Systematics in Transversity Asymmetry

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Outline

- Asymmetry Components.
- Monitors and Corrections.
- Future Plan.

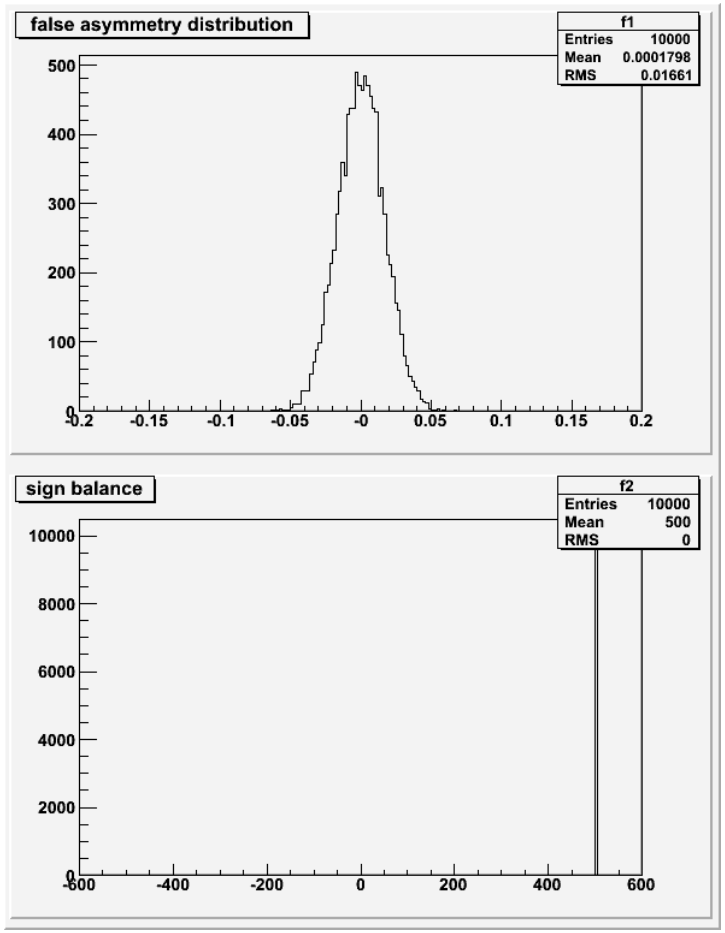
Simple Formalism of Asymmetry

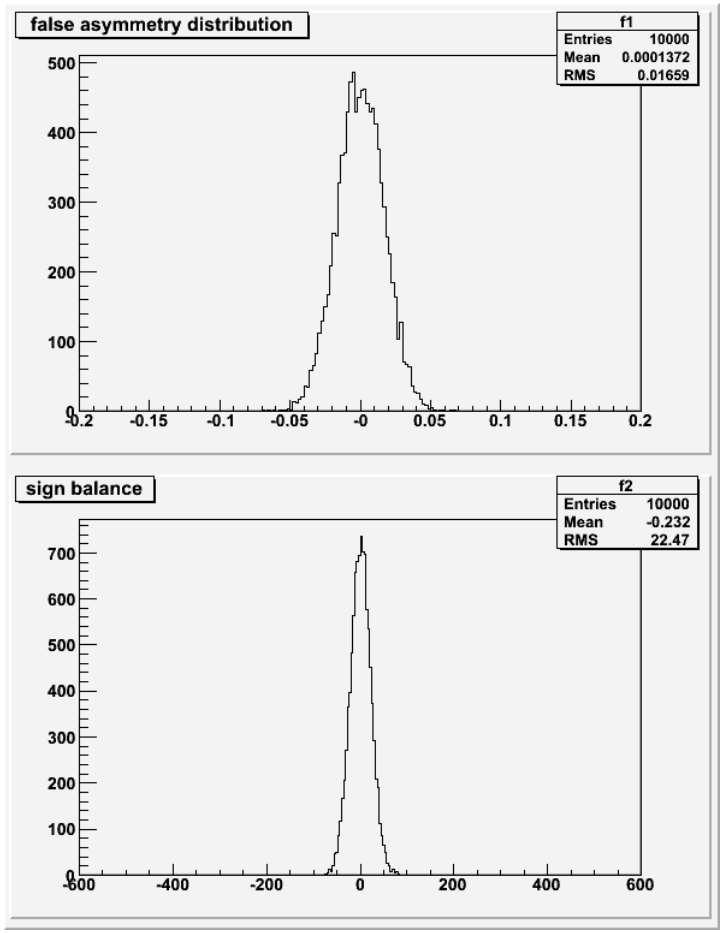
- Four components of asymmetry
  - Physics asymmetry: A_{Phy}
  - Statistical fluctuation: A_{stat}
  - Spin unrelated noise: A_{noise}
  - Spin related fluctuation: A_{spin}
- Contribute to final asymmetry
  - A = Aphy + Aspin
  - $\sigma_A = \mathrm{sqrt}(\sigma_{Aphy}^2 + \sigma_{Astat}^2 + \sigma_{Anoise}^2 + \sigma_{Aspin}^2)$

Basic Simulation Parameters

- Total time : 20000 min (14 days)
- Flip time : 20 min
- Pion rate : 0.6 Hz
- Dilution factor : $f = 0.2$
- Target polarization : $P_T = 42\%$
- Neutron polarization: $P_n = 87\%$
- Total factor : $C = 1/f/P_T/P_n = 14$
- Statistic error : 1/C/sqrt(N) = 1.7%

Pure Statistic Simulation





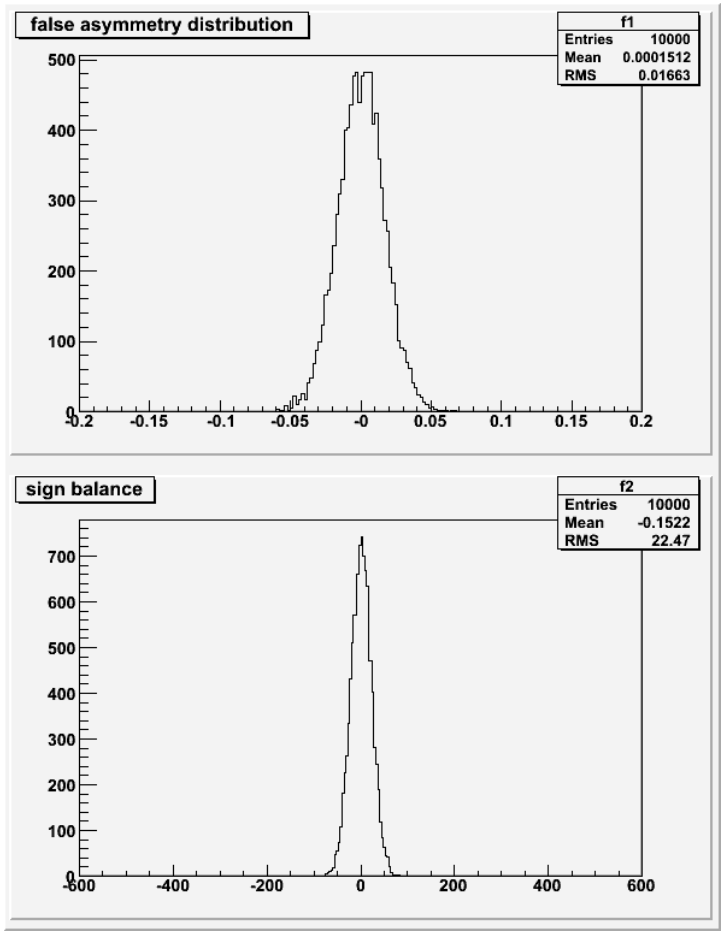
Regular Flip

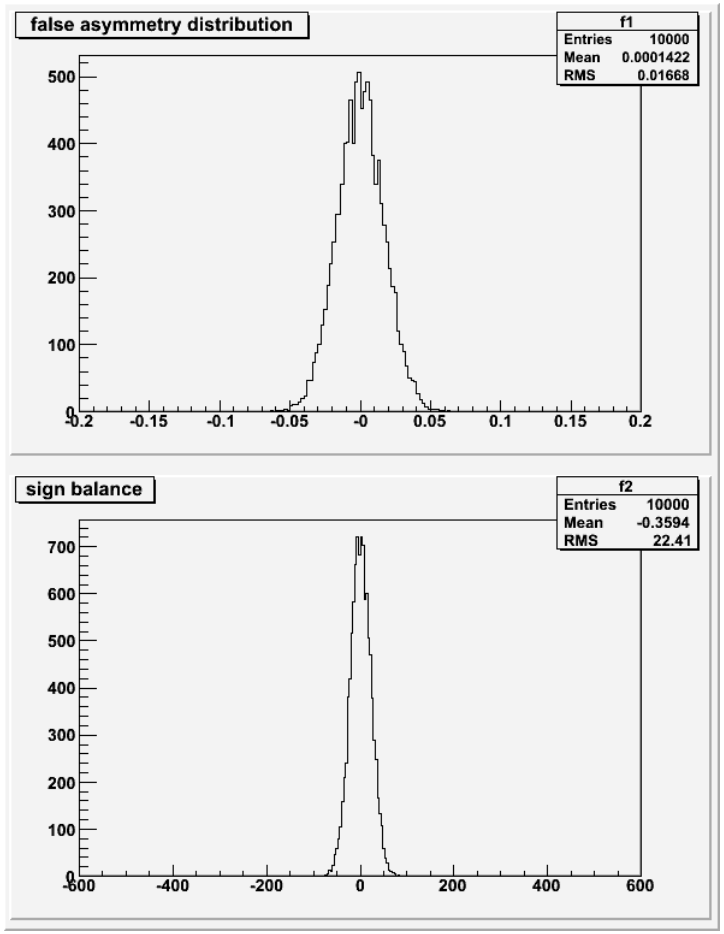
$A = 0$

$\sigma_A = \sigma_{Astat}$

Random Flip

Blind Analysis of Pure Statistic





Regular Flip

$A = 0$

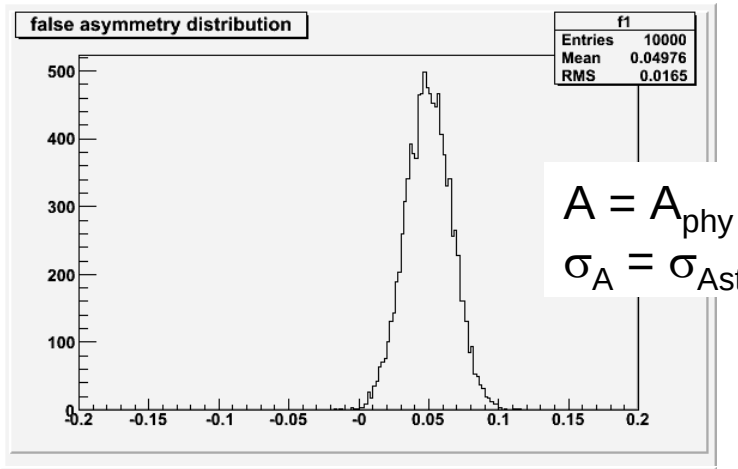
$\sigma_A = \sigma_{Astat}$

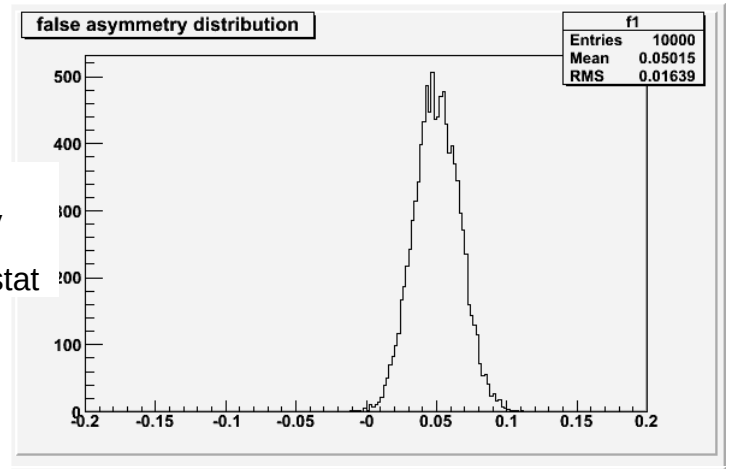
Random Flip

Add Physics Asymmetry (5%)

Repeated Experiment

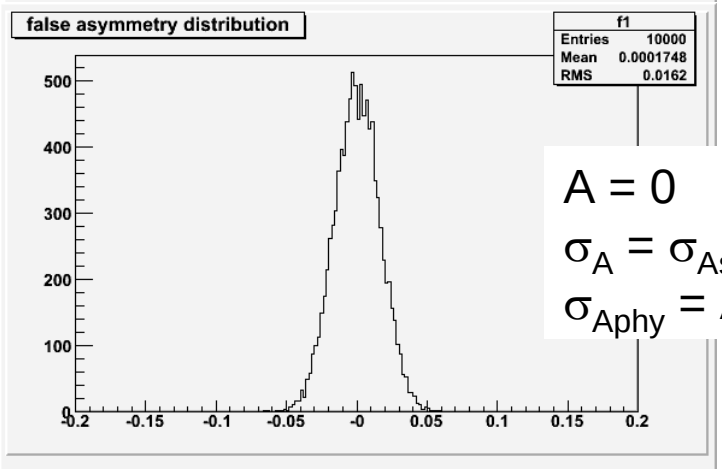
Blind Analysis

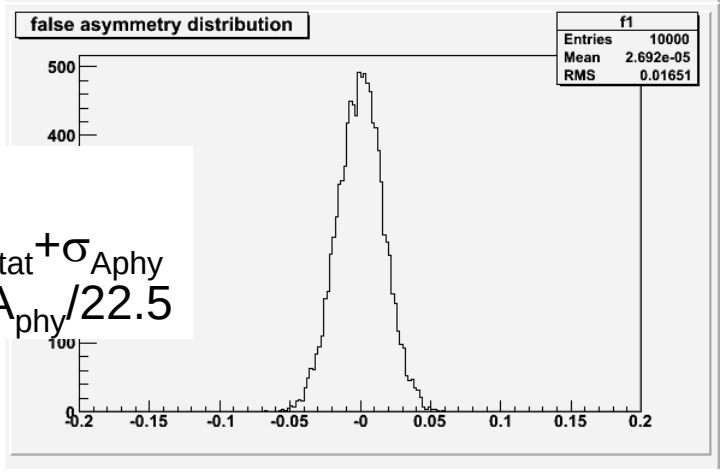




$A = A_{phy}$

$\sigma_A = \sigma_{Astat}$





$A = 0$

$\sigma_A = \sigma_{Astat} + \sigma_{Aphy}$

$\sigma_{Aphy} = A_{phy}/22.5$

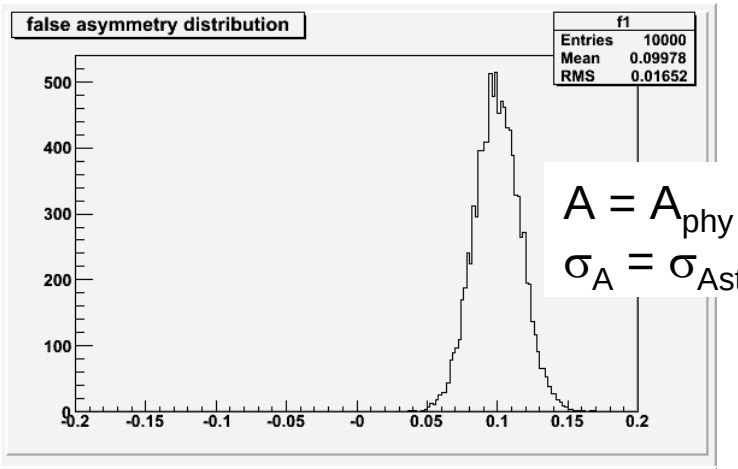
Regular Flip

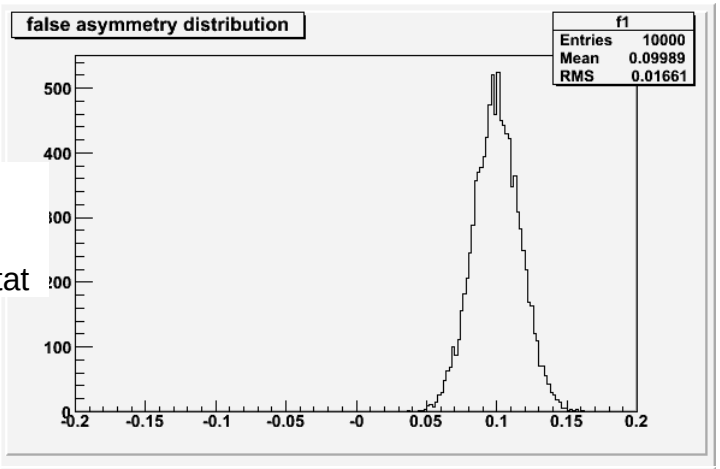
Random Flip

Add Physics Asymmetry (10%)

Repeated Experiment

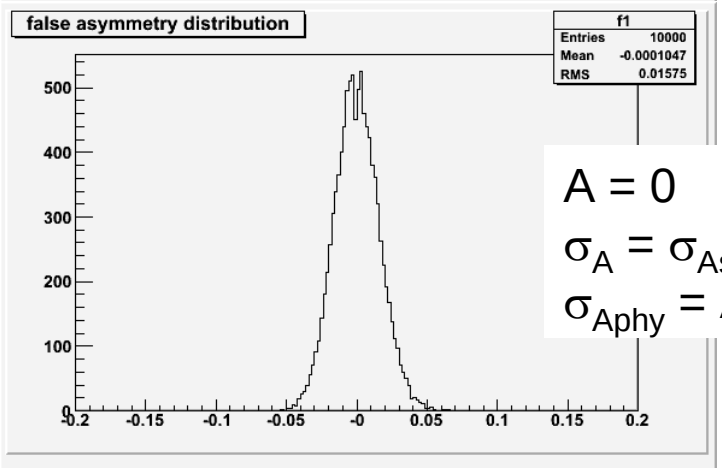
Blind Analysis

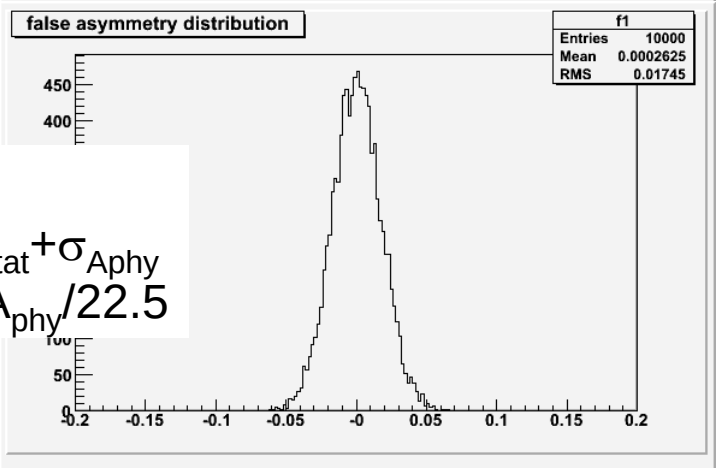




$A = A_{phy}$

$\sigma_A = \sigma_{Astat}$





$A = 0$

$\sigma_A = \sigma_{Astat} + \sigma_{Aphy}$

$\sigma_{Aphy} = A_{phy}/22.5$

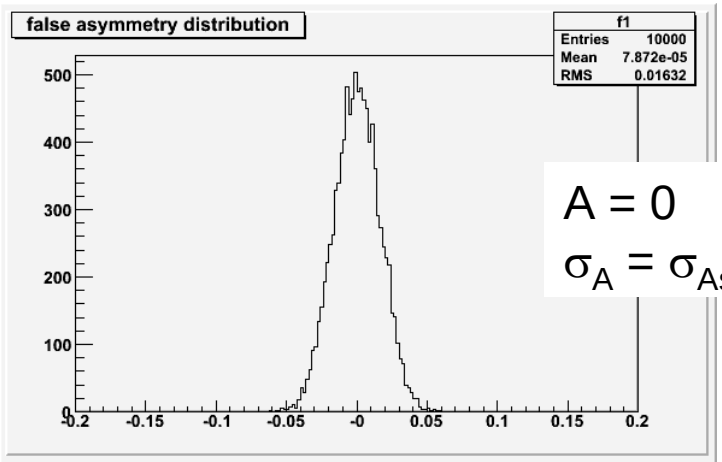
Regular Flip

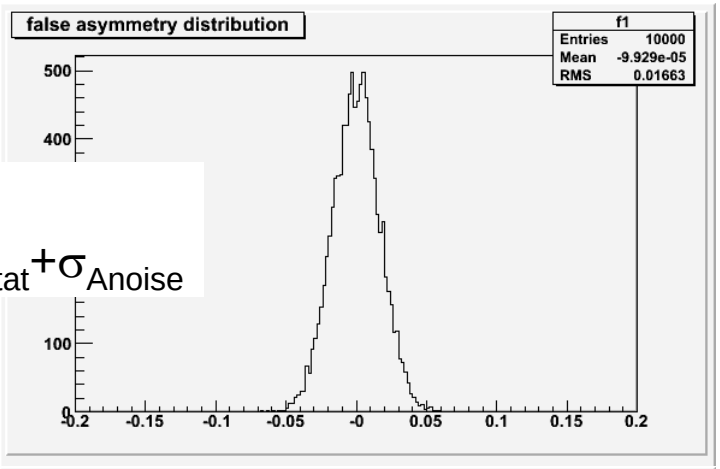
Random Flip

Add Detector Oscillation (10%, 60Hz)

Repeated Experiment

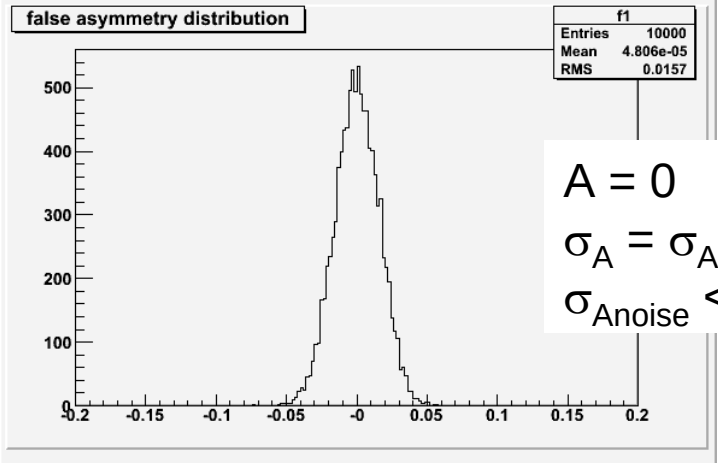
Blind Analysis

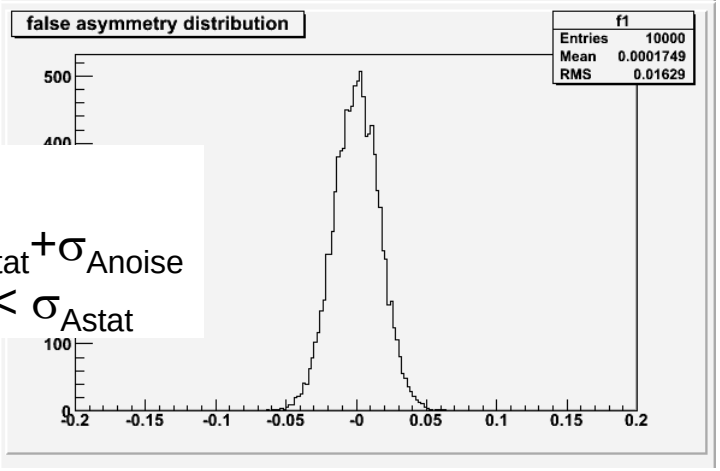




$A = 0$

$\sigma_A = \sigma_{Astat} + \sigma_{Anoise}$





$A = 0$

$\sigma_A = \sigma_{Astat} + \sigma_{Anoise}$

$\sigma_{Anoise} << \sigma_{Astat}$

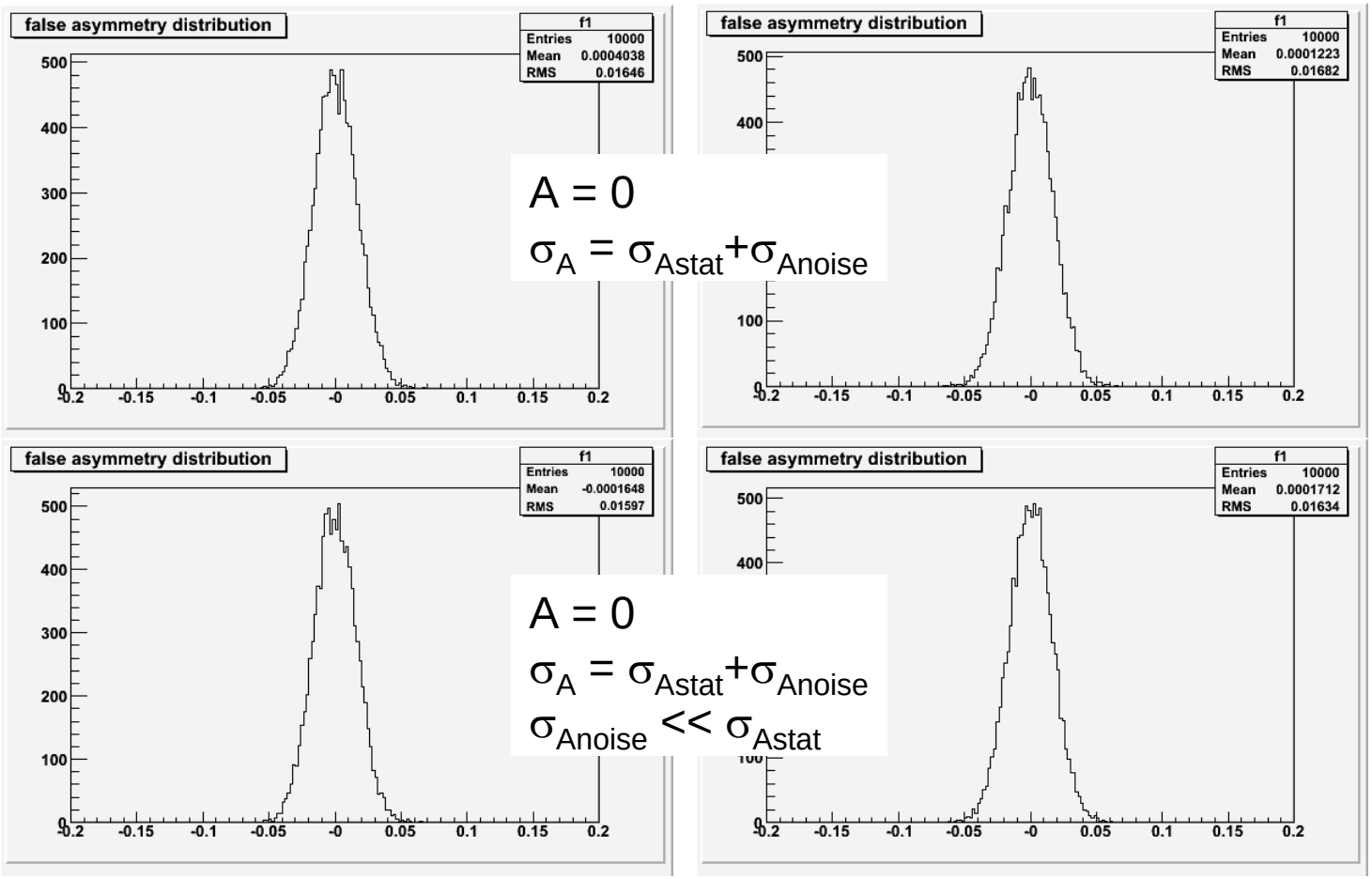
Regular Flip

Random Flip

Add Detector Oscillation (10%, 8hr)

Repeated Experiment

Blind Analysis



$A = 0$

$\sigma_A = \sigma_{Astat} + \sigma_{Anoise}$

$A = 0$

$\sigma_A = \sigma_{Astat} + \sigma_{Anoise}$

$\sigma_{Anoise} << \sigma_{Astat}$

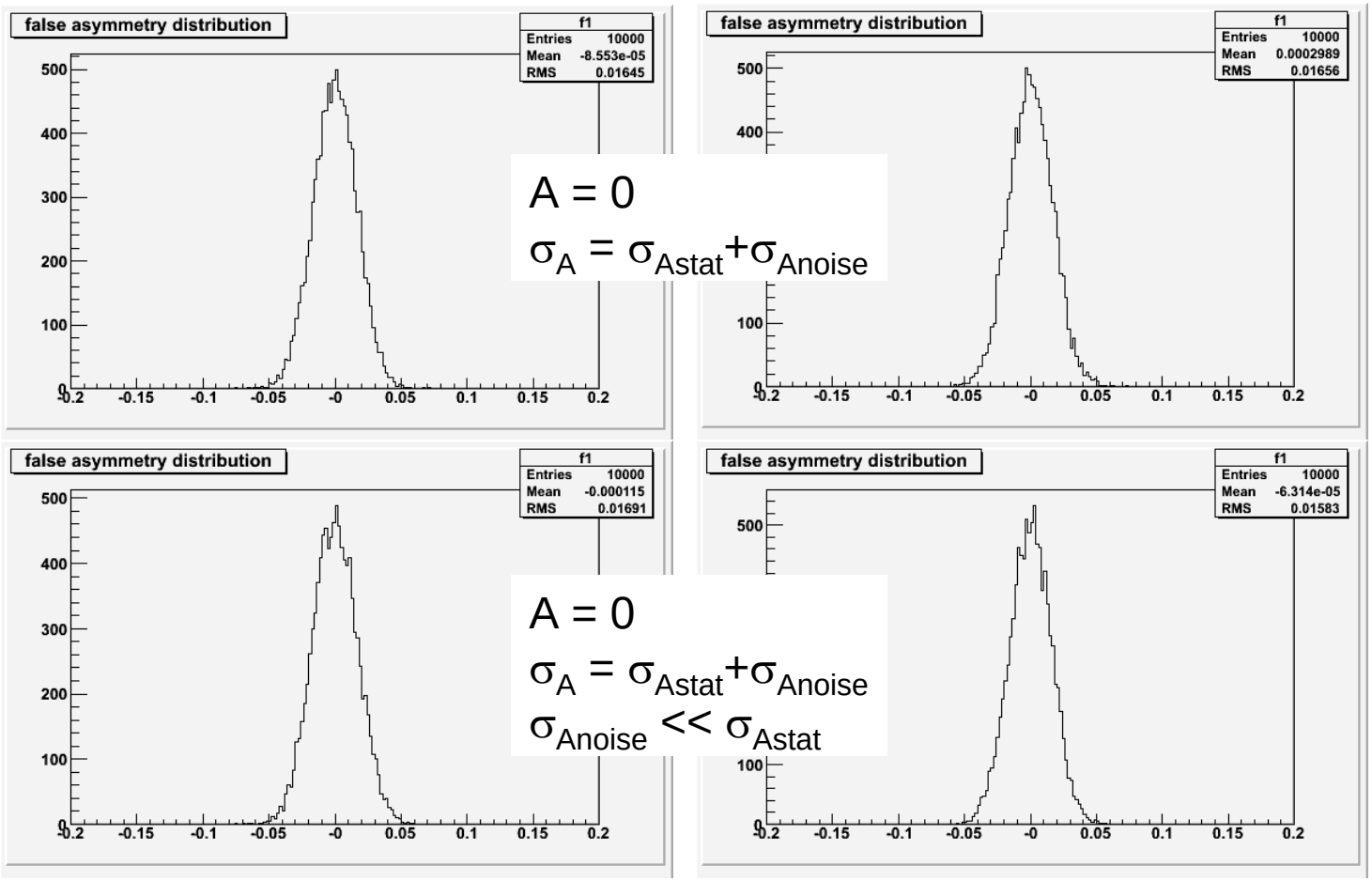
Regular Flip

Random Flip

Add Detector Oscillation (10%, 1day)

Repeated Experiment

Blind Analysis



$A = 0$

$\sigma_A = \sigma_{Astat} + \sigma_{Anoise}$

$A = 0$

$\sigma_A = \sigma_{Astat} + \sigma_{Anoise}$

$\sigma_{Anoise} << \sigma_{Astat}$

Regular Flip

Random Flip

Summary of Asymmetry Components

- Regular and random flips show no significant difference in false asymmetry.
- Statistic error dominates,
- Spin related asymmetry is combined with physics asymmetry and can not be extracted from blind analysis,
- Needs corrections for spin related false asymmetry: Lumi,
- Still need other monitors to control noise level.

Things need to be Monitored

- Spin related fluctuation
  - Target Density
- Spin unrelated noise
  - Beam current: BCM
  - Beam position: BPM
  - Detector response.

Luminosity Monitor (LUMI)

- Luminosity Monitor
  - Monitors small angle charged particles,
  - Small systematic error ~$10^{-5,}$
  - Independent with target system, no spin related fluctuation,
  - Two components:
    - Luminosity = target density X beam current
    - Detector response fluctuation
    - Both of them smaller than the total systematic error
  - Can be used to correct A_{spin}

Singles

- The target density is monitored by LUMI with very high precision.
- Singles can be used to monitor the detector response of BigBite and HRS:
  - Coincidence rate is about 0.6 Hz,
  - Assume the single rate is prescaled to about 100Hz,
  - Singles will control the error from detector fluctuation 10 times smaller than the statistic error (raw error ~ 10^{-3}).
- Possible single arm raw SSA ~ 10^{-5}.

Monitoring and Correction Summary

- LUMI and Singles are good enough to provide target density, detector fluctuation monitoring and correction. The resulted errors are 1 magnitude smaller than statistic error.
- For BigBite SSA, new approach is needed for a better systematic control ($<10^{-5}$)

Future Plan

- LUMI test
- Method of control SSA systematic error.
- Some real tests on flip scheme regarding the background level.