Summary on April 7, 2023 - nonzero <cos2beta> in a small eta cut

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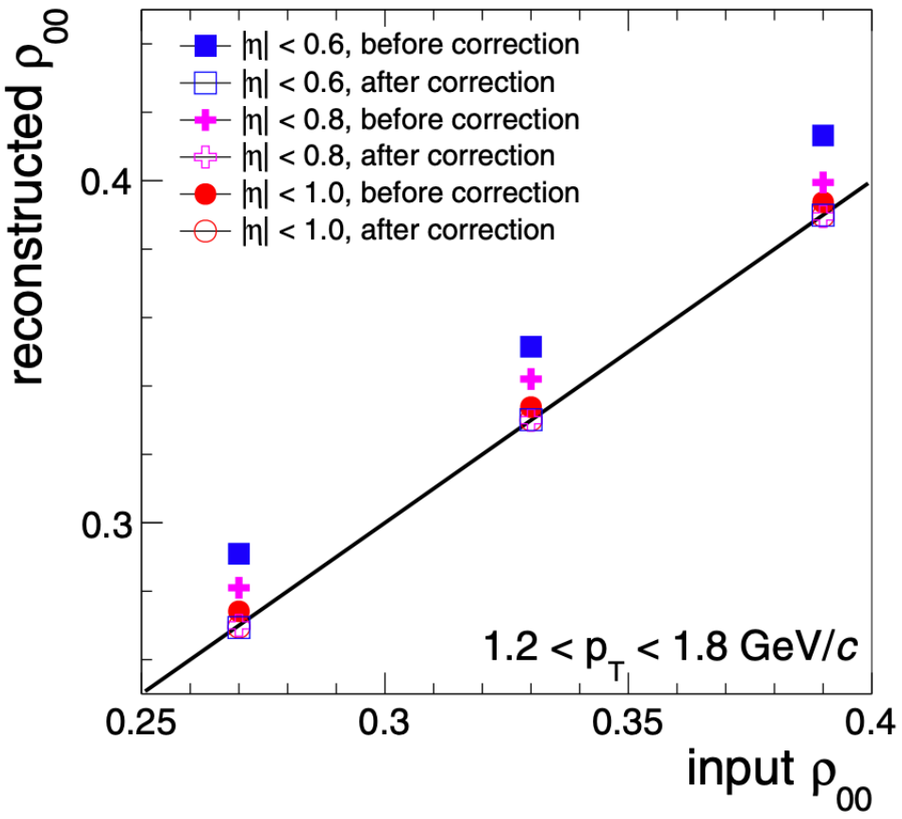
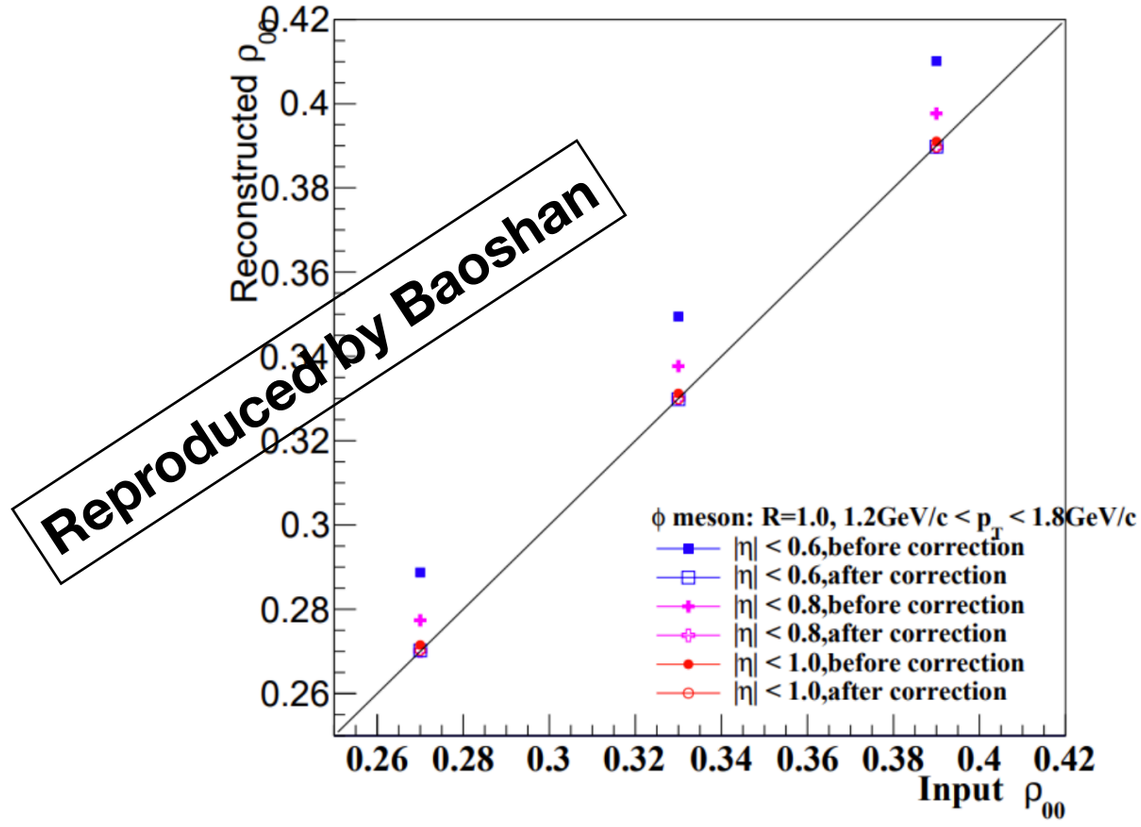
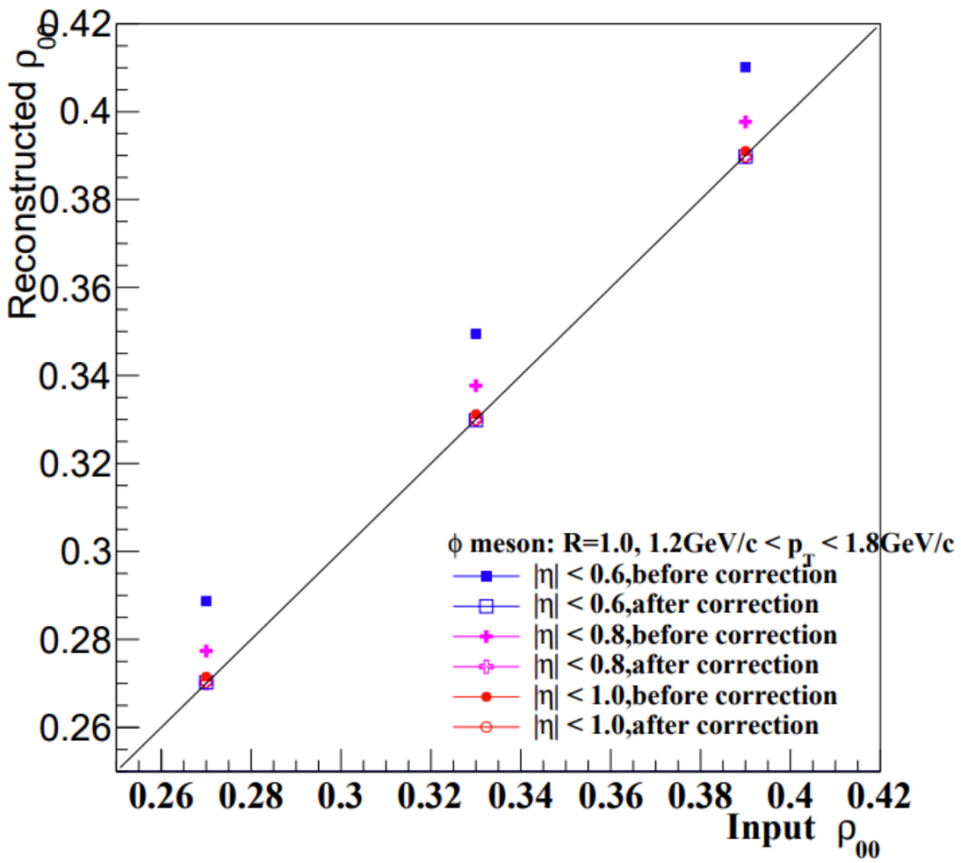


R=1

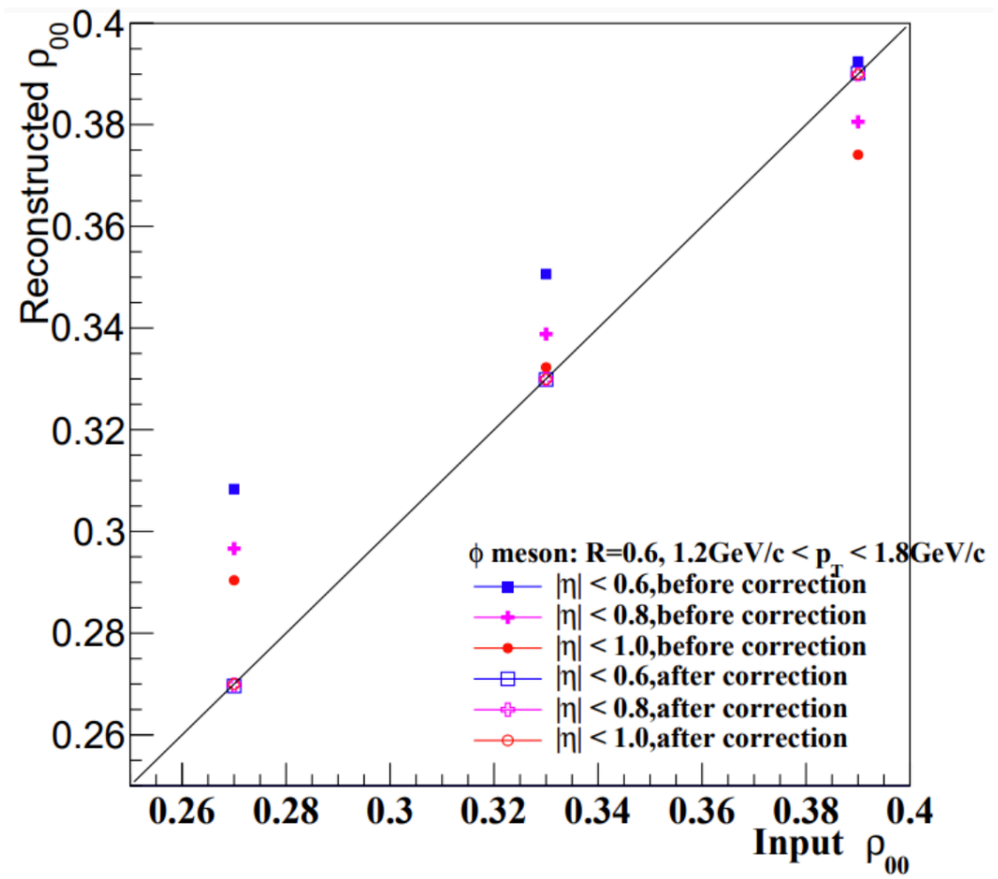


This plot is obtained by using reaction plane, i.e. resolution = 1.

R=1



R=0.6



For finite event plane resolution, observed ρ_{00} is “rotated”, but still can be corrected to the input.

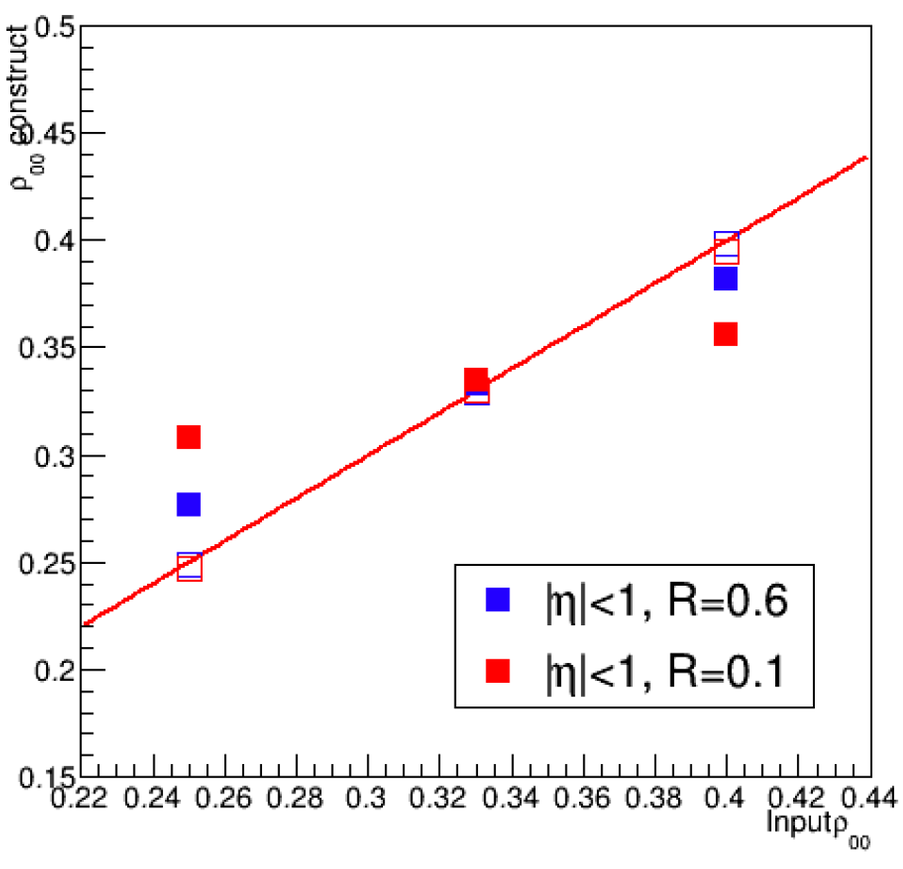
Dependence of the extracted F on the ρ_{00} and resolution:

$$g(\theta^*, \beta) = 1 + F^* \cos^2\theta$$
$$\propto 1 + F\cos^2\theta^* + F\sin^2\theta^*\cos 2\beta, \qquad (23)$$

As eq. 23 is an approximation of acceptance effect, and it is obtained by fitting $\cos(\theta^*)$ distribution with $\propto 1 + F\cos^2\theta^*$ which requires $\langle\cos 2\beta\rangle = 0$. It is not perfect so that F may have few percentage variation, but this has negligible effect on ρ_{00}.

In oder to illustrate the effect, we simulated few cases:

1. $|\eta| < 1$, **resolution = 1.0, input ρ_{00} = 0.25**
2. $|\eta| < 1$, **resolution = 1.0, input ρ_{00} = 0.33**
3. $|\eta| < 1$, **resolution = 1.0, input ρ_{00} = 0.40**
4. $|\eta| < 1$, **resolution = 0.6, input ρ_{00} = 0.25**
5. $|\eta| < 1$, **resolution = 0.6, input ρ_{00} = 0.33**
6. $|\eta| < 1$, **resolution = 0.6, input ρ_{00} = 0.40**
7. $|\eta| < 1$, **resolution = 0.1, input ρ_{00} = 0.25**
8. $|\eta| < 1$, **resolution = 0.1, input ρ_{00} = 0.33**
9. $|\eta| < 1$, **resolution = 0.1, input ρ_{00} = 0.40**



We use F obtained from $|\eta| < 1$, resolution = 1.0 (reaction plane), input ρ_{00} = 1/3 to correct all those cases.

Subtleties in coding:

There are two versions of the code, one is fitting $\cos\theta^*$ histogram after eta cut directly with $\propto 1 + F\cos^2\theta^*$ function. In this version, the $\cos\theta^*$ histogram is obtained before the spin alignment sampling introduced.

```
if(TMath::Abs(KplusEta)<=eta_gap && TMath::Abs(KminusEta)<=eta_gap){
  h_theta->Fill(TMath::Abs(CosThetaStarZP));
  h_theta_star->Fill(TMath::Abs(CosThetaStarSP));
  CosBeta->Fill(0.5,cos(2.*beta));
}

if(!Sampling(f_rhoPhy,CosThetaStarRP)) return;

if(TMath::Abs(KplusEta)<=eta_gap && TMath::Abs(KminusEta)<=eta_gap){
  h_eta->Fill(TMath::Abs(CosThetaStarSP));
}

return;
```

It is important to have this distribution to be a constant, so that g function is reflected by $\cos\theta^*$ histogram after cut

$$\left[\frac{d\mathrm{N}}{d\cos\theta^* d\beta}\right]_{|\eta|} = \frac{d\mathrm{N}}{d\cos\theta^* d\beta} \times g(\theta^*, \beta). \qquad (22)$$

Constant means ρ_{00} = 1/3

Another method fills $\cos\theta^*$ histogram after the spin alignment sampling, in this case one has to take the ratio of $\cos\theta^*$ histogram of before and after eta cut, then fits with $\propto 1 + F\cos^2\theta^*$

```
if(!Sampling(f_rhoPhy,CosThetaStarRP)) return;
h_theta_star_before->Fill(TMath::Abs(CosThetaStarEP));

double eta_gap = 0.8;
double pt_gap = 0.2;
if(TMath::Abs(PiplusEta)<=eta_gap && TMath::Abs(PiminusEta)<=eta_gap) h_theta_star->Fill(TMath::Abs(CosThetaStarEP));
return;
```

$$\frac{\left[\dfrac{d\mathrm{N}}{d\cos\theta^* d\beta}\right]_{|\eta|}}{\dfrac{d\mathrm{N}}{d\cos\theta^* d\beta}} = \frac{\cancel{d\mathrm{N}}}{\cancel{d\cos\theta^* d\beta}} \times g(\theta^*, \beta). \qquad (22)$$

```
h_theta_star->Divide(h_theta_star_before);
```

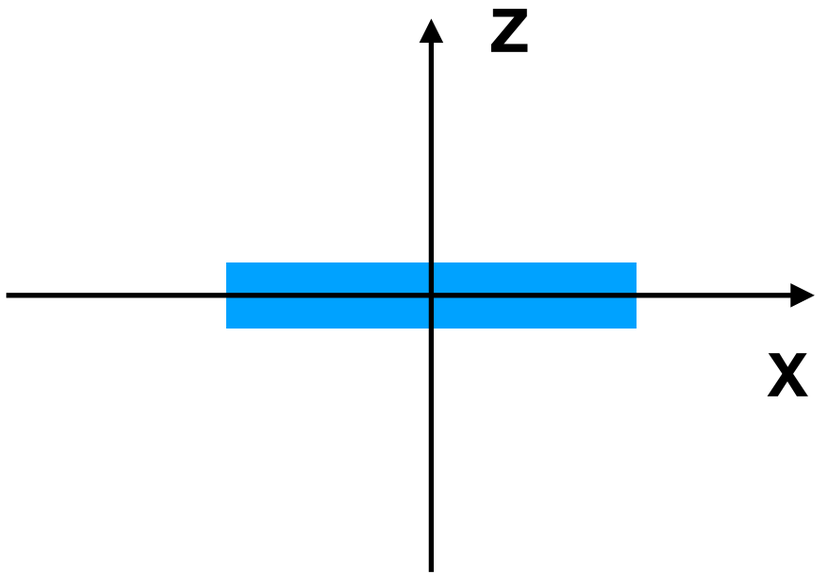
$$g(\theta^*, \beta) = 1 + F^* \cos^2\theta$$
$$\propto 1 + F\cos^2\theta^* + F\sin^2\theta^*\cos 2\beta, \qquad (23)$$

what has been used in the code: $1 + F\cos^2\theta^*$ **, based on naive expectation**

$$\int \cos 2\beta d\beta = 0$$

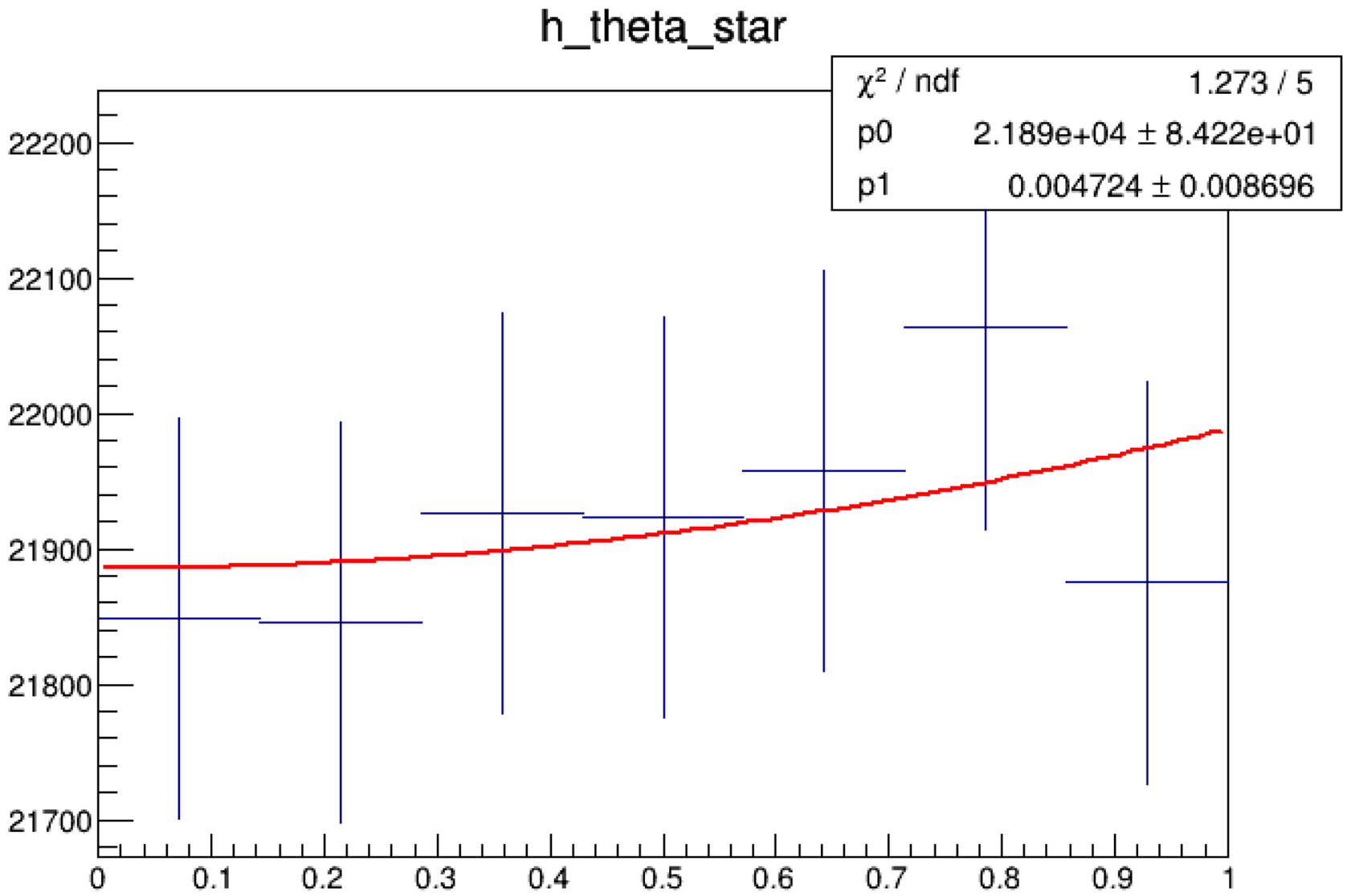
```
h_theta_star->Fit(Func_A,"ER");
TF1 *Func_A = new TF1("Func_A","[0]*(1.+[1]*(x*x))",0,1);
```

But this is only true for perfect acceptance, for finite acceptance "v_2" != 0



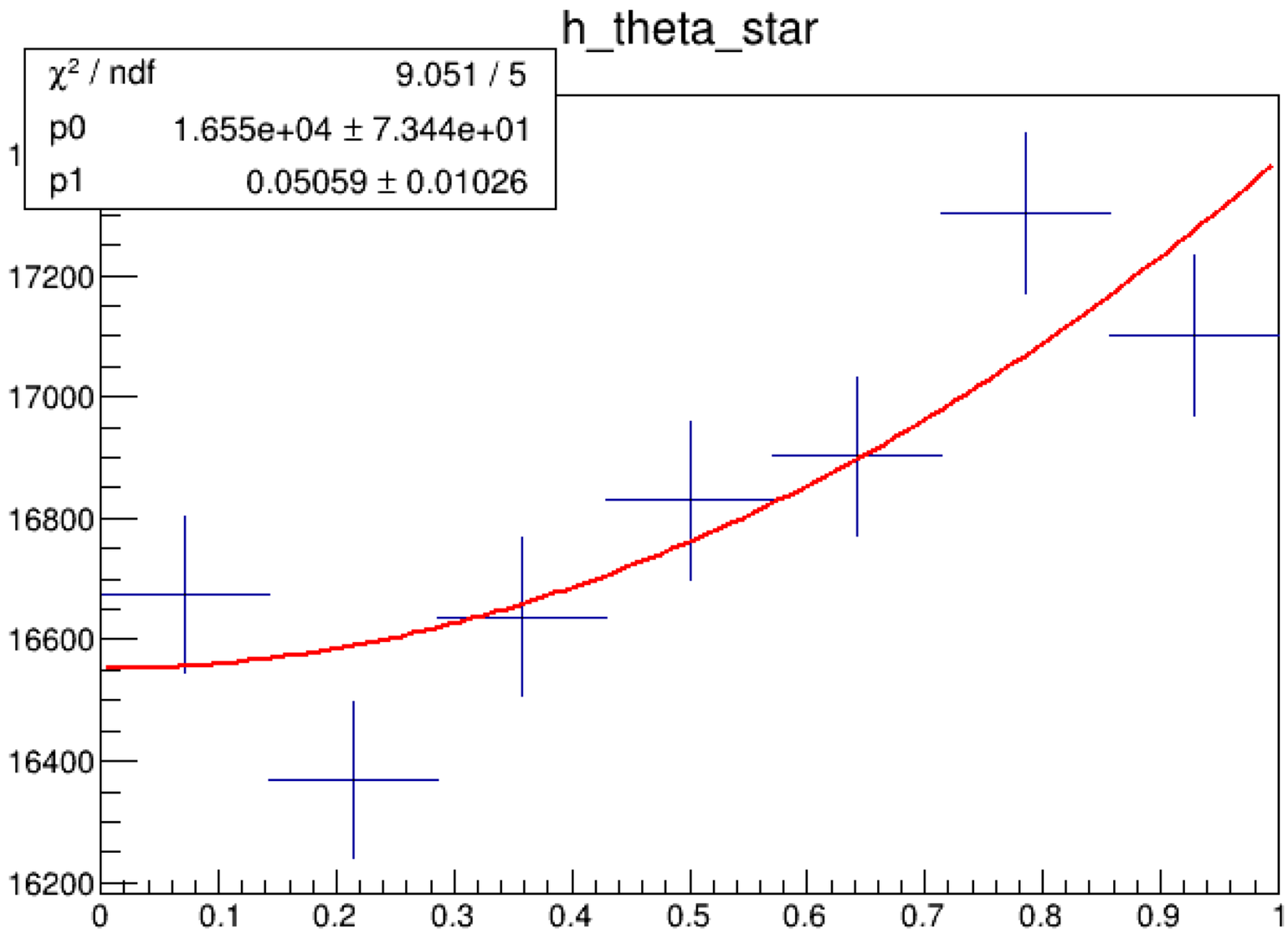
$|\eta| < 1$

cos2beta: 0.00207089 +/- 0.00180267



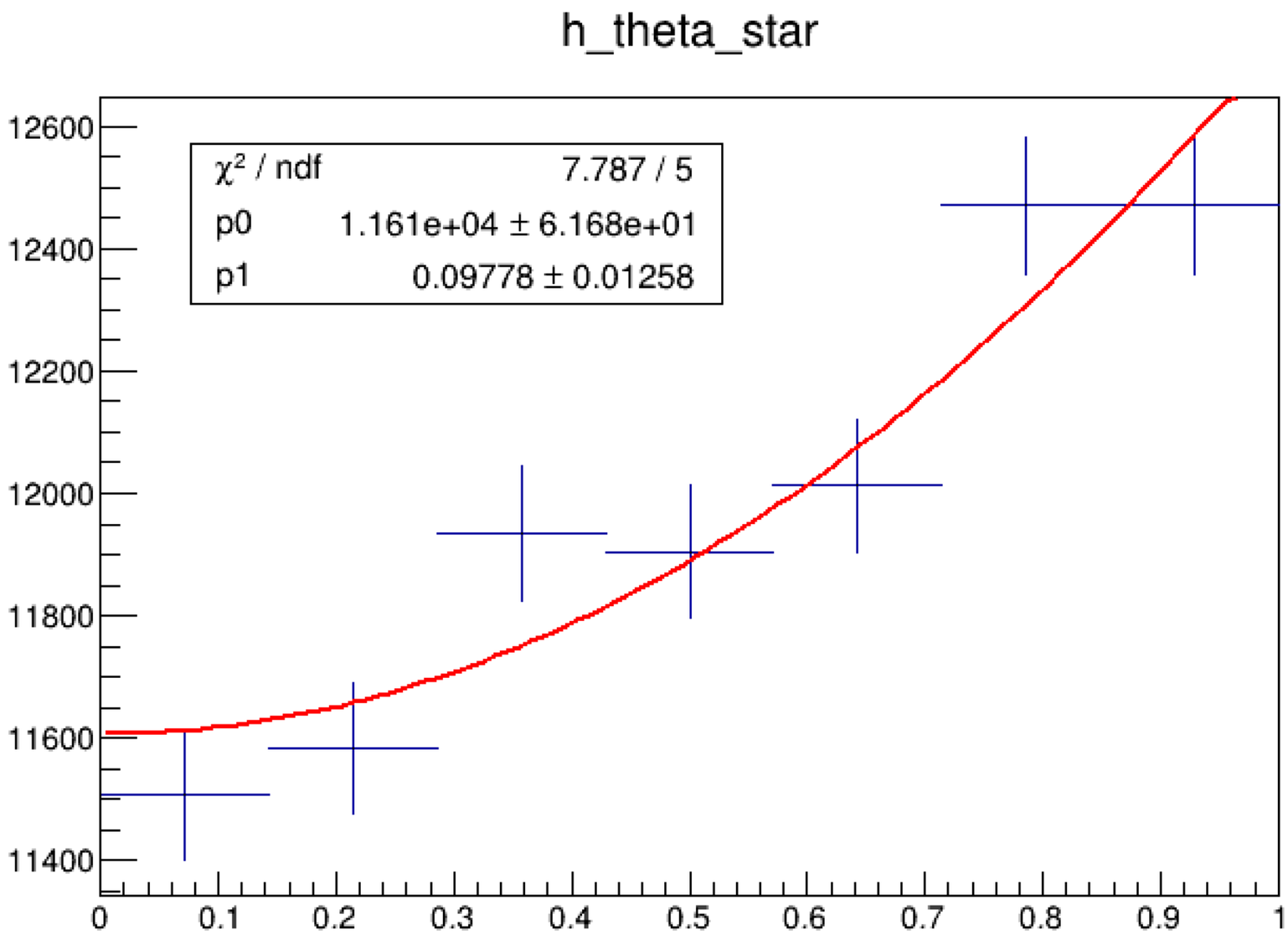
$|\eta| < 0.8$

cos2beta: 0.0127654 +/- 0.00206018



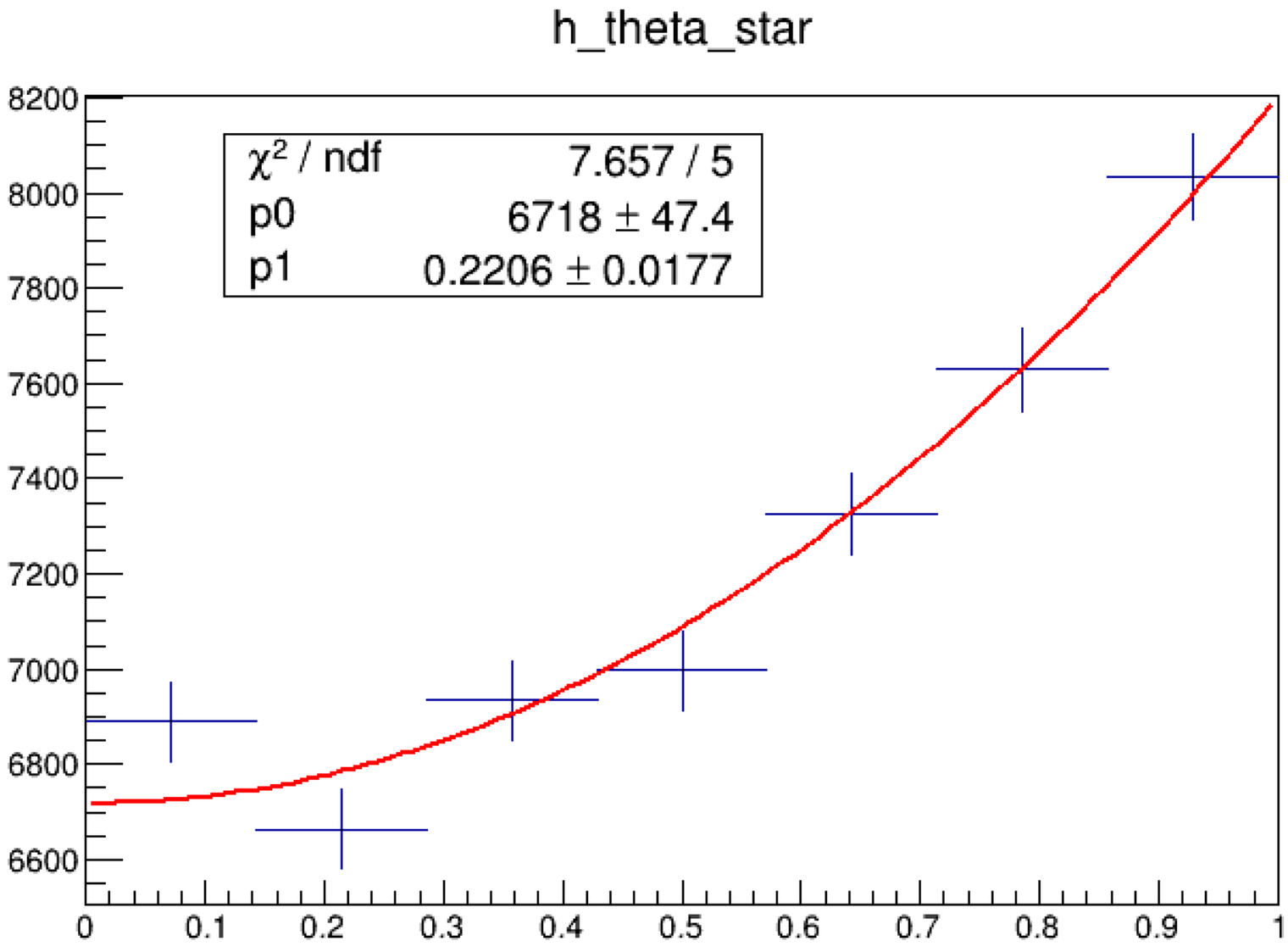
$|\eta| < 0.6$

cos2beta: 0.0273808 +/- 0.00243961



$|\eta| < 0.4$

cos2beta: 0.0721493 +/- 0.00313708



$|\eta| < 0.2$

cos2beta: 0.251166 +/- 0.00508128