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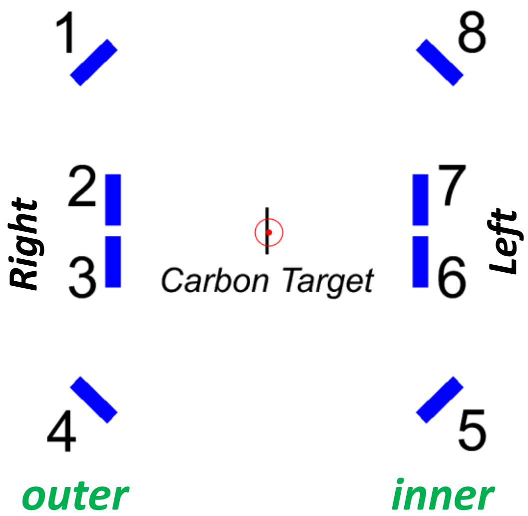
Luminosity and Acceptance Asymmetry Profiles.

- Comparison of the positive/negative polarity beam profiles.
- Testing of the uniformity of the target velosity.
- Rate correction calibration using acceptance asymmetry measurements.

AGS CNI Polarimeter 2012



4 different detector types:

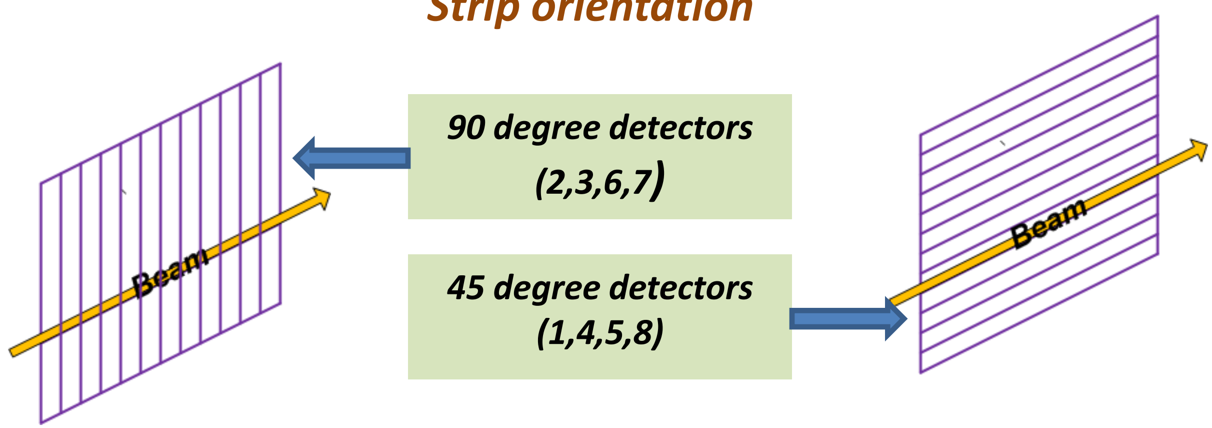
1,8 - Hamamatsu, slow preamplifiers, L = 51 cm

2,7 - BNL 2mm, fast preamplifiers, L = 30 cm

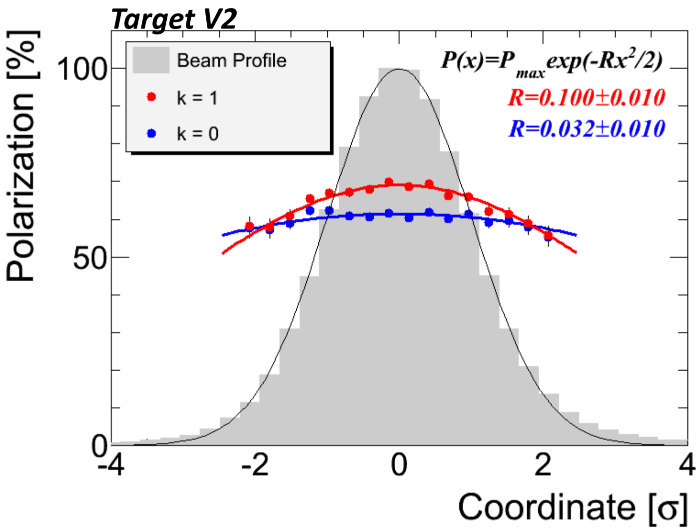
3,6 - BNL 1 mm, fast preamplifiers, L = 30 cm

4,5 - Hamamatsu, fast preamplifiers, L = 51 cm

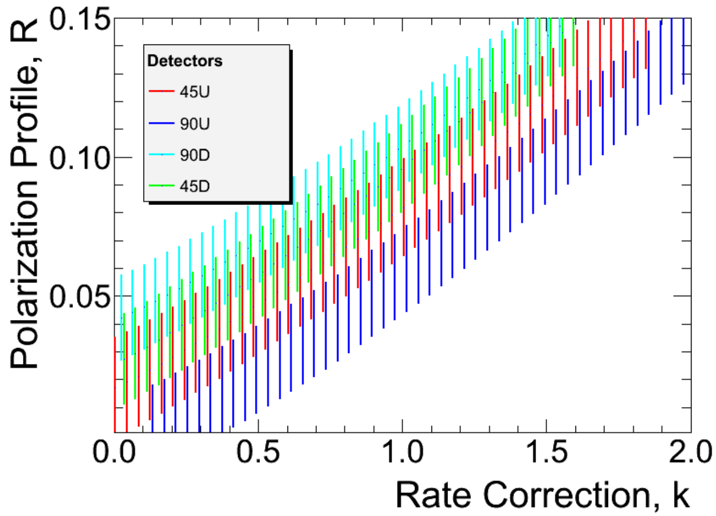
Strip orientation

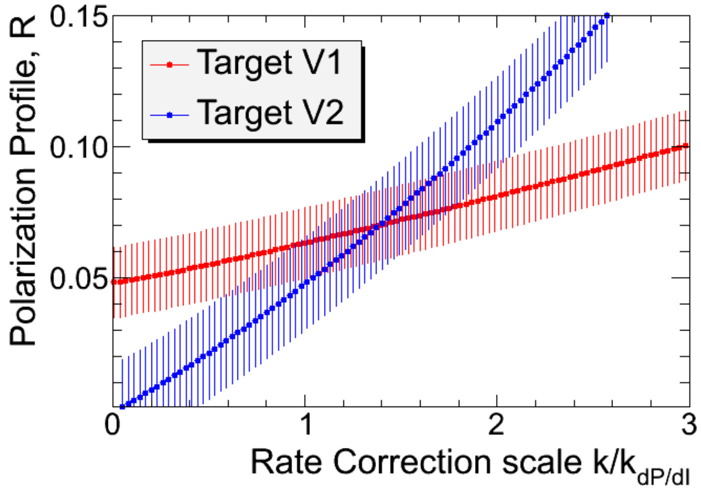


Sweeping Target Measurements



- **<u>Main goal:</u> polarization profile $R=\sigma^2_{beam}/\sigma^2_{pol}$. determination.**
- **The measured value of *R* is rate correction dependent.**
- **Comparison of thin and thick targets results may allow one to isolate rate correction contribution to the value of R.**
- **In the Run12, statistics was insufficient to calibrate rate corrections.**

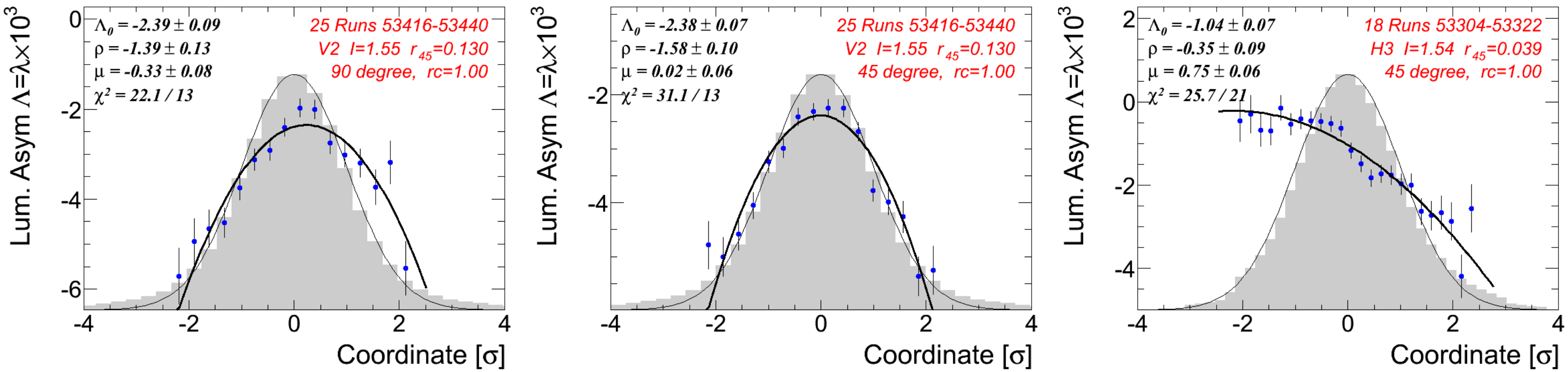




As a part of polarization measurement , unbiased values of acceptance ε and luminosity λ asymmetries are calculated (square root formula) . Study of the ε and λ profiles are very helpful for monitoring of the quality of the polarization measurements.

Luminosity (l) Asymmetry (λ) Profile

$$I_{\pm}(x) \propto (1 \pm \lambda) \exp\left[-\frac{(x \pm \mu)^2}{2(1 \pm \rho)}\right] \quad \Rightarrow \quad \lambda_{\text{meas}}(x) \approx \lambda - \mu x + \rho x^2/2$$



Results interpretation:

Beam width: $\sigma \sim 1$ mm

$$\langle x_+ \rangle - \langle x_- \rangle = -2\mu\sigma \sim 1\ \mu\text{m}$$

$$\frac{\sigma_+^2 - \sigma_-^2}{\sigma_+^2 + \sigma_-^2} = \rho \sim 10^{-3}$$

$$\frac{I_+ - I_-}{I_+ + I_-} = \lambda \sim 10^{-3}$$

The parameter μ may directly affect polarization measurements:

$$P \to P\left(1 + \frac{2\mu\sigma}{\langle A_N \rangle L}\right)$$

(L is the distance between target and detector}

$$\mu\sigma \approx 30\ \mu\text{m} \Rightarrow \delta P \approx 1\%$$

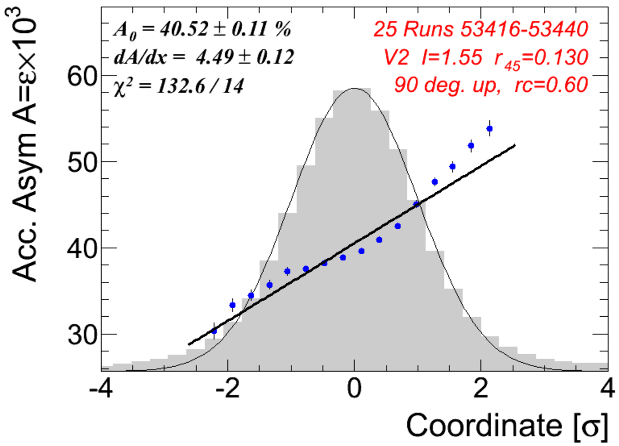
WARNING: ***Currently data analysis in AGS polarimeter may modify results of determination of the μ.***
This page should be considered as the method preview only.

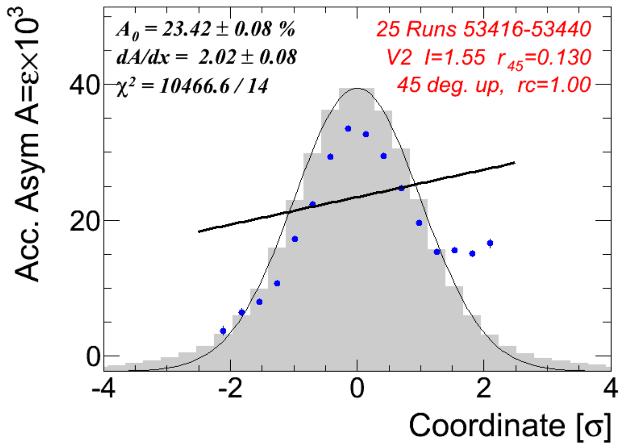
Acceptance (A) Asymmetry (ε) Profile

$$A(x) = A(0)\frac{L_0^2}{(L_0+x)^2} \approx A(0) \times (1 - 2x/L_0)$$

$$\epsilon(x) = \frac{A_R(x) - A_L(x)}{A_R(x) + A_L(x)} \approx \epsilon + 2x/L$$

BNL 2 mm

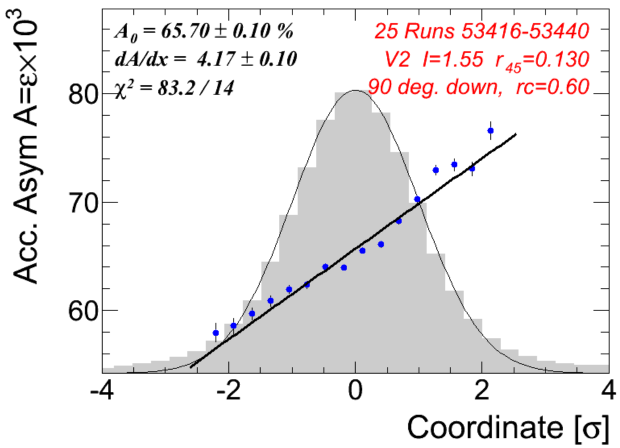


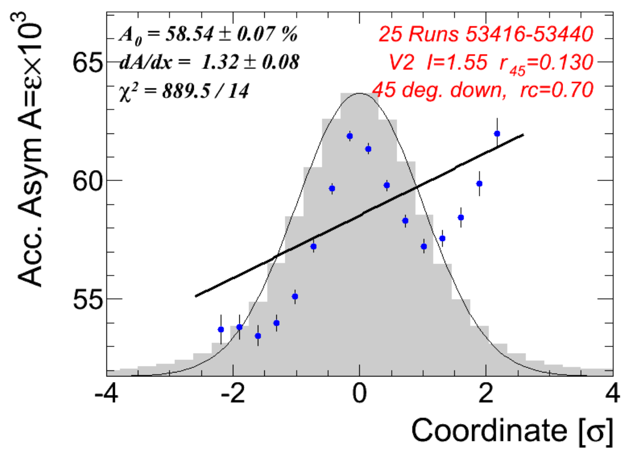


Hamamatsu, slow

Factor 3 (!?) discrepancy (at x=0) Is it related to the det. 7 problem ?

BNL 1 mm





Hamamatsu, fast

10 % discrepancy (at x=0)

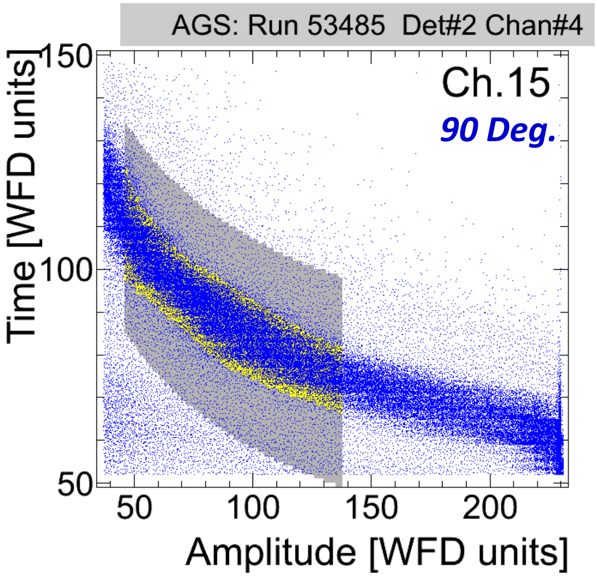
- **Reasonably good result for 90 deg. detectors** ***σ = 0.70±0.03 mm***
- **Something wrong with 45 deg., nonetheless** ***σ = 0.68±0.14 mm***

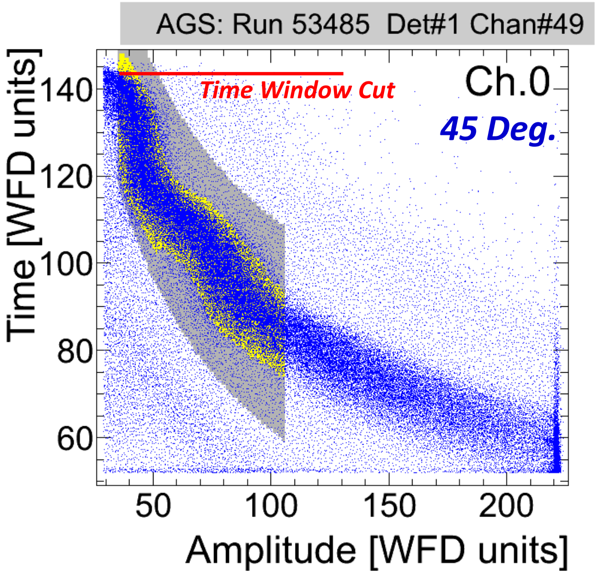
Errors indicate discrepancy between Up/Down detectors

What is wrong with Hamamatsu detectors ?

A guess: $A = A_{\text{geom}} \times A_{DAQ}$

The method is sensitive to the A_{geom}, and it is implicitly assumed that $A_{\text{DAQ}}=const$.
In 45 degree detectors low energy signals are very close to the DAQ time cut. As result, A_{DAQ} may be unstable and dependant on intensity (especially due to the noise)





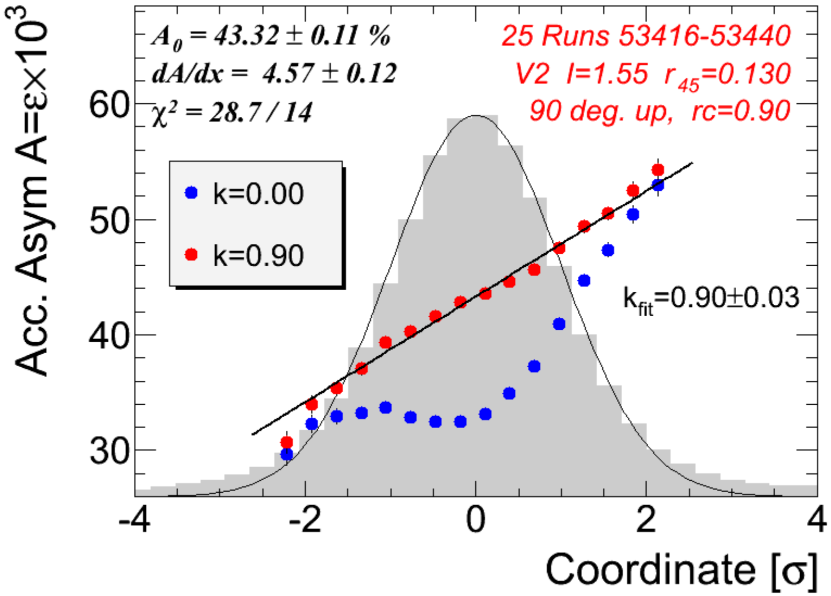
Beam Intensity 1.5×10^{11}

Workaround:

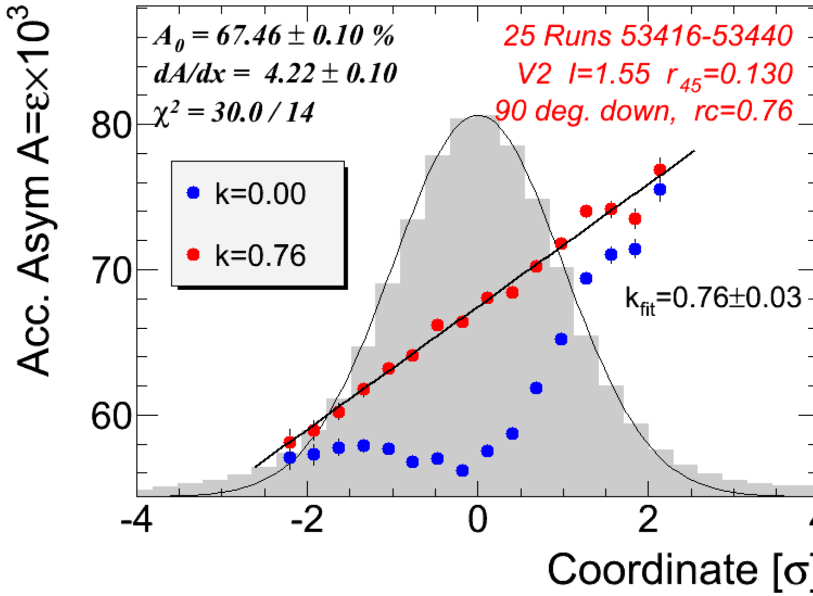
- Increase the DAQ Time Window in 45 deg. detectors (Run13 ?)
- Increase the minimal Carbon energy (400 keV → ?) in data analysis.
- Fix the noise problem.

Rate Correction Calibration using Acceptance Asym. Profile

BNL 2 mm



BNL 1 mm



First impression is very optimistic, but more detailed study is needed (e.g. an estimate of the A_{DAQ} symmetry contribution).

Rate Calibration from the *dI/dx*

Detector	k	
45U	1.00 ± 0.12	Hamamatsu, slow
90U	0.61 ± 0.10	BNL, 2mm
90D	0.57 ± 0.14	BNL, 1mm
45D	0.69 ± 0.10	Hamamatsu, fast

The value of k is larger than in dI/dx method:

Good: *measured value of polarization will be increased by about 2-3%*

Bad: *the value of R will be increased to 0.09-0.10*

Explanation of the ε sensitivity to the rate corrections.

$$\begin{cases} N_R^+ = N_0(1+a)(1+\epsilon)(1+\lambda) \\ N_R^- = N_0(1-a)(1+\epsilon)(1-\lambda) \\ N_L^+ = N_0(1-a)(1-\epsilon)(1+\lambda) \\ N_L^- = N_0(1+a)(1-\epsilon)(1-\lambda) \end{cases}$$

a – polarization asymmetry
ε – acceptance asymmetry
λ – luminosity asymmetry

Rate Corrections

$$N_{\rm meas} = N(a,\epsilon,\lambda) \times [1 - cN(a,\epsilon,\lambda)]$$

Equations are symmetri relative to the *a,ε,λ* and, thus, rate corrections are the same for the *a,ε,λ*.

$$\begin{cases} a_{\rm meas} = a(1-kr) \\ \epsilon_{\rm meas} = \epsilon(1-kr) \\ \lambda_{\rm meas} = \lambda(1-kr) \end{cases}$$

In the Run12:

$$\langle a \rangle \approx (5 \div 8) \times 10^{-3}$$
$$\langle \epsilon \rangle \approx 60 \times 10^{-3}$$
$$\langle \lambda \rangle \approx {\rm few} \times 10^{-3}$$
$$\sigma_a = \sigma_\epsilon = \sigma_\lambda \sim 1/\sqrt{N}$$

I. Acceptance asymmetry *ε* is almost a factor 10 more sensitive to the rate correction than polarization asymmetry *a* (factor 100 gain in statistics!).

II. Acceptance asymmetry dependences on target position and rate corrections are not correlated.

$$\epsilon_{\rm meas} = \epsilon_0 + 2x/L - kce^{-x^2/2}$$

Imperfect construction of the polarimeter (ε≈6%) results in

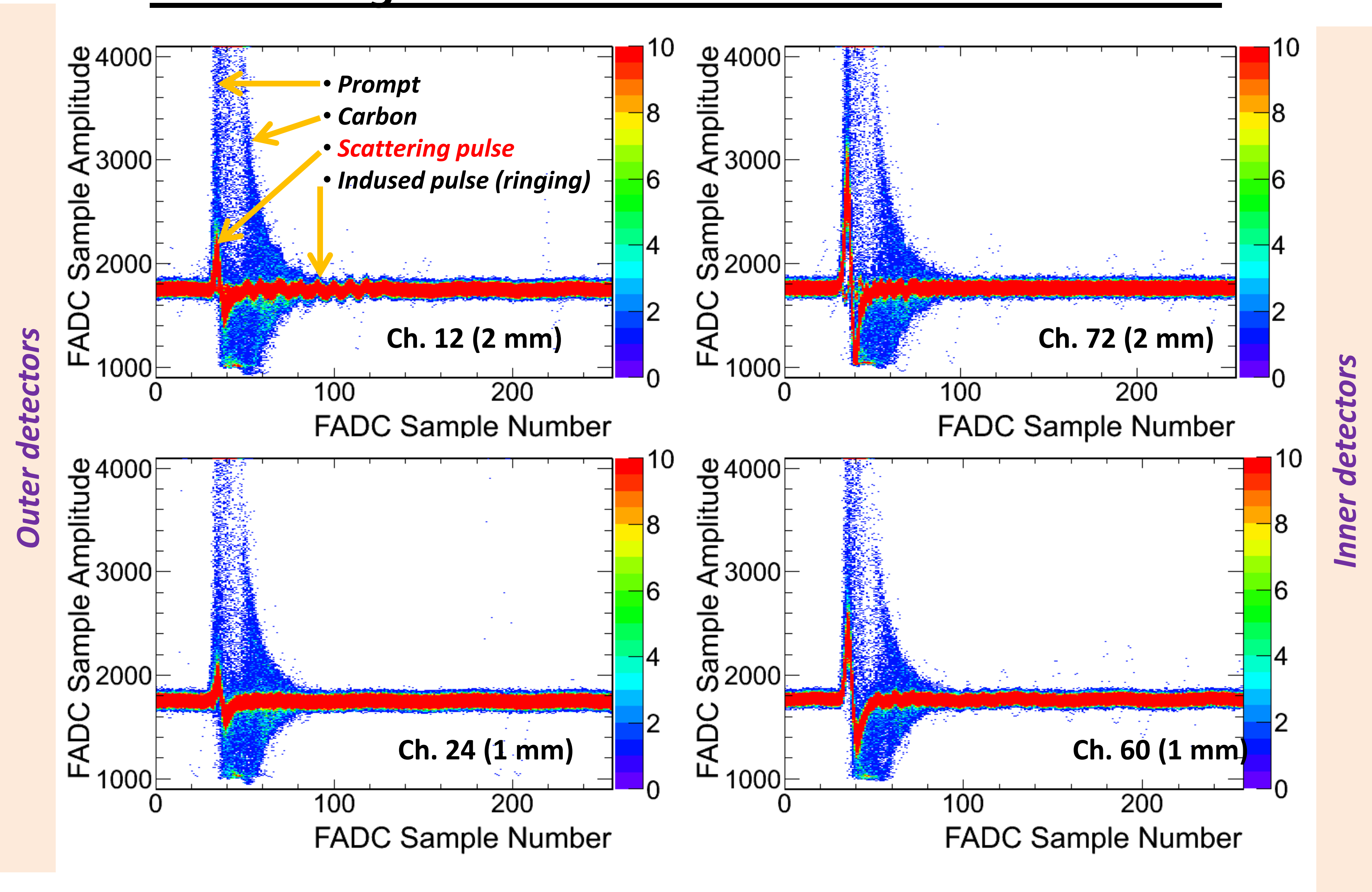
- ***capability of accurate measurements of rate corrections***
- ***with no degrade of accuracy of the polarization measurements***

Summary

• Acceptance and luminosity asymmetry profiles provides us with a powerful tool to control the polarimeter performance.
• Corresponding histograms must be employed for a routine monitoring of the data analysis.
• Acceptance asymmetry may be used for the precise calibration of the rate corrections:
  - more study is needed
  - improvements for 45 degree detectors is required
  - rate dependence has a simple signature
  - due to the high sensitivity to the rate corrections we have a lot of opportunities for the detailed analysis

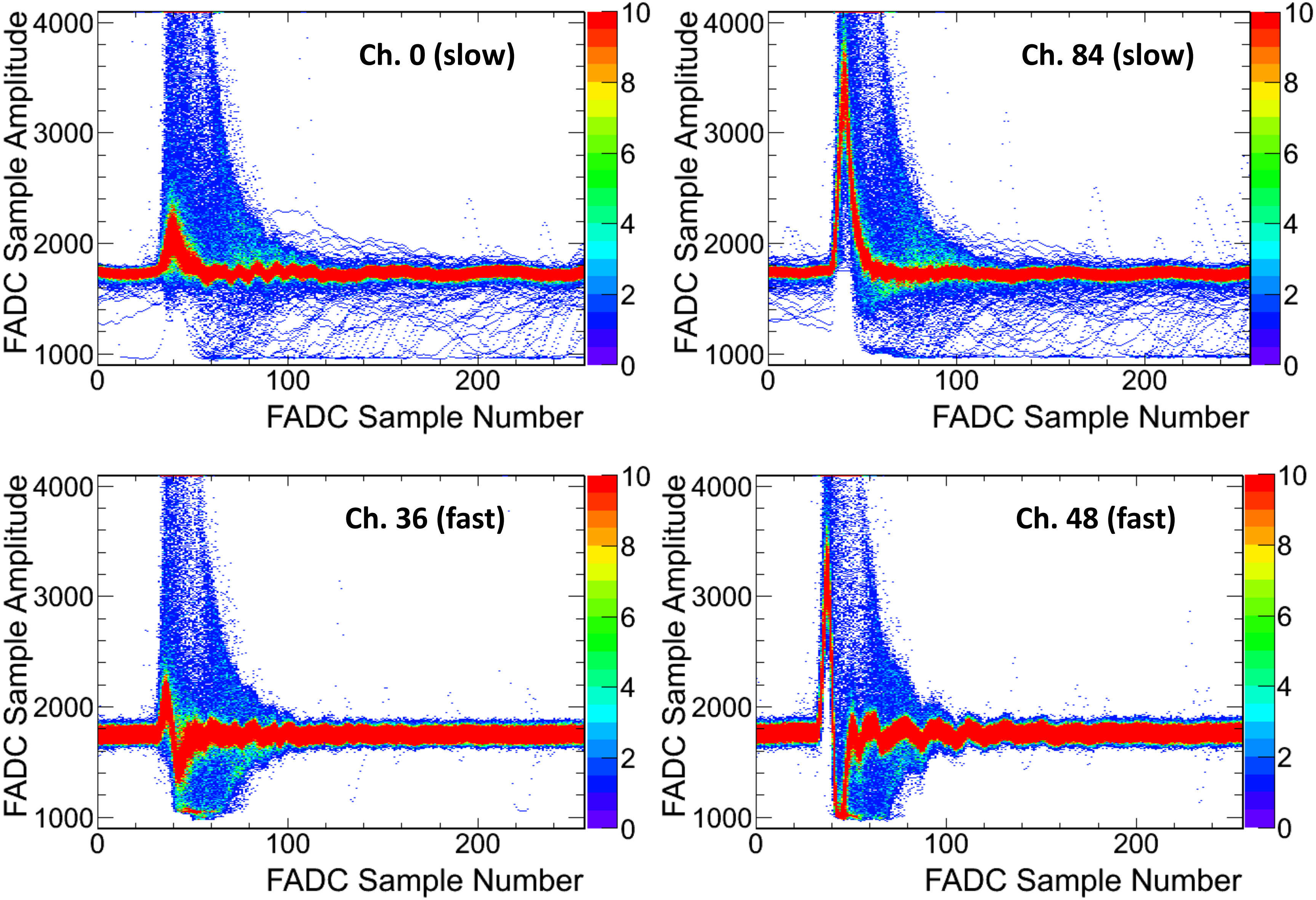
Backups

"Scattering Pulse". BNL detectors. LateCBM=1.7



“Scattering Pulse”. Hamamatsu det. LateCBM=1.7

Outer detectors



Inner detectors