Status of the $B \to hh'$ Padova Analysis

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BPH Meeting 02/27/2013

- Analysis Strategy
- Very Preliminary Results
- Next Steps

Analysis Strategy

- Motivation:

Estimate BKG from $B \rightarrow hh'$ in the $B \rightarrow \mu\mu$ Analysis

(not a BR measurement!)

  - Use same normalization channel $B^+ \rightarrow K^+ J/\Psi$
  - Use different trigger samples:

    -Muon with PT>12GeV, 2 Jets with PT>40, 20 GeV, 2 btagged Jets

    -Displaced J/Ψ (muonia)

- Two different Strategies:

  - Fast: Start the $B \rightarrow hh'$ reconstruction from the secondary vertexes in Jets (any bias?)
  - Strong: Use all the tracks combinations (as in the $\mu\mu$ Analysis)

Analysis Strategy

- Goal: determine the number of hh' events in the $B \rightarrow \mu\mu$ sample from the extracted $B \rightarrow hh'$ signal in the Padova sample. How can we do it?
- Recipe:
  - Exploit the $N(B \rightarrow hh')/N(B^+ \rightarrow K^+ J/\Psi)$ ratio in the two different trigger samples
  - Take into account:
    - Different number of b events in the two samples
    - Difference in the efficiency for the $K^+ J/\Psi$ channel
    - Difference in the efficiency for the hh' channel
    - Misidentification $\omega(hh' \rightarrow \mu\mu)$ (from independent study)

Analysis Strategy

- $B \rightarrow \mu\mu$ Analysis:
  - $N_{B^+} = N_b^{(muonia)} * f_u * BR(B^+ \rightarrow K^+ J/\Psi) * \varepsilon(B^+)$
  - $N_{hh'} = N_b^{(\mu\mu)} * f_d * BR(B \rightarrow hh') * \varepsilon(\mu\mu) * \omega(hh' \rightarrow \mu\mu)$
- Padova hh' Analysis:
  - $N_{B^+}(PD) = N_b(PD) * f_u * BR(B^+ \rightarrow K^+ J/\Psi) * \varepsilon(B^+)(PD)$
  - $N_{hh'}(PD) = N_b(PD) * f_d * BR(B \rightarrow hh') * \varepsilon(hh')(PD)$

- $N_{hh'}$: quantity to be determined, mostly $B^0 \rightarrow K\pi$ (expression to be slightly modified to include $B_s \rightarrow KK$)
- $N_b^{(muonia)}$, $N_b^{(\mu\mu)}$, $N_b(PD)$: Number of b's in the different trigger samples
- $\varepsilon(B^+)$, $\varepsilon(B^+)(PD)$: Efficiency for the $K^+ J/\Psi$ normalization channel

Analysis Strategy

- $B \rightarrow \mu\mu$ Analysis:
  - $N_{B^+} = N_b^{(muonia)} * f_u * BR(B^+ \rightarrow K^+ J/\Psi) * \varepsilon(B^+)$
  - $N_{hh'} = N_b^{(\mu\mu)} * f_d * BR(B \rightarrow hh') * \varepsilon(\mu\mu) * \omega(hh' \rightarrow \mu\mu)$
- Padova hh' Analysis:
  - $N_{B^+}(PD) = N_b(PD) * f_u * BR(B^+ \rightarrow K^+ J/\Psi) * \varepsilon(B^+)(PD)$
  - $N_{hh'}(PD) = N_b(PD) * f_d * BR(B \rightarrow hh') * \varepsilon(hh')(PD)$

- $\varepsilon(\mu\mu)$, $\varepsilon(hh')(PD)$: Efficiency for the $\mu\mu$ and hh' channels
- $\omega(hh' \rightarrow \mu\mu)$: Misidentification for the hh' channel
- $f_u = N_{B^+}/N_b$, $f_d = N_{B^0}/N_b$, in the following naively assume $f_d = f_u$ and no b-hadron fraction difference between the two trigger samples (systematic uncertainty to be estimated).

Analysis Strategy

- By factorizing the corresponding quantities:

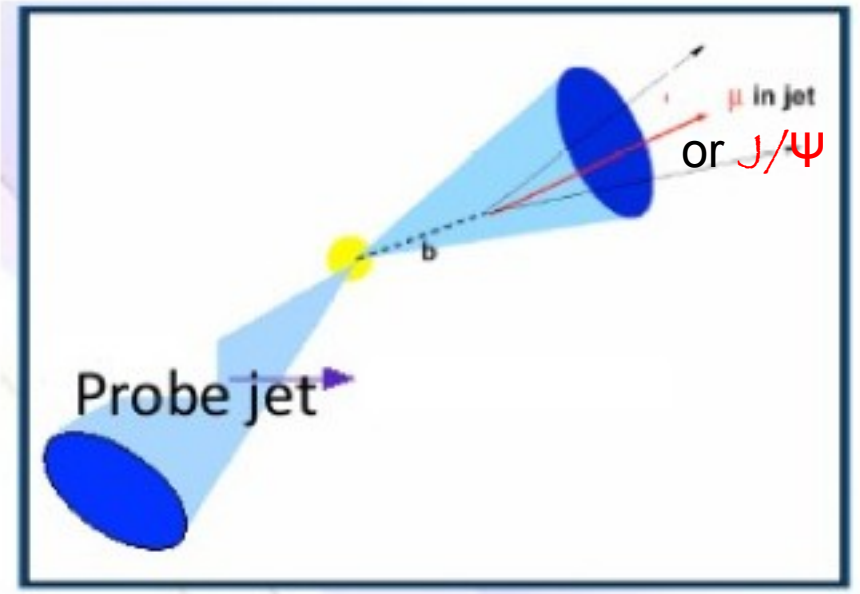
$$Nhh' = \frac{NB^{+}}{C\,NB^{+}(PD)} \frac{\epsilon\, B^{+}(PD)}{\epsilon\, B^{+}} \frac{\epsilon(\mu\mu)\,\omega(hh')}{\epsilon\, hh'(PD)} Nhh'(PD)$$

- First ratio accounts for normalization of the three different trigger samples, ($C \approx Nb^{(muonia)} / Nb^{(\mu\mu)}$ in the $B \rightarrow \mu\mu$ Analysis)
- Second ratio accounts for possible bias in the reconstruction strategy (different trigger samples, Jet vs all tracks combinations)
- Third ratio accounts for different analyses goals ($\mu\mu$ or hh' selection)

- NB^{+}, $NB^{+}(PD)$, $Nhh'(PD)$ from counting
- $\epsilon(B^{+})(PD)$, $\epsilon(hh')(PD)$ from MC
- $\epsilon(B^{+})$, $\epsilon(\mu\mu)$, C from the $B \rightarrow \mu\mu$ Analysis
- $\omega(hh')$ from the ongoing study by Mario & Jacopo

Very Preliminary Results

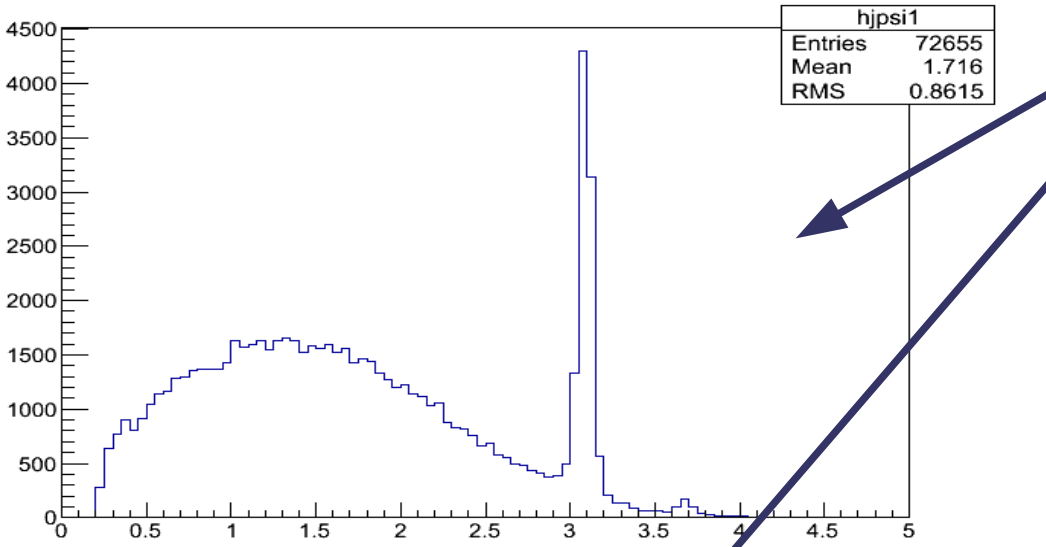
- Jet Based Strategy:
  - Tag a b-jet by means of a High PT μ (or a displaced J/Ψ)
  - Reconstruct $B^+ \longrightarrow K^+ J/\Psi$ & $B \longrightarrow hh'$ decays starting from secondary vertexes not associated to the Tag jet.



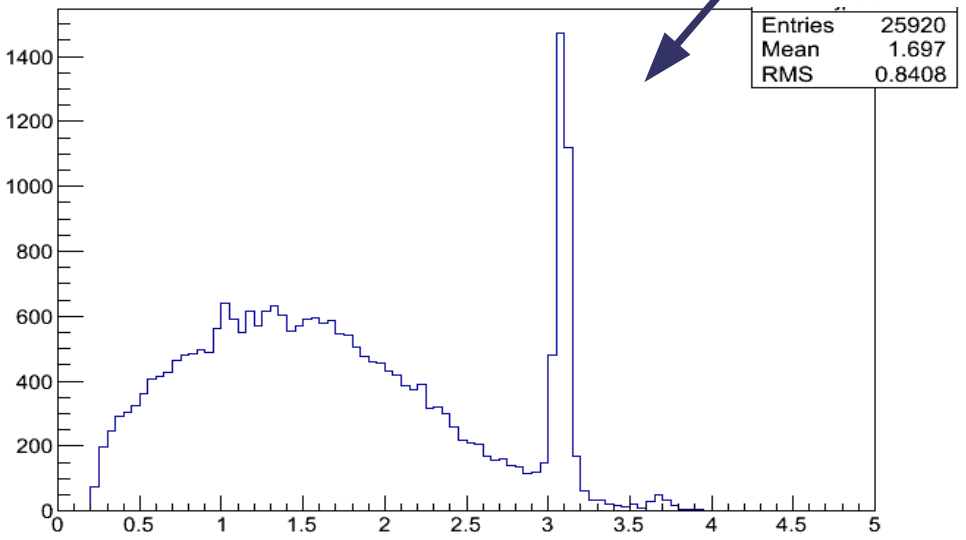
- Results obtained using Single-Muon trigger HLT_Mu12_eta2p1_DiCentral_40_20_DiBTagIP3D1stTrack
- Displaced J/Ψ trigger will be included in a few days.

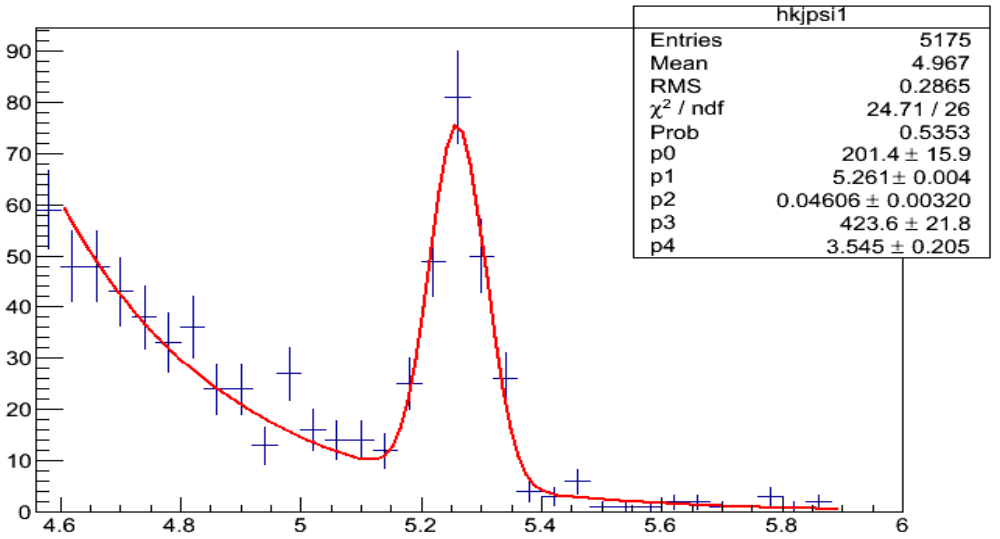
"Jet Based Strategy" Results

- Normalization channel $B^+ \rightarrow K^+ J/\Psi$



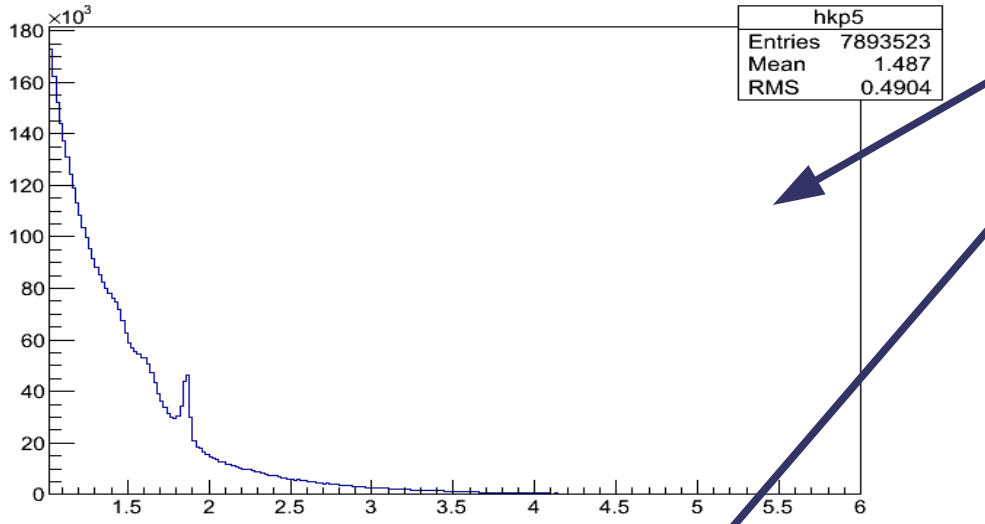
- About 7500 J/Ψ in Probe jets out of which 3000 from secondary vertexes with 3 tracks
- Assuming the third track is a Kaon: $N(K^+ J/\Psi) \sim 200$



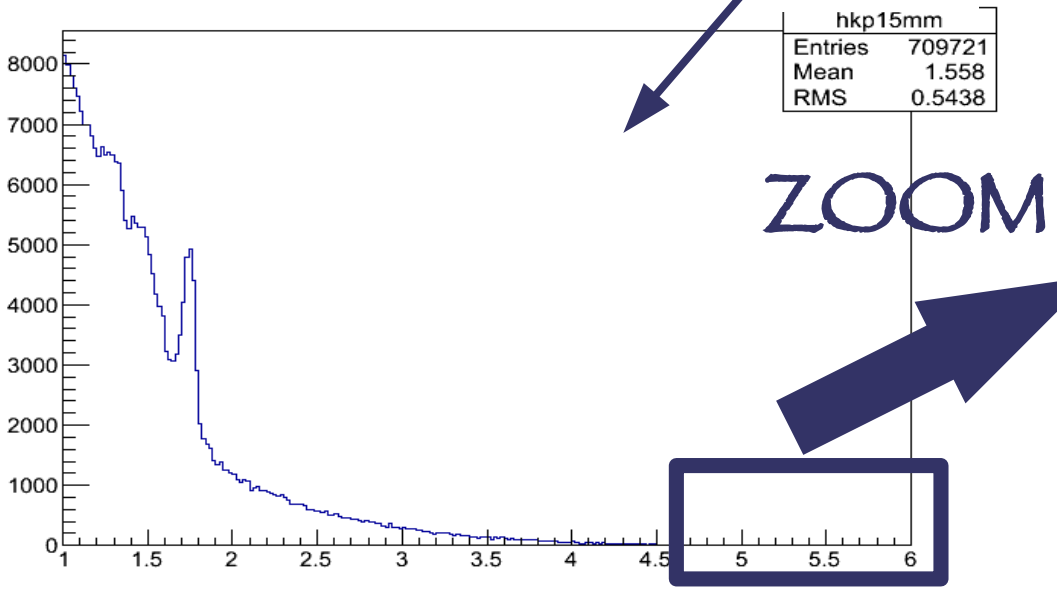


"Jet Based Strategy" Results

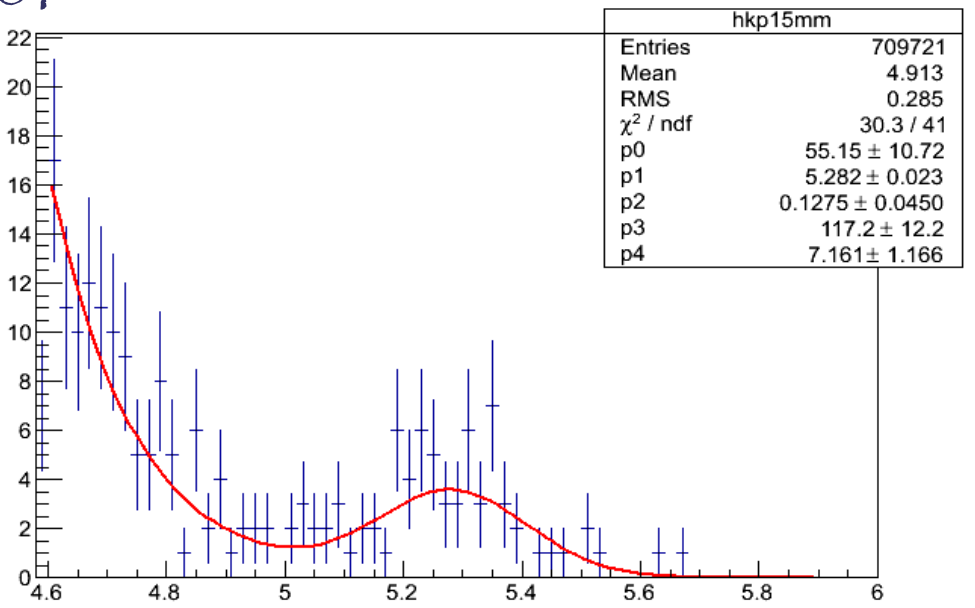
- Signal channel $B \rightarrow hh'$



- Look at the invariant mass of vertexes with 2 tracks (PT>3GeV) not identified as muons.
- Isolation cut applied on the Sum(PT) over a cone of $\Delta R<0.3$
- Invariant mass with the μ mass hypothesis: $N_{hh'} \sim 50$



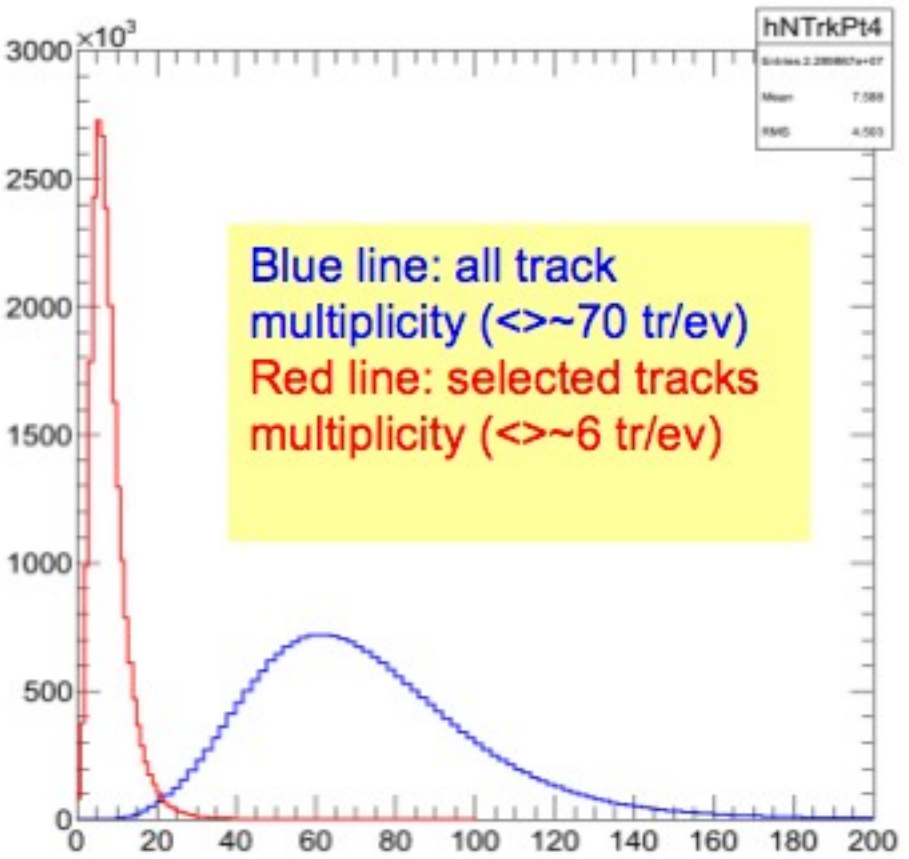
ZOOM



"All Tracks Combi" Results

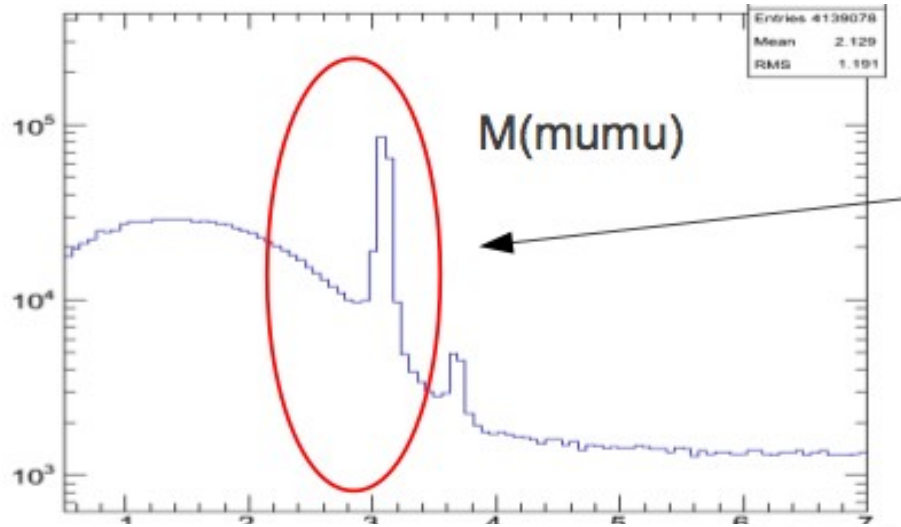
- "All Tracks Combination" Strategy:
  - Tag a b-jet by means of a High PT μ (or a displaced J/Ψ)
  - Reconstruct $B^+ \rightarrow K^+ J/\Psi$ & $B \rightarrow hh'$ decays starting from the combinations of all the tracks with PT>4 GeV not belonging to the Tag jet.

- Number of tracks surviving PT cut seems reasonable to allow hh' reconstruction

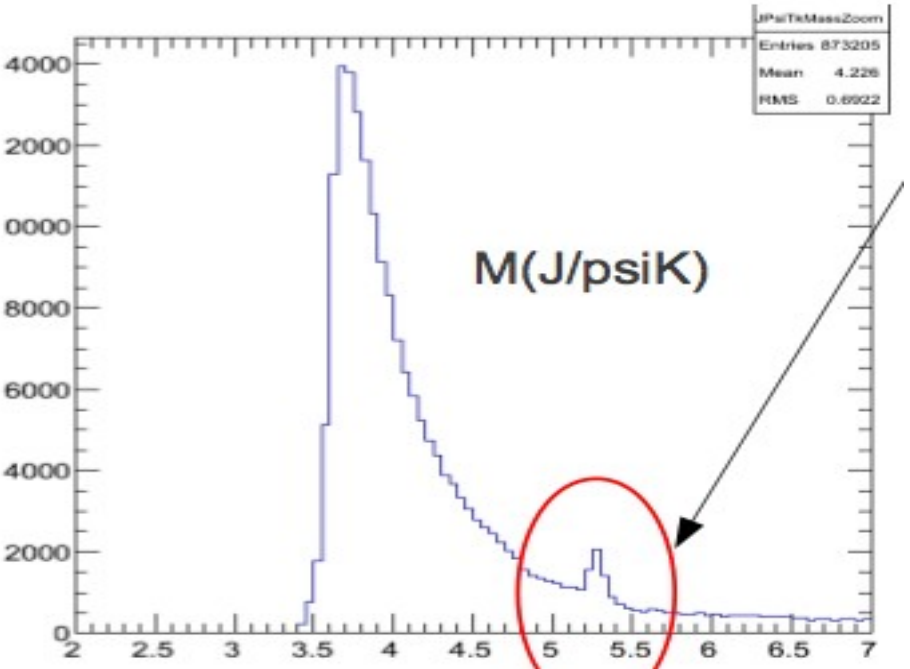


"All Tracks Combi" Results

- Normalization channel $B^+ \rightarrow K^+ J/\Psi$



- J/Ψ from 2 muons combination

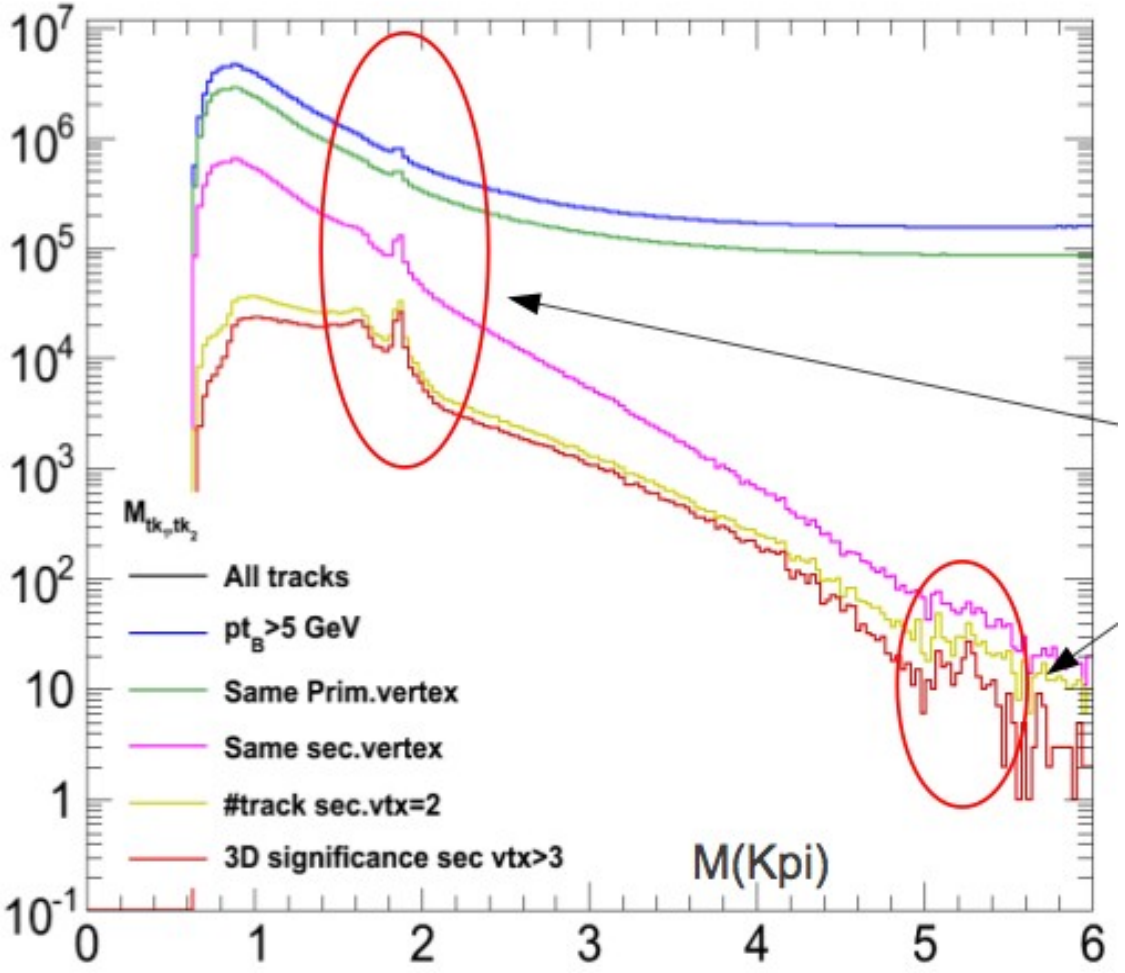


- Associate a third track (not a muon) with Kaon mass hypothesis

- Caveat: trigger muon not correctly excluded yet

"All Tracks Combi" Results

- Signal channel $B \rightarrow hh'$



- Combination of two tracks (not muons):
  - Leading: K-mass
  - Sub-leading: π mass
- Clear D^0 signal, hint of B^0 signal...

- Results obtained using harder and harder selection cuts

Next Steps

- Optimize Analysis Cuts to enhance hh' & K^+J/Ψ statistics (isolation):
  - Few days
- Include the Muonia Displaced J/Ψ trigger sample:
  - End of the week
- Compute the analysis efficiency from simulation:
  - MC rootoples production finalized
  - End of next week
- "All tracks combination" Strategy:
  - Less advanced: use it for the final number or just as a cross check?
- Feedback from the BPH Working Group welcome!