# Update of impact of magnetic field on BBC AN measurements

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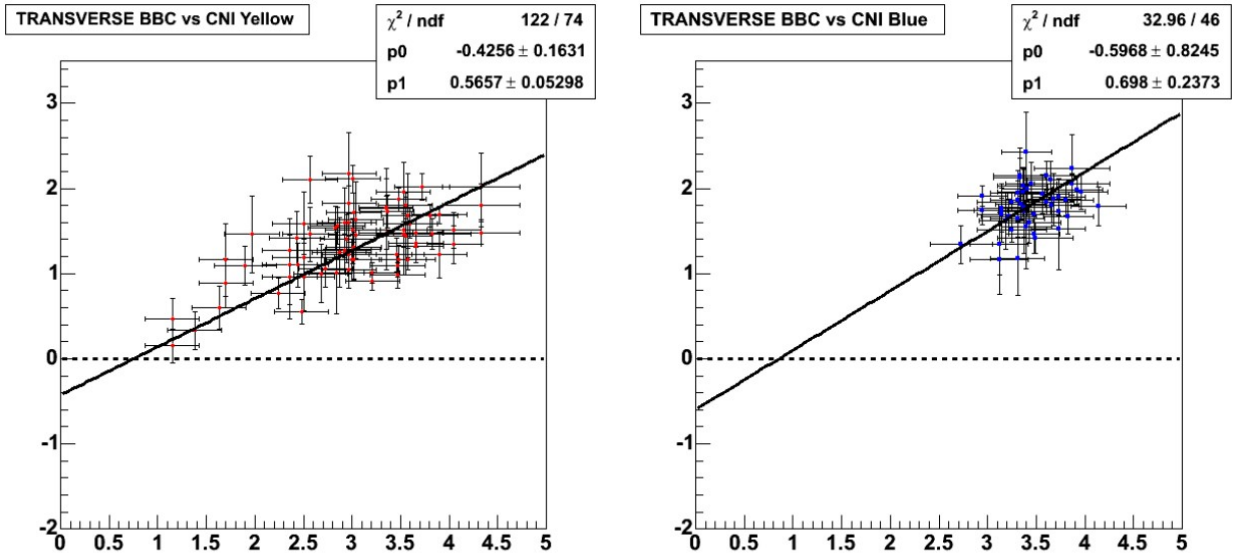
# Motivation




(a) (b)

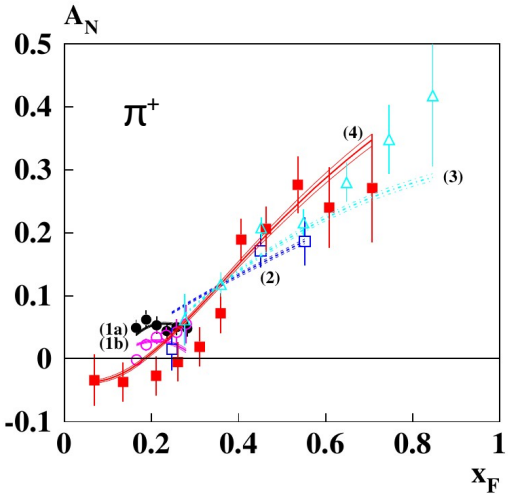
Figure 5.1: Correlation of the beam asymmetries measured by the RHIC *pC* CNI polarimeter [429, 430] and left (a) and right (b) STAR BBCs (in arbitrary units).

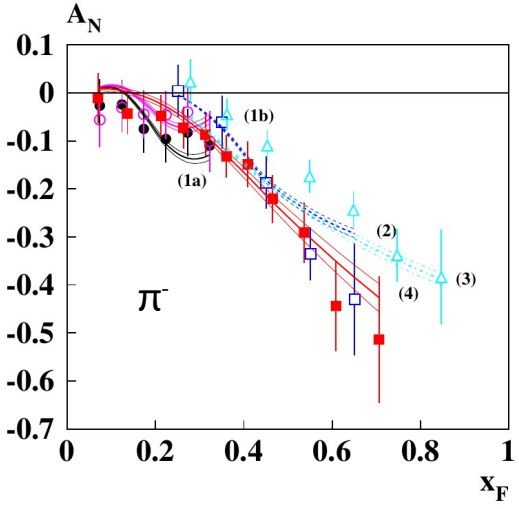
Figure from SPD CDR

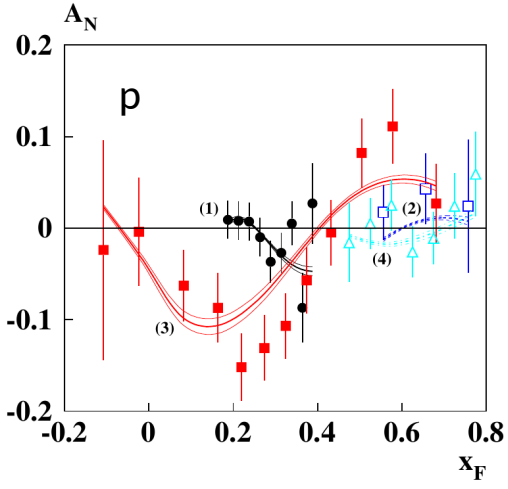
Observed effective analyzing power at RHIC at BBC is ~ 0.6-0.7%.

# Model for weighting

According to measurements, $A_N$ depends on **both $p_T$** and **$x_F$**. It's not possible to get definite parametrization from data. Consequently, the **chromomagnetic polarization of quarks (CPQ)** model calculations by V. Abramov are used (J.Phys.Conf.Ser. 678 (2016) 1, 012039)



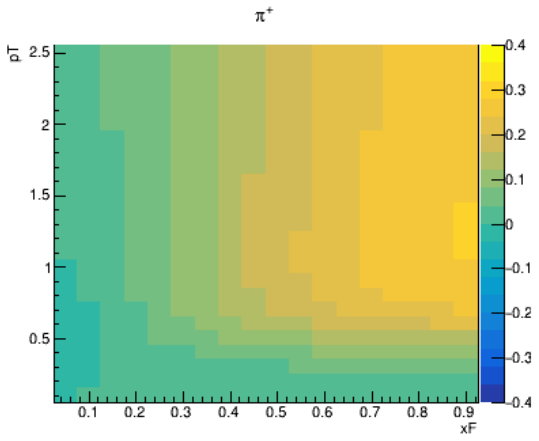



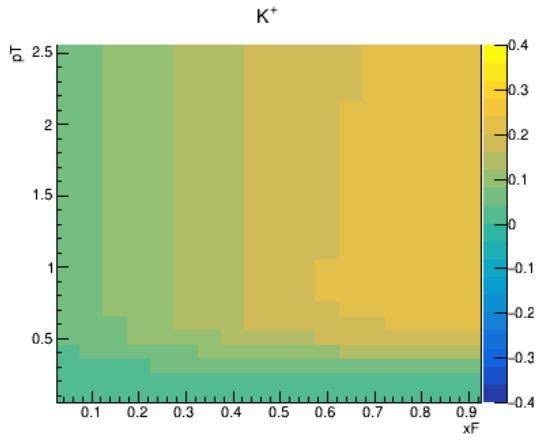



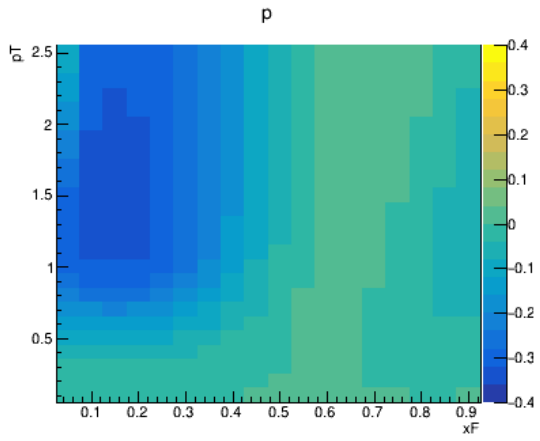

1. BRAHMS (200 GeV)
2. BRAHMS (64 GeV)
3. E704 (19.4 GeV)
4. FODS (8.77 GeV)

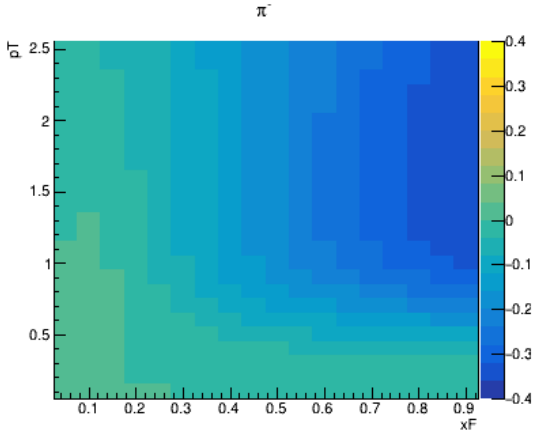
Kaons can be also taken into account but don't significantly affect the results (see talks by A. Terekhin).

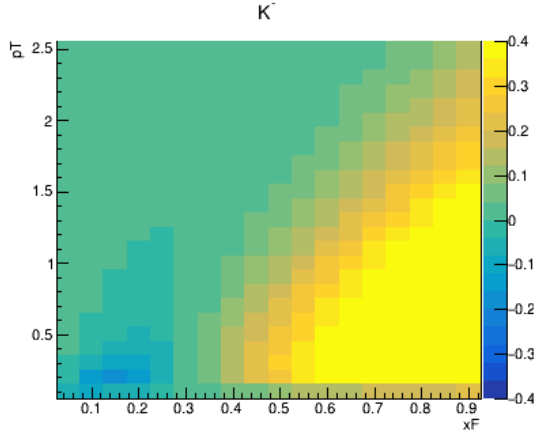
# CPQ model prediction grid (√s=27 GeV)



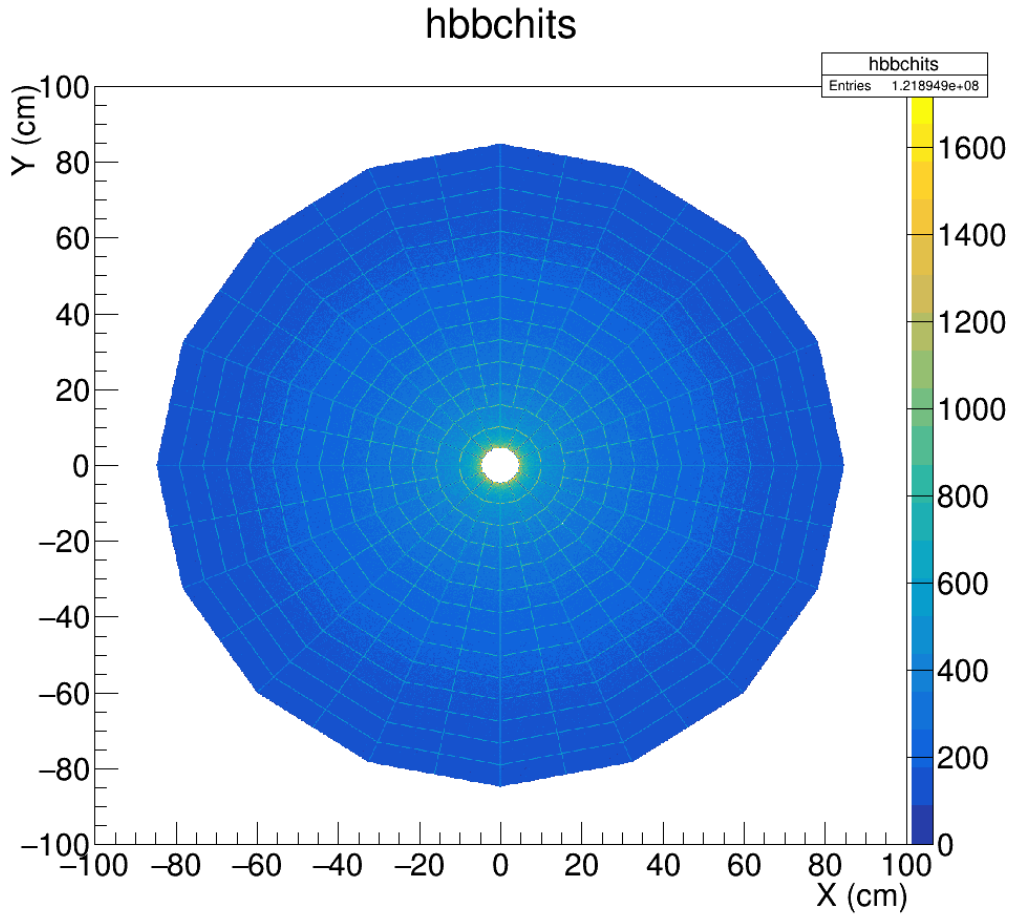

Thanks to Victor Abramov!

# Overview

- We can expect magnetic field to **smear polarization effect for BBC or introduce phase bias**. We are interested in "visible $A_N$" in each BBC ring (each ring has different xF Vs. pT acceptance and momenta spectra and composition of charged particles).
- Currently, we don't have event generator for collisions of polarized particles, so the weighting procedure is used (requires a significant number of events for stable results).
  - *Track weighting*: weight each track individually ($w = 1 + A_N(x_F, p_T)*\cos(\varphi)$).
  - *Event weighting*: weight event (weight is given by a product of $(1 + A_N(x_F, p_T)*\cos(\varphi))$ for each track). It produces artifacts at low $x_F$.
- **Toy study**: 500M Pythia8 MB @27 GeV, analytical track parametrization, charged pion and proton tracks are weighted (my talk P&MC, 17.04.24)
- **This talk**: the simulation in SpdRoot.

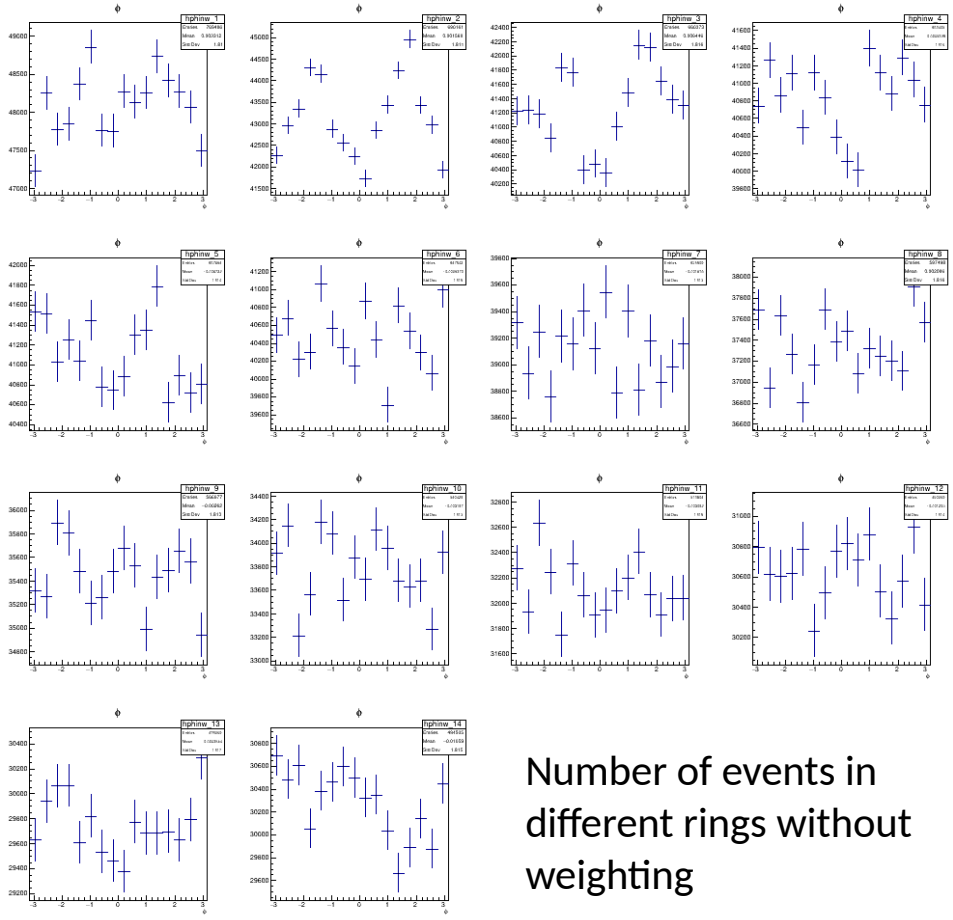
# Simulation details

- **Production data**: “System test”, S2, 27 GeV, 20M events simulated and reconstructed with SpdRoot 4.1.7 development version.
- Secondaries are weighted based on the G1 particle
- Found simulation/reconstruction issues:
  - sometimes particle produces more than 1 BBC hit
  - issue with ring tile number
  - issues with sector number and minor geometry updates  addressed in the new singularity image to be used in the next productions



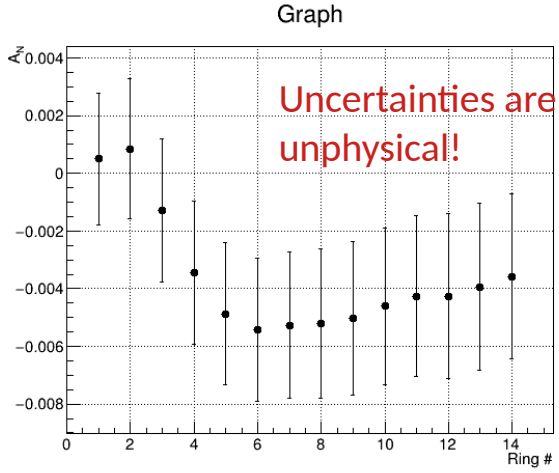
# Analysis

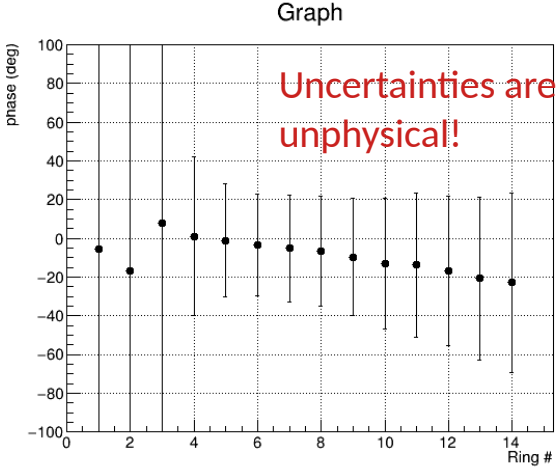
- Since the tile number was unavailable after reconstruction, *the MC-truth hit information* was used to fill φ-histograms (16 bin, -π, π) for 14 rings based on radial distance
- The track weighting method was used (what if more than one track hit a tile?)
- Strange patterns in φ-bins in rings (~1%) - more precise geometry description needed?
- To be checked and understood with the next release, *for this analysis taken as an acceptance acc ~ 1/$N_{uw}$ in each φ bin*

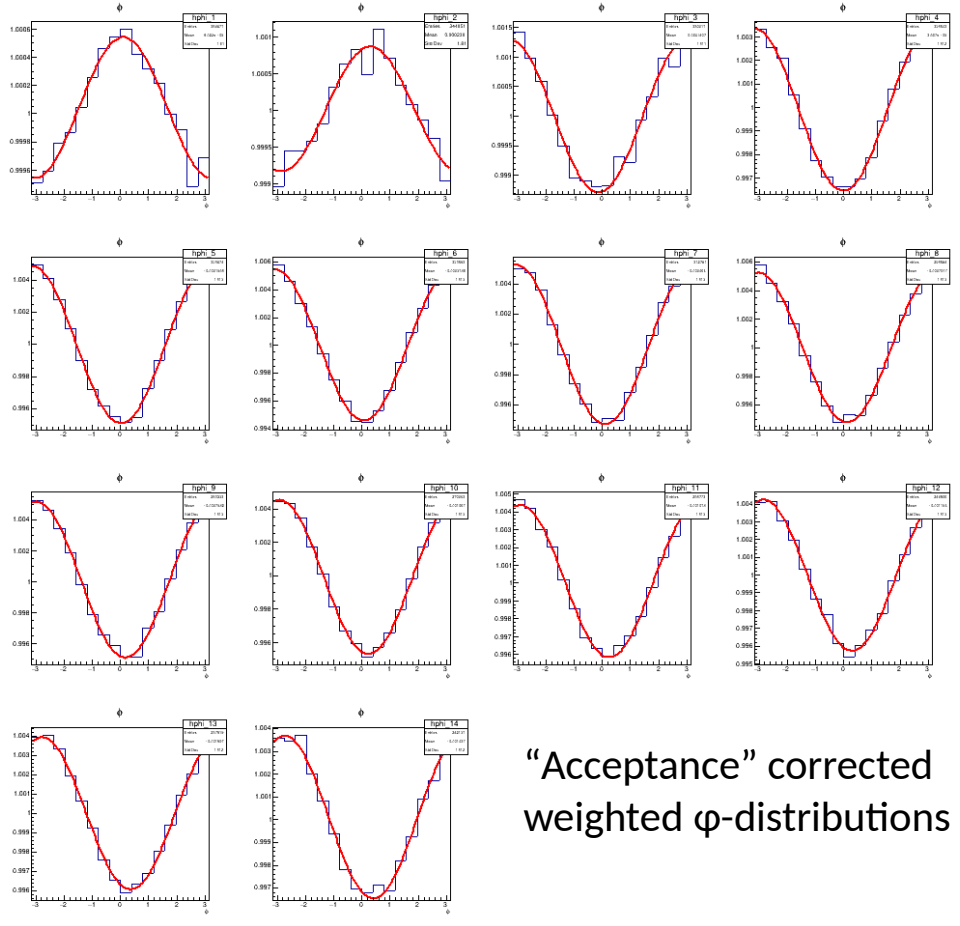


Number of events in different rings without weighting

# Analysis results



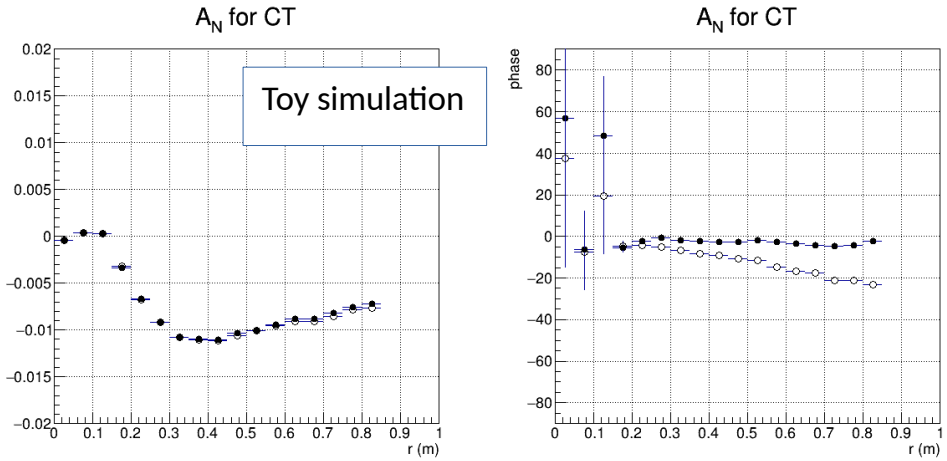



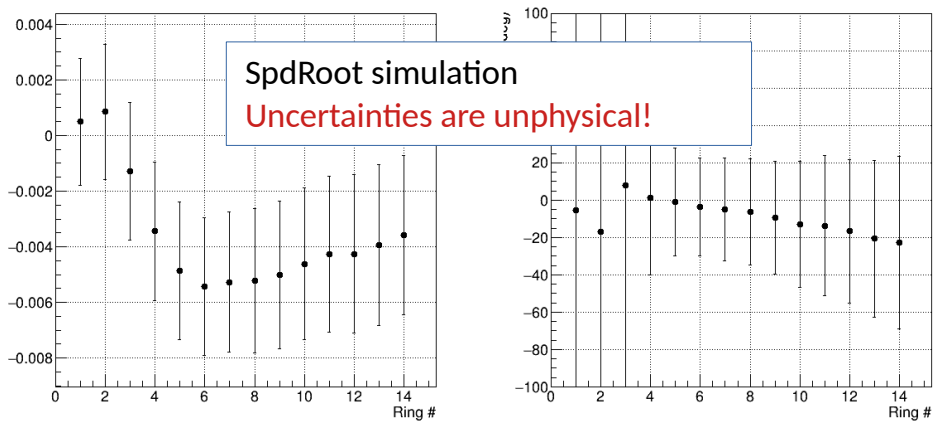



"Acceptance" corrected weighted φ-distributions

# Comparison with the “toy simulation”

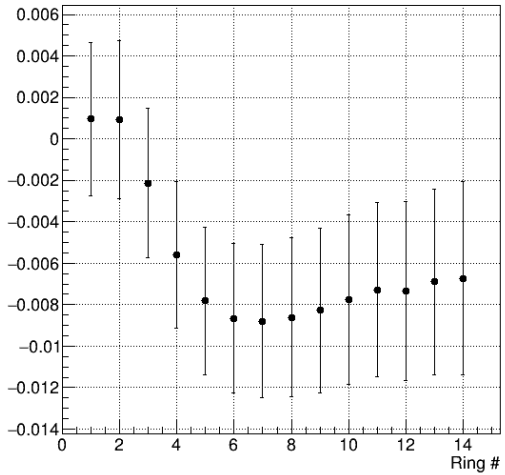
- The absolute value for AN has similar r-dependence, but is ~ two times smaller in magnitude
- The phase shift is almost the same: starting from zero in the first bins and reaching ~20 degrees for outer layers
- The reason is being investigated

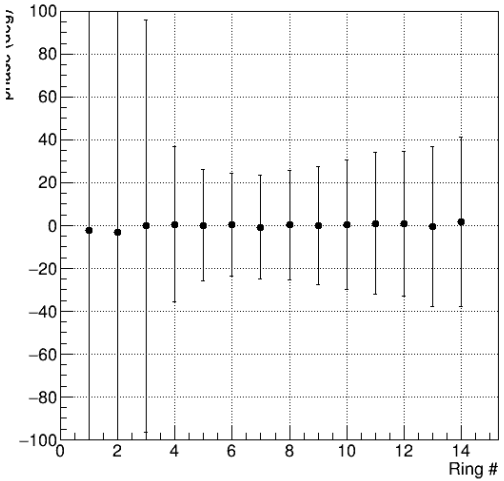


# $A_N$ at the “generation stage”

- At the “generation stage”, the asymmetry is larger reaching almost 0.9%
- Several factors to be checked with the updated SpdRoot code (hits, geometry issues)




SpdRoot simulation, 1-st gen. particles that hit BBC
Uncertainties are unphysical!

# Summary

- The full SpdRoot simulation shows the same pattern for $A_N$ as a function of BBC radius as the toy study before. The absolute value of asymmetry is almost two times smaller, which requires additional investigation. The phase behavior is almost the same and the effect of the magnetic field leads to almost 20 degrees at the outer layer.
- There were issues found with hit creation, geometry description and navigation, and acceptance. They are addressed in the SpdRoot code update.
- The results will be updated with the new SpdRoot update.
- Now one can make a rough estimation for the time required to measure the beam asymmetry with given precision.
- Lower collision energies should be studied.