HJET 2017
Beam Polarizations

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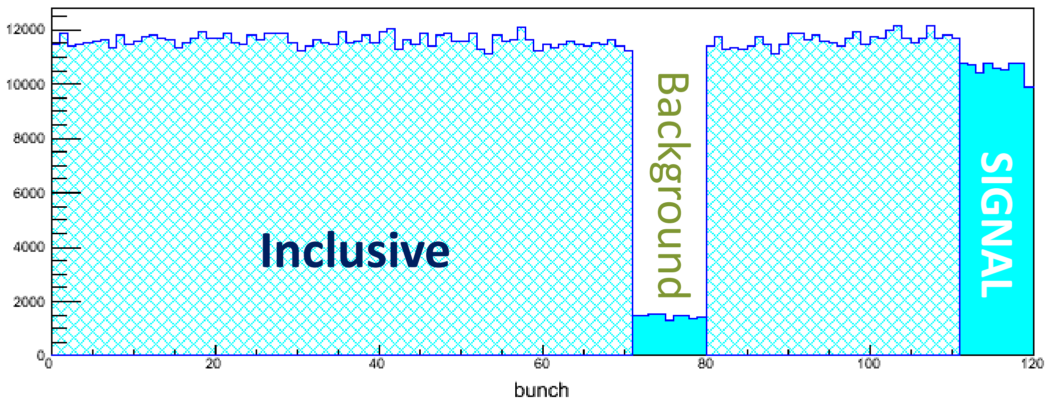
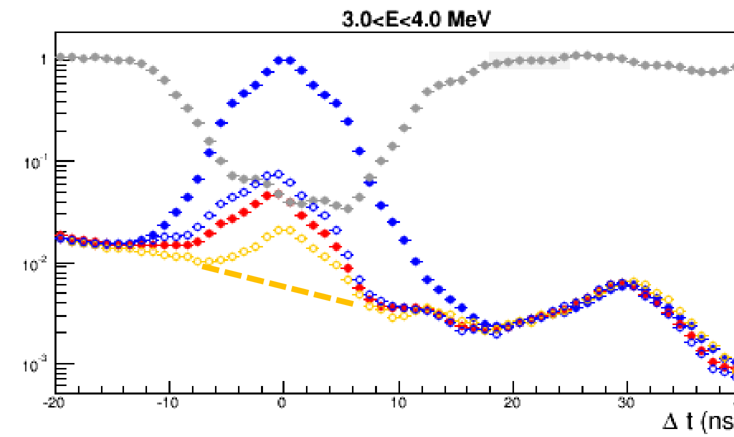
March 13, 2018

Background Estimation Obsolete





Previous background estimation by missing mass

- Collimator window limited vertex position
- Different methods had similar shape

In 2017

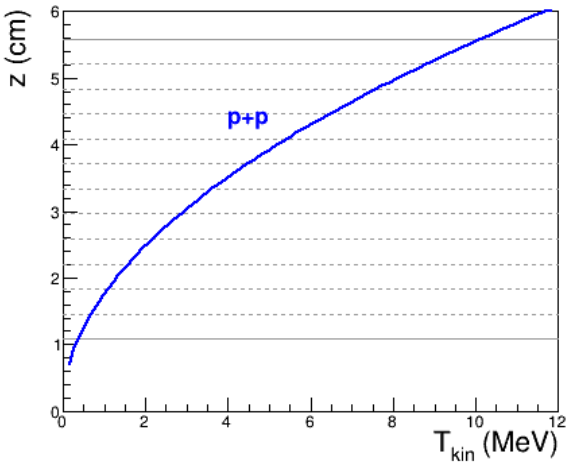
- No collimator windows
- Correlation between missing mass and detector position much weaker
- Also significant contribution from opposite beam, possibly with residual target polarization

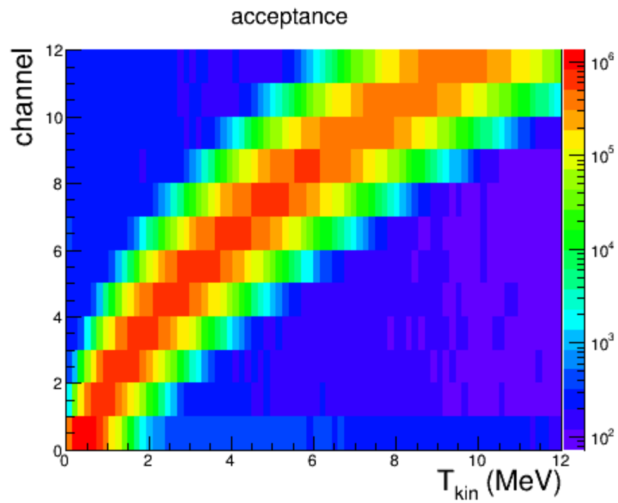
	$m_{miss} \approx m_P$	$m_{miss} \neq m_P$
Inclusive	●	○
Abort gap	○	
Signal		●

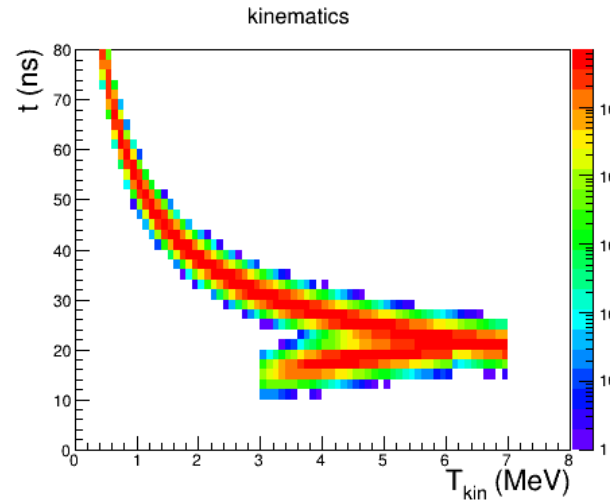
Elastic signal also present in "abort gap" (should be linear around $\Delta t \approx 0$)

Target Size & Detector Acceptance

Toy model: atomic and molecular target size

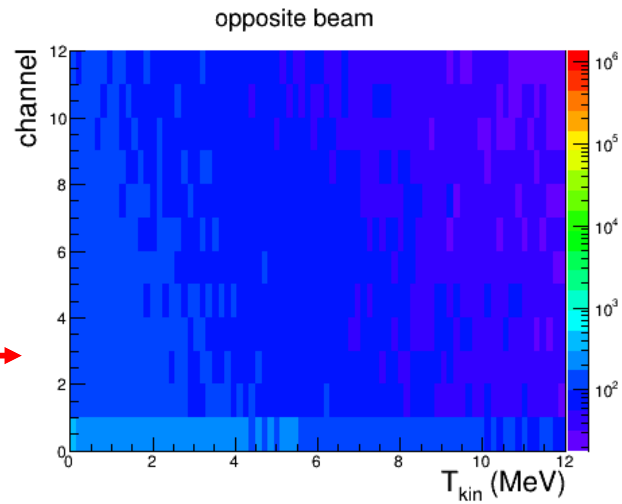


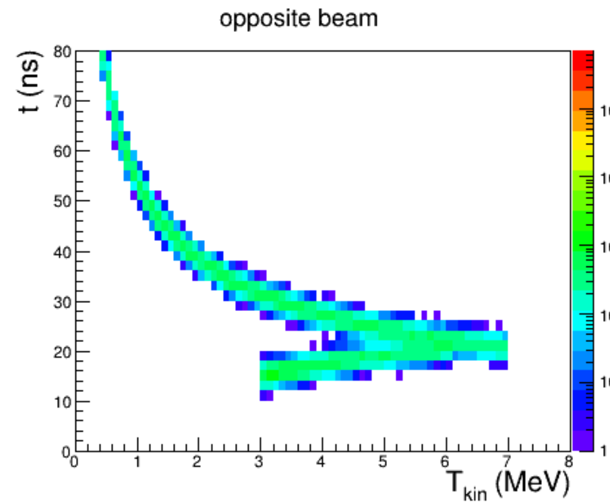




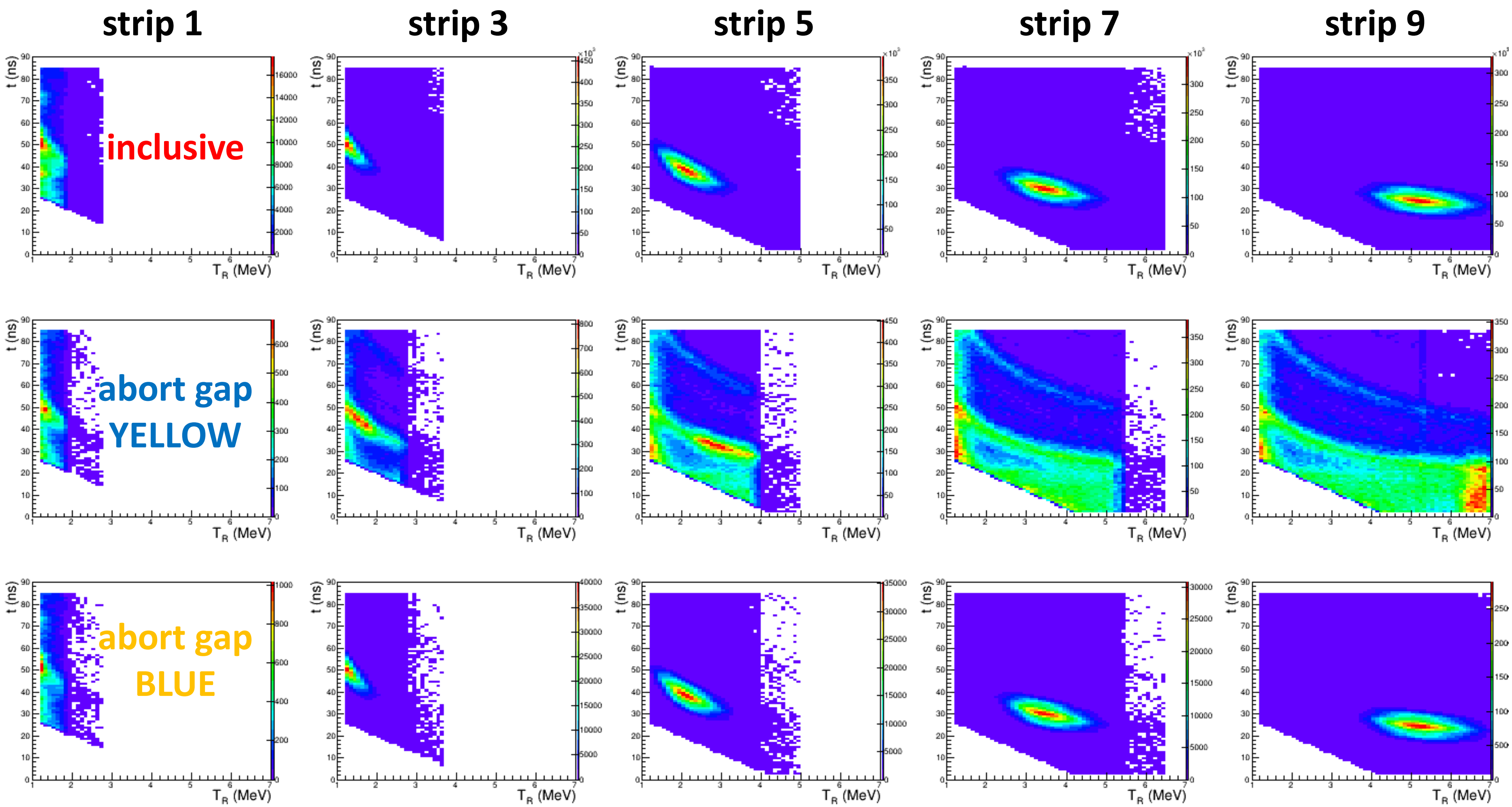
bunch length σ_B = 1.0 ns
target width σ_T = 0.3 cm
molecular width σ_M = 9.0 cm
molecular fraction r = 1%

Completely elastic kinematics
Same vertical scale
$\approx 10^{-3}$ suppressed





Kinematics & Detector Acceptance



- significant contribution from opposite beam
- potentially with flipped target asymmetry

(*) not the same z-scales (linear)

opposite beam fraction similar to previous slide

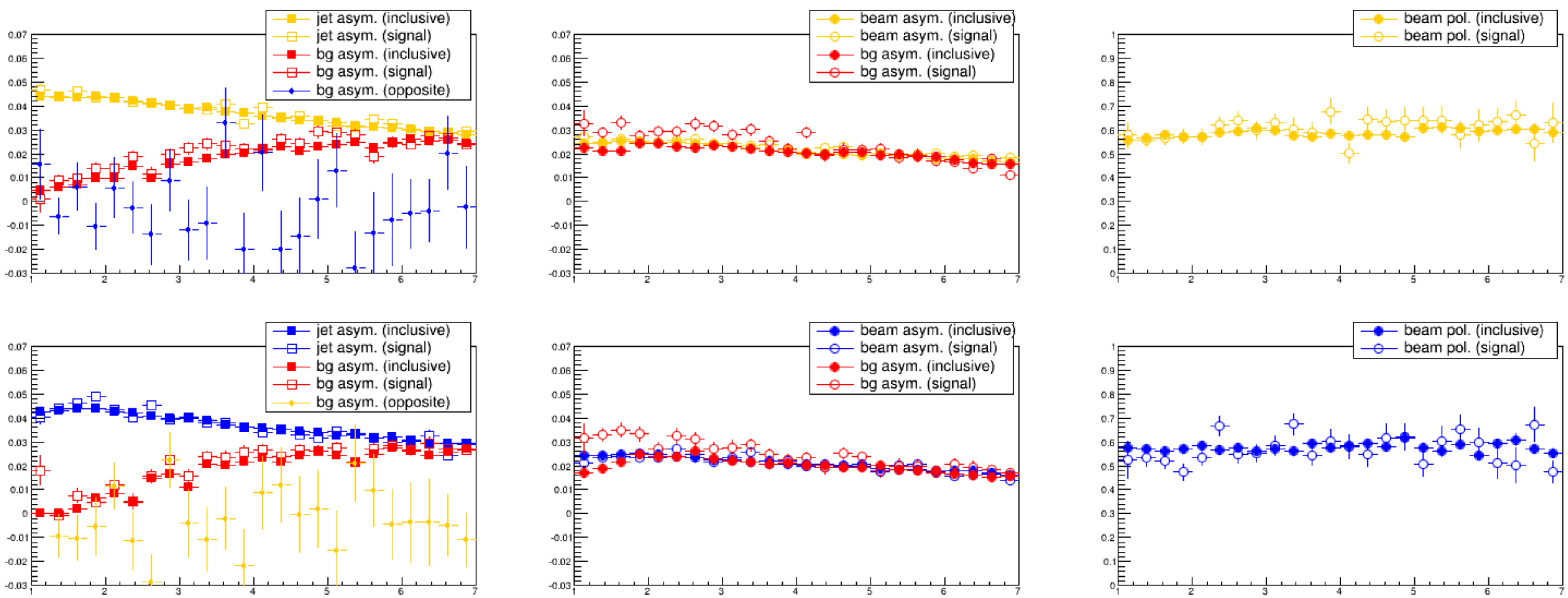
Asymmetries: Target & Beam

Beam and target asymmetries as function of energy

signal: $|\Delta m_{miss}| < 60\ \mathrm{MeV/c^2}$

background: $|\Delta m_{miss}| > 120\ \mathrm{MeV/c^2}$

- Full run 2017 data
- Missing mass not useful for estimation of background (elastic recoil with shifted vertex)
- Non-zero background asymmetry from opposite beam
- Negligible effect on determination of beam polarization



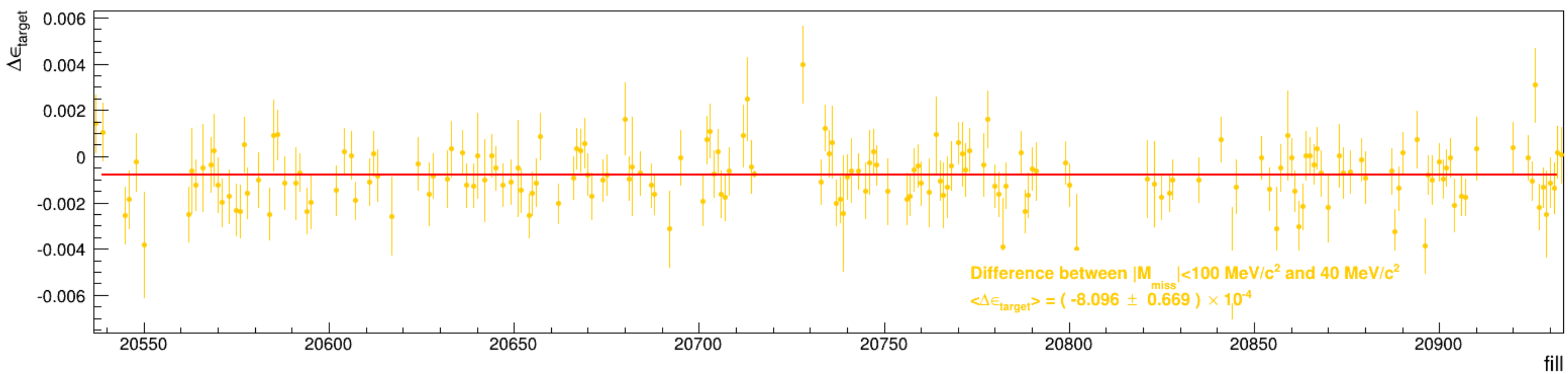
leak through from α-source

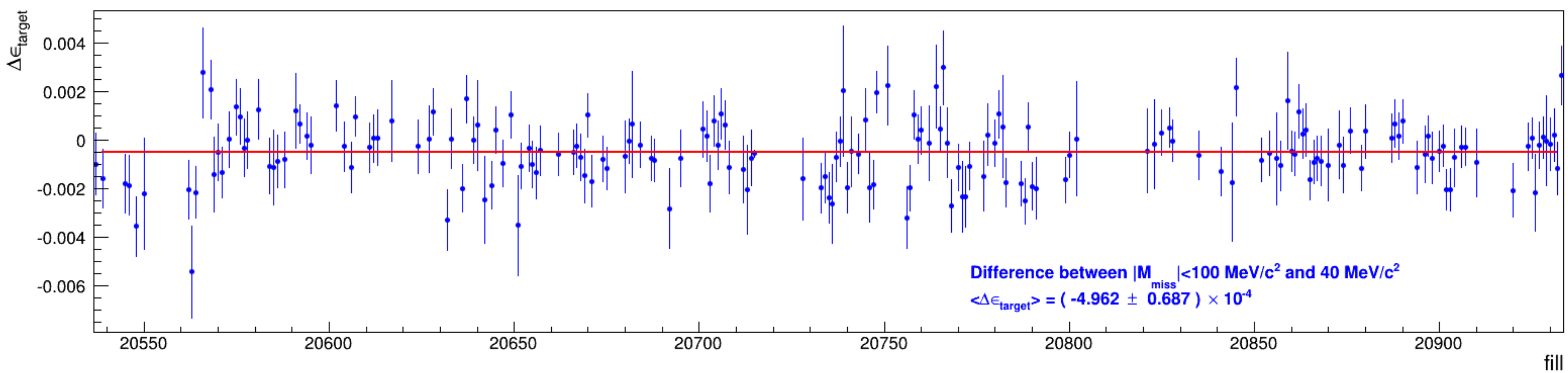
Effect of Background Asymmetries

Difference of target asymmetries for different missing mass cuts

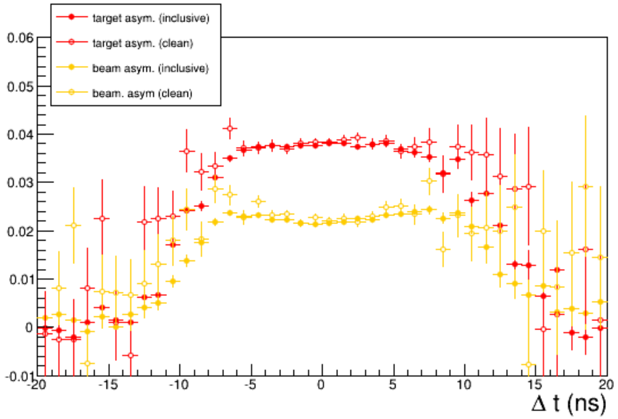
- Significantly non-zero ($> 5\ \sigma$)
- Small (compared to a signal of $\approx 4\%$)

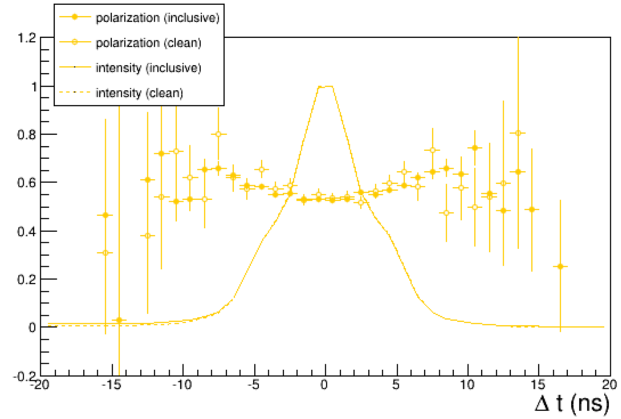
RHICf not shown

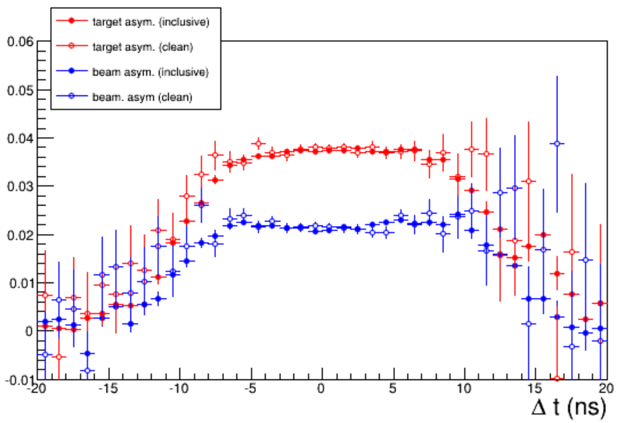


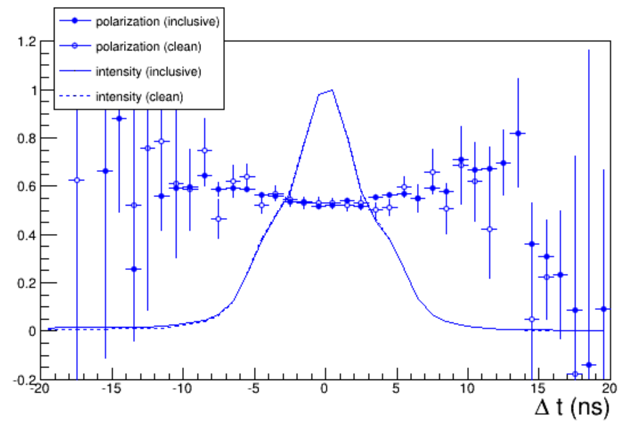


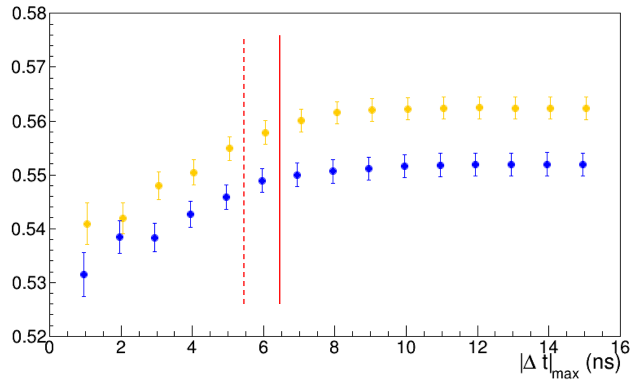
Bunch Profile











- Small differences between inclusive and clean asymmetries
- Consistent beam polarization measurement
- Longitudinal polarization profile (target asymmetry flat)
- Wider time of flight window for polarization determination, 6.0 ns
- Include longitudinal profile in luminosity weighting?

$$1.5 < T_R < 7.0 \text{ MeV}$$
$$|\Delta t| < 6.0 \text{ ns}$$
$$|\Delta m_{miss}| < 60 \text{ MeV/c}^2$$

Final Beam Polarizations

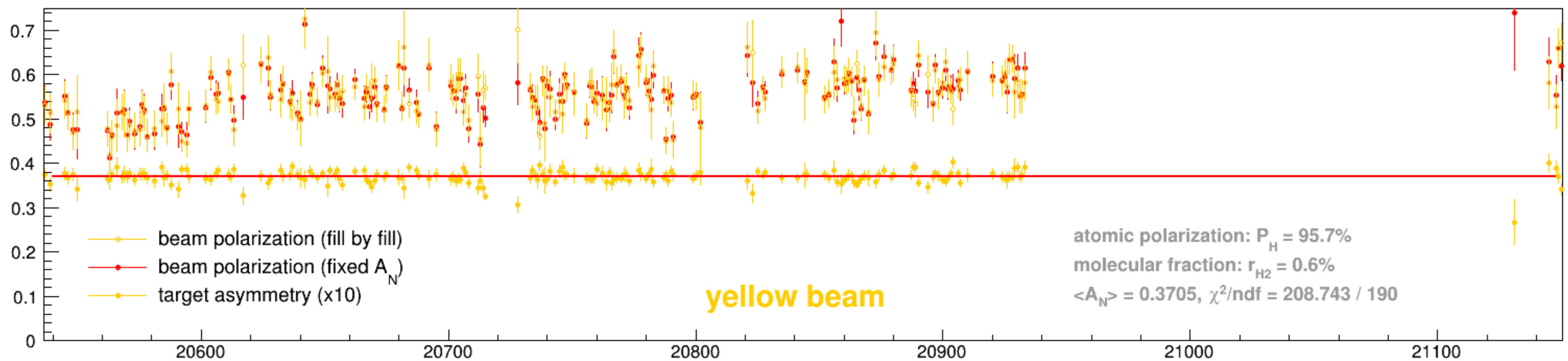
Compare fill by fill ratio of asymmetries with mean target asymmetry

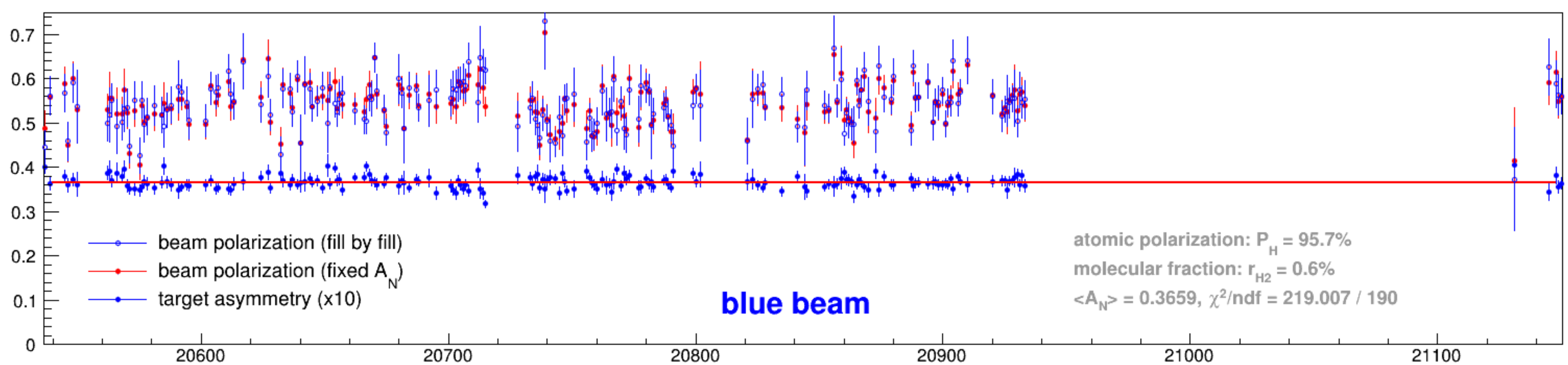
- No background correction
- Blue target asymmetry has slightly elevated χ^2

Updated numbers for jet polarization and molecular fraction

$$1.5 < T_R < 7.0 \text{ MeV}$$

$$P_{Beam} = -\frac{\epsilon_{Beam}}{\epsilon_{Jet}} P_{Jet}$$

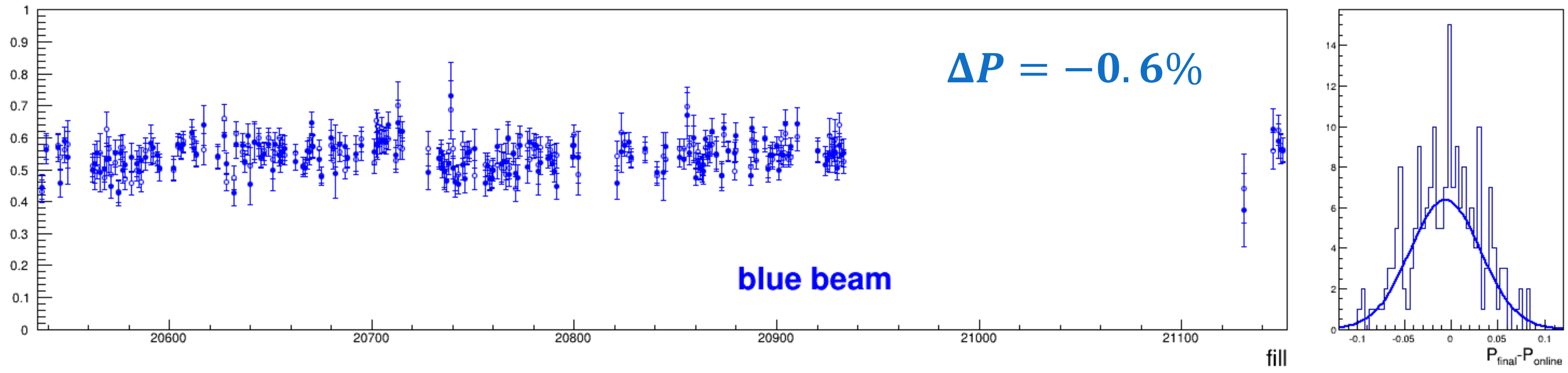


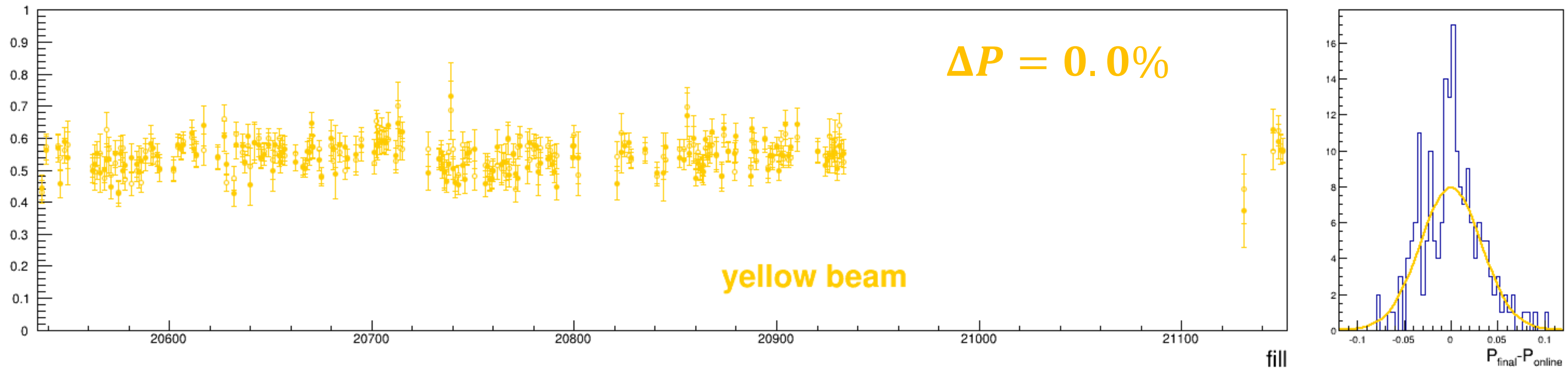


Comparison with Online Results

Fairly large variations from fill to fill

- Masking of noisy channels & Carbon movement
- Wider window for time of flight ($5.0 \rightarrow 6.0$ ns)
- Mean shift less than 1% ($\sigma \approx 0.3\%$)





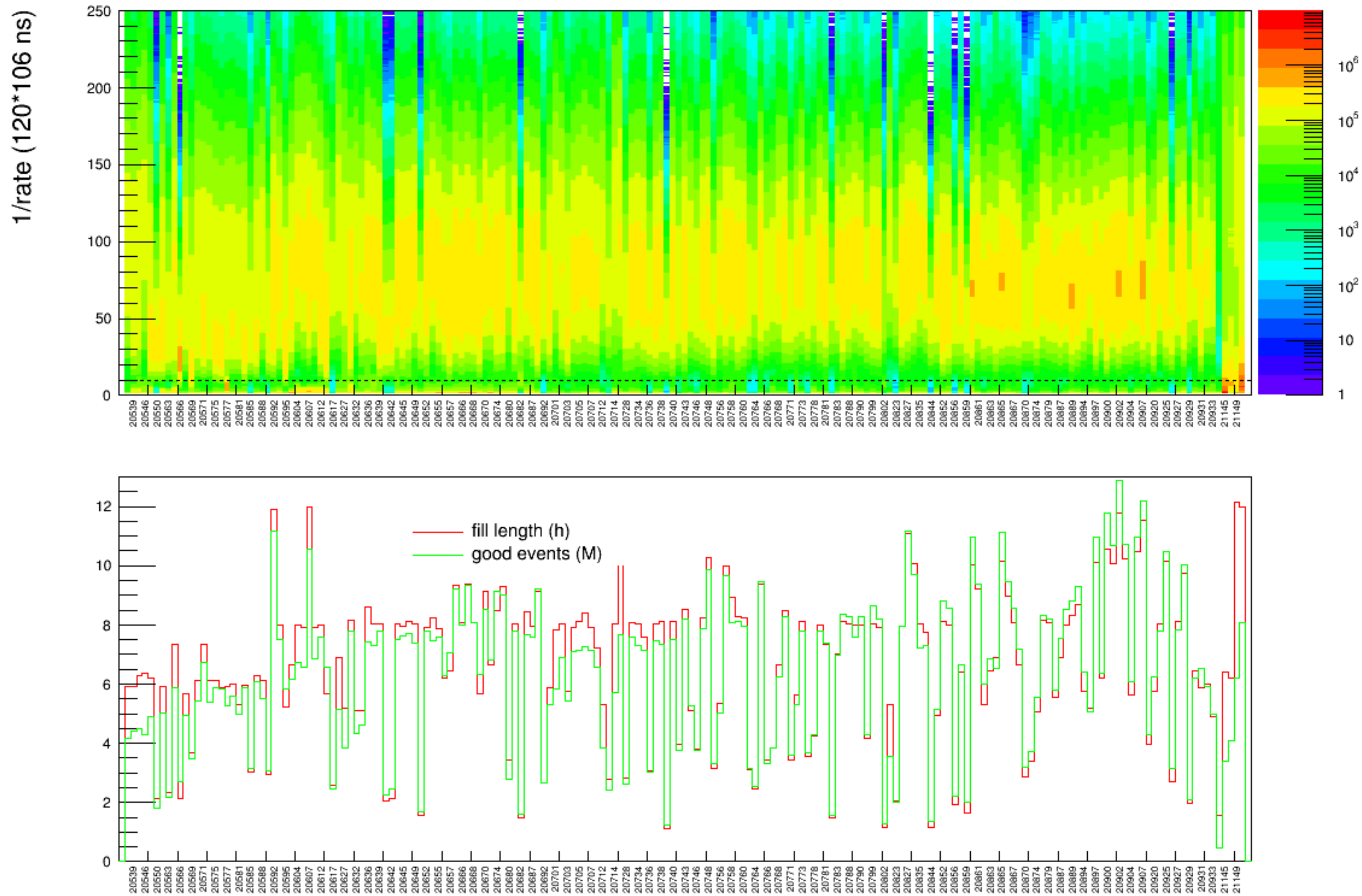
Summary / Conclusion

- Offline detector alignment / beam angle
- Masking of noisy channels
- Masking of Carbon target movements ($t_R < 10$ rev)
- Punch through particles removed
- Check of stability of target asymmetries (and background)
- Final beam polarizations determined with
  - $1.5 < T\_R < 7.0$ MeV
  - $|\Delta m_{miss}| < 60$ MeV/c^2
  - $|\Delta t| < 6.0$ ns
- No background correction
- $P_{Jet} = 95.7\%$
- $R_{H2} = 0.6\%$

I can try a different approach for unpolarized background correction if we are interested in the physics observable AN as such. Otherwise, for the beam polarization, the current method is sufficient.

…backup

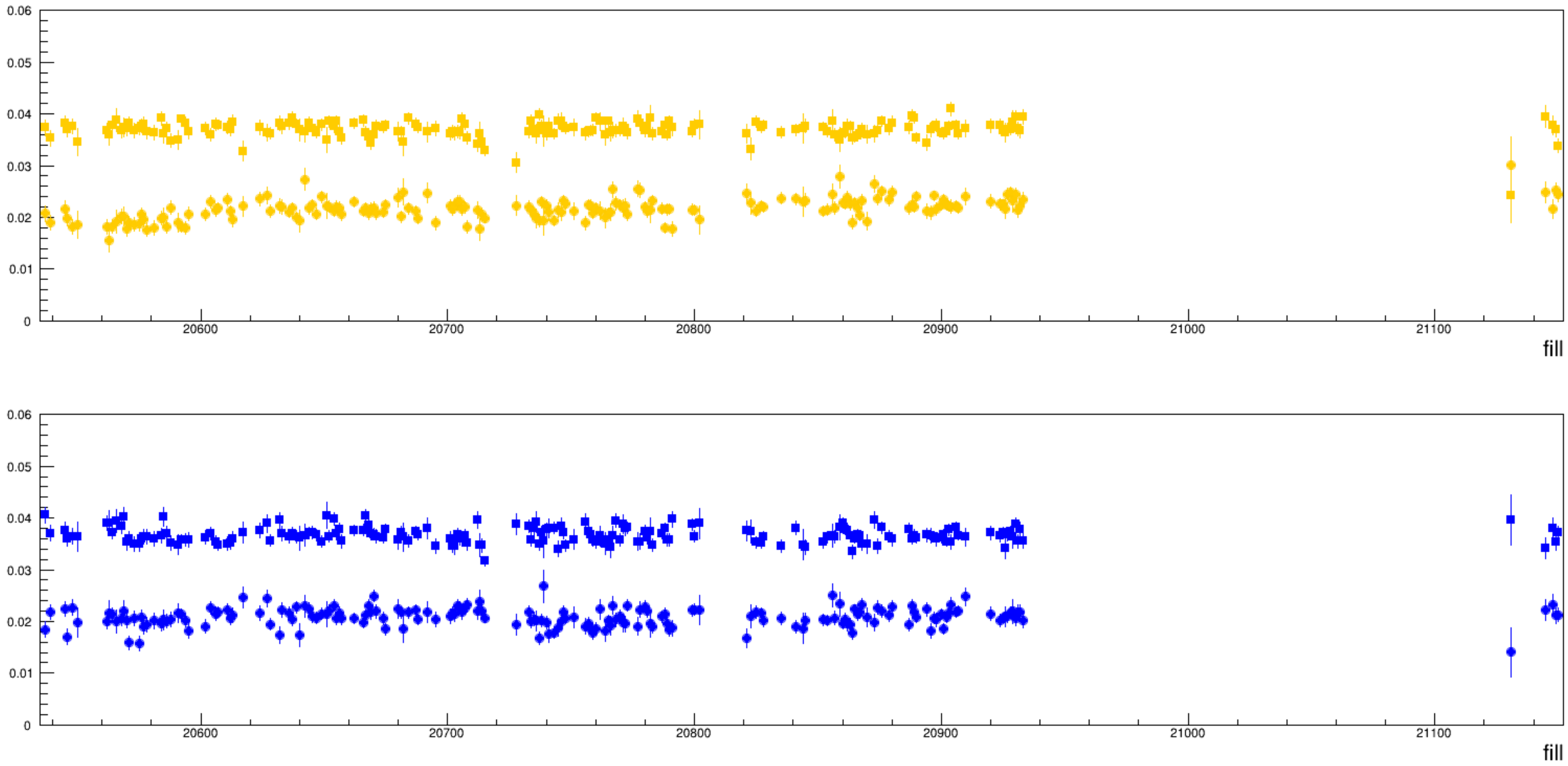
Rates, Events & Fill Length



dynamic β^* squeeze

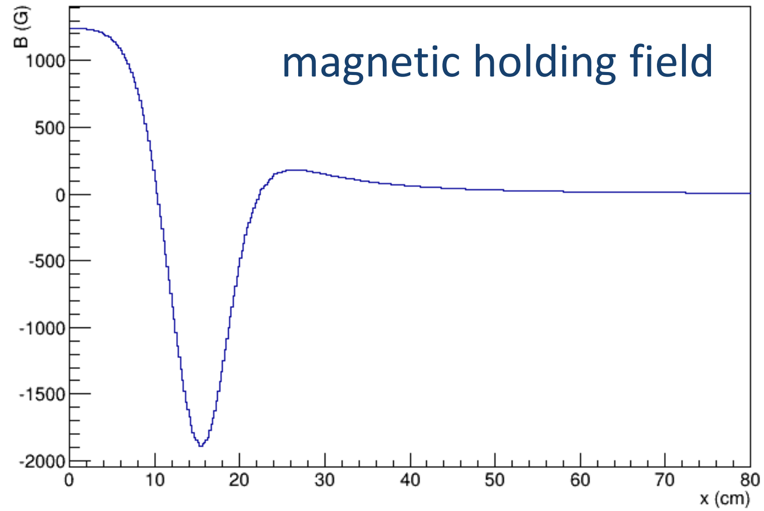
RHICf

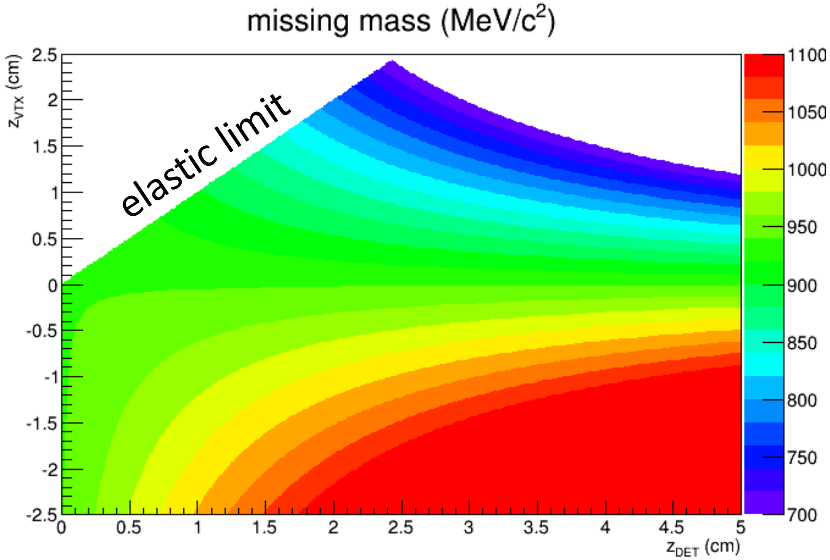
Asymmetries per Fill



Displaced Vertex

- Holding field extends comfortably far longitudinally
- Detector range is ± 5 cm
- Jet target size is less than 1 cm





$$m_{miss}^2 = m_p^2 - 2(m_p + p_{beam})T_R + 2p_{beam}\sqrt{2m_pT_R}\sin\alpha$$

$$m_{miss}^2 = m_p^2 - \frac{4m_p p_B^2}{m_p + p_B}(\sin^2\alpha' - \sin\alpha'\sin\alpha)$$

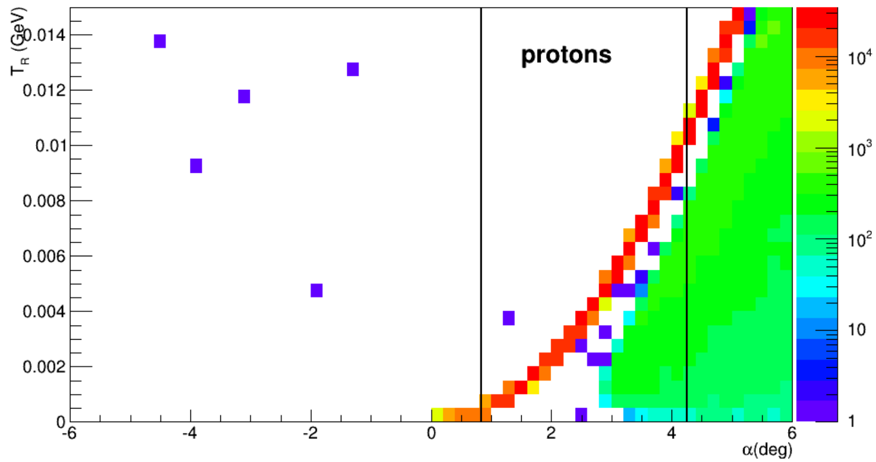
α: detector
α': physics (elastic recoil)

$$\sin\alpha = \frac{z}{\sqrt{z^2 + d^2}}$$

(*) This is for $p_{beam} = 100$ GeV/c.
The mass difference scales with p_{Beam}!

Collision Background

- p+p at $\sqrt{s} = 21.6\ \mathrm{GeV}$
- PYTHIA 6.4.28, Perugia 0
  - QCD $2 \rightarrow 2$
  - Elastic
  - Diffractive



- Prompt background
  - pions / photons up to a few GeV
  - covering whole detector (down- & upstream)
  - target asymmetries suppressed from both beams