BCM1F TDCs

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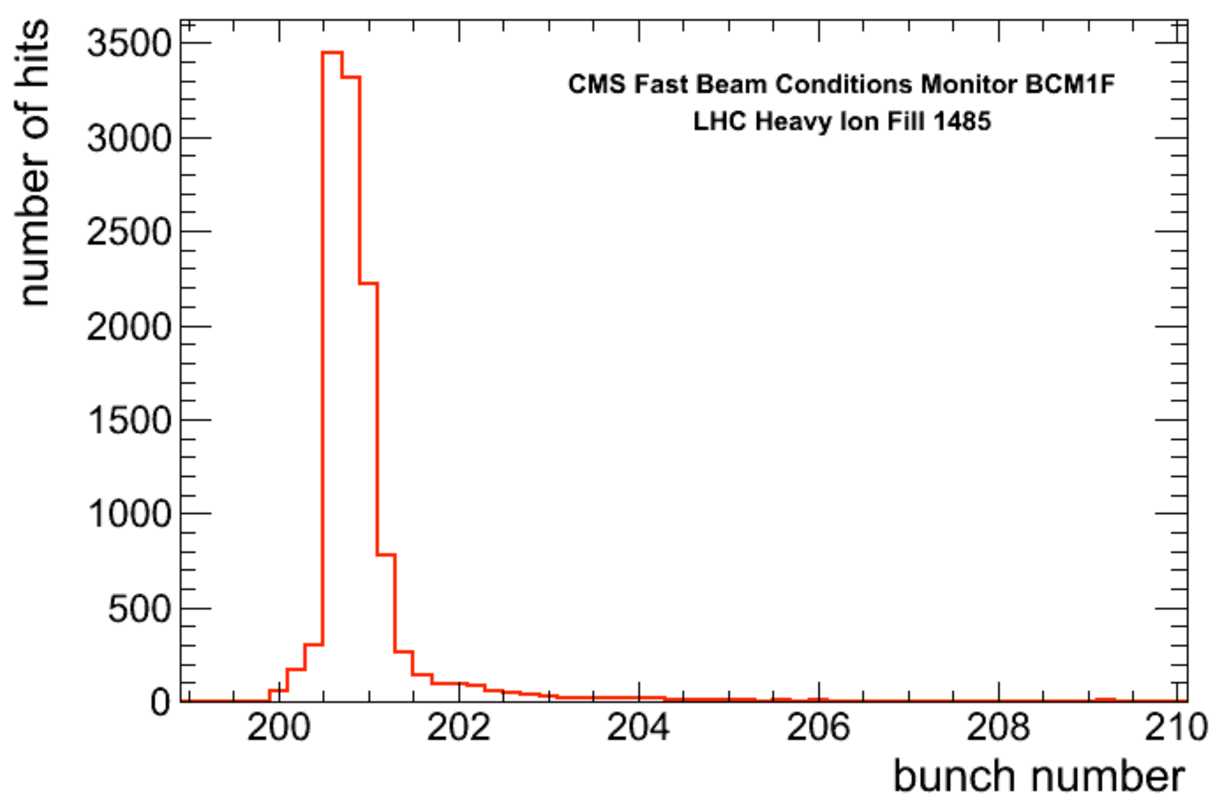
FCAL-CMS Weekly Meeting
29.11.2010

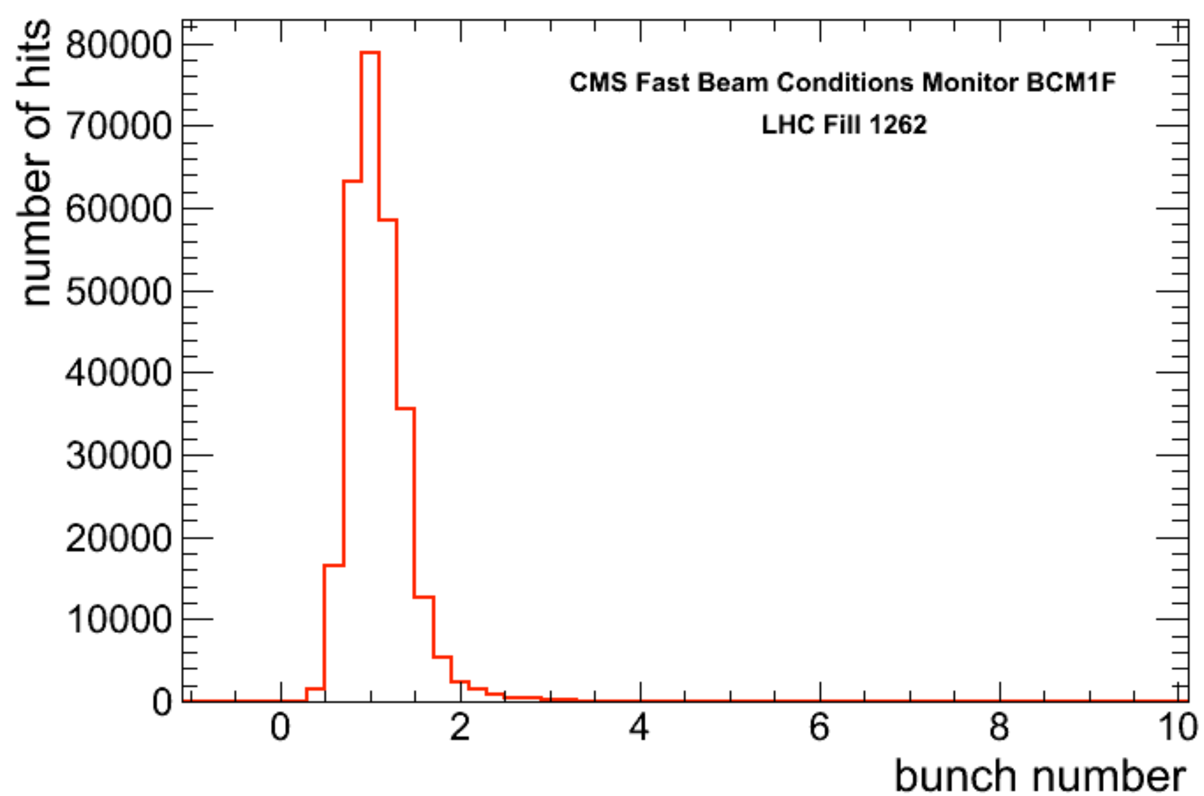
Heavy ions — Fill 1485

- 10.11.2010.
- Using the p-p reference time = 6290 ns to build the bunch number.
- In Pb-Pb collisions observed shift in bunch number.
- First colliding bunch in fill 1485 is #201, in the plot it is 200.5

heavy ion



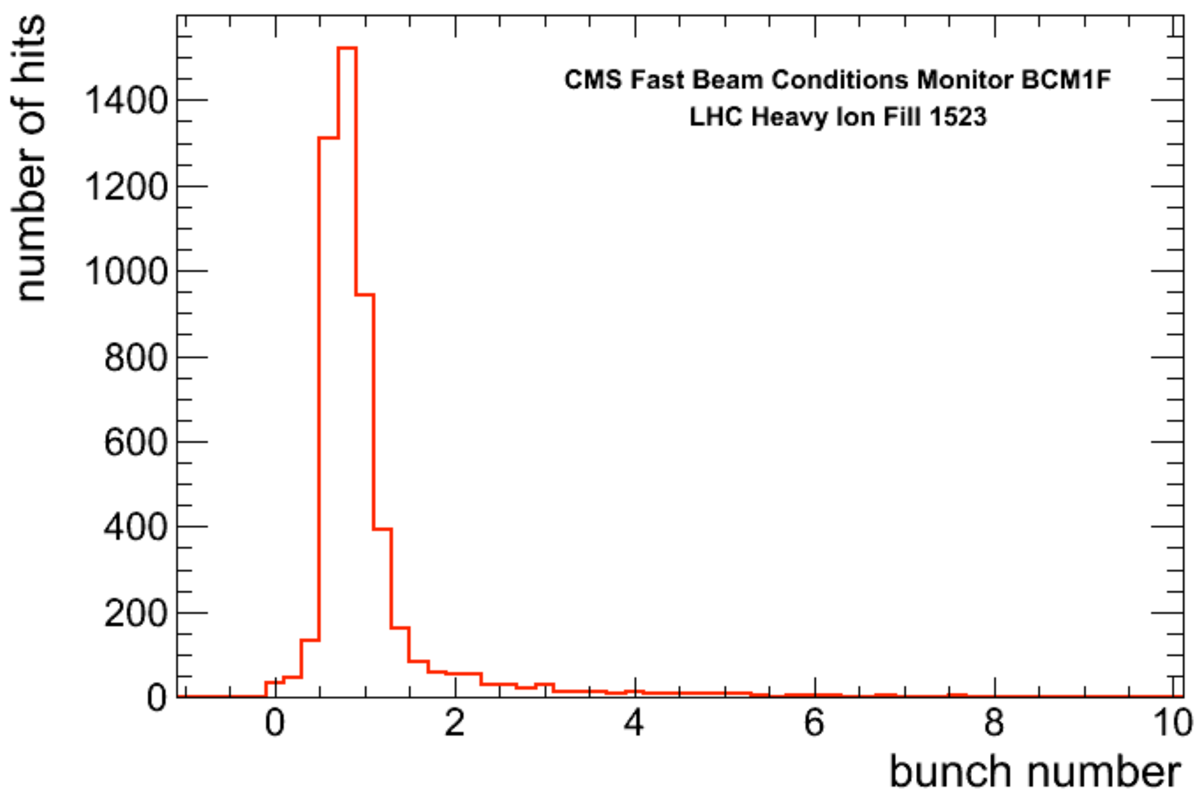
proton



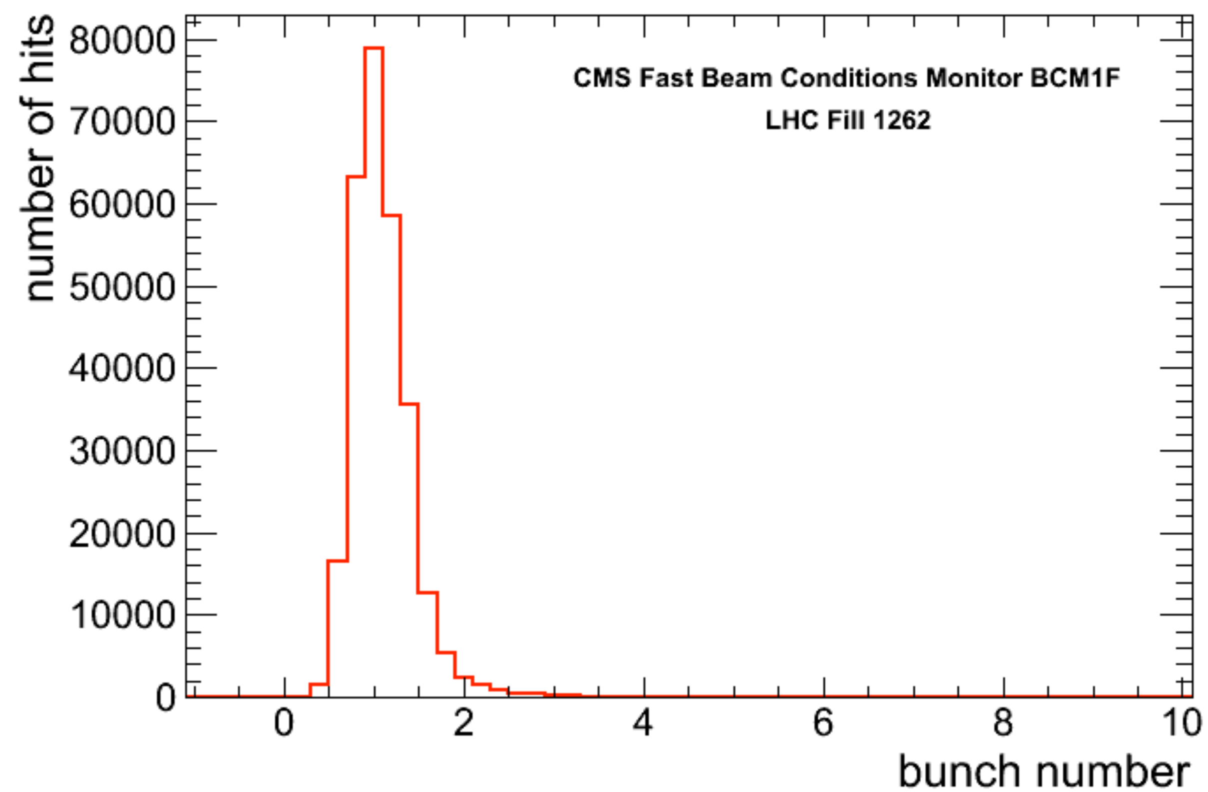
Heavy ions — Fill 1523

- Shift in bunch number seems constant over the HI period.

heavy ion

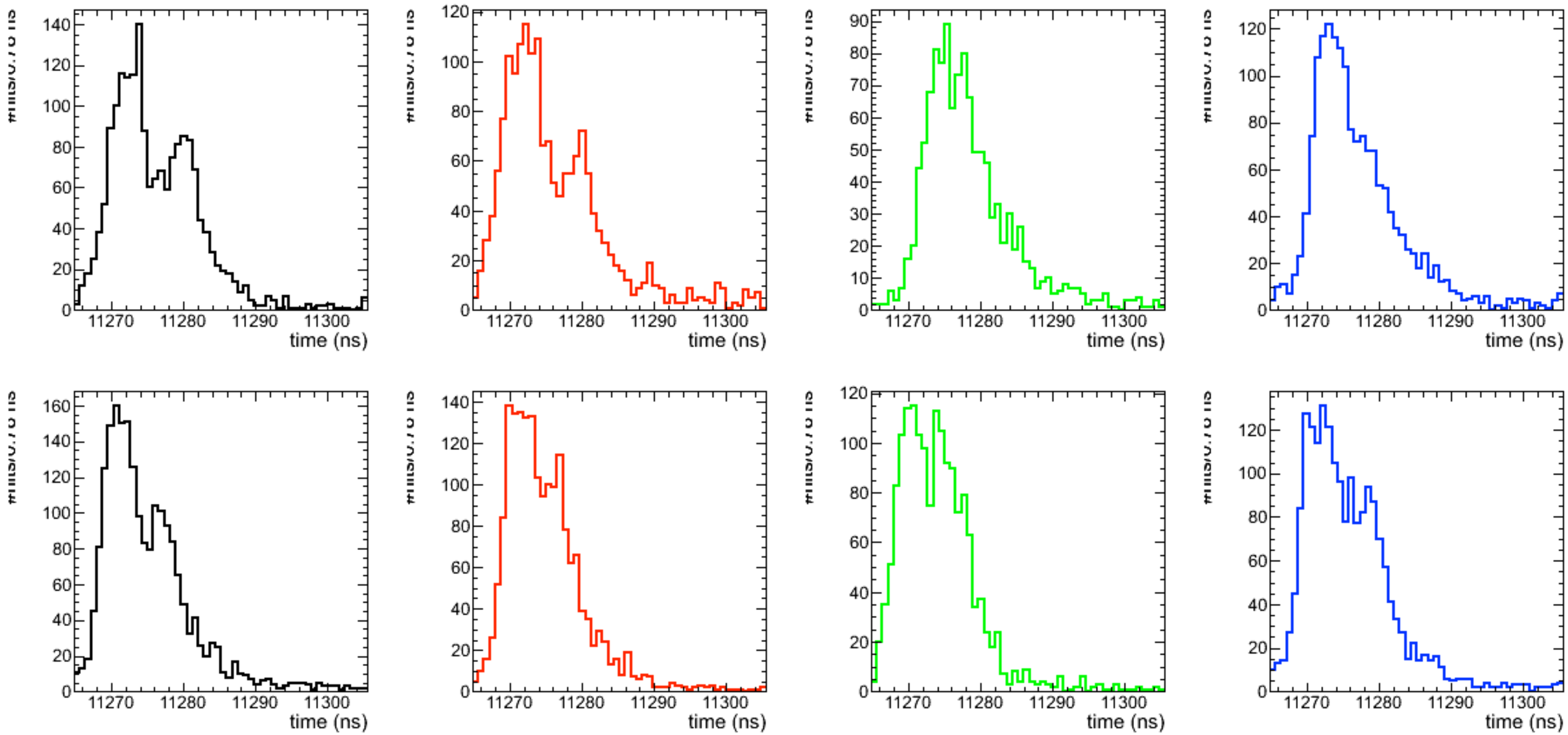


proton



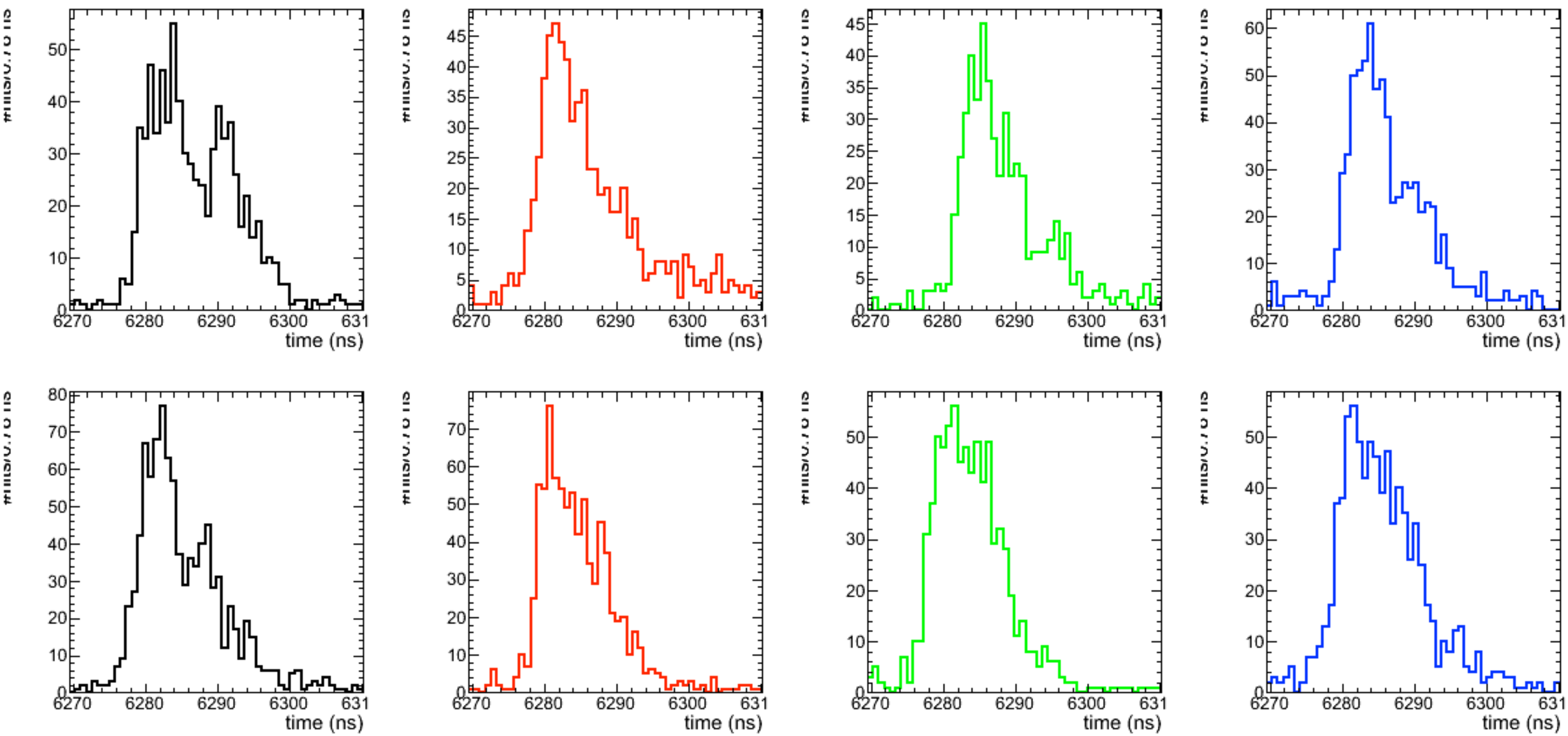
Heavy ions — Fill 1485

- First colliding bunch is #201. Peak of main collision should be at t=11280 ns.
- Multiple peaks. Ghost buckets?



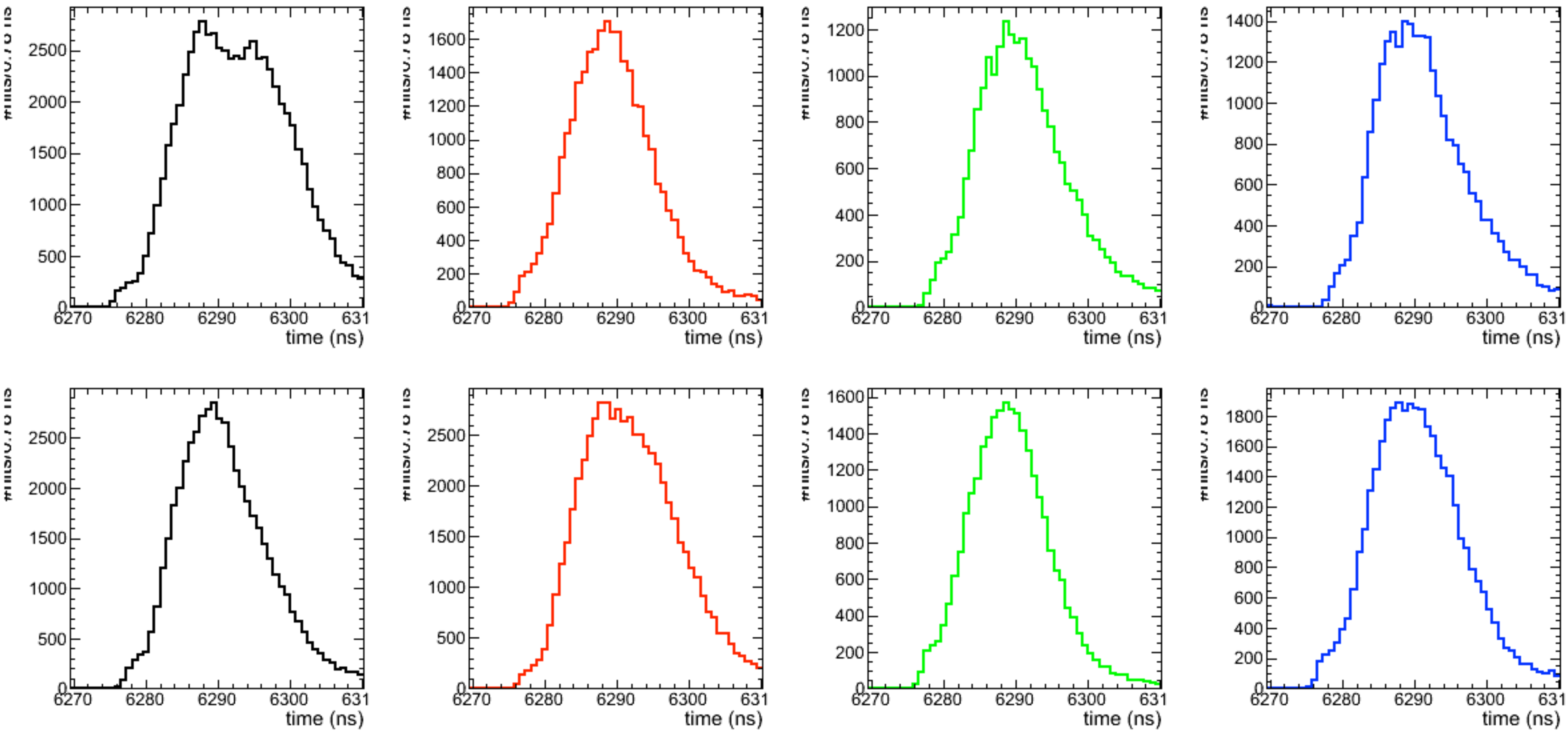
Heavy ions — Fill 1523

- 27.11.2010.
- Multiple peaks. Ghost buckets?



Protons — Fill 1262

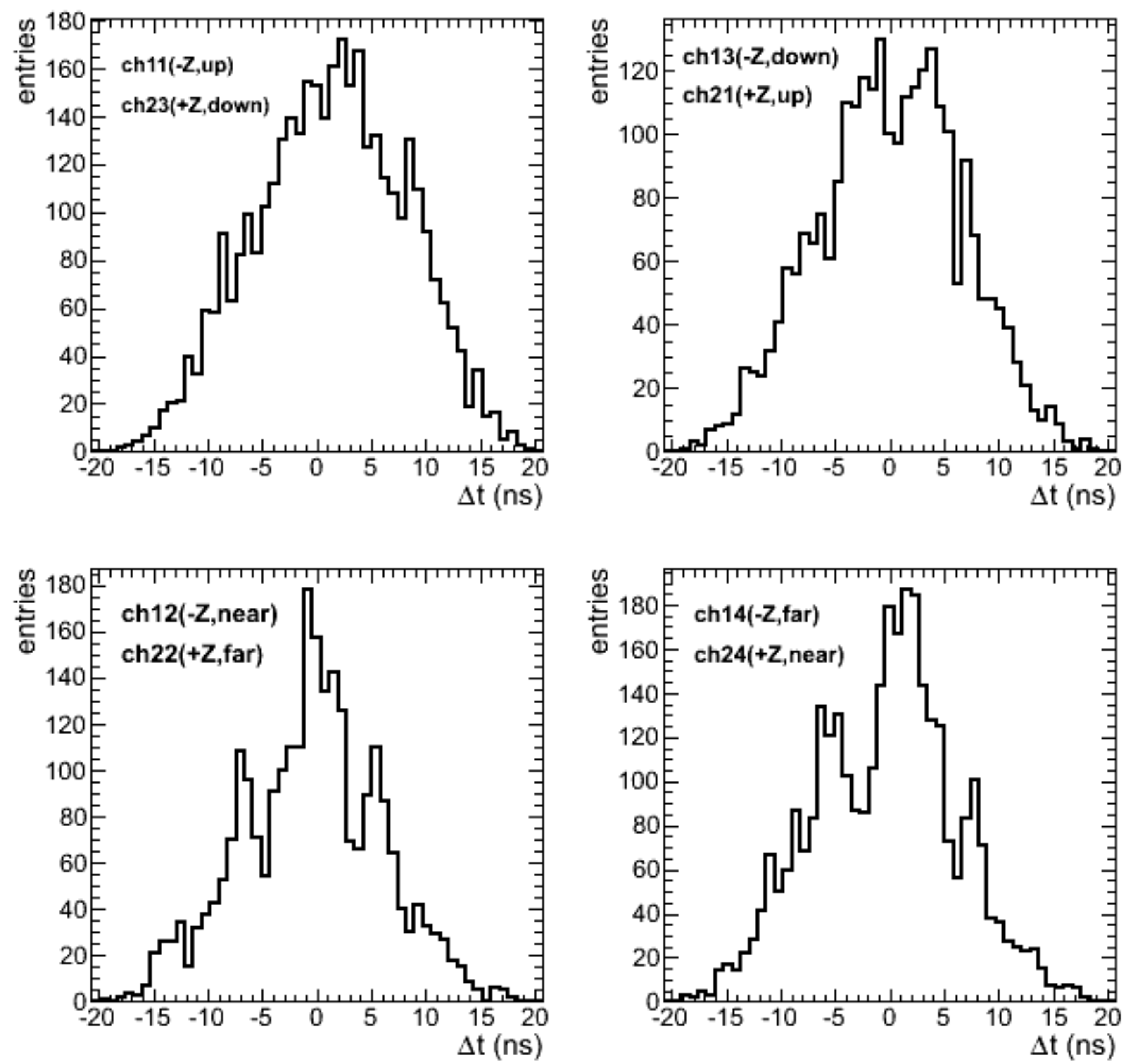
- In the first plot what thought to be noise could be from ghost bucket.
- Better resolved in HI due to new thresholds?



Ghost buckets — protons

- Δt distributions of back-to-back channels should peak at zero from collision products of elastic+diffractive scattering.
- Secondary peaks in the Δt distributions $\Delta t \simeq \pm 5$ ns, ± 10 ns.
- Not understood why the rates of such peaks are so large compared with the primary one from collisions.
- Where are the ghost bunches?

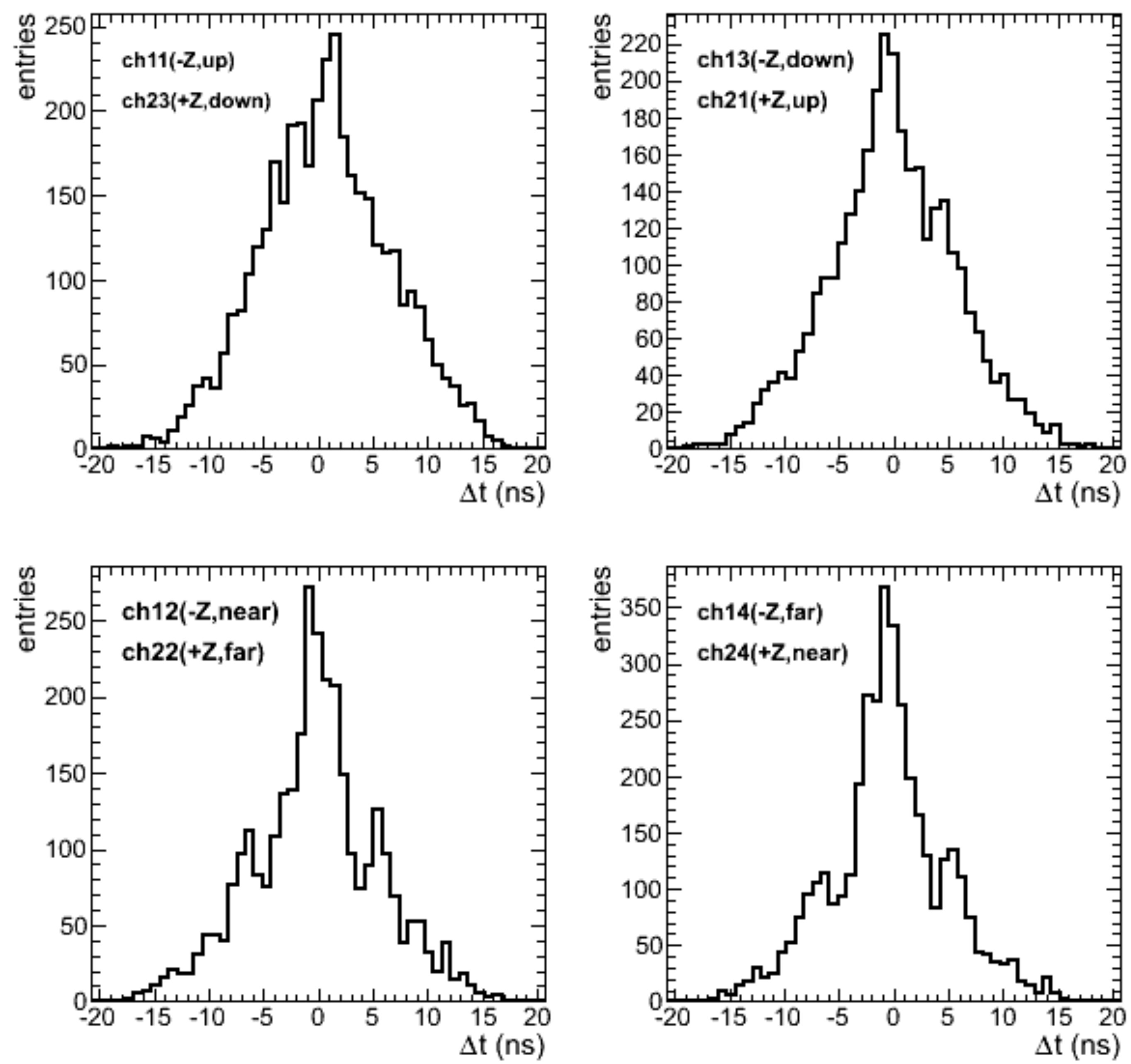
Fill 1262 — p-p collisions



Ghost buckets — HI

- Secondary peaks also seen in Pb-Pb collisions.
- Rates are smaller compared to peak at 0.
  - Less intense ghost bunches?
  - Contributions from different processes?
- Questions like these require simulations to answer.
- But qualitatively we can infer some things...

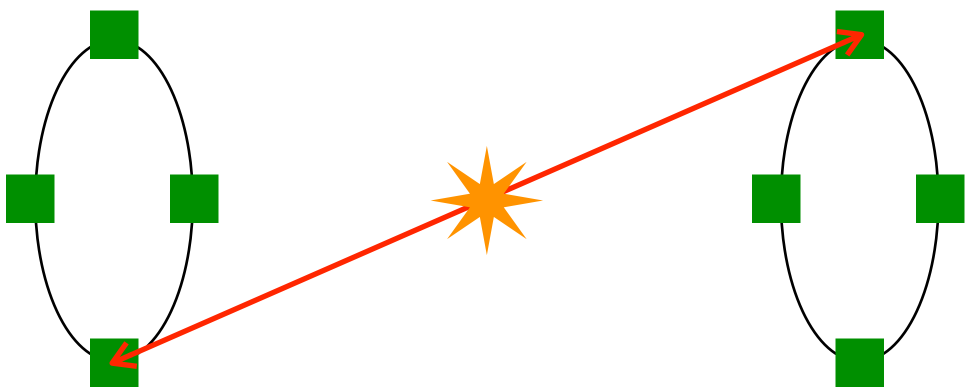
Fill 1523 — Pb-Pb collisions



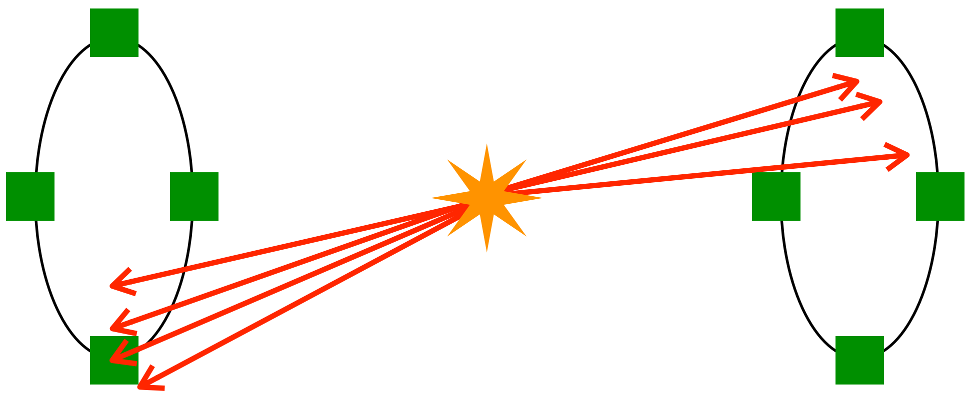
Ghost buckets

- p-p collisions
  - cross sections (not sure of the contributions at low angles...)
    - inelastic: 60 mb
    - elastic: 40 mb
    - single diffractive: 12 mb
  - Hit rate from elastic + diffractive should be much smaller than inelastic, due to low efficiency (need simulations) because of low particle multiplicity.
  - Back-to-back coincidences suppress inelastic scattering.
- Pb-Pb collisions are essentially inelastic(?) Back-to-back coincidences due to high particle multiplicity.

Elastic scattering

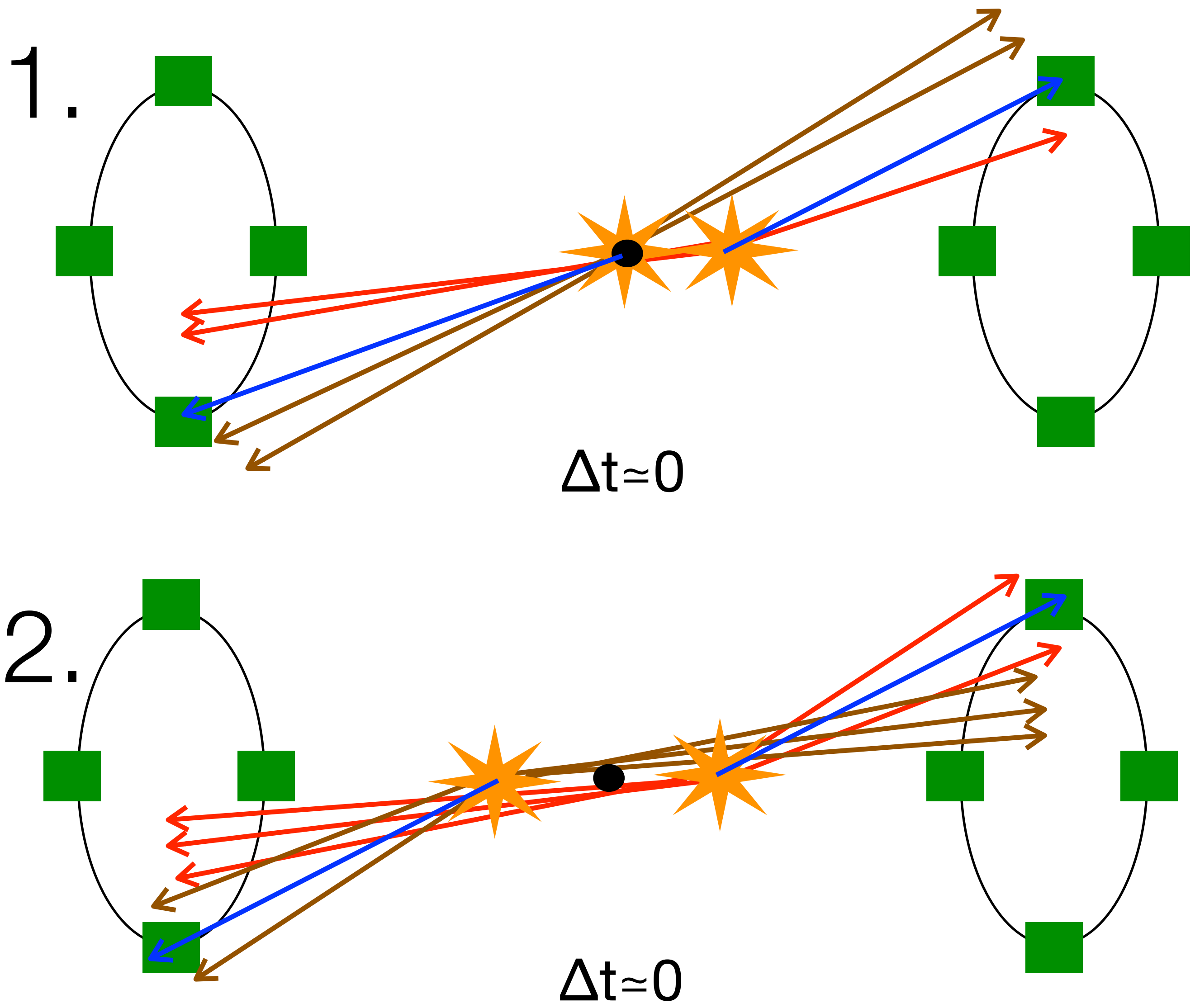


Inelastic scattering



Ghost buckets

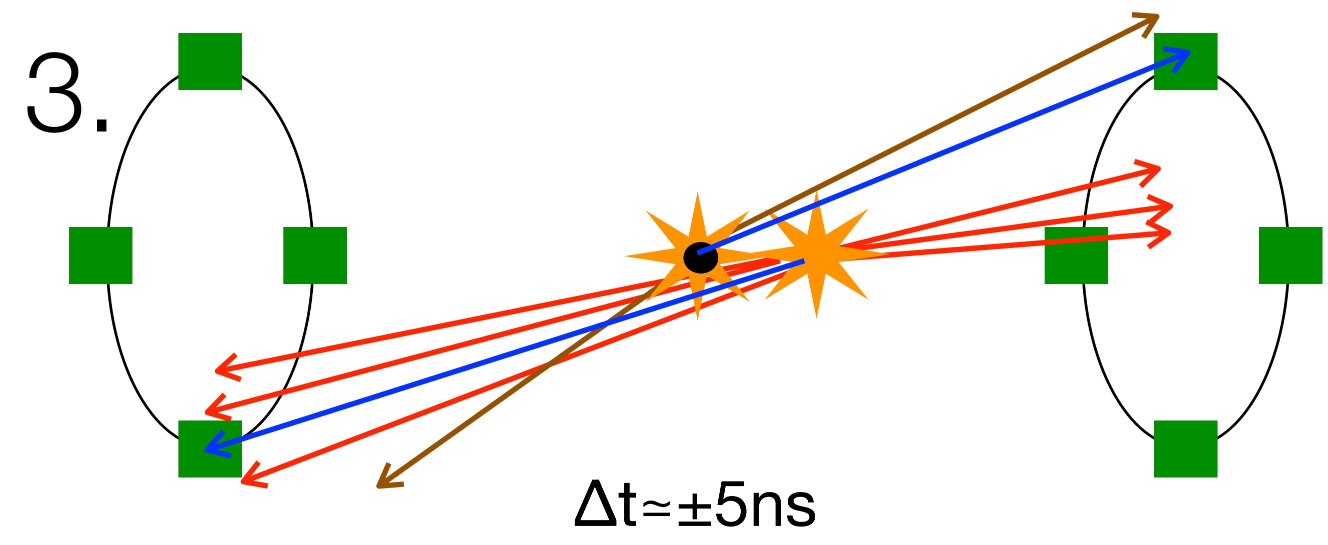
- If a neighbour bucket, say 5 ns behind the main bucket, is filled with particles, it will collide with the main bucket 2.5 ns after the main collision.
- Four main scenarios could happen (considering only inelastic scattering):
   1. One channel fired from main collision, the opposite channel fired from secondary collision (close to the channel).
   2. Both channels fired from two secondary collisions (higher order contribution)
- 1+2 contributes to $\Delta t \simeq 0$, but they are not proportional to the luminosity!

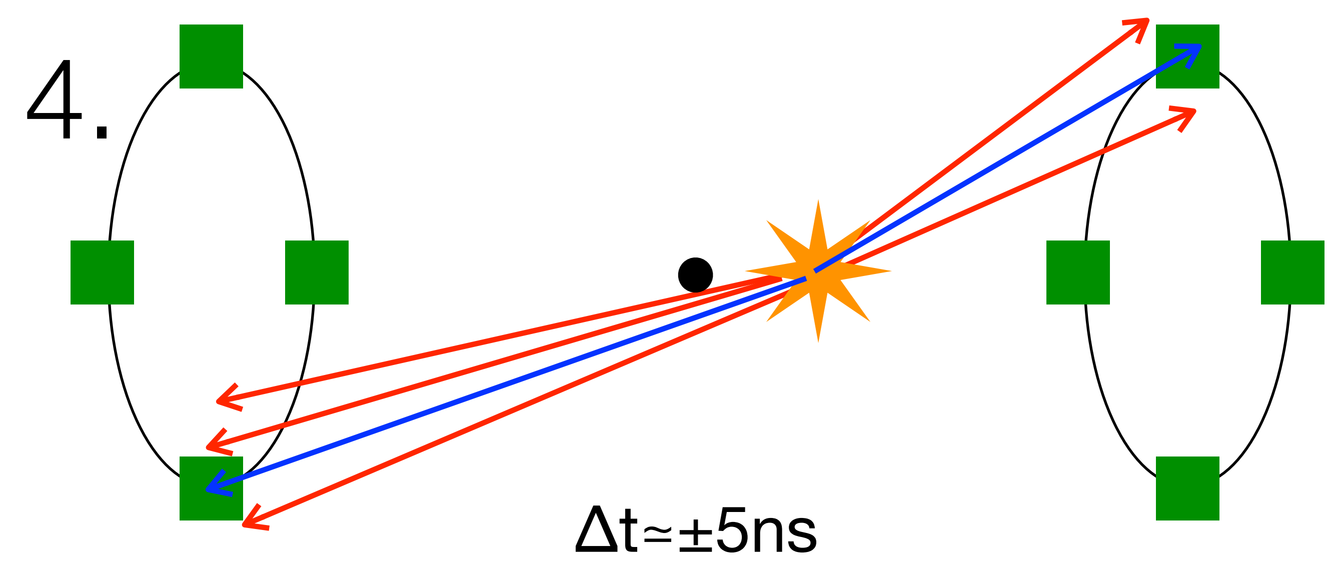


Ghost buckets

3. One channel fired from main collision, the opposite channel fired from secondary collision (far from the channel).
4. Both channels fired from on secondary collision.

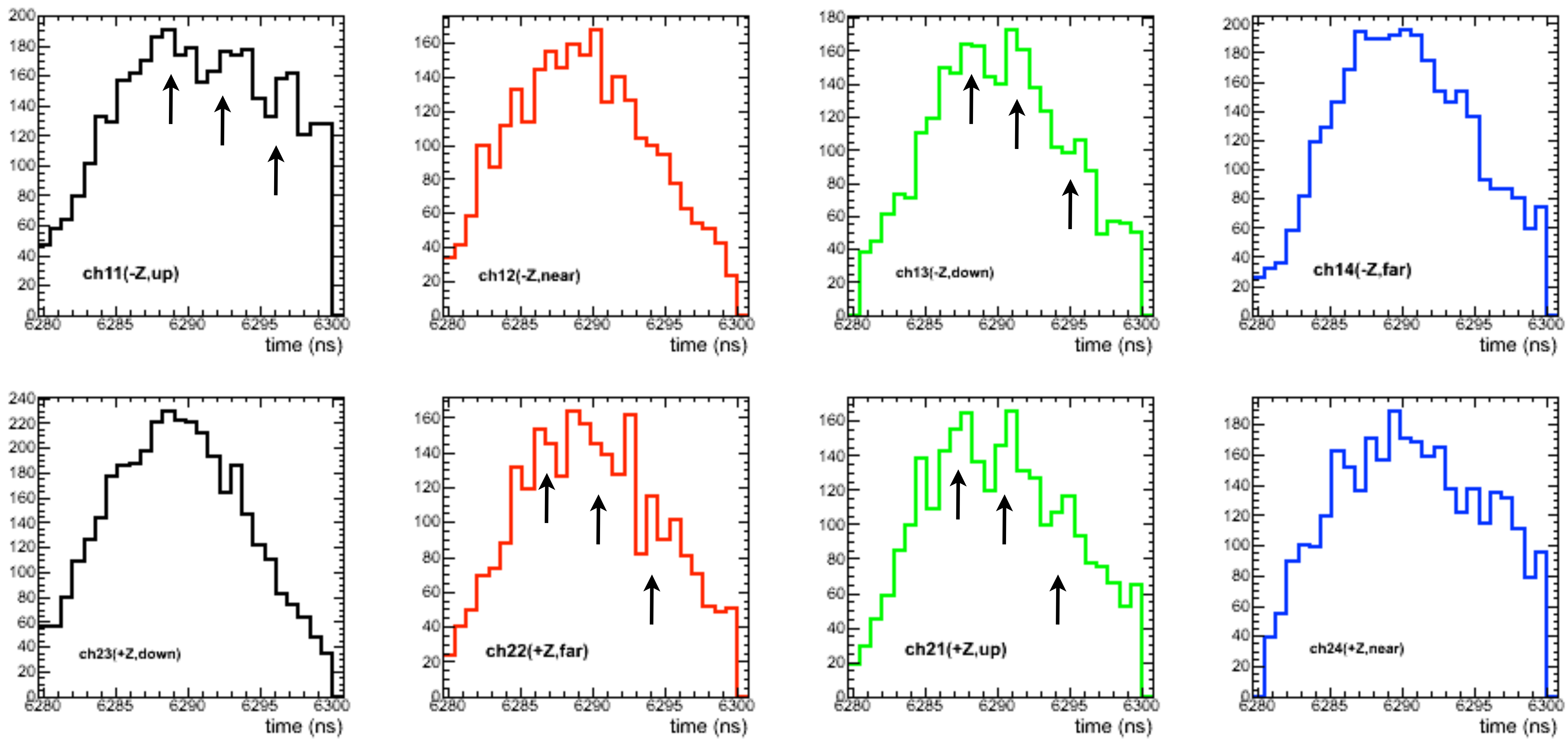
- 3+4 contributes to Δt≃±5ns.
- Have in mind that raw rates are at least 3 orders of magnitude larger than the secondary peak rates in coincidences.
- First neighbour bucket would collide with the main bucket only 1.25 ns after the main collision. BCM1F resolution is at least 1.3 ns.





Ghost buckets

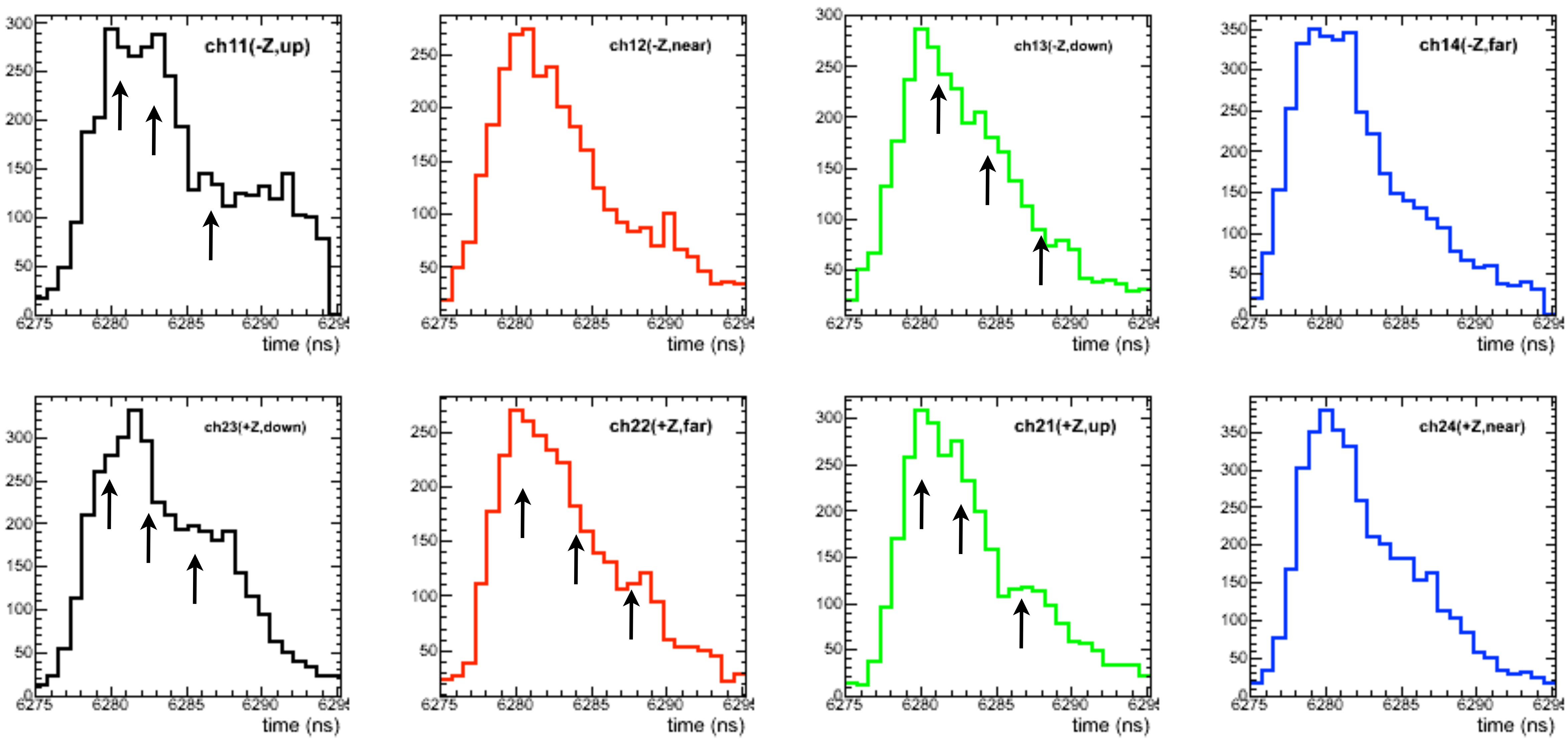
- If there are ghost buckets at 5 ns after the main bucket then, there should be excess hits ~2.5 ns and ~7.5 ns after the main collision.
- Time distributions of coincident hits of one bunch



Fill 1262 — p-p collisions

Ghost buckets

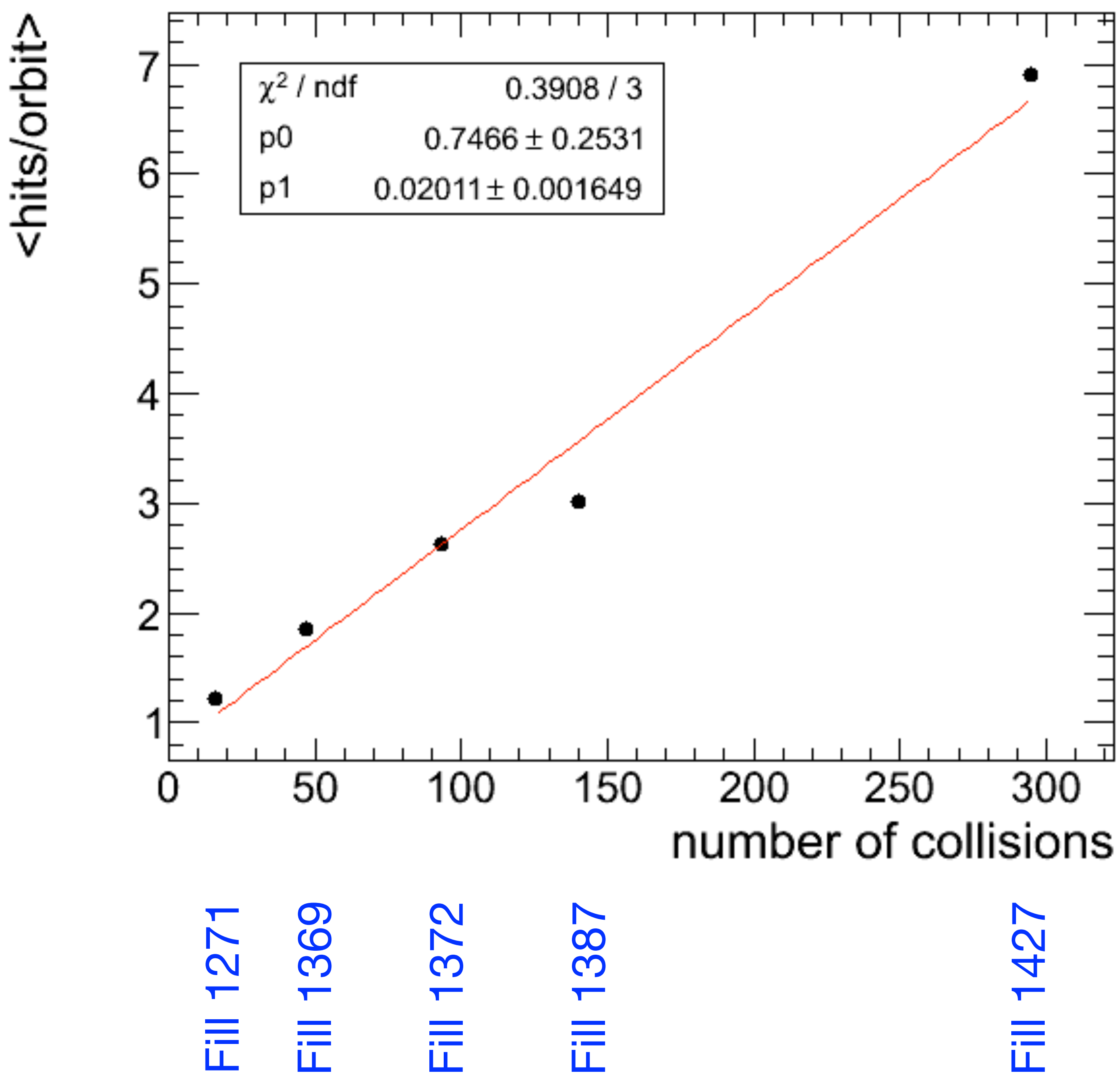
- Heavy ions



Fill 1523 — Pb-Pb collisions

Hit rate per orbit x # collisions

- The plot shows the mean number of hits per orbit versus the number of collisions before new thresholds, at maximum bunch intensity.
- Assuming linearity, i.e., double the number of collisions twice the number of hits: $y = p0+p1.x$
- The maximum number of hits in an orbit the TDC buffer can handle is 16383, which would be reached with 819000 bunches!?
- A possible explanation is the new thresholds… or the baseline changed during that period (23-30 Oct)



Pre-scaling

- Still investigating. But a possibility is to use start trigger matching mode.
- A trigger signal is needed.

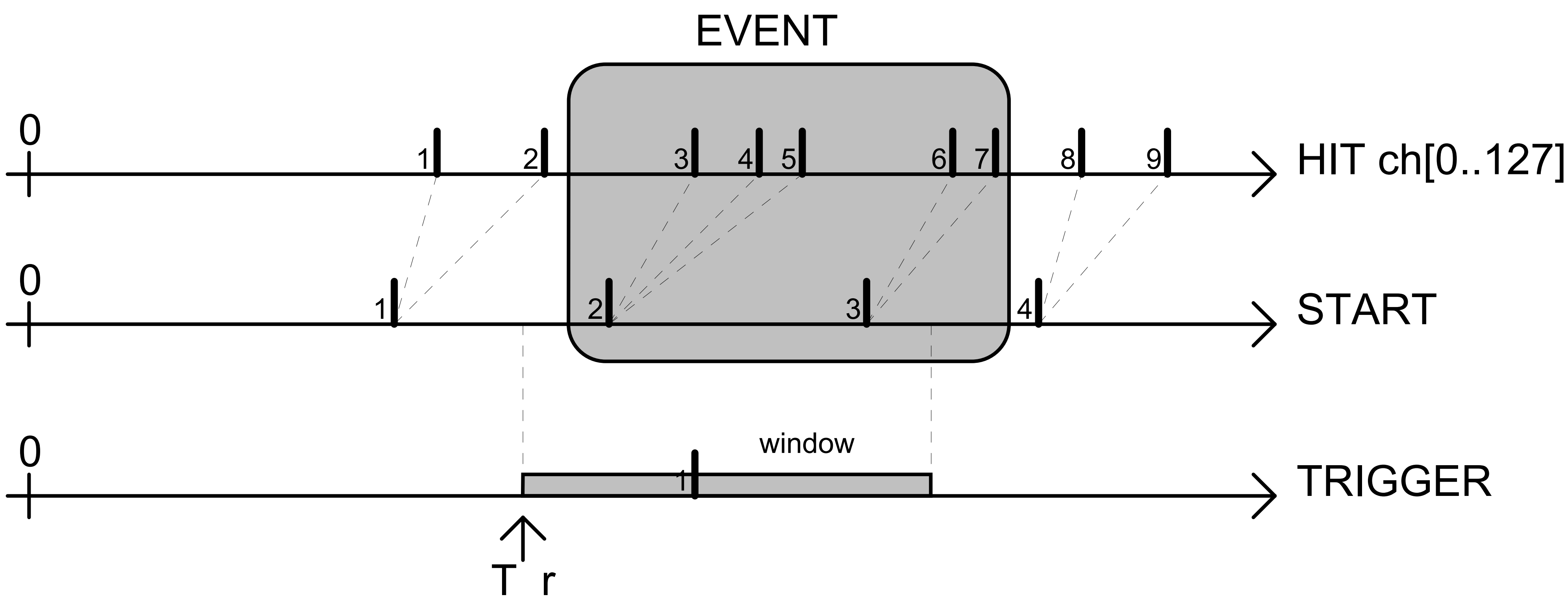


Fig. 1.3: Start Trigger Matching Sequence

Summary

- Observed shift of the time reference in heavy ion collisions wrt pp collisions.
- In heavy ion collisions more pronounced evidence of secondary collisions are observed.
- Secondary peaks in the Δt distributions of coincident back-to-back hits, already seen in p-p collisions, seen in Pb-Pb.
- Possible explanation are ghost buckets at the second neighbour bucket.
- The maximum number of hits in one orbit before overflowing the TDC buffer, before the new discriminator thresholds, would be reached with 819000 bunches.
- Investigating data available after the new thresholds. But most of the time the TDCs were not running (filling the disk very fast: 3Gb/h), when running LHC was doing tests.
- Possible pre-scaling is to use the start trigger matching mode of the TDC.

Extra

Heavy ions — Fill 1523

- Bunch #2515, shift of bn.
  - Secondary interactions seen