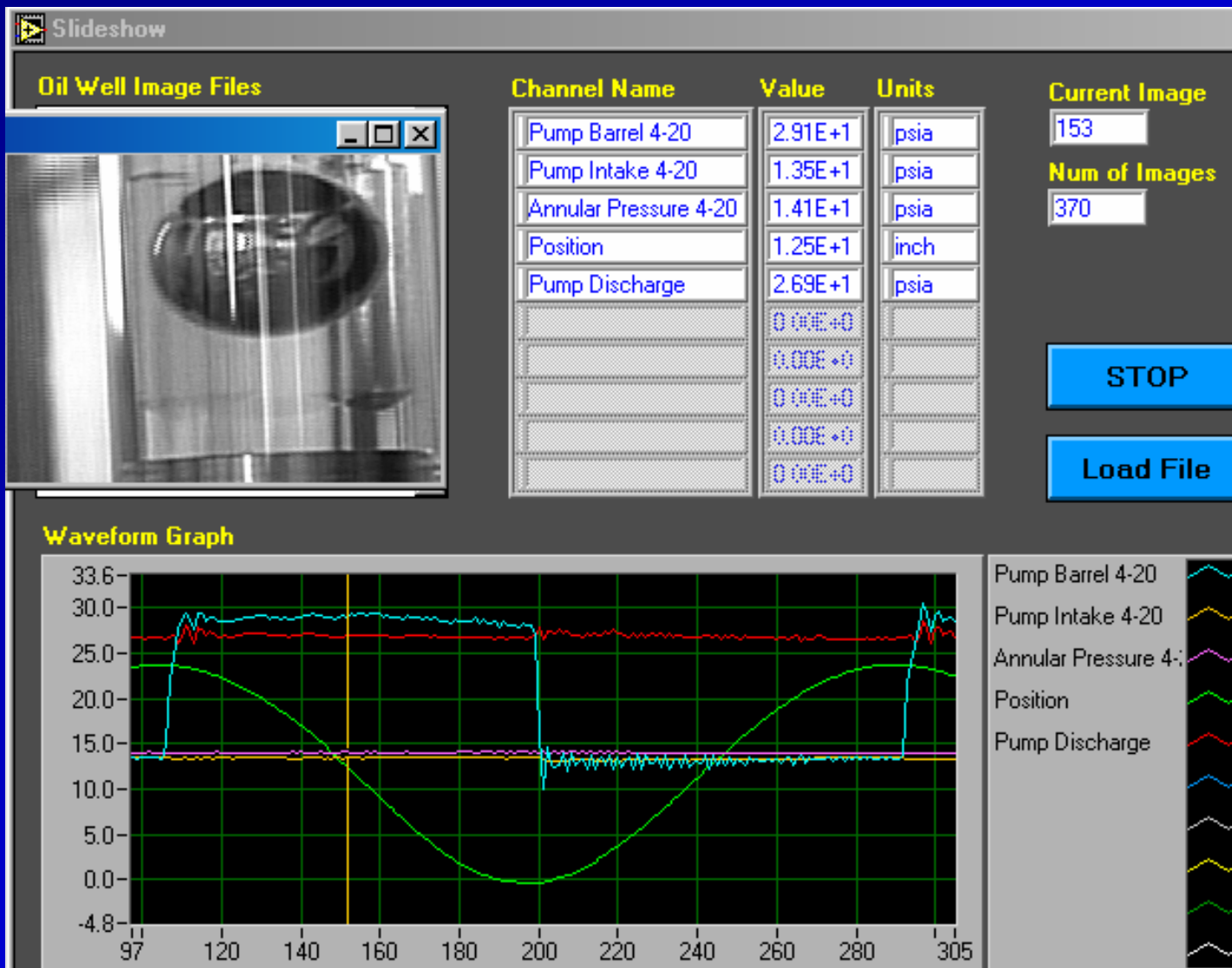
Plunger falling and at 23.6 inch

Downstroke – TV Opening



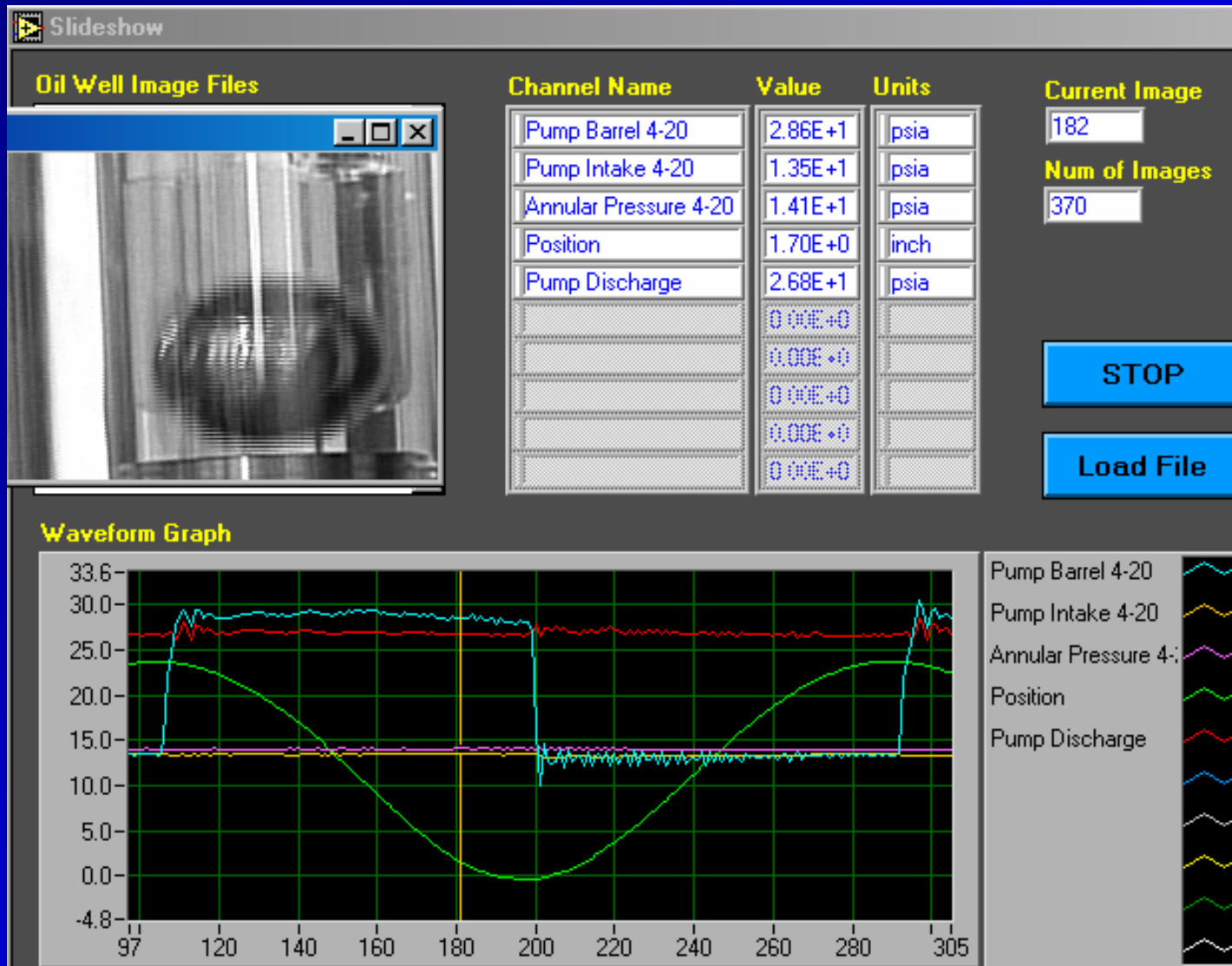
Plunger falling and at 23.5 inch from bottom

Middle of Downstroke – TV Open



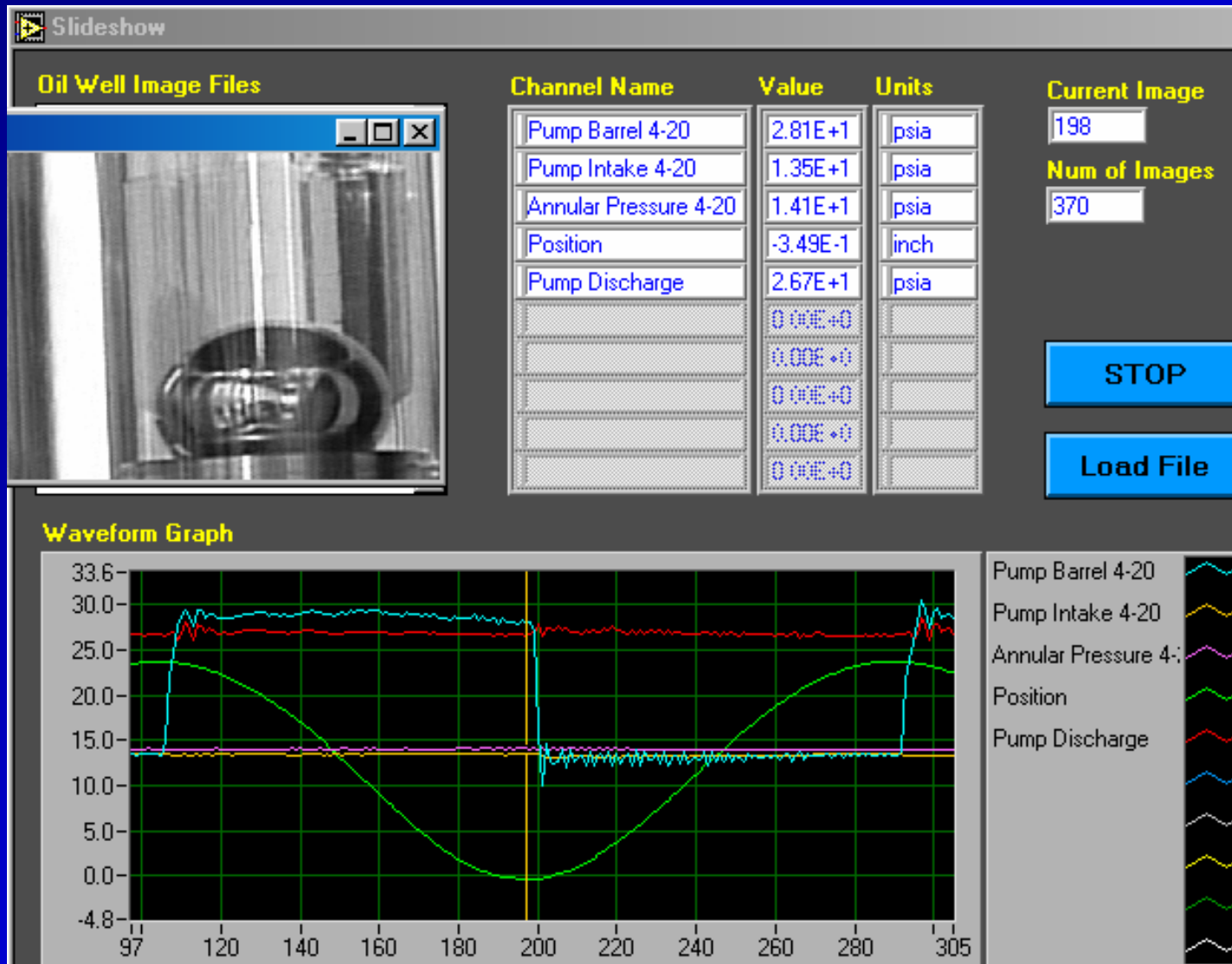
Plunger
at 12.5
inch
from
bottom

End of Downstroke – TV Closing



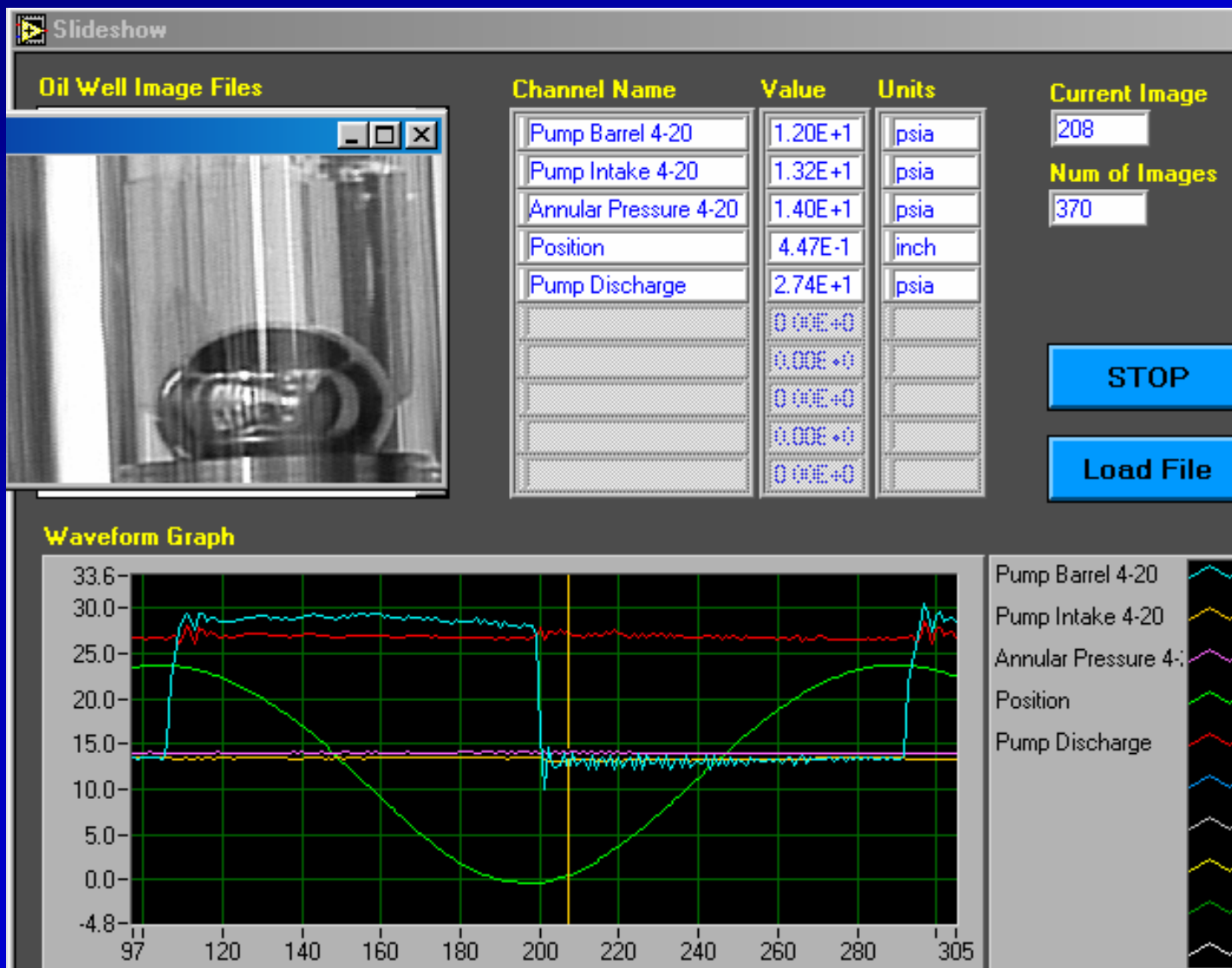
Plunger
at 1.7
inch
from
bottom

Bottom of Downstroke – TV Closed



Plunger
at 0
inch,
bottom
of stroke

Beginning of Next Upstroke – TV Closed



Plunger
at 0.4
inch

Pump Filled With Liquid

Slideshow

Oil Well Image Files

Sandia_110400_3-20_PM.img

Channel Name	Value	Units
Pump Barrel 4-20	2.82E+1	psia
Pump Intake 4-20	1.38E+1	psia
Position	-3.34E-1	inch
Pump Discharge	2.68E+1	psia
	0.00E+0	
	0.00E+0	
	0.00E+0	
	0.00E+0	
	0.00E+0	
	0.00E+0	

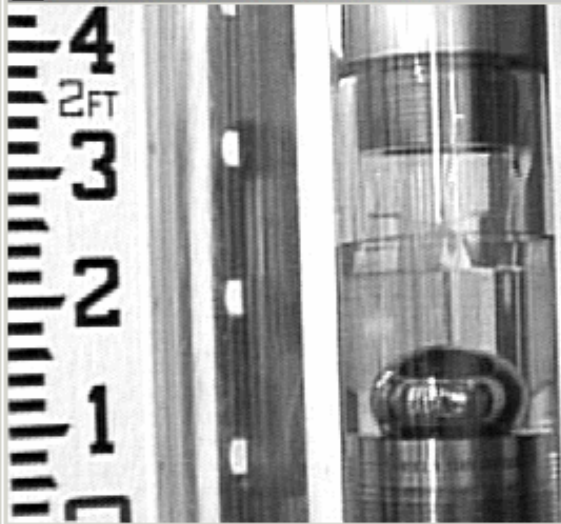
Current Image: 593

Num of Images: 1235

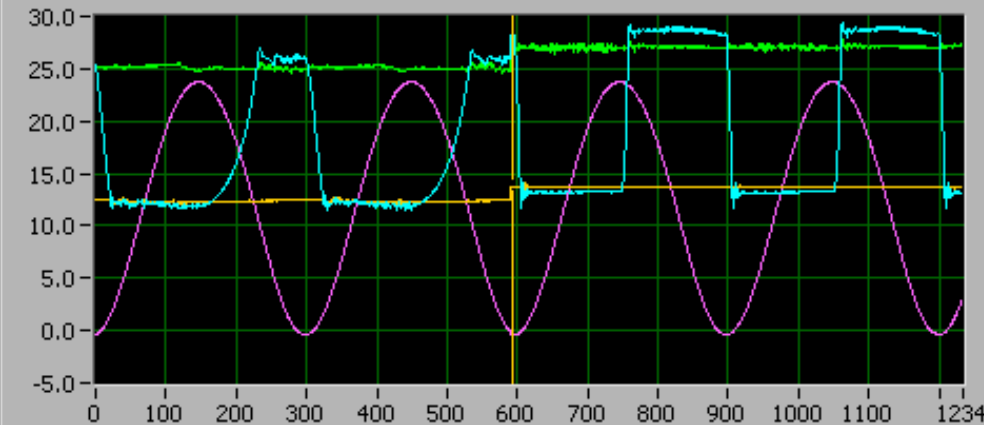
STOP

Load File

Slide 593



Waveform Graph



Pump Barrel 4-20

Pump Intake 4-20

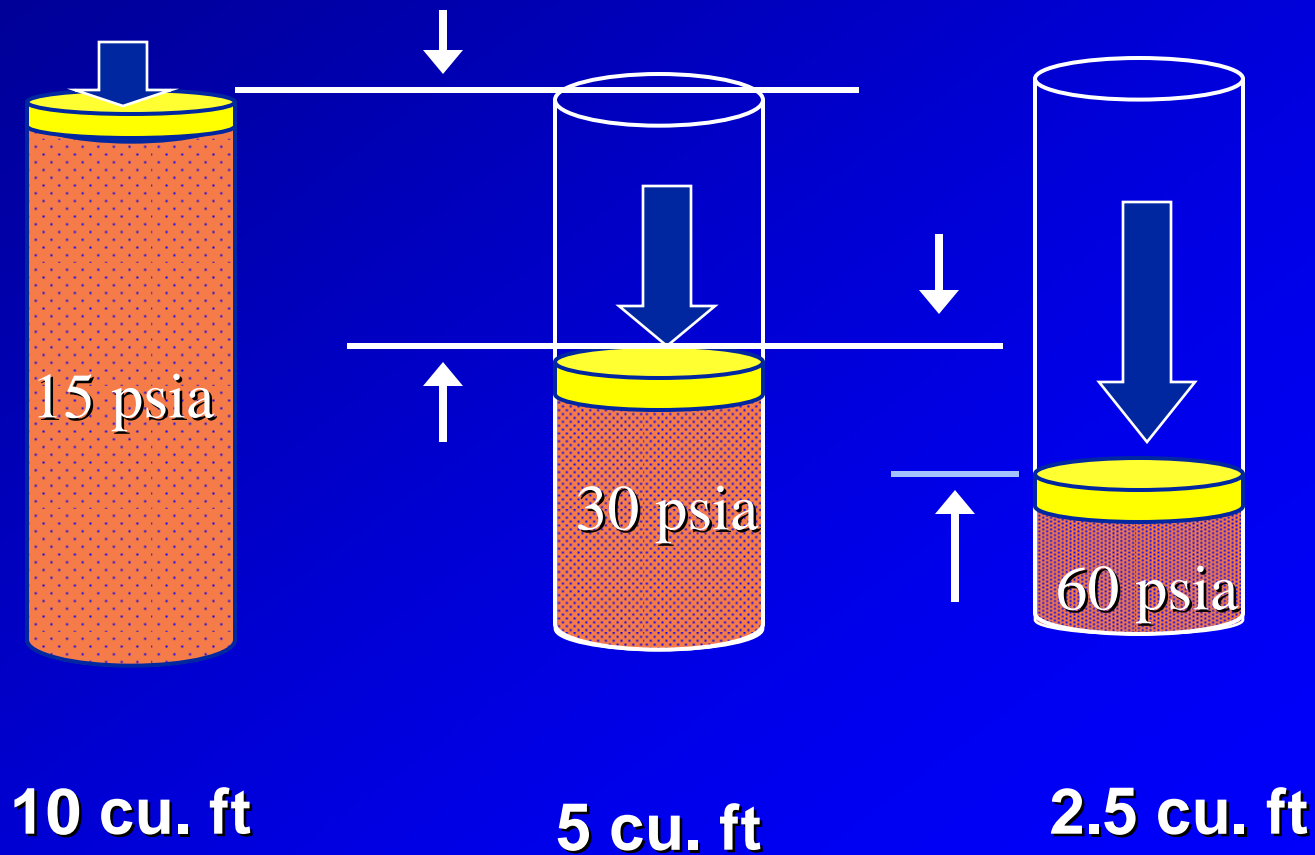
Position

Pump Discharge

1 200 400 600 800 1000 1235

Compression of Gas at Constant Temperature

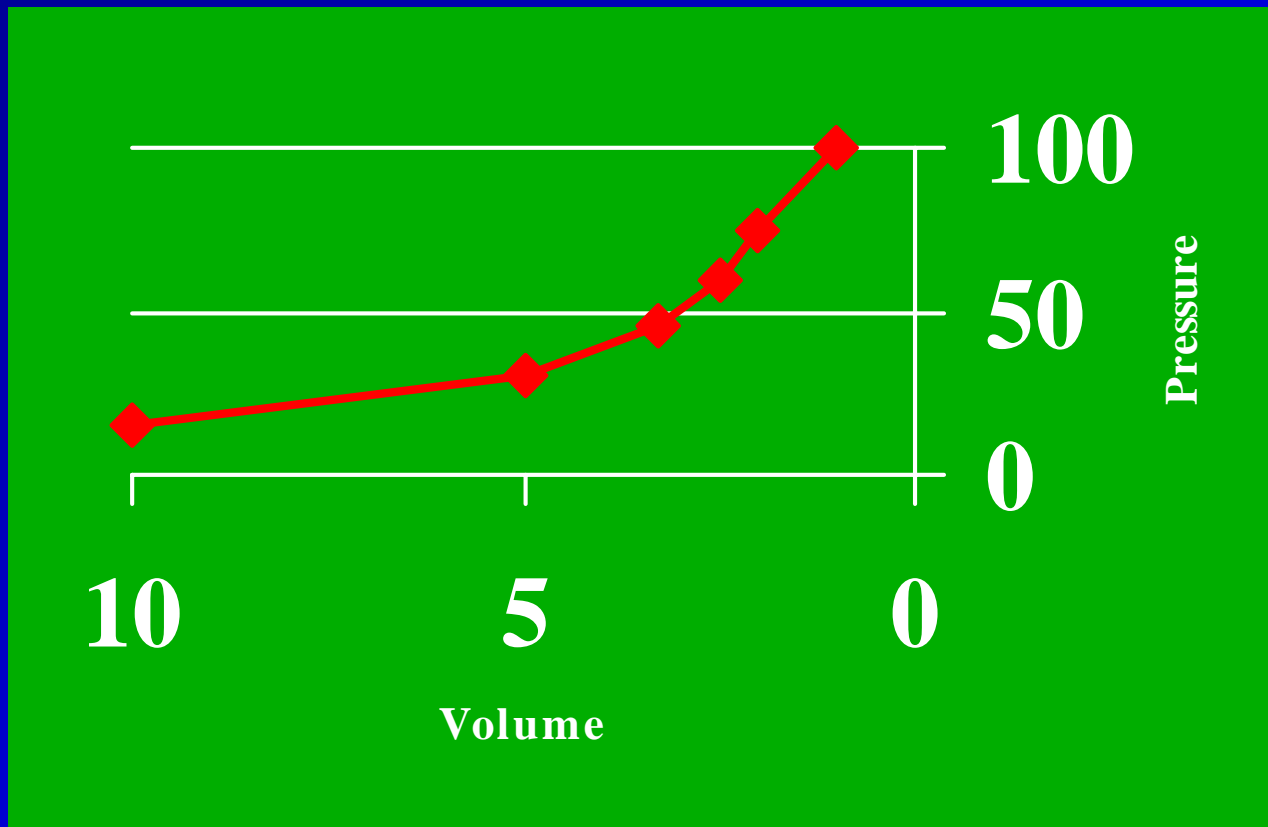
Plunger moves $\frac{1}{2}$ the distance to bottom of the barrel and pressure only doubles



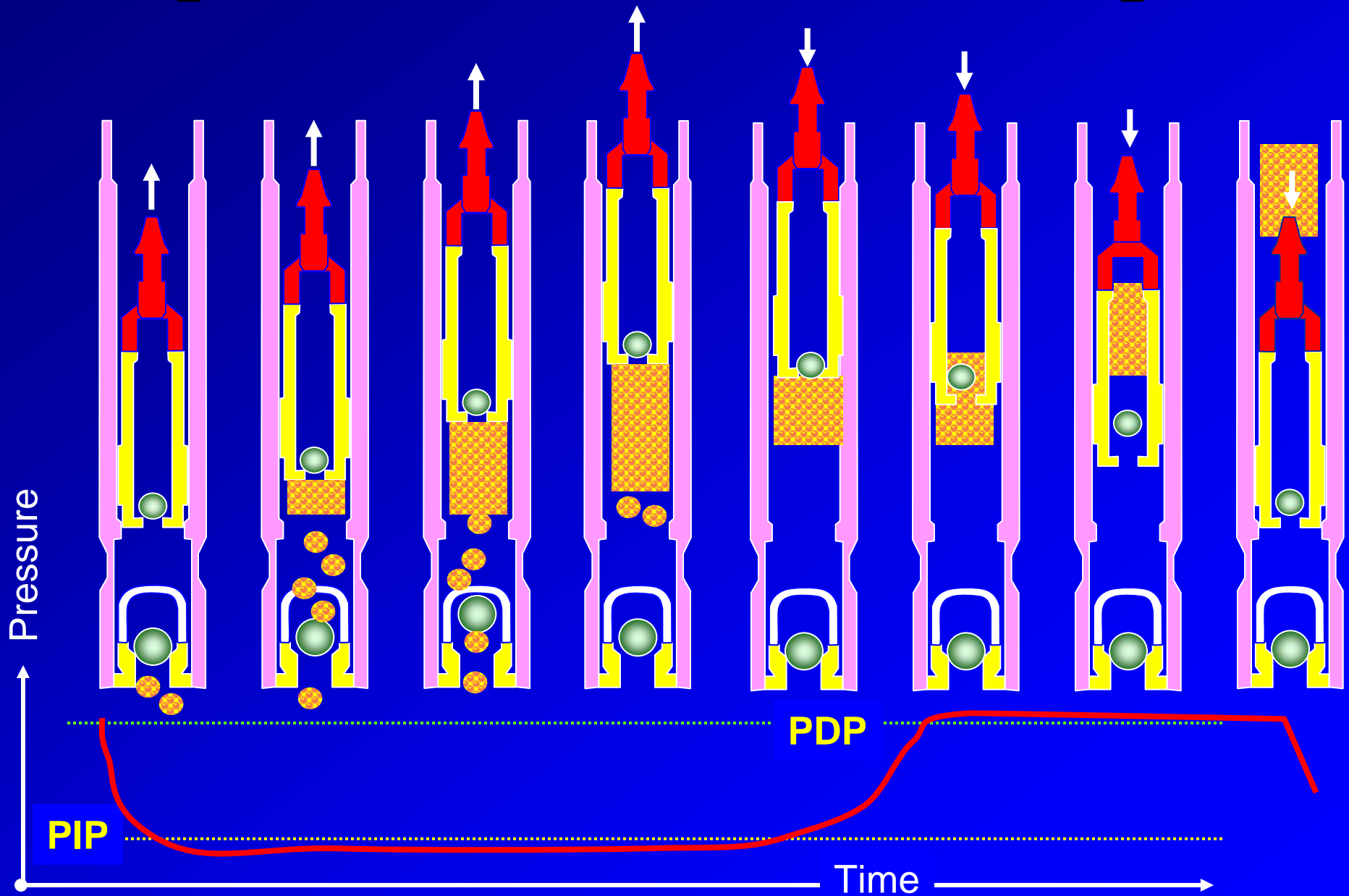
Gas Compression

Constant temperature, ideal gas

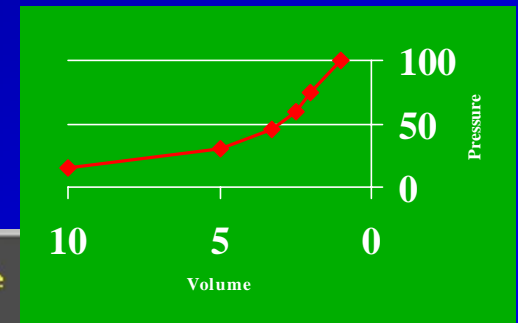
$$P_1 * V_1 = P_2 * V_2$$



Pump Pressure with Gas & Liquid



Compression Cycle



Channel Name	Value	Units
Pump Barrel 4-20	1.21E+1	psia
Pump Intake 4-20	1.22E+1	psia
Position	2.37E+1	inch
Pump Discharge	2.48E+1	psia
	0.00E+0	
	0.00E+0	
	0.00E+0	
	0.00E+0	
	0.00E+0	
	0.00E+0	

Current Image

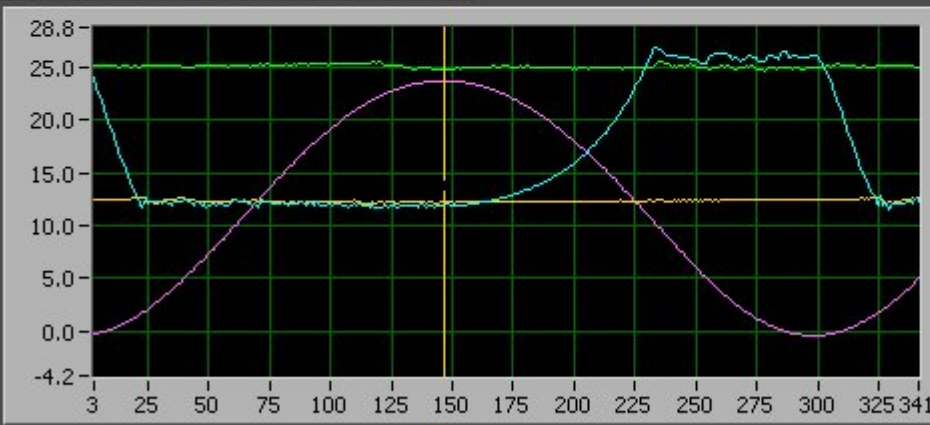
148

Num of Images

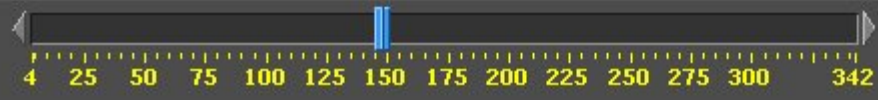
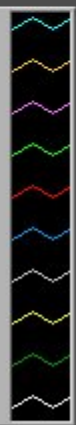
1235

STOP

Load File

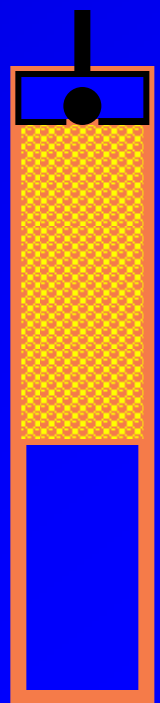


Pump Barrel 4-20
Pump Intake 4-20
Position
Pump Discharge

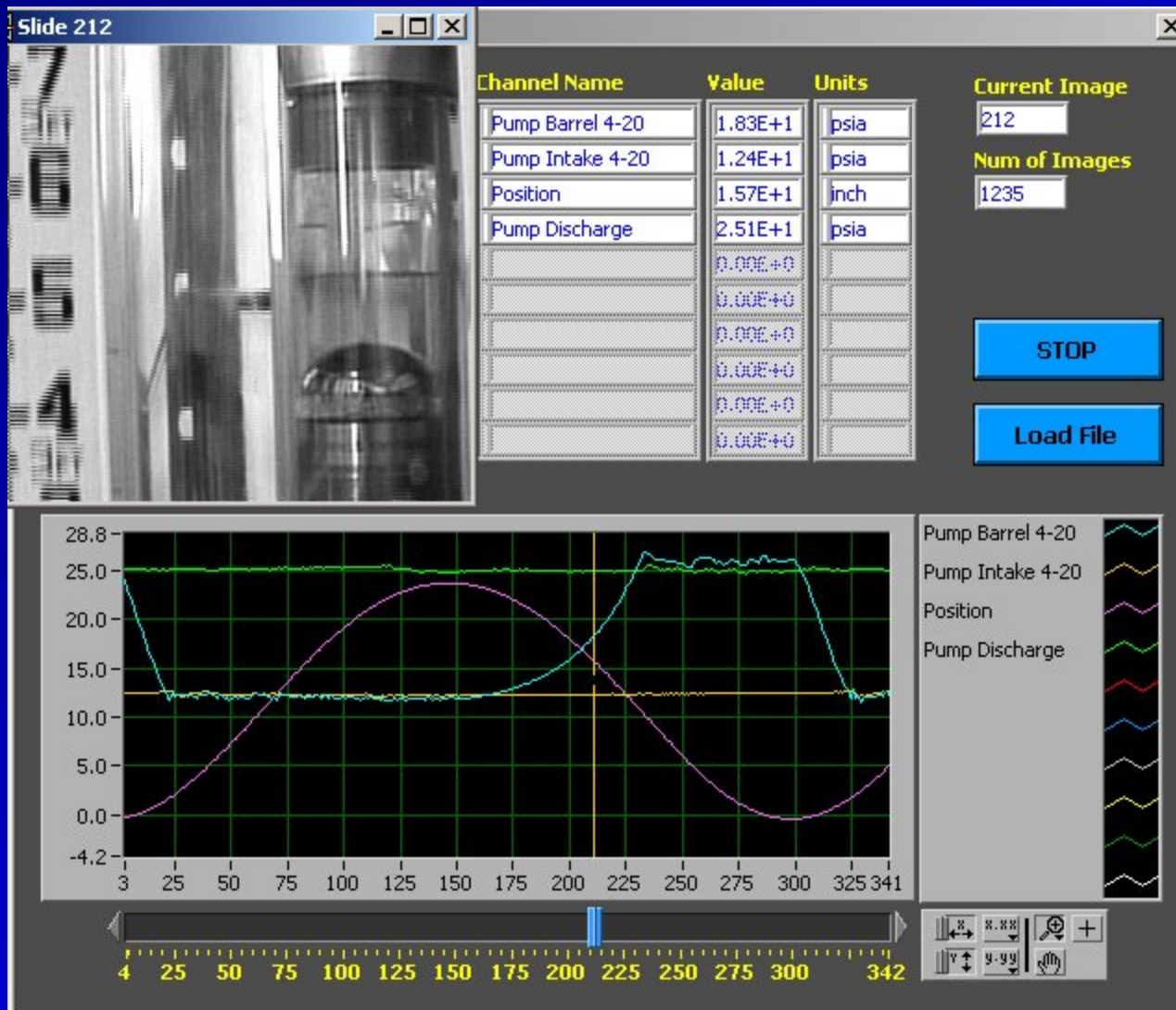


Navigation icons: Home, Back, Forward, Stop, Refresh, Zoom In, Zoom Out, Print, Help.

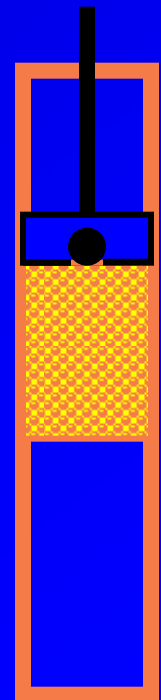
Plunger
at top at
23.7
inch
from
bottom



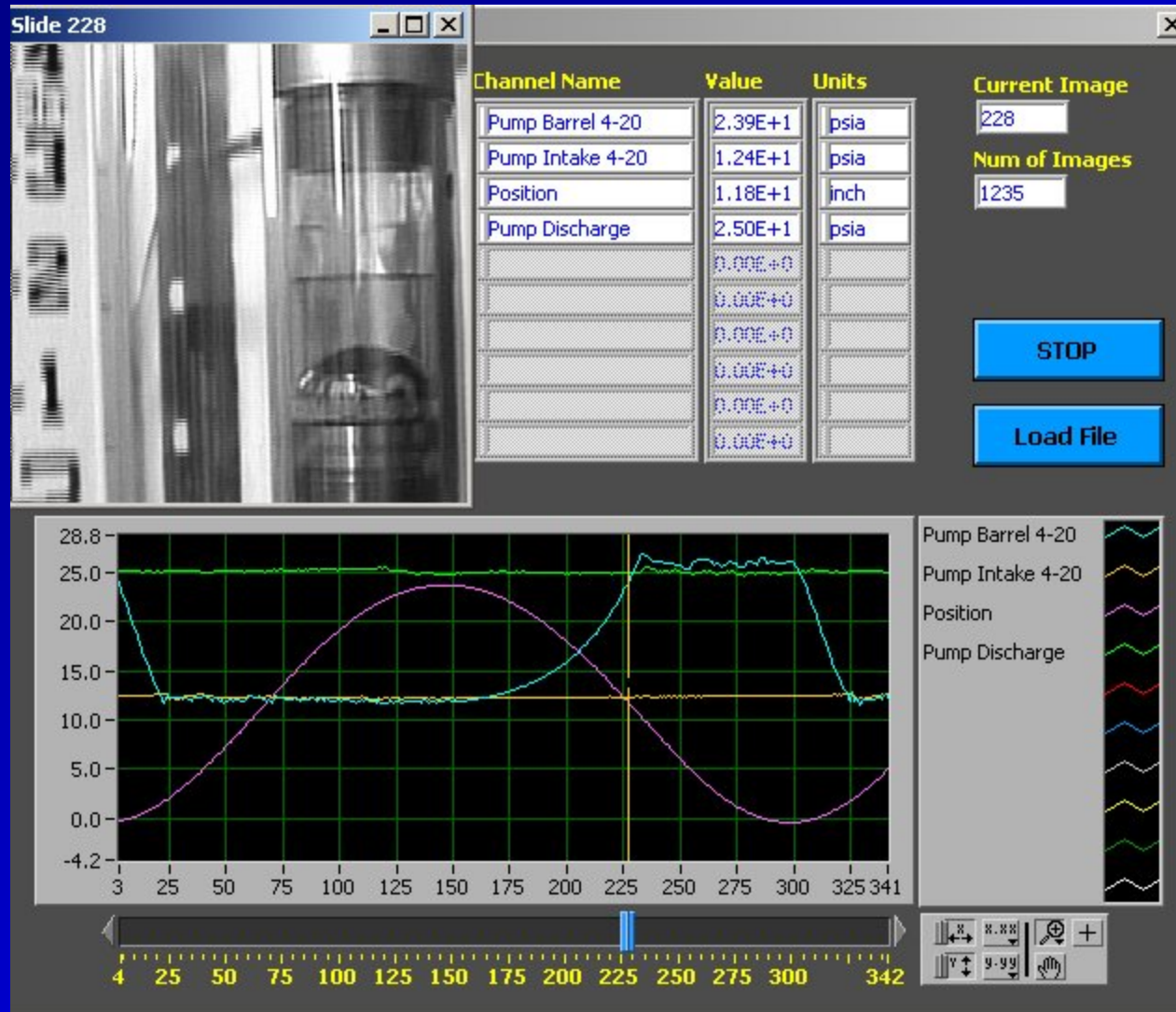
Downstroke



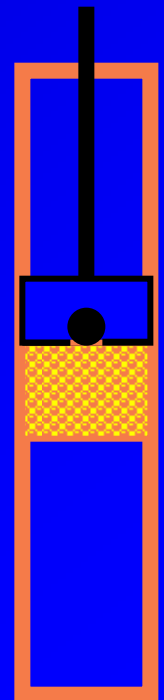
Plunger
Falling
and at
15.7
inch
from
bottom



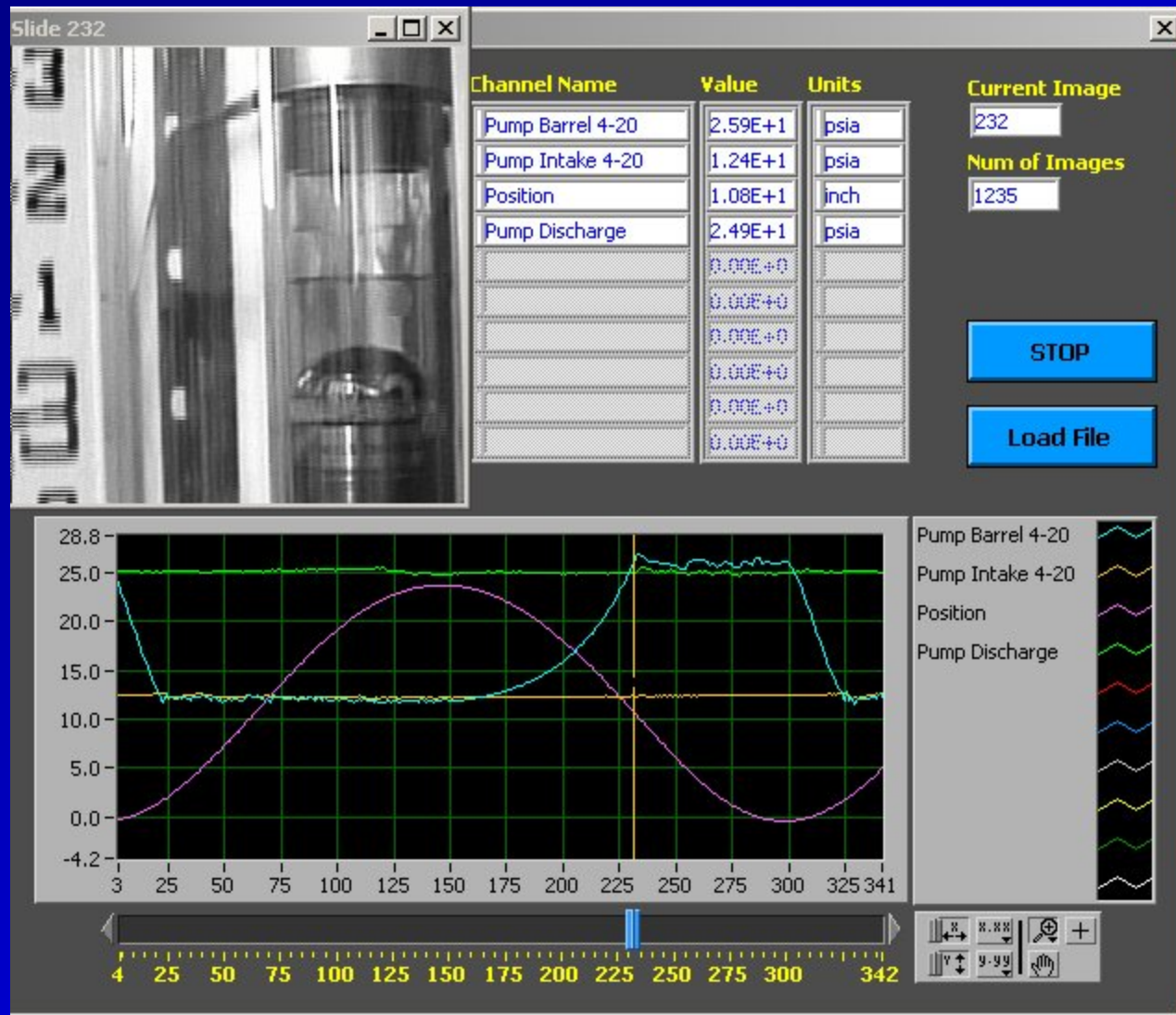
Downstroke



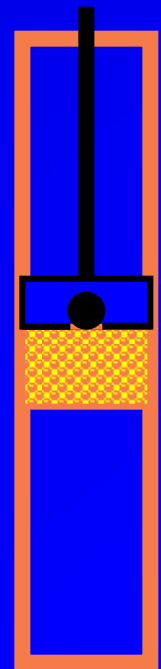
Plunger
Falling
and at
11.8
inch
from
bottom



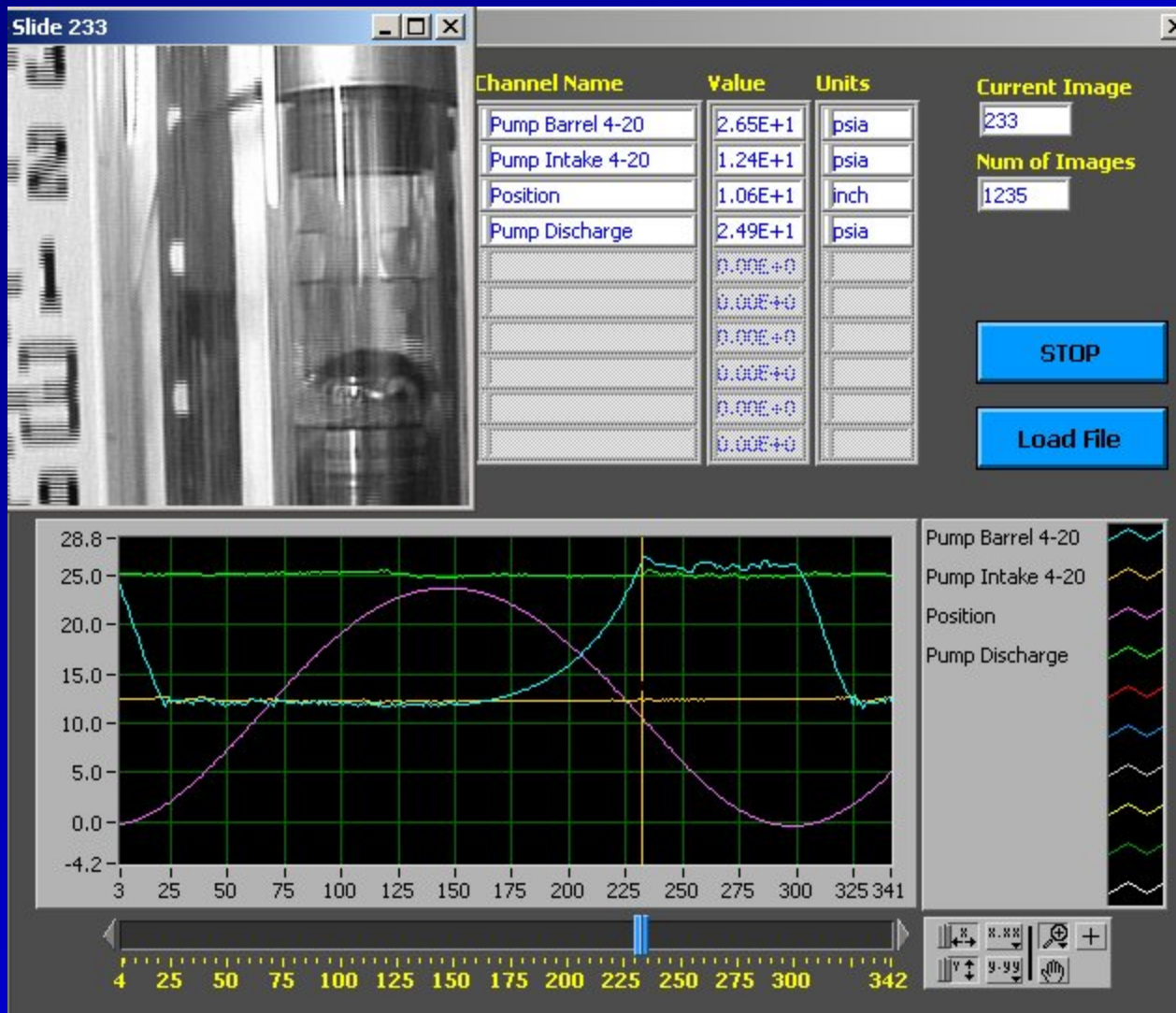
Downstroke



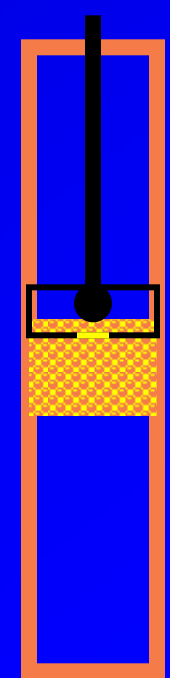
Plunger
Falling
and at
10.8
inch
from
bottom



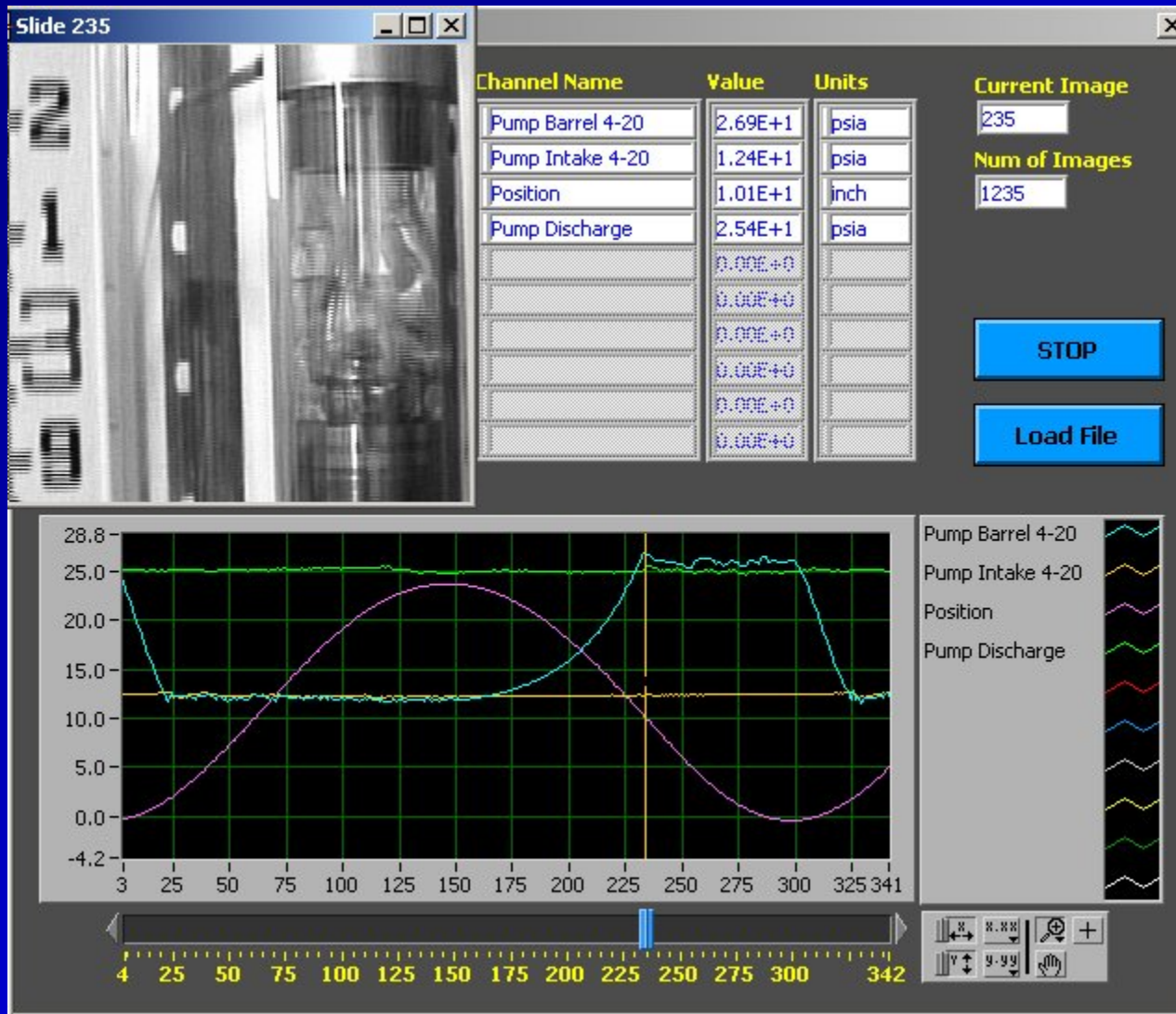
TV Beginning to Open



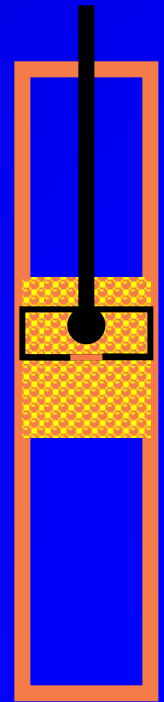
Plunger
Falling
and at
10.6
inch
from
bottom



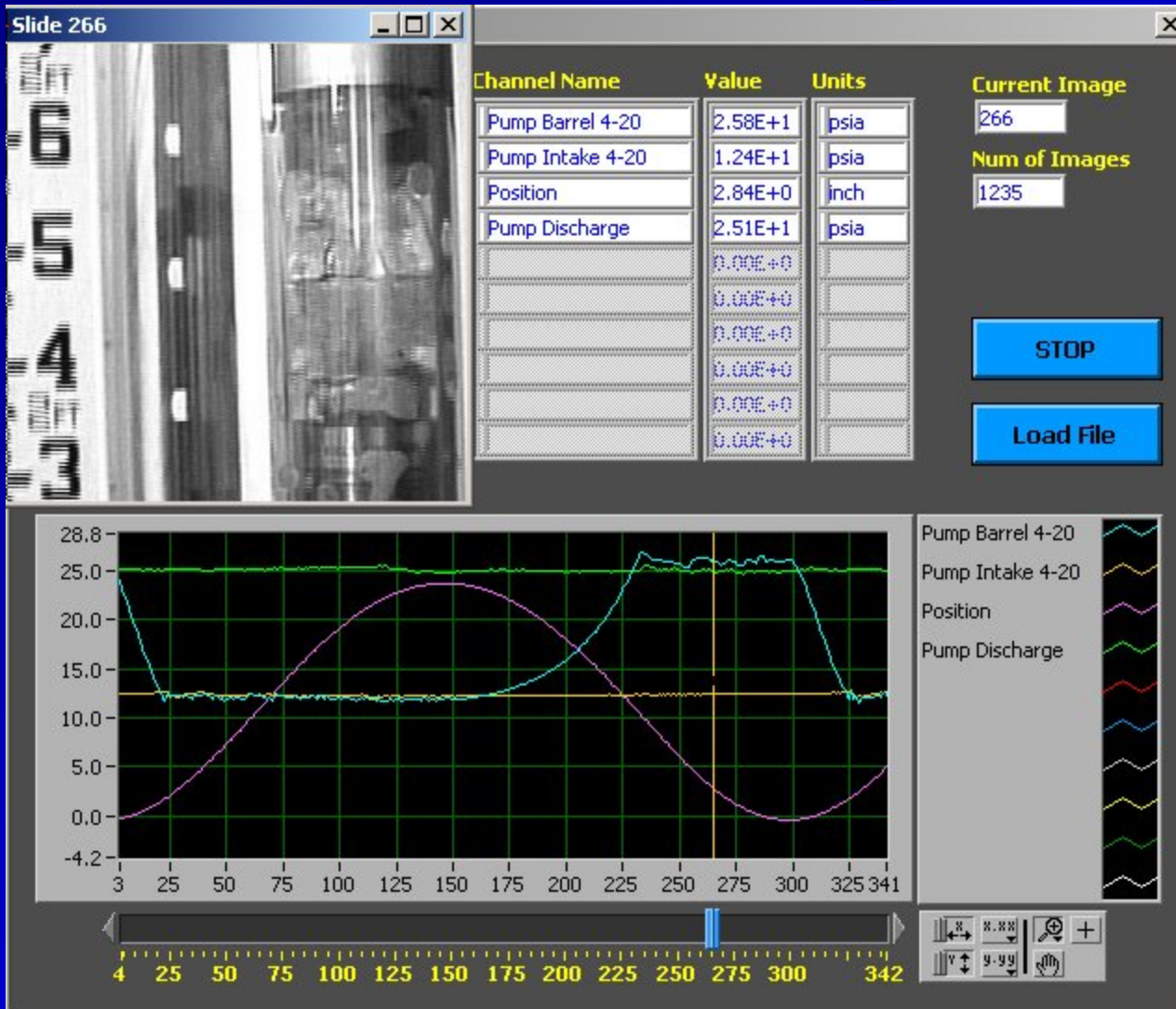
Gas Starts Flowing Through TV



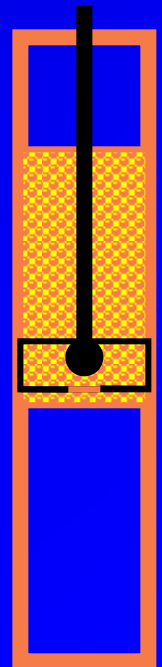
Plunger
Falling
and at
10.1
inch
from
bottom



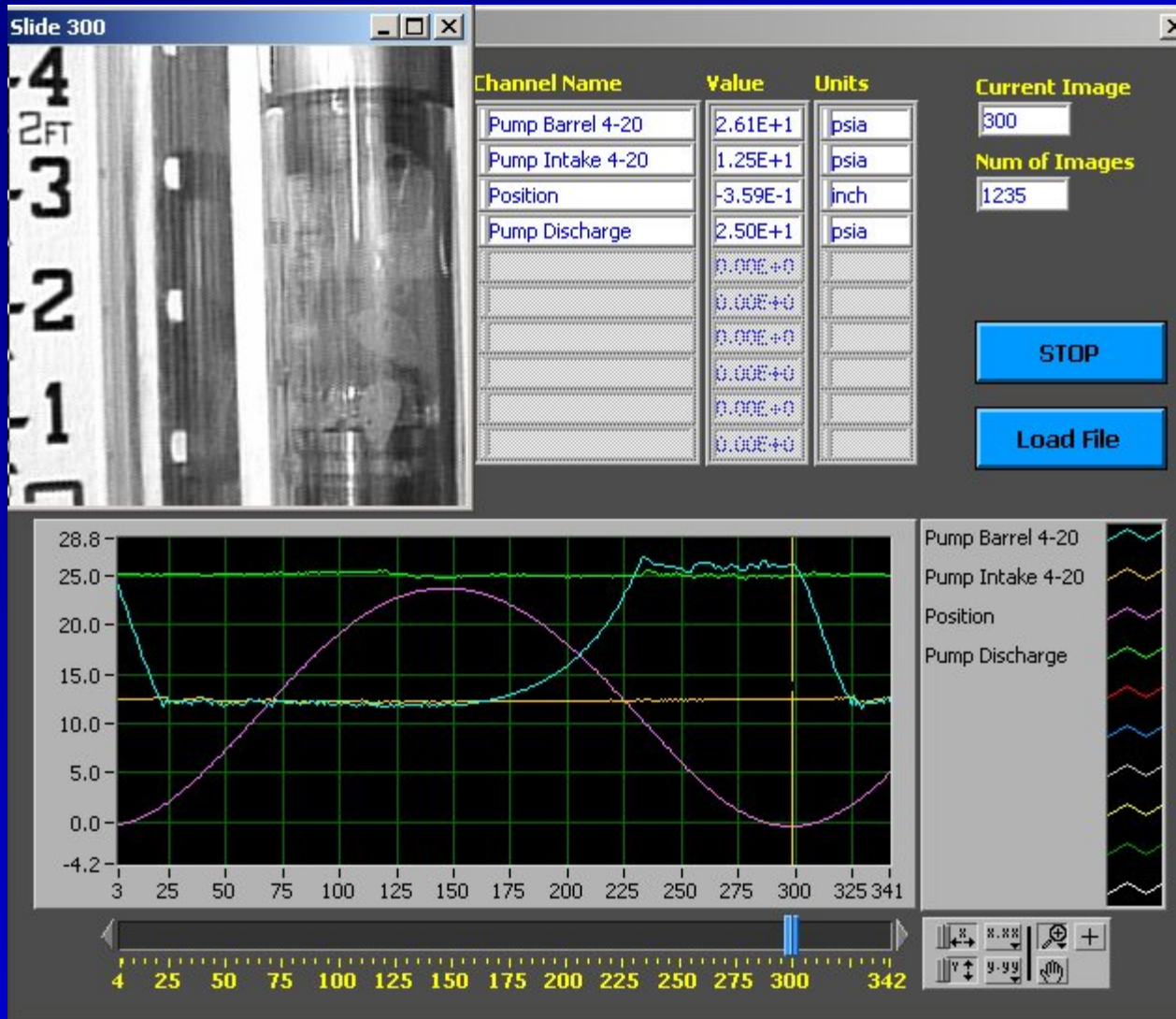
Gas Flow then Liquid Flow



Plunger
Falling
and at
2.8 inch
from
bottom



Bottom of Downstroke



Plunger
at
bottom



Pump Partially Filled With Gas

Slideshow Slide 1

Oil Well Image Files

Sandia_110400_3-20 PM.img

Channel Name	Value	Units
Pump Barrel 4-20	2.53E+1	psia
Pump Intake 4-20	1.25E+1	psia
Position	-3.60E-1	inch
Pump Discharge	2.50E+1	psia
	0.00E+0	
	0.00E+0	
	0.00E+0	
	0.00E+0	
	0.00E+0	
	0.00E+0	

Current Image
1

Num of Images
1235

STOP

Load File

Waveform Graph

Pump Barrel 4-20
Pump Intake 4-20
Position
Pump Discharge

1 200 400 600 800 1000 1235

4 2FT 3 2 1

Summary

- ◆ Rod loading from pump is controlled by difference in pressure above and below traveling valve.
- ◆ Pressure in barrel is a function of plunger travel and compressibility of fluid in barrel.
- ◆ Discharge pressure is pressure at bottom of tubing.
- ◆ Intake pressure is determined by casing pressure, fluid column in annulus and pump submergence
- ◆ Fluid column in annulus depends on well inflow performance.
- ◆ Partial liquid fillage has three possible causes: gas interference, well pump-off and choked pump.

TABLE OF CASING/TUBING/PUMP SIZE

Casing Size	Tubing Size, Max	Sucker Rod Size, Max	RW Insert Pump, Max	RH Insert Pump, Max	TH Tubing Pump, Max	Oversize Tubing Pump, Max
2-7/8", 6.5#	1-1/2" Reg.	5/8", Slim Hole Cplgs	1-1/4"		1-1/2"	2"
3-1/2", 7.7-10.2#	2-1/16" Integral Jnt	3/4", Slim Hole Cplgs	1-1/4"		1-1/2"	2"
4", 9.5-14.0#	2-3/8"	7/8" Slim Hole Cplgs	1-1/2"	1-1/4"	1-3/4"	2-1/4"
4-1/2", 9.5-12.6#	2-7/8" Spec Clear Cplg	1", Slim Hole Cplgs	2"	1-3/4"	2-1/4"	2-3/4"
5", 11.5-20.3#	2-7/8"	1" Slim Hole Cplgs	2"	1-3/4"	2-1/4"	2-3/4"
5-1/2", 14-20#	3-1/2" Flush Joint	1-1/8"	2-1/2"	2-1/4"	2-3/4"	3-3/4"
6-5/8", 20-28#	3-1/2"	1-1/8"	2-1/2"	2-1/4"	2-3/4"	3-3/4"
7", 17-29#	4-1/2"	1-1/8"	3-1/4"	2-3/4"	3-3/4"	4-3/4"
7-5/8" and Larger	4-1/2"	1-1/8"	3-1/4"	2-3/4"	3-3/4"	5-3/4"

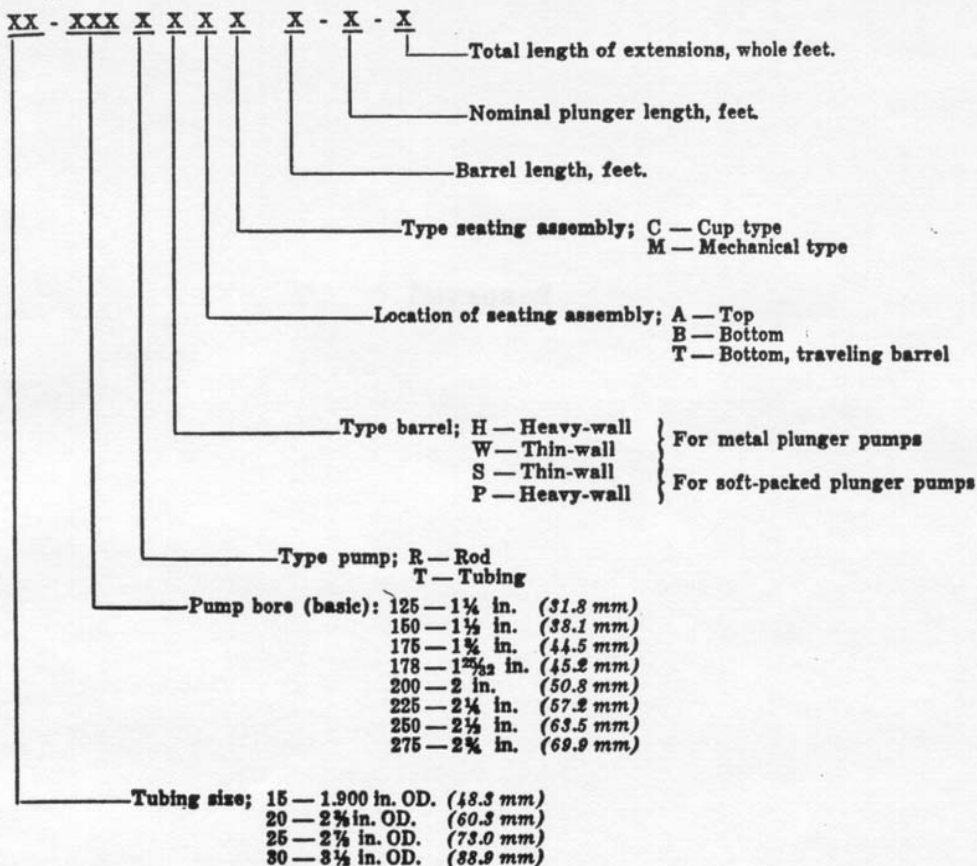
Note: These are maximum sizes. Smaller tubing, sucker rods or pumps can be used than those shown for any particular row of maximum size choices.

PUMP DESIGNATION

The basic types of pumps and letter designation covered by this specification are as follows:
Letter Designation

Type of Pump	Metal Plunger Pumps		Soft-packed Plunger Pumps	
	Heavy-Wall Barrel	Thin-Wall Barrel	Heavy-Wall Barrel	Thin-Wall Barrel
Rod Pumps				
Stationary Barrel, Top Anchor	RHA	RWA	RSA
Stationary Barrel, Bottom Anchor	RHB	RWB	RSB
Traveling Barrel, Bottom Anchor	RHT	RWT	RST
Tubing Pumps	TH	TP

Complete pump designations include: (1) nominal tubing size, (2) basic bore diameter, (3) type of pump, including type of barrel and location and type of seating assembly, (4) barrel length, (5) plunger length, and (6) total length of extensions when used, as follows:



Example: A 1 1/4 in. (31.8 mm) bore rod type pump with a 10 ft. (3.048 m) heavy wall barrel and 2 ft. (0.610 m) of extensions, a 4 ft. (1.219 m) plunger, and a bottom cup type seating assembly for operation in 2-3/8 in (60.3 mm) tubing, would be designated as follows:

20-125 RHBC 10-4-2

API Rod Pump Designation

20-125 RHBC 10-4-2

↓
2-3/8 Tubing

↘
1-1/4 Bore

Rod Heavy Bottom Cup

10 ft long barrel

4 ft plunger

2 ft extension

Questions ?

