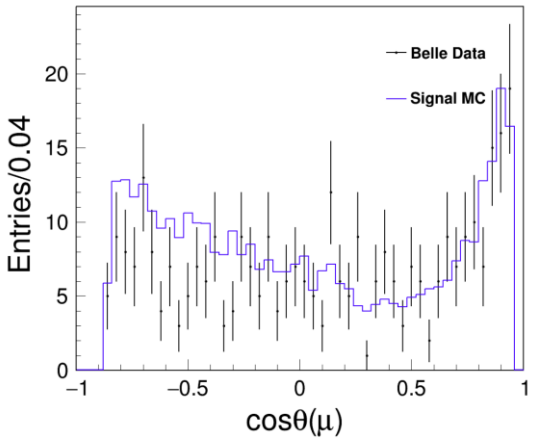
Group meeting

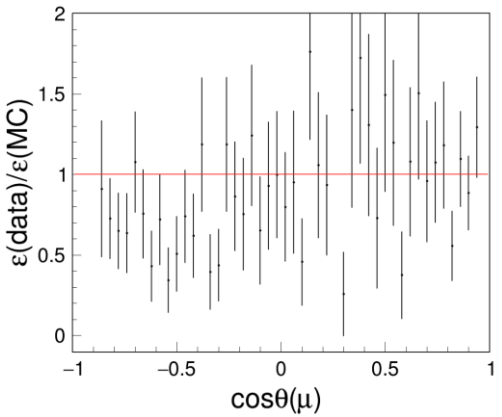
2024/9/13

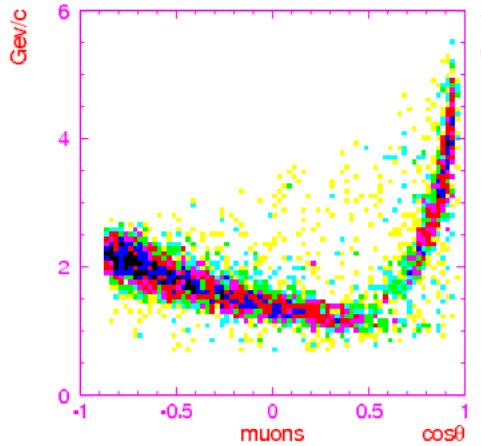
PID 效率修正&&系统误差

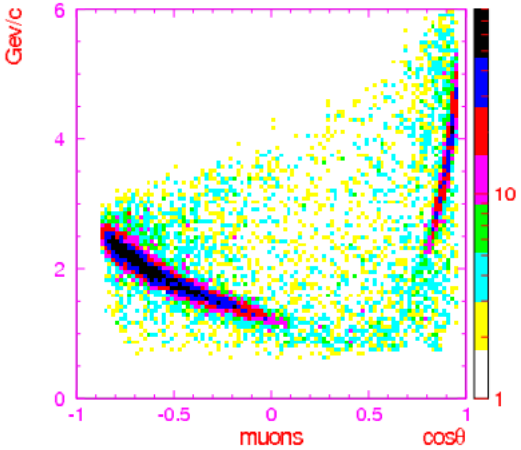
对于前后端盖部分，MC的模拟与数据差别较大，PID组结果无法直接使用

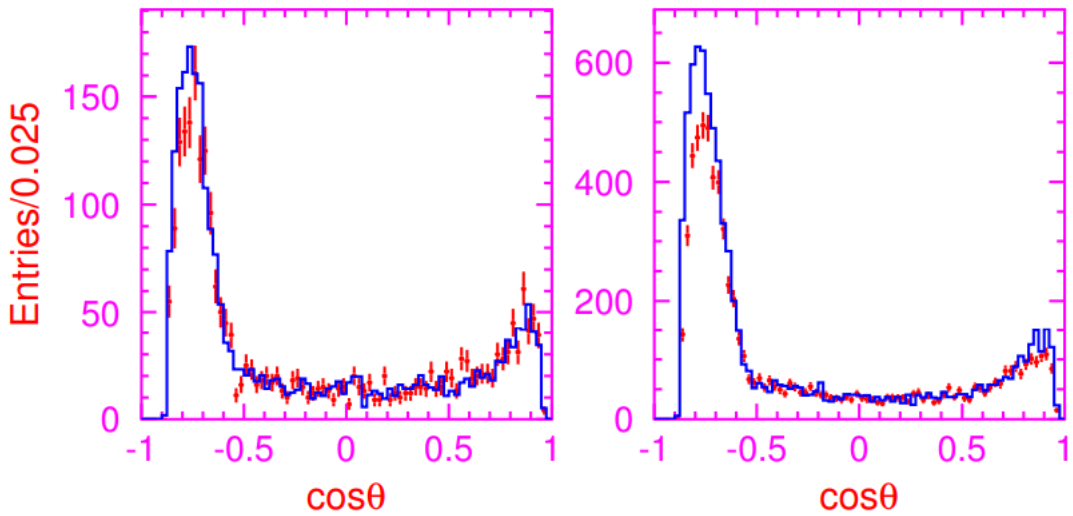
第一排左侧两张图来自Belle data，右侧来自BN982， 第二排来自BN978

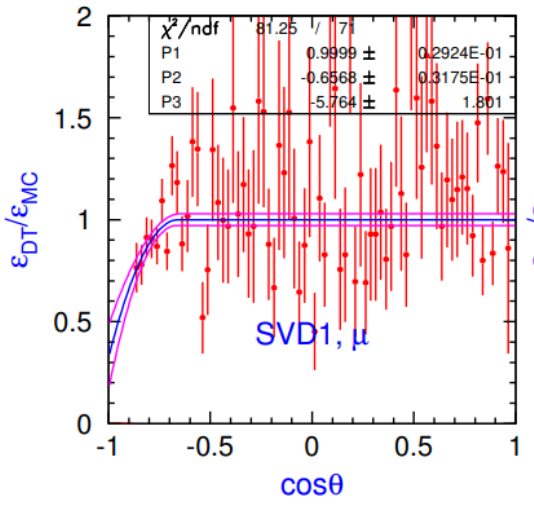


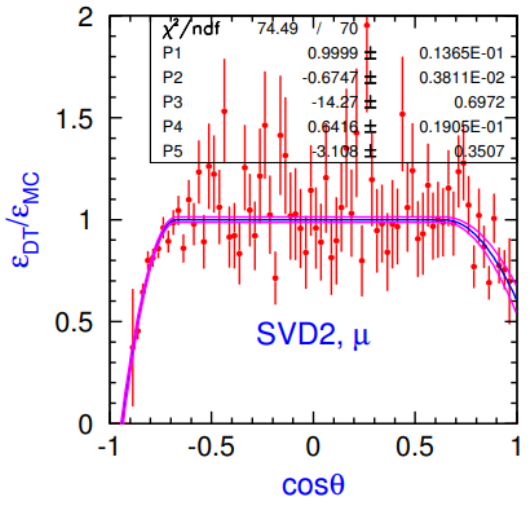








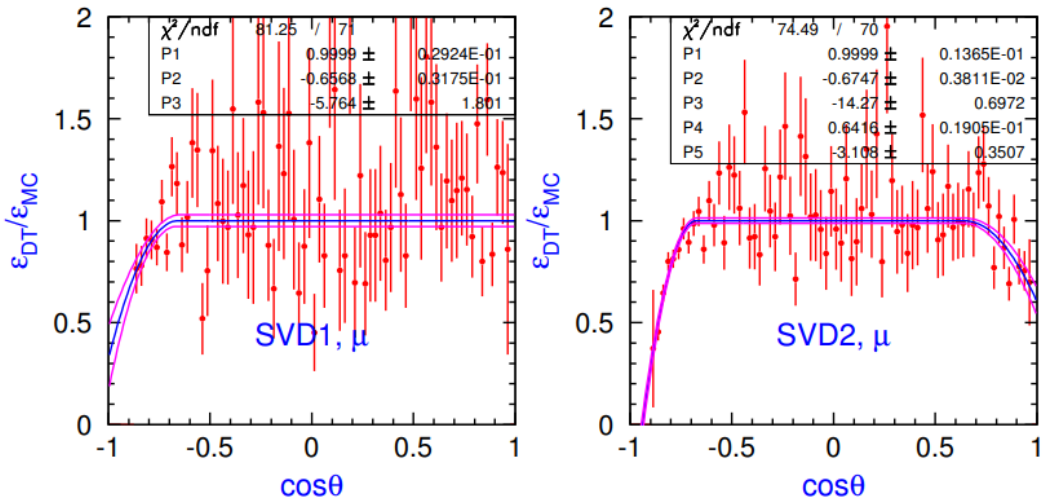




解决方法@Belle

利用桶部事例归一化后对不同$cos\theta$下的$\frac{\varepsilon_{DT}}{\varepsilon_{MC}}$曲线进行二项式拟合，得到对应值和标准差，利用曲线进行抽样得到效率修正值和系统误差(端盖提供)，桶部修正进行保守估计

$$f=\frac{\varepsilon_{DT}}{\varepsilon_{MC}}=\begin{cases} p1+p3(x-p2)^2 & x\le p2 \\ p1 & p2<x<p4 \\ p1+p5(x-p4)^2 & x\ge p4 \end{cases}$$



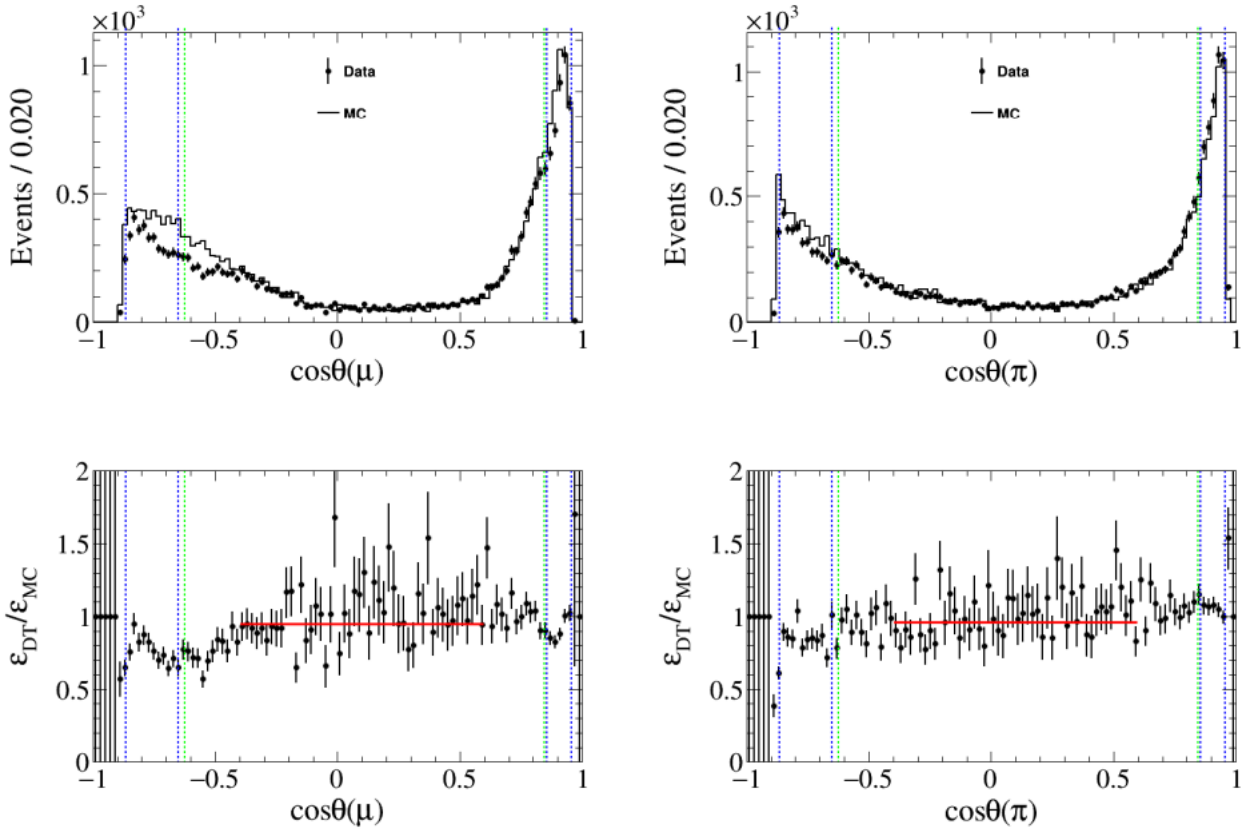

```
      if ( m_mc && m_expNo< 30 ) {     // SVD1
//e
      std::cout<<"correction beginning!!!"<<endl;
        if(shift3==1){
   if(abs(lp.mag()-0.000511)<0.05){           yv1 = 0.9850;
        if(xv1<-0.5149) yv1=0.9850-1.177*(xv1+0.5149)*(xv1+0.5149);
        if(xv1> 0.8401) yv1=0.9850-10.48*(xv1-0.8401)*(xv1-0.8401);
        if(random1>yv1)return;}
   if(abs(lm.mag()-0.000511)<0.05) {           yv2 = 0.9850;
        if(xv2<-0.5149) yv2=0.9850-1.177*(xv2+0.5149)*(xv2+0.5149);
        if(xv2> 0.8401) yv2=0.9850-10.48*(xv2-0.8401)*(xv2-0.8401);
        if(random2>yv2)return;}}
//e error
       if(shift3==2){
   if(abs(lp.mag()-0.000511)<0.05){           yv1 = 0.9815;
        if(xv1<-0.5068) yv1=0.9815-2.901*(xv1+0.5068)*(xv1+0.5068);
        if(xv1>0.8077)  yv1=0.9815-7.685*(xv1-0.8077)*(xv1-0.8077);
        if(random1>yv1)return;}
   if(abs(lm.mag()-0.000511)<0.05) {           yv2 = 0.9815;
         if(xv2<-0.5068) yv2=0.9815-2.901*(xv2+0.5068)*(xv2+0.5068);
         if(xv2>0.8077)  yv2=0.9815-7.685*(xv2-0.8077)*(xv2-0.8077);
         if(random2>yv2)return;}}
```

The above uncertainties did not include the absolute efficiency difference in the barrel portion of the detector for the pion and muon ID. According to the measurement of the pion ID efficiency using D^* events [10], the MC simulated data within about 0.5% for each pion, and 2.0% (1.0%) was taken to be the systematic error for pion ID of the $\pi^+\pi^- J/\psi$ ($\mu^+\mu^-$) mode . For the lepton ID, according to the measurement of $\gamma\gamma \to \ell^+\ell^-$ events [11], the uncertainties on identification were 2.0% and 0.5% for each electron/position, and muon track candidate surviving the selection criteria, respectively. In the $\pi^+\pi^- J/\psi$ mode, $\varepsilon_{\ell^+\ell^-} = (\varepsilon_{e^+e^-} + \varepsilon_{\mu^+\mu^-})/2$ and $\varepsilon_{e^+e^-} = (0.358 \pm 0.003) \times \varepsilon_{\ell^+\ell^-}$, $\varepsilon_{\mu^+\mu^-} = (0.642 \pm 0.003) \times \varepsilon_{\ell^+\ell^-}$. The systematic error of the lepton ID and lepton efficiency correction is 2.0%. Here we need to mention that only one muon candidate with $LK(\mu) > 0.9$ is required. The systematic error of μID is 2.0%.

解决方法 from BELLE2-NOTE-PH-2024-024

利用桶部事例归一化后，桶部提供的修正由PID组结果得到，前后端盖中的每个bin修正值设定为$\frac{\varepsilon_{DT}}{\varepsilon_{MC}}$，且只取统计误差$\sqrt{N}$，最后再根据事例数进行加权得到最终修正与误差

问题：桶部归一带来的bias如何确定？



修正方法in this work

利用桶部事例归一化后对不同$cos\theta$下的$\frac{\varepsilon_{DT}}{\varepsilon_{MC}}$曲线进行二项式拟合，得到对应值和标准差，利用曲线计算端盖区域各个bin的修正因子与标准差，桶部采用Belle KID table，最后得到最终结果。（合并方式 fromBN779）

$$R = \frac{1}{N}\sum_l n_l R_l, \qquad \delta R = \frac{1}{N}\left(\sqrt{\sum_l \left(n_l \delta R_l^{\mathrm{stat}}\right)^2} + \sum_l n_l \delta R_l^{\mathrm{syst}}\right) + R_{\mathrm{const}}.$$

问题：Belle PID组桶部区域在低动量区域存在没有修正因子的情况(假设这些区域$\frac{\varepsilon_{DT}}{\varepsilon_{MC}}$=1？)

2	4	0102	0.9985	0.0020	0.0003	0.9970	0.0011	1.0015	0.0023	0.0003	0
2	4	0103	0.9976	0.0017	0.0003	0.9995	0.0007	0.9981	0.0018	0.0003	0
2	4	0104	0.9969	0.0027	0.0049	0.9981	0.0012	0.9988	0.0030	0.0049	0
2	4	0105	0.9957	0.0039	0.0005	0.9978	0.0017	0.9979	0.0043	0.0005	0
2	4	0106	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1
2	4	0107	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1
2	4	0108	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1
2	4	0109	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1
2	4	0110	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1
2	4	0111	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1
2	4	0112	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	1