

Update: Thermal Imaging

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ISU WEEKLY STAVE QA MEETING
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Fluid Loss

- ▶ Quantifying fluid loss and finding our leak has been the main priority over the last few weeks. No definite culprit has been found.
- ▶ Designed excel file to find approximate fluid loss.
 - ▶ Fluid loss **F**, is measured in cm with uncertainty of 1.4 mm in its measurement
 - ▶ This is ignoring expansion uncertainty and requires the entire cooling system to be at equilibrium. This requires the chiller and all pipes to be at room temperature meaning all measurements should be done after the chiller has been dormant for a few hours.
 - ▶ Fluid conversion **C**, is approximately 40 +/- 10 ml/mm. This is based upon a rough measurement of the fluid height as a function of fluid added to the system
 - ▶ Chiller run time **T**, is normally insignificant to these two other forms of uncertainty

$$R = \frac{FC}{T}, E_R = \frac{1}{T} \sqrt{E_F^2 C^2 + E_C^2 F^2}$$

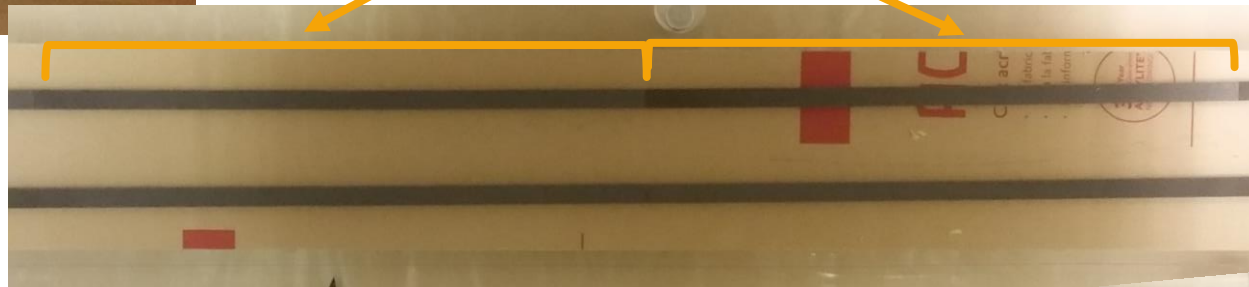
Notable Measurements, Estimates

Measurement	Loss Rate [ml/hr]	Percent Error [%]	Run Time [hr]	Fluid Loss [mm]	Max Run Cost [\$] (80 \$/L)
Best Run (Cycling 80 times low temp)	9.4 +/- 2.6	28	51.1	12	49.01
Off over Weekend (3-24:27-2018)	0.6 +/- 0.9	143.6	63.5	1	7.80
+40 C Run(3-26-2018)	16 +/- 8	51	7.6	3	14.72
-40 C Run(3-27-2018)	0 +/- 7	-	8.1	0	-
Req to Meas < 10ml/hr	5.0 +/- 2.7	53	24	3	14.72
Req to Meas < 1ml/hr	0.6 +/- 0.3	53	200	3	14.72
Running Both Pipes 1 month (max cur.)	24		1500		2880.00
Running Both Pipes 1 month (avg cur.)	16		1500		1920.00
Running Both Pipes 1 month (min cur.)	8		1500		960.00

Some Pictures (Will take better when done with taking data)



Maximum piece length is ~1 ft



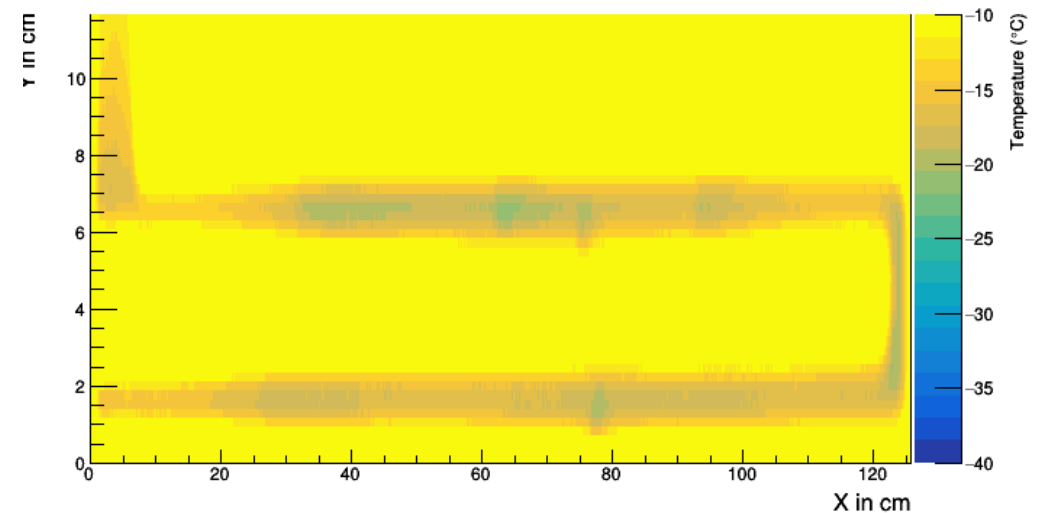
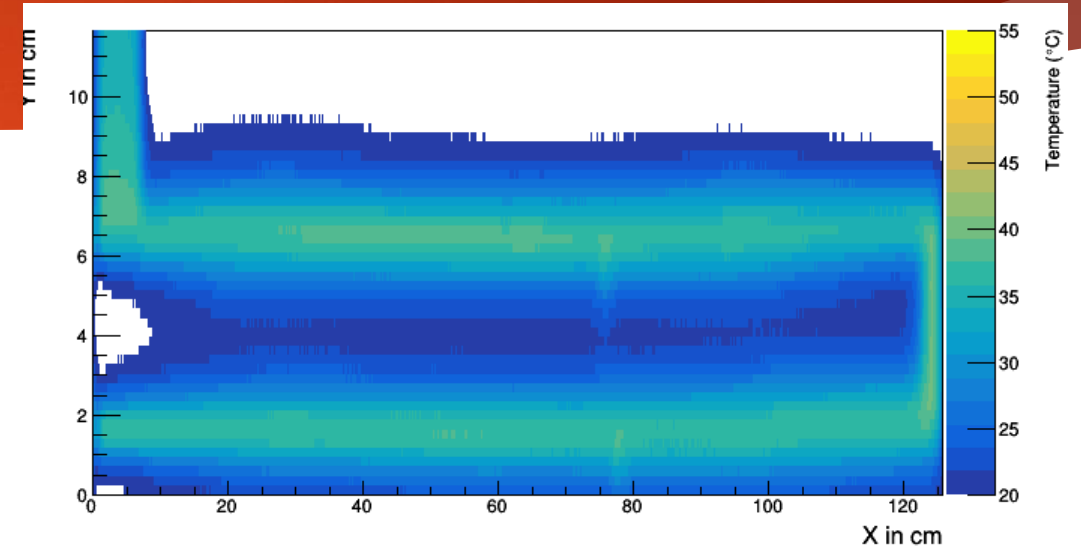
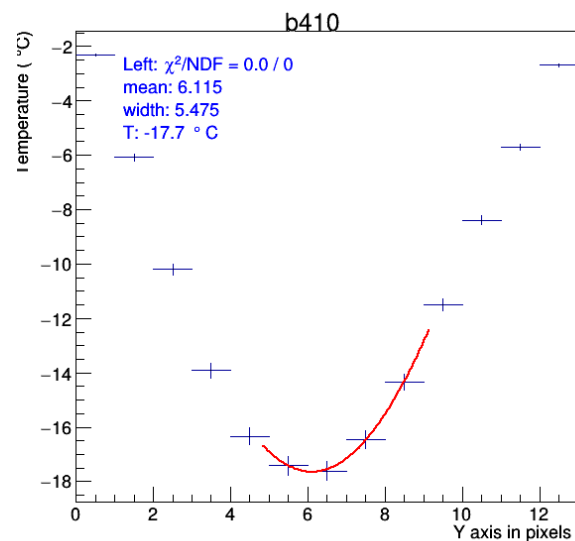
More Pics



Pipe Foam Assembly J-side

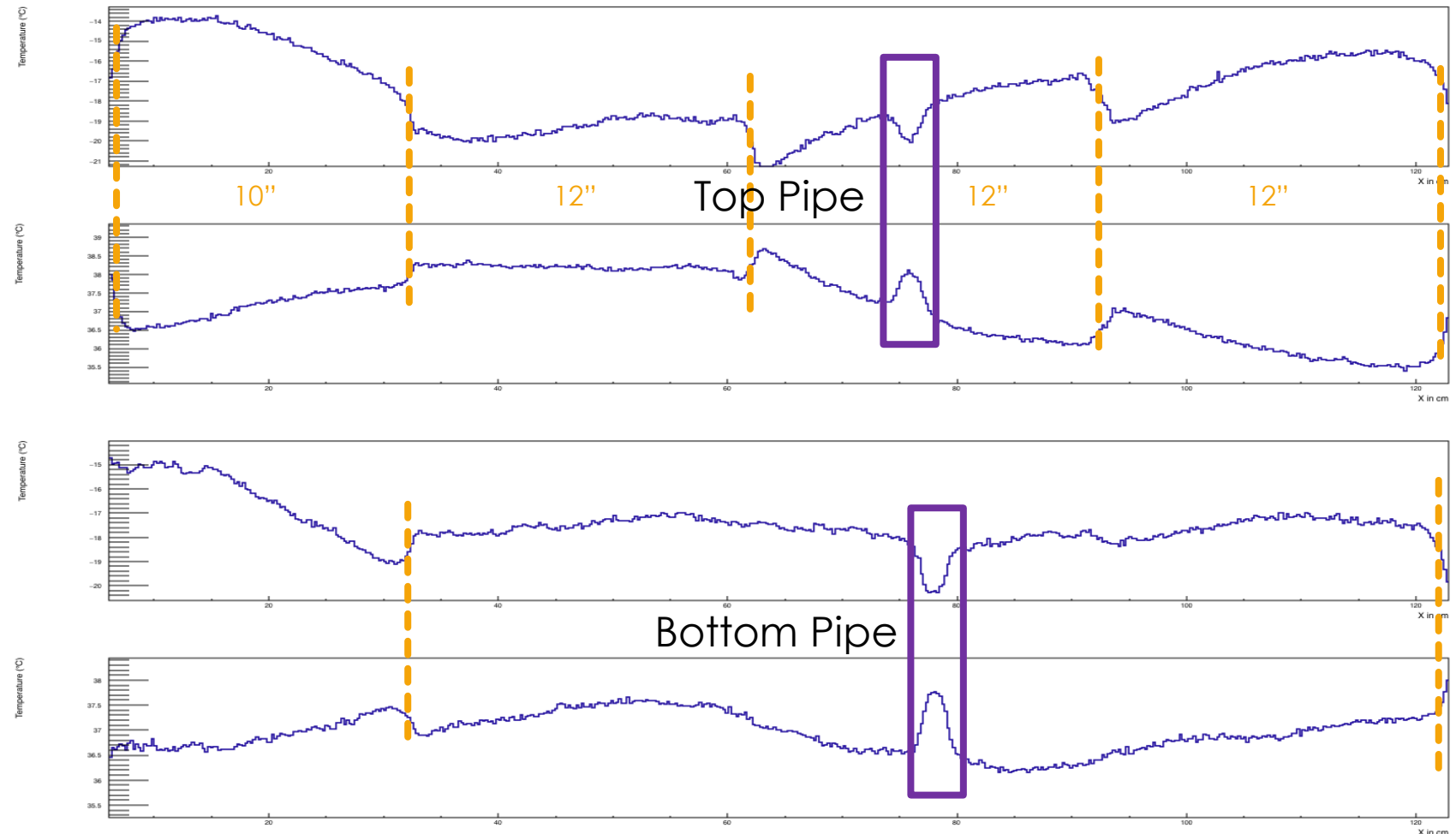
- ▶ Two measurements were done on the stove with the chiller set to -55 and +50 C.
 - ▶ 200 frames taken at 25 frames/second were averaged over.
 - ▶ Peak finding algorithm was used to find the maximum along each pipe

- ▶ Example →

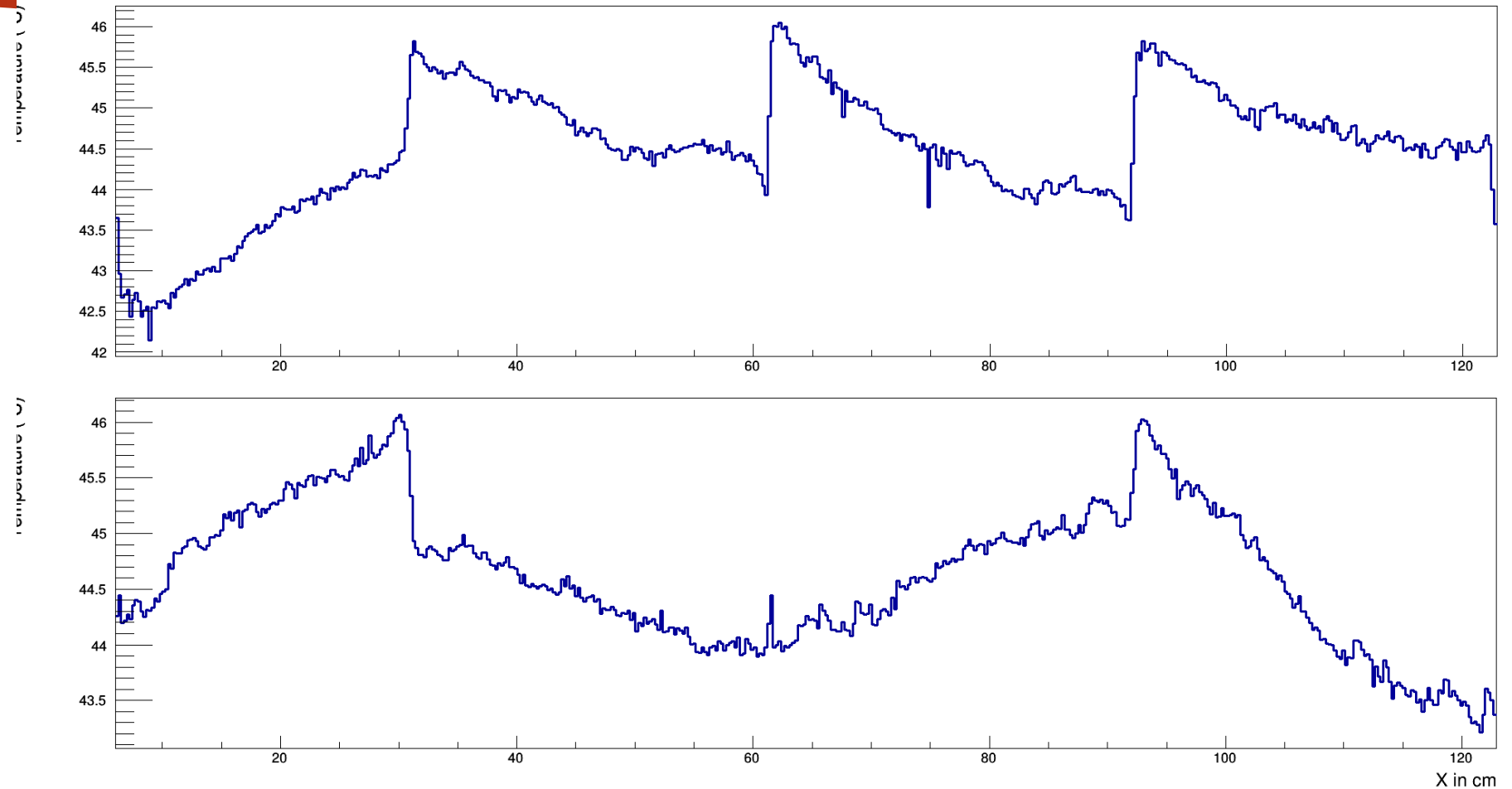


Hot and Cold Comparisons- Jside

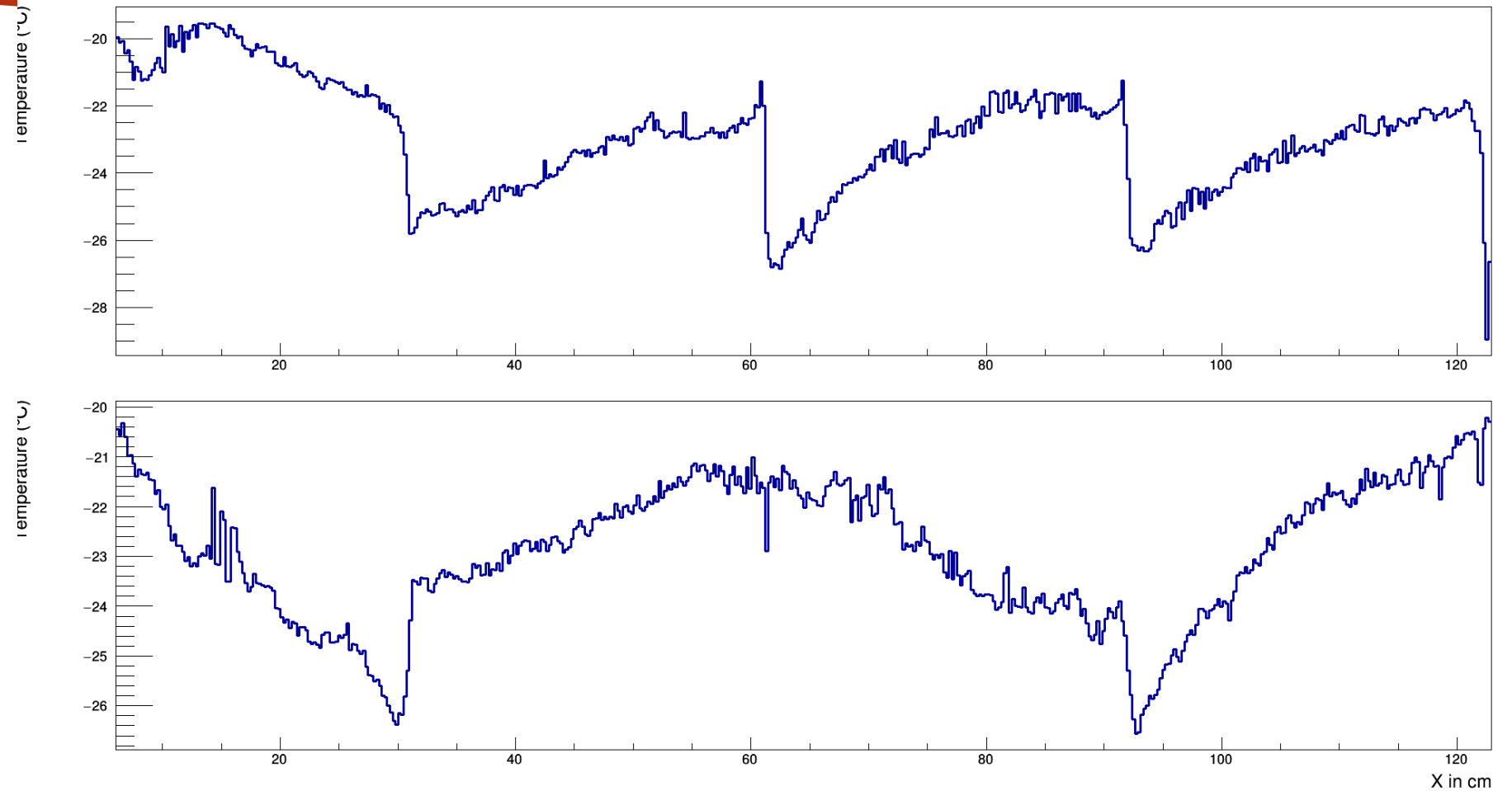
- ▶ Each flat portion corresponds to a ~1 ft section of the foam
- ▶ The bumps (purple) are due to material that was used to help align the Pipe Foam.
 - ▶ The measurements will be redone without them



Last Second Plots (Jside Hot)



Last Second Plots (Jside Cold)



Backup Slides