The BESIII experiment
(and the need for PWA)

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IHEP, Beijing
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• Welcome to PWA10/ATHOS5

• Welcome to Institute of High Energy Physics (IHEP), Chinese Academy of Sciences (CAS)
May 19, 1950:
Institute of Modern Physics

Oct. 6, 1953:
Institute of Physics

July 1, 1958:
Institute of atomic energy

Feb. 1, 1973:
Institute of High Energy Physics, CAS

Main entrance to IHEP

LINAC

BEPC (Beijing electron-positron collider)

BES detector
Beijing Electron Positron Collider (BEPC)

- Founded: 1984
  - Ecm = 2.0-4.6 GeV
- 1989-2005 (BEPC):
  - $L_{\text{peak}} = 1.0 \times 10^{31} \, \text{cm}^2\text{s}$
- 2008-now (BEPCII):
  - $L_{\text{peak}} = 1.0 \times 10^{33} \, \text{cm}^2\text{s}$
  - (Apr. 5, 2016)

LINAC

BEPCII
(Beijing electron-positron collider)

BESIII detector
BESIII Detector

- Magnet yoke
- SC magnet, 1T
- RPC
- TOF, 80ps
- Be beam pipe
- MDC, 120 μm, 0.5% at 1 GeV/c
- CsI(Tl) calorimeter, 2.5% @ 1 GeV

Total weight 730 ton,
~40,000 readout channels,
Data rate: 5kHz, 50Mb/s

Has been in full operation since 2008,
all subdetectors are in very good status!
BESIII Collaboration

14 countries
66 institutions
~500 members
Can cover 0-4.6 GeV from direct annihilation or ISR

J/ψ $6 \times 10^9$

$\phi$

$\rho$

$\rho'$

$\omega$

$J/\psi$

$\psi(2S)$

$\psi'$ $0.5 \times 10^9$

$\psi''$ $2.9 \text{ fb}^{-1}$

4040 $0.5 \text{ fb}^{-1}$

4230+4260 $1.9 \text{ fb}^{-1}$

4270 $3.0 \text{ fb}^{-1}$

4360 $0.5 \text{ fb}^{-1}$

4420 $1.0 \text{ fb}^{-1}$

4600 $0.6 \text{ fb}^{-1}$

PDG 2015

u, d, s

3 loop pQCD

Energy Scan 526 pb$^{-1}$

Naive quark model

Inclusive measurements

4190, 4200, 4210, 4220, 4236, 4245, 4270, 4280:

3.9 fb$^{-1}$
What physics interested us

• Light hadrons $\rightarrow$ QCD
  – Meson & Baryon Spectroscopy
  – Exotic hadrons: glueballs, hybrids, multiquark states, molecules ...
  – Decay dynamics

• Charm physics $\rightarrow$ QCD, EW & Beyond
  – CKM matrix elements and unitarity test
  – Decay constants & form factors
  – $\bar{D}D$ mixing and CPV

• Charmonium & charmoniumlike states $\rightarrow$ QCD
  – Spectroscopy and transitions
  – XYZ states: spectroscopy, production, and decay
  – Decay dynamics: “$\rho\pi$ puzzle”, charmless decays of $\psi$”

• Tau, R values, EM FFs, two-photon photon physics $\rightarrow$ SM
  – Precision measurement of the tau mass
  – HVP in $(g-2)_\mu$, $\alpha(s)$; HLBL in $(g-2)_\mu$
  – Meson & baryon structures

• Search for rare and forbidden decays $\rightarrow$ SM & Beyond

PWA is needed for almost all the studies!
A few examples of the BESIII samples

$e^+e^- \rightarrow \pi^+\pi^-J/\psi$: 1500 evts $\Rightarrow$ 6000 evts

$J/\psi \rightarrow \pi^+\pi^-\pi^0$: 50M tagged evts

$D \rightarrow K\pi\eta'$: 2500 tagged evts

$\psi' \rightarrow pp\eta$: 745 evts in 106M $\psi'$

$ISR\ e^+e^- \rightarrow \pi^+\pi^-\pi^0\pi^0$: lots of evts up to 3.4 GeV

untagged corrected bgr BESIII Preliminary
BEPCII Upgrade

• Increase of beam energy
  – $E_{\text{beam}} = 2.30 \rightarrow 2.35 \rightarrow 2.45$ GeV
  – Plan:
    • get to 2.35 GeV in 2019
    • Get to 2.45 GeV in 2020-21, change ISPB (Interaction region SePtum Bending) magnet, big challenge
  – Funding approved

• Top-up injection
  – Data taking efficiency increases by 20~30%
  – Funding approved
BESIII Upgrade

- **CGEM inner tracker ongoing**
  - 3 layers construction completed
  - Will be shipped to IHEP this summer, Installation in summer 2019

- **Super Conducting Magnet**
  - New valve box of SC magnet: funding approved

- **Others**
  - Under discussion
Can cover 0-4.6 GeV from direct annihilation or ISR.

12
4230 + 4260
1.9 fb

PDG 2015
u, d, s
3 loop pQCD
Naive quark model

Can cover 0-4.6 GeV from direct annihilation or ISR.

Energy Scan 526 pb^{-1}
Inclusive measurements

4190, 4200, 4210, 4220, 4236, 4245, 4270, 4280:
3.9 fb^{-1}

2175
0.1 fb^{-1}

R Scan 1.3 fb^{-1} (130 points)

J/ψ

J/ψ
6 x 10^9

ψ(2S)

ψ'
0.5 x 10^9

ψ''
2.9 fb^{-1}

ψ_{3770}

ψ_{4040}
4040
0.5 fb^{-1}

ψ_{4260}
4230 + 4260
1.9 fb^{-1}

ψ_{415}
4420
1.0 fb^{-1}

ψ_{4600}
4600
0.6 fb^{-1}

ψ_{4180}
4180
3.0 fb^{-1}

ψ_{4360}
4360
0.5 fb^{-1}

ψ_{2019+}

2019+
Welcome!

- Welcome you again for coming to this workshop
- I wish the workshop every success and look forward to fruitful discussions and great achievements!
- I hope you have a pleasant stay in Beijing.
- I hope you explore and enjoy the beauty of Beijing.

Thanks a lot!