Estimation of spin precession effect in SPD interaction region for online polarimetry

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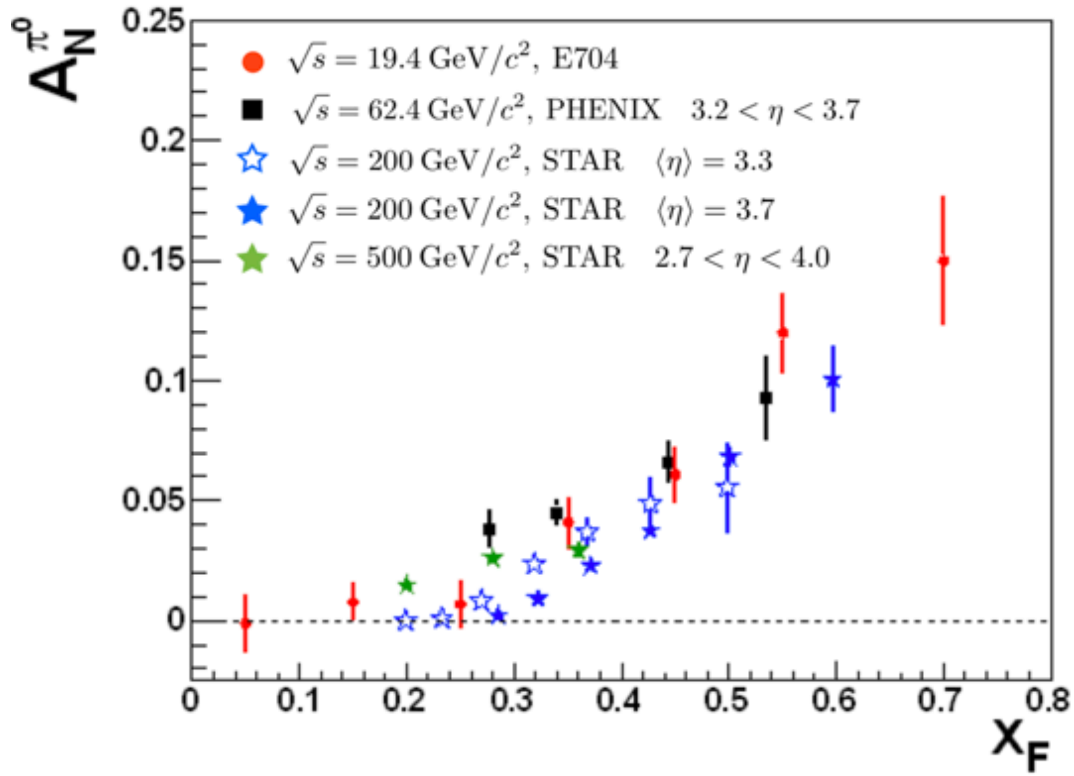
$$\frac{d\sigma}{d\phi} = \left(\frac{d\sigma}{d\phi}\right)_0 (1 + A_N P \cos(\phi))$$

$$N(\phi) = 1 + amp \cdot \cos(\phi + \phi_0)$$

$$amp = A_N P$$

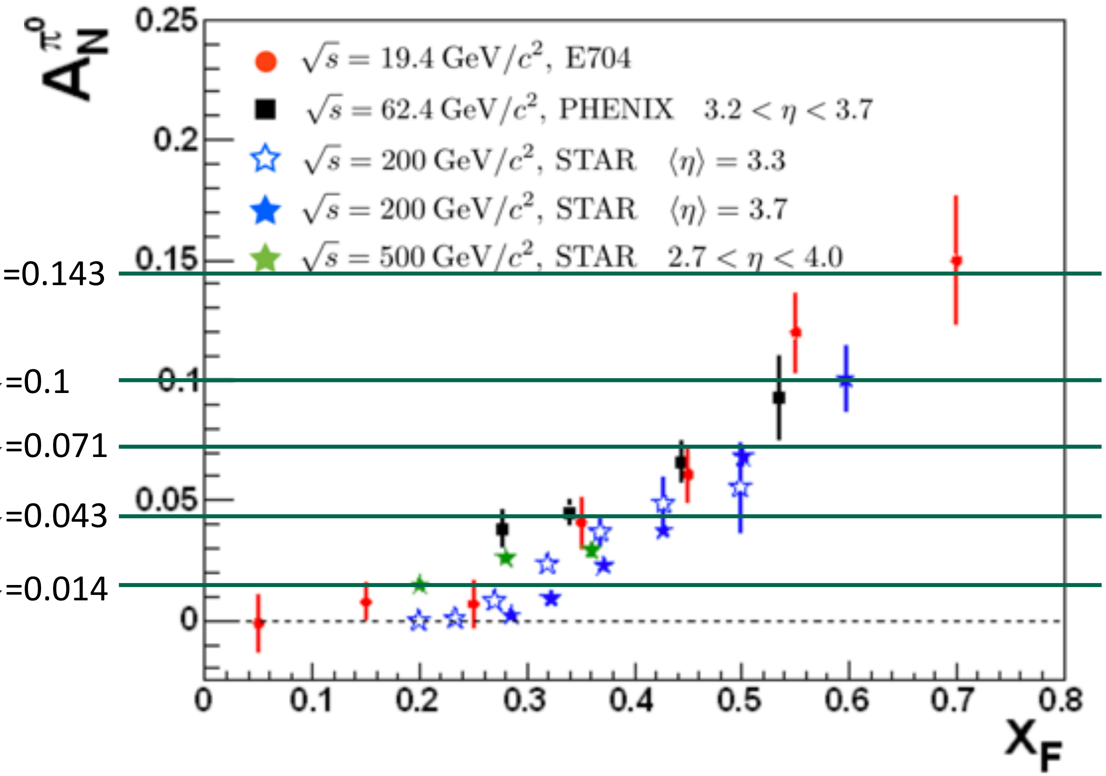


$$N(\phi) = 1 + amp \cdot \cos(\phi + \phi_0)$$

$$amp = A_N \cdot P$$

Assuming P = 0.7

- amp = 0.1 ⇒ A_N=0.143
- amp = 0.07 ⇒ A_N=0.1
- amp = 0.05 ⇒ A_N=0.071
- amp = 0.03 ⇒ A_N=0.043
- amp = 0.01 ⇒ A_N=0.014



$$A_N = \frac{amp}{P}$$

amp	0.01	0.02	0.03	0.04	0.05	0.06	0.07	0.08	0.09	0.1
A_N	0.014	0.029	0.043	0.057	0.071	0.086	0.1	0.114	0.129	0.143

- Spin precession angle of a proton traveling length = 60cm , B = 1T, $\sqrt{s}$=27 GeV:

$$\phi_0 = \frac{g_p \cdot \mu_N \cdot B}{\beta\gamma \cdot \hbar c} Length = 0.037\, rad\ (2.13\, deg)$$

$$\phi_0 = \phi_0(Z)$$

- Create *cosine* function to sample ϕ :

$$\boldsymbol{fcos} = 1 + [0]\cos(\phi + [1])$$

- Fix *input amplitudes*: 0.01, 0.02, 0.03, 0.04, 0.05, 0.06, 0.07, 0.08, 0.09, 0.1

- LOOP over 50000 events:

  - Random position Z: $[-60, 60]cm \leftarrow Gaus(0{,}30)$

  - Generate ϕ_0 according to $\phi_0 = \frac{g_p \cdot \mu_N \cdot B}{\beta\gamma \cdot \hbar c} Z$, and set as parameter [1] in $\boldsymbol{fcos}$

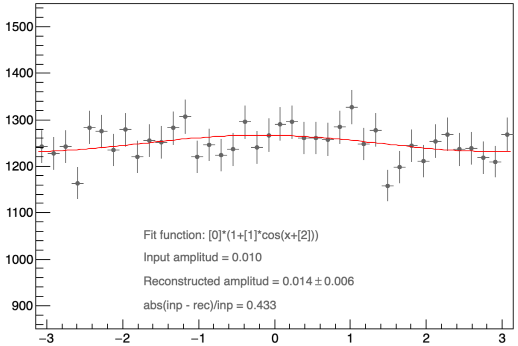
  - Retrieve random ϕ from the cosine function $\boldsymbol{fcos}$

  - Fit histogram $\frac{dN}{d\phi}$ and fit → $[0](1.0 + [1] \cdot \cos(x + [2]))$

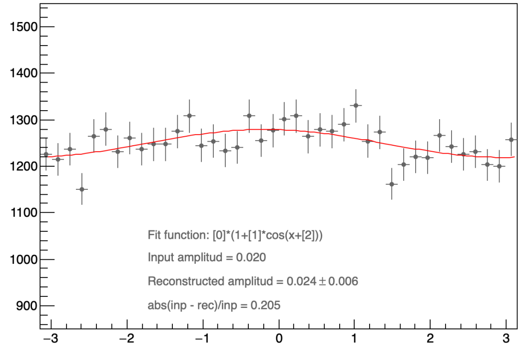
  - Extract parameter [1] and compare with the input asymmetry

Simple MC

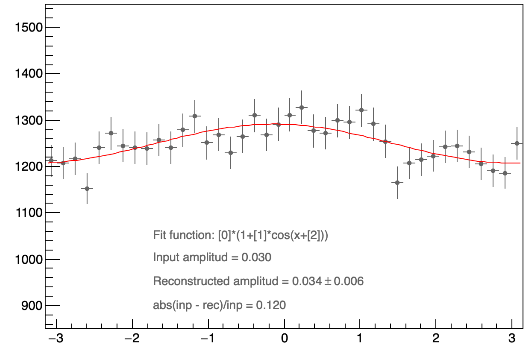
$amp_{inp} = 0.01$



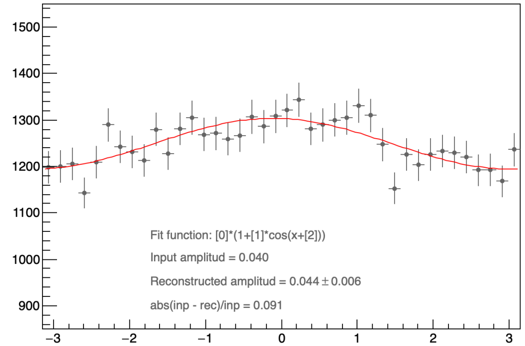
$amp_{inp} = 0.02$



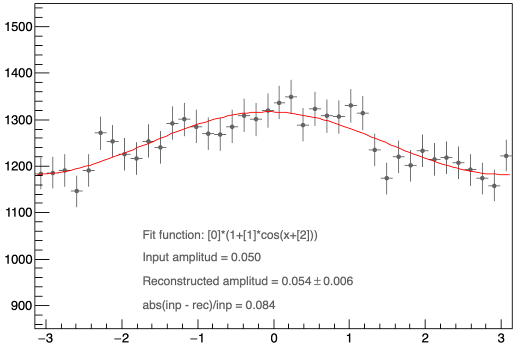
$amp_{inp} = 0.03$



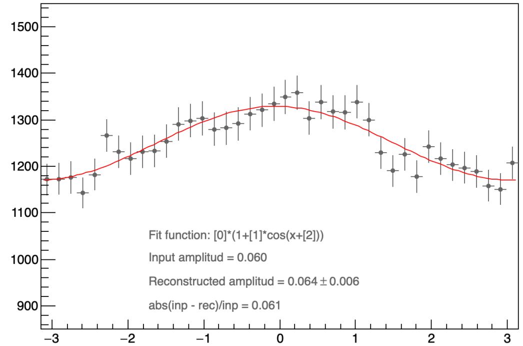
$amp_{inp} = 0.04$



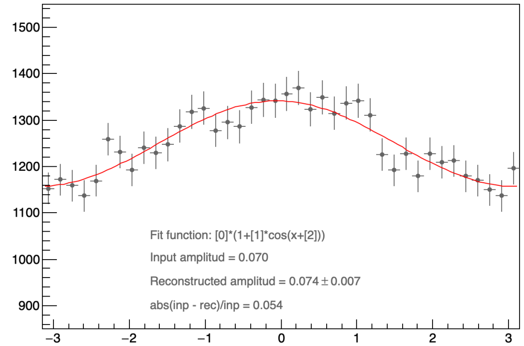
$amp_{inp} = 0.05$



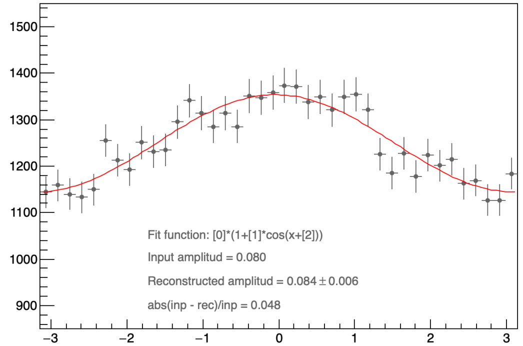
$amp_{inp} = 0.06$



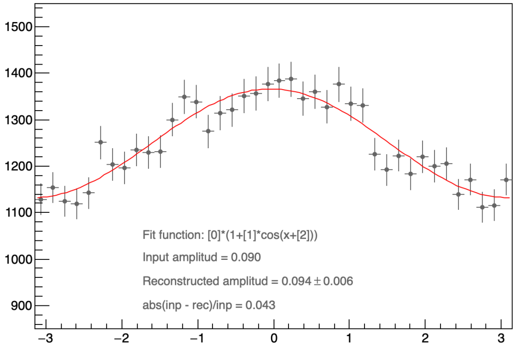
$amp_{inp} = 0.07$



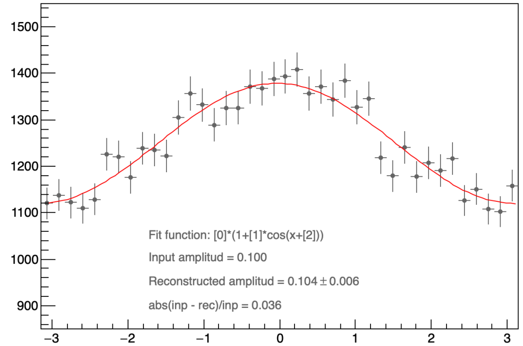
$amp_{inp} = 0.08$



$amp_{inp} = 0.09$



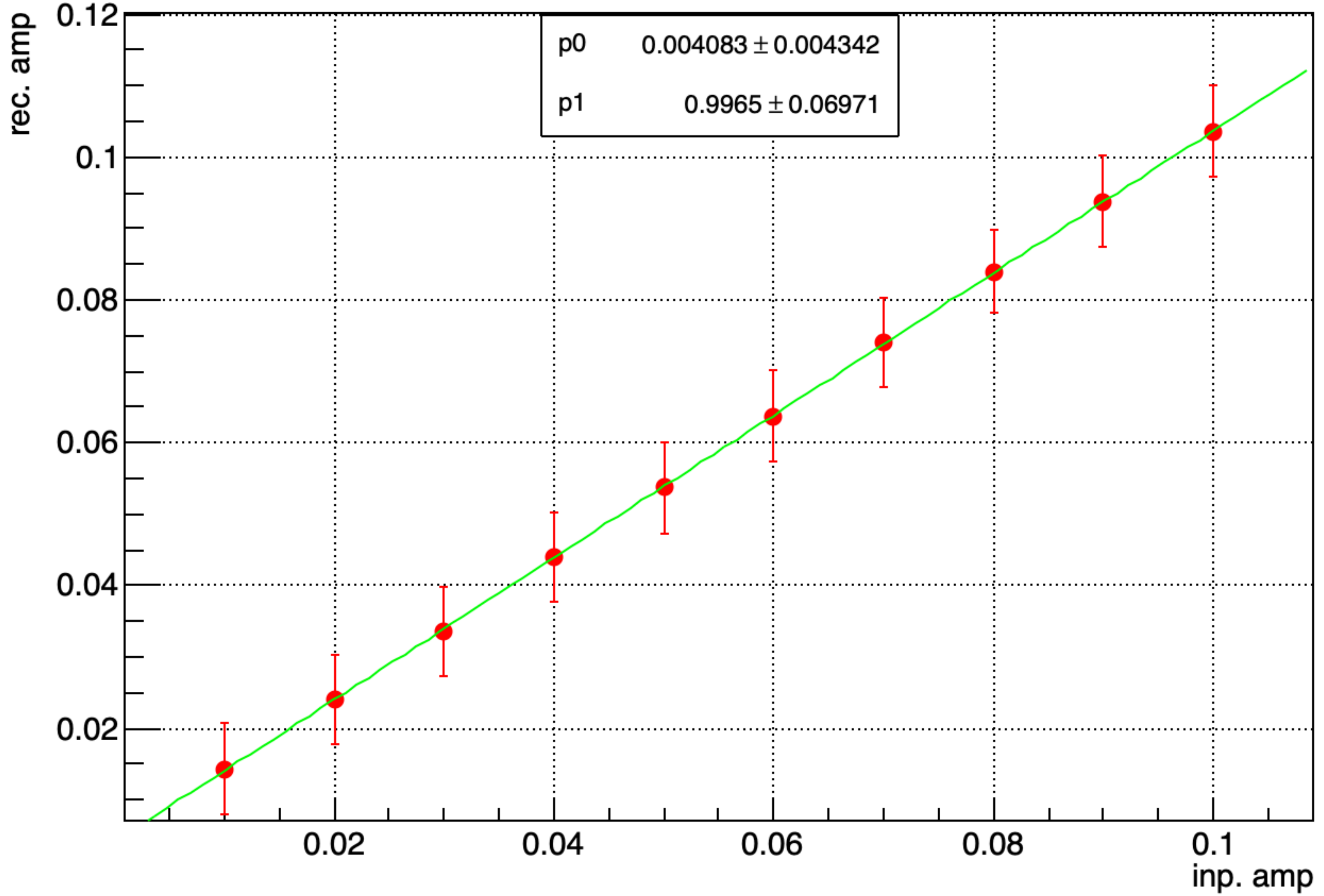
$amp_{inp} = 0.1$



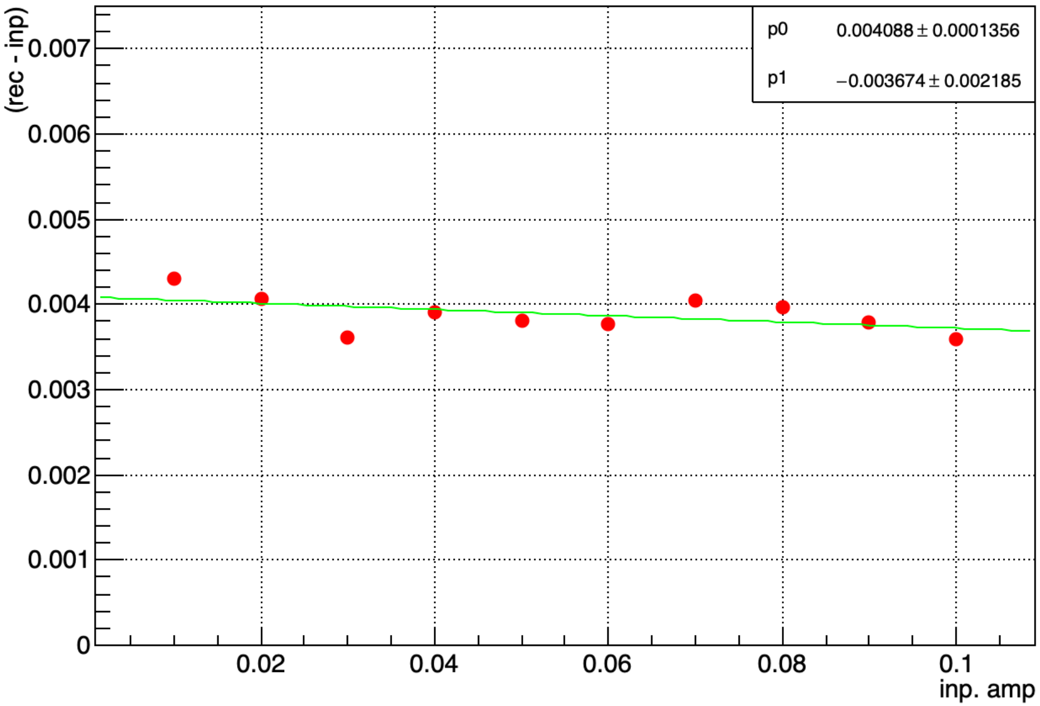
A_N	**0.014**	**0.029**	**0.043**	**0.057**	**0.071**
amp_{inp}	0.01	0.02	0.03	0.04	0.05
amp_{rec}	0.014 $\pm$0.006	0.024 $\pm$0.006	0.034 $\pm$0.006	0.044 $\pm$0.006	0.055 $\pm$0.006

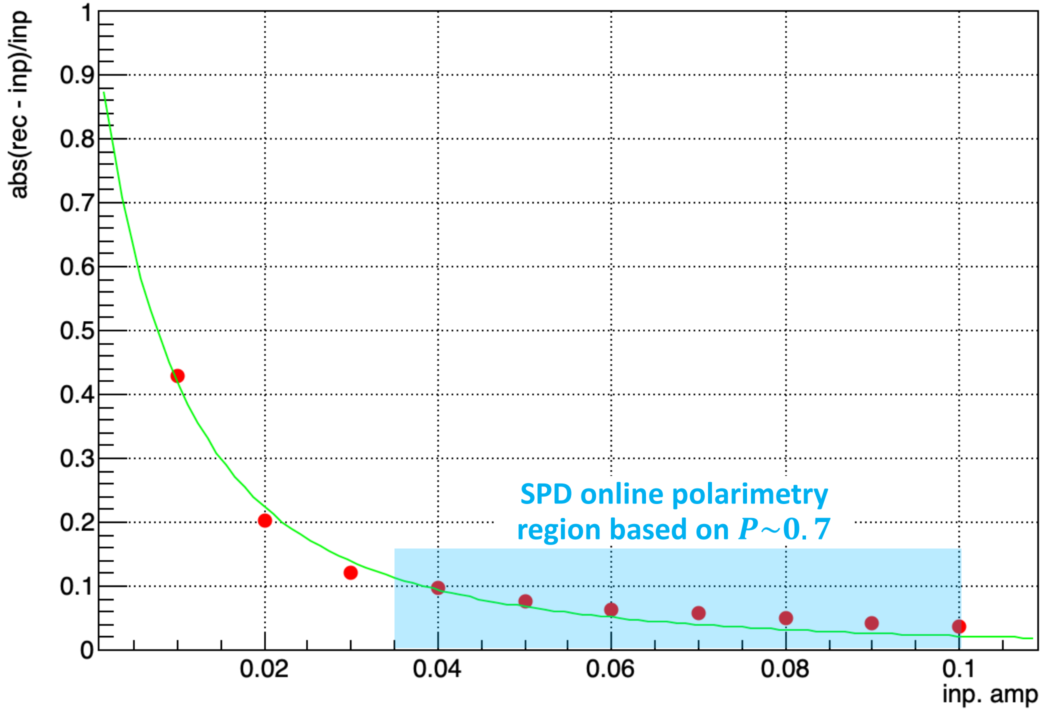
A_N	**0.086**	**0.1**	**0.114**	**0.129**	**0.143**
amp_{inp}	0.06	0.07	0.08	0.09	0.1
amp_{rec}	0.064 $\pm$0.006	0.074 $\pm$0.007	0.084 $\pm$0.006	0.094 $\pm$0.006	0.104 $\pm$0.006

Reconstructed amplitude vs. input amplitude



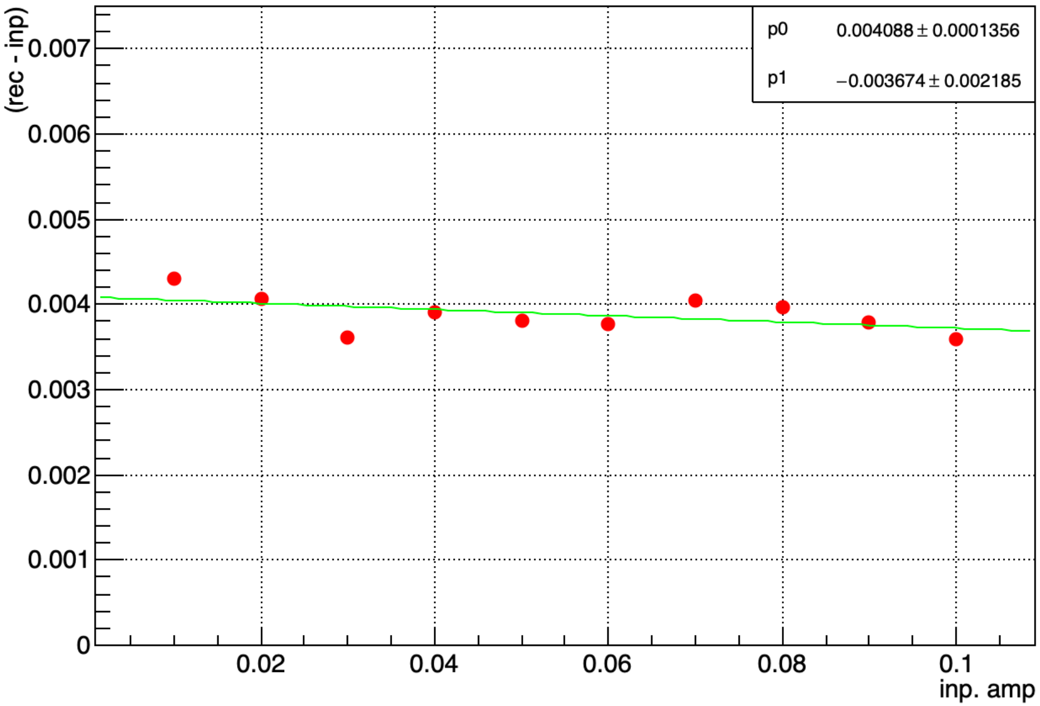
Difference between the reconstructed amplitude and the **input amplitude**

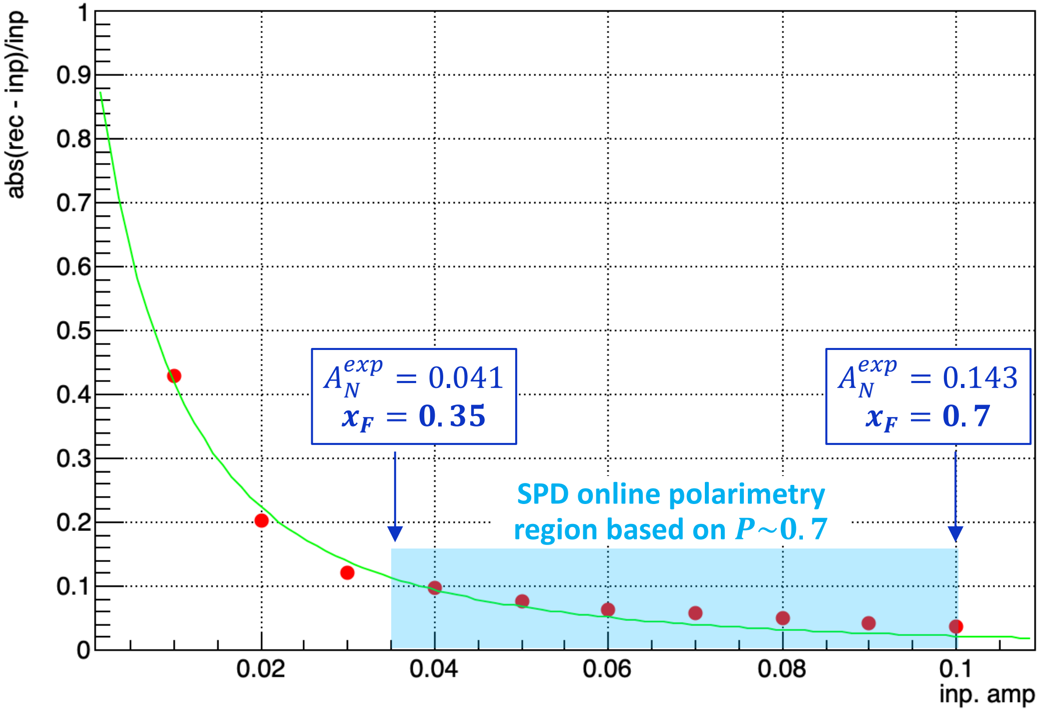




amp_{inp}	**0.010**	**0.020**	**0.030**	**0.040**	**0.050**	**0.060**	**0.070**	**0.080**	**0.090**	**0.100**
amp_{rec}	0.014	0.024	0.034	0.044	0.054	0.064	0.074	0.084	0.094	0.104
$\frac{\lvert amp_{inp} - amp_{rec} \rvert}{amp_{inp}} \cdot 100\%$	42	20	12	9.8	7.6	6.3	5.8	5.0	4.2	3.6

Difference between the reconstructed amplitude (ϕ smeared) and the **input amplitude**





amp_{inp}	**0.010**	**0.020**	**0.030**	**0.040**	**0.050**	**0.060**	**0.070**	**0.080**	**0.090**	**0.100**
amp_{rec}	0.014	0.024	0.034	0.044	0.054	0.064	0.074	0.084	0.094	0.104
$\frac{\lvert amp_{inp} - amp_{rec}\rvert}{amp_{inp}} \cdot 100\%$	42	20	12	9.8	7.6	6.3	5.8	5.0	4.2	3.6

$\sim 10\%$ ($x_F = 0.35$)

$\sim 4\%$ ($x_F = 0.7$)

- The ϕ smearing based on the spin rotation angle, affects the asymmetry, by $\sim 10\%$ at $x_F = 0.35$ down to $\sim 4\%$ at $x_F = 0.7$

Thanks to Igor Denisenko for his contribution and useful ideas!