

## Mastering the Details of Phacoemulsification with Active Fluidics



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  Stein Eye Institute

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## Financial Disclosures

- Alcon
- BVI
- Johnson & Johnson Surgical Vision
- Long Bridge Medical
- Oculus USA



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## Phaco Machines Available in the United States

Only one supports active fluidics.



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## MASTERING THE ALCON CENTURION

Sponsored by the ASCRS  
Cataract Clinical Committee



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## What is the relationship between bottle height, flow rate, and IOP?

Bottle raised to 110 cm above the eye

Higher bottle height creates higher intraocular pressure (IOP) at zero flow.

No flow

IOP = 110 cm H<sub>2</sub>O or 81 mmHg

Pump Off

Bottle Height	IOP
75 cm	55 mmHg
100 cm	74 mmHg
110 cm	81 mmHg

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## Fundamental Concept

**Electrical terms**

- $\Delta V_r = I \times R$
- ( $\Delta$ voltage = current x resistance)

**Fluidics terms**

- $\Delta P_r = F \times R$
- ( $\Delta$ pressure = flow x resistance)
- The greater the flow across a resistor, the greater the drop in pressure.

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### What is the relationship between bottle height, flow rate, and IOP?

Bottle raised 110 cm above eye

← No flow      With flow →

IOP drops →

Pump Off      Pump On

With the bottle height maintained...  
When **flow > 0, IOP drops**. Higher flows produce larger decreases in pressure (up to 50 mmHg drops at the highest flows of 60cc/min!).  
At very low IOP, chamber stability is at risk.  
Understandably, surgeons raise the bottle to compensate for this drop in IOP during surgery.

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### The Relationship between IOP and AFR (which = IFR)

80 mmHg

Surgical IOP

30 mmHg

10      20      30      40

Aspiration Flow Rate (AFR)

Surgical IOP reduces somewhat linearly with increased aspiration flow rate.  
So in an attempt to work at 55 mmHg, the surgeon must deal with surgical IOP fluctuations from 30 to 80 mmHg.

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### Raising the bottle is one way to compensate.

Bottle raised to 150 cm H<sub>2</sub>O  
= 110 mmHg  
Almost 5 feet

Flow

Surgical IOP

Aspiration Flow Rate (AFR)

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### Pressurizing the bottle is another way to compensate.

Bottle raised to 110 cm

Flow

Air Pump

40 mmHg of air pressure added

Surgical IOP

Aspiration Flow Rate (AFR)

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### This is how B&L Stellaris DigiFlow system works.

Phaco Stage	Bottle Height DigiFlow (cm)	DigiFlow Setting (mmHg)
Chopping/Sculpting	59.0 ± 29.4	64.1 ± 25.0
Nucleus Removal	69.7 ± 30.3 ~70 cmH <sub>2</sub> O	69.4 ± 13.4 ~70 mmHg

Bottle raised to 95 cm

Flow

DigiFlow

Air Pump

50 mmHg of air pressure added

IOP

Pump

DigiFlow allows for a higher IOP than the maximum IOP that can be achieved with the maximum bottle height.

\*Data based on average of the bottle heights used by 55 surgeons for nucleus removal (from Dr. Sheri Rowen's study presented at the 2015 Park City Surgical Summit Meeting)

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### The Active Fluidics method used by Alcon is different.

Active feedback systems continuously measure pressure in the irrigation and aspiration lines, as well as the flow rate, at 100 Hz to precisely control a motor-controlled plate to maintain IOP under flow and no-flow conditions.

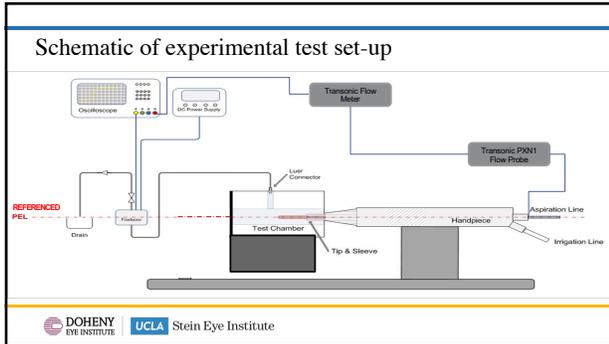
A motor-controlled plate squeezes and releases a BSS bag, which allows for an **Active or Dynamic** change in bag pressure.

IOP is maintained at a user-selected set point. (Example: 55 mmHg)

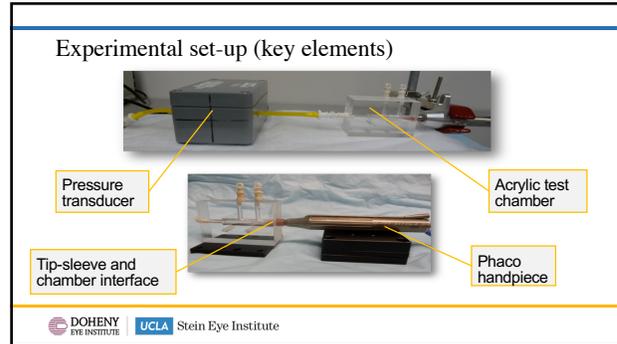
IOP remains constant while AFR and IFR vary.

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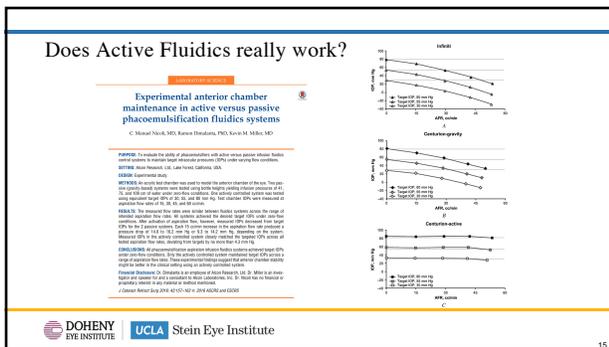
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### Brief Overview of the Remaining Talk

- Machine set up
- Making Adjustments to Settings
- IOP Regulation and Active Fluidics

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### Major Components of the Alcon Active Fluidics System

- An Active Fluidics irrigation bay
- A compressible BSS bag
- A high-performance pump system
- An intelligently designed FMS
- Proprietary hardware and software to set and maintain the target IOP

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### Centurion Active Fluidics Irrigation Bay

The Active Irrigation Bay consists of:

- A static side that holds the BSS bag against a Bag Pressure Sensor (BPS)
- A single movable compression plate
- A vision system that confirms the presence of a valid Alcon bag
- An irrigating fluid escape

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### Components of the Centurion Fluidics Module

- 7 independent spring-loaded rollers
- Latching mechanism with consistent loading action
- Stepper motor-controlled pump
- Stepper motor-controlled valves
- Optical pressure sensors (OPS)

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### Optical Pressure Sensors

**Features:**

- Two Lasers & Two Cameras (Pressure Sensing)
- One Camera (Barcode reading)

**Benefits:**

- Accurately measures deflection of the Irrigation & Aspiration pressure sensor diaphragms
- Quick response to Irrigation or Aspiration changes
- Consistent performance with calibration info

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### Single Peristaltic Pump

**SINGLE FLUID WAVE**

Large Peaks

Large Troughs

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### Dual Segment Technology

Large Peaks

Large Troughs

Combined Fluid Wave= More efficient & smoother flow

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1993

2003

2013

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### Active Fluidics Components

- Active Irrigation
- IOP settings
  - Target IOP
  - IOP Ramp
- Patient Eye Level "PEL"
- Vacuum Rise
- Irrigation Factor

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### Passive Fluidics

Bottle Height	IOP
95 cm	70 mmHg

95 cm H<sub>2</sub>O = 70 mmHg  
IOP = 70 mmHg  
Footswitch Position 1 = Irrigation On / No Flow

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### Bottle height to IOP conversion

Infiltri® Vision System: 95 cm H<sub>2</sub>O  
Centurion® Vision System: 70 mmHg  
X 0.74 =

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### Passive Fluidics

Bottle Height	IOP
50 cm	37 mmHg
75 cm	55 mmHg
95 cm	70 mmHg
100 cm	74 mmHg
125 cm	92 mmHg

95 cm H<sub>2</sub>O = 70 mmHg  
IOP = 70 mmHg

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### Passive Fluidics

No Flow: 95 cm H<sub>2</sub>O = 70 mmHg, IOP = 70 mmHg  
Flow: 95 cm H<sub>2</sub>O = 70 mmHg, IOP < 70 mmHg  
Pressure is lost through the resistive tubing and infusion sleeve

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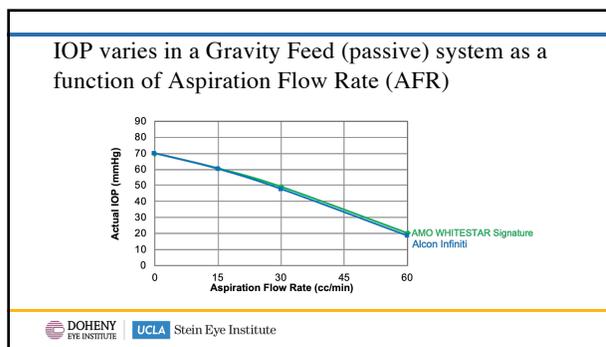
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### Passive Fluidics

No Flow: 95 cm H<sub>2</sub>O = 70 mmHg, IOP = 70 mmHg  
Flow: 95 cm H<sub>2</sub>O = 70 mmHg, IOP < 70 mmHg  
High Flow significantly lowers surgical IOP

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### Sources of Irrigation Resistance

95 cm H<sub>2</sub>O = 70 mmHg  
 No Flow  
 IOP = 70 mmHg  
 Pump Off

Flow  
 Tubing Resistance  
 Infusion Sleeve Resistance  
 Aspiration Resistance  
 Eye IOP

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### Active fluidics

Pressure Source  
 Irrigation Bag  
 Eye IOP  
 Aspiration

Adjust Pressure  
 Flow Variations

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### Test Results

#### Actual IOP vs. Aspiration Flow Rate

Centurion IOP, Mini-Flared Tip, Ultra Sleeve, Flowing IOP (Active), 50cm bottle (Gravity), All data normalized to tubing at 8 cc/min

Actual IOP (mmHg)  
 Aspiration Flow Rate (cc/min)

$\Delta P = 2.6$  mmHg  
 Alcon® Centurion® (w Active Fluidics)  
 Active Fluidics Compensates for Pressure Losses due to flow to maintain target IOP.  
 AMO WHITESTAR Signature  
 Alcon Infra

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### There is no need to operate at high IOP.

#### Actual IOP vs. Aspiration Flow Rate

Centurion IOP, Mini-Flared Tip, Ultra Sleeve, Flowing IOP (Active), 50cm bottle (Gravity), All data normalized to tubing at 8 cc/min

Actual IOP (mmHg)  
 Aspiration Flow Rate (cc/min)

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### And there is no need to pressurize the infusion bottle with air.

#### Actual IOP vs. Aspiration Rate

Centurion IOP, Mini-Flared Tip, Ultra Sleeve

Actual IOP (mmHg)  
 Aspiration Flow Rate (cc/min)

Systems with pressurized bottle (e.g. B&L, Stellars)  
 EXCE  
 Alcon® Centurion® (w Active Fluidics)  
 AMO WHITESTAR Signature  
 Alcon Infra

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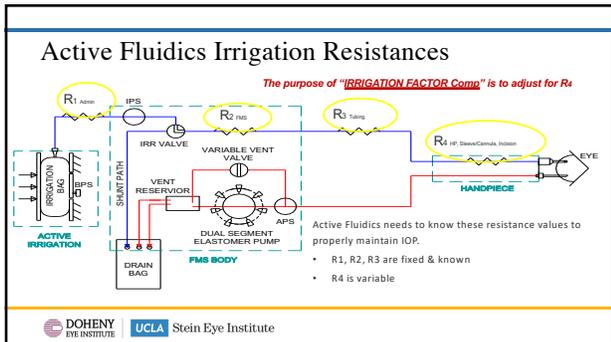
### IOP Ramp

The IOP Ramp is a feature that allows for the adjustment of how quickly the irrigation pressure builds in foot position 1. This function is designed to result in **better patient comfort**.

- The default IOP Ramp = 1.0 second.
- The adjustment ranges from 0 seconds to 3.0 seconds.
- IOP Ramp only applies when using Active Fluidics™.
- It determines the rate of rise of irrigation pressure when in foot position 1.

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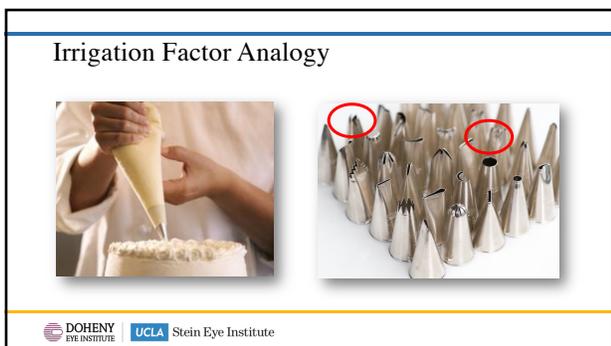
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### Irrigation Factor

The Irrigation Factor is something that can be adjusted to compensate for numerous influences that restrict irrigation flow including tip, sleeve, wound architecture, wound size, and surgical technique.

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### Irrigation Factor Settings

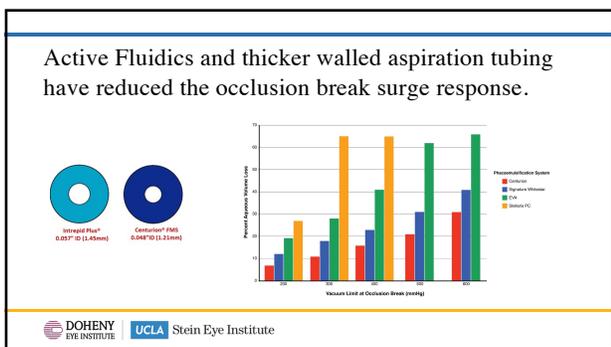
A higher irrigation factor means greater force will be applied to the BSS Bag to compensate for irrigation pressure loss

The default Irrigation Factor is set to 1.0 based upon the flow characteristics of a 2.4 incision, w/ultra sleeve and 45° mini-flared Kelman tip.

- 1.0 irrigation factor for 2.4-2.2 (normal) incisions with Ultra sleeve combination
- 1.2 irrigation factor for 2.4-2.2 (tight) incisions with Ultra sleeve combination
- 1.4 irrigation factor for 2.2-2.0 (normal) incision with Nano sleeve combination
- 1.6 irrigation factor for 2.0-1.8 (tight) incision with Nano sleeve combination
- LenSx surgeries may need a .1 or .2 increase irrigation factor due to tighter incisions.

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### Brief Review

- Machine set up
- Making Adjustments to Your Settings
- IOP Regulation and Active Fluidics

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