Correlations between A_N and P_{beam}

Considerations Regarding Possible Background Contributions in the Hydrogen Jet Polarimeter

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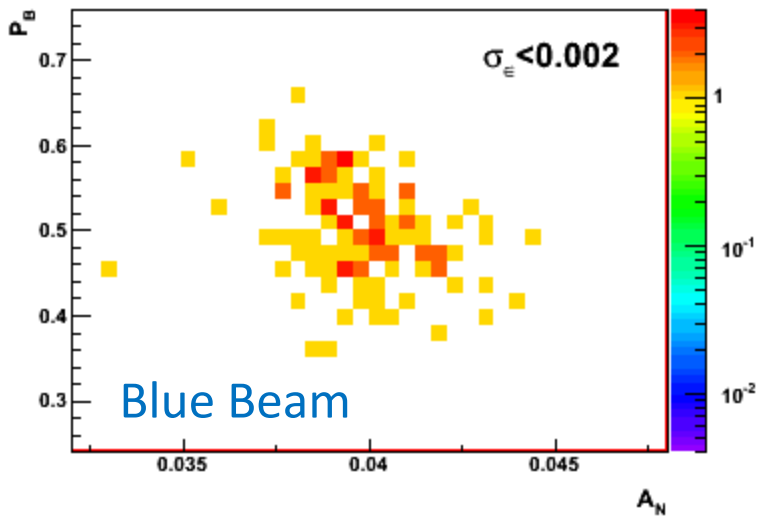
Hydrogen Jet Target Asymmetries

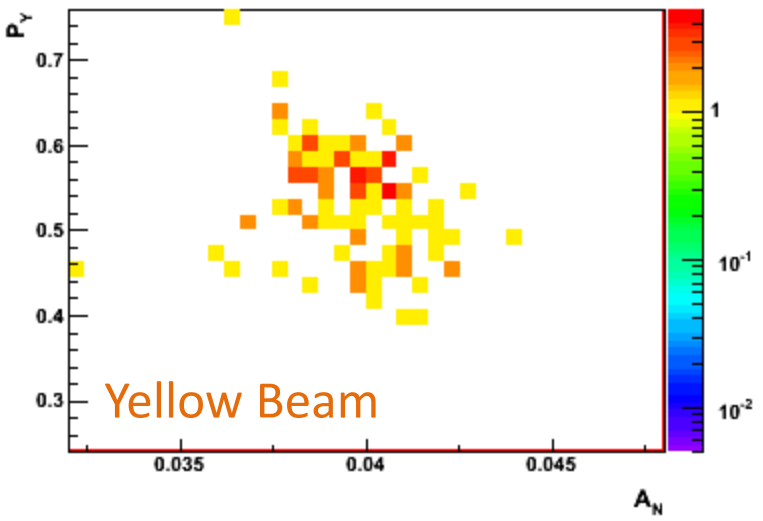
Determination of beam polarization: $P_{Beam} = \frac{\varepsilon_B}{\varepsilon_T} \cdot P_{Target}$

$$\varepsilon_T = A_N \cdot P_{Target}$$
$$\varepsilon_B = A_N \cdot P_{Beam}$$

} assume A_N is the same

beam polarization





target asymmetry

(*) only include fills with $\sigma_\varepsilon < 0.002$

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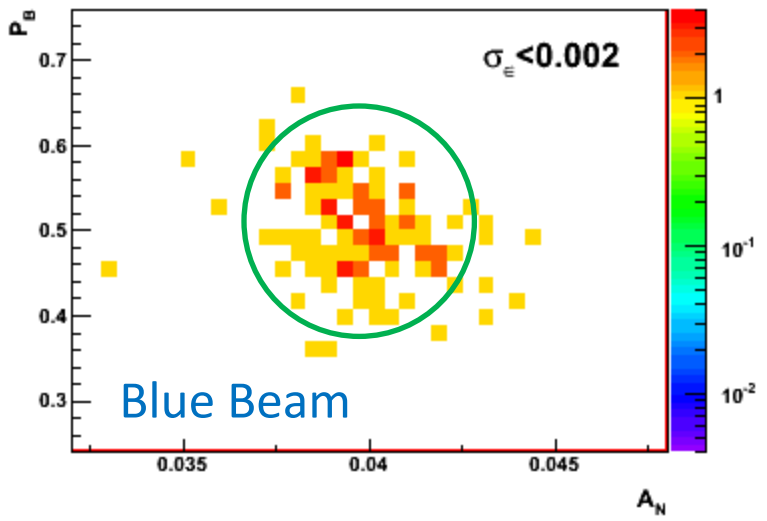

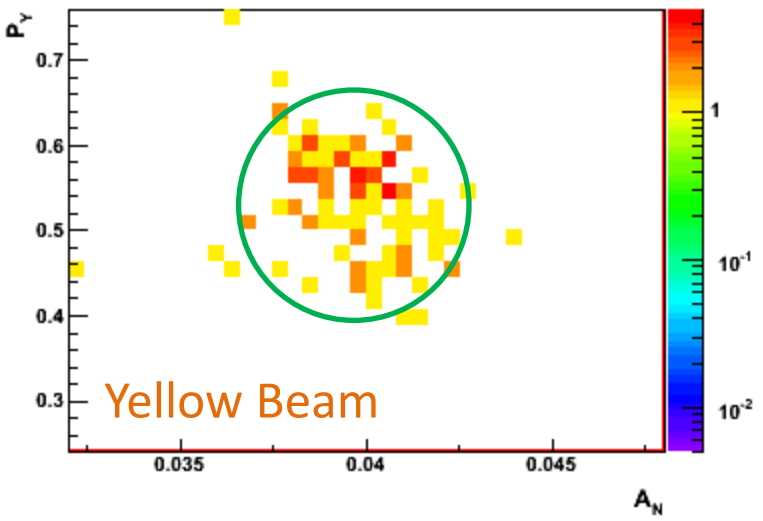

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Background Contributions

$$\varepsilon = \frac{N^{\uparrow} - N^{\downarrow}}{N^{\uparrow} + N^{\downarrow} + 2 \cdot N_{bg}} \Rightarrow \frac{\varepsilon_B}{\varepsilon_T} = \frac{N_B^{\uparrow} - N_B^{\downarrow}}{N_T^{\uparrow} - N_T^{\downarrow}}$$

Unpolarized background will dilute the asymmetry, but does not affect the determination of the beam polarization.

$$A_N = \frac{A_N^{inc} - r \cdot A_N^{bg}}{1 - r}$$

Polarization dependent background effectively changes the signal (A_N) – but it is the same for target and beam asymmetries.

What if? $\left[\varepsilon_N^{bg}\right]_T \neq \left[\varepsilon_N^{bg}\right]_B$

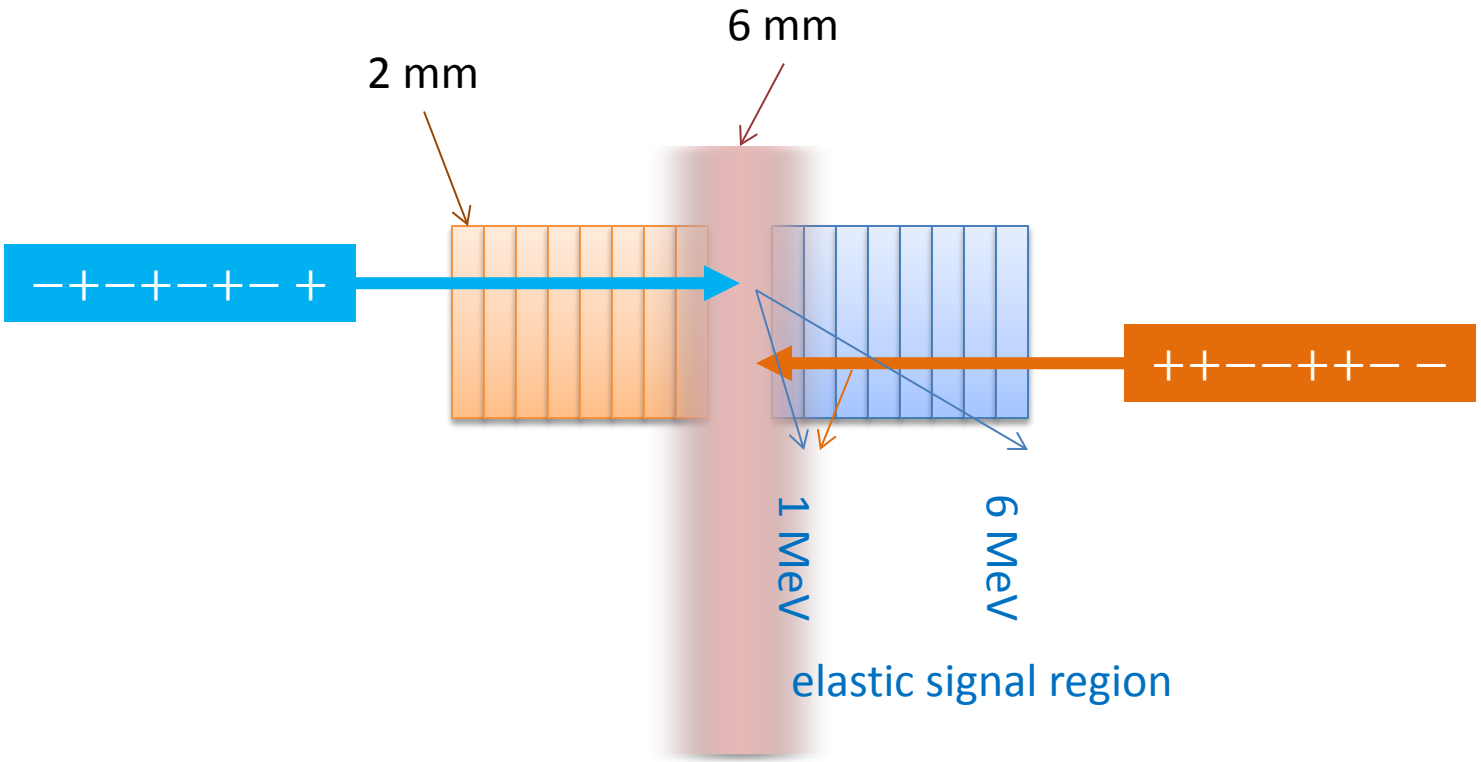
$$r \approx 7\%$$

$$A_N^{bg} = 0.0 \rightarrow A_N = \frac{1}{0.93} \cdot A_N^{inc}$$

$$A_N^{bg} = A_N^{inc} \rightarrow A_N = A_N^{inc}$$

$$P_B = \frac{\left[A_N^{inc}\right]_B}{\left[A_N^{inc}\right]_T} \cdot P_T$$

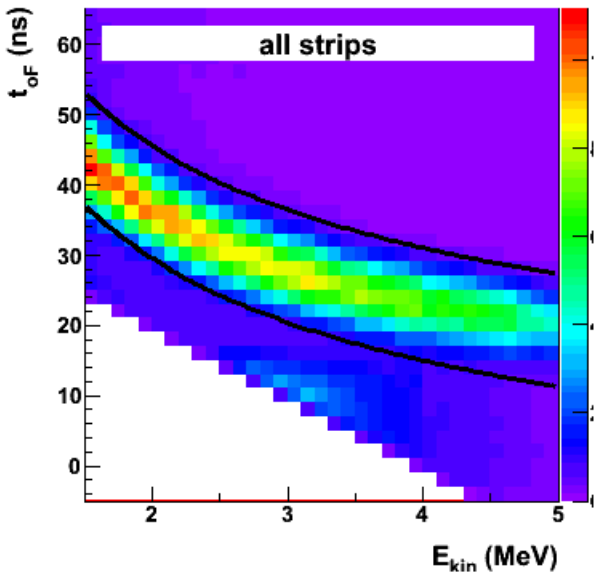
Detector Geometry

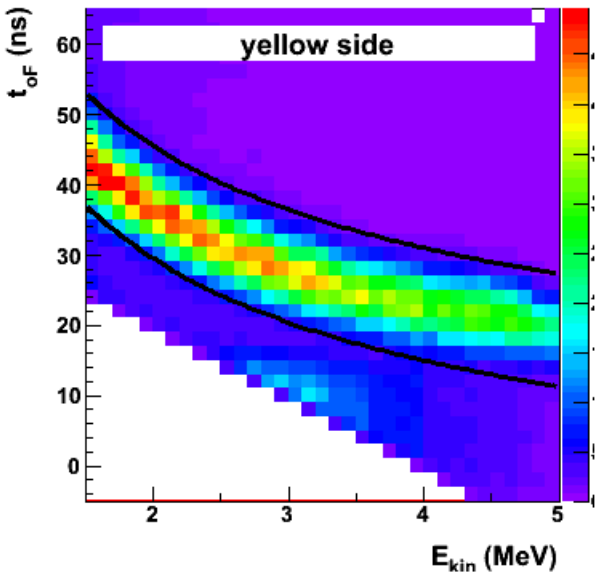


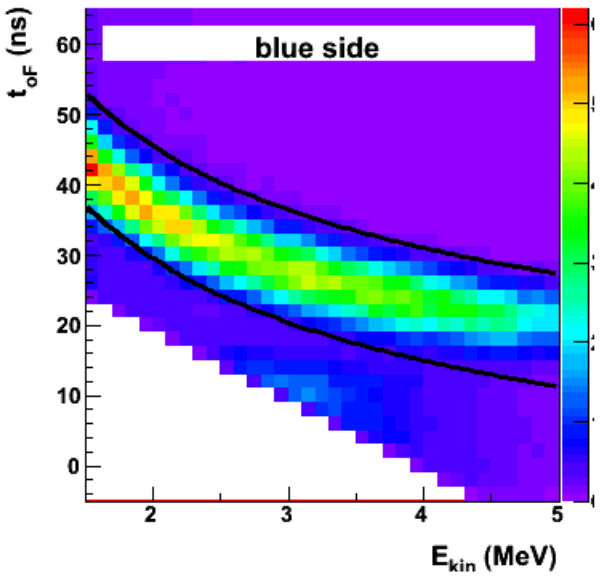
Depending on the longitudinal (*z*) size of the jet target, the opposite beam can add to the elastic signal at low recoil energies. This background carries the target asymmetry but is unpolarized with respect to the considered beam (*ignoring relative luminosity differences of bunches in opposite beam*).

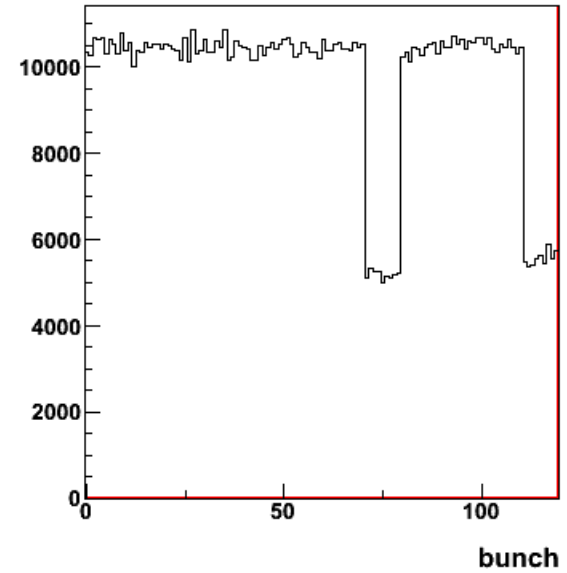
- How well is the jet target centered?
- Is the jet target profile symmetrical in *z*-direction? Tails?

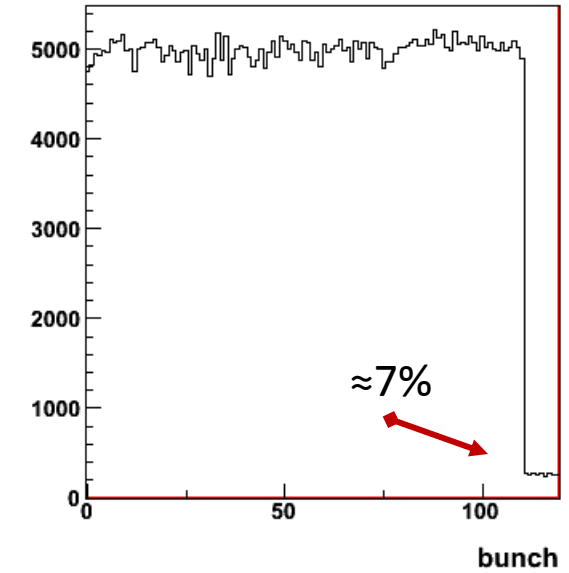
Elastic p+p Signal (Fill 17568, 8 hours)

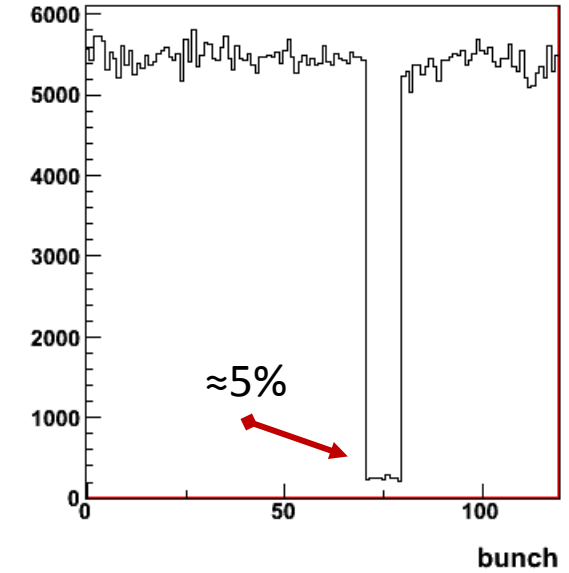




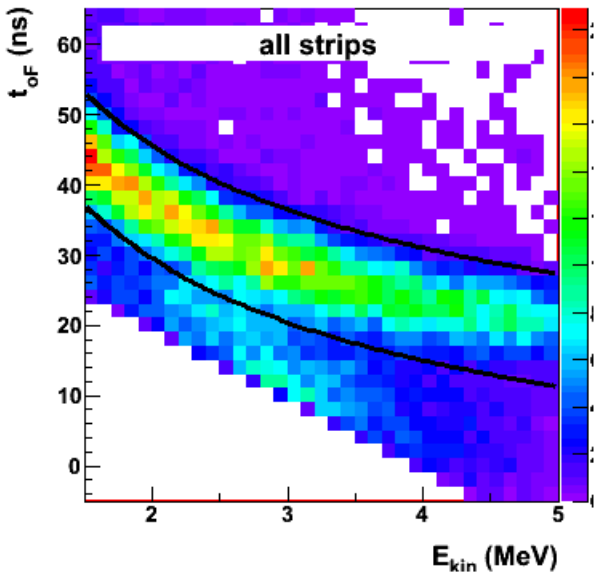


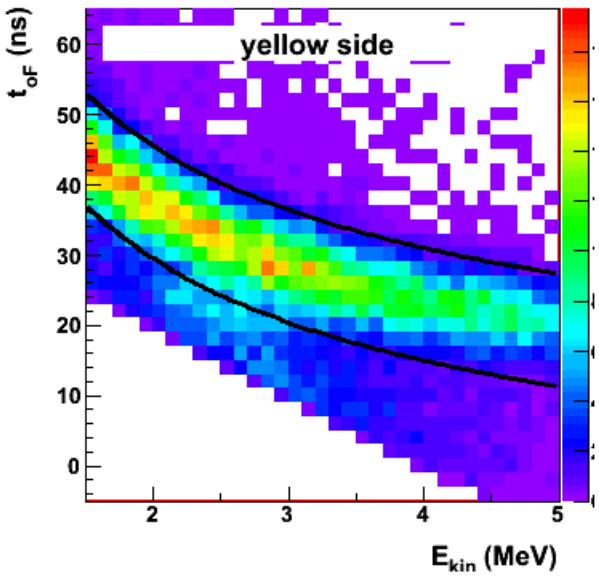


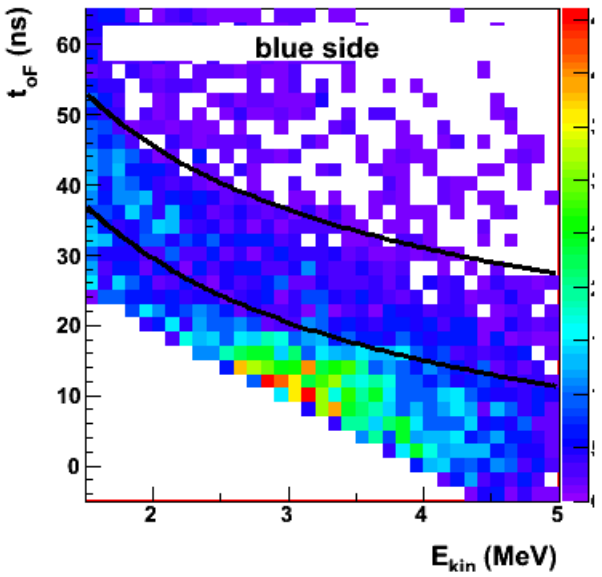


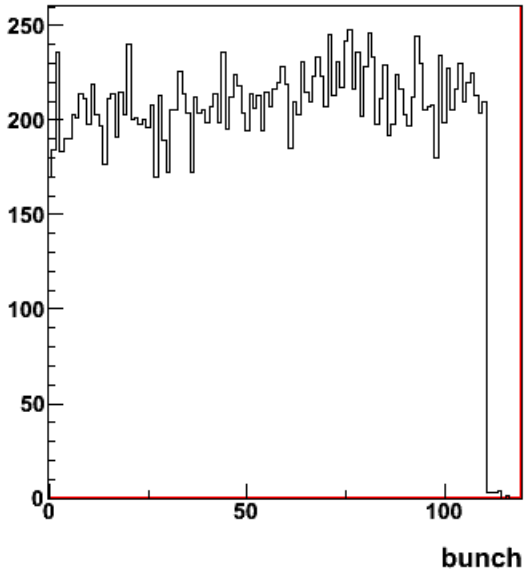


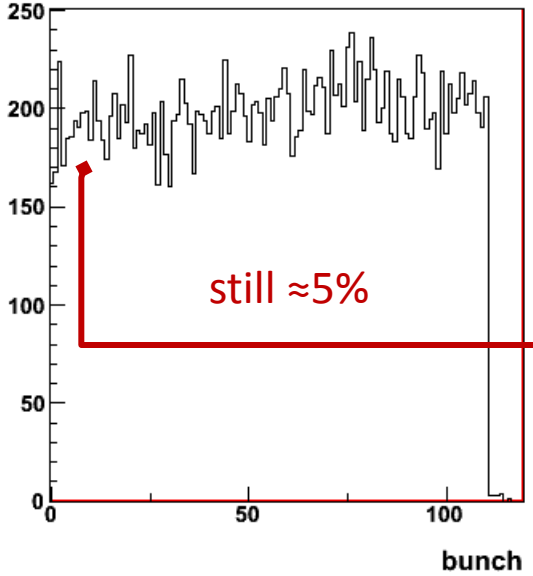
Single Yellow Beam (Fill 17568, 15 min)

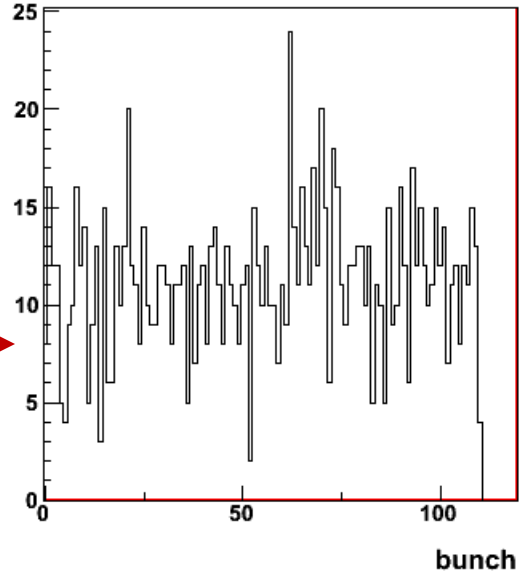




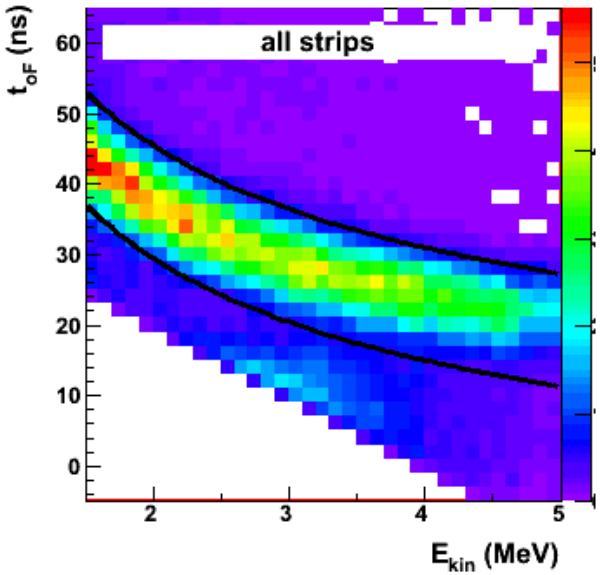


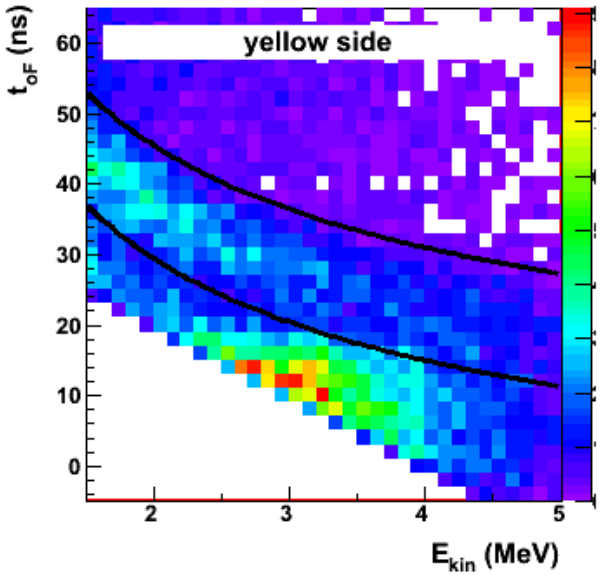


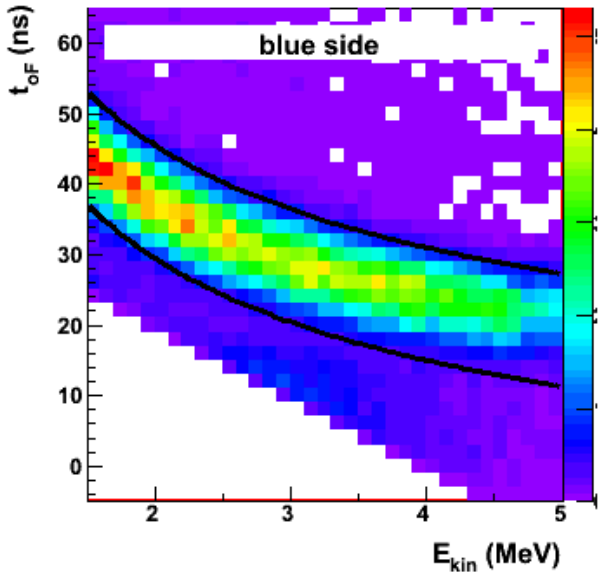


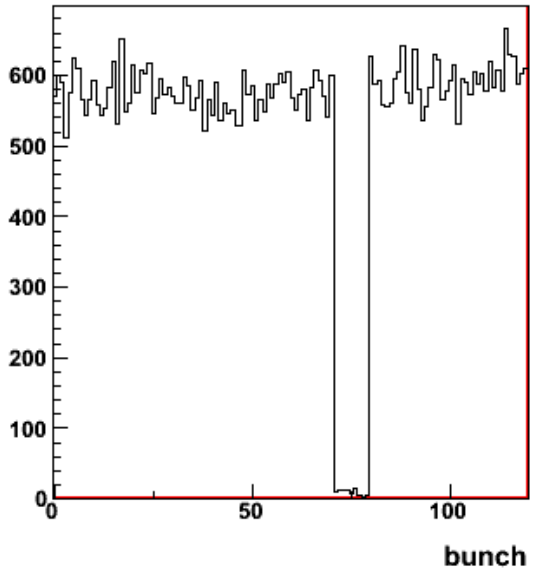


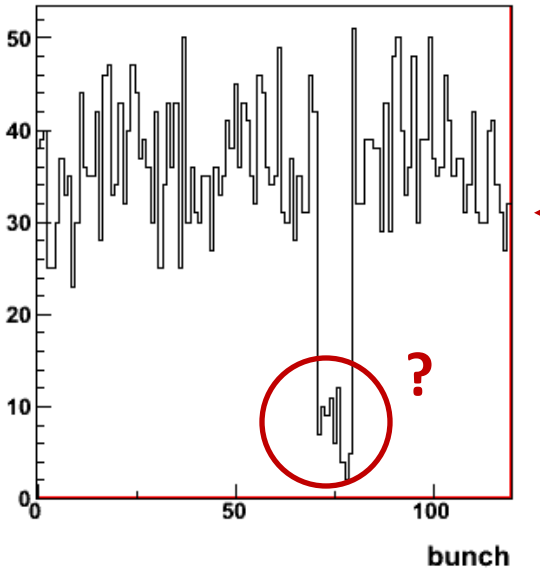
Single Blue Beam (Fill 17583, 30 min)

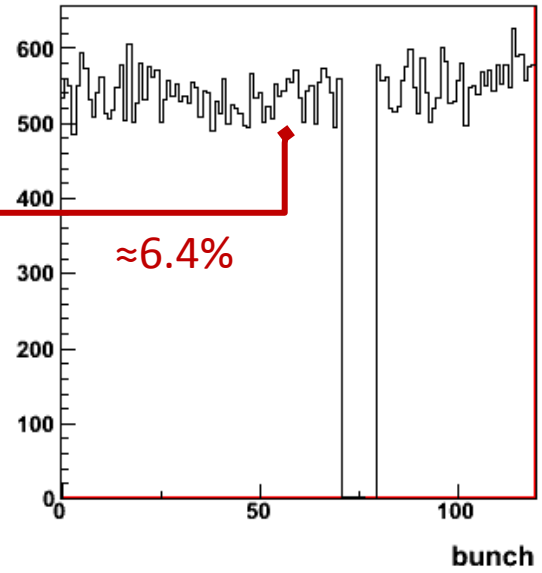




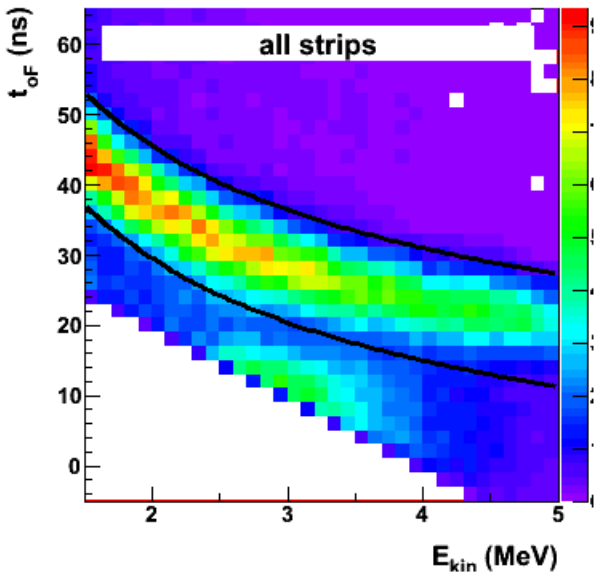


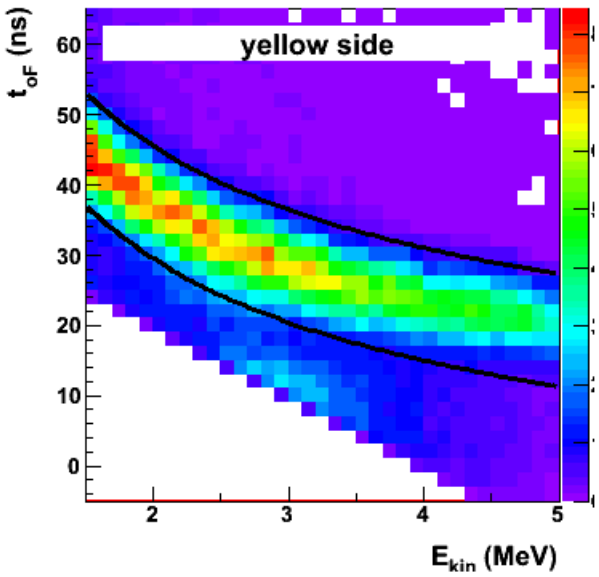


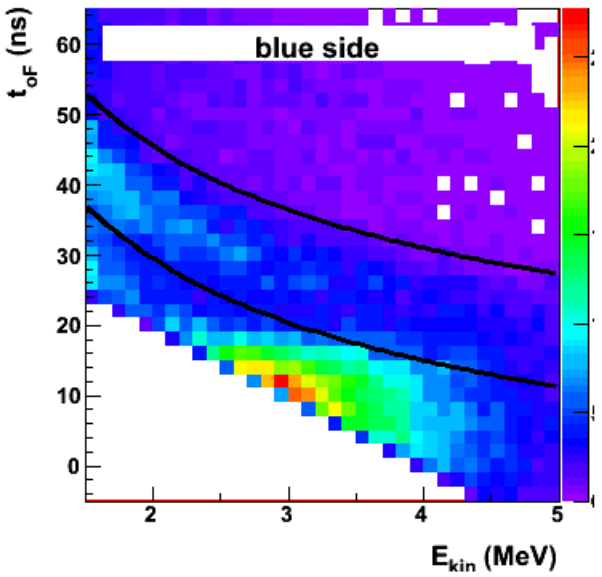


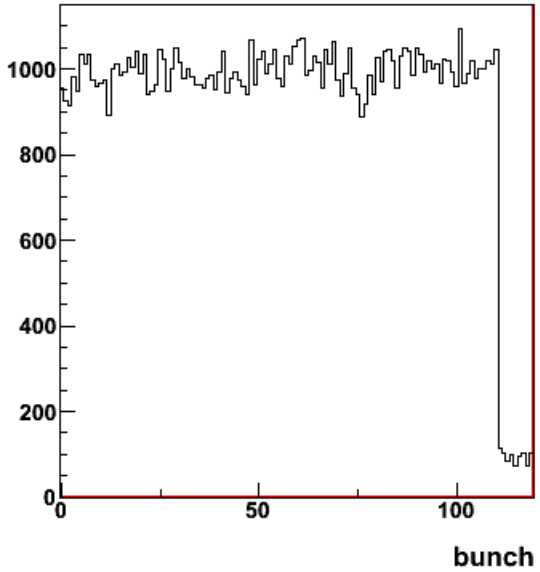


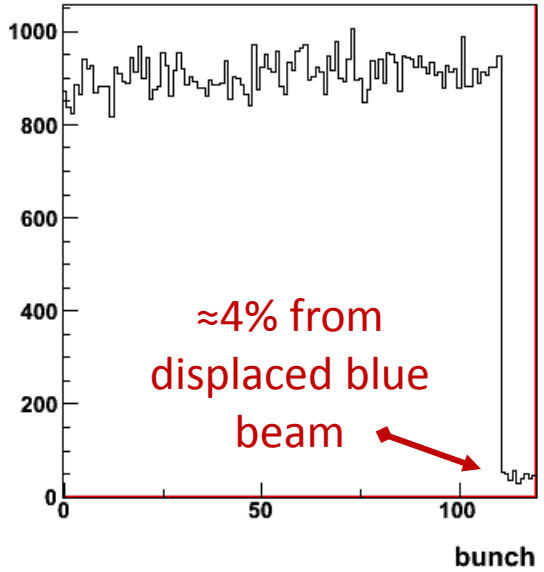
Displaced Beam (Fill 17571, 30 min)

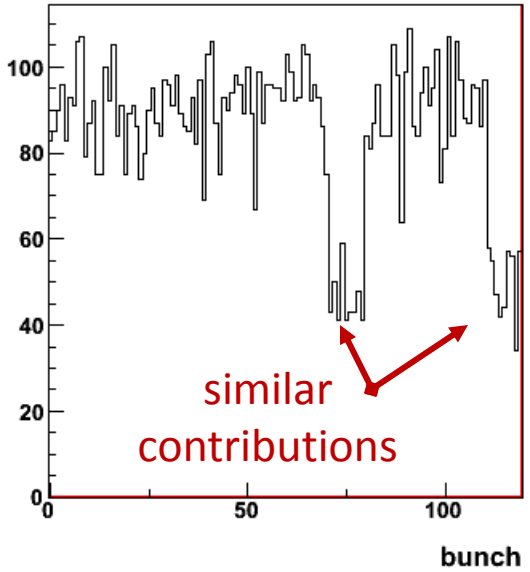












Background Studies

$$\varepsilon_{sig} = \frac{\varepsilon_{inc} - r \cdot \varepsilon_{bg}}{1 - r}$$

assuming $r \approx 0.05 \ldots 0.07$ for 9 bunches

$\sigma_{bg} \approx \sqrt{176 \ldots 247} \cdot \sigma_{inc}$

increase statistical uncertainty by ≈47…70%

- Abort gap studies can be done, but will have changing conditions and significant impact on final uncertainty
- Displaced *single* beam studies will ***NOT*** help with understanding of the background
- Background effects are larger on yellow signal side

$\varepsilon_{inc,max} \approx 0.04$

15 minutes in fill 17568 → $\sigma_{bg} \approx 0.03$

30 minutes in fill 17573 → $\sigma_{bg} \approx 0.02$

8 hours → $\sigma_{bg} \approx 0.005$