$a_\mu^{2\pi}$ in spacelike region (work in collaboration with M. Della Gatta, F. Ignatov and M. Passera)

GV

12/9/18

- Comparison of $a_\mu^{2\pi}$ for KLOE, BaBar, CMD2 in spacelike region
- Sensitivity of MUonE to different dataset (to be done)

Relevant formulae

$$a_\mu^{HLO} = \frac{\alpha}{\pi}\int_0^1 dx\,(1-x)\cdot\Delta\alpha_{had}\left(-\frac{x^2 m_\mu^2}{1-x}\right)$$

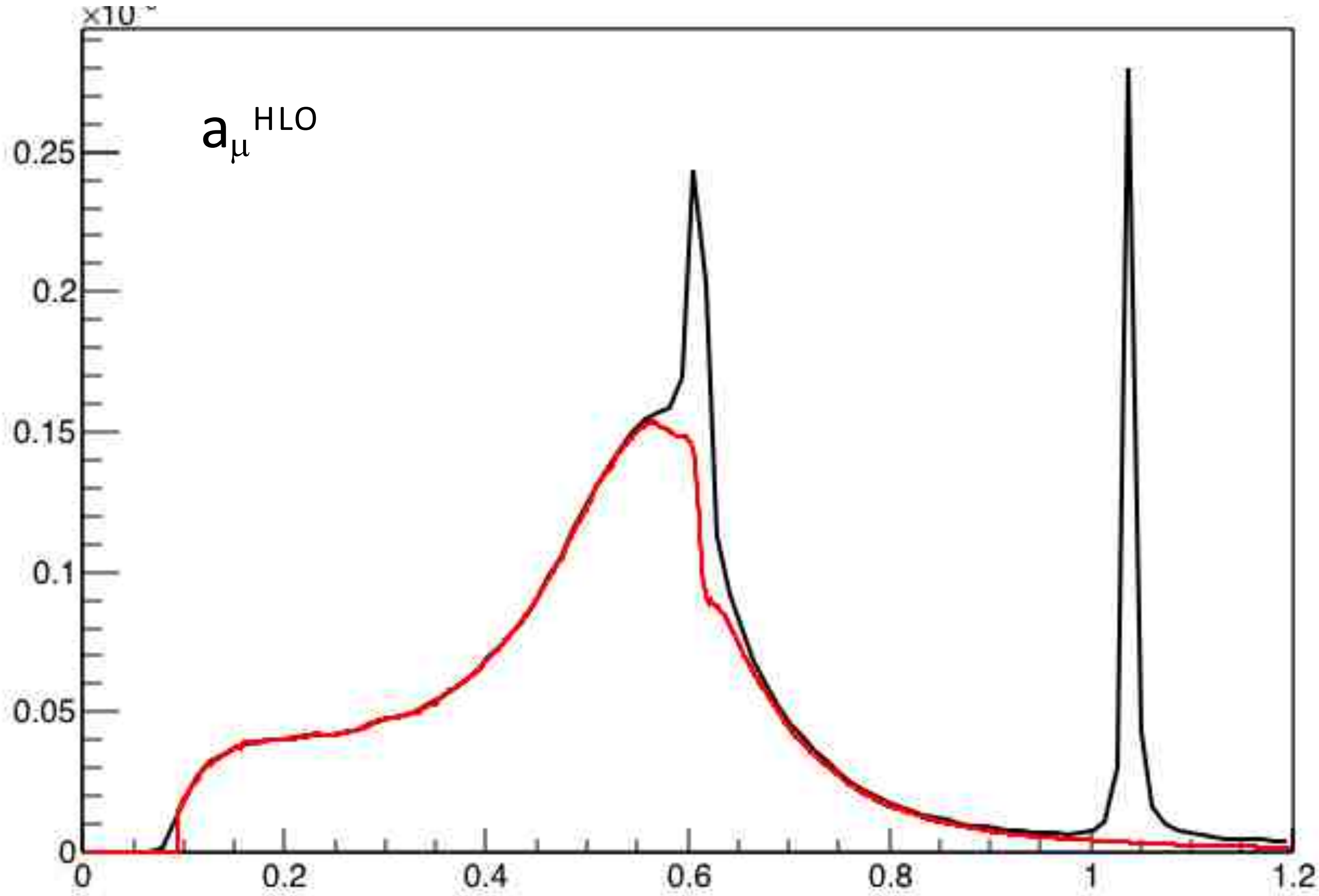
$$\Delta\alpha_{HAD}(t) = -\frac{\alpha t}{3\pi}\int_{4m_\pi^2}^{\infty}\frac{R(s)}{s(s-t)}$$

We consider now the 2pi contribution

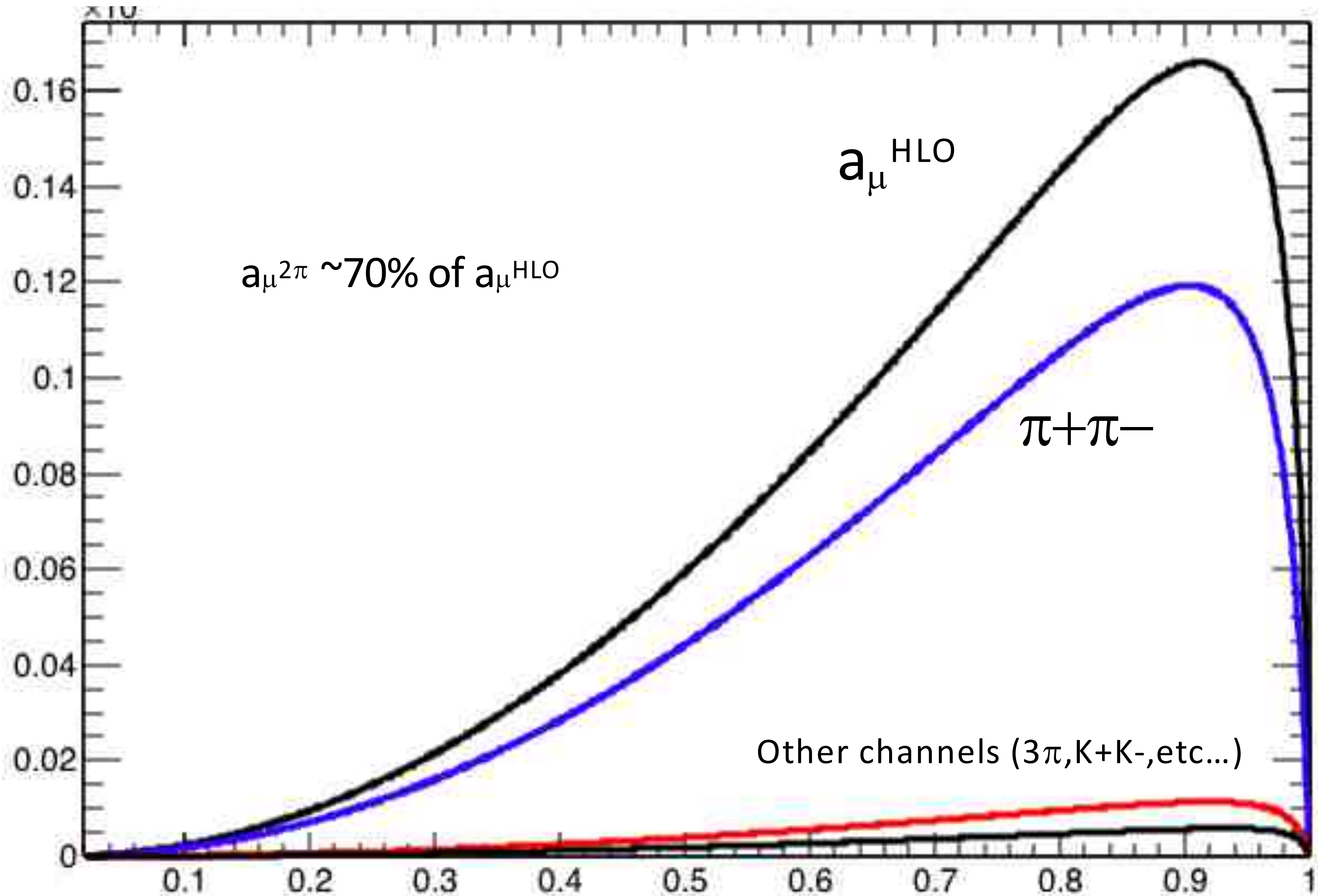
$$R(s) = \frac{\sigma^0_{TOT}(e^-e^+ \longrightarrow \pi^-\pi^+)}{\sigma^0_{TOT}(e^-e^+ \longrightarrow \mu^-\mu^+)} = \frac{\frac{\alpha^2\pi}{3s}\left(1-\frac{4m_\pi^2}{s}\right)^{\frac{3}{2}} \mid F_\pi^0(q^2)\mid^2}{\frac{4\pi\alpha^2}{3s}} =$$

$$\frac{1}{4}\left(1-\frac{4m_\pi^2}{s}\right)^{\frac{3}{2}} \mid F_\pi^0(q^2)\mid^2$$

2π contribution to a_μ^{HLO} timelike



2π contribution to a_μ^{HLO} spacelike



Contribution of different channels to a_μ^{HLO}

Table 2. Contributions to a_μ in the energy region from 0.305 to 1.8 GeV from exclusive channels (Table 4 from [10]).

Channel	HLMNT (11) [10]	DHMZ (10) [1]	Difference
$\eta\pi^+\pi^-$	0.88 ± 0.10	1.15 ± 0.19	-0.27
K^+K^-	22.09 ± 0.46	21.63 ± 0.73	0.46
$K_S^0K_L^0$	13.32 ± 0.16	12.96 ± 0.39	0.36
$\omega\pi^0$	0.76 ± 0.03	0.89 ± 0.07	-0.13
$\pi^+\pi^-$	505.65 ± 3.09	507.80 ± 2.84	-2.15
$2\pi^+2\pi^-$	13.50 ± 0.44	13.35 ± 0.53	0.15
$3\pi^+3\pi^-$	0.11 ± 0.01	0.12 ± 0.01	-0.01
$\pi^+\pi^-\pi^0$	47.38 ± 0.99	46.00 ± 1.48	1.38
$\pi^+\pi^-2\pi^0$	18.62 ± 1.15	18.01 ± 1.24	0.61
$\pi^0\gamma$	4.54 ± 0.14	4.42 ± 0.19	0.12
$\eta\gamma$	0.69 ± 0.02	0.64 ± 0.02	0.05
$\eta 2\pi^+2\pi^-$	0.02 ± 0.00	0.02 ± 0.01	0.00
$\eta\omega$	0.38 ± 0.06	0.47 ± 0.06	-0.09
$\eta\phi$	0.33 ± 0.03	0.36 ± 0.03	-0.03
$\phi(\rightarrow$ unaccounted)	0.04 ± 0.04	0.05 ± 0.00	-0.01
Sum of isospin channels	5.98 ± 0.42	6.06 ± 0.46	-0.08
Total	634.28 ± 3.53	633.93 ± 3.61	0.35

Parametrization of $\sigma_{\pi\pi}$

$\sigma\pi\pi$=C*F ^{2}(0)*(1+δ_{FSR})= C*GS*(1+δ_{FSR})

δ_{FSR}= $\frac{\alpha}{\pi}\Lambda(s)$

GS=Gounaris-Sakurai parametrization

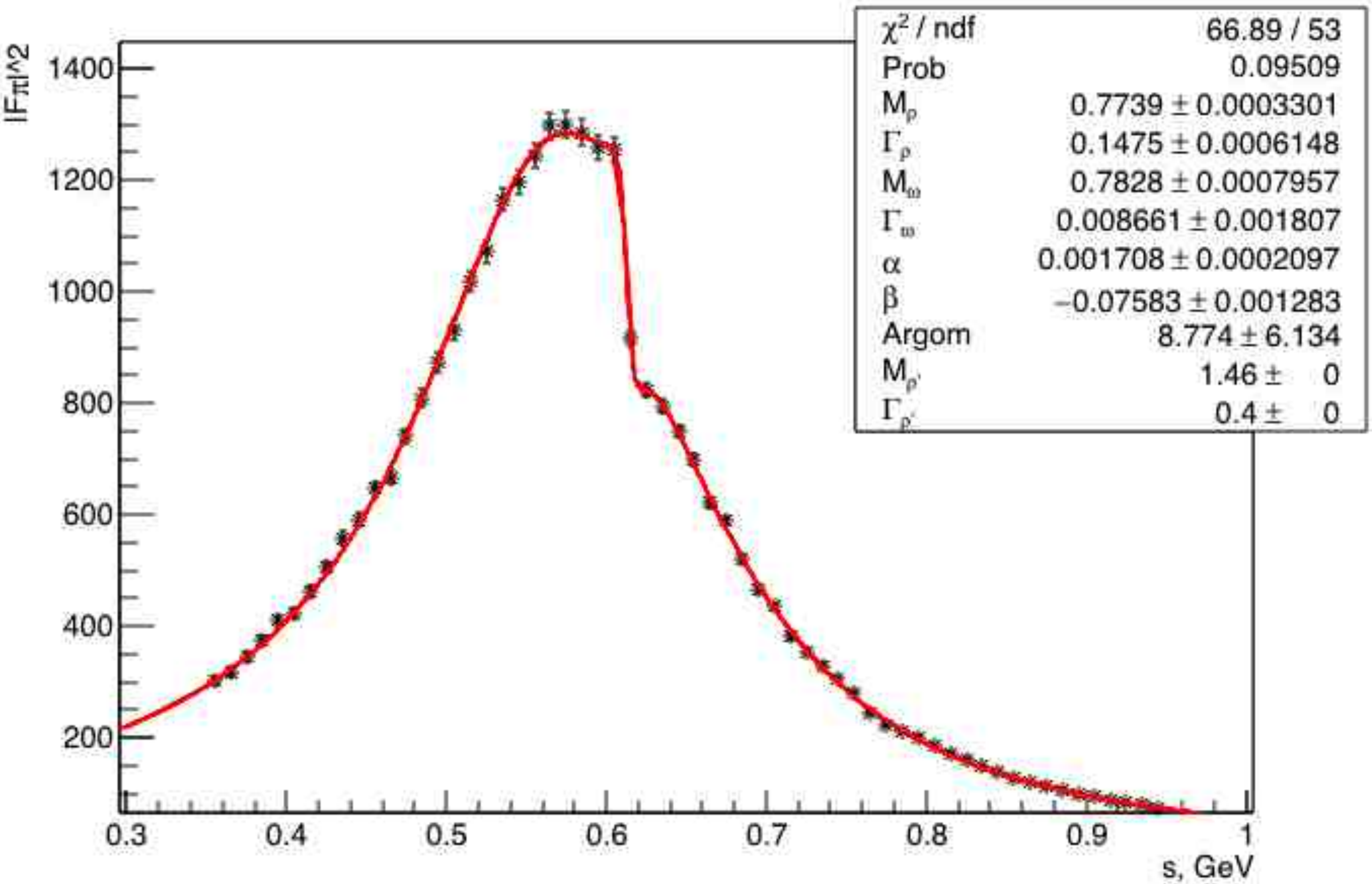
$$F_\pi(s) = \left(\mathrm{BW}^{\mathrm{GS}}_{\rho(770)}(s) \cdot \left(1 + \delta \frac{s}{M_\omega^2}\mathrm{BW}_\omega(s)\right) + \beta \cdot \mathrm{BW}^{\mathrm{GS}}_{\rho(1450)}(s)\right)(1+\beta)^{-1}, \qquad (8)$$

FSR

$$\Lambda(s) = \frac{1+\beta_\pi^2}{\beta_\pi}\left\{4\,\mathrm{Li}_2\left(\frac{1-\beta_\pi}{1+\beta_\pi}\right) + 2\,\mathrm{Li}_2\left(-\frac{1-\beta_\pi}{1+\beta_\pi}\right) - \left[3\ln\left(\frac{2}{1+\beta_\pi}\right) + 2\ln\beta_\pi\right]L_{\beta\pi}\right\} - 3\ln\left(\frac{4}{1-\beta_\pi^2}\right) - 4\ln\beta_\pi + \frac{1}{\beta_\pi^3}\left[\frac{5}{4}(1+\beta_\pi^2)^2 - 2\right]L_{\beta_\pi} + \frac{3}{2}\frac{1+\beta_\pi^2}{\beta_\pi^2}, \qquad (6)$$

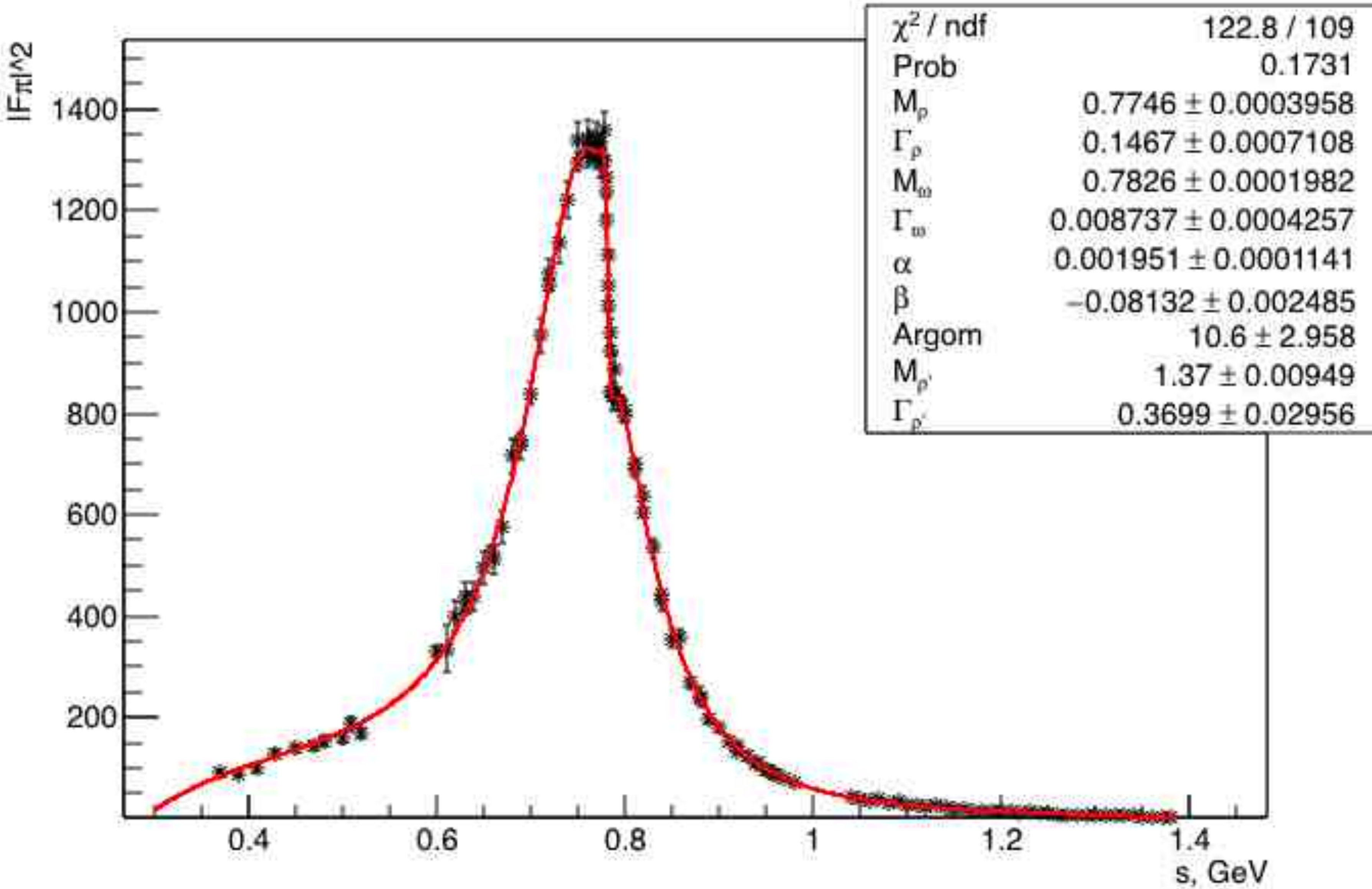
where $L_{\beta_\pi} = \ln\frac{1+\beta_\pi}{1-\beta_\pi}$, $\mathrm{Li}_2(z) = -\int_0^z \frac{dx}{x}\ln(1-x)$,

KLOE



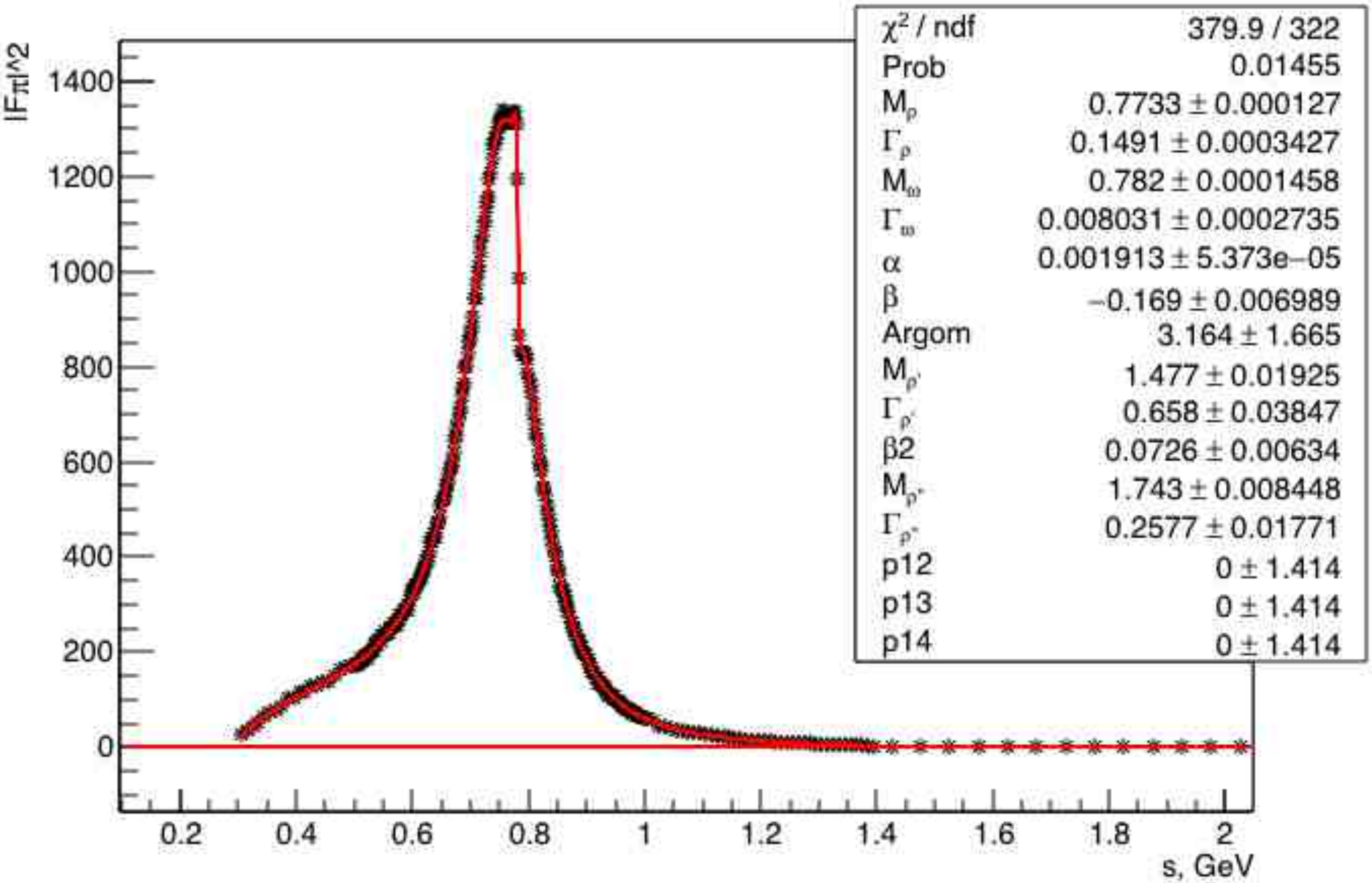
χ^2 / ndf 66.89 / 53
Prob 0.09509
M_ρ 0.7739 ± 0.0003301
Γ_ρ 0.1475 ± 0.0006148
M_ω 0.7828 ± 0.0007957
Γ_ω 0.008661 ± 0.001807
α 0.001708 ± 0.0002097
β −0.07583 ± 0.001283
Argom 8.774 ± 6.134
$M_{\rho'}$ 1.46 ± 0
$\Gamma_{\rho'}$ 0.4 ± 0
$|F_\pi|$^2
1400
1200
1000
800
600
400
200
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1
s, GeV

CMD2



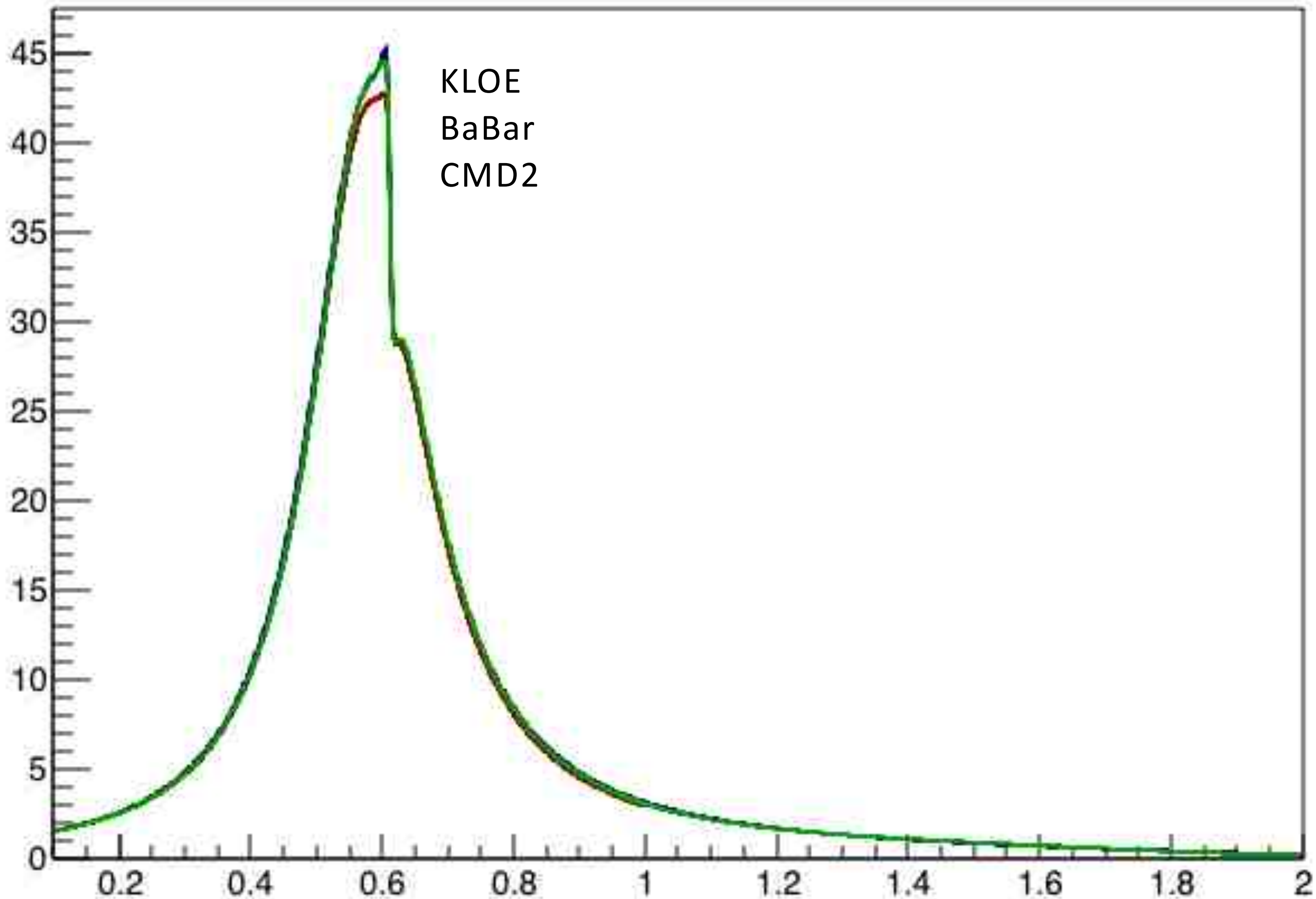
χ² / ndf 122.8 / 109
Prob 0.1731
Mρ 0.7746 ± 0.0003958
Γρ 0.1467 ± 0.0007108
Mω 0.7826 ± 0.0001982
Γω 0.008737 ± 0.0004257
α 0.001951 ± 0.0001141
β −0.08132 ± 0.002485
Argom 10.6 ± 2.958
Mρ' 1.37 ± 0.00949
Γρ' 0.3699 ± 0.02956
|Fπ|^2
1400
1200
1000
800
600
400
200
0.4
0.6
0.8
1
1.2
1.4
s, GeV

BaBar

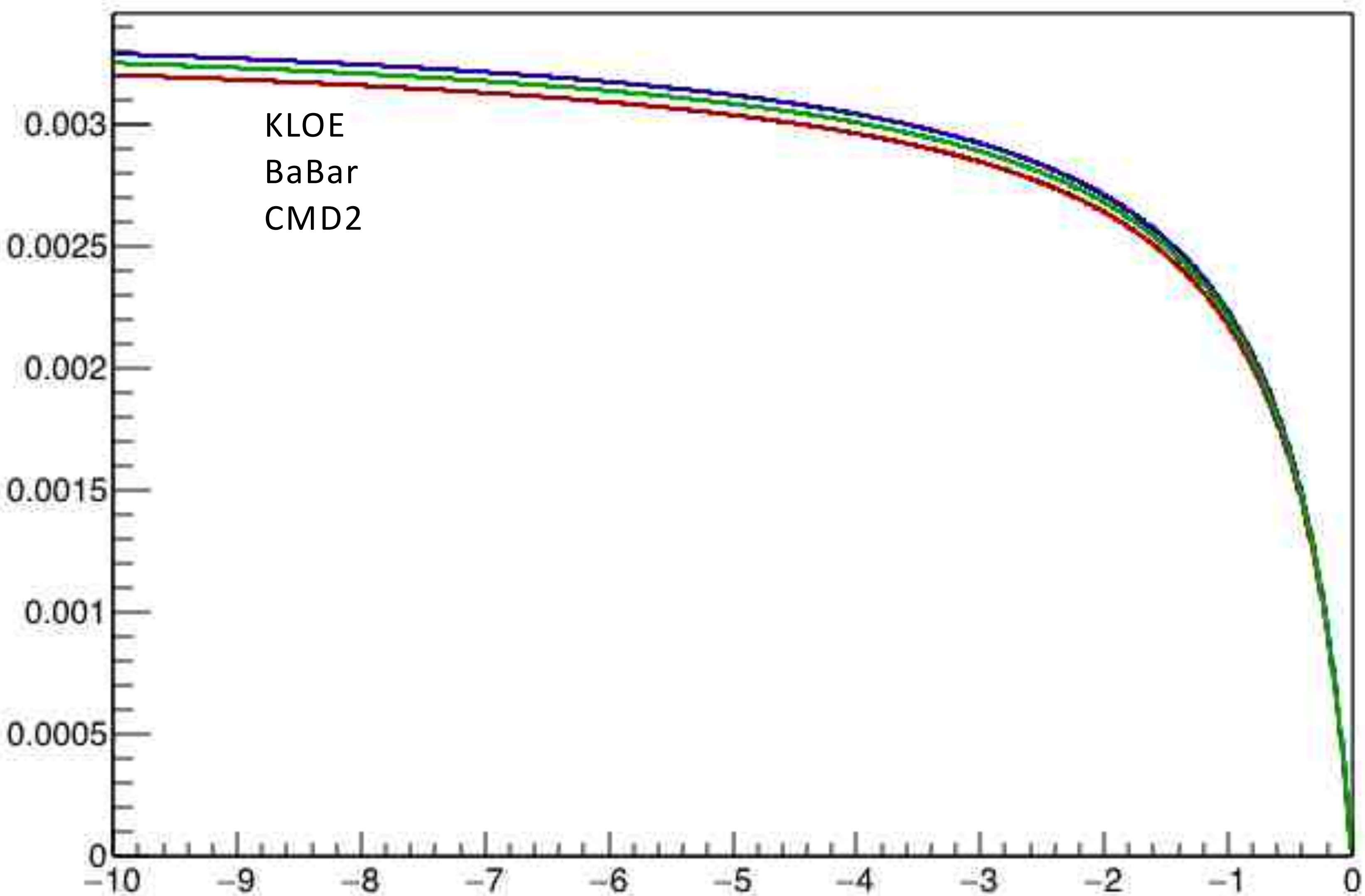


$|F_\pi|$^2
1400
1200
1000
800
600
400
200
0
0.2
0.4
0.6
0.8
1
1.2
1.4
1.6
1.8
2
s, GeV
χ^2 / ndf 379.9 / 322
Prob 0.01455
M_ρ 0.7733 ± 0.000127
Γ_ρ 0.1491 ± 0.0003427
M_ω 0.782 ± 0.0001458
Γ_ω 0.008031 ± 0.0002735
α 0.001913 ± 5.373e−05
β −0.169 ± 0.006989
Argom 3.164 ± 1.665
$M_{\rho'}$ 1.477 ± 0.01925
$\Gamma_{\rho'}$ 0.658 ± 0.03847
β2 0.0726 ± 0.00634
$M_{\rho''}$ 1.743 ± 0.008448
$\Gamma_{\rho''}$ 0.2577 ± 0.01771
p12 0 ± 1.414
p13 0 ± 1.414
p14 0 ± 1.414

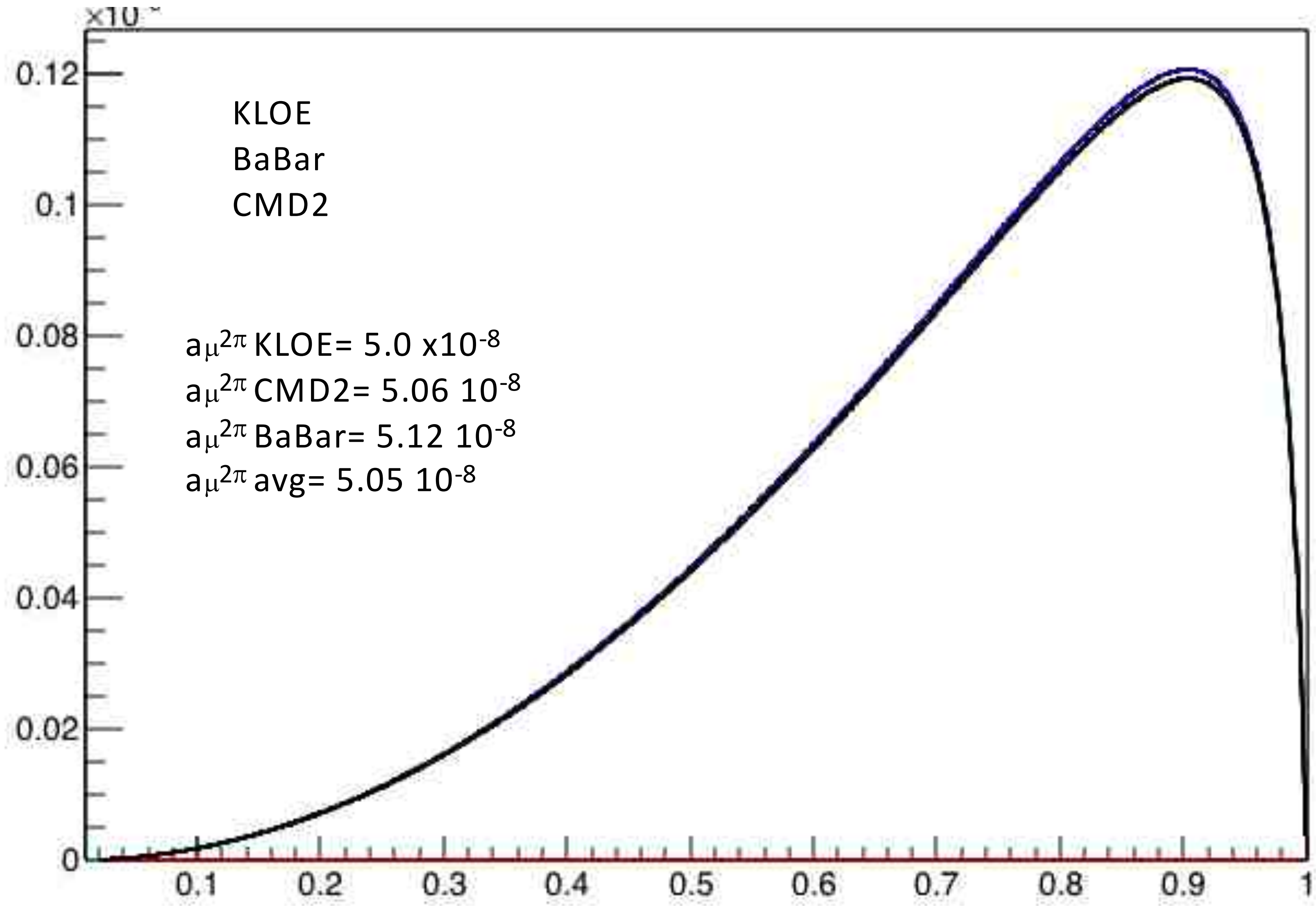
Comparison for different data: F_π^2



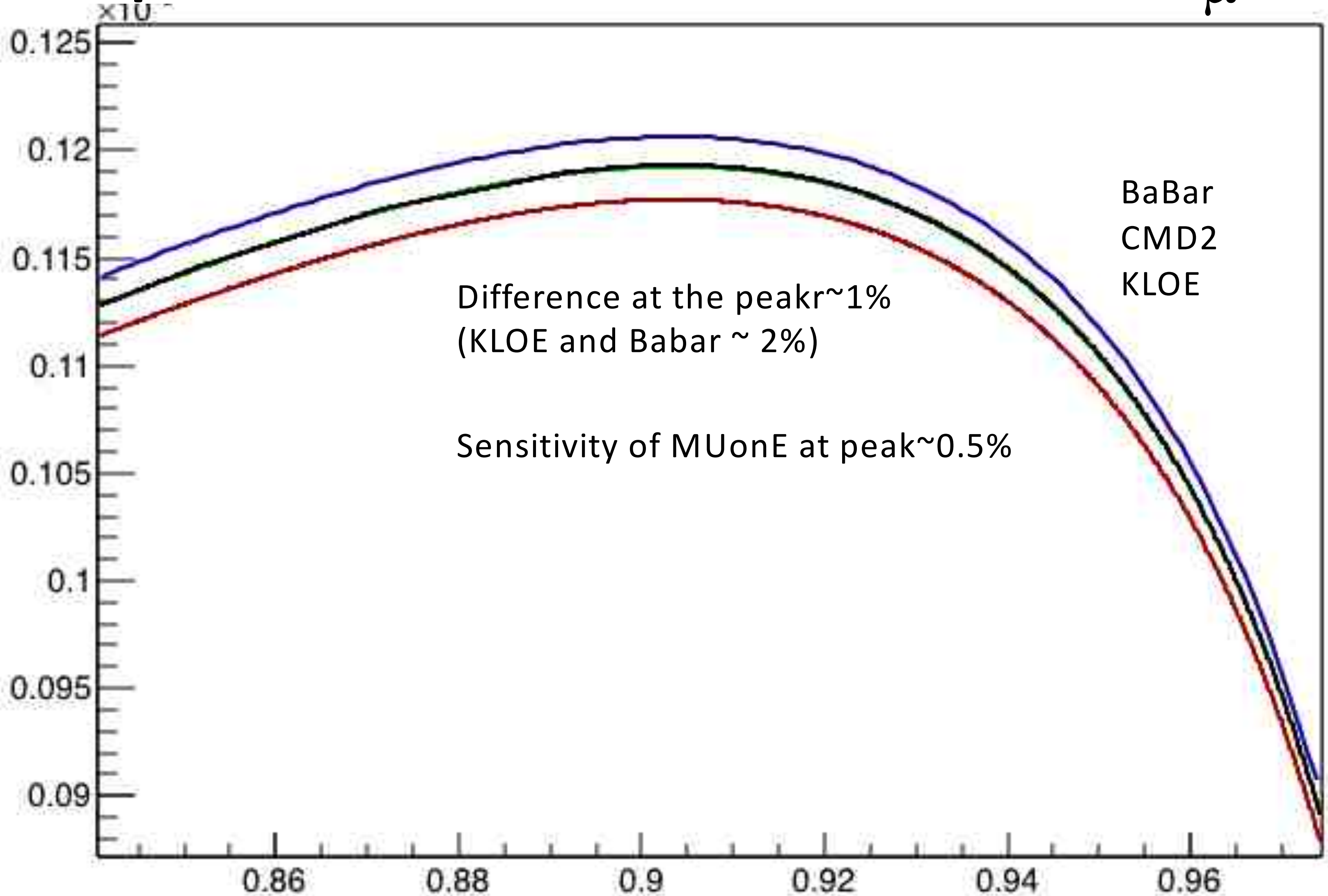
Comparison for different data: $\Delta\alpha_{2\pi}(t)$



Comparison for different data: $a_\mu^{2\pi}$ SL



Comparison for different data: $a_\mu^{2\pi}$ SL



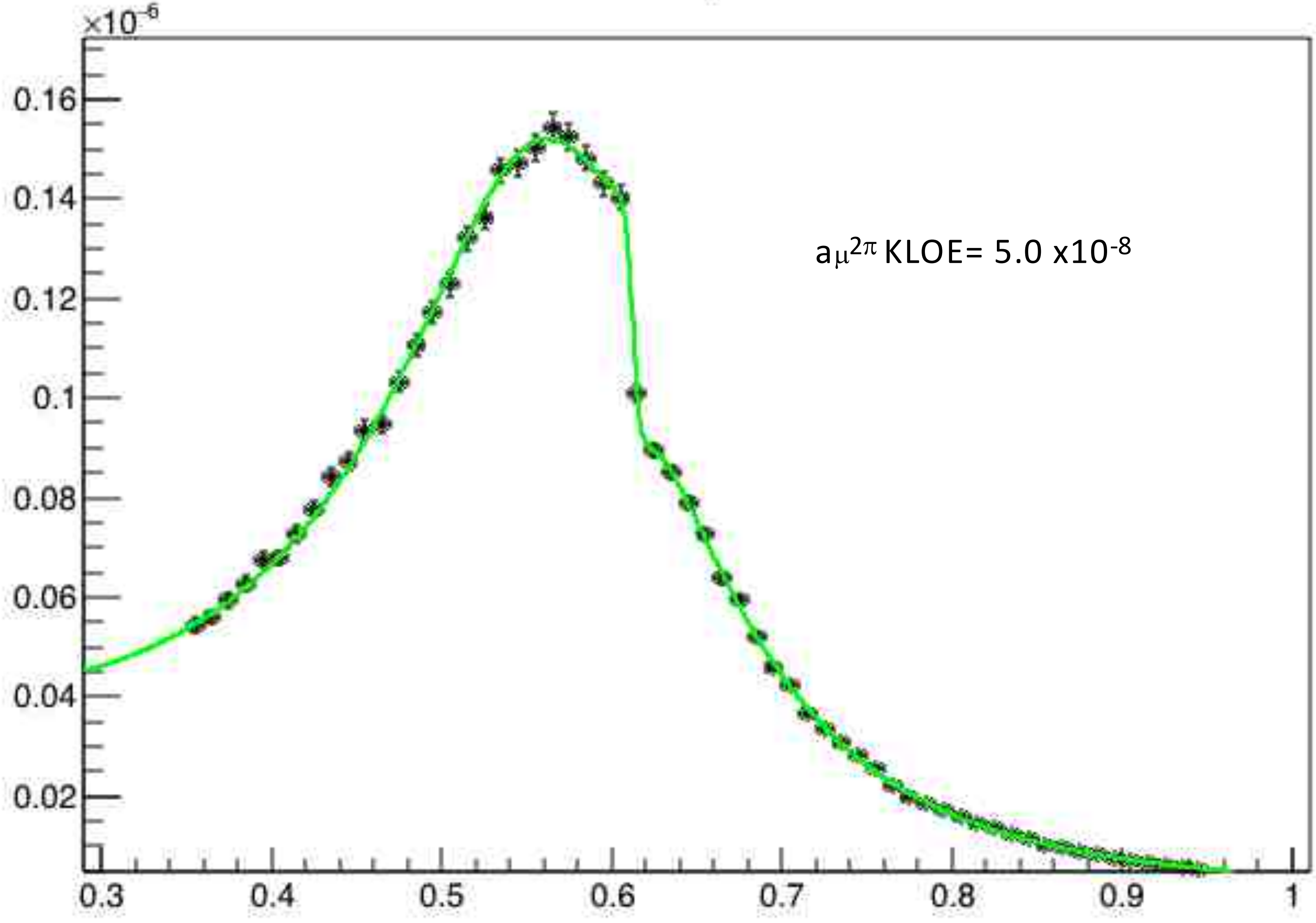
Conclusion

- Comparison of $a_\mu^{2\pi}$ for KLOE, BaBar, CMD2 in spacelike region show ~1% difference (2% btw KLOE and BaBar)
- Sensitivity of MUonE at peak (should be)~ 0.5%. Sufficient to distinguish amongst the different data?

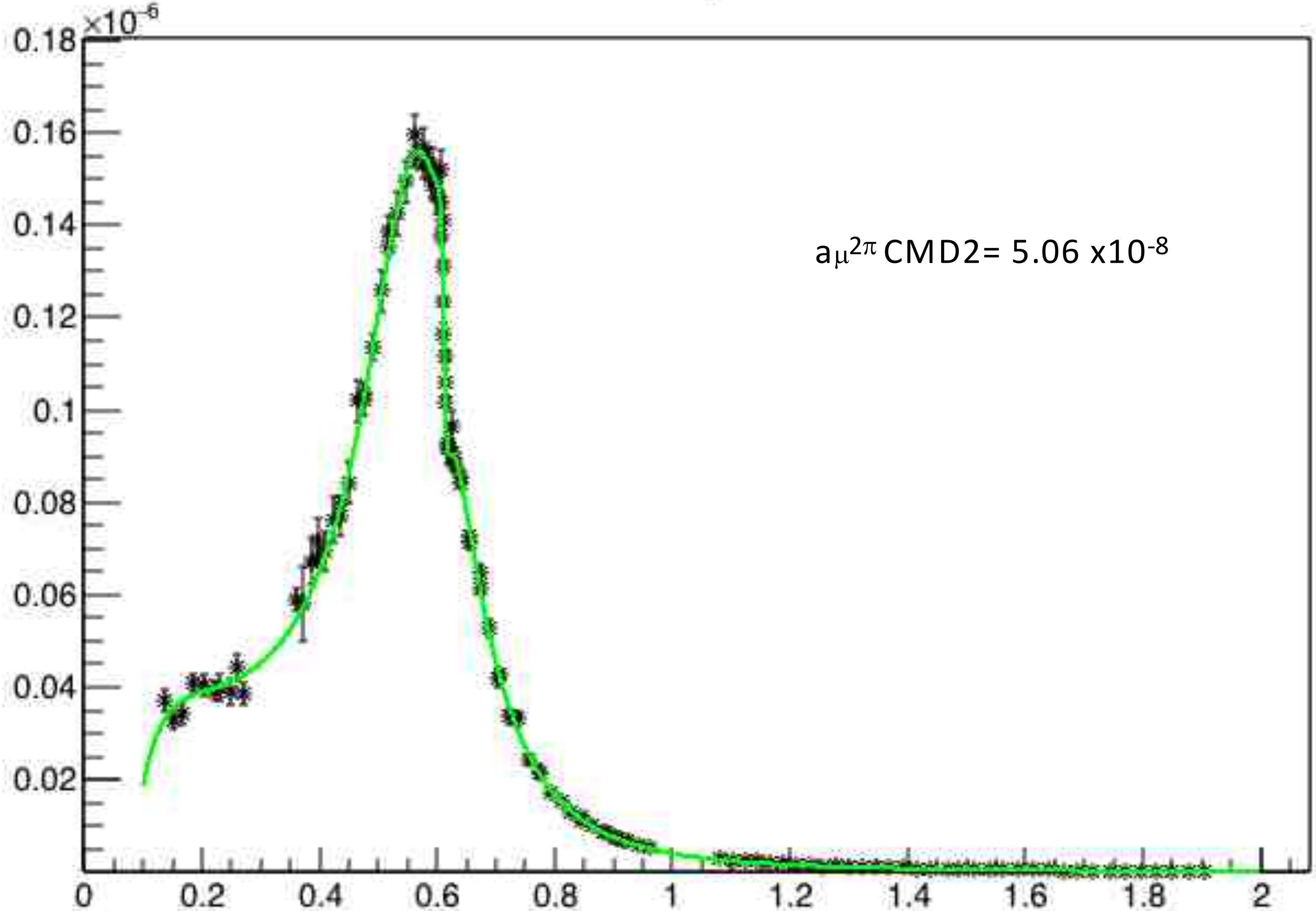
Continue…

Backup

$a_\mu^{2\pi}$ TIMELIKE KLOE



$a_\mu^{2\pi}$ TIMELIKE CMD2



$a_\mu^{2\pi}$ TIMELIKE BaBar