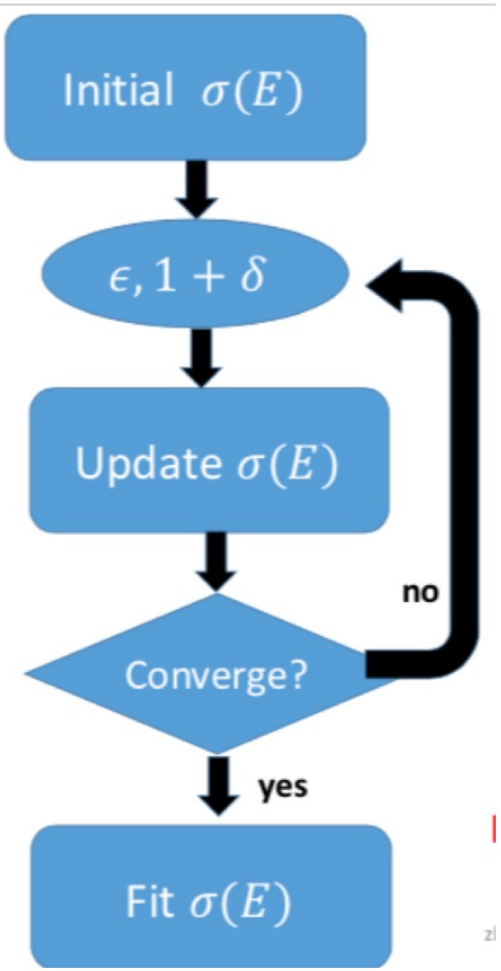
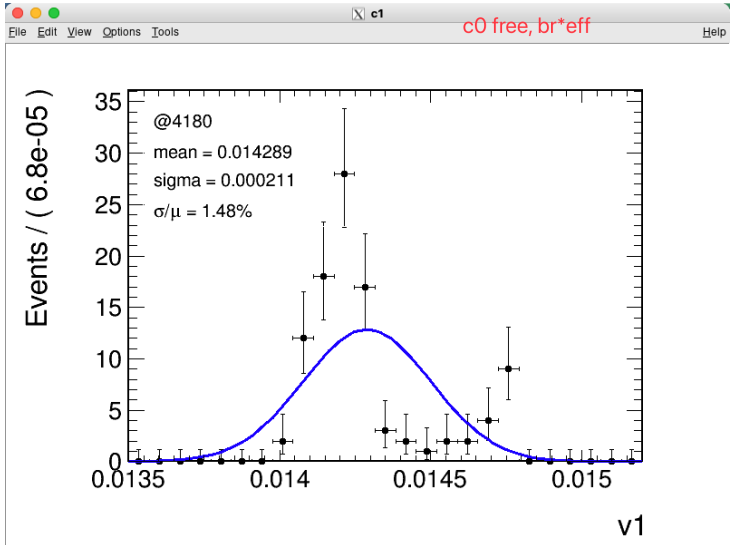
Systematic uncertainty

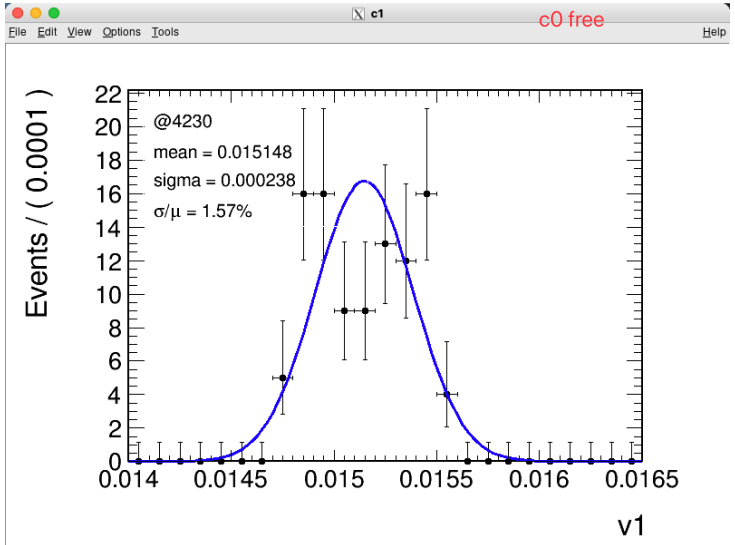
ISR correction

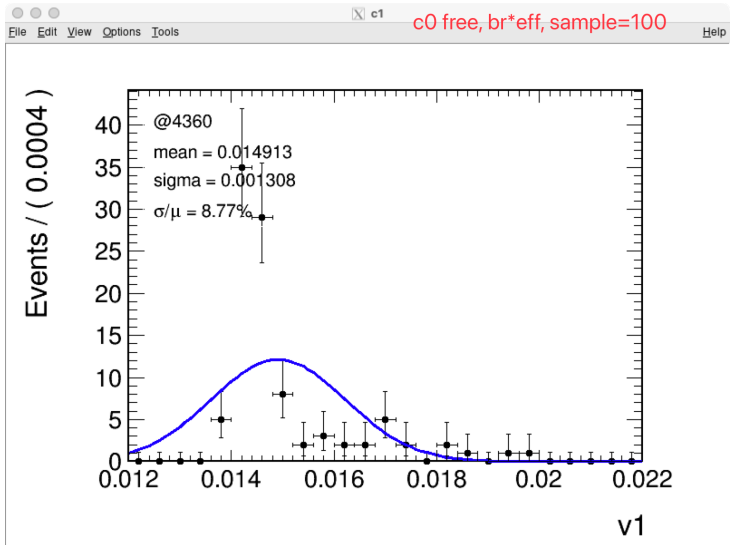
- An alternative way for the iteration (from idea of Lianjin Wu in PS meeting)
  - a flat lineshape to generate MC
  - calculate born cross section with ISR and eff from the MC
  - fit the new lineshape of the born cross section
  - event-by-event weight assign to events, $W_i = \sigma(\sqrt{s_{effective}})/\sigma(\sqrt{s_0})$
  - $\epsilon^{weight} = \Sigma_i^{N_{left}} W_i / \Sigma_i^{N_{gen}} W_i$
  - $(1+\delta)^{weight} = (1+\delta)^{initial} \cdot \Sigma_i^{N_{gen}} W_i / N_{gen}$
  - iterate weights, so that of ϵ^{weight} and $(1+\delta)^{weight}$, to get new cross sections and lineshape

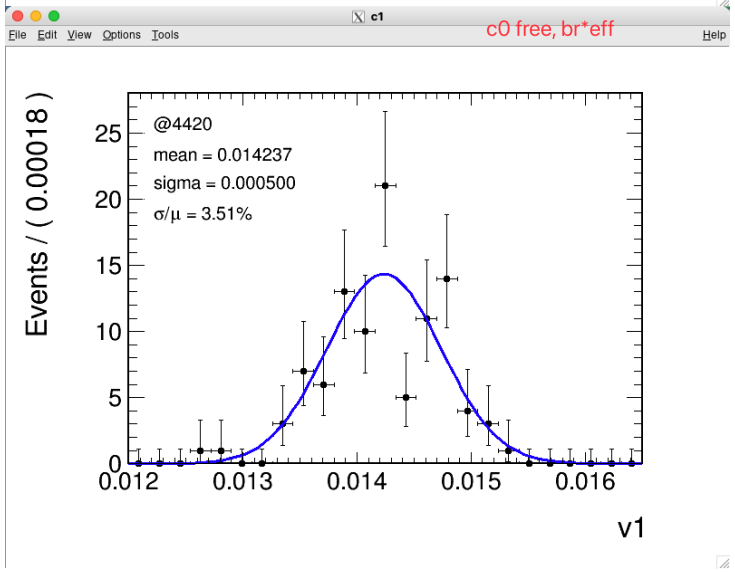


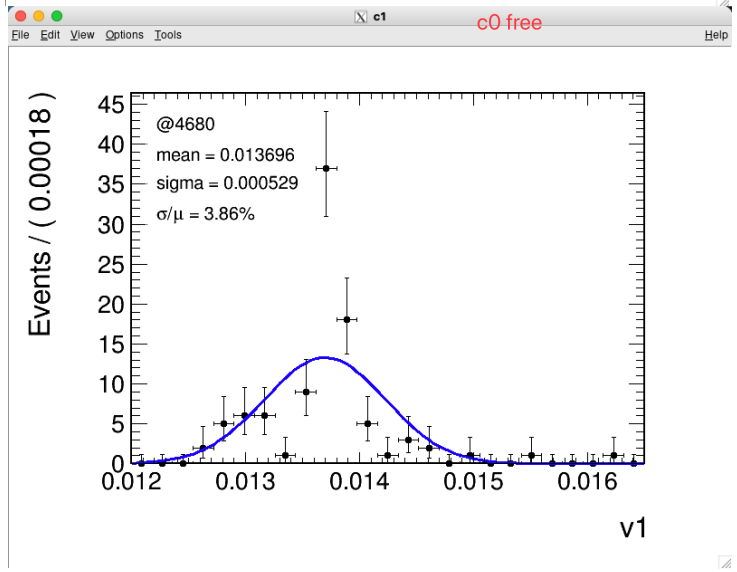
$$(1+\delta^{ISR})*\Sigma_i Br_i \epsilon_i$$

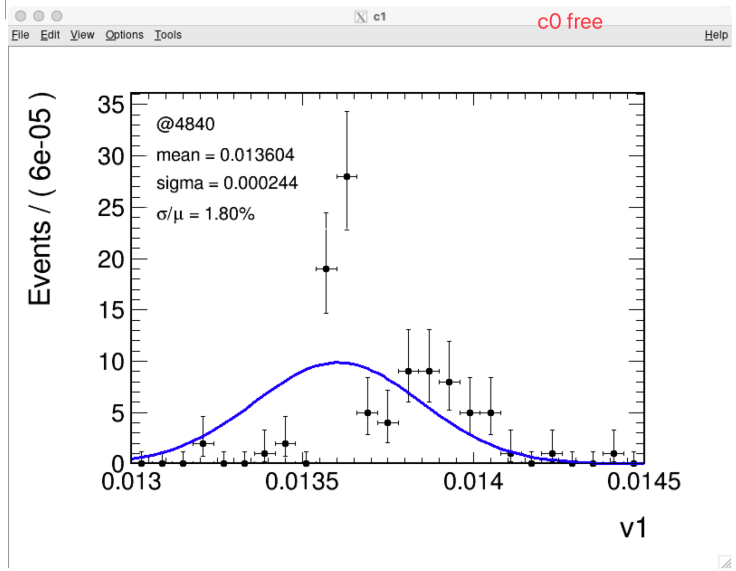








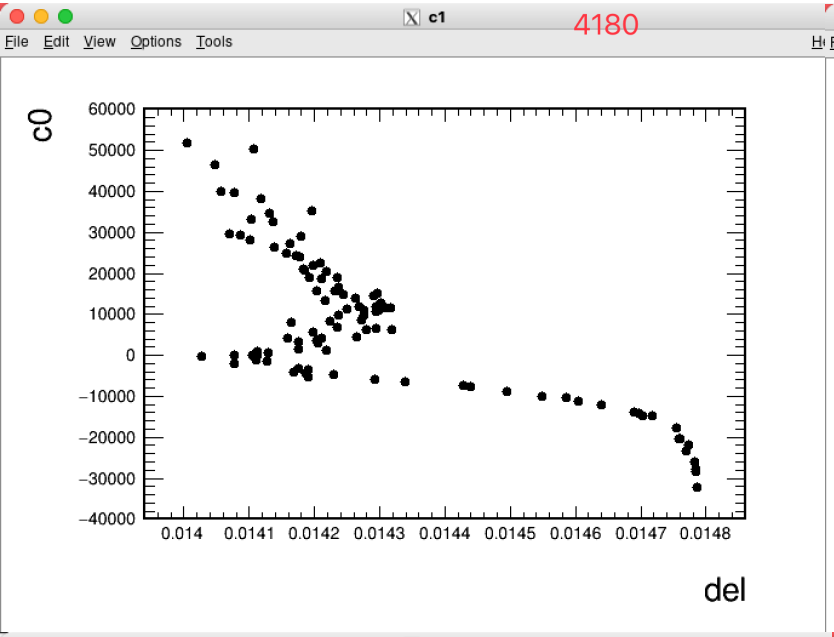




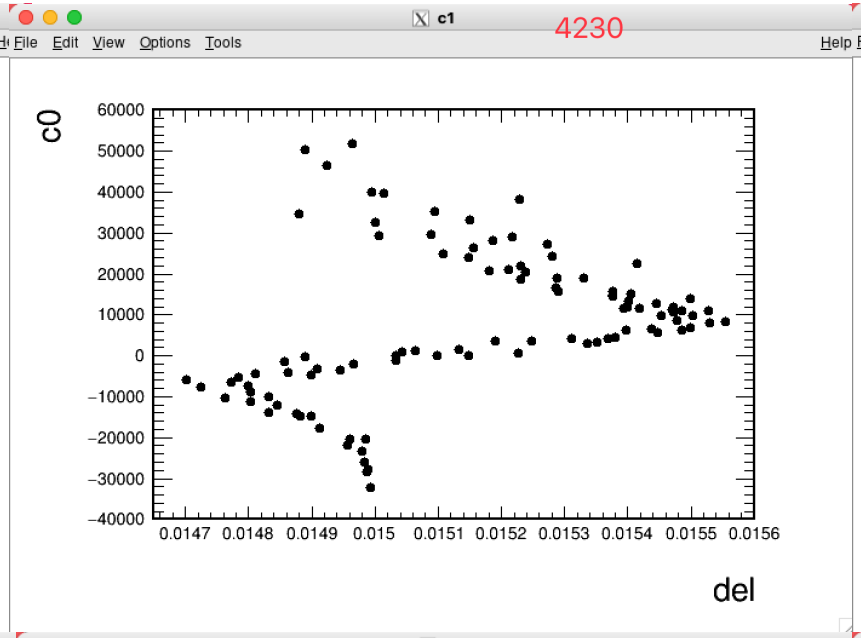
$$\sigma_{fit} = \left| C_0 \sqrt{\Psi(\sqrt{s})} + BW_1(\sqrt{s})e^{i\phi 1} + BW_2(\sqrt{s})e^{i\phi 2} + BW_3(\sqrt{s})e^{i\phi 3} \right|^2 \qquad \Psi(\sqrt{s}) = \frac{q^3}{s^n}$$

9.33885e+03 1.79256e+04

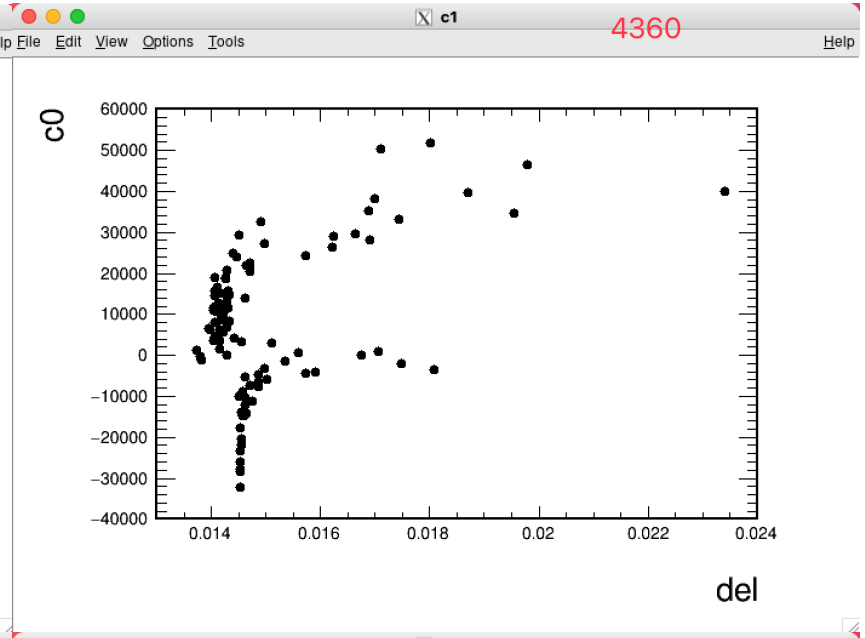
4180



4230



4360



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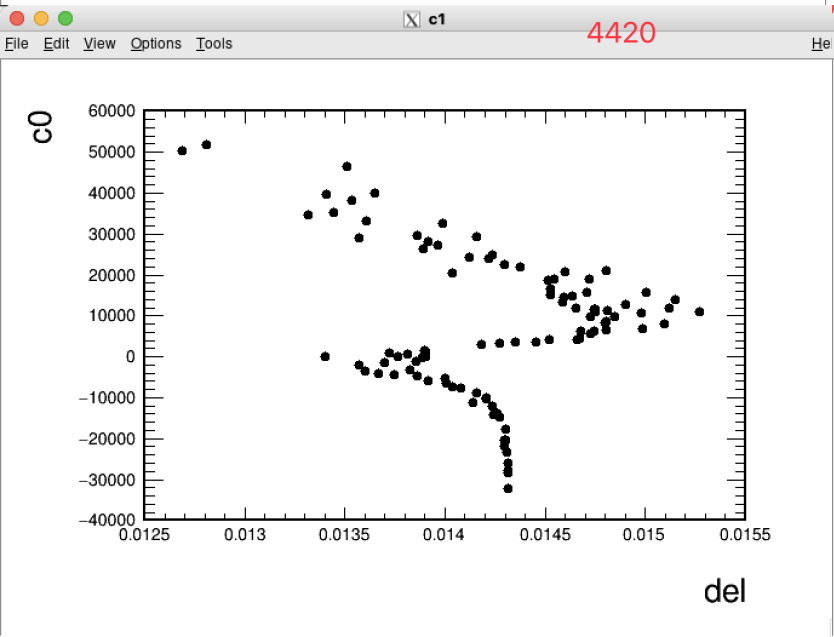

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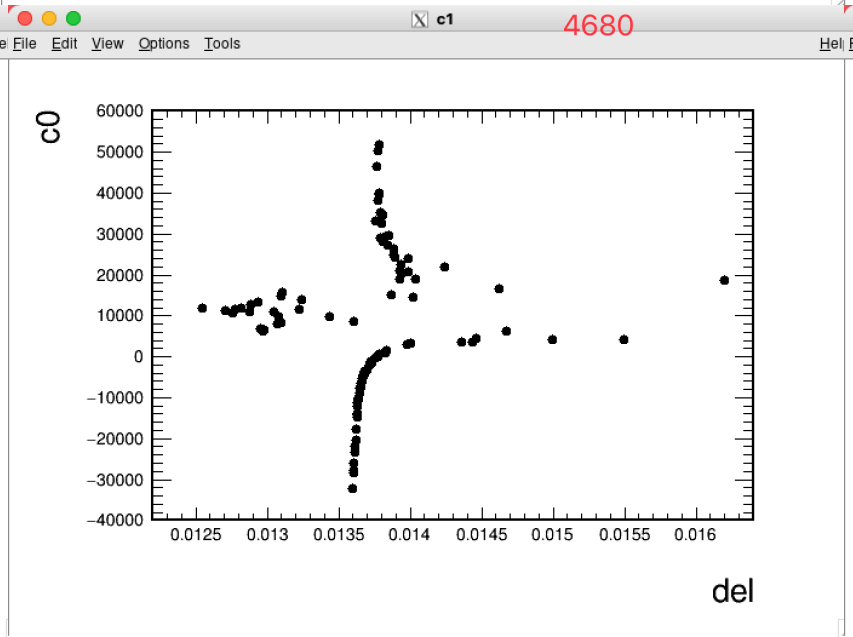

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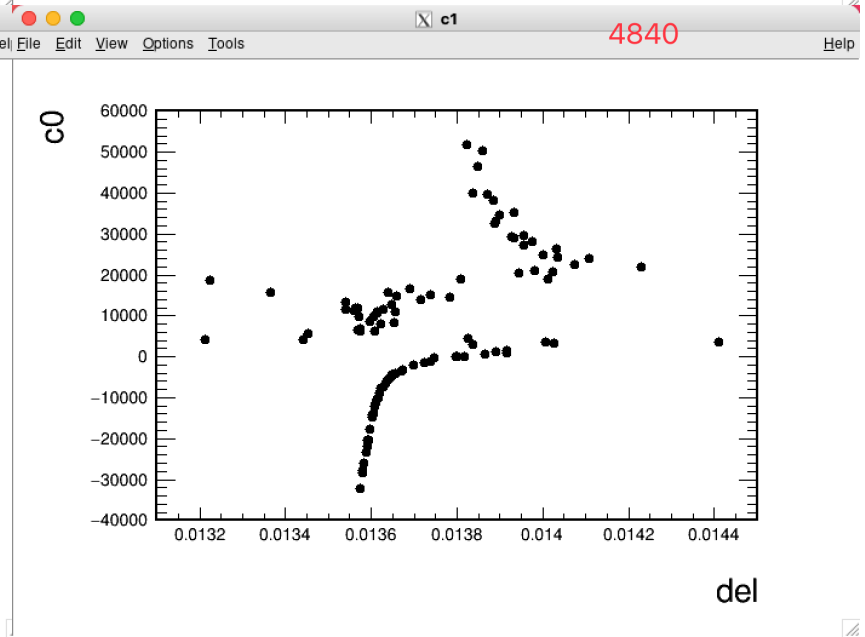

```
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FCN=77.5423 FROM HESSE     STATUS=OK             115 CALLS         7294 TOTAL
                     EDM=6.89305e-08    STRATEGY= 1      ERROR MATRIX ACCURATE
 EXT PARAMETER                                   INTERNAL      INTERNAL
 NO.   NAME      VALUE            ERROR          STEP SIZE       VALUE
  1  Mass_Psi4040(GeV)          4.03900e+00   constant
  2  Width_Psi4040(GeV)         8.00000e-02   constant
  3  Gammaee*Br(Psi4040)(eV)    1.21840e+00   2.81150e-01   1.21797e-05  -1.34958e+00
  4  Phi4040(rad)               3.03237e+00   2.13520e-01   3.30649e-06  -3.49002e-02
  5  Mass_Psi4220(GeV)          4.21638e+00   2.17857e-03   3.12179e-05  -1.20980e-01
  6  Width_Psi4220(GeV)         7.93006e-02   4.32322e-03   8.51401e-06   6.26129e-01
  7  Gammaee*Br(Psi4220)(eV)    7.53617e+00   9.55210e-01   8.42272e-07  -1.01461e+00
  8  Phi4220(rad)               4.13529e+00   1.35971e-01   1.88070e-06   3.21537e-01
  9  Mass_Psi4360(GeV)          4.38804e+00   1.09871e-02   8.37304e-06  -1.19870e-01
 10  Width_Psi4360(GeV)         1.14164e-01   2.82637e-02   9.22441e-06  -2.41243e-01
 11  Gammaee*Br(Psi4360)(eV)    2.52142e+00   9.50710e-01   1.60199e-06  -1.25187e+00
 12  Phi4360(rad)               2.52227e+00   1.67183e-01   3.05679e-06  -1.98544e-01
 13  a                          9.33885e+03   1.79256e+04   1.89048e-07  -1.51000e+00
 14  n                          5.67335e+00   1.28707e+00   9.36858e-07   3.85320e-02
                               ERR DEF= 0.5
 EXTERNAL ERROR MATRIX.    NDIM=  25    NPAR= 12    ERR DEF=0.5
 ELEMENTS ABOVE DIAGONAL ARE NOT PRINTED.
  7.906e-02
 -4.553e-05  4.566e-02
 -2.790e-04  2.907e-05  4.755e-06
  8.373e-05  5.701e-04  1.247e-06  1.876e-05
 -3.817e-02  1.603e-01  1.059e-03  2.726e-03  9.128e-01
  8.252e-03 -2.293e-03  9.787e-05 -1.031e-04  4.147e-02  1.850e-02
 -8.985e-04 -1.106e-03 -5.336e-06 -2.795e-05 -6.807e-03 -2.804e-04  1.212e-04
  2.965e-04  3.284e-03  3.129e-05  4.329e-05  2.322e-02  2.335e-03 -1.784e-04  8.091e-04
  4.212e-02  1.313e-01  8.766e-04  2.204e-03  8.221e-01  7.211e-02 -8.024e-03  2.479e-02  9.050e-01
  1.732e-03  6.140e-03  1.459e-04 -4.464e-05  6.629e-02  1.921e-02 -1.607e-04  2.428e-03  8.601e-02  2.798e-02
 -2.994e+03 -1.325e+03  2.327e+00 -3.591e+01 -7.365e+03 -9.687e+02  1.242e+02 -2.674e+02 -1.121e+04 -9.234e+02  3.217e+08
 -2.114e-01 -1.054e-01  9.506e-05 -2.710e-03 -5.775e-01 -7.055e-02  9.103e-03 -2.034e-02 -8.411e-01 -7.020e-02  2.339e+04
 -2.114e-01 -1.054e-01  9.506e-05 -2.710e-03 -5.775e-01 -7.055e-02  9.103e-03 -2.034e-02 -8.411e-01 -7.020e-02  2.339e+04  1.704e+00
 PARAMETER  CORRELATION COEFFICIENTS
       NO.  GLOBAL      3      4      5      6      7      8      9     10     11     12     13     14
        3  0.92103   1.000 -0.001 -0.455  0.069 -0.142  0.216 -0.290  0.037  0.157  0.037 -0.594 -0.576
        4  0.97997  -0.001  1.000  0.062  0.616  0.785 -0.079 -0.470  0.540  0.646  0.172 -0.346 -0.378
        5  0.93695  -0.455  0.062  1.000  0.132  0.508  0.330 -0.222  0.504  0.423  0.400  0.059  0.033
        6  0.94524   0.069  0.616  0.132  1.000  0.659 -0.175 -0.586  0.351  0.535 -0.062 -0.462 -0.479
        7  0.99544  -0.142  0.785  0.508  0.659  1.000  0.319 -0.647  0.854  0.904  0.415 -0.430 -0.463
        8  0.98563   0.216 -0.079  0.330 -0.175  0.319  1.000 -0.187  0.604  0.557  0.844 -0.397 -0.397
        9  0.95092  -0.290 -0.470 -0.222 -0.586 -0.647 -0.187  1.000 -0.570 -0.766 -0.087  0.629  0.633
       10  0.98108   0.037  0.540  0.504  0.351  0.854  0.604 -0.570  1.000  0.916  0.510 -0.524 -0.548
       11  0.99413   0.157  0.646  0.423  0.535  0.904  0.557 -0.766  0.916  1.000  0.541 -0.657 -0.677
       12  0.97303   0.037  0.172  0.400 -0.062  0.415  0.844 -0.087  0.510  0.541  1.000 -0.308 -0.322
       13  0.99991  -0.594 -0.346  0.059 -0.462 -0.430 -0.397  0.629 -0.524 -0.657 -0.308  1.000  0.999
       14  0.99991  -0.576 -0.378  0.033 -0.479 -0.463 -0.397  0.633 -0.548 -0.677 -0.322  0.999  1.000
```
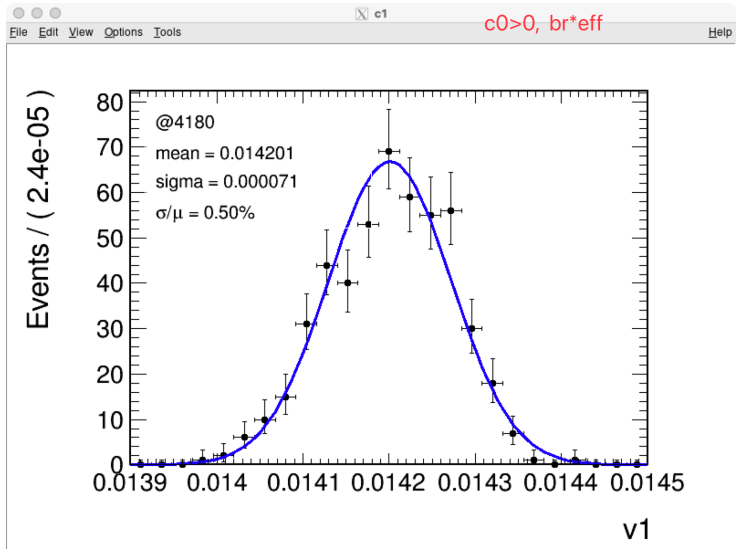
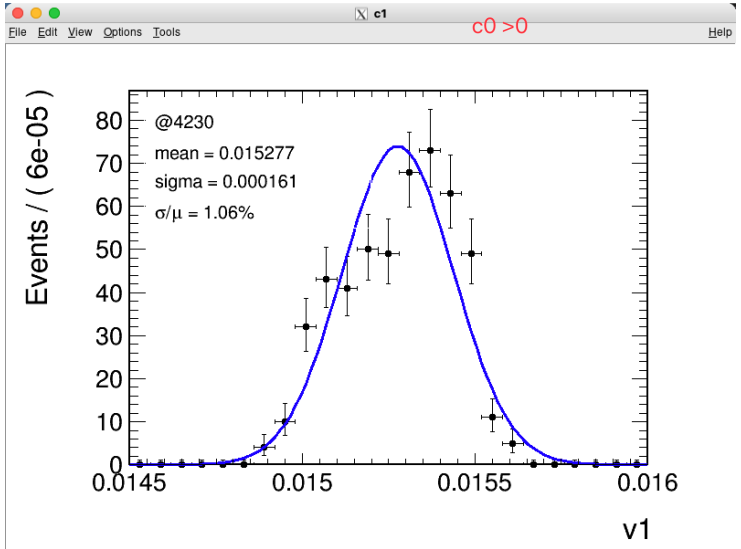
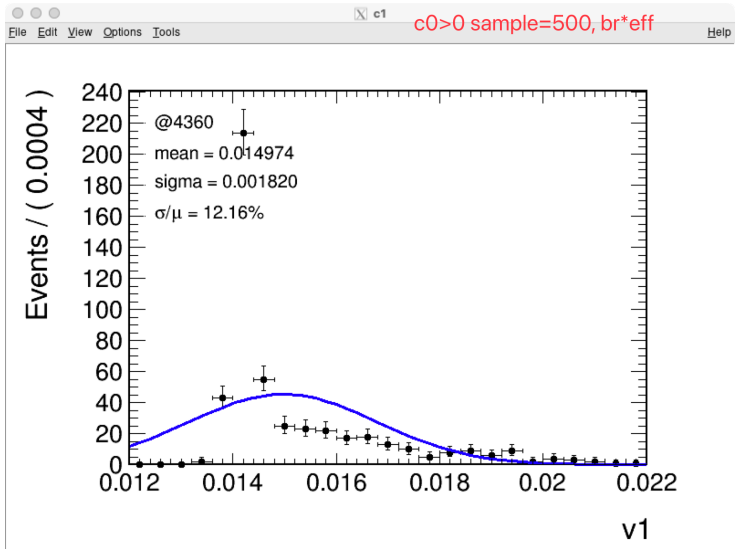
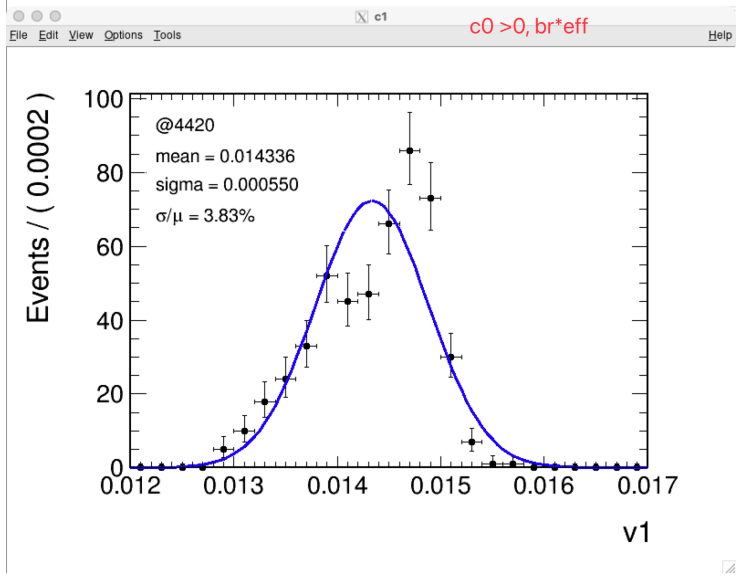
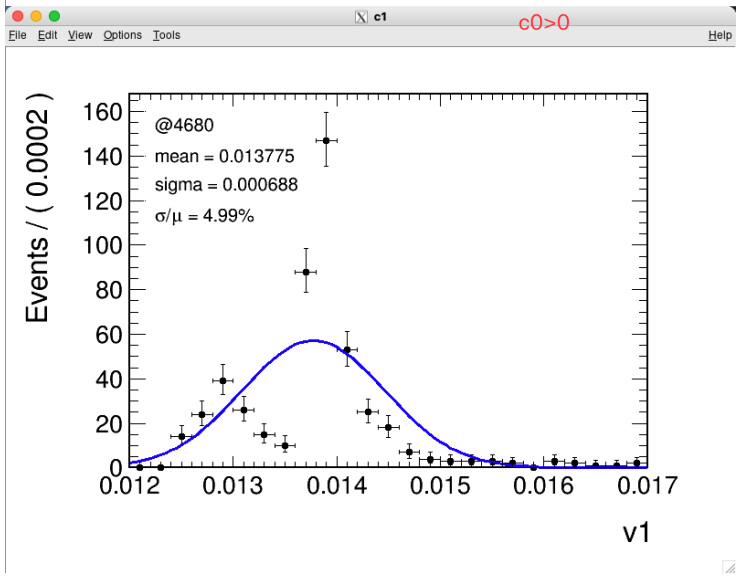

$$(1+\delta^{ISR})*\Sigma_i Br_i \epsilon_i \qquad c0 > 0$$

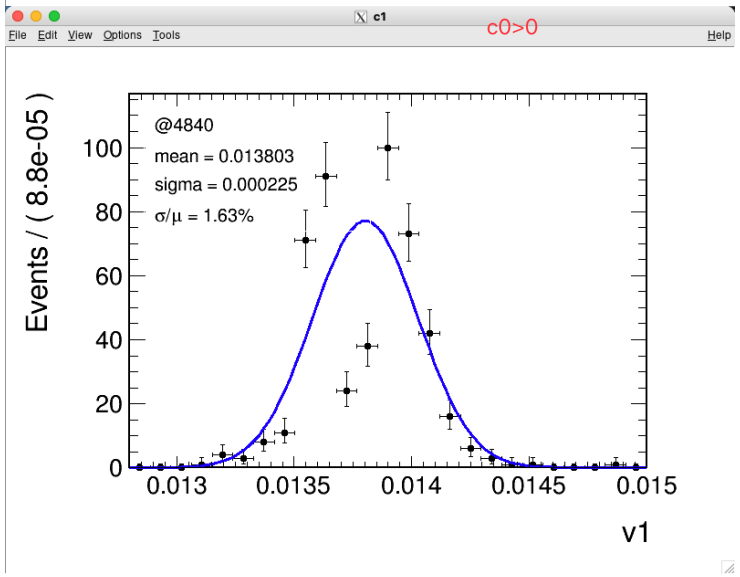






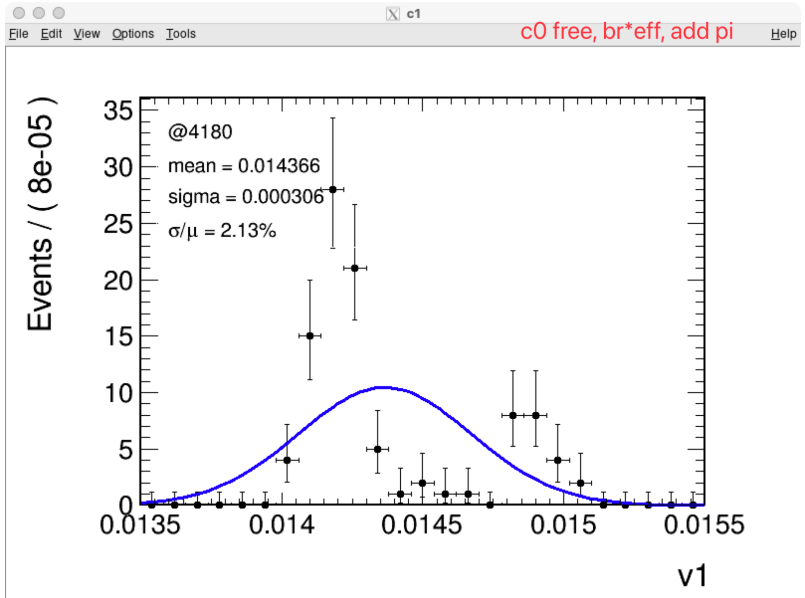


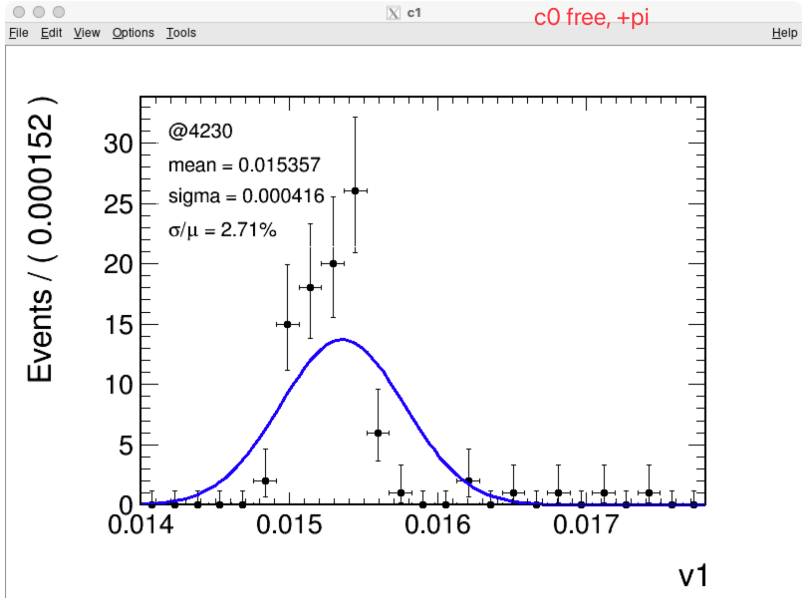


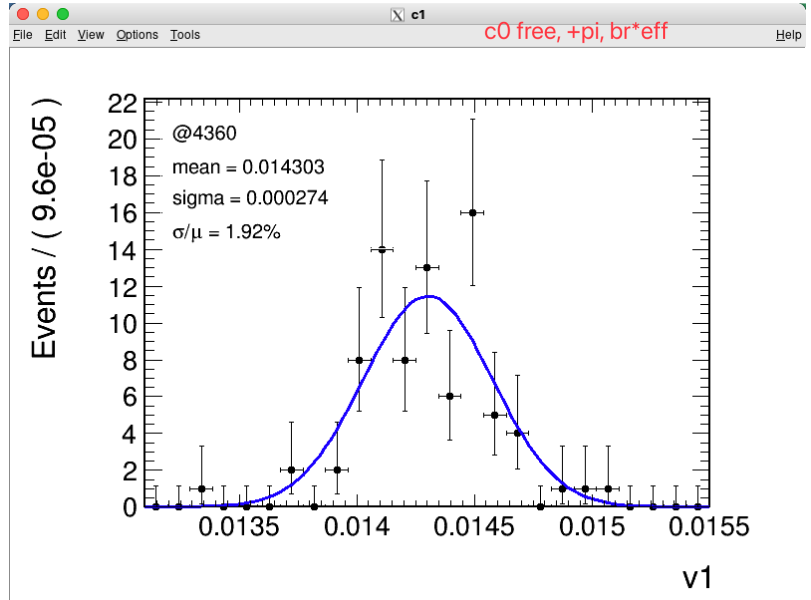


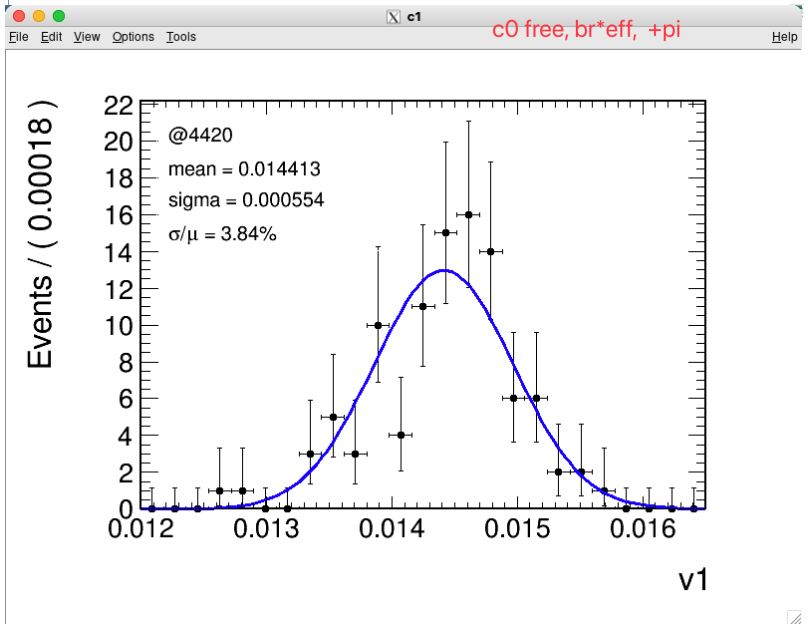
$(1+\delta^{ISR})*\Sigma_i Br_i \epsilon_i$ when c0<0, $\phi+\pi$

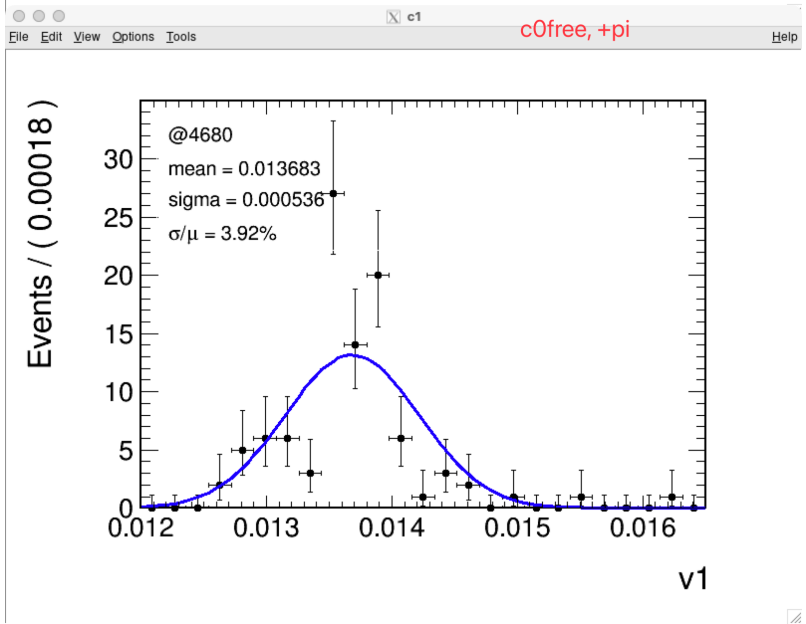
$$\sigma_{fit}=\left|C_0\sqrt{\Psi(\sqrt{s})}+BW_1(\sqrt{s})e^{i\phi 1}+BW_2(\sqrt{s})e^{i\phi 2}+BW_3(\sqrt{s})e^{i\phi 3}\right|^2 \qquad \Psi(\sqrt{s})=\frac{q^3}{s^n}$$

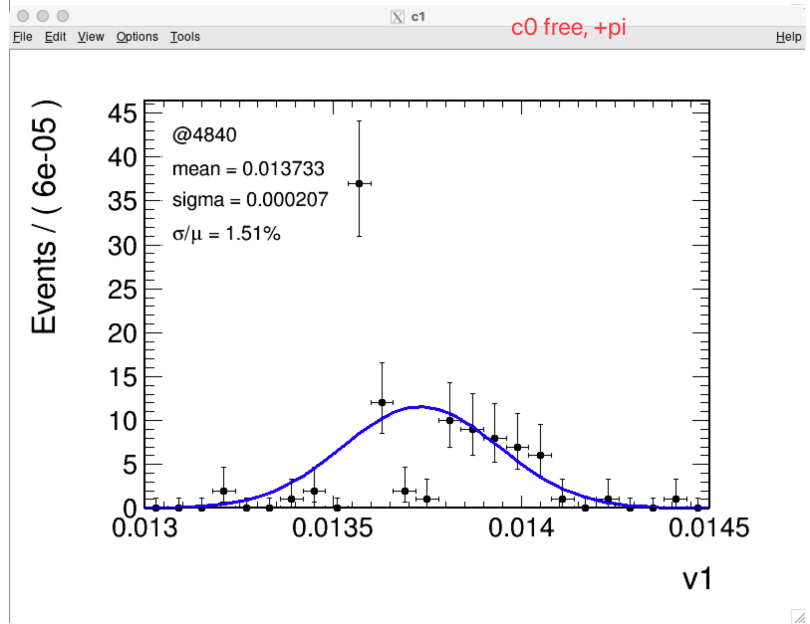




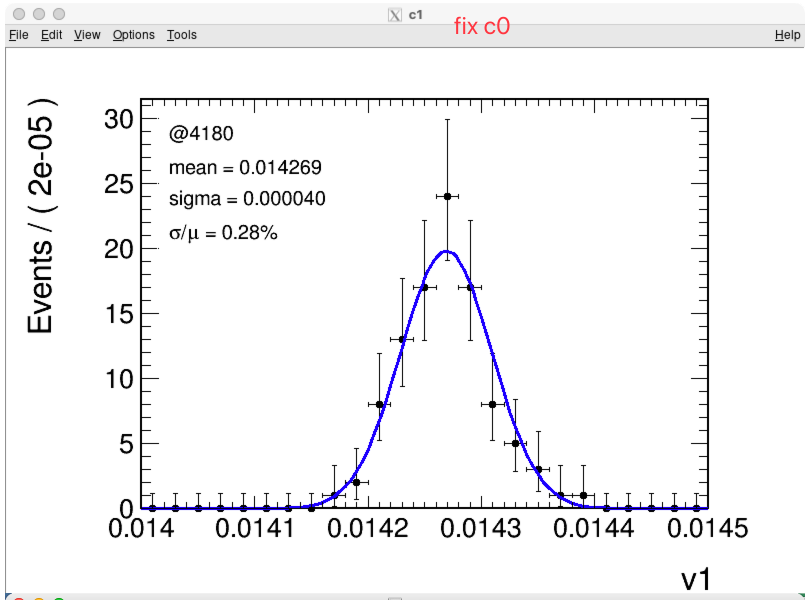


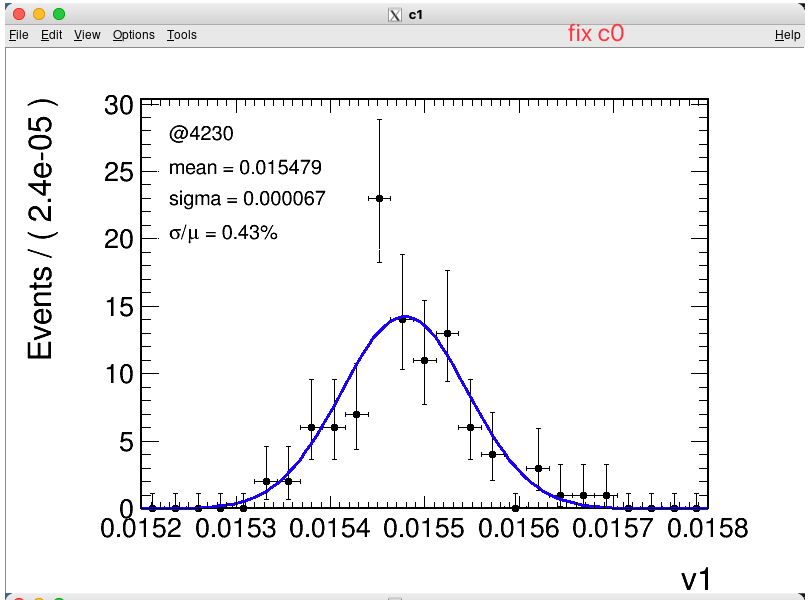


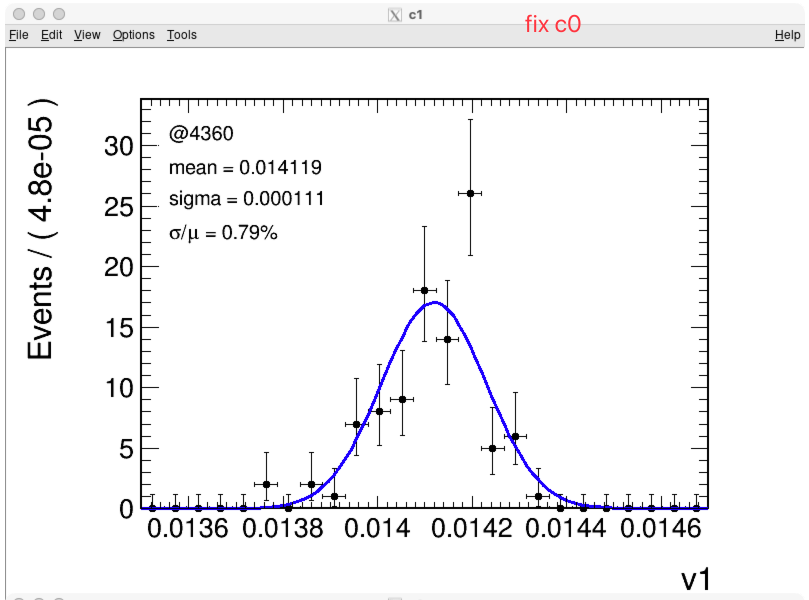


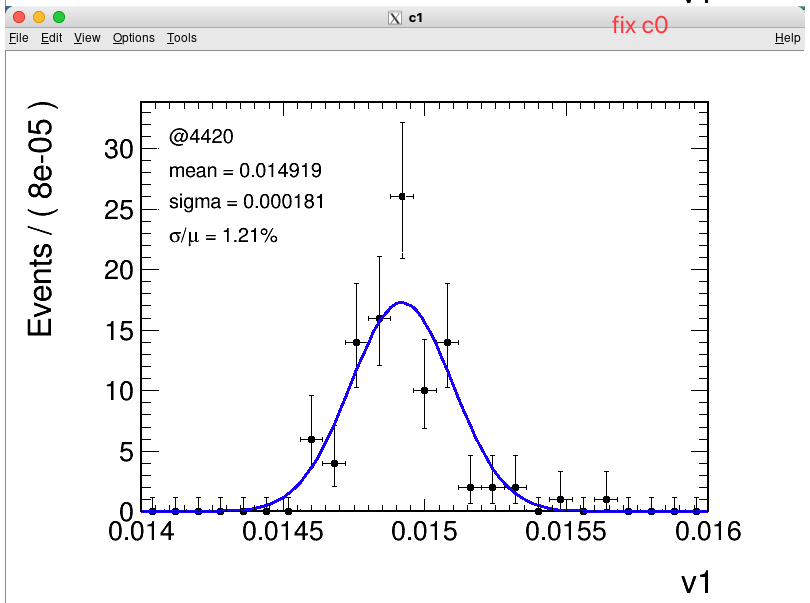


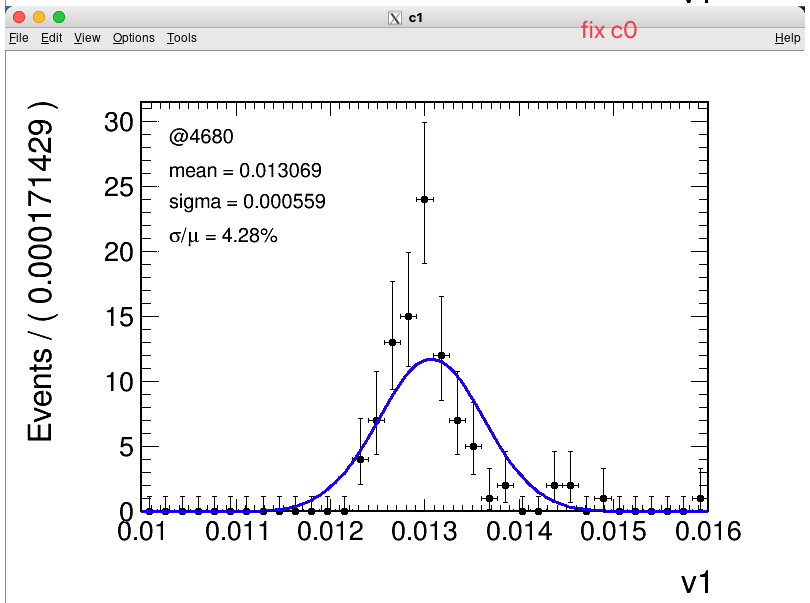
$(1+\delta^{ISR})*\Sigma_i Br_i \epsilon_i$ fix c0

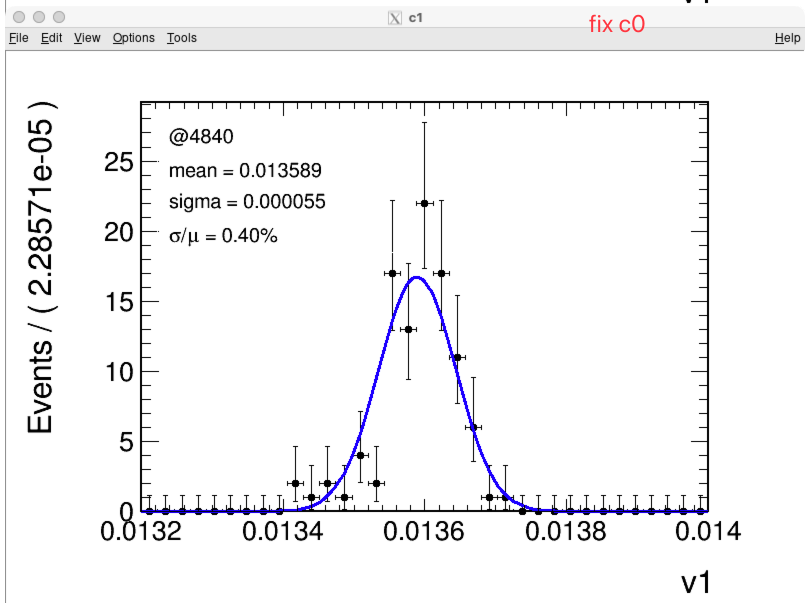






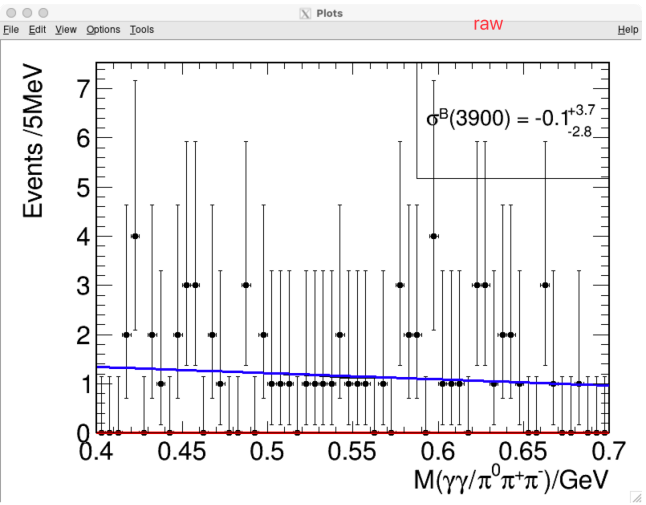


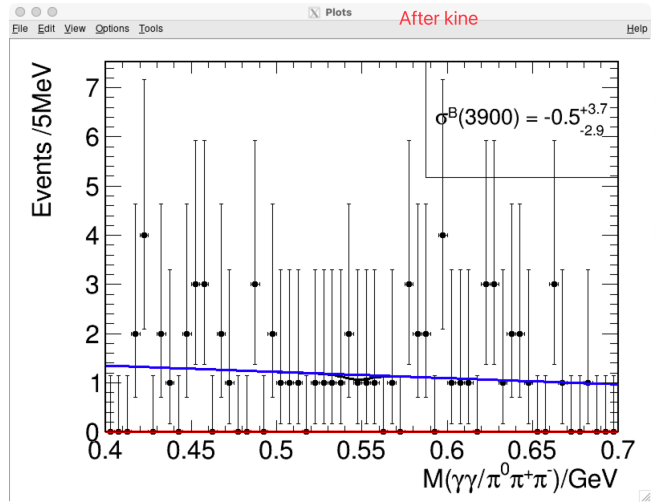


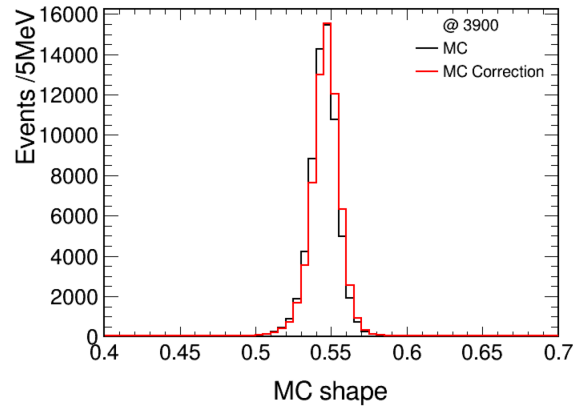


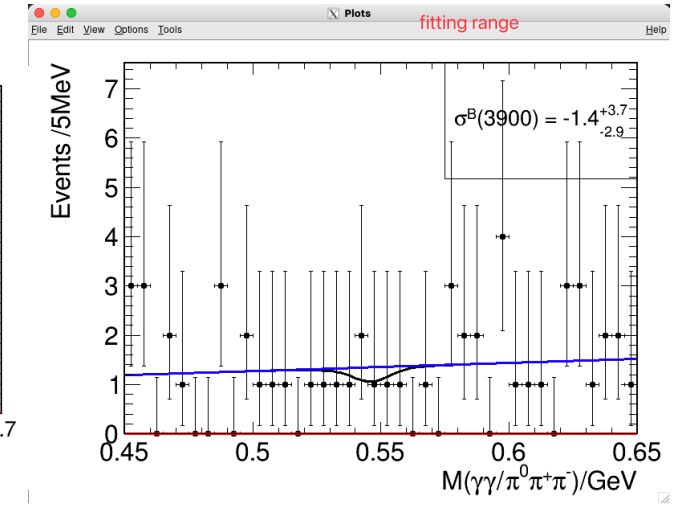
label	jpsi mass win	pi track	kinematic fit	bkg shape	signal shape	fitting range
3810	0.07%	0.50%	5.8%	55.46%	6.90%	127.65%
3872	0.15%	0.57%	1.19%	5.27%	0.12%	10.57%
3900	1.18%	5.64%	221%	269.10%	49.74%	846.93%
4009	0.10%	0.51%	0.9%	0.47%	0.47%	1.86%
4090	0.15%	0.38%	2.6%	7.14%	2.00%	3.60%
4130	0.09%	0.52%	0.6%	0.89%	0.52%	3.98%
4160	0.08%	0.47%	1.0%	0.03%	0.47%	1.41%
4180	0.07%	0.45%	0.73%	0.51%	0.31%	0.95%
4190	0.05%	0.44%	0.9%	0.46%	0.26%	0.80%
4200	0.05%	0.44%	0.6%	0.22%	0.27%	1.03%
4210	0.03%	0.43%	0.8%	0.37%	0.32%	0.72%
4220	0.06%	0.43%	0.9%	0.12%	0.29%	0.54%
4230	0.06%	0.44%	0.73%	0.31%	0.31%	0.97%
4237	0.08%	0.44%	0.8%	0.16%	0.30%	1.74%
4246	0.17%	0.46%	0.8%	0.06%	0.30%	9.29%
4260	0.22%	0.50%	1.17%	0.57%	0.42%	2.90%
4270	0.18%	0.50%	1.0%	0.59%	0.55%	2.29%
4280	0.22%	0.47%	1.4%	14.53%	0.21%	7.55%
4290	0.27%	0.60%	0.9%	0.77%	0.78%	8.16%
4310	0.20%	0.38%	2.3%	1.43%	0.17%	7.43%
4315	0.22%	0.58%	1.4%	1.59%	0.90%	3.67%
4340	0.11%	0.36%	0.3%	1.02%	0.08%	1.75%

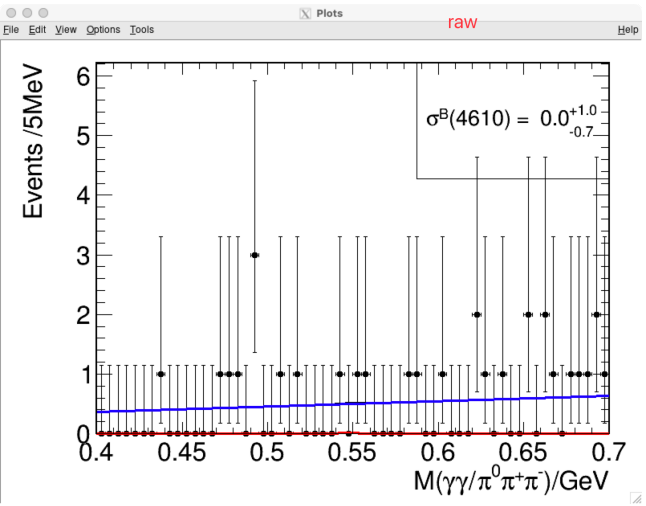
label	jpsi mass win	pi track	kinematic fit	bkg shape	signal shape	fitting range
4360	0.09%	0.51%	0.24%	1.82%	0.20%	3.42%
4380	0.11%	0.52%	1.2%	2.88%	0.66%	0.54%
4390	0.03%	0.43%	1.7%	3.61%	1.43%	158.90%
4400	0.03%	0.52%	0.8%	0.59%	0.76%	3.50%
4420	0.06%	0.68%	0.38%	0.59%	0.41%	0.53%
4440	0.12%	0.55%	1.2%	1.44%	0.62%	2.22%
4470	0.16%	0.34%	15.1%	8.75%	4.48%	18.79%
4530	0.78%	0.91%	14.0%	270.48%	9.14%	99.40%
4575	0.69%	0.68%	58.8%	148.82%	23.90%	58.59%
4600	0.32%	0.29%	6.5%	0.77%	2.06%	6.68%
4610	6.34%	6.22%	151.0%	480.07%	28.57%	871.70%
4630	0.58%	0.25%	41.7%	7.58%	0.41%	50.24%
4640	0.48%	0.21%	339.0%	7.19%	8.60%	393.99%
4660	0.15%	0.27%	470.2%	157.61%	31.91%	774.66%
4680	0.04%	0.31%	7.49%	6.84%	0.54%	33.14%
4700	0.14%	0.31%	43.2%	733.96%	147.18%	246.92%
4740	0.03%	0.35%	22.2%	8.46%	12.18%	13.89%
4750	0.03%	0.28%	15.0%	6.86%	9.40%	18.31%
4780	0.06%	0.27%	1.7%	8.47%	0.97%	1.75%
4840	0.03%	0.25%	33.98%	95.23%	0.64%	32.59%
4914	0.06%	0.24%	0.6%	0.91%	0.20%	12.43%
4946	0.08%	0.23%	2.8%	2.05%	0.52%	32.19%

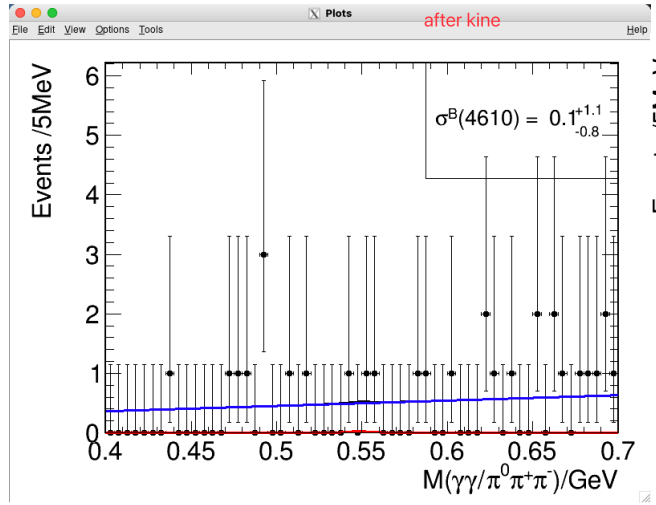

Plots
File Edit View Options Tools Help
raw
$\sigma^B(3900) = -0.1^{+3.7}_{-2.8}$
Events /5MeV
$M(\gamma\gamma/\pi^0\pi^+\pi^-)$/GeV

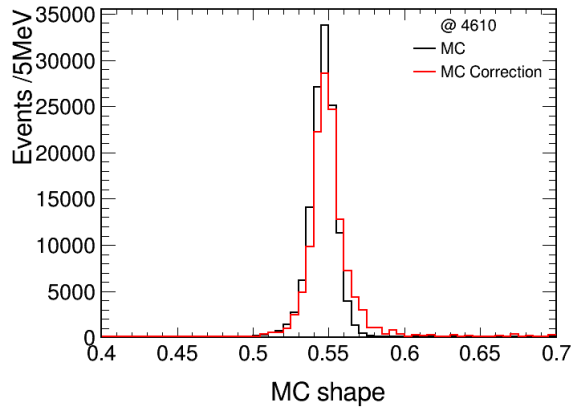

Plots
File Edit View Options Tools Help
After kine
$\sigma^B(3900) = -0.5^{+3.7}_{-2.9}$
Events /5MeV
$M(\gamma\gamma/\pi^0\pi^+\pi^-)$/GeV

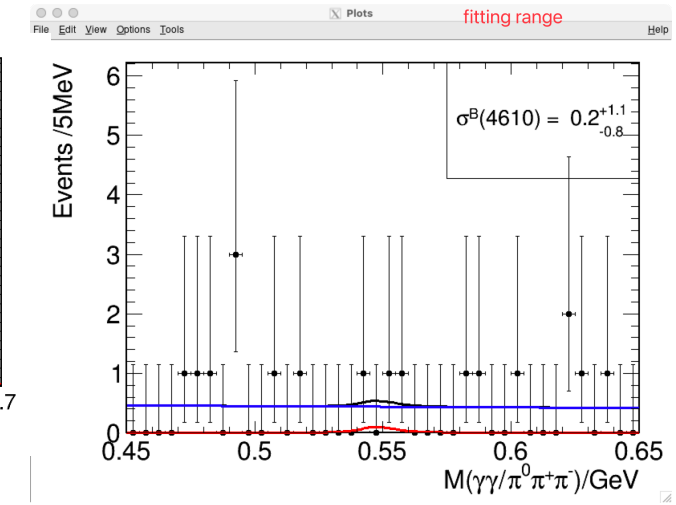

@ 3900
MC
MC Correction
Events /5MeV
MC shape


Plots
File Edit View Options Tools Help
fitting range
$\sigma^B(3900) = -1.4^{+3.7}_{-2.9}$
Events /5MeV
$M(\gamma\gamma/\pi^0\pi^+\pi^-)$/GeV


Plots
File Edit View Options Tools Help
raw
$\sigma^B(4610) = 0.0^{+1.0}_{-0.7}$
Events /5MeV
$M(\gamma\gamma/\pi^0\pi^+\pi^-)$/GeV


Plots
File Edit View Options Tools Help
after kine
$\sigma^B(4610) = 0.1^{+1.1}_{-0.8}$
Events /5MeV
$M(\gamma\gamma/\pi^0\pi^+\pi^-)$/GeV

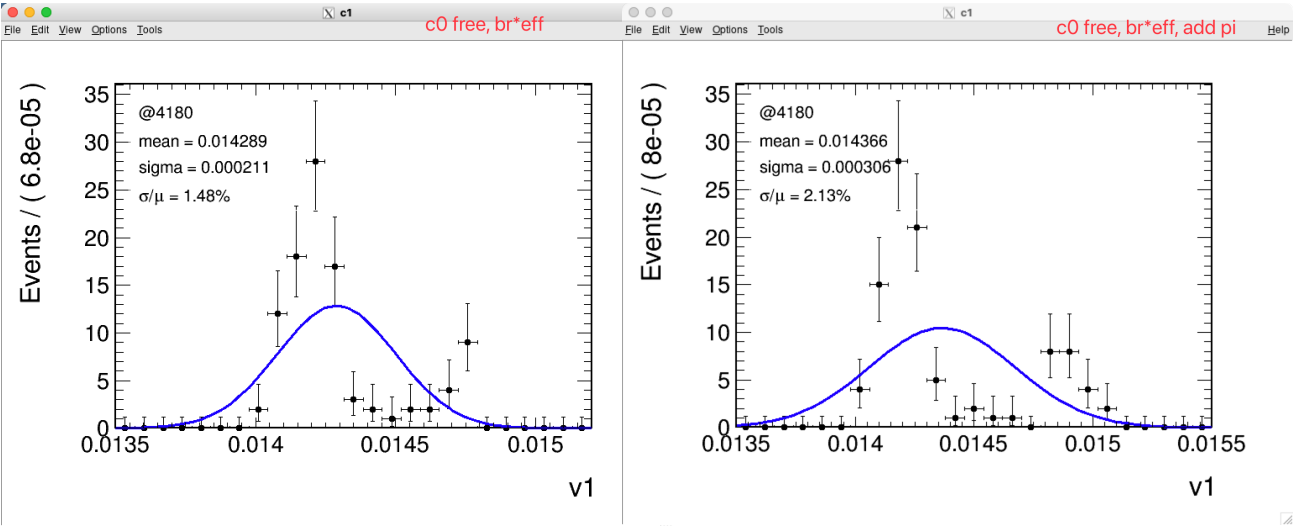

@ 4610
MC
MC Correction
Events /5MeV
MC shape


Plots
File Edit View Options Tools Help
fitting range
$\sigma^B(4610) = 0.2^{+1.1}_{-0.8}$
Events /5MeV
$M(\gamma\gamma/\pi^0\pi^+\pi^-)$/GeV

Back up

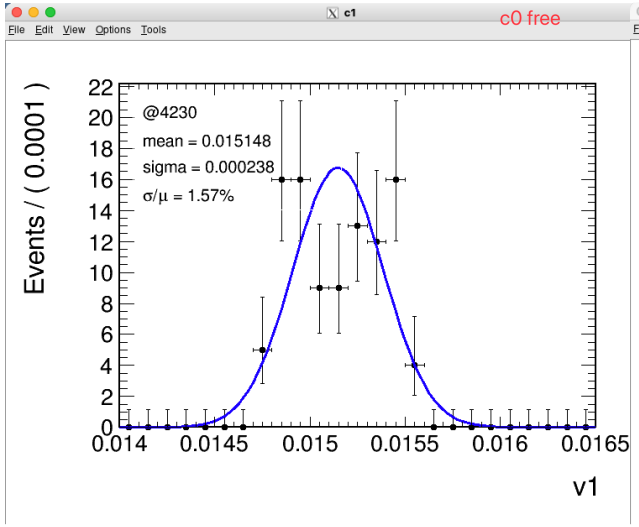
$$(1+\delta^{ISR})*\Sigma_i Br_i \epsilon_i$$

c0 free, br*eff

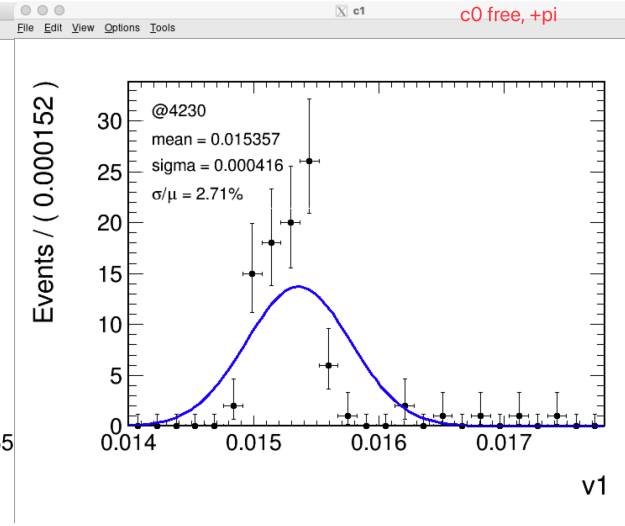


c0 free, br*eff, add pi

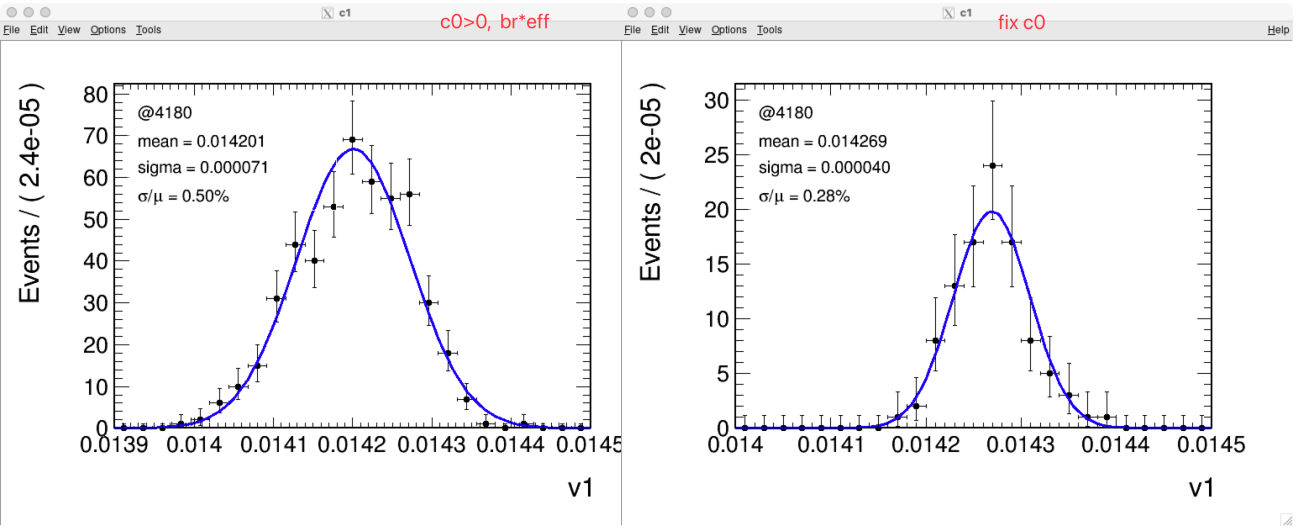
c0 free



c0 free, +pi

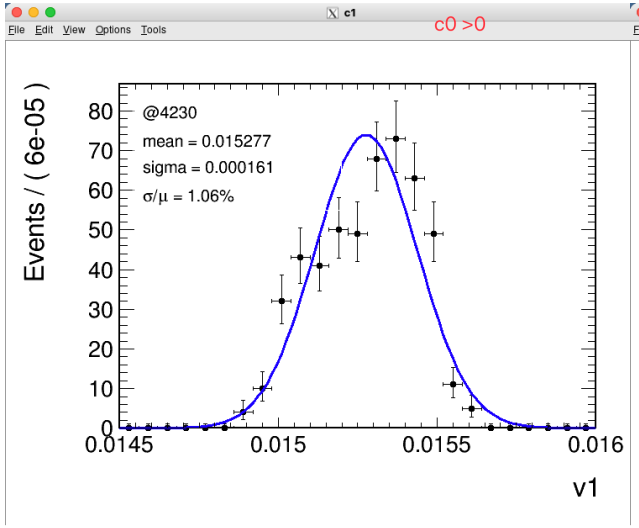


c0>0, br*eff

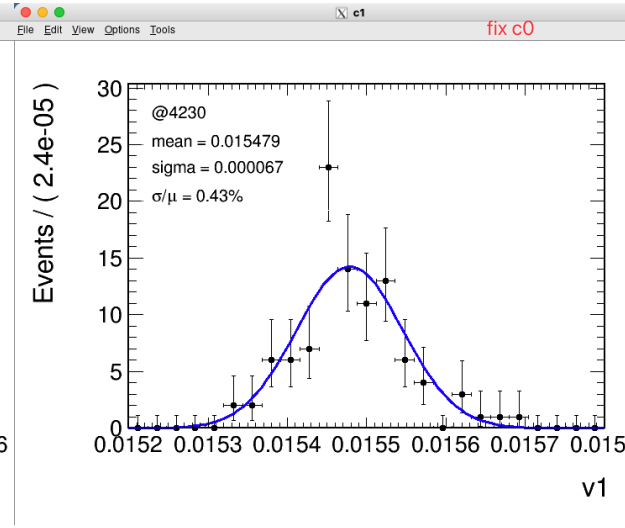


fix c0

c0 >0

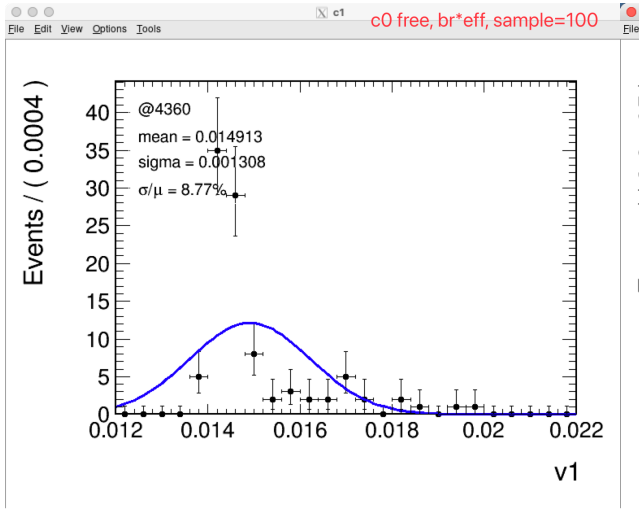


fix c0

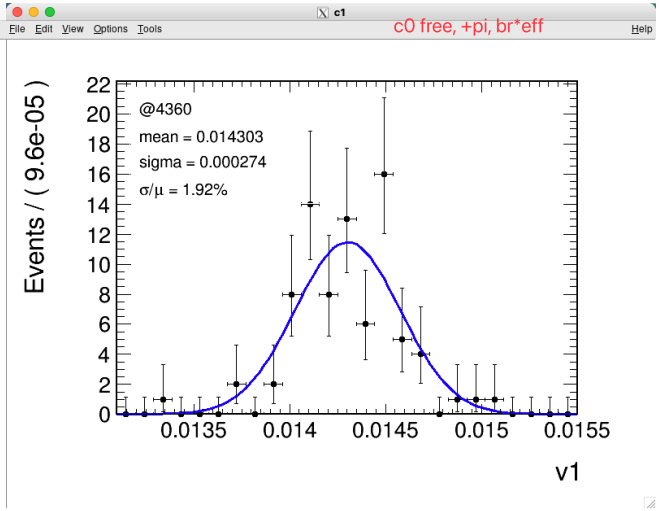


$$(1+\delta^{ISR})*\Sigma_i Br_i \epsilon_i$$

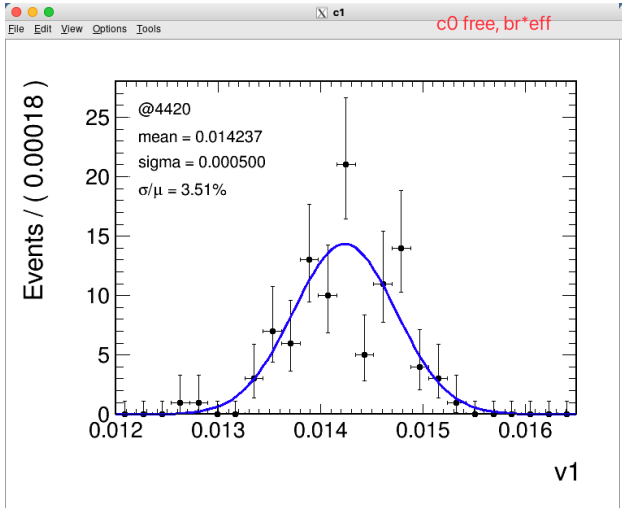
c0 free, br*eff, sample=100



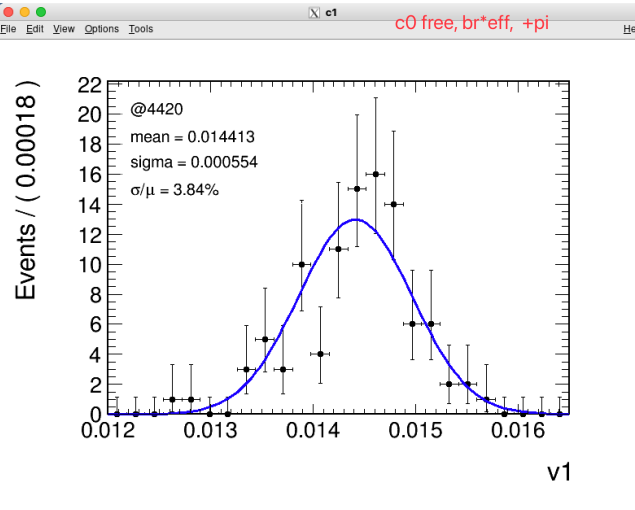
c0 free, +pi, br*eff



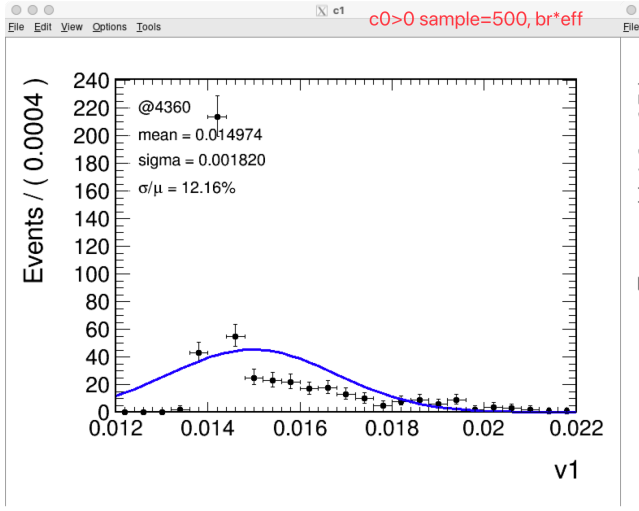
c0 free, br*eff



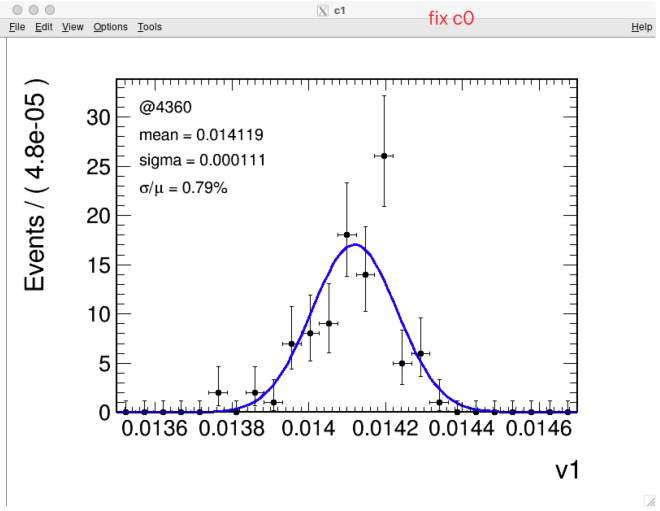
c0 free, br*eff, +pi



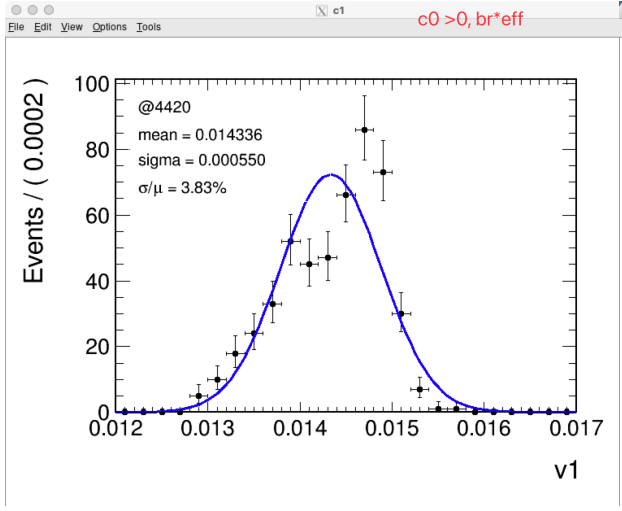
c0>0 sample=500, br*eff



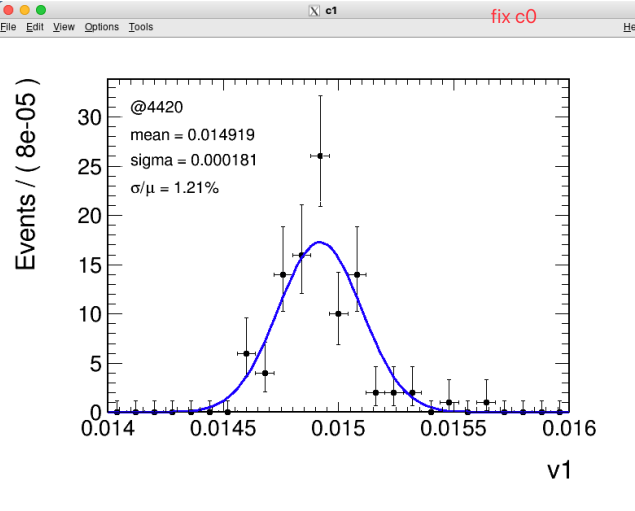
fix c0



c0 >0, br*eff

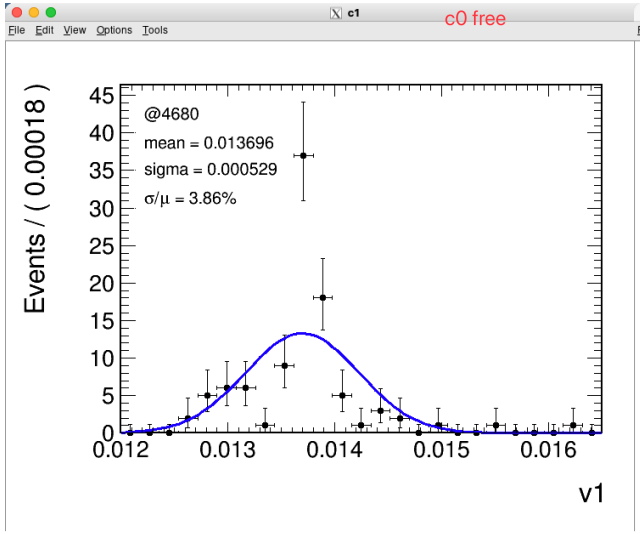


fix c0

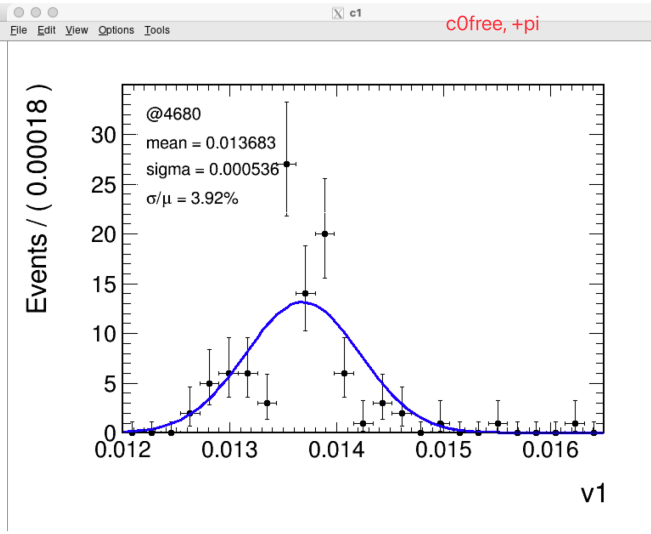


$$(1+\delta^{ISR})*\Sigma_i Br_i \epsilon_i$$

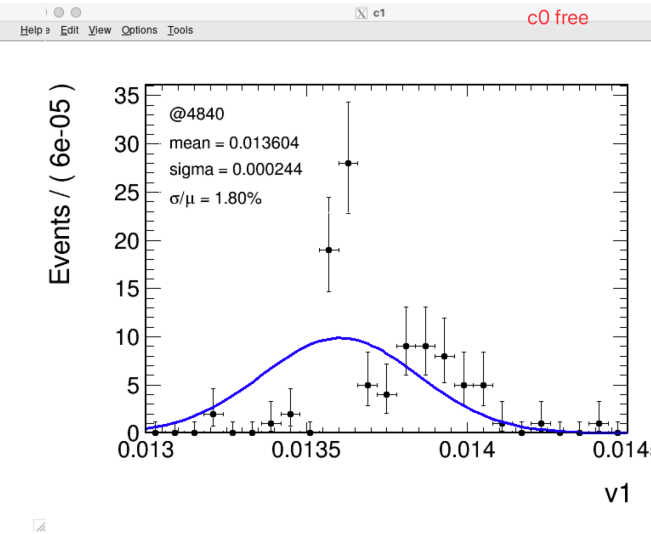
c0 free



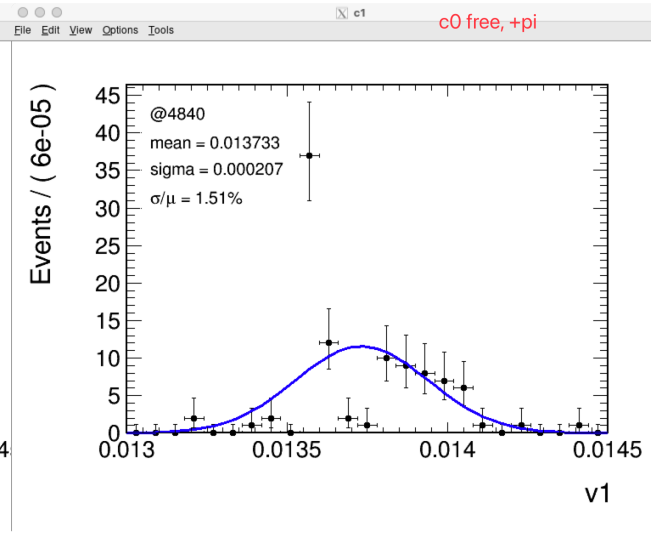
c0free, +pi



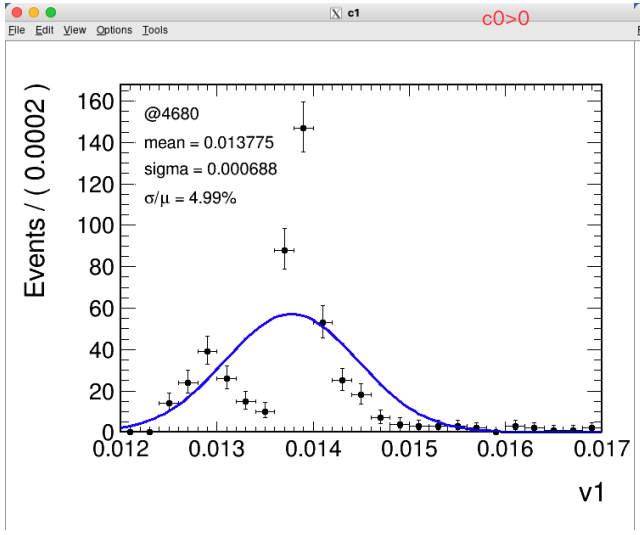
c0 free



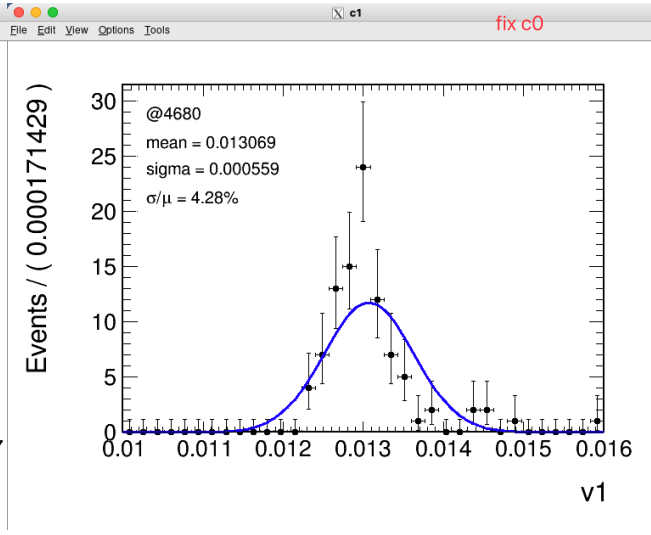
c0 free, +pi



c0>0



fix c0



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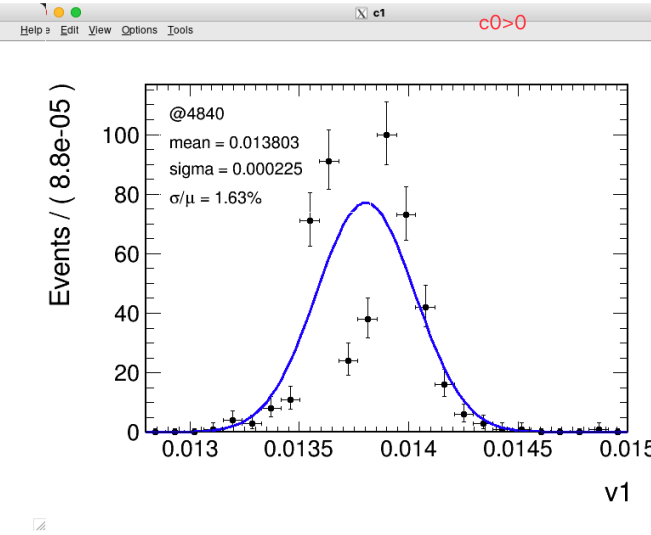

fix c0