超级陶粲装置
Super Tau-Charm Facility

中山大學
SUN YAT-SEN UNIVERSITY

# STCF物理模拟工作进展

耿 聪

中山大学

超级陶粲装置工作组

2026年10月18日　　成都理工

# 目 录

- STCF项目介绍
- STCF物理工作组
- 物理模拟工作进展
- 总结和展望

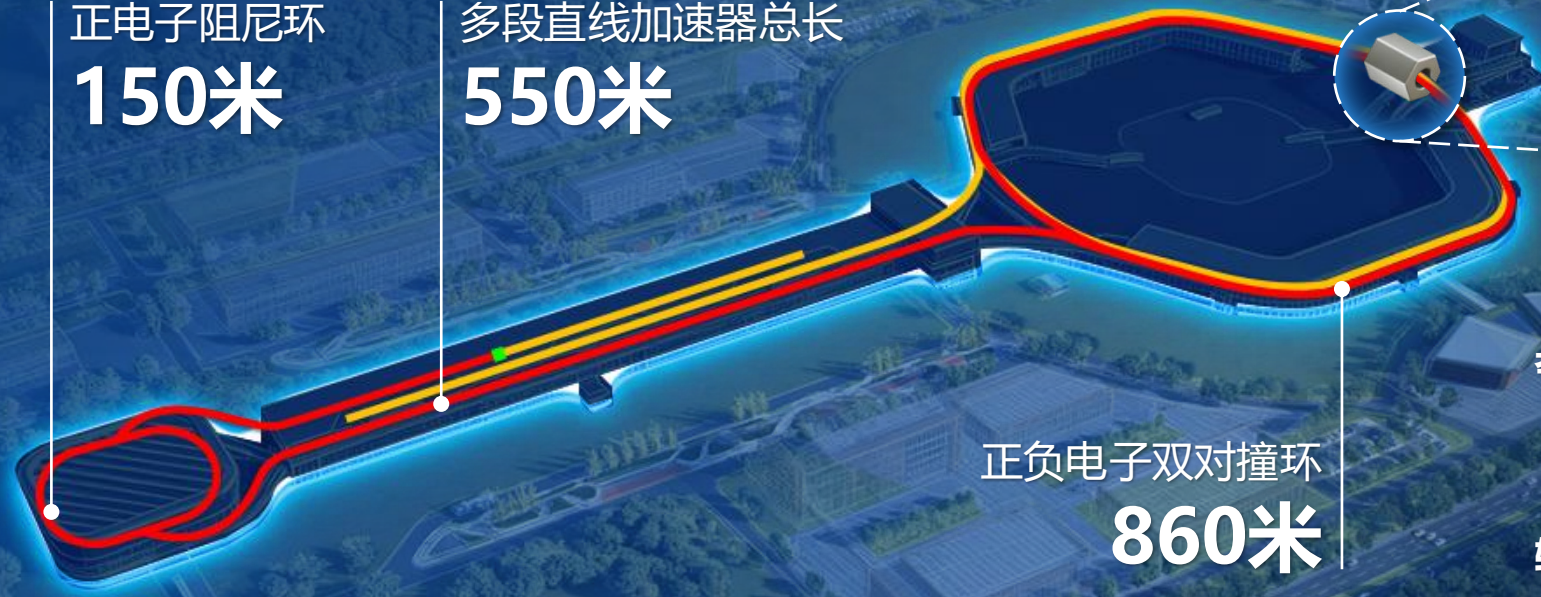
# 新一代大科学工程： 超级陶粲装置(STCF)

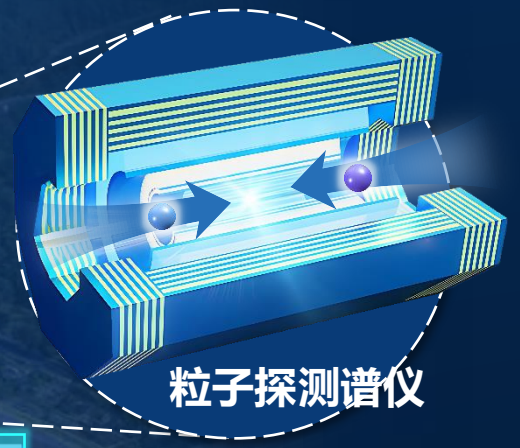
**前瞻引领型新一代正负电子对撞机实验装置**
**国际高亮度前沿核心装置之一**

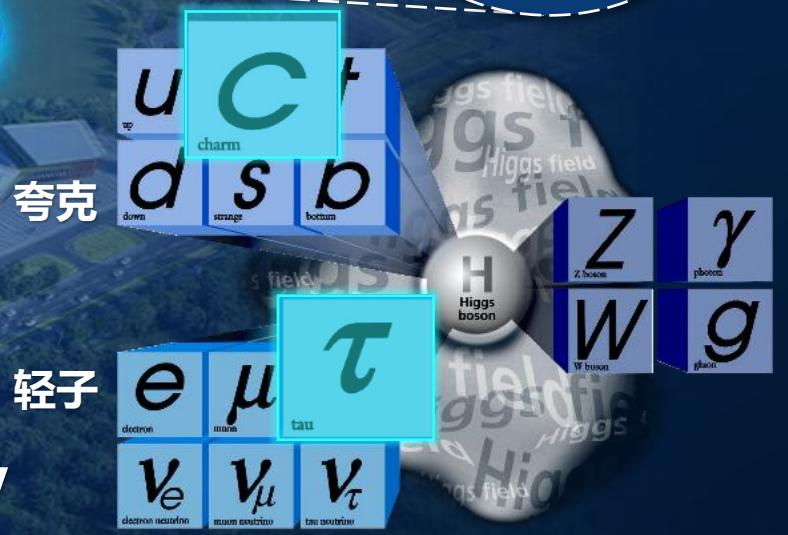
正电子阻尼环
**150米**

多段直线加速器总长
**550米**

正负电子双对撞环
**860米**





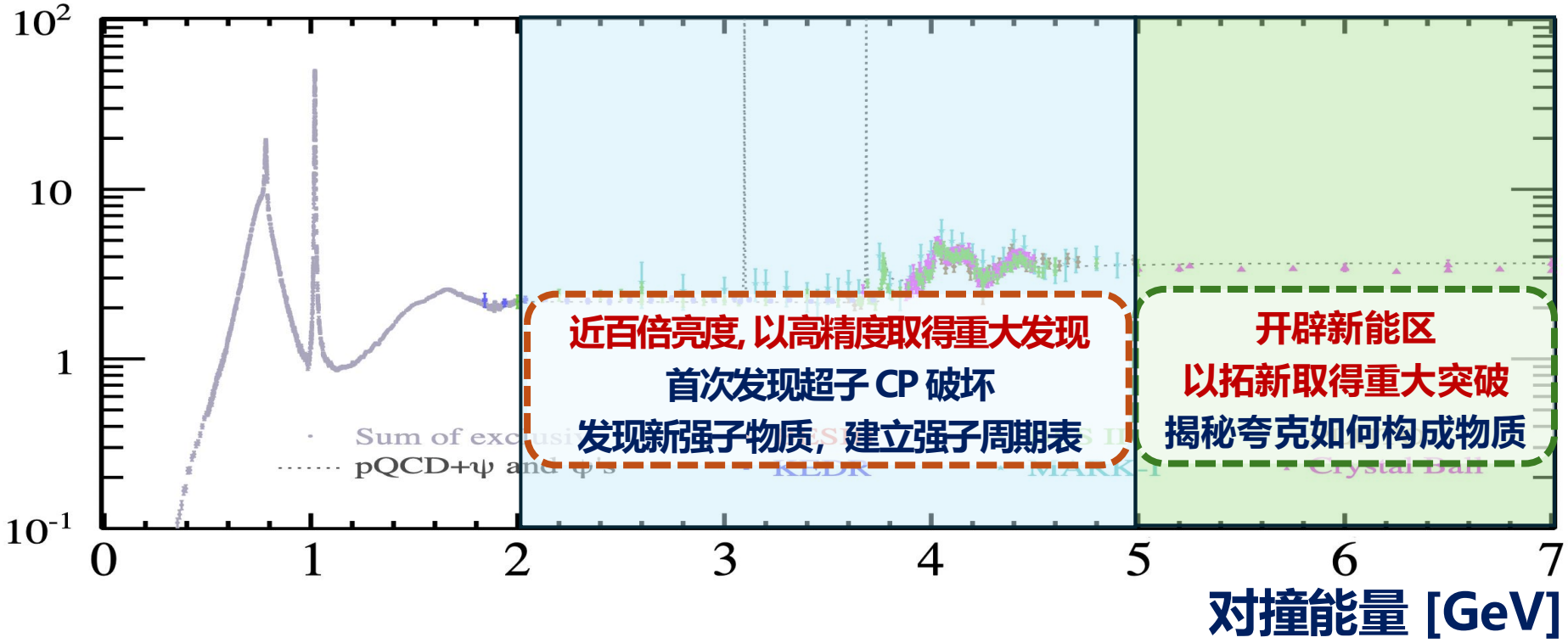




**质心能量**： 2-7 GeV， **对撞亮度** > $0.5\times10^{35}$ $cm^{-2}$ $s^{-1}$ @ 4 GeV

| | | | |
|---|---|---|---|
| 超高亮度<br>超宽连续可调能区 | 超高精度、超快响应<br>粒子探测与鉴别 | 超丰富<br>物理频谱 | 产生比现有装置高两个<br>量级的粲夸克和陶轻子 |

# 基础科学问题

- 微扰与非微扰量子色动力学的过渡能区
- 丰富共振结构、超大粲偶素态产生截面、众多强子对和 $\tau$ 轻子对产生阈值
- 大量奇特量子数强子、胶子态、多夸克态、夸克胶子混合态




## 重大研究方向

**基本对称性检验**

超子和陶轻子CP破坏

$K^0 - \bar{K}^0$系统CPT对称性

轻子味破坏等

**色禁闭之谜探索**

强子谱和强子结构

碎裂函数和能量关联

**基本物理量精确测量**

R值、陶轻子质量

电磁、强跑动耦合常数

CKM矩阵元

# 工程目标

## 正负电子对撞机

| | |
|---|---|
| 质心能量 | 2~7 GeV 连续可调 |
| 亮度 | $0.5\times10^{35}$ $cm^{-2}s^{-1}$ @ 4 GeV |

**超高亮度、超宽能区<br>稳定运行**

## 粒子探测谱仪

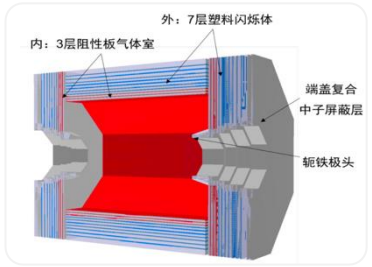
| | |
|---|---|
| 动量分辨率 | 0.5% @ 1 GeV/c |
| 能量分辨率 | 2.5% @ 1 GeV |
| 粒子鉴别能力 | $K/\pi$ $4\sigma$ @ 2 GeV/c |

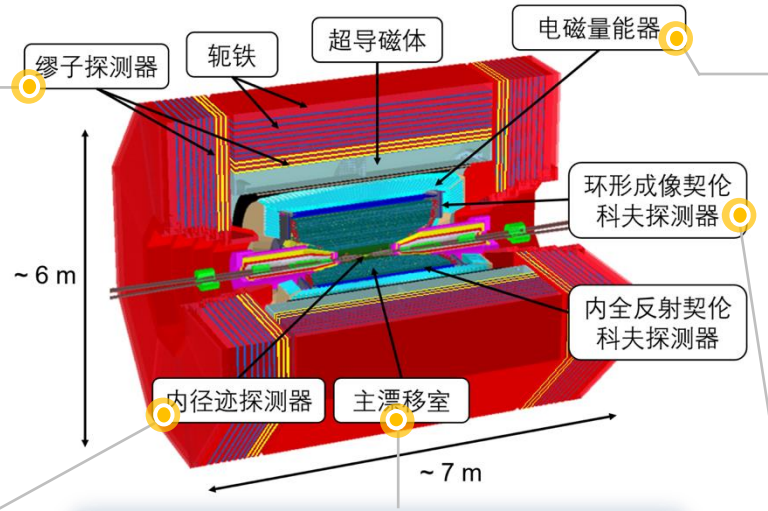
**超高事例率、超高本底、宽动态范围<br>超高精度的粒子探测**

# 探测器谱仪设计

## 新型缪子探测器

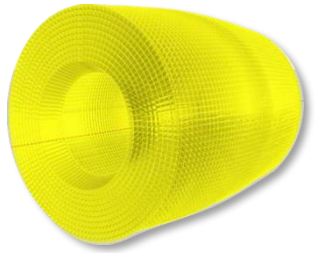
阻性板室 + 塑料闪烁体探测



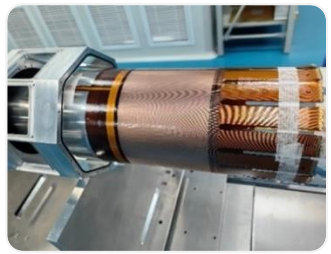

## 有时间信息晶体量能器

纯碘化铯+APD读出



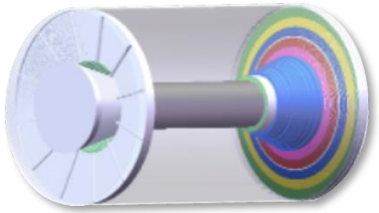
## 低物质量内径迹探测器

阻性微槽型气体探测器



## 高计数率主漂移室

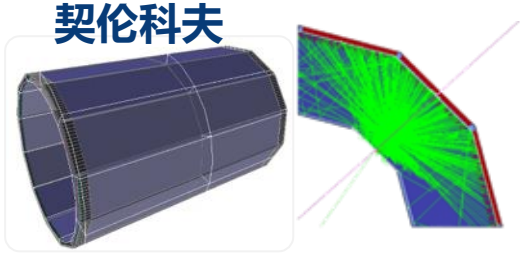
超低物质量、超小单元漂移室



## 新型成像粒子鉴别器

内全反射型契伦科夫

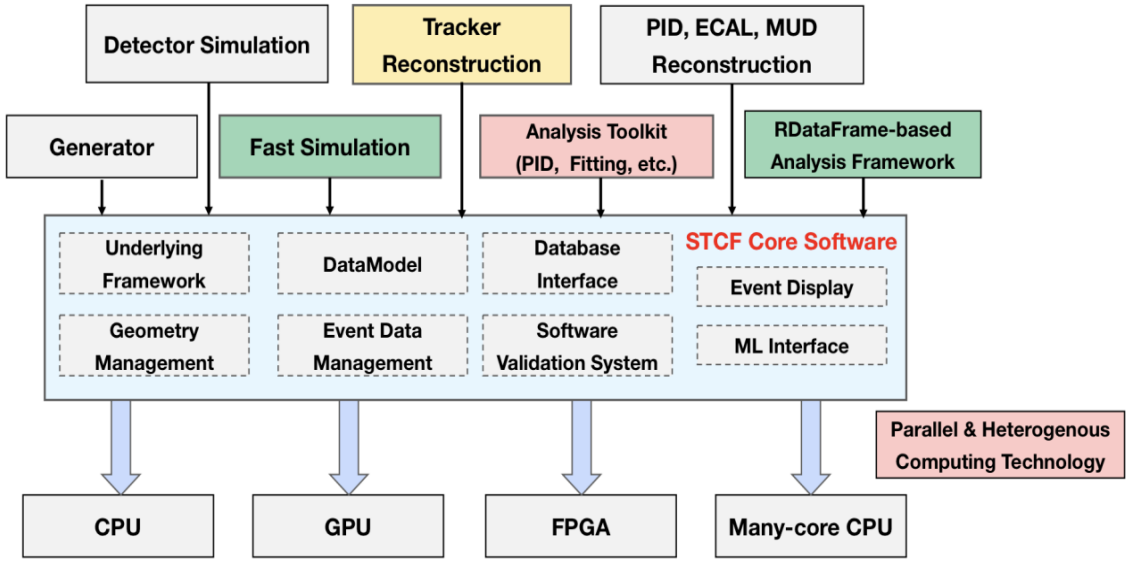
环形成像型



**争对各系统持续开展关键技术攻关，已取得多项重大突破**

# 软件研究进展-OSCAR

- 离线软件系统 (OSCAR) 覆盖模拟→ 数字化 → 重建 → 物理分析全链条，并新增智能体性能验证系统，全面支撑探测器设计和多项物理模拟研究的开展，核心指标达到设计需求
- 在模拟、重建等多个环节，引进国际先进软件（Key4HEP、ACTS、RDataFrame等）和机器学习技术（BDT、GAN、CNN、transformer等），实现优异的性能




| 类别 | 实现指标 |
|---|---|
| 径迹重建 | 效率 >90% @ $p_T$>100 MeV；动量分辨 ~0.5% @ $p$ =1 GeV |
| 电磁量能器重建 | 单光子分辨：$\sigma_E$ < 2.5%, $\sigma_{pos}$ < 5 mm, $\sigma_t$ < 300 ps @ $E$ = 1 GeV;<br>$\pi^0$质量分辨5.2 MeV@ $p$ = 0.5 GeV |
| 粒子鉴别 | $\pi$ 效率 >97%（< 2 GeV，$K\to\pi$ 误判 2%）；<br>$\mu$ 效率 >95%（> 1 GeV，$\pi\to\mu$ 误判 3.3%） |
| 计算资源 | ~1.1 s/事例，~100 KB/事例（四径迹，与BESIII相当） |

# 目 录

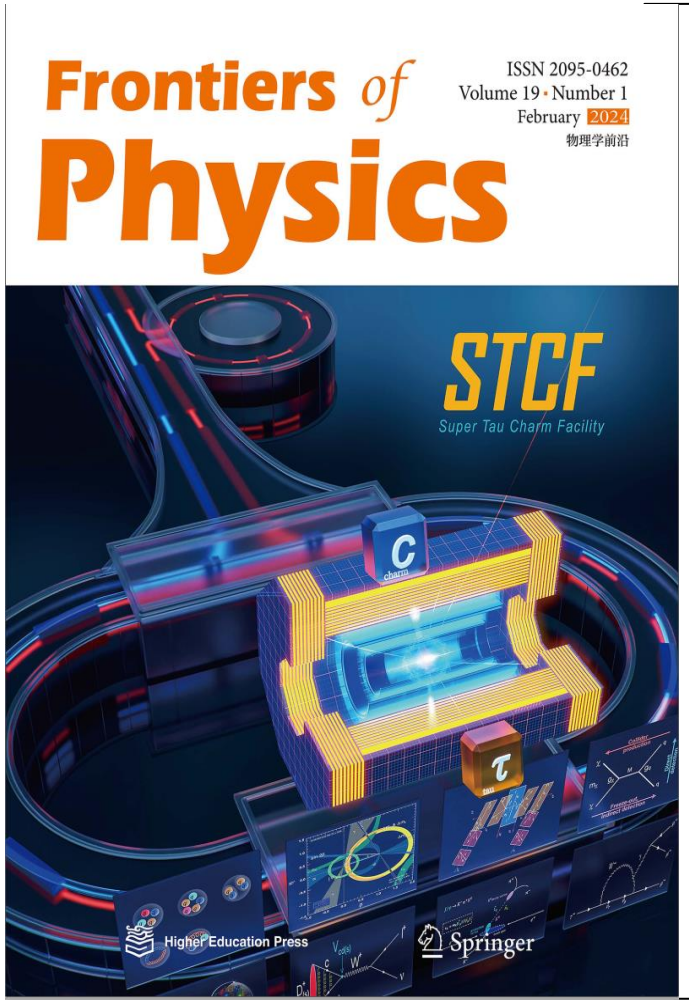

◆ STCF项目介绍

◆ **STCF物理工作组**

◆ 物理模拟工作进展

◆ 总结和展望

# TDR、CP专题




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## arXiv:2502.08907, 投稿 Physics Report

*CP* violation studies at Super tau-charm facility


Hai-Yang Cheng[a], Zhi-Hui Guo[b], Xiao-Gang He[c], Yingrui Hou[d], Xian-Wei Kang[e], Andrzej Kupsc[f,g], Ying-Ying Li[h], Liang Liu[h], Xiao-Rui Lyu[d], Jian-Ping Ma[i], Stephen Lars Olsen[j,k], Haiping Peng[h], Qin Qin[q], Pablo Roig[m,n], Zhi-Zhong Xing[o], Fu-Sheng Yu[p], Yu Zhang[q], Jianyu Zhang[d], Xiaorong Zhou[h]

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[m]*Departamento de Física, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Mexico City, AP 14740, CP 07000, Mexico*
[n]*IFIC, Universitat de València – CSIC, Paterna, E-46980, Spain*
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**Abstract**

Charge-parity ($CP$) violation in the tau-charm energy region is one of the promising areas to search for. The future tau-charm facility of next generation is designed to operate in a center-of-mass energy from 2.0 to 7.0 GeV with a peak luminosity of $0.5 \times 10^{35}$ cm$^{-2}$s$^{-1}$. Huge amount of hadrons and tau ($\tau$) leptons will be collected with good kinematic constraint and low-background environment. In this report, possibilities of $CP$ violation studies in tau-charm energy region and at the future tau-charm facility are discussed from various aspects, *i.e.* in the production and decay of hyperons and $\tau$ lepton; in the decay of charmed hadrons. The $CPT$ invariance test in $K^0 - \bar{K}^0$ mixing is also presented.



*Preprint submitted to PHYSICS REPORTS* *September 25, 2024*

# 物理工作组

- 凝练关键物理课题和**建议书**科学目标
- 开展**OSCAR全链条模拟，**确定物理**敏感度，优化探测器方案**
- 计划和撰写**TDR物理部分**

**总负责人：**周小蓉、吕晓睿

**成立三个TDR物理工作组**

1. 基本对称性检验（召集人：张宇、刘明依）
2. 色禁闭之谜（召集人：耿聪、罗涛、康晓珅）
3. 基本物理量精确测量（召集人：康晓琳、李惠静）

**确定物理敏感度：**

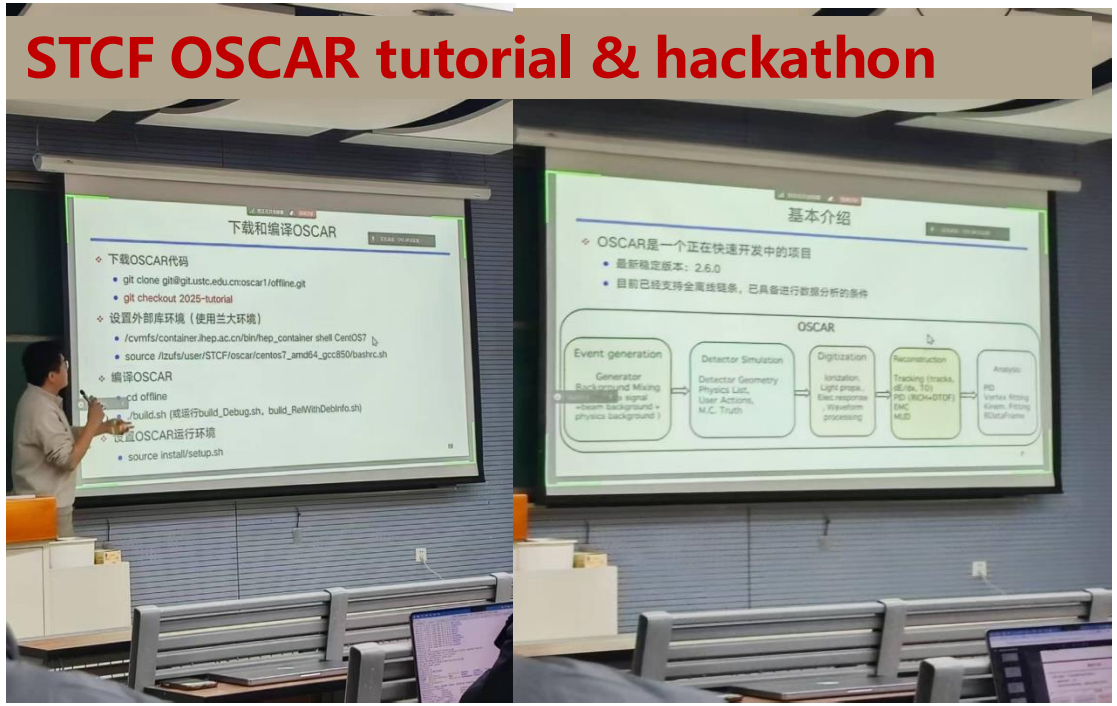
- 公共数据样本产生；
- 程序框架和信号分析；
- 与BESIII实验结果对比

**探测器优化：**

- 多径迹重建效率
- $\pi^0$重建效率
- 顶点拟合效率
- …

# 模拟预研工作持续开展

- 2025年1月，物理工作组成立
- 三个课题组固定周会，大物理组会2周一次
- 约15家国内单位、超过30位学生参与
- 目前大约30个物理工作在开展




Home » Experiments » STCF » Physics and Software

## Physics and Software

输入您的搜索词

创建事

| | |
|---|---|
| Software -- Core Software Meeting | 4 个事件 |
| Software -- General Weekly Meeting | 305 个事件 |
| Software -- Digitization Meeting | 77 个事件 |
| Software -- Tracking Weekly Meeting | 127 个事件 |
| Software -- PID Biweekly Meeting | 52 个事件 |
| Physics -- Physics/Simulation Meeting | 76 个事件 |
| Physics -- Symmetry | 142 个事件 |
| Physics -- Confinement | 53 个事件 |
| Physics -- SM parameters | 55 个事件 |
| Physics -- Fastsimulation | 29 个事件 |
| Physics -- Analysis Review | 3 个事件 |
| Calibration and Systematic uncertainty | 5 个事件 |

# 基本对称性组

| 物理目标 | 物理过程 | 性能检验 | 状态 | 完成人 |
|---|---|---|---|---|
| **超子CP破坏和EDM研究** | $J/\psi \to \Lambda\bar{\Lambda}$ | 径迹重建和分辨，顶点拟合 | To be submitted to CPC | 于明玉（山大）<br>张剑宇（国科大） |
| | $J/\psi \to \Xi^+\bar{\Xi}^-$ | | Note preparation | 徐月（复旦） |
| **陶轻子物理(EDM, 量子关联, 稀有衰变)** | $\tau \to \pi(\pi\pi^0)\nu$ | 粒子鉴别, $\pi^0$重建 | arXiv: 2610.03024; submitted to EPJC | 鲍晨涛（中科大）<br>李晓康（北大） |
| | $\tau \to \pi\pi\pi\nu$ | | Working in progress | |
| | $\tau \to 3\mu$ | $\pi/\mu$鉴别 | Working in progress | 屈可立（山大） |
| | Radiative decay | 光子重建 | Working in progress | 赵志鹏（山大） |
| **中性粲介子混合、强相位差** | C-even correlated $D\bar{D}$ | D介子标记，光子/$\pi^0$重建 | Draft ready | 王英豪（兰大） |
| **$\Lambda_c^+$衰变中的CP破坏研究** | $\Lambda_c^+ \to \Lambda K^+, \Sigma^0 K^+, \Sigma^+ K_S^0$ | $\pi/K$鉴别，光子重建 | PRD 112 (2025) 112002 | 王鸿鉴（兰大） |
| **$K^0 - \bar{K}^0$系统CPT对称性检验** | $J/\psi \to K_S^0 K\pi$ | 顶点拟合 | Working in progress | 张慧斌（国科大） |
| **Invisible decay** | $J/\psi \to \omega/\phi\eta(')$ | 本底研究 | Working in progress | 陶智博、夏一航（吉大） |
| **重子数破坏** | $\Lambda_c^+ \to \pi/K$+invisible | 粒子鉴别，中性强子 | PRD 114 (2026) 015033 | 唐馨茹（南华） |
| **轻子味破坏** | $J/\psi \to \gamma ll'$ | 轻子鉴别 | Working in progress | 陶智博（吉大） |

# 色禁闭组

| 物理目标 | 物理过程 | 性能检验 | 状态 | 完成人 |
|---|---|---|---|---|
| （类）粲偶素态、多夸克态 | $X(3872)$扫描 | 能量刻度和分辨 | Note ready | 李一凡（中科大） |
| | $e^+e^- \to P_c\bar{p} \to J/\psi p\bar{p}$ | 径迹重建, 低能质子重建 | Draft ready | 陈梓康（中大） |
| | $e^+e^- \to J/\psi\eta_c$ | 径迹分辨 | arXiv:2609.25870 Submitted to CPL | 董焯娟（中大） |
| 极化碎裂函数 | $e^+e^- \to KK, \pi\pi, K\pi$ | $\pi$/K鉴别 | Working in progress | |
| 电磁形状因子 | $e^+e^- \to p\bar{p}$ | 质子鉴别 | Working in progress | 田文辉（中大） |
| | Neutral particles ($K_L$ and $\bar{n}$) | 反中子和$K_L$鉴别 | Working in progress | 李梦翔（兰大）、黄钰贺（中科大） |
| 跃迁形状因子、超子衰变 | $\Sigma^+ \to pe^+e^-$ | 电子鉴别、$\gamma$-conversion | Working in progress | 梁晓霞（山大） |
| | $\Sigma^+ \to \pi^0 p, \Sigma^+ \to \gamma p$ | 光子/$\pi^0$重建 | Working in progress | 周哲妍（中科大） |
| | $\Lambda \to pe\nu$ | 顶点拟合，电子鉴别 | Draft ready | 石家磊（成理）、罗涛（复旦） |
| | $\Xi^- \to \Lambda e\nu$ | 顶点拟合，电子鉴别 | Note ready | 韩许（中科大） |
| | $J/\psi \to \gamma\phi$ (C-violation) | 光子重建、$\pi$/K鉴别 | Working in progress | 姜庆贺（辽大） |

# 基本物理量组

| 物理目标 | 物理过程 | 性能检验 | 状态 | 完成人 |
|---|---|---|---|---|
| **R值测量** | $e^+e^- \to hadrons$ | 亮度测量 | | |
| **双光子物理** | $\gamma\gamma \to hadrons$ | 前向区 | Working in progress | 王杰（地大） |
| | $\eta_c \to \gamma\gamma$ | 光子鉴别 | Working in progress | 景新媚（国科大） |
| **陶轻子质量** | $e^+e^- \to \tau^+\tau^-$ near threshold | 能量刻度和分辨 | | |
| **CKM矩阵元$\|V_{us}\|$, $\|V_{cs}\|$, $\|V_{cd}\|$** | $D \to \pi\mu\nu$ | D介子标记，$\pi/\mu$鉴别 | Working in progress | 黄清源（国科大） |
| | $D \to \mu\nu$ | D介子标记，$\pi/\mu$鉴别 | Note ready | 乔佳辉（河南师大） |
| | $D \to inclusive$ | D介子标记 | Working in progress | 刘弘锐、粟佳元（华科） |
| | $\tau \to K\nu$ | $\pi$/K鉴别 | | |
| **强相互作用跑动常数$\alpha_s$** | $e^+e^- \to \tau^+\tau^-, \tau \to l\nu\nu, \tau \to \pi\pi^0\nu_\tau, \to K\pi^0\nu_\tau$ | $\pi/K$鉴别 | Note ready | 李珊珊（湖大） |

# 目 录


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◆ STCF物理工作组

◆ **物理模拟工作进展**

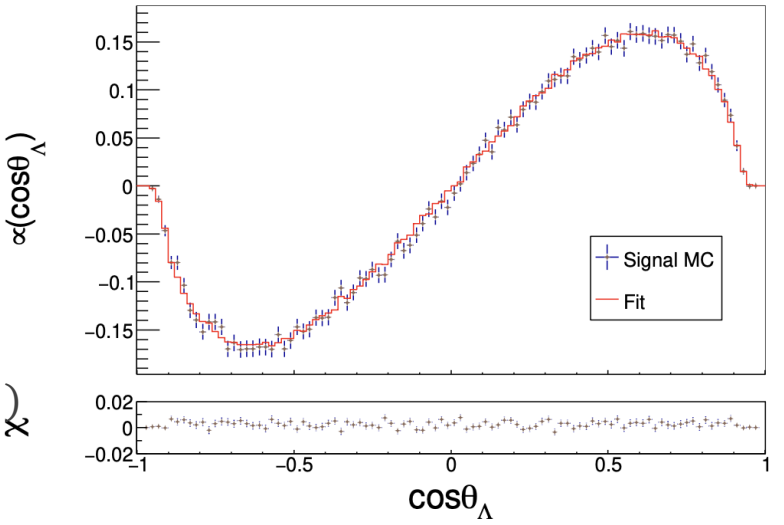
◆ 总结和展望

# Λ EDM

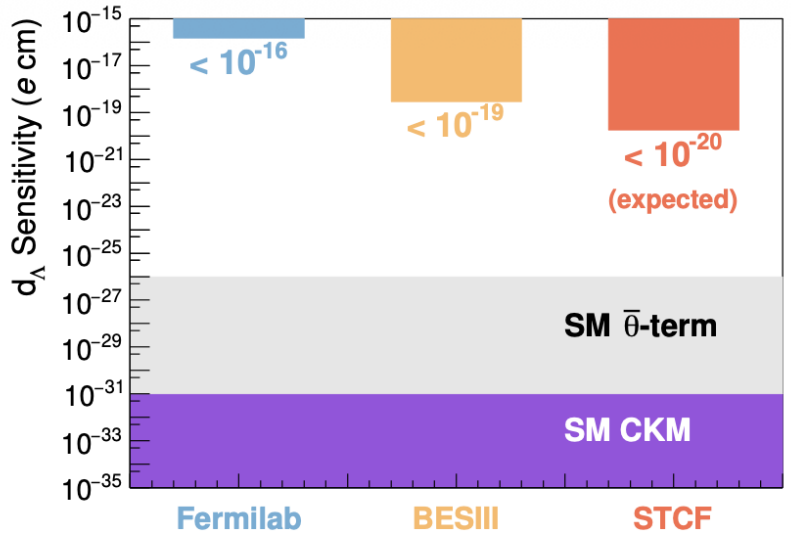
于明玉、黄性涛（山大）、张剑宇（国科大）

- OSCAR 2.6.2
- $3\times10^6$ MC events $J/\psi \to \Lambda(\to p\pi^-)\bar{\Lambda}(\to \bar{p}\pi^+)$
- Projected to 1 year data : $3.4\times10^{12}$ $J/\psi$ events
- $A_{CP}\sim 10^{-4}$ , Λ EDM $\sim 10^{-20}$ e cm

$$\mathcal{A} = \epsilon_\mu(\lambda)\bar{u}(\lambda_1)\left(F_V\gamma^\mu + \frac{i}{2M_\Lambda}\sigma^{\mu\nu}q_\nu H_\sigma + \gamma^\mu\gamma^5 F_A + \sigma^{\mu\nu}\gamma^5 q_\nu H_T\right)\nu(\lambda_2)$$




| Parameters | BESIII Result [25] ($1.0\times10^{10}$ $J/\psi$) | Projected Sensitivity at STCF ($3.4\times10^{12}$ $J/\psi$) |
|---|---|---|
| $\alpha_\Lambda$ | $0.7524 \pm 0.0036 \pm 0.0008$ | $2.0\times10^{-4}$ |
| $\alpha_{\bar{\Lambda}}$ | $-0.7571 \pm 0.0036 \pm 0.0008$ | $2.0\times10^{-4}$ |
| $\mathrm{Re}(G_2)$ | $(9.71 \pm 0.06 \pm 0.24)\times10^{-4}$ | $2.964\times10^{-7}$ |
| $\mathrm{Im}(G_2)$ | $(9.14 \pm 0.04 \pm 0.23)\times10^{-4}$ | $2.227\times10^{-7}$ |
| $P_L$ | $(-1.8 \pm 1.2 \pm 0.8)\times10^{-3}$ | $6.7\times10^{-5}$ |
| $\mathrm{Re}(F_A)$ | $(-2.4 \pm 1.6 \pm 3.1)\times10^{-6}$ | $8.7\times10^{-8}$ |
| $\mathrm{Im}(F_A)$ | $(-7.9 \pm 3.7 \pm 2.5)\times10^{-6}$ | $2.1\times10^{-7}$ |
| $\mathrm{Re}(H_T)$ | $(-1.4 \pm 1.4 \pm 0.2)\times10^{-6}$ | $8.1\times10^{-8}$ |
| $\mathrm{Im}(H_T)$ | $(1.3 \pm 1.2 \pm 0.4)\times10^{-6}$ | $6.3\times10^{-8}$ |
| $\alpha_{J/\psi}$ | $0.4748 \pm 0.0022 \pm 0.0017$ | $1.202\times10^{-4}$ |
| $\Delta\Phi$ | $0.7552 \pm 0.0042 \pm 0.0013$ | $2.275\times10^{-4}$ |
| $A_{CP}$ | $(-3.1 \pm 4.6 \pm 1.1)\times10^{-3}$ | $2.6\times10^{-4}$ |
| $\mathrm{Re}(d_\Lambda)$ | $(-3.1 \pm 3.2 \pm 0.5)\times10^{-19}$ | $1.8\times10^{-20}$ |
| $\mathrm{Im}(d_\Lambda)$ | $(2.9 \pm 2.6 \pm 0.6)\times10^{-19}$ | $1.4\times10^{-20}$ |



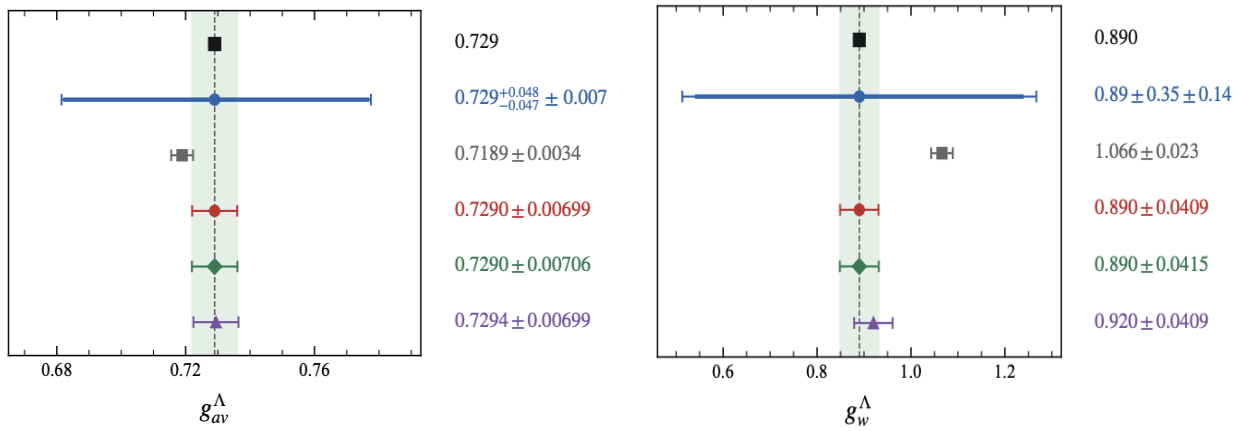
# $\Lambda \to pev$

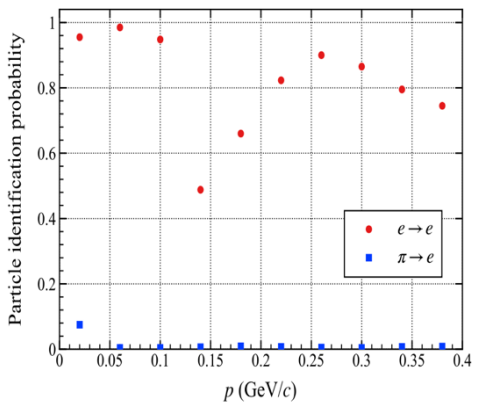
石家磊（成都理工）、周俊贤、罗涛（复旦）

- Form factor conventions as

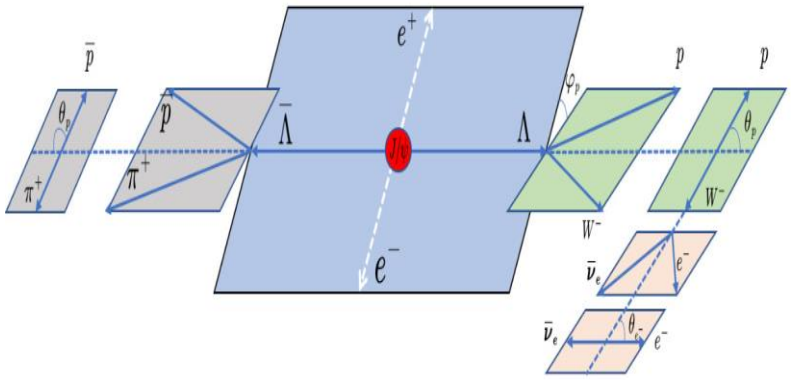
$g_{av} = \frac{g_1(0)}{f_1(0)}$, $g_w = \frac{f_2(0)}{f_1(0)}$, set $g_{av2} = \frac{g_2(0)}{f_1(0)} = 0$

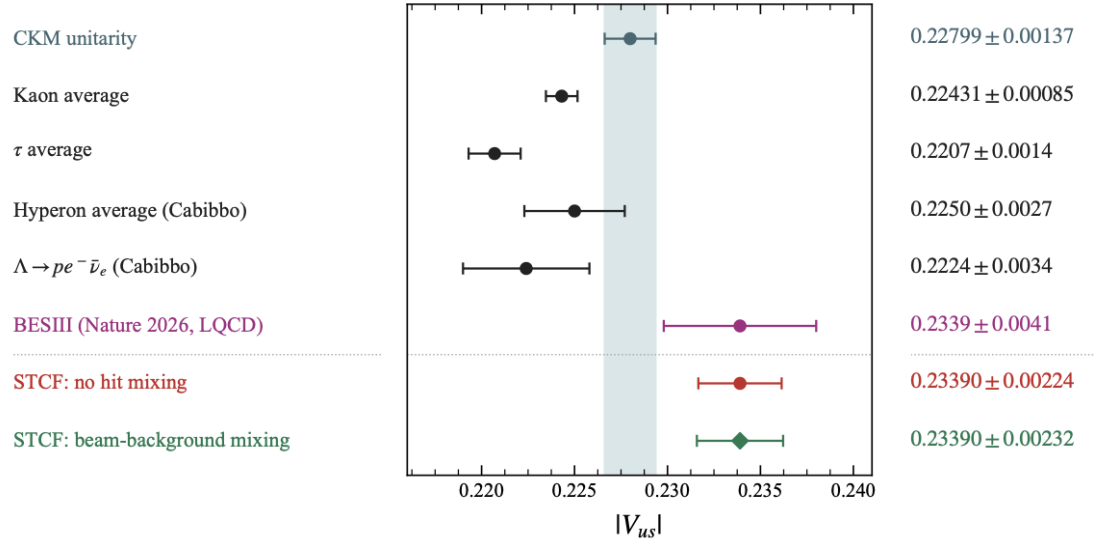
- To extract $|V_{us}|$ (PRD 70, 114036)
  by $g_1(0) = -0.8178 \pm 0.0055$ (LQCD)
- 1 year $3.4\times10^{12}$ $J/\psi$ events :
  - 1% in $g_{av}$, 5% in $g_w$
  - 0.022 in $|V_{us}|$




Electron-PID



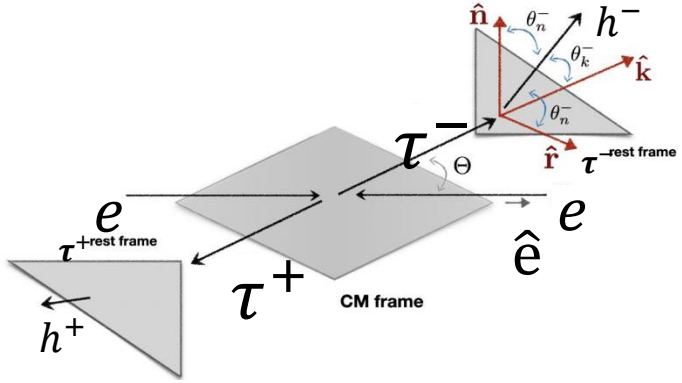


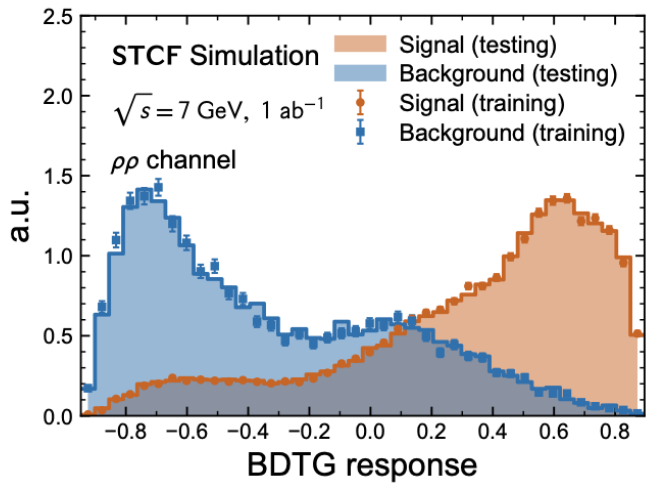
# Entanglement in $e^+e^- \to \tau^+\tau^-$

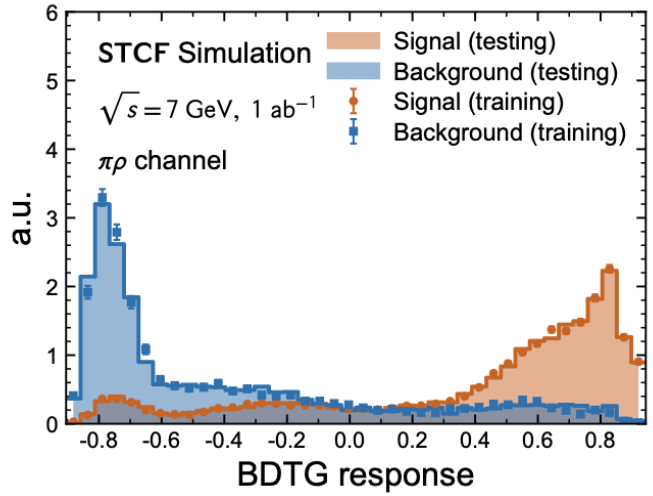
- At 7 GeV, $1\times10^9$ $e^+e^- \to \tau^+\tau^-$ events for 1 ab$^{-1}$
- Generator: MadGraph5 aMC@NLO
- Two modes: $\tau^+\tau^- \to \pi\rho, \rho\rho$
- Efficiency : 4.8% for $\pi\rho$, 4.5% for $\rho\rho$
- Purity: 93.2% for $\pi\rho$, 87.6% for $\rho\rho$

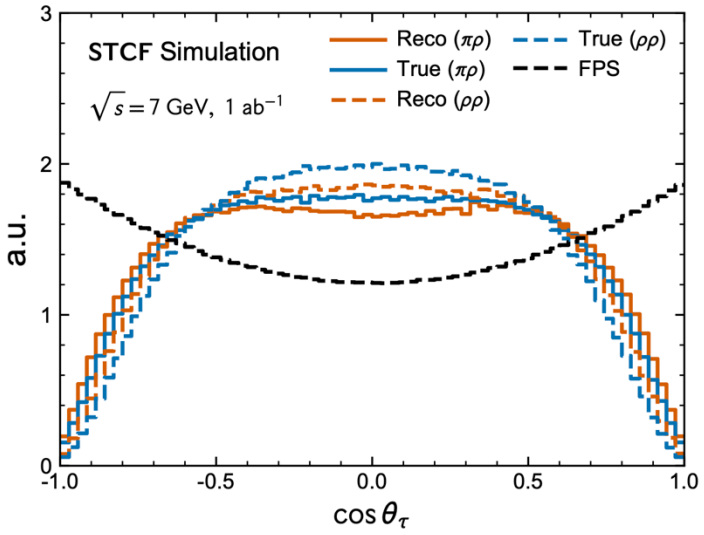
鲍晨涛（浙大）、刘明依（中科大）
arXiv: 2610.03024, submitted to EPJC

| Channel | Observable | Central value | $\delta_{\rm stat}$ | $\delta_{\rm det}$ | $\delta_{\rm tot}$ | Significance |
|---|---|---|---|---|---|---|
| $\rho\rho$ | $C[\rho]$ | 0.303 | 0.003 | 0.006 | 0.007 | 45.4 |
| | $m_{12}[C]$ | 1.109 | 0.006 | 0.014 | 0.015 | 7.2 |
| $\pi\rho$ | $C[\rho]$ | 0.306 | 0.003 | 0.006 | 0.007 | 44.6 |
| | $m_{12}[C]$ | 1.051 | 0.007 | 0.015 | 0.016 | 3.2 |



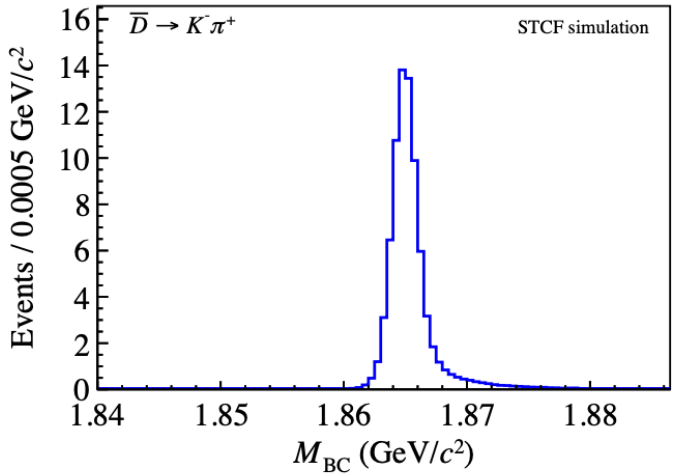
# $D\bar{D}$ parameters

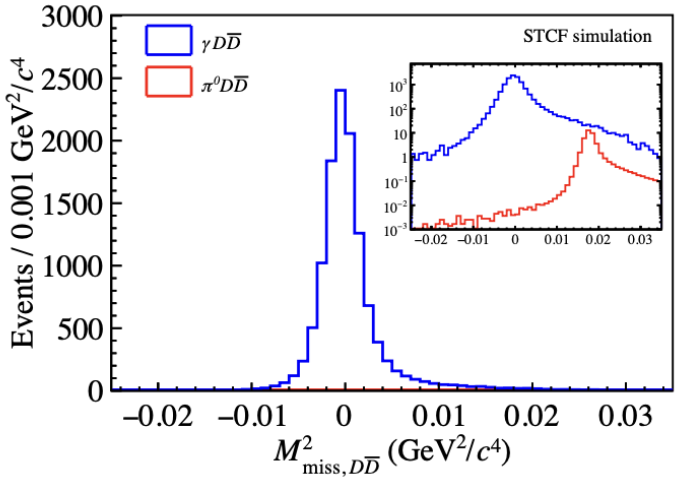
王英豪（兰大）、张宇（南华）

- Double-tag: Flavor tag, CP tag, and self-conjugate tag
- Complementary C-even and C-odd $D\bar{D}$ sample: 3.773 and 4.030 GeV

$$|\Psi_C\rangle = \frac{1}{\sqrt{2}}\left[|D^0\rangle_1 |\bar{D}^0\rangle_2 + C\,|\bar{D}^0\rangle_1 |D^0\rangle_2\right] \quad C = \pm 1$$

- 1 ab$^{-1}$ MC samples simulated for both energy points
- Signal decays: $D \to K^-\pi^+\pi^+\pi^-$, $K^-\pi^+\pi^0$, $K^-\pi^0$
- Four-bin scheme for $D \to K^-\pi^+\pi^0$ to improve the precision



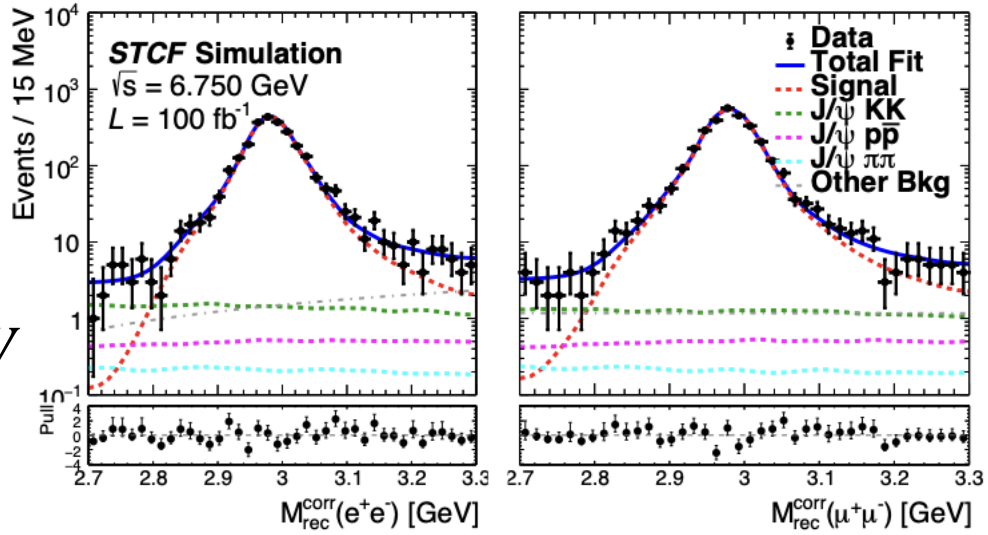

| Parameter | STCF expected precision | Current measurement |
|---|---|---|
| $r^1_{K3\pi}$ (%) | 0.015 | $5.48 \pm 0.05$ |
| $r^2_{K3\pi}$ (%) | 0.016 | $5.96 \pm 0.05$ |
| $r^3_{K3\pi}$ (%) | 0.016 | $5.86 \pm 0.05$ |
| $r^4_{K3\pi}$ (%) | 0.013 | $4.83 \pm 0.04$ |
| $\delta^1_{K3\pi}$ (°) | 0.63 | $124^{+10}_{-8}$ |
| $\delta^2_{K3\pi}$ (°) | 1.3 | $170^{+14}_{-12}$ |
| $\delta^3_{K3\pi}$ (°) | 1.0 | $179 \pm 11$ |
| $\delta^4_{K3\pi}$ (°) | 0.56 | $260^{+10}_{-13}$ |
| $R^1_{K3\pi}$ | 0.011 | $0.72 \pm 0.14$ |
| $R^2_{K3\pi}$ | 0.0052 | $0.65^{+0.08}_{-0.07}$ |
| $R^3_{K3\pi}$ | 0.0039 | $0.80^{+0.07}_{-0.06}$ |
| $R^4_{K3\pi}$ | 0.013 | $0.54^{+0.18}_{-0.19}$ |
| $r_{K\pi\pi^0}$ (%) | 0.016 | $4.41 \pm 0.08$ |
| $\delta_{K\pi\pi^0}$ (°) | 0.50 | $209^{+7}_{-8}$ |
| $R_{K\pi\pi^0}$ | 0.0026 | $0.75 \pm 0.03$ |
| $r_{K\pi}$ (%) | 0.018 | $5.855^{+0.009}_{-0.010}$ |
| $\delta_{K\pi}$ (°) | 0.44 | $191.4 \pm 2.4$ |

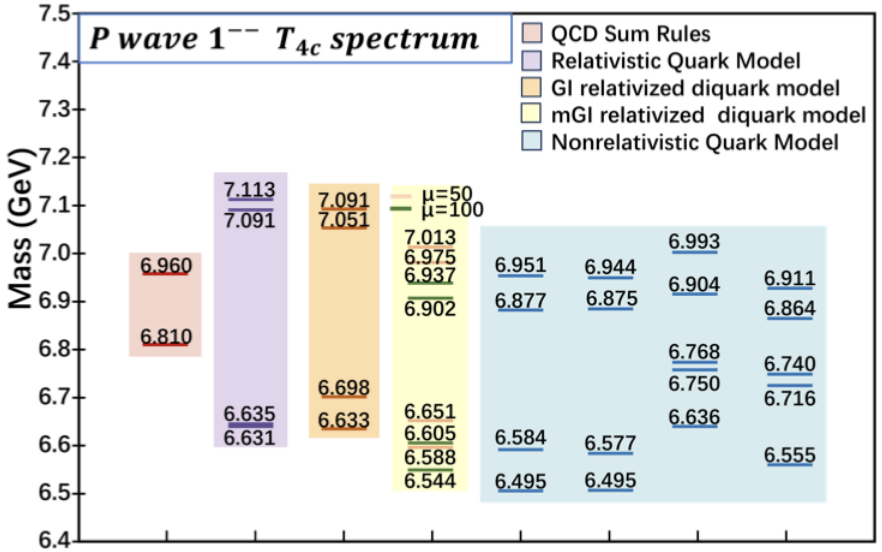
| | STCF expected uncertainty | | HFLAV 2025 |
|---|---|---|---|
| Parameter | Integrated | Four-bin | Result |
| $x$ ($10^{-3}$) | 0.53 | 0.40 | $4.05 \pm 0.43$ |
| $y$ ($10^{-3}$) | 0.26 | 0.23 | $6.36 \pm 0.24$ |
| $\lvert q/p \rvert$ | 0.029 | 0.027 | $0.983^{+0.015}_{-0.014}$ |
| $\phi$ (°) | 2.0 | 1.9 | $-1.51^{+1.03}_{-1.06}$ |

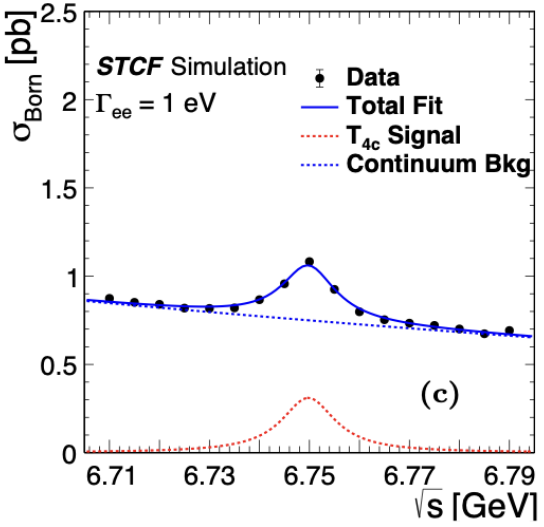
# $e^+e^- \to T_{4C} \to J/\psi\eta_c$

董焯娟、耿聪（中大）
arXiv:2609.25870, Submitted to CPL

- Set $M(T_{4C}) = 6.75$ GeV, $\Gamma_{J/\psi\eta_c} = 0.17$ MeV
- Energy scan between $\sqrt{s} = 6.71$ and $6.79$ GeV:
  - 17 energy points, 100 fb$^{-1}$ for each point
- Reconstruct the signal by single-tag $J/\psi \to e^+e^-/\mu^+\mu^-$
- Dominant background continuum $J/\psi\eta_c$, from Belle
- Investigate sensitivity with hypothesis : $\Gamma_{ee} = 0.25, 0.5, 1\ eV$



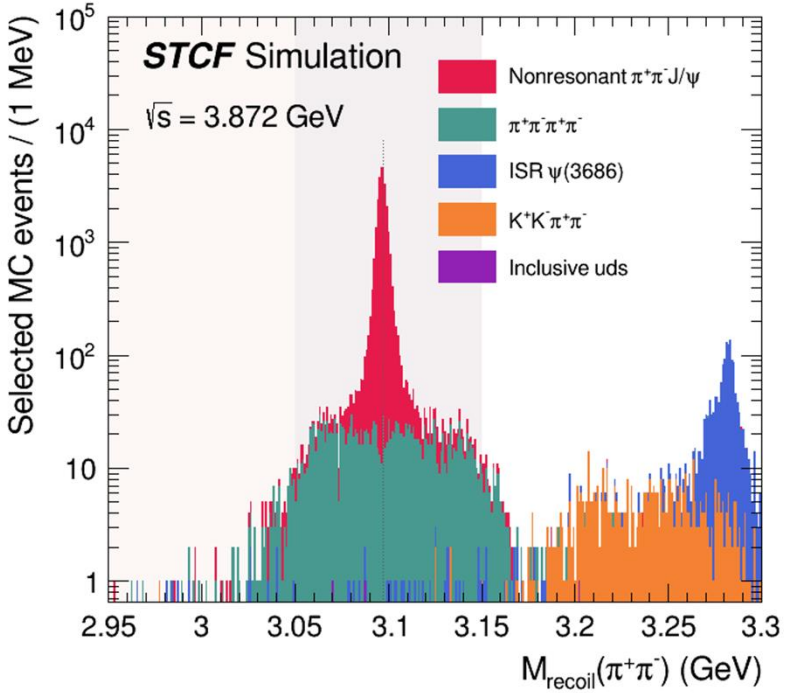

| $\Gamma_{ee}$ (eV) | Signal cross section (fb) | ST | DT |
|---|---|---|---|
| 0.25 | 81.0 | $5.1\,\sigma$ | $0.7\,\sigma$ |
| 0.5 | 162.0 | $10.6\,\sigma$ | $1.9\,\sigma$ |
| 1.0 | 324.0 | $20.5\,\sigma$ | $3.1\,\sigma$ |

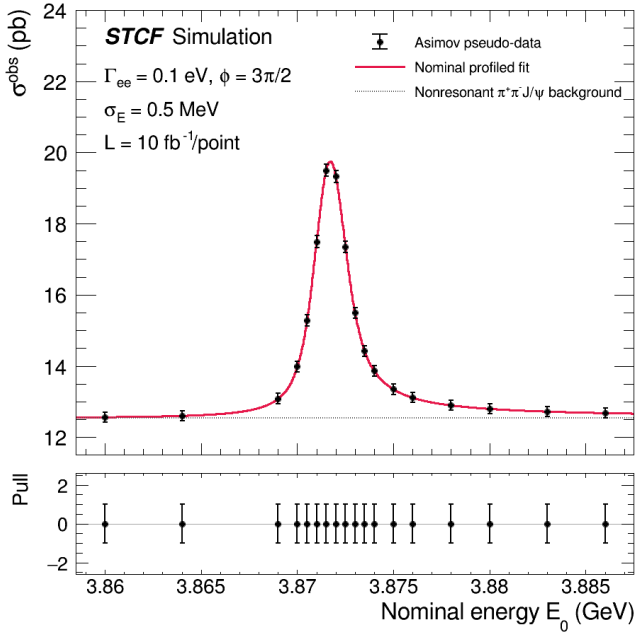
# X(3872) scan

李一凡、鲁楠（中科大）

- 18 energy points between $\sqrt{s} = 3.86$ and 3.886 GeV: 100 fb$^{-1}$ per point
- Reconstruct signal with $\pi^+\pi^- J/\psi(\to e^+e^-/\mu^+\mu^-)$
- Generator: ConExc ; different energy spread scenario : 0.5, 2.0 MeV
- Three $\Gamma_{ee}$ hypothesis: 0.03, 0.1, 0.311 eV
- Consider the interference between signal and continuum

$$\sigma_i(\gamma_X, \phi, c, \eta) = c + \gamma_X T_{1i}(\eta) + \sqrt{\gamma_X}\sqrt{\frac{c}{c_0}}\left[T_{2ci}(\eta)\cos\phi + T_{2si}(\eta)\sin\phi\right]$$




Nominal profiled $Z_{\text{ref}}$; $\sigma_E = 0.5$ MeV

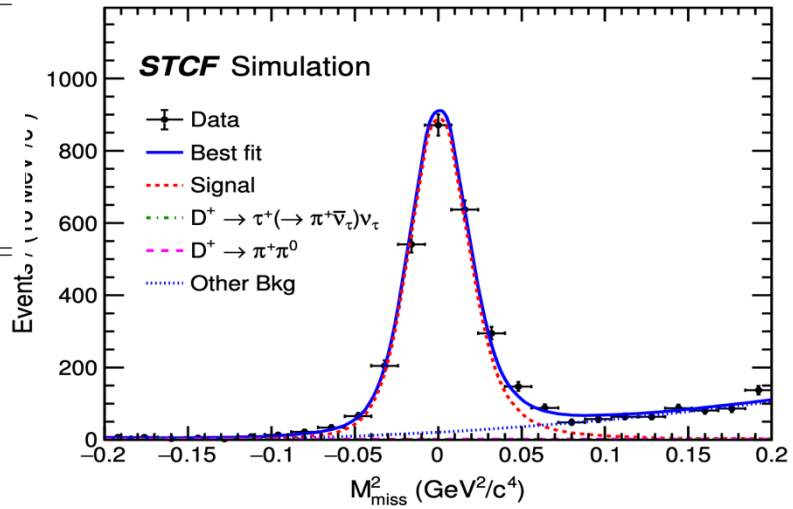
| Injected $\Gamma_{ee}$ [eV], phase | $L$ per point [fb$^{-1}$] = 0.1 | 1 | 5 | 10 | 50 | 100 |
|---|---|---|---|---|---|---|
| 0.030, 0 | 2.5 | 9.7 | 22.2 | 31.5 | 70.6 | 99.9 |
| 0.030, π/2 | 2.0 | 8.2 | 19.0 | 27.0 | 60.5 | 85.7 |
| 0.030, π | 2.5 | 9.8 | 22.5 | 31.9 | 71.5 | 101.1 |
| 0.030, 3π/2 | 2.7 | 10.0 | 22.9 | 32.5 | 72.9 | 103.1 |
| 0.100, 0 | 5.3 | 18.1 | 40.8 | 57.7 | 129.2 | 182.8 |
| 0.100, π/2 | 3.9 | 13.7 | 31.0 | 44.0 | 98.5 | 139.4 |
| 0.100, π | 5.4 | 18.5 | 41.7 | 59.0 | 132.1 | 186.9 |
| 0.100, 3π/2 | 6.0 | 19.7 | 44.2 | 62.6 | 140.1 | 198.1 |
| 0.311, 0 | 10.0 | 32.5 | 72.8 | 103.0 | 230.4 | 325.9 |
| 0.311, π/2 | 5.5 | 18.4 | 41.4 | 58.7 | 131.3 | 185.8 |
| 0.311, π | 10.4 | 33.7 | 75.5 | 106.8 | 238.8 | 337.7 |
| 0.311, 3π/2 | 11.8 | 37.2 | 83.2 | 117.7 | 263.2 | 372.3 |

# $D^+ \to \mu^+\nu$

乔佳辉、李惠静（河师大）

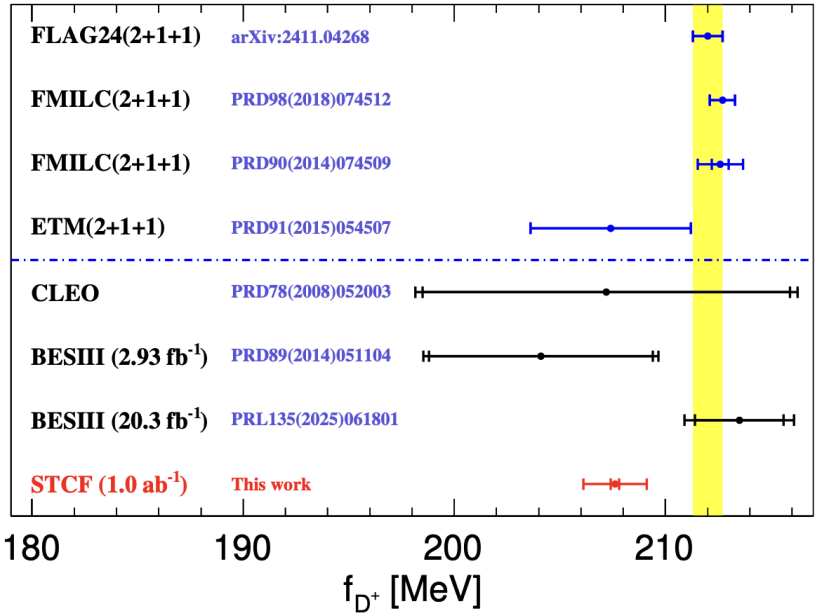
- Double-tag approach at 3.773 GeV
- MC simulation corresponds to 18 fb$^{-1}$
- Project to 1 ab$^{-1}$ data

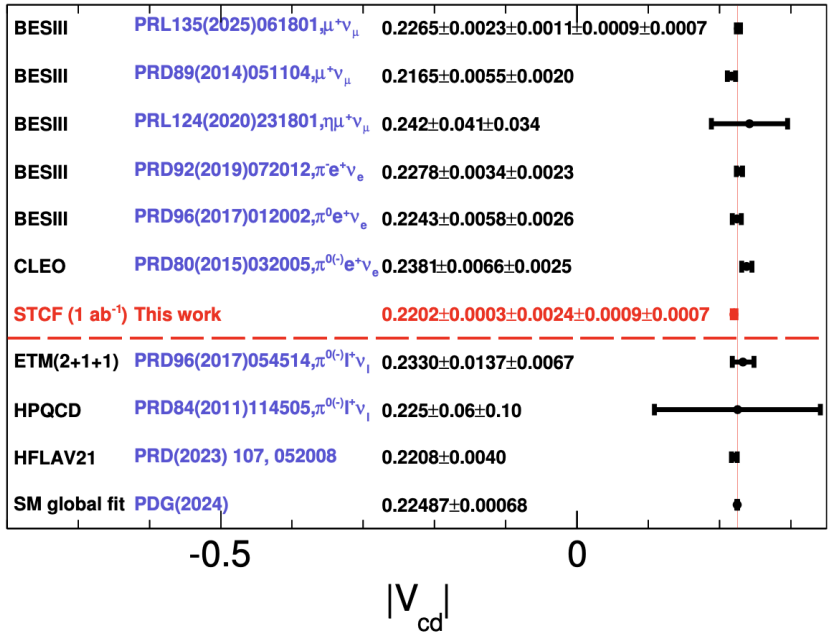
| Tag mode | ST efficiencies (%) |
|---|---|
| $D^- \to K^-\pi^+\pi^-$ | 50.87 ± 0.11 |
| $D^- \to K^0_S\pi^-$ | 56.12 ± 0.11 |
| $D^- \to K^+\pi^-\pi^-\pi^0$ | 23.36 ± 0.09 |
| $D^- \to K^0_S\pi^-\pi^0$ | 27.06 ± 0.09 |
| $D^- \to K^0_S\pi^-\pi^-\pi^+$ | 33.09 ± 0.10 |
| $D^- \to K^+K^-\pi^-$ | 40.33 ± 0.11 |



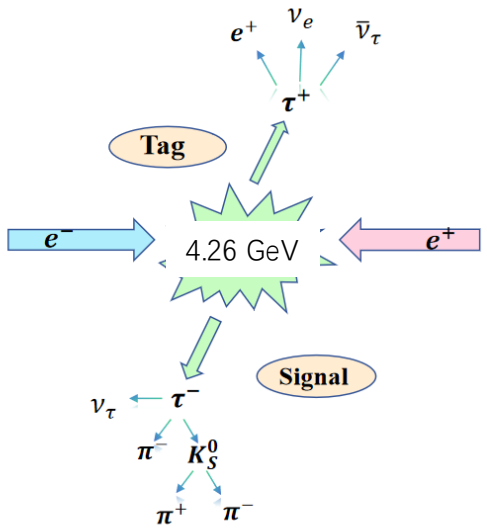

$$B(D^+ \to \mu^+\nu) = (3.813 \pm 0.009_{stat} \pm 0.038_{syst}) \times 10^{-4}$$

$$f_{D^+}|V_{cd}| = (46.69 \pm 0.06_{stat} \pm 0.24_{syst} \pm 0.11_{input} \pm 0.14_{EM})\ MeV$$



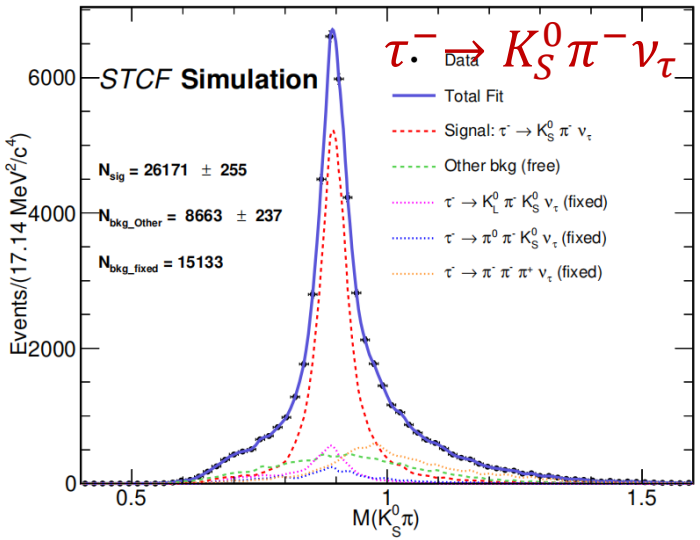
# $\tau^- \to h\pi\nu_\tau$

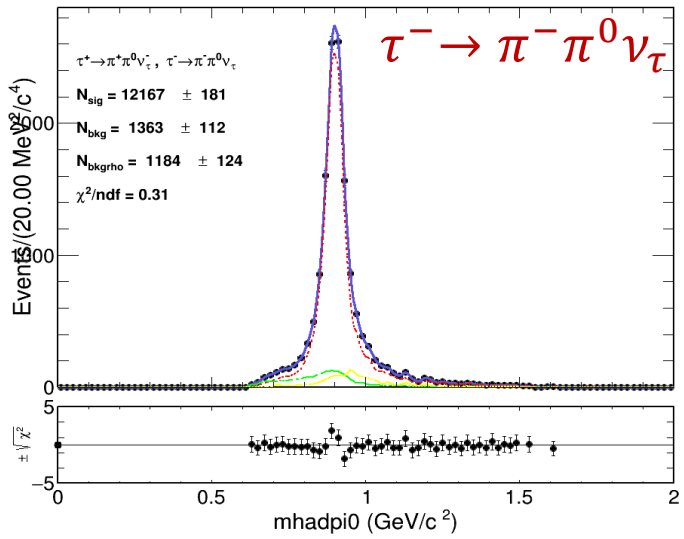


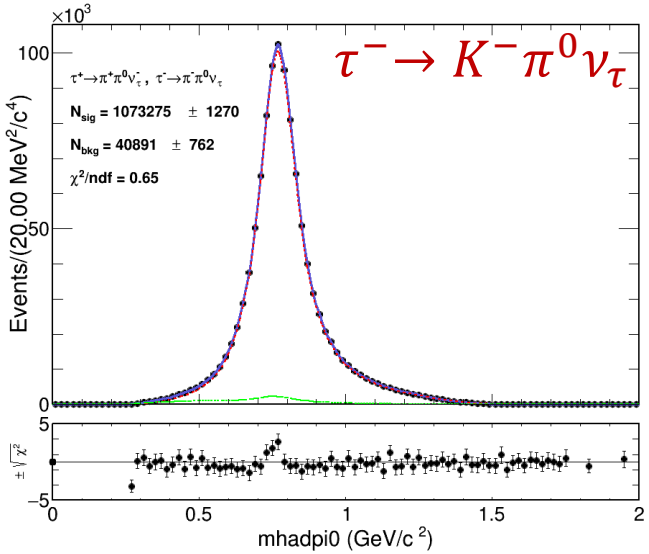

- $\tau^- \to K_S^0\pi^-\nu_\tau$: CP violation sensitivity
  - Simulation at $\sqrt{s} = 4.26$ GeV
  - $\delta A_{CP}$ reach 0.173% for 1 ab$^{-1}$, 0.055% for 10 ab$^{-1}$
- $\tau^- \to \pi^-\pi^0\nu_\tau$: strong coupling $\alpha_s$

李珊珊、张书磊（湖大）

| Experiment / Analysis | $\alpha_s(m_\tau^2)$ | Remark |
|---|---|---|
| ALEPH (1998) | $0.334 \pm 0.022$ | $V+A$ moments |
| OPAL (1998) | $0.348 \pm 0.009_{\text{exp}} \pm 0.019_{\text{th}}$ | CIPT |
| ALEPH update (2007) | $0.345 \pm 0.004_{\text{exp}} \pm 0.009_{\text{th}}$ | updated analysis |
| STCF projection | $0.32036 \pm 0.00001_{\text{stat}} \pm 0.00413_{R_\tau} \pm 0.00757_{\text{th}}$ | this work |



# 目 录


◆ STCF项目介绍

◆ STCF物理工作组

◆ 物理模拟工作进展

◆ **总结和展望**

# 总结和展望

- ◆STCF物理工作组基于OSCAR软件开展物理模拟预研工作
  - ➢ OSCAR全链条模拟，确定物理敏感度，优化探测器方案
  - ➢ 三个课题组：基本对称性、色禁闭、基本物理量
  - ➢ 大约15家国内单位、30名学生参加，约30个物理工作在进行
- ◆已有大约10个物理工作投稿或进入撰写文章阶段
- ◆欢迎更多的国内单位参与物理预研工作，期待来自理论方向的新思路。
- ◆下一步：协助完成探测器优化，推进剩余物理工作的完成，规划综述和专题文章...

谢谢大家对STCF物理工作组的支持！