INTT Weekly Meeting

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Hot/Dead Channel Analysis

- Re-evaluation of original approach
  - Representations of each term were too vague
  - Needed more constraints on initial parameters
- Analyzed more runs
  - Most analysis was done on 20869
  - Analyzed runs 20444, 20447-20449
  - Gave greater insight into a good classification scheme

Overview

(For each run)

- Go through and append hits to an array (one entry per channel)
- Normalize entries of the array by the number of events in the run
- Write each element of the array to a `TTree`
  - Branches for hitrate, felix server, felix channel, sensor chip, sensor channel
  - This makes re-fitting/classifying convenient since the entire run does not need to be re-analyzed

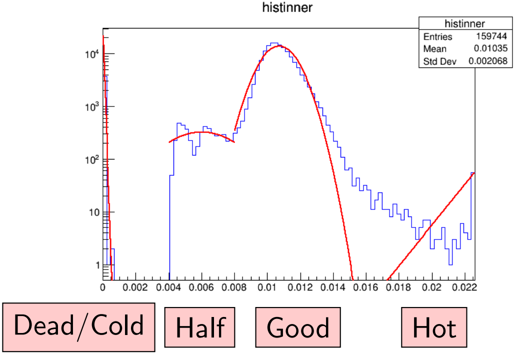
Overview (cont'd)

(For each run)

- Obtain mean/standard deviation of this hitrate distribution
  - Used to determine range of `TH1`, at most only so many standard deviations from the mean are kept
- Fill the `TH1`
  - Inner/Outer barrels are seperated and chips are normalized by their length (either 2.0 or 1.6 cm)
  - Catch entries that would underflow/overflow based on its range and put them in the first/last bins
  - This gives us the hot channel peak on the right edge
- Fit the `TH1` as a sum of several **terms**:
  - Exponential decays from dead/hot at extremes of the histogram
  - Gaussians for half-entry and good channels
  - Example shown on later slide
  - Parameters/constraints chosen based on inspection of multiple runs

Example of application–logscale plot of hitrate distribution (run 20444 inner barrel). The *x*-axis is the normalized hitrate. Each **term** is fitted over a subrange and are labeled below:

- Dead/cold region (exp. decay)
- Half-entry region (Gauss)
- Good region (Gauss)
- Hot region (exp. decay)



Overview (cont'd)

(For each run)

- Once fitted, go back through the `TTree` and classify channels using Bayes' Theorem
  - The channel's state is the term which evaluates the highest for its hitrate
  - Cold channels with hitrates of identically 0.0 are classified as "dead"
- Write a separate `TTree` to a new `TFile` with the additional state information included as an enum ("0" for "good" and positive for other non-good **terms**)

All analysis codes for this project can be found in a subdirectory of the INTT repository:

- https://github.com/sPHENIX-Collaboration/INTT/tree/main/general_codes/josephb/codes/channel_classifier

I will add a `README` eventually but you can reach out with questions via my email (`jbertau@purdue.edu`) or over Mattermost.

Some results

Portion of channels classified as "good" in each run

20444	0.952111
20447	0.950477
20448	0.948154
20449	0.947051

This is effectively our acceptance run-by-run. It seems to be run dependent and potentially time dependent–there is a downward trend in efficiency for this set of runs.

Some results (cont'd)

Table of run-run agreement of "good" channels. For a pair of runs the agreement is computed as

$$\text{agreement} = \frac{\text{number of channels good in BOTH runs}}{\text{number of channels good in EITHER run}} \tag{1}$$

This is designed to check if the same set of channels are found to be "good" run-to-run. We do not expect this to be exactly 1.0 but it should be close.

	20444	20447	20448	20449
20444	-	0.992059	0.994265	0.993388
20447		-	0.990085	0.989326
20448			-	0.995658

Because this is much closer to 1.0 than the direct efficiency, it is likely a similar set of channels being identified as "good" between different runs

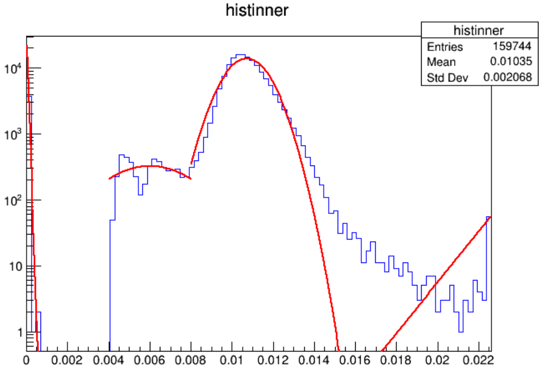


Figure: Fitted, normalized, logscale hitrate distribution for the inner barrel of INTT. Run 20444

20444 - Outer

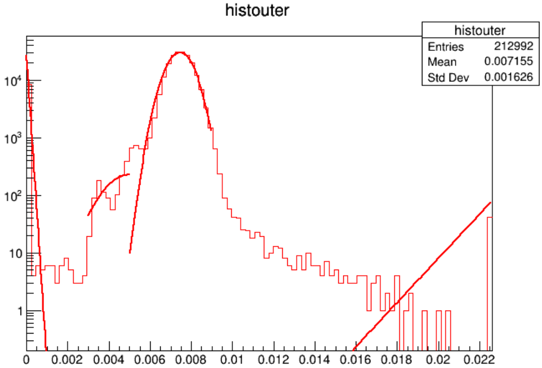


Figure: Fitted, normalized, logscale hitrate distribution for the outer barrel of INTT. Run 20444

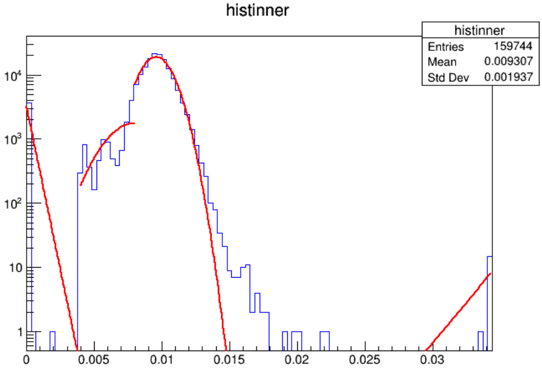


Figure: Fitted, normalized, logscale hitrate distribution for the inner barrel of INTT. Run 20447

Plots

20447 - Outer

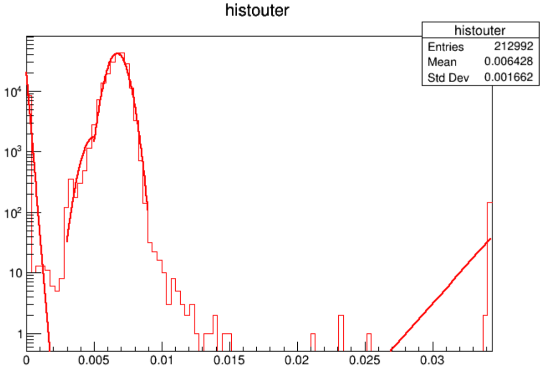


Figure: Fitted, normalized, logscale hitrate distribution for the outer barrel of INTT. Run 20447

Plots

20448 - Inner

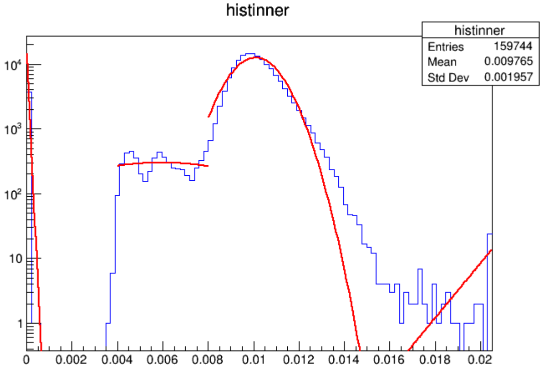


Figure: Fitted, normalized, logscale hitrate distribution for the inner barrel of INTT. Run 20448

Plots

20448 - Outer

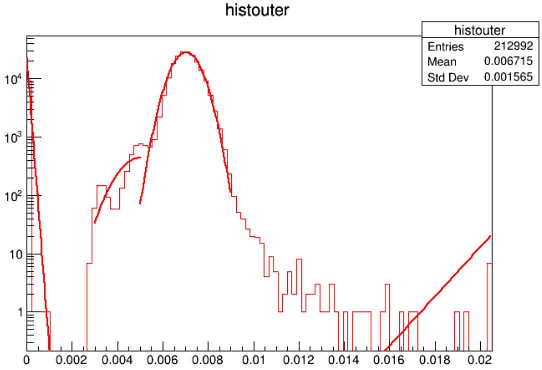


Figure: Fitted, normalized, logscale hitrate distribution for the outer barrel of INTT. Run 20448

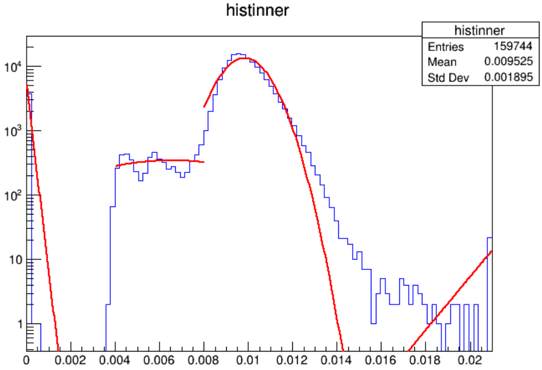


Figure: Fitted, normalized, logscale hitrate distribution for the inner barrel of INTT. Run 20449

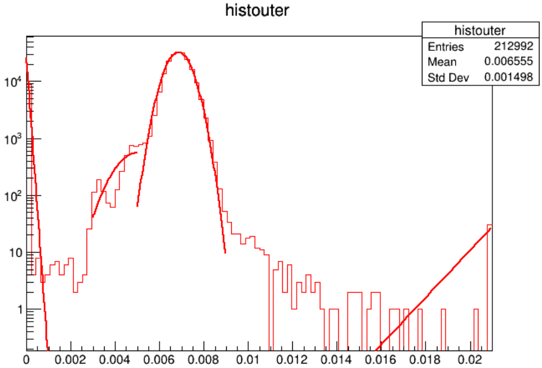


Figure: Fitted, normalized, logscale hitrate distribution for the outer barrel of INTT. Run 20449

Future work/conclusions

- Current approach seems very reasonable
- However, future work could be to do a more sophisticated normalization of channel acceptance using survey data
  - E.g., normalization by the solid angle subtended by the channel with respect to the primary vertex location
- Study of detector efficiency as a function of time

Backup

Theory behind term-by-term classification

We want to compute the probability a channel is in some state s given its hitrate h, that is, $P(s|h)$. We have functional forms to guess for each term, $P(h|s)$ (e.g., Gauss or exponential).

$$P(s|h)P(h) = P(h|s)P(s) \tag{2}$$

We write our function as

$$f(h) = P(h|s)P(s) \tag{3}$$

where the coefficients $P(s)$ and the specific parameters of $P(h|s)$ can be fitted to our histogram. Thus the evaluation of each term is the posterior probability (up to a common normalization factor) that the channel is in state s given its hitrate h.