中国科学技术大学
University of Science and Technology of China

Master to Ph.D. Candidate Defense Report

Bo Wang (王博)

SA21004022

Outline

- Personal Introduction
- Research Situation
  - Search for $J/\psi \to \gamma D^0/\bar{D}^0$ on BESIII
  - Study of K_s^0 efficiency in $\psi(3770)$ data on BESIII
  - Study of simulation and reconstruction of EMC on STCF
- Summary and Future Plan

Personal Introduction

- Basic situation
  - Name: Bo Wang (王博)
  - Student ID: SA21004022
  - Major: Particle and Nuclear Physics
  - Supervisor: Haiping Peng(彭海平)

- Education
  - 2017-2021: Bachelor of Physics at Sichuan University
  - 2021-now: Master student in Particle and Nuclear Physics at USTC

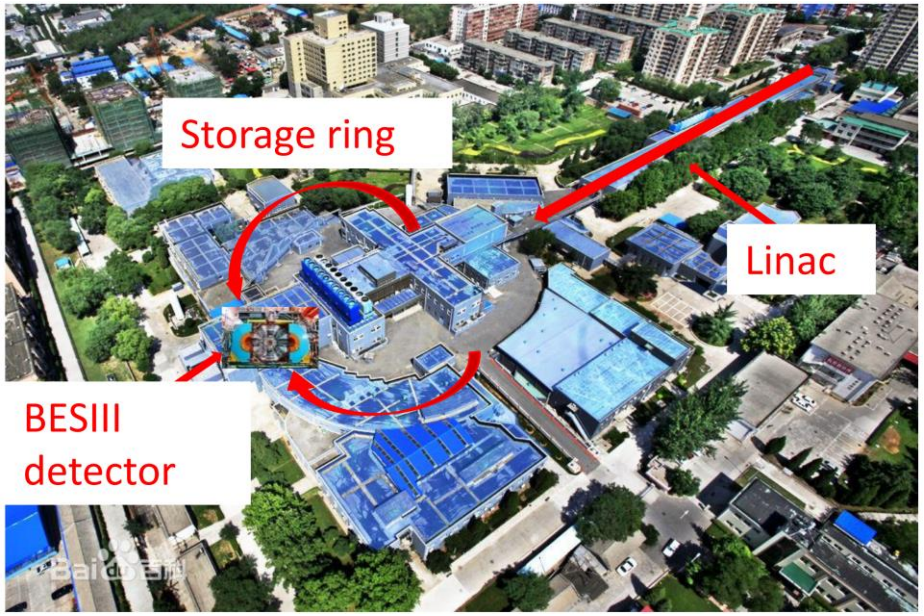
Personal Introduction

➢Scores

学号：SA21004022	姓名：王博	校验结果：尚未合格
您适用的培养计划标准：	物理学硕士	重新进行培养计划校验
培养计划校验详情：	缺学位论文开题报告；	
培养计划标准备注：		
培养计划要求	已经获得学分	是否合格
总学分(带必修环节)>=35	总学分=35	合格
基础课加权平均>=75	基础课加权平均=87	合格
基础课学分>=16	基础课学分=24	合格
学科基础课学分>=8	学科基础课学分=8	合格
公共必修课学分=7	公共必修课学分=7	合格
基础英语课学分>=2	基础英语课学分=2	合格
应用英语课学分>=2	应用英语课学分=2	合格
学位论文开题报告		尚未合格

Research Situation

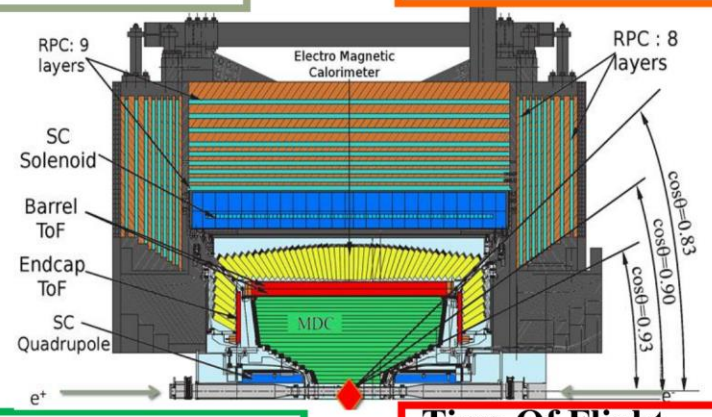
➢BEPCII and BESIII



Double ring: e^+ and e^-
Circumference: 237.53m
Cross angle: 2 × 11 mrad
E_{cm}=2.0-4.6 GeV (2.0-4.95 GeV since 2019)
Peak luminosity: $1.1 \times 10^{33} cm^{-2} s^{-1}$@$\psi(3770)$

Electromagnetic Calorimeter
CsI(Tl): L=28 cm
Barrel σ_E=2.5%
Endcap σ_E=5.0%

Muon Counter
RPC
Barrel: 9 layers
Endcap: 8 layers
$\sigma_{spatial}$: 1.48 cm



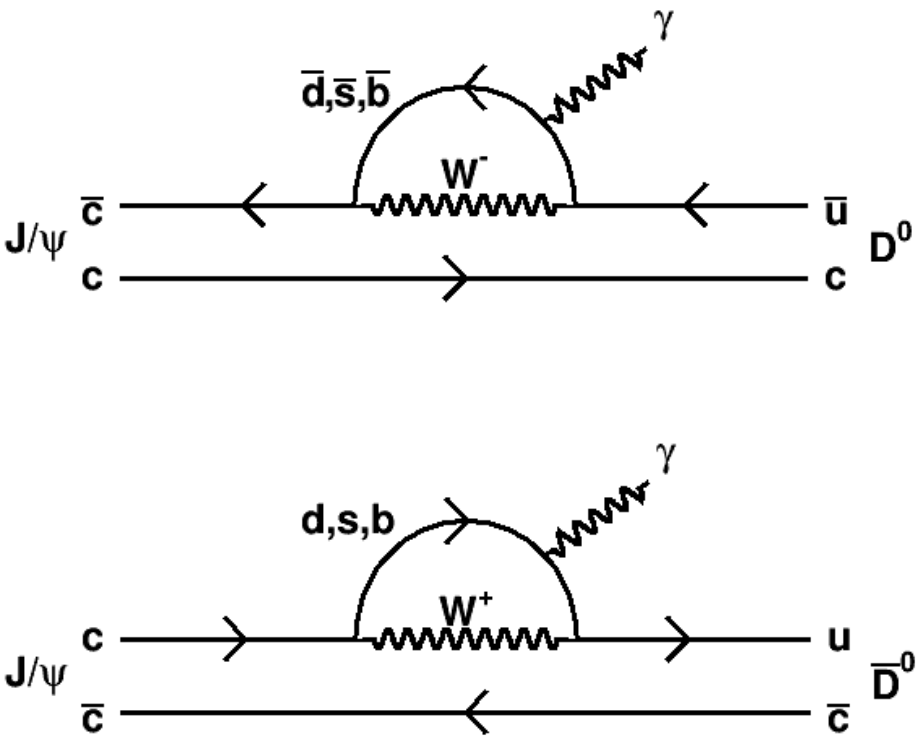
Main Drift Chamber
Small cell, 43 layer
σ_{xy}=130 μm
dE/dx~6%
σ_p/p= 0.5% at 1 GeV

Time Of Flight
Plastic scintillator
σ_T(barrel): 80 ps
σ_T(endcap): 110 ps
(update to 65 ps with MRPC)

Search for $J/\psi \to \gamma D^0/\bar{D}^0$ on BESIII

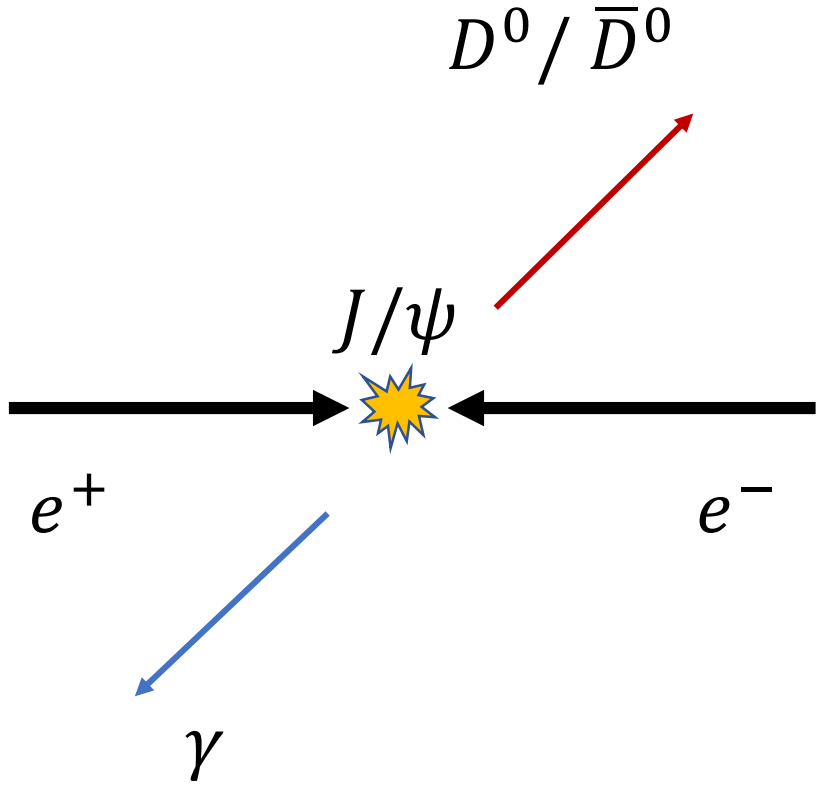
Motivation

- In the standard model (SM), due to Glashow-Iliopoulos-Maiani (GIM) mechanism, flavor changing neutral currents (FCNC) is forbidden at the tree level but can occur at the loop level.
- FCNC process is a good probe for New Physics beyond SM.
- 10 billion J/ψ data with clean environment provides an exceptional condition to study FCNC process.



Analysis Strategy

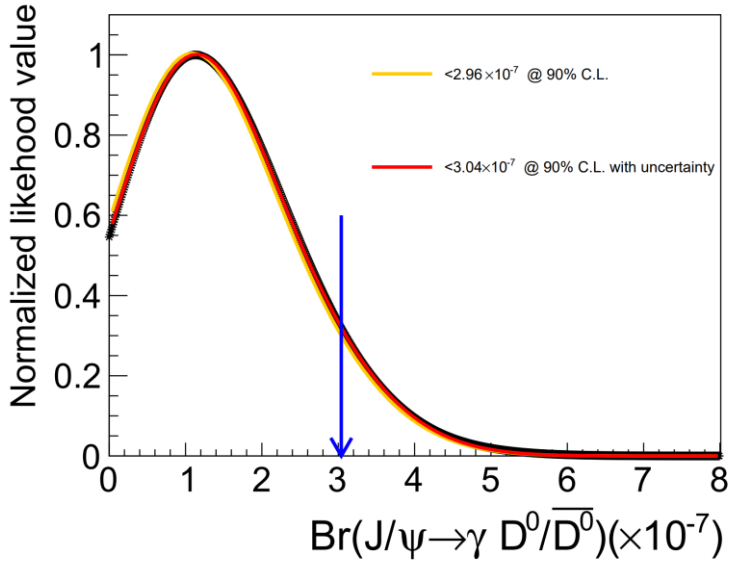
- The signal is reconstructed by a $D^0/\bar{D}^0$ from D tag channels and a photon.
- Blind analysis strategy is adopted to avoid bias by only using total inclusive MC and part of the data.
- Reconstructed D mass is used to extract signal.
- The upper limit will be given if no obvious signal is found.
- Lots of kinds of background
  - Alternative kinematic fit for K/π misidentification
  - Mass window for K_S^0 , ω and K decay
  - TMVA method for K_L^0 background
  - E/P for e misidentification

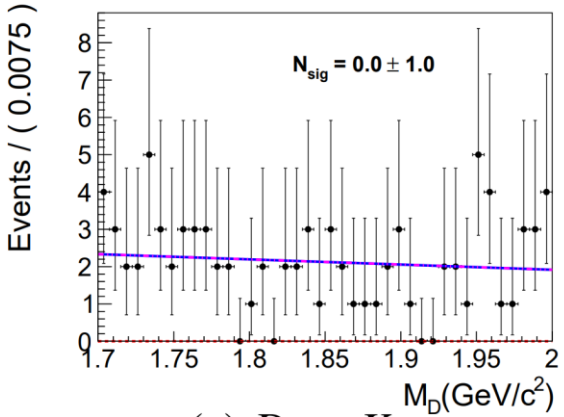


$D^0/\bar{D}^0$ gold tag channel
$D^0 \to K^-\pi^+$+c.c.
$D^0 \to K^-\pi^+\pi^0$+c.c.
$D^0 \to K^-\pi^+\pi^+\pi^-$+c.c.

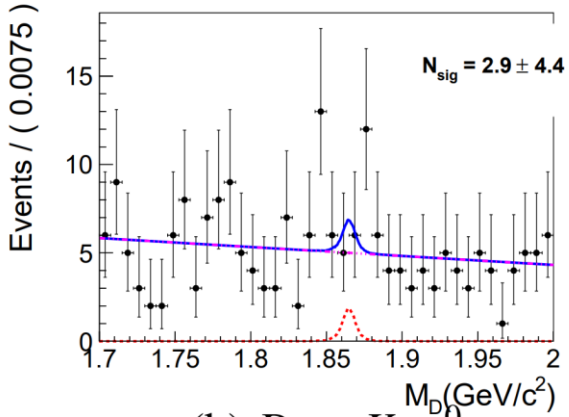
Result

- No obvious signal is observed.
- Bayes Method is used to calculate the upper limit
- Likelihood of three channels with systematic uncertainty is combined to get the upper limit at 90%C.L.
- The upper limit: $\mathrm{Br}(J/\psi \rightarrow \gamma D^0/\bar{D}^0) < 3.04 \times 10^{-7}$

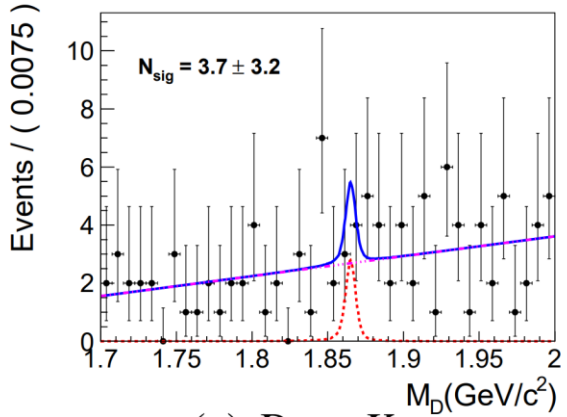




(a) $D \rightarrow K\pi$



(b) $D \rightarrow K\pi\pi^0$



(c) $D \rightarrow K\pi\pi\pi$

Prospect

- The upper limit of branching fraction measurement and systematic uncertainty analysis have already been completed.
- This work has been reported at BESIII Physics & Software workshop and New Physics Group.
- The memo is prepared and being reviewed by supervisor and the next step is reviewed by collaboration.

8:00 PM **Search for J/ψ → γ D**
Speaker: Bo Wang (University of Science and Technology of China)
JpsigD update.pdf Video

3:15 PM **Search for J/ψ → γD**
Speaker: Bo Wang (University of Science and Technology of China)
JpsigD.pdf Video

3:20 PM → 3:40 PM **Searching for FCNC process J/psi to gammaD0**
Speaker: 博 王 (University of Science and Technology of China)
JpsigD.pdf

BESIII

Memo version 1.0

BESIII Analysis Memo

DocDB-XXX

BAM-XXX

April 22, 2023

Search for $J/\psi \to \gamma D^0/\bar{D}^0$ at BESIII

Bo Wang[a,b], Huangchao Shi[a,b], and Yingchun Zhu[a,b], and Haiping Peng[a,b]

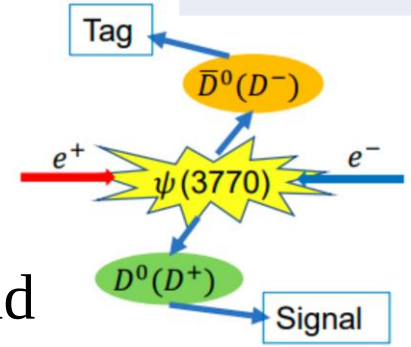
[a]*University of Science and Technology of China*
[b]*State Key of Particle Detection and Electronics*
[c]*Institute of High Energy Physics, CAS*

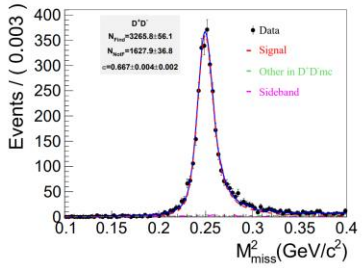
Study of K_S^0 efficiency in $\psi(3770)$ data on BESIII

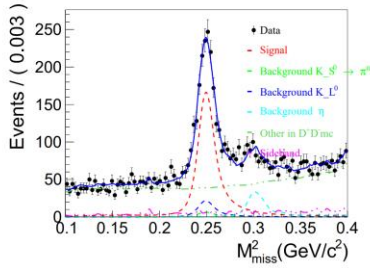
- BESIII Collaboration has taken $5fb^{-1}$ new data sample (round15) at $\psi(3770)$ in 2021.
- A service work for charm physics analysis.

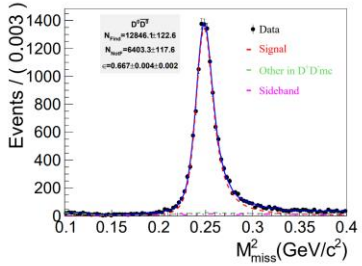
- All $8fb^{-1}$ $\psi(3770)$ data is used.
- Control sample: $D^0\bar{D}^0$ and D^+D^- sample
- Double-tag and missing K_S^0 method
- Vertex fit and second vertex fit select find and not find sample
- Simultaneous fit
  - Ratio of $K_S^0 \to \pi^+\pi^-$ and $K_S^0 \to \pi^0\pi^0$: Fixed by inclusive MC
  - Ratio of K_S^0 and K_L^0: Corrected by PDG and floated with a constrain.

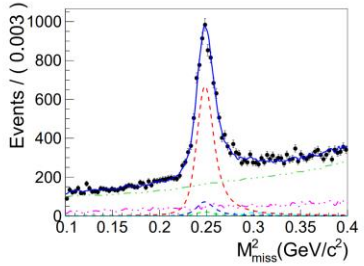
Tag mode	Signal mode
$D^0 \to K^-\pi^+$+c.c.	$\bar{D}^0 \to K_S^0\pi^+\pi^-$+c.c.
$D^0 \to K^-\pi^+\pi^0$+c.c.	$\bar{D}^0 \to K_S^0\pi^+\pi^-\pi^0$+c.c.
$D^0 \to K^-\pi^+\pi^+\pi^-$+c.c.	$\bar{D}^0 \to K_S^0\pi^0$+c.c.
$D^+ \to K^-\pi^+\pi^+$++c.c.	$D^- \to K_S^0\pi^-$+c.c.
	$D^- \to K_S^0\pi^-\pi^0$+c.c.
	$D^- \to K_S^0\pi^+\pi^-\pi^-$+c.c.





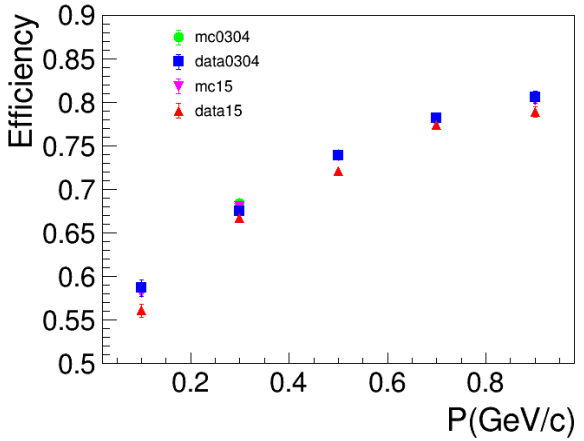


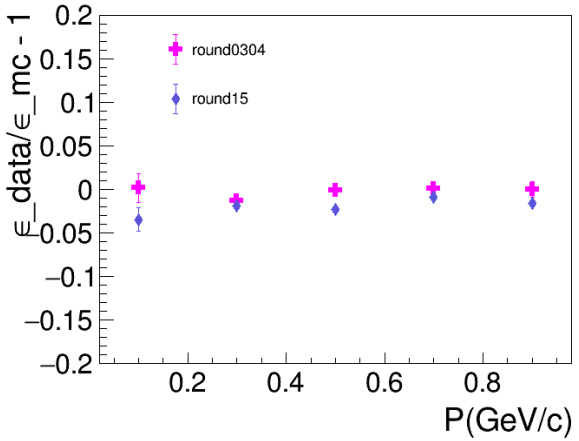




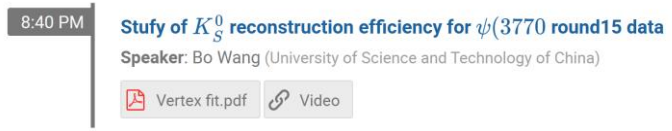
Result and Prospect

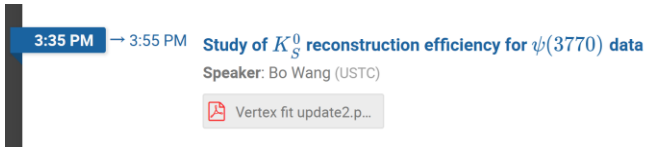
- Difference of efficiency between data and MC
  - ~2% for momentum <0.2GeV with error ~1%
  - <2% for momentum >0.2GeV with error 1%

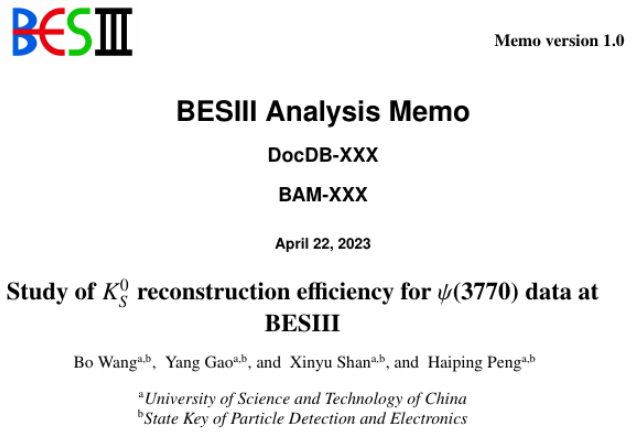




- This work has been reported at BESIII Physics & Software workshop and Charm Group.
- The analysis memo is preparing.

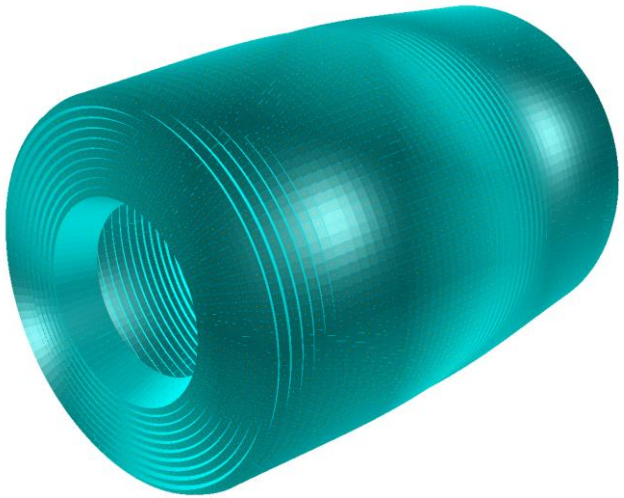






Study of simulation and reconstruction of EMC on STCF

- The electromagnetic calorimeter (EMC) is a important subdetector of the STCF detector.
- Energy and position measurements for photons, electrons and hadrons with high resolution.



What to do:

- Test the performance of EMC
- Explore new geometry
- Study simulation with machine learning
- Particle identification base on EMC

Summary and Future Plan

Summary

- The upper limit of FCNC process $J/\psi \to \gamma D^0/\bar{D}^0$ on BESIII is measured which is $< 3.04 \times 10^{-7}$, and the memo is prepared.
- The K_S^0 efficiency in $\psi(3770)$ data on BESIII is calculated and memo preparing.
- Preliminary understand the geometry and the physical process, the software of simulation and reconstruction of EMC on STCF.

Future Plan

- Finish the present work on BESIII
- Go on doing physics analysis on BESIII
- Go on doing the work for simulation and reconstruction of EMC on STCF
- Still many things to learn

Thank for your listening!