Update: Thermal Imaging

WILLIAM HEIDORN

IOWA STATE UNIVERSITY

ISU WEEKLY STAVE QA MEETING

JULY 30, 2018

Flow Meter Calibration

- The flow through the stave is measured using a Proteus 08004BN1 flow meter.
  - A paddlewheel device that outputs a voltage depending on the rotation speed
  - Before use the flow meter was calibrated for water, so it needed to be calibrated for HFE7100.
- Calibration was done by measuring the output voltage and the flow rate by measuring the flow out of the pipe over a set time at different temperatures

Flow Measurement

- Fluid was poured out of the pipe into a glass jug with a stop watch counting the time the pipe was open and fluid was flowing out.

- The volume of fluid was measured using a 250 ml and 500 ml graduated cylinders.

- The volume was corrected by using the expansion coefficient of the fluid and the temperature change from the outflow of the fluid. The uncertainty in the temperature measurement is added into the uncertainty of the flow rate

- The evaporation of the fluid is not taken into account in these measurements, though on +40C measurements this could mean a 3-5% loss of fluid measured.

Finding the Fit Function

▶ A function for the flowrate as a function of voltage and temperature was found.

- ▶ The flow rate at each temperature was fit with a line to find an offset value

- ▶ The offsets for all of the lines were removed and all of the data sets were fit with a single line forced through zero to find the slope

- ▶ The slope and voltage was then removed to fit the resultant as a function of temperature

- ▶ A parabola was used to find the temperature function

▶ Final function is found to be:

F = 1.15950427365*V + -0.190529119312 + -0.00135912949604*T + 3.14170448696e-05*T*T
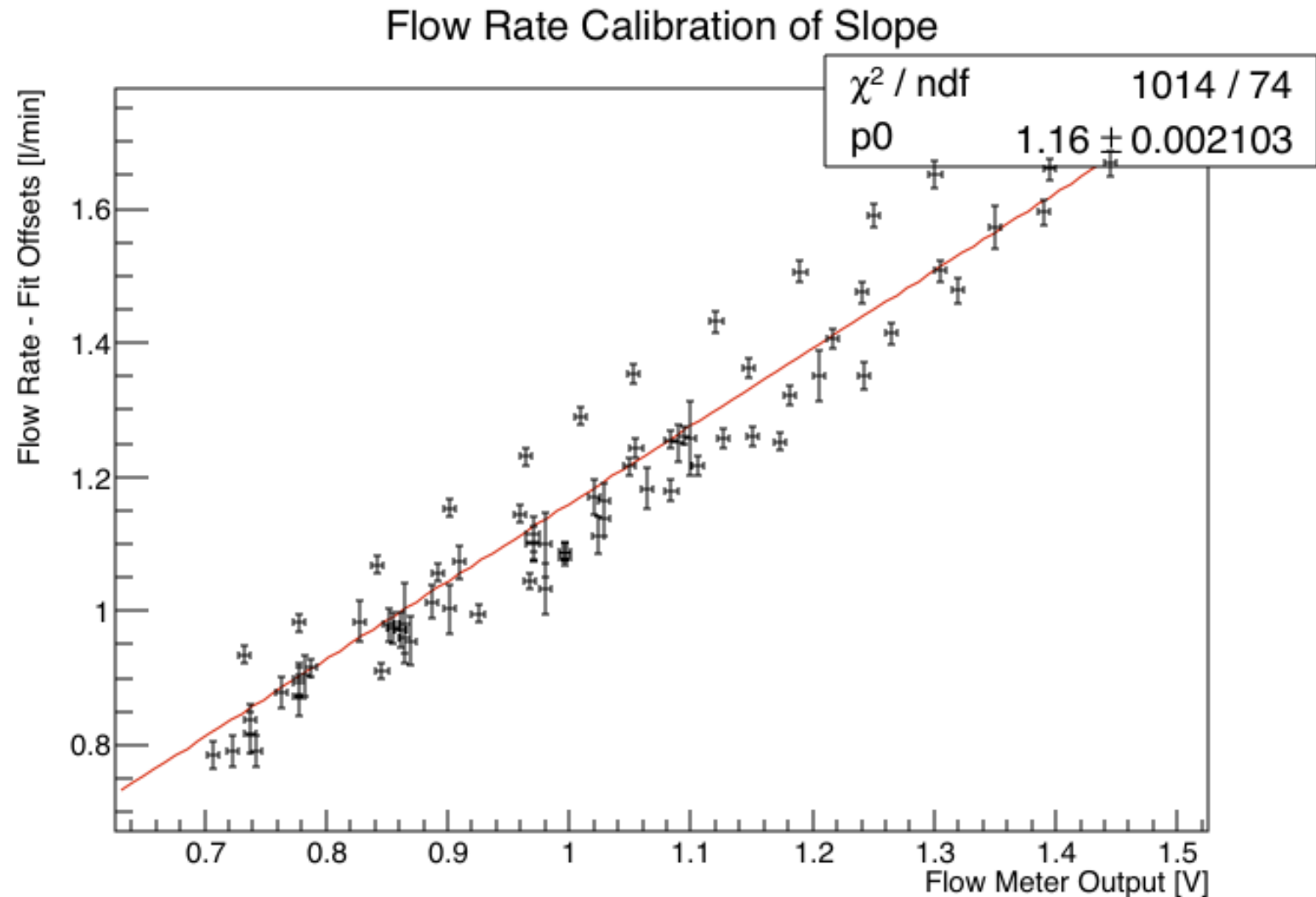
Initial Fits
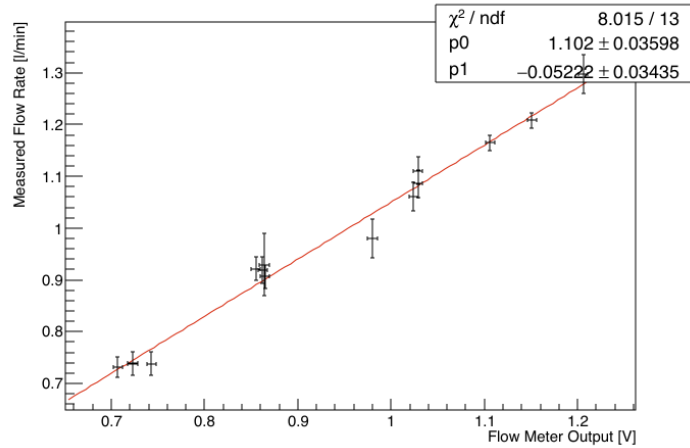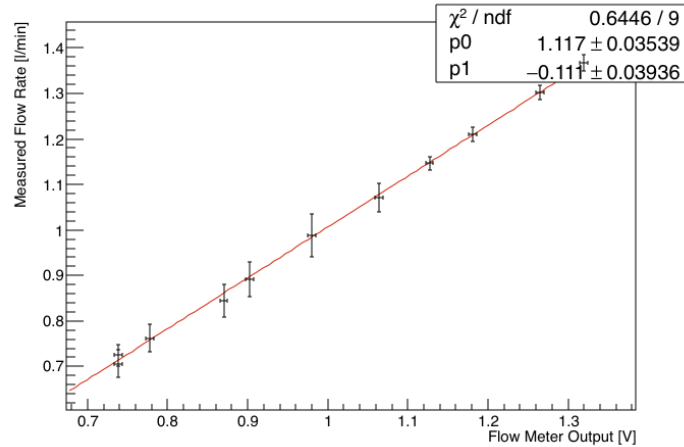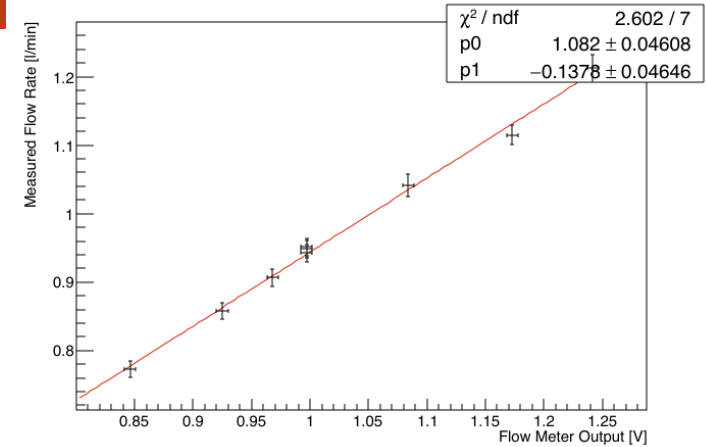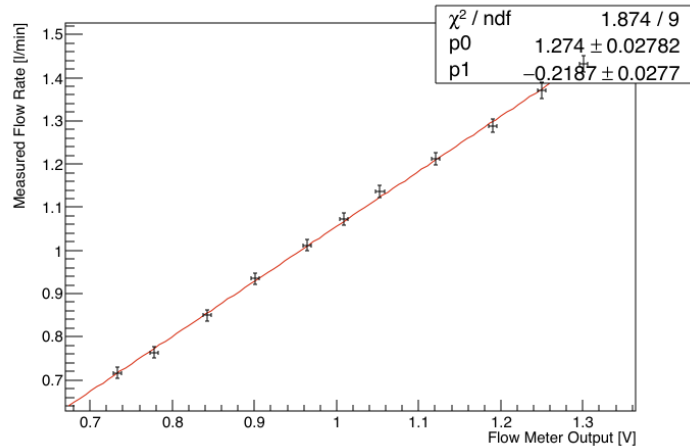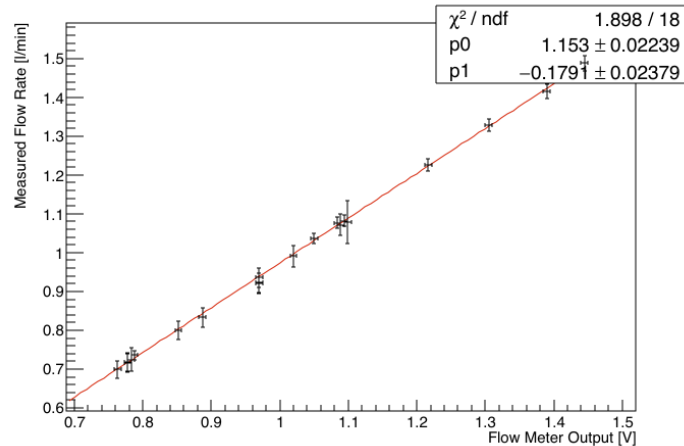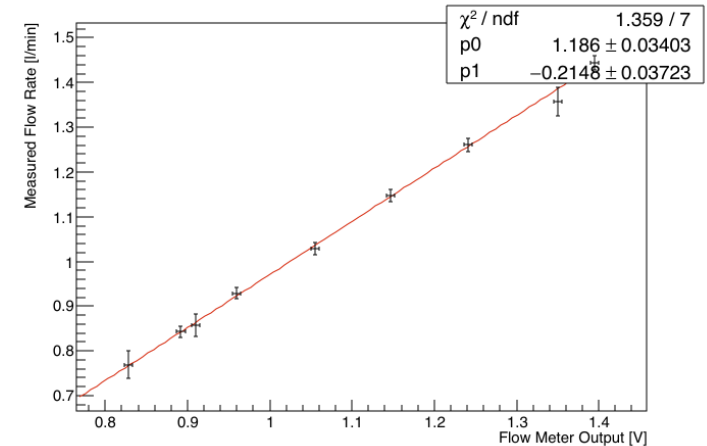
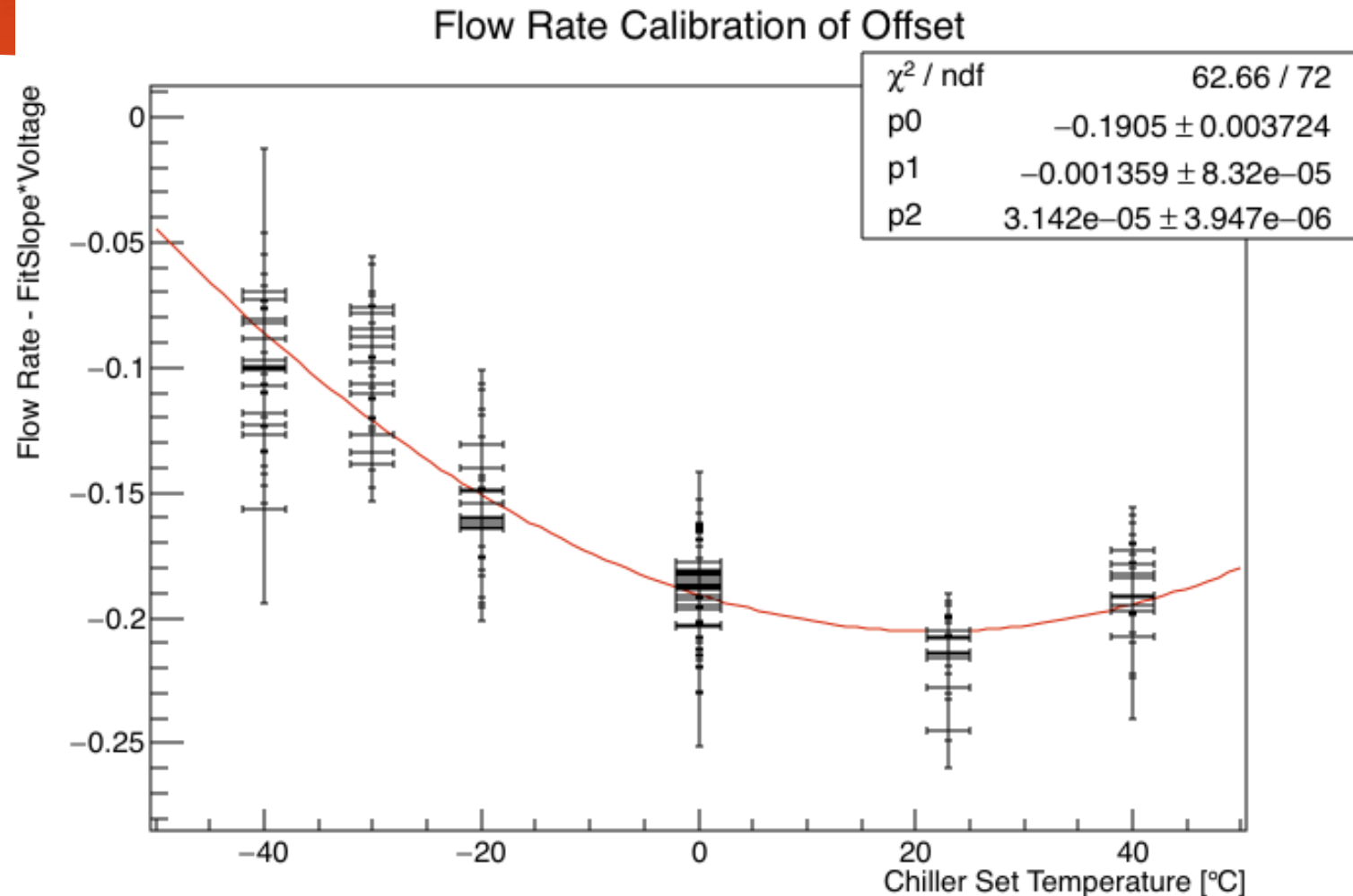# Combined Plot for slope

- All of the lines have their offset removed and then they are fit to one line.

- After adding the -30C data it seems that there is either a bug in my code or something wrong here since the -30C data seems to form its own line above the rest of the data
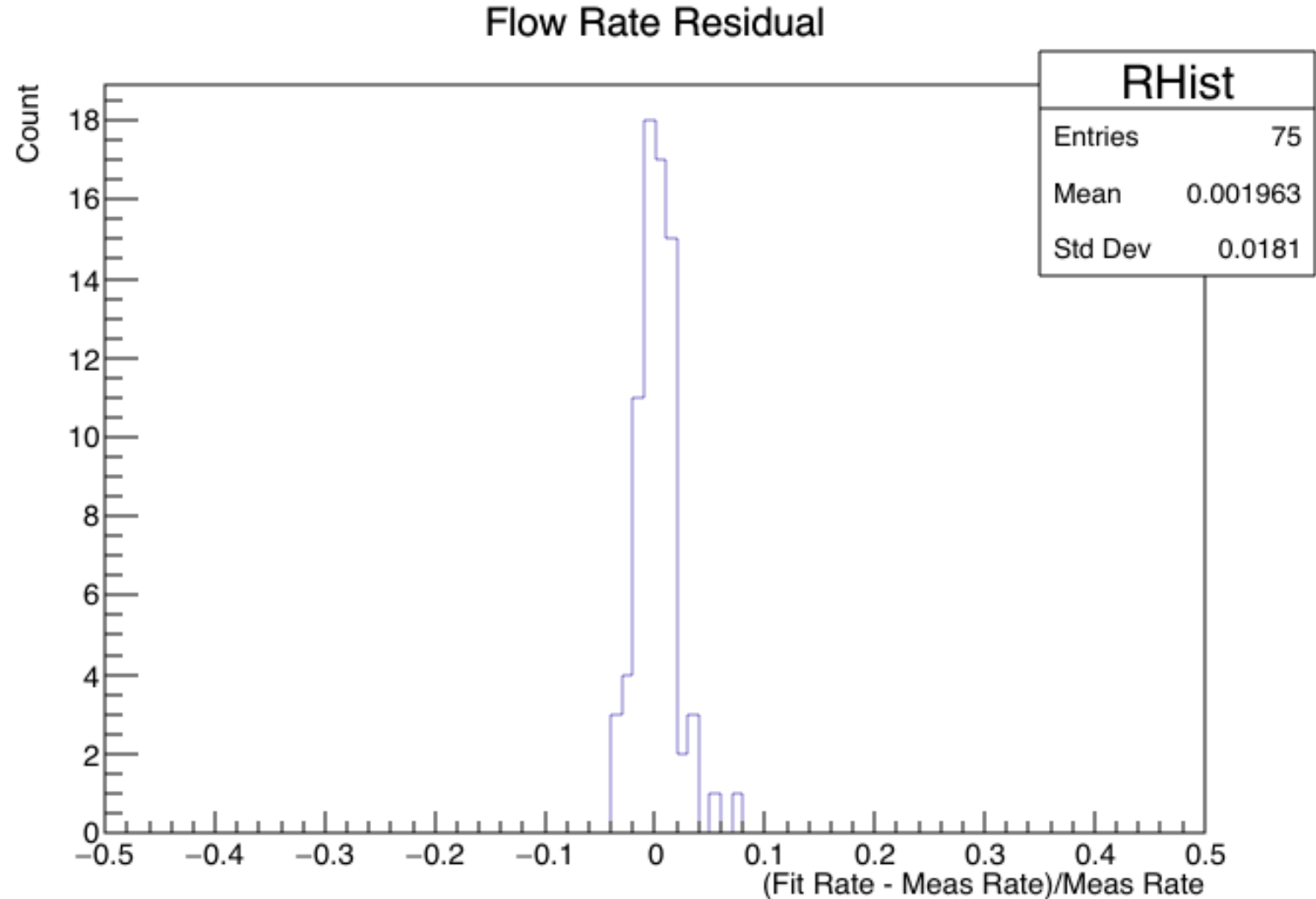

Flow Rate Calibration of Slope

χ^2 / ndf	1014 / 74
p0	1.16 ± 0.002103

Finding the Offset as a Function of T

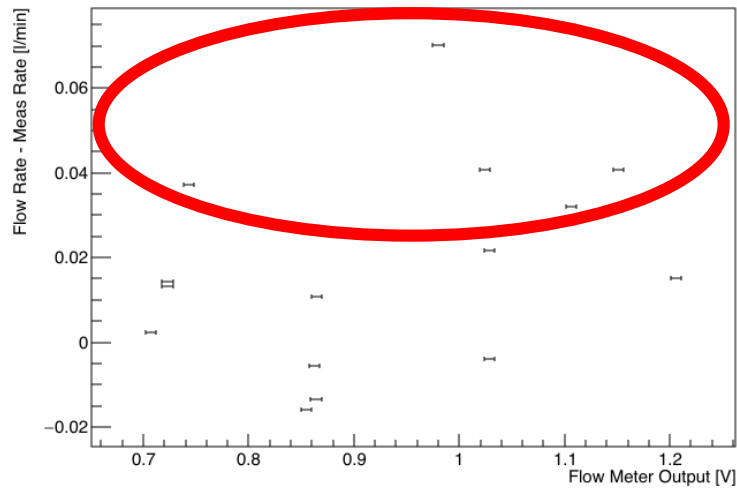▶ Since the warmer temperatures seem to have a higher offset than the room temperature values a parabola was used

Flow Rate Calibration of Offset

χ^2 / ndf	62.66 / 72
p0	-0.1905 ± 0.003724
p1	$-0.001359 \pm 8.32e{-}05$
p2	$3.142e{-}05 \pm 3.947e{-}06$

Final Overall Residual

▶ The residuals of all of the data is then calculated by subtracting the measured rate from the fit rate.

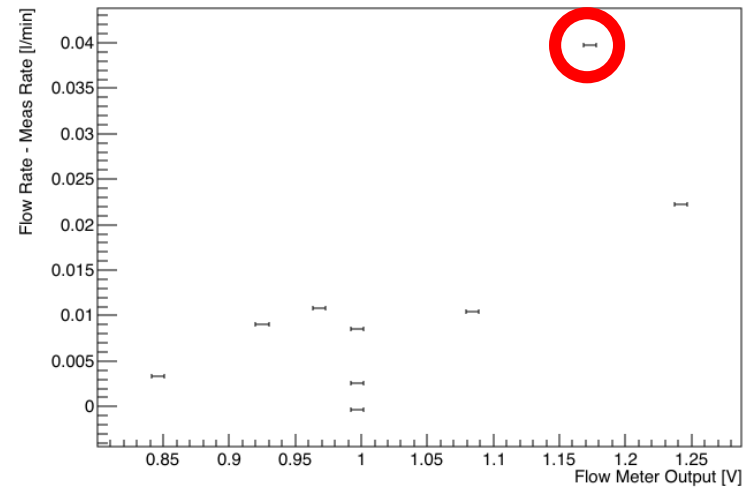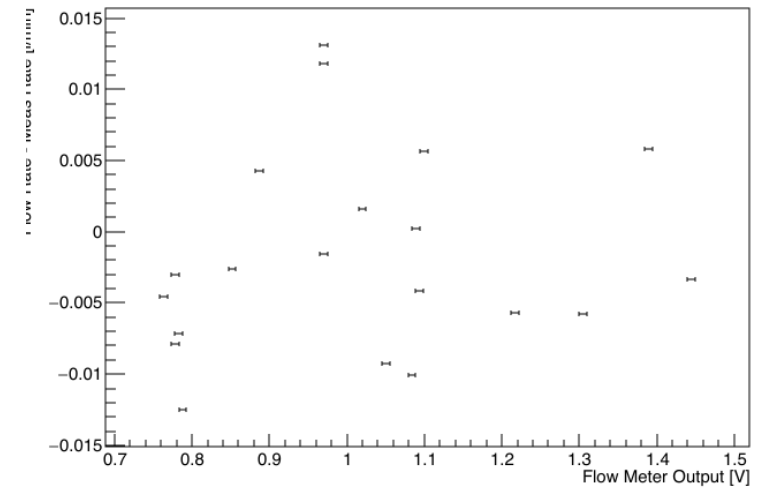▶ The standard deviation shows that the residual of the fit is around 2%

Flow Rate Residual

RHist	
Entries	75
Mean	0.001963
Std Dev	0.0181

(Fit Rate - Meas Rate)/Meas Rate

Bias from measurements

Backup Slides

Fit Slope as a function of temperature

$y = -0.0003x + 1.1512$
$R^2 = 0.01295$

Slope

Fluid Temperature [C]