Update: Thermal Imaging

WILLIAM HEIDORN, JIE YU

IOWA STATE UNIVERSITY

ISU WEEKLY STAVE QA MEETING

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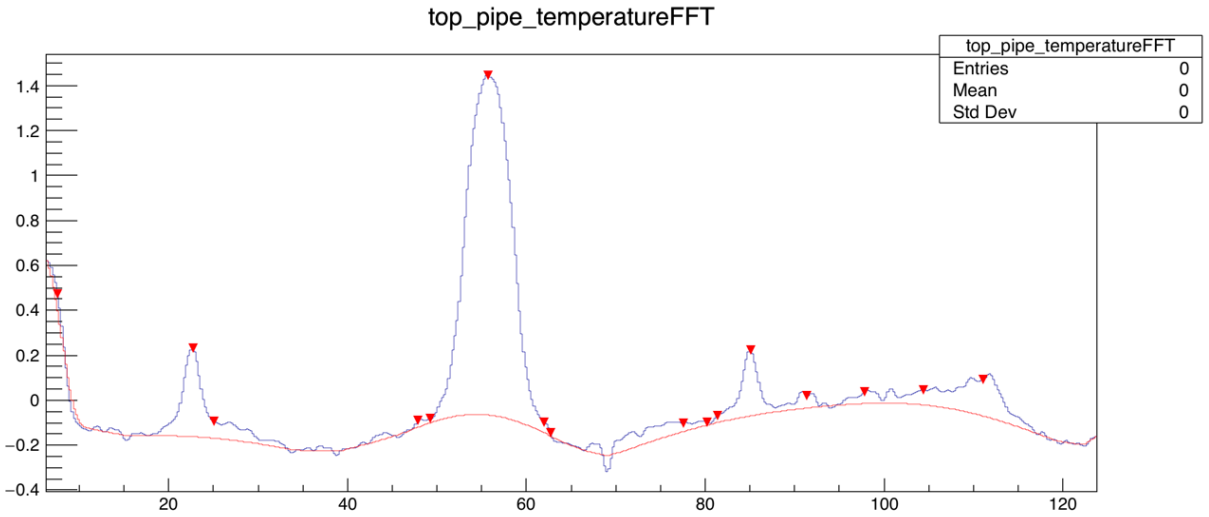
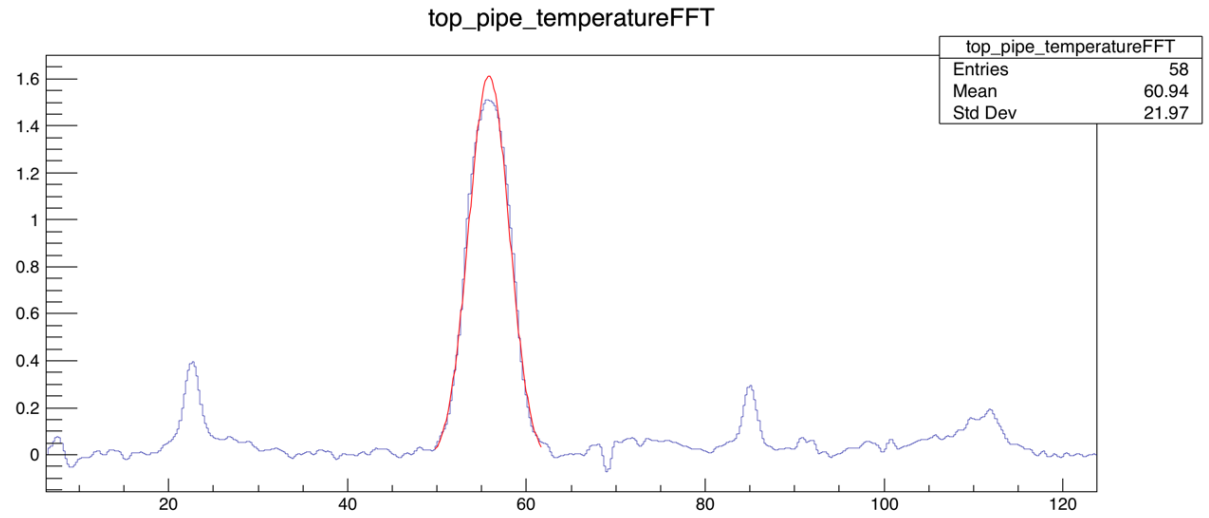
Improved Fitting Code

- Prepare Spectra
  - Find Background and Peaks with TSpectrum
  - Use background subtraction
- Fit Background subtracted spectra
  - Fit with simple gaussian
  - Using prior results-> Fit with offset gaussian
  - Using prior results-> Fit with offset line gaussian
  - Keep best fit of the 3
- Cut resulting peaks based upon:
  - Peak Goodness (ChiSq/DegFrdm < 0.05)
  - Peak Position (+/- 2 cm from TSpec results)
  - Peak Width (1<Width<8 cm)
  - Peak Height (Height > 0.2 cm)

Preparing Spectra

- The raw thermal data is put through the band pass filter and inverted
- Using TSpectrum.Search the "peaks" are found in the spectrum
  - Obviously many are not real peaks, so they will need to be filtered out
- Using TSpectrum.Background(17) a background is found for each spectrum
  - It does not work well with very large flaws
- The Background is then subtracted from the data. This gives the "Flaw" data

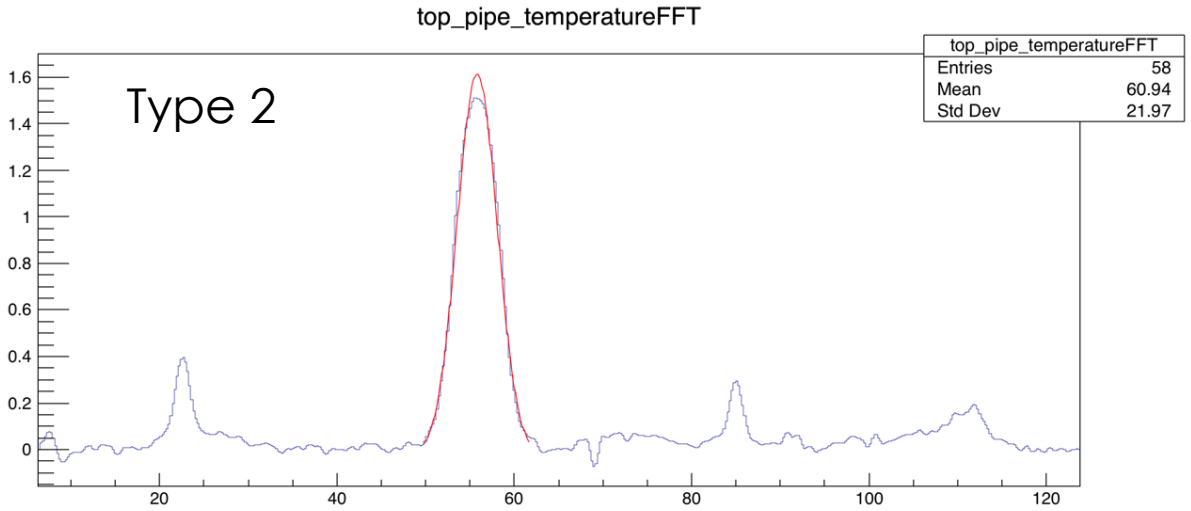


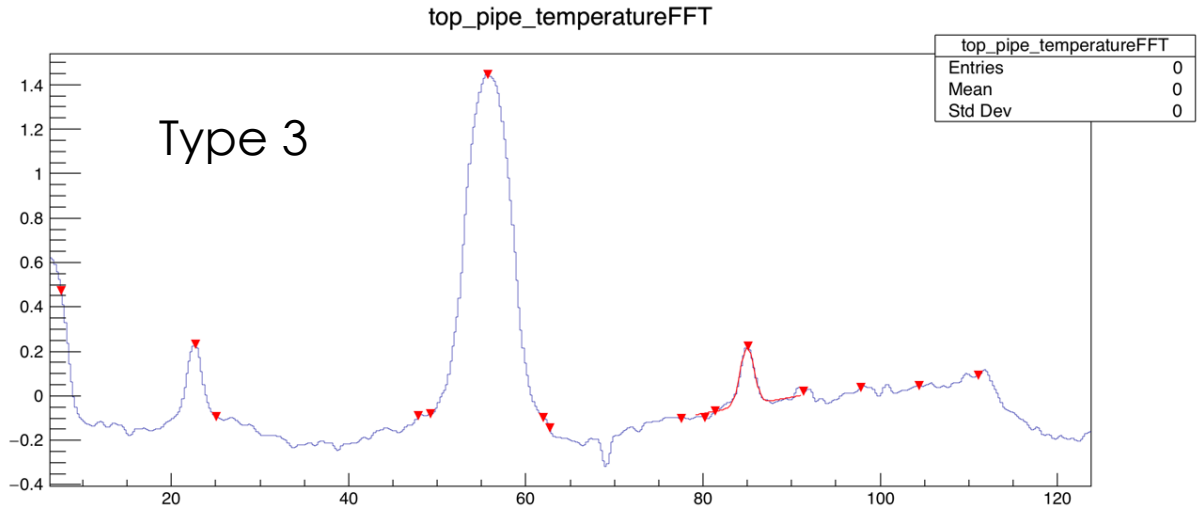


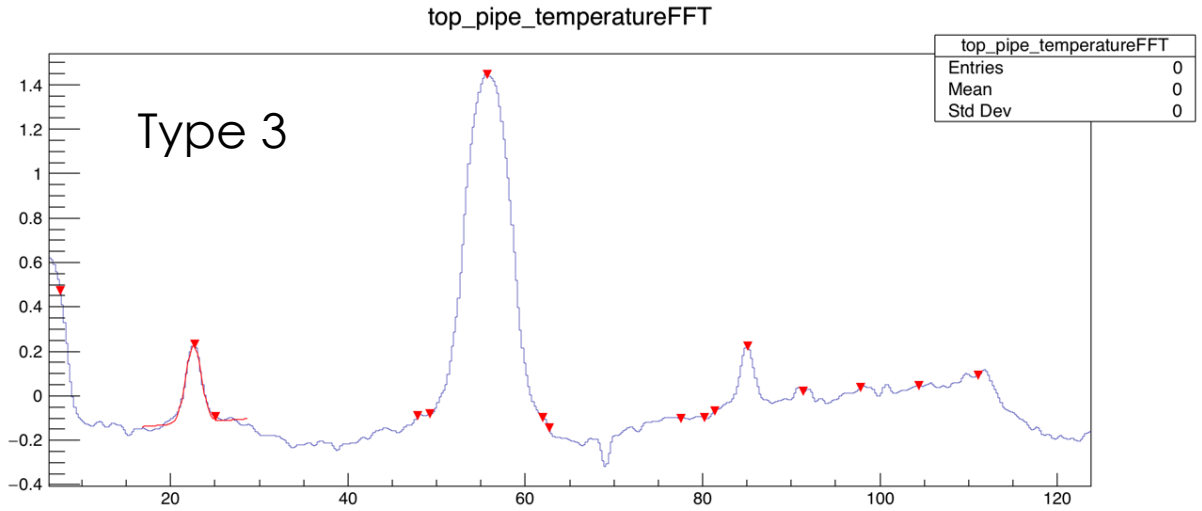
Fitting the Peaks

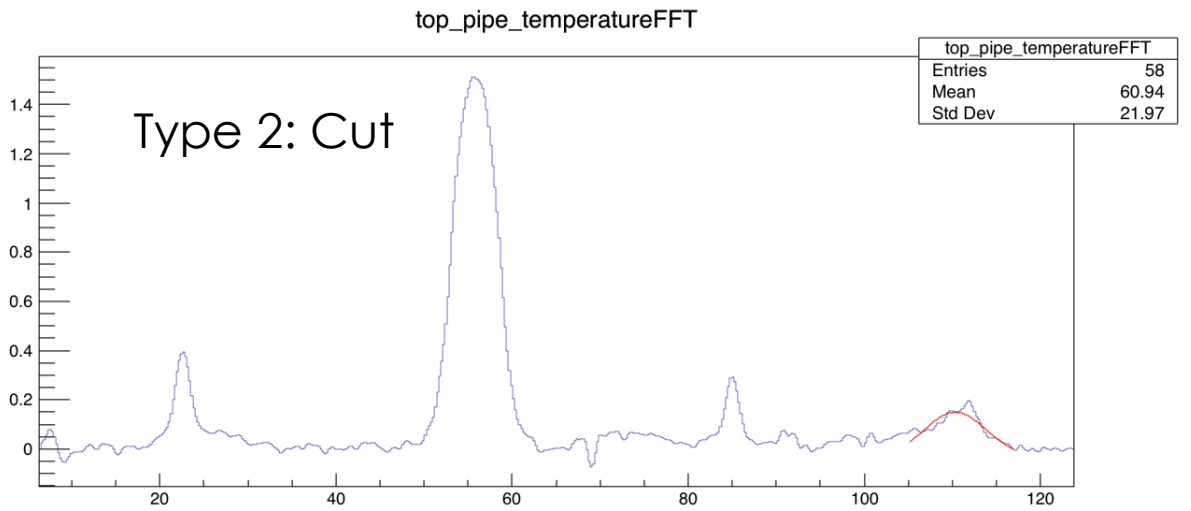
- Each Peak is fit 3 times. After each fit the resultant values are used for each other fit. If the fit has a smaller ChiSq/DegFr then it is kept. Below are the parameter limits and starting values.
  - Fit 1 "[0]*exp(-0.5*((x-[1])/[2])^2)"
    - 0->(0,5) 1->(peakPos-5,peakPos+5) 2->(0.25,10) StartingVals->(1,peakPos,1)
  - Fit 2 "[0]*exp(-0.5*((x-[1])/[2])^2)+[3]"
    - Same as above with 3->(-0.5,0.5) and StartingVals->(FitHeight,FitPeakPos,FitSigma,0)
  - Fit 3 "[0]*exp(-0.5*((x-[1])/[2])^2)+[3]+[4]*x"
    - This fit is done on the band passed data, not the background subtracted
    - 0->(FitHeight-0.1,FitHeight+0.1) 1->(FitPeakPos-1,FitPeakPos+1)
      2->(FitSigma -1, FitSigma +1) 3->(-1,1) 4->(-2,2)
      StartingVals->(FitHeight,FitPeakPos,FitSigma,0,0)

Example Peak Fits









Cuts

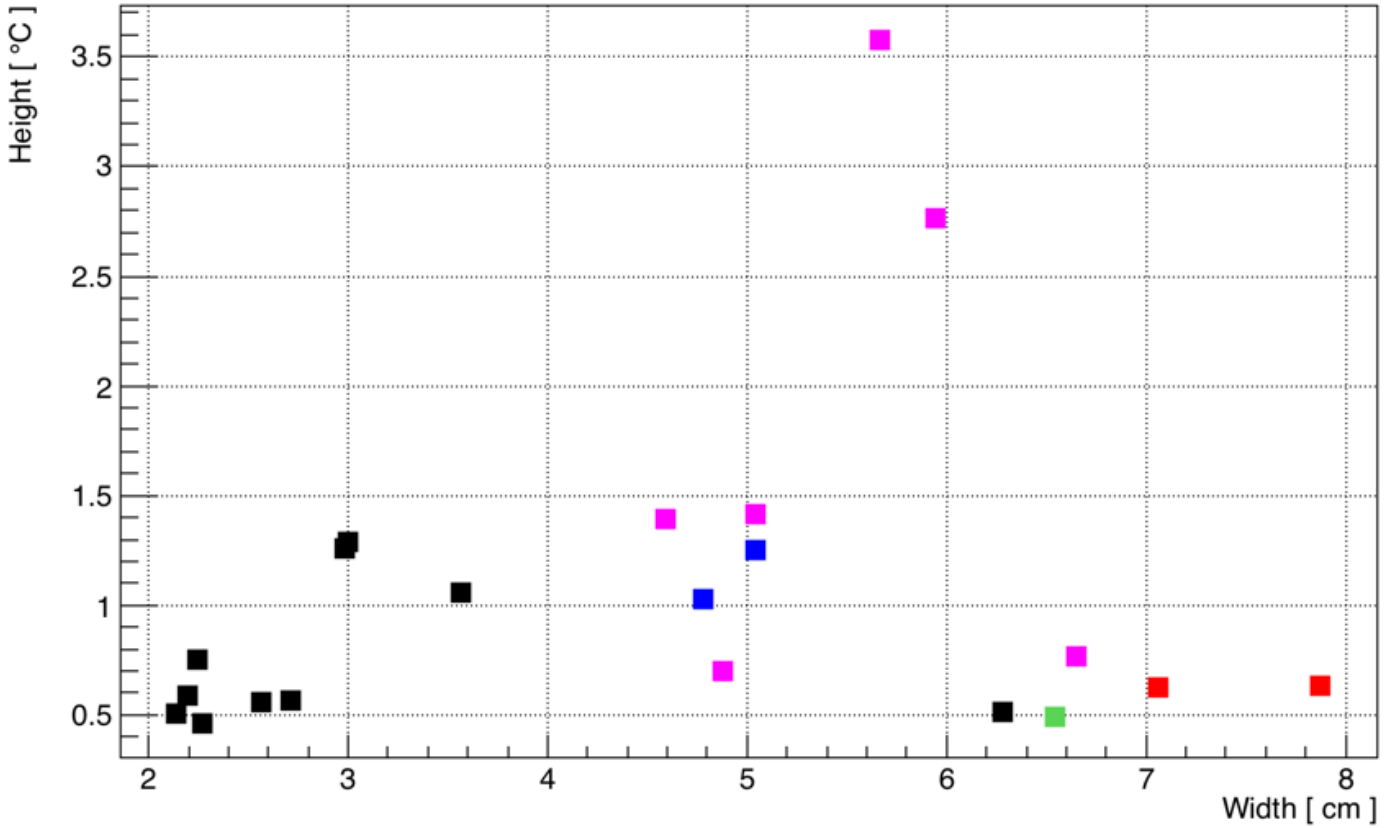
- Peak Position Cuts:
  - 1. The Peak found by the best fit must be within 2 cm of the peak found by the peak finder (Removes duplicating flaws)
  - 2. Peak Maximums must be more than 2 cm away from the edge of the stave (Need to ignore end of stave effects)
- Peak Fit Goodness Cut: After looking at all of the data from staves 2, 2R and 4, Peaks with a ChiSq/NDFreedom > 0.05 were very poor, and this cut out a few non-implemented poor peaks.
- Peak Size Cuts:
  - Width: The defect width is required to be between 1 and 8 cm. Anything with a larger width will be missed by the fitting.
  - Height: The flaw height must be greater than 0.2 C. Originally this was set to 0.1C, but it finds a larger amount of things that could be considered background or just fluctuations of the measurement.

Height Estimation

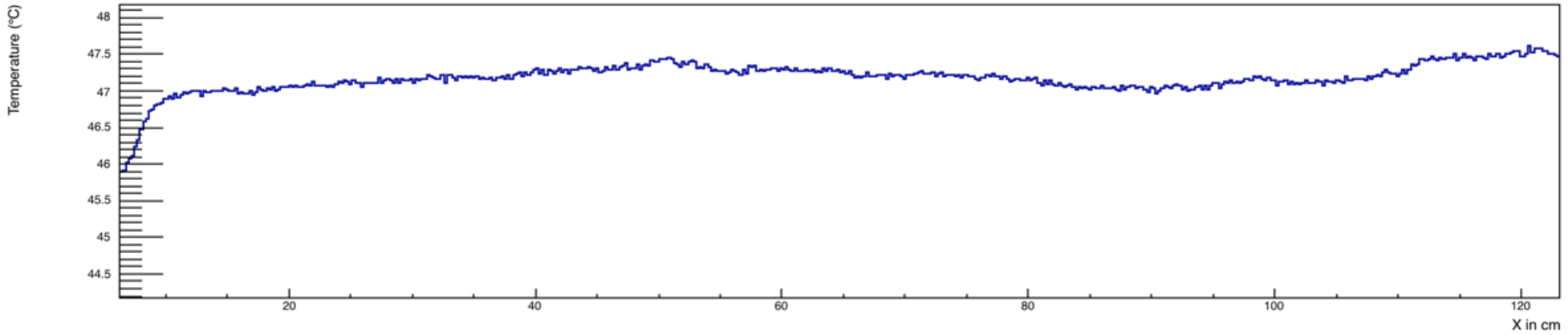
- Using the Band Pass filter rescales the y axis. Therefore height measurements must be done using the original inverted dataset.
- Using all of the fit information from before, the height is measured using the best fit parameters of a fourth fit. This height is not used in the cuts

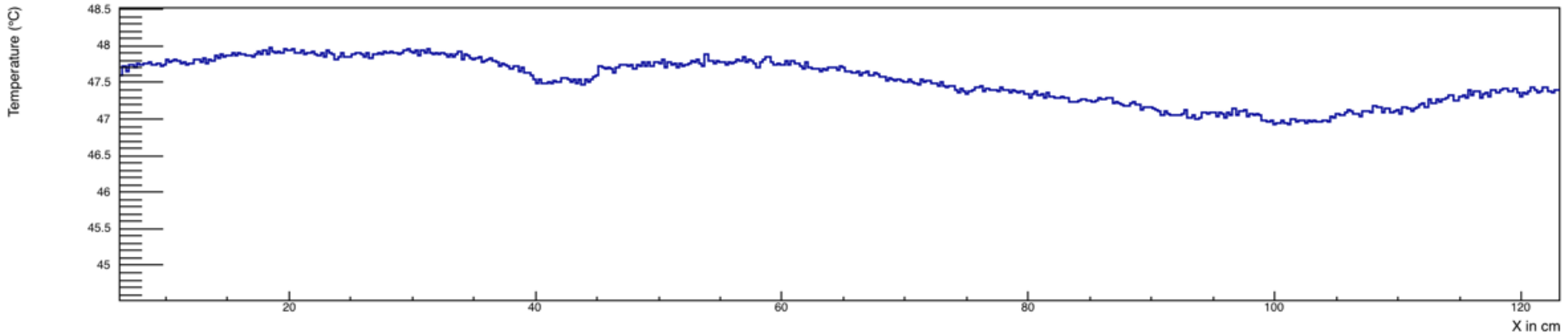
Width as a function of Height

- Purple are pipe-foam flaws
- Blue is the secret flaw
- Green is a lone partial flaw
- Red are flaws that are found, but not accurately described due to their size

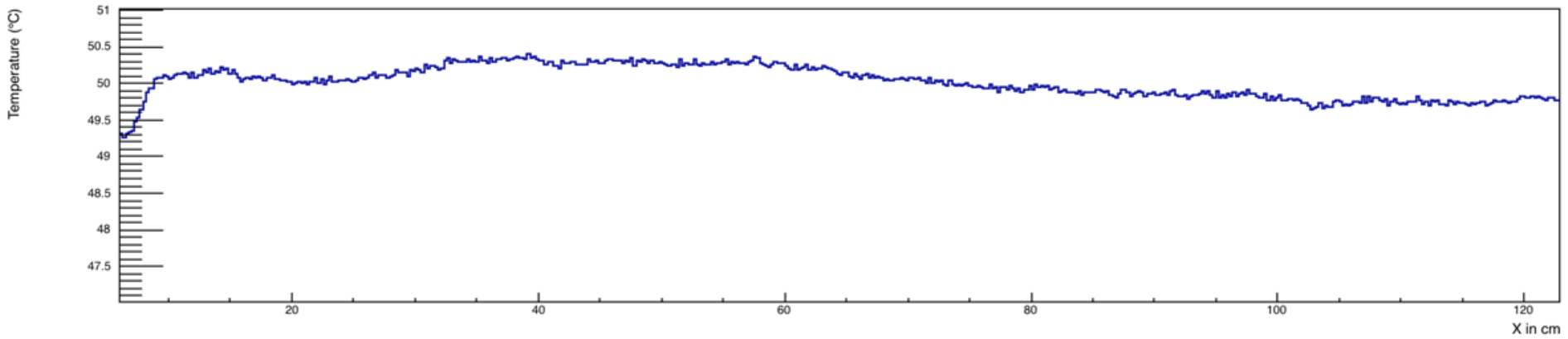


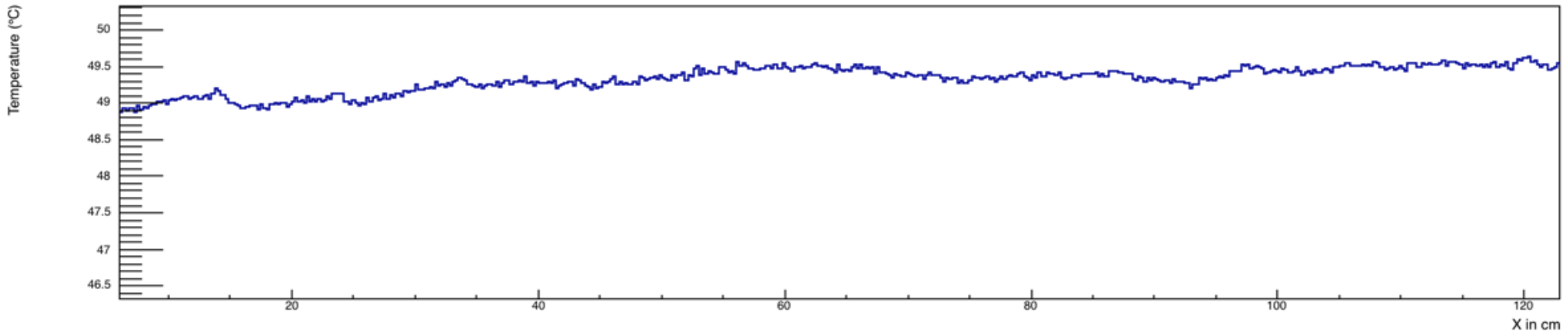
Final Results: Stave 5-L



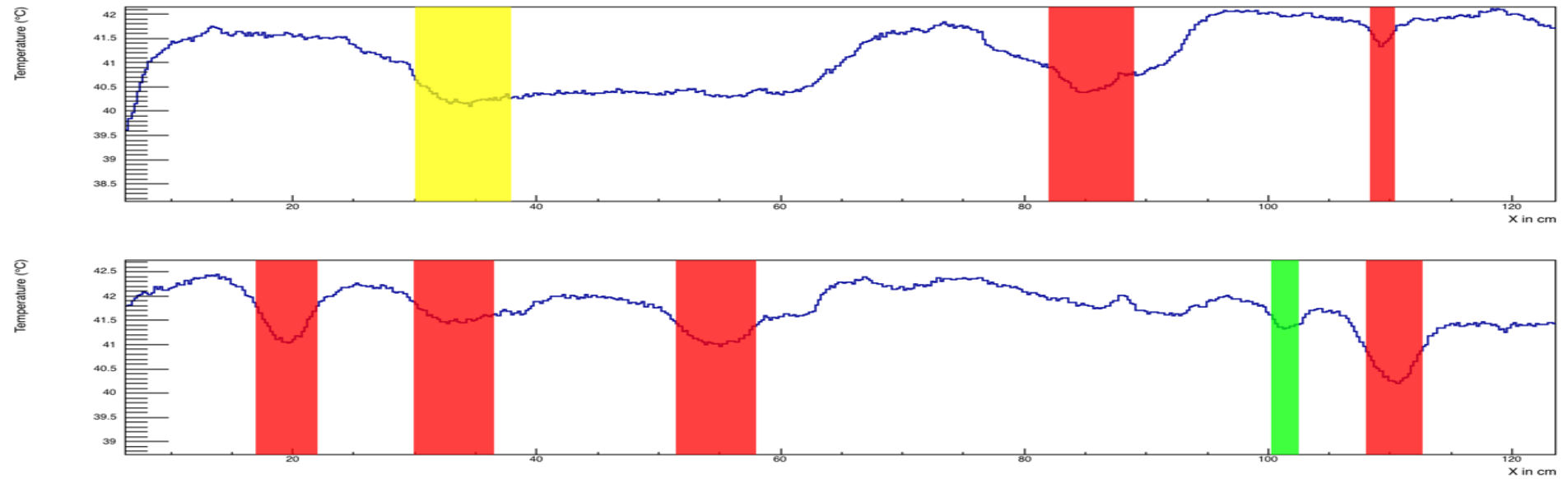


Final Results: Stave 5-J

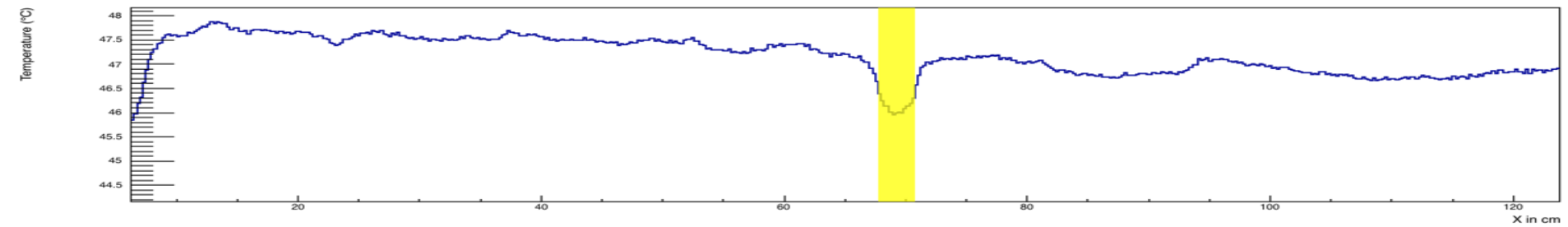


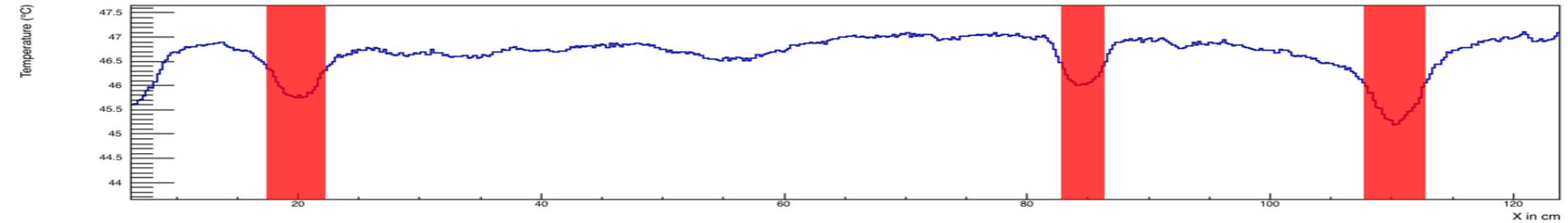


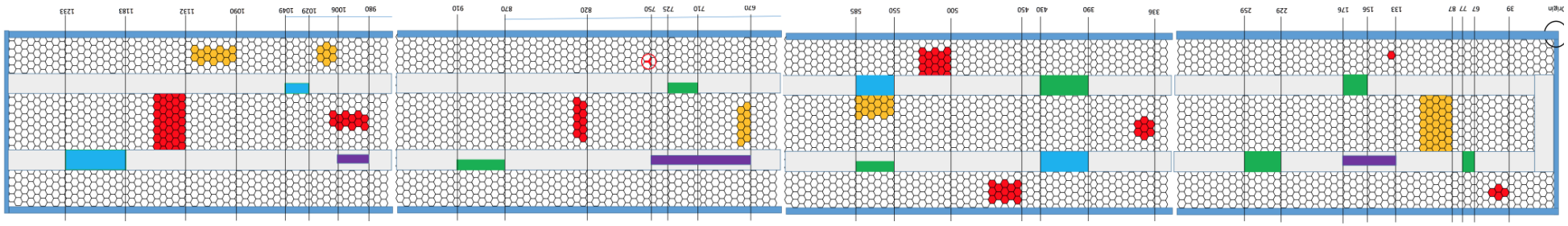
Final Results: Stave 2-L (The bad one)



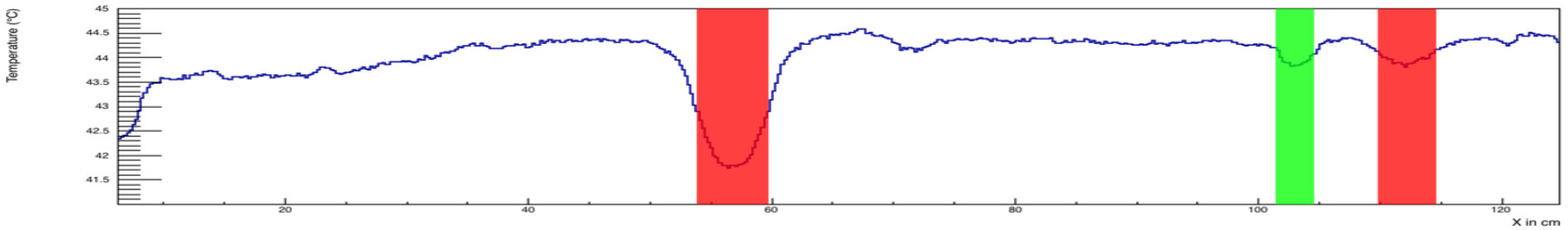
Final Results: Stave 2-J

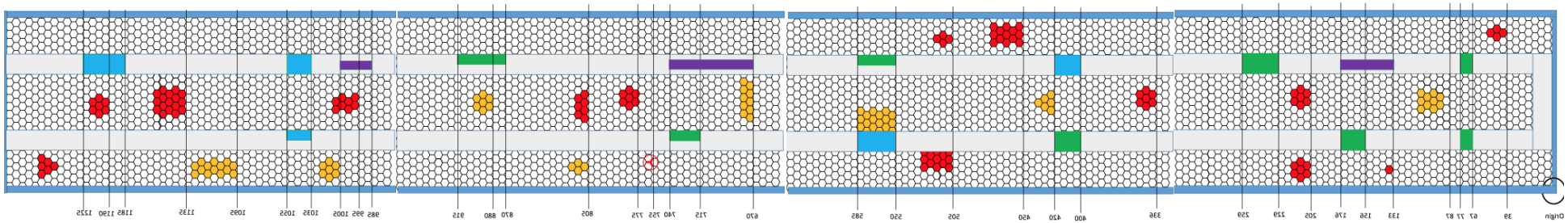




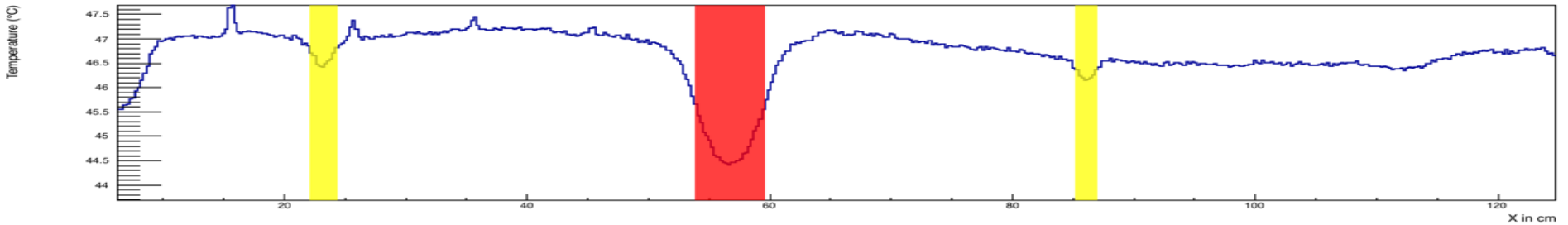


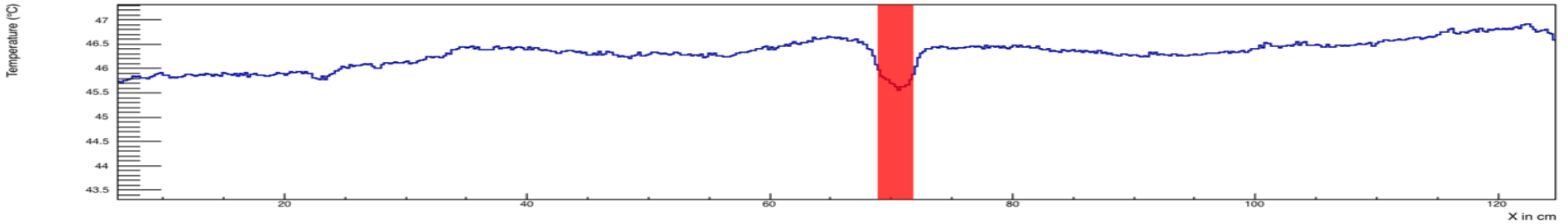
Final Results: Stave 2R-L (Feb 2017)

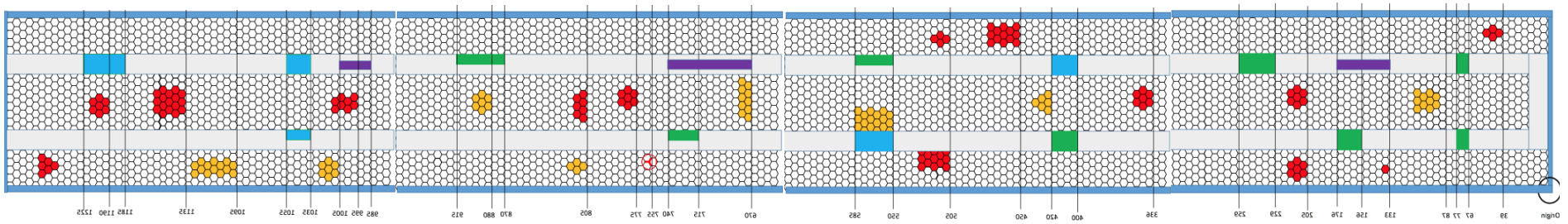




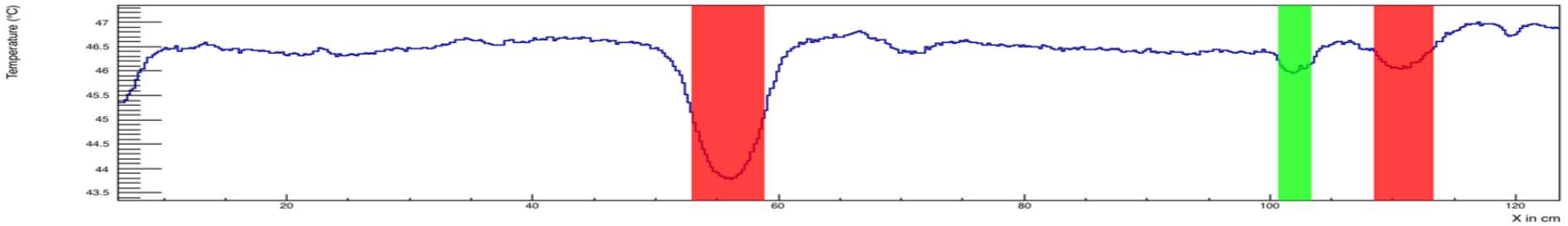
Final Results: Stave 2R-J (Feb 2017)

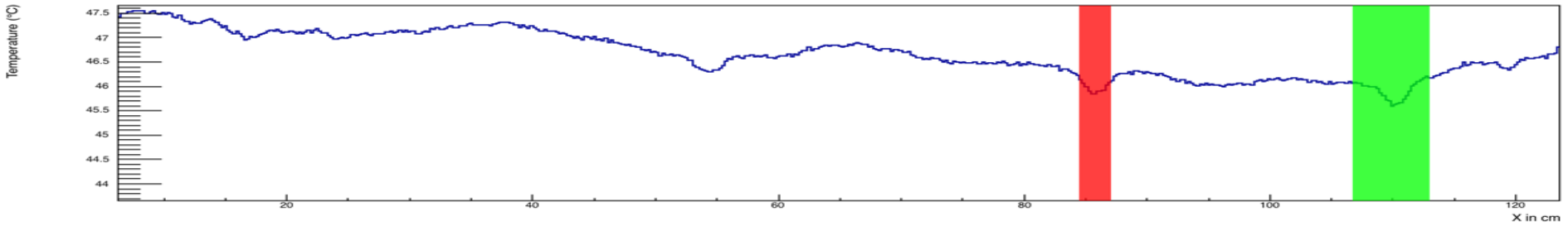


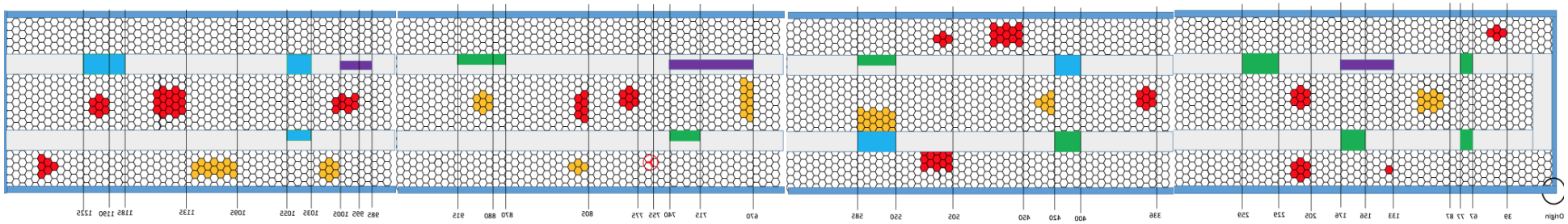




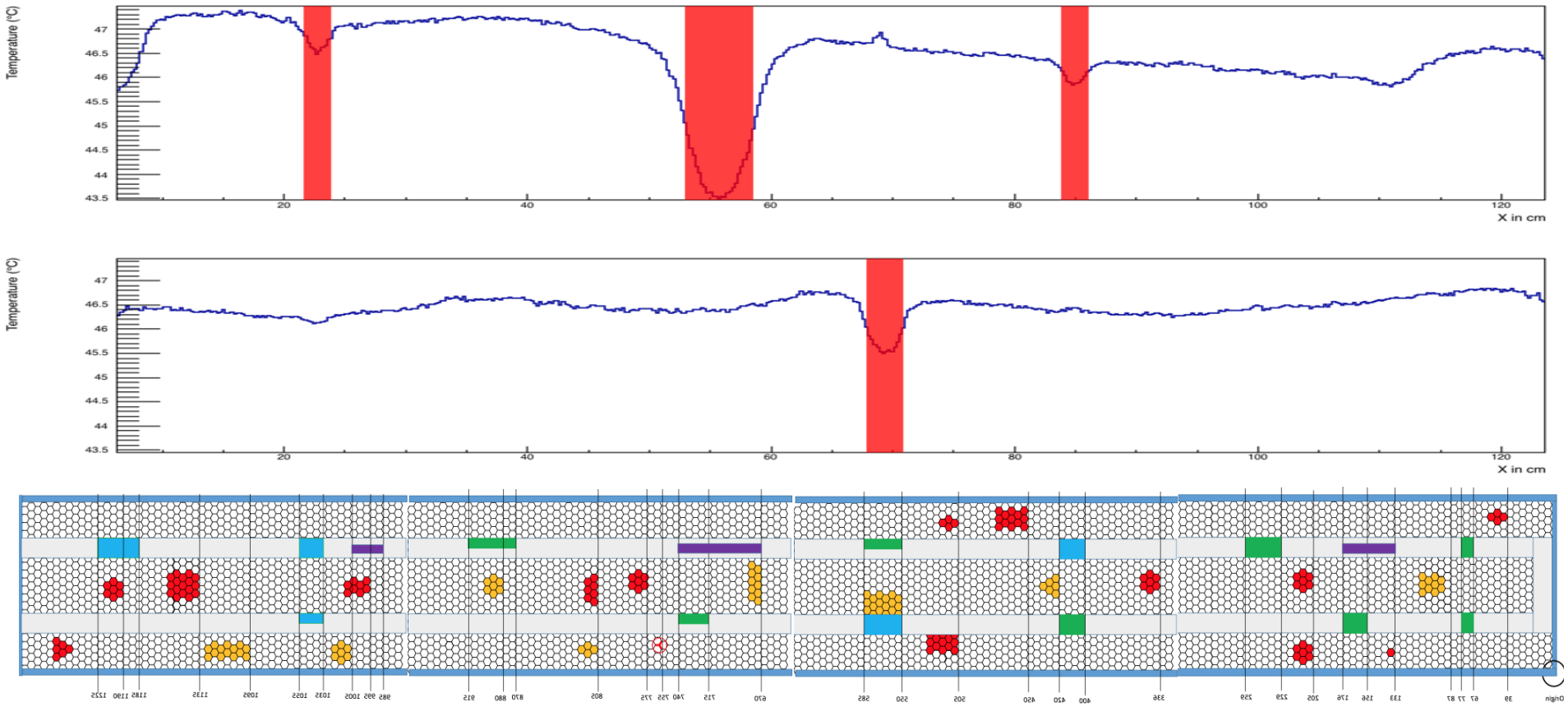
Final Results: Stave 2R-L (Nov 2017)



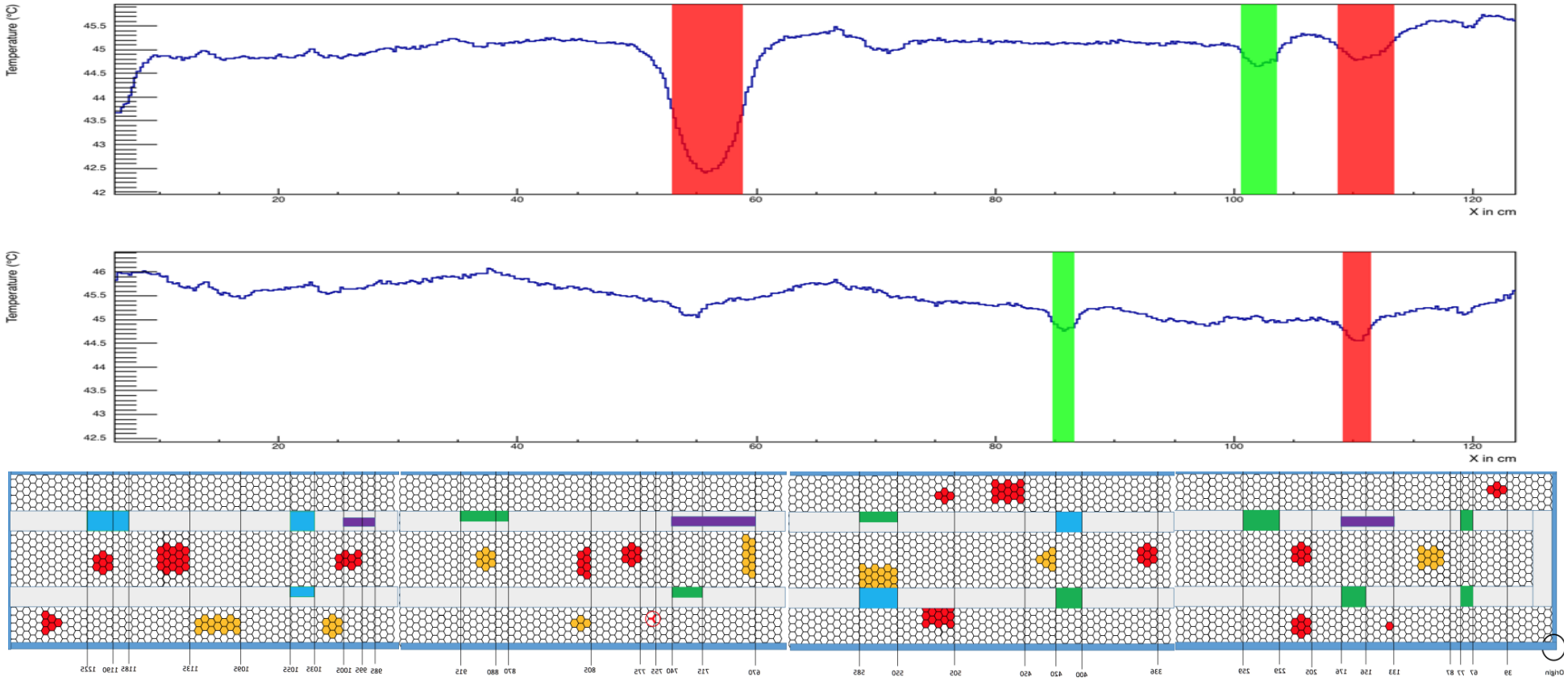




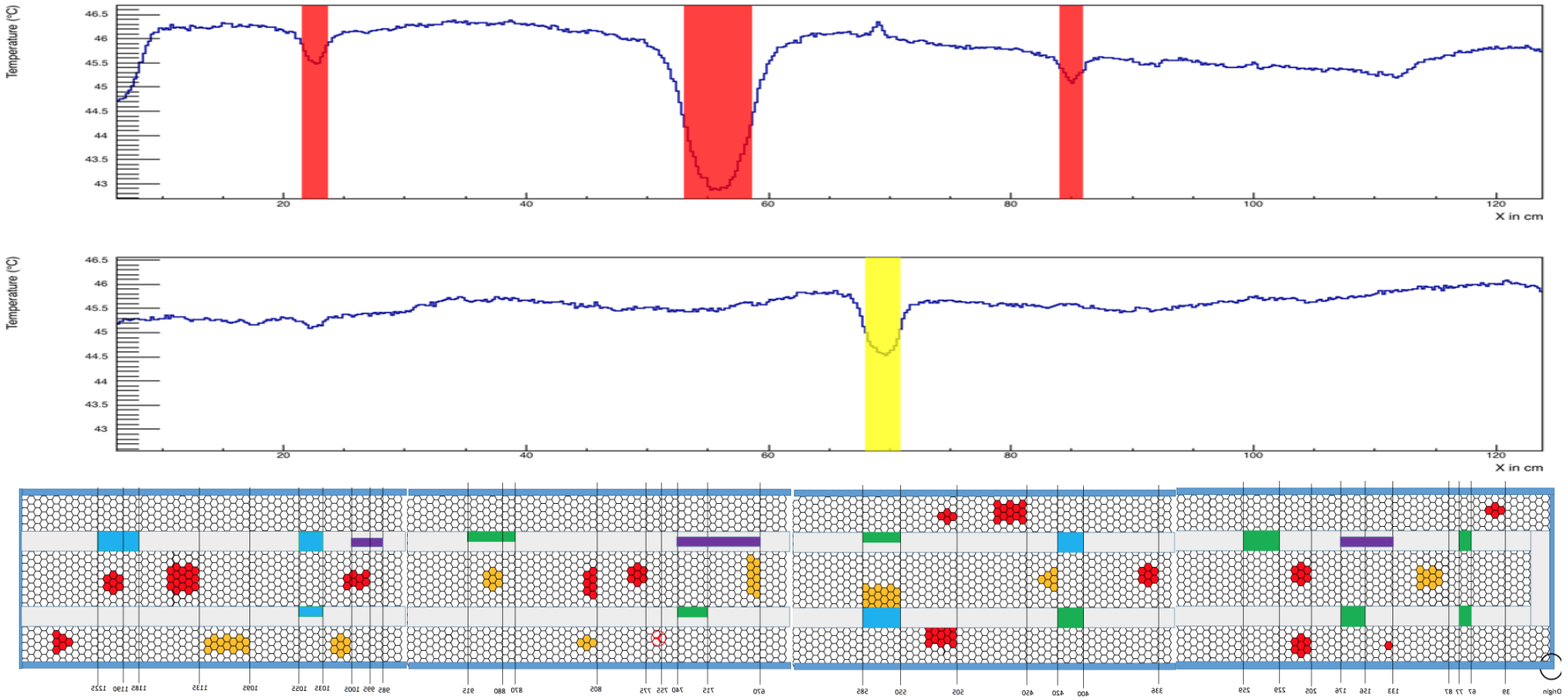
Final Results: Stave 2R-J (Nov2017)



Final Results: Stave 2R-L (Dec 2017)



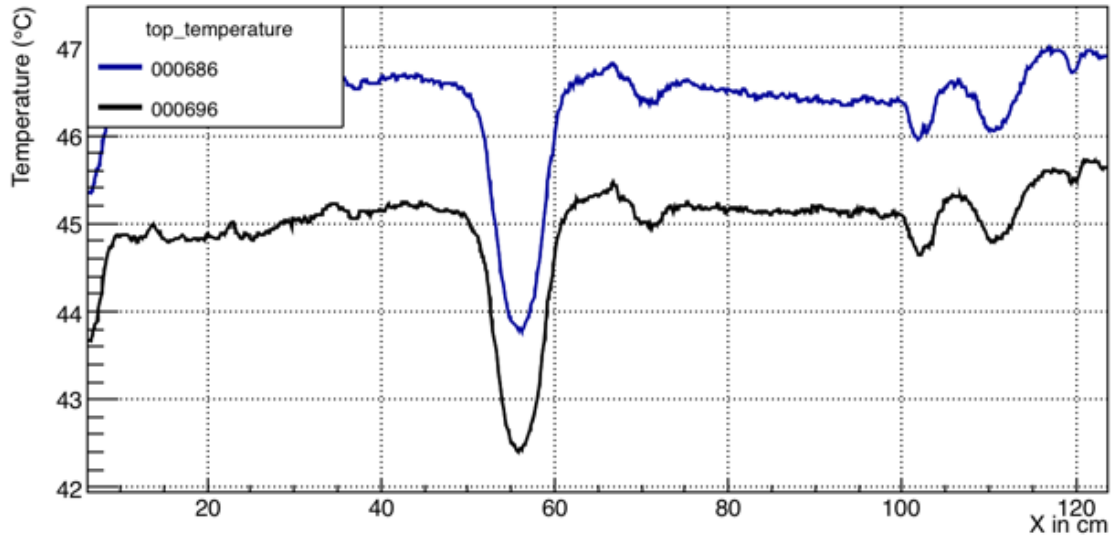
Final Results: Stave 2R-J (Dec 2017)

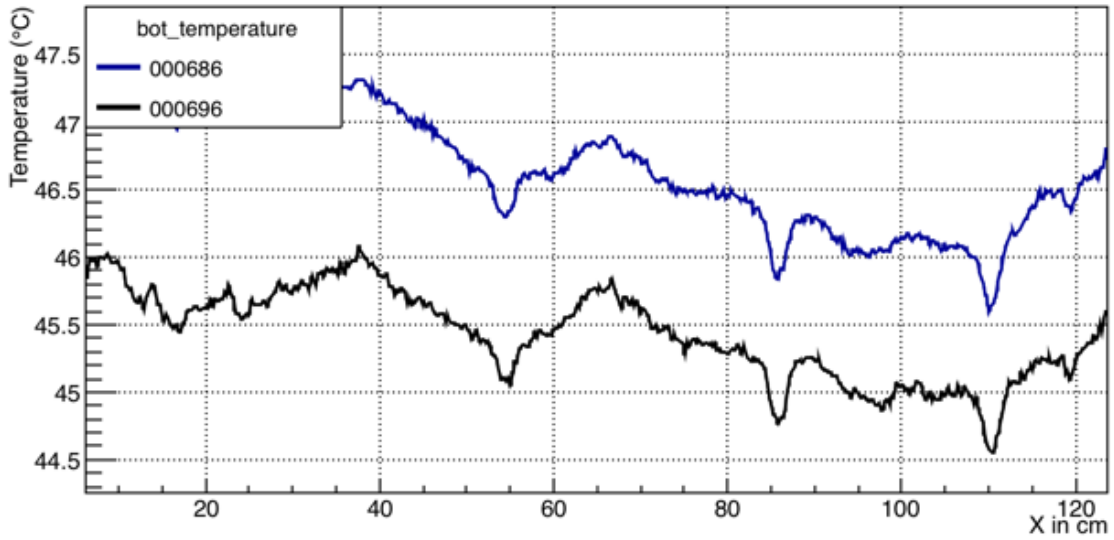


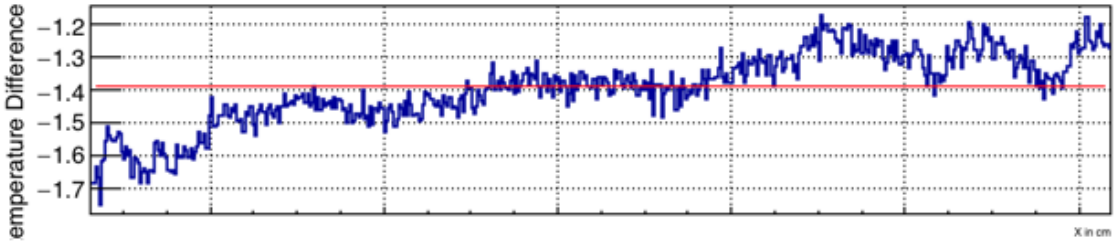
Conclusions

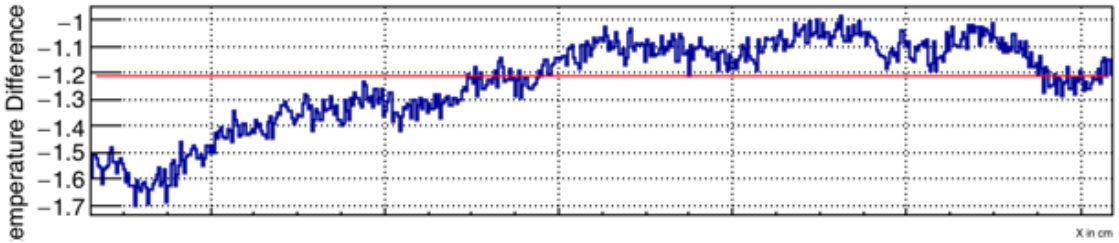
- Success rate for detecting implemented flaws with a size greater than 1cm
  - Foam Facing: 85% (11/13)
    - Two were missed because they were in the edge region near the end of stave card
  - Pipe Foam 50% (6/12)
    - All 2cm defects went undetected
    - One 3cm defect went undetected
    - One 8cm defect went undetected
    - All visible peak-like defects are caught by the program
- Program misses large scale defects, like those found on stave 2L

Backup: 2R-L Temp Difference

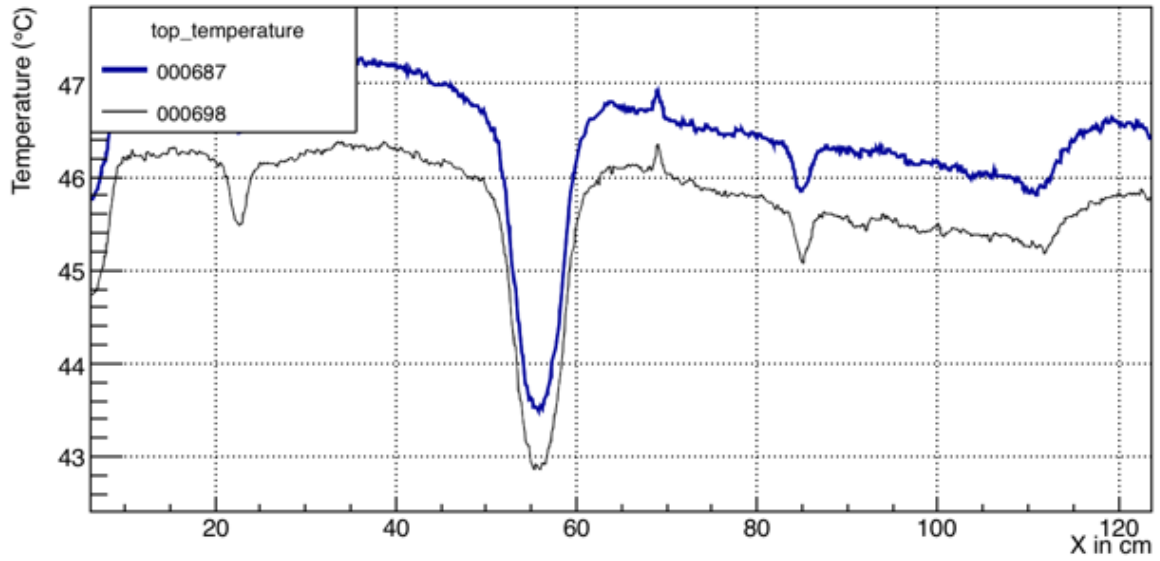


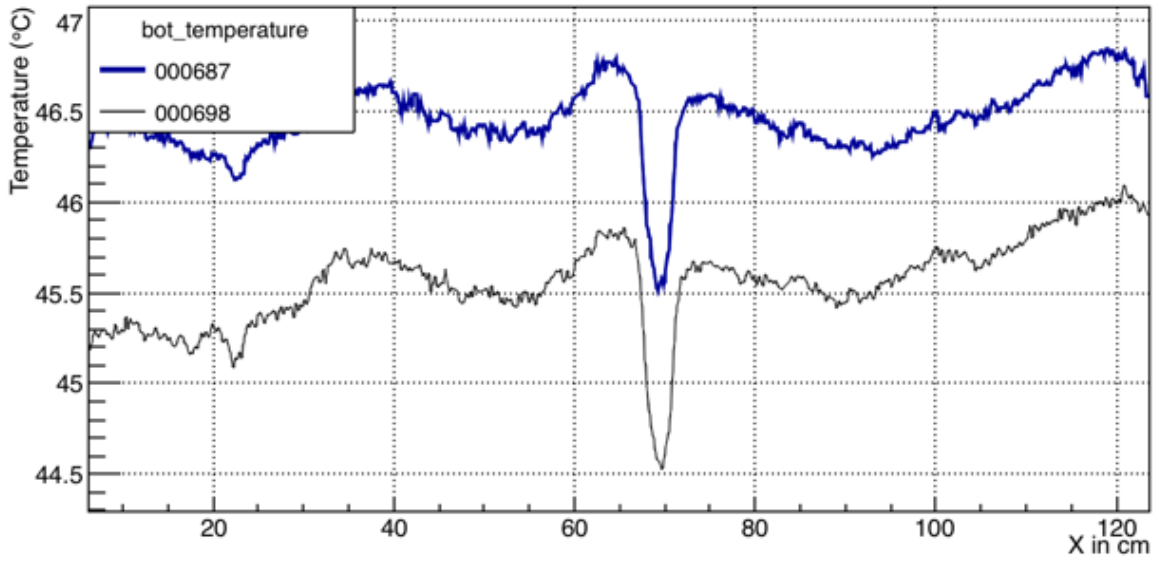


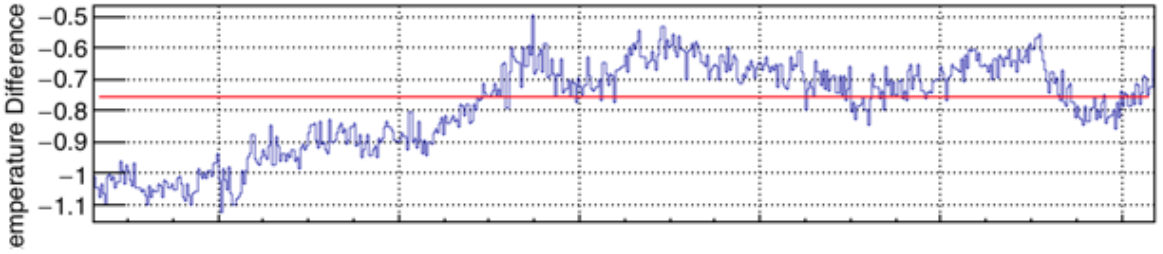


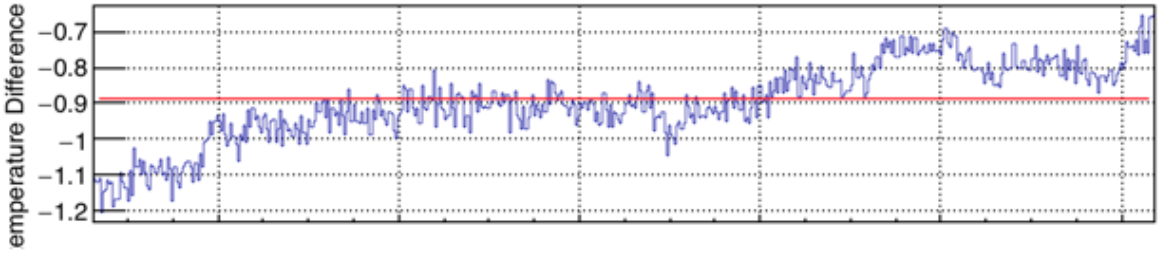


Backup: 2R-J Temp Difference









Backup: All Stave Histograms