7th CLHCP, Nanjing, China

Search for structures near $\Upsilon(1S)\Upsilon(1S)$ mass threshold

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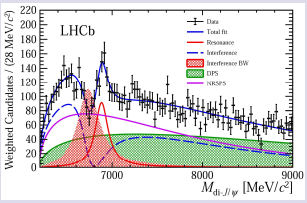
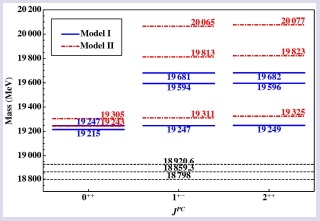
Introduction

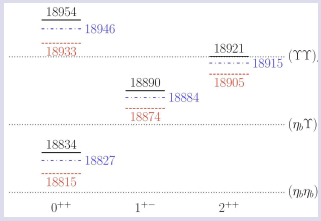
- Observation of X(6900) by LHCb[1] provided strong evidence for the existence of four heavy quarks resonances.
- Four charm tetraquarks research is ongoing in CMS, see two talks below:
  - *Search for near-threshold structures in $J/\psi J/\psi$ and $\psi(2S)J/\psi$ invariant mass spectrum (CMS), by Jinjing Gu*
  - *Recent Heavy Flavor Results in CMS, by Jingqing Zhang*
- This analysis, a search for the four bottom tetraquarks by CMS RunII data is launched.



Motivation

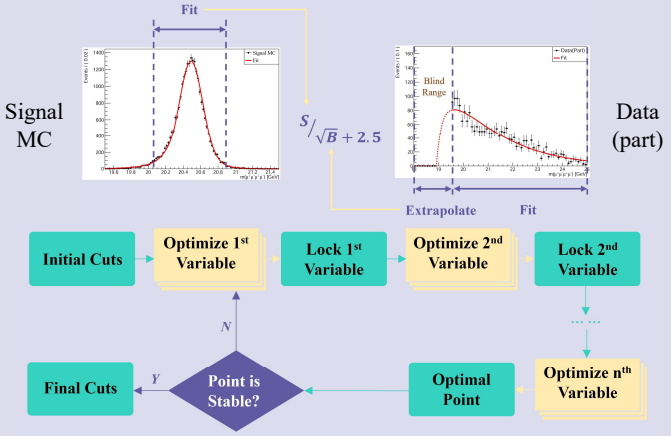
- Existence of full heavy tetraquark state has been theoretically predicated since several decades ago.
- Several exotica particles have been discovered, e.g. $X(3872)$, $Z^+(4430)$,$Z_c^+(3900)$, etc.
- Theoretical work gave some predictions about the mass spectrum of four bottom tetraquarks recently[2,3].





Cut Optimization

- After skim selections, cut need to be optimized to enhance the significance of signal.
- Several cut variables can be optimized, e.g. $Pt(\mu)$,$Pt(\mu^+\mu^-)$,etc.
- FOM: $S/\sqrt{B}+2.5$ will be used to do the optimization work.

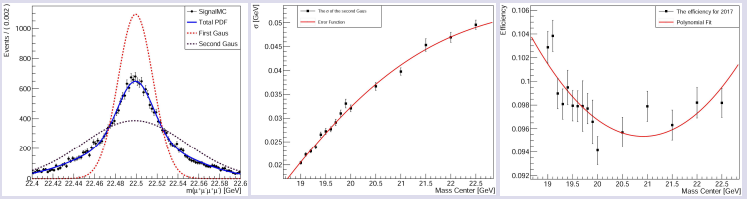


MC

- Several private MC(UL) samples were produced.

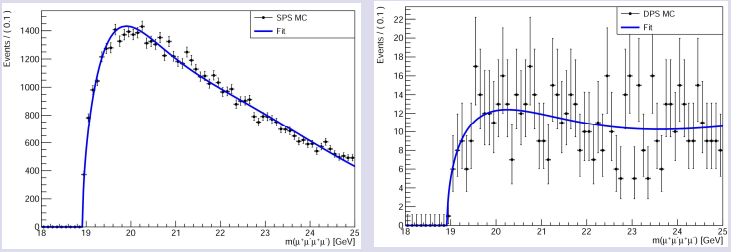
Signal MC (JHUGen)

- Signal MC samples with several mass centers are produced (0^{++}), decay channel of which was set as: $gg \to \Upsilon\Upsilon \to \mu^+\mu^-\mu^+\mu^-$
- Resolution and efficiency distributions are evaluated by the samples.



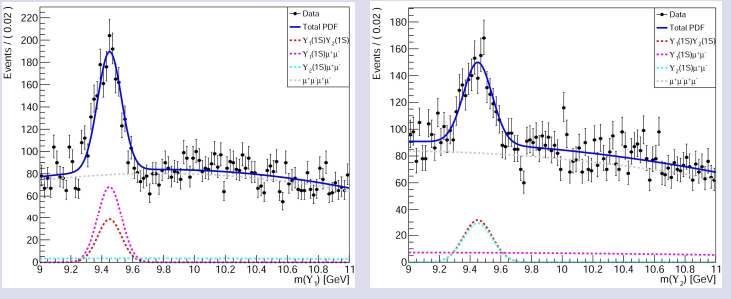
Background MC (Pythia8)

- SPS (Single-Parton-Scattering) and DPS (Double-Parton-Scattering) are considered as the main non-resonance background (besides the combinatorial background).



Data

- CMS RunII MuOnia dataset will be used. $\Upsilon\Upsilon$ Signal has been observed by 2D fit in advance.



Future Plan

- Background modeling.
- Cut optimization.
- $\Upsilon\Upsilon$ Mass spectrum fit.
- Systematic error calculation.

References: [1]. LHCb Collaboration. Observation of structure in the J/ψ-pair mass spectrum - ScienceDirect[J]. Science Bulletin, 2020.
[2]. Wang, G. J. , Meng L. , Zhu S. L. . Spectrum of the fully-heavy tetraquark state "$qq\bar{q}\bar{q}$"[J]. 2019.
[3]. Wu J. , Liu Y. R. , Chen K. , et al. Heavy-flavored tetraquark states with the $qq\bar{q}\bar{q}$ configuration[J]. Phys. Rev. D, 2018.