Centrality of Cross Section – Binning by measurement or calculation?

Quote from Tom:

Nature will produce some observable, e.g. a stiff hadron in the muon arm, based upon it's own physical properties. A simple scaling that we wish to test the integrated production against, centrality by centrality, is Ncollision scaling. The property of nature that we hope to measure is particles/nbinary and having observed many collisions, the average over these collisions <particles/nBinary>. Specifically, we would like to measure this in different classes of nBinary and so we set off to sort our collisions by this factor using some imperfect measure like BBC yield. The latter quantity we divied for simplicity sake into percentage-wise bins (such as 0-20%).

https://www.phenix.bnl.gov/phenix/WWW/p/lists/phenix-physics-groups-l

Correction of Centrality: Trigger Bias or/and Centrality Bias (bin shifting)

Quote from Tatsuya's note:

Jamie and Chun showed last week on Hadron/Global meeting that by using:

1. the unbiased nBBCS hit distribution in pp (not requiring BBLL1 trigger),
2. nBBCN hit efficiency as a function of nBBCS hit in pp.

from p+p and (Nbin, Npart) distributions in dAu from AN210, dAu nBBCS hit distributions are calculated for MB, high pT central, and muon arms under the several assumptions, there is an overall agreement between real and calculated nBBCS hit distributions in dAu MB events. The BBCLL1 trigger efficiency in this study is 86%, which is very close to the previous result (88.5%).

This is trigger efficiency. Can I understand this has nothing to do with Trigger Bias?

Centrality of Cross Section – Binning by measurement or calculation? (continued)

Then for the two bias mentioned:

Finally, the table of <Nbin>, centrality class, and corresponding cut on nBBCS hit is shown for MB events. Furthermore, bias effect on high pt events are studied. First, for trigger bias, it is consistent with AN209/210 for the central arm high pT, and similar bias effects are seen in muon arms. Second, the bias effect from trigger bias *AND* bin shifting is shown. There is a significant effect due to bin shift correction compared to the trigger bias only,

And Jamie and Chun claimed this will change Rcp a lot. Felix ever wondered:
a) How a rare event (High Pt>5GeV) can make such big effect.
b) If this effect depends on Pt

But I personnaly think he now agrees with Jamie on a), and is ready to test b)

Then What is Rcp, together with Nbin Normalization? Again from Tom

One such technique is to use a convolution of Glauber-weighted NBD's to describe the overall function, then invert the distribution to find both the spectrum and mean nBinary for a given percentage-wise centrality slice. This determines the *sample-averaged* <nBinary>. It is argued (correctly) that rare events which are mis-categorized have not disturbed the *sample-averaged* <nBinary>. Analysis then proceeds to determine the sample-averaged <particles> and produce as a result <particles>/<nBinary>. This result is a sample-averaged quantity and is correct as such. Unfortunately, the *physical* quantity (i.e. the one we should publish) is nature's production rate <particles/nBinary>.

One then argues (and better yet calculates) the magnitude of the problem using Monte Carlo techniques with a simple ansatz about <particles/nBinary> and sees under simulation of our imperfect trigger conditions what is the magnitude of the error resulting from using a sample average (measurable) as compared to the known input. This is what Jamie and Chun have done and it is a justified concern and necessary to extract good physics. The question must become a detailed cross-check of the inputs and estimation of the systematic errors of the extraction of the corrections, not a question of whether the calculation is necessary or not.

The calculation essentially follows the lines:

1) Estimate the BBC signal distribution for purely unbiased collisions.
2) Estimate the BBC signal biased *only* by the "process of interest" (not by our hardware).
3) Calculate the error introduced by using the sample-averaged <particles>/<nBinary> after the introduction of the detector effects.

Tom claimed this is the bin-shifting that Chun and Felix had discussed.

But, ShinIchi made some question, and I don't see Jamie's reply on public list yet ...

ShinIchi asked Jamie and Chun:

(His quote from Chun: "Since the BBC has more hits in high pT proton-proton events compared with minimum bias events, it is more likely that high pT hadrons are bin shifted into a higher centrality category than are regular events.")

(1) BBC multiplicity depends on number of participant and binary collisions, [...], where 52% is bbc trigger bias and 75% is with the high pt hadrons. So the trigger bias correction, [...] does some part (maybe not all) of the centrality bin shifting correction you are concerned about.

(2) The event with more BBC hits caused by the high pT track in the spectrometer is a part of the minimum bias events. [...] I do not think we should reshuffle the centrality depending on the high pT track in the spectrometer.

(3) What we can do is to do (A) the centrality dependent trigger bias correction, where we need to define the "52%" and "75%" for each centrality selection. [...] Or (B) we do not apply any trigger bias correction, but use the measured yield, which is biased by BBC. We can not get the absolute (true) yield in this case, but we get the corrected RdA by using the modified number of average binary collision in each centrality with the condition of the high pT track in the spectrometer.

Then ShinIchi asked if doing both A and B would be over correction.

And now it's Mike's opinion. I will use Ron's understanding, which is approved by Mike:

Mike's words:
https://www.phenix.bnl.gov/phenix/WWW/p/lists/phenix-physics-groups-l/msg00841.html
https://www.phenix.bnl.gov/phenix/WWW/p/lists/phenix-physics-groups-l/msg00842.html

Ron's understanding:

Your first method appears to be similar to what Jamie and Chun are doing -- to convolute one hard collision with n-1 m.b. collisions to calculate the bin shift --- except that you propose shifting the value of <Ncoll> for the bin rather than adjusting the event counts.

Does this agrees with ShinIchi by saying not doing both correction together?

In the second message, you seem to be advocating modifying the placement of the BBC bins themselves, in order to preserve the values of <Ncoll> that were determined for the BBC bins. Thus the bins for M.B. and high-pT would correspond to different BBC boundaries, but you claim that <Ncoll> for each bin would work out to be the same for both M.B. and high-pT cases.

Did he suggest a (highest) Pt dependent Centrality Decision Method? (BBC plus Pt decides which centrality bin to fall in, while in each bin the <Ncoll> is fixed by simulation or calculation.)

And My Concern, In the Form of naïve Questions:

Is it propriate to shift events (much easier than recalculating the <Ncoll> over our current (BBC) centrality bins), if we find these events receive trigger bias?

Indeed, what is trigger bias? I imagine a central event always have higher chance to be detected by BBC than a peripheral event. Is that called a trigger bias? Or, do we need to assume that High-Pt event happens equal-chance in central or peripheral events? I didn't look into Jamie and Chun's code yet, so I don't know if they consider the number of High-Pt tracks.

We do simulation to get nBBChits distribution for certain Ncoll, then derive <Ncoll> for a given nBBChit. Is that correct? And if in each centrality bin the Ncoll varies little, the systematic error (by Tom) from <particle/Ncoll> to <particle>/<Ncoll> should vanish, right?

If <particles/Ncoll> is used to calculate Rcp, and centrality “C” or “P” also depends (only) on Ncoll, maybe only Mike's second e-mail will satisfy this, since in his way those differecnt categories of events always have the same Ncoll (or <Ncoll>?) in the same centrality bin.

Appendix: More Options

Quote from Tamas:
https://www.phenix.bnl.gov/phenix/WWW/p/lists/phenix-global-l/msg02980.html

I think that one of the key advantage of the RHIC heavy ion programme is that there is an essentially common centrality determination method in all the four RHIC experiments, which makes the these measurements cross-checkable against one another. It is OK to introduce new centrality measures e.g., based on BBC alone or on FCAL, but at the end it is important to keep in mind that centrality selection is an issue where a similar method in all the four RHIC experiments is an extra bonus which would be good to preserve in the forthcoming works. I think it is good to kept this trivia in mind when proposing new centrality measures.

And next page is picked from Sasha Milov's talk on the same Hadron/Global meeting.

Bin-by-bin vs. event-by-event.

It is accustomed in PHENIX to do analysis based on centrality bins and divide them later by corresponding number of N_p/N_c in the class. That is usually done so because the mixing or else. As a result PHENIX usually publishes <A>/<B> instead of <A/B>.

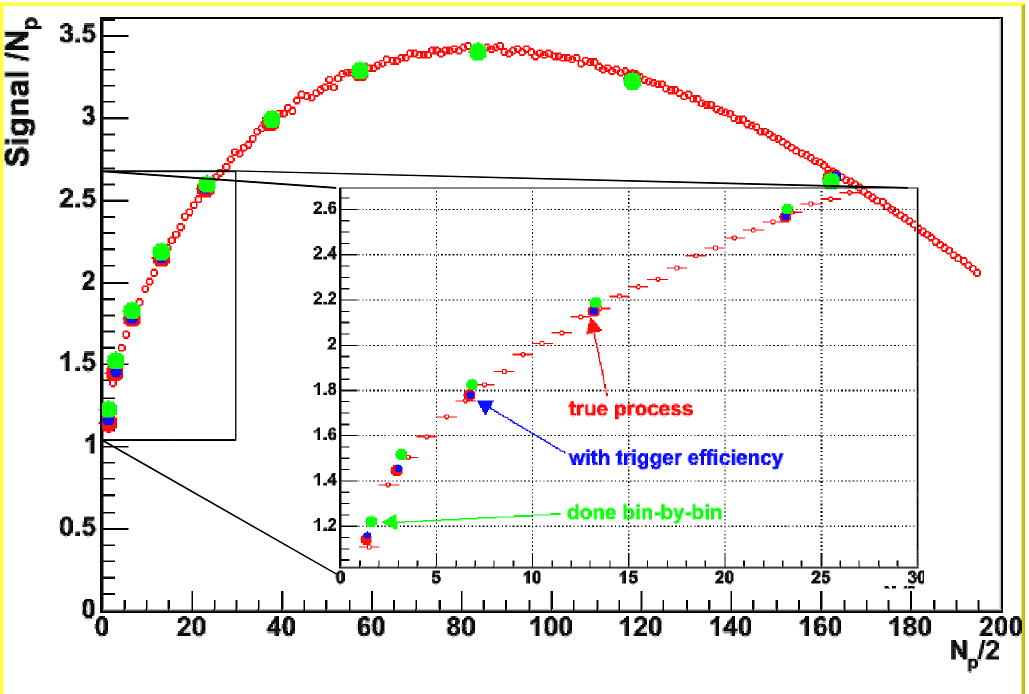

Figure shows some signal divided by participant pair vs. N_p. Small red markers is the true process.

Using larger bins the result of $\langle S/N_p \rangle$ is the same: large red markers.

Because of the trigger inefficiency PHENIX will measure blue points which can rather trivially be corrected back to red points using efficiency curve.

However if the analysis is done bin-by-bin in centrality and <S> is later divided by $\langle N_p \rangle$ in the class one gets bias shown with green markers. Note that the effect of the BBC resolution is not taken into account yet.