Bs to J/ψγ

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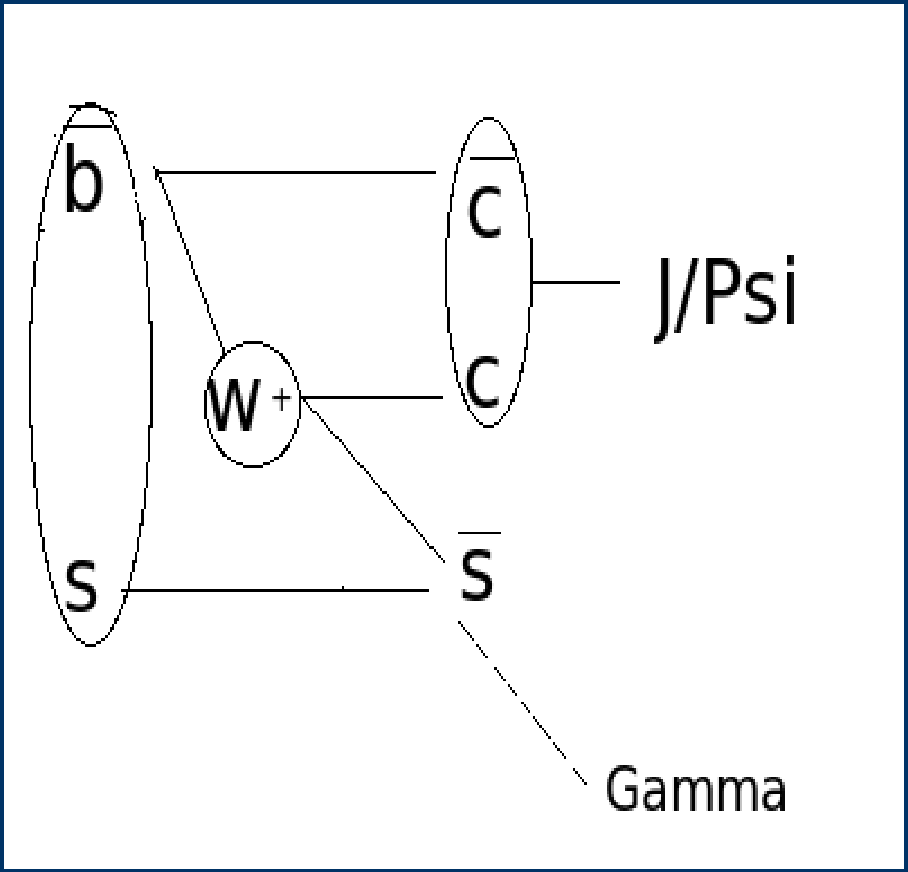
Quick Review

- The rare decay of Bs meson into a J/ Ψγ has not been observed
- Interesting because both B_s and it's anti-particle decay into J/Ψγ
- Using the data available form CDF (Collider Detector at Fermilab)
- Set a maximum limit for the branching fraction

Components in the process

- B_s meson is a bound state of an anti b quark and an s quark
- J/ Ψ is a bound state of a charm and an anti charm quark.
- γ is a photon formed from the annihilation of a strange and anti strange quark

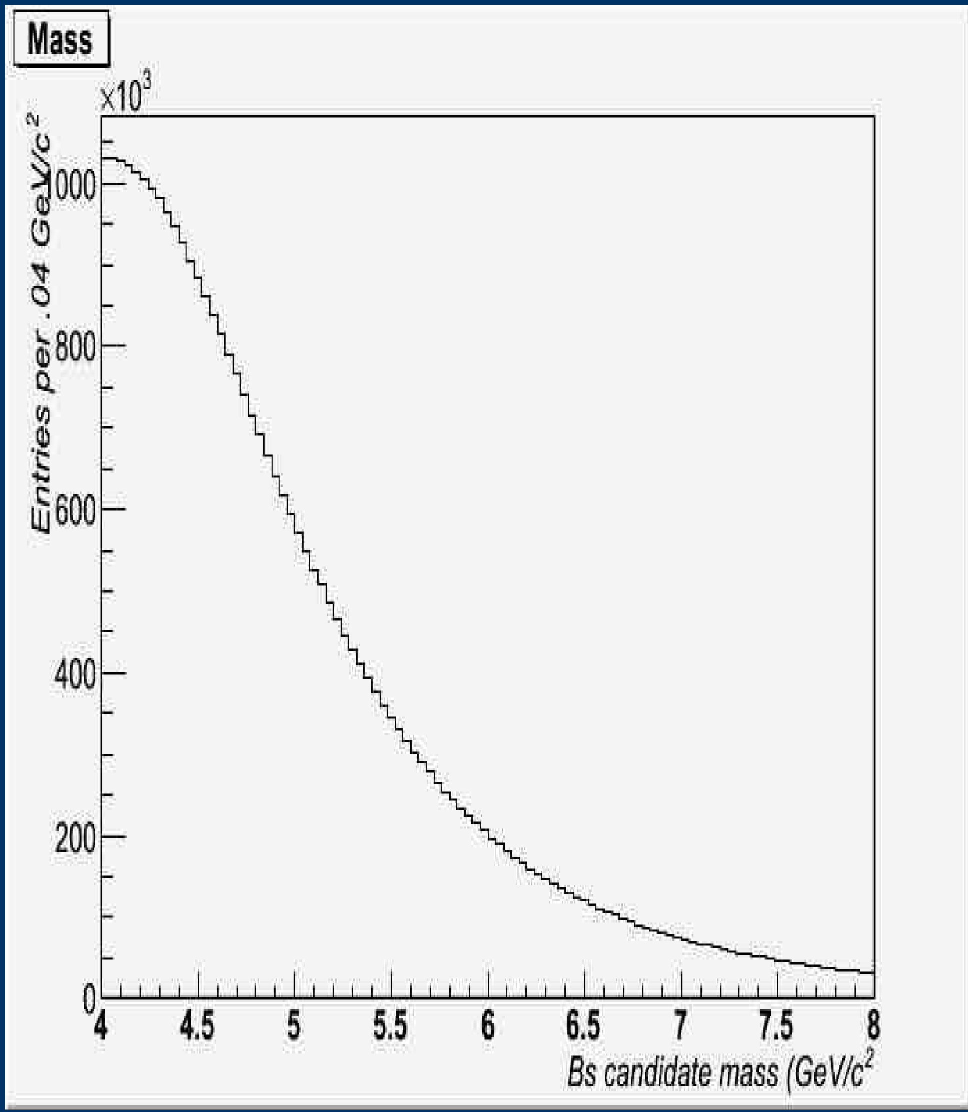


Theoretical Predictions

- Two calculations exist for the branching fraction of $B_s \rightarrow J/\psi\ \gamma$: $1.395 * 10^{-6}$, $5.795 * 10^{-8}$
  - Which is right ? Or are either of them right?
  - How does our value compare with these values
  - It is equal to $5 * 10^{-5}$(way big) but this is only a limit

What Happened

- We took all J/ Ψ->μ+μ- events
- Reconstructed a photon from the information available from the calorimeter
- If there were any significantly large signal it would peak in the Bs mass region.
- With no purification there is no visible signal available

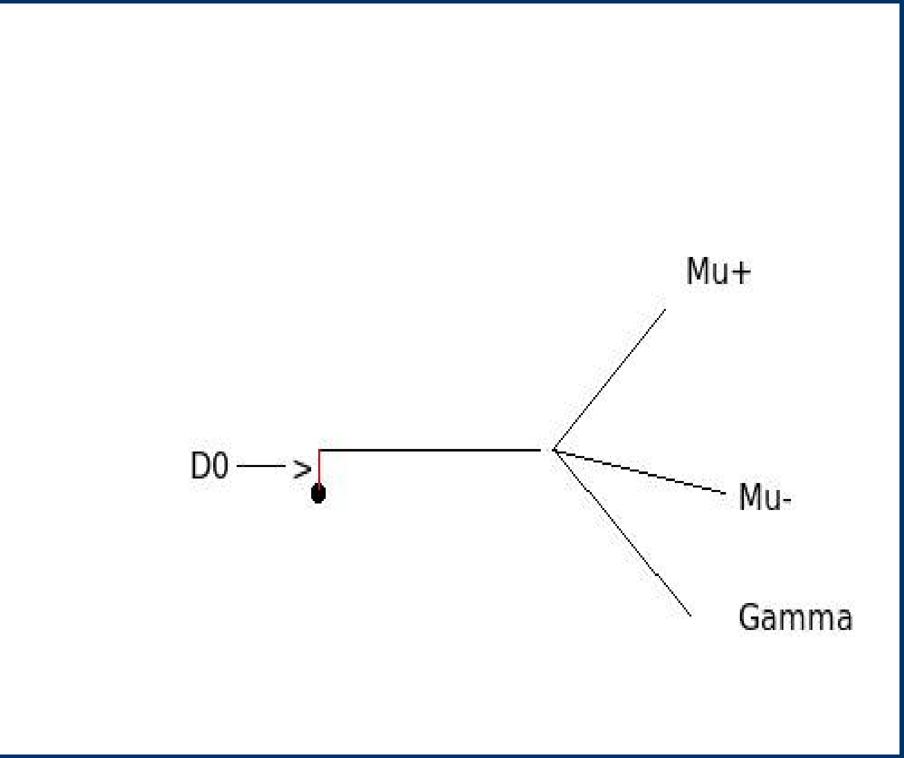


What are the backgrounds

- Prompt J/ Ψ, the ones that are formed at primary vertex
- J/ Ψ from other B decay
- Prompt J/ Ψ with a fake photon
- J/ Ψ from B decay with fake photon

Most powerful cuts

- Mass of J/ Ψ
- Proper time for decay
- Length travelled in x-y plane before decay (Lxy)
- Match likelihood
- Impact parameter(D0)
- Energy of photon

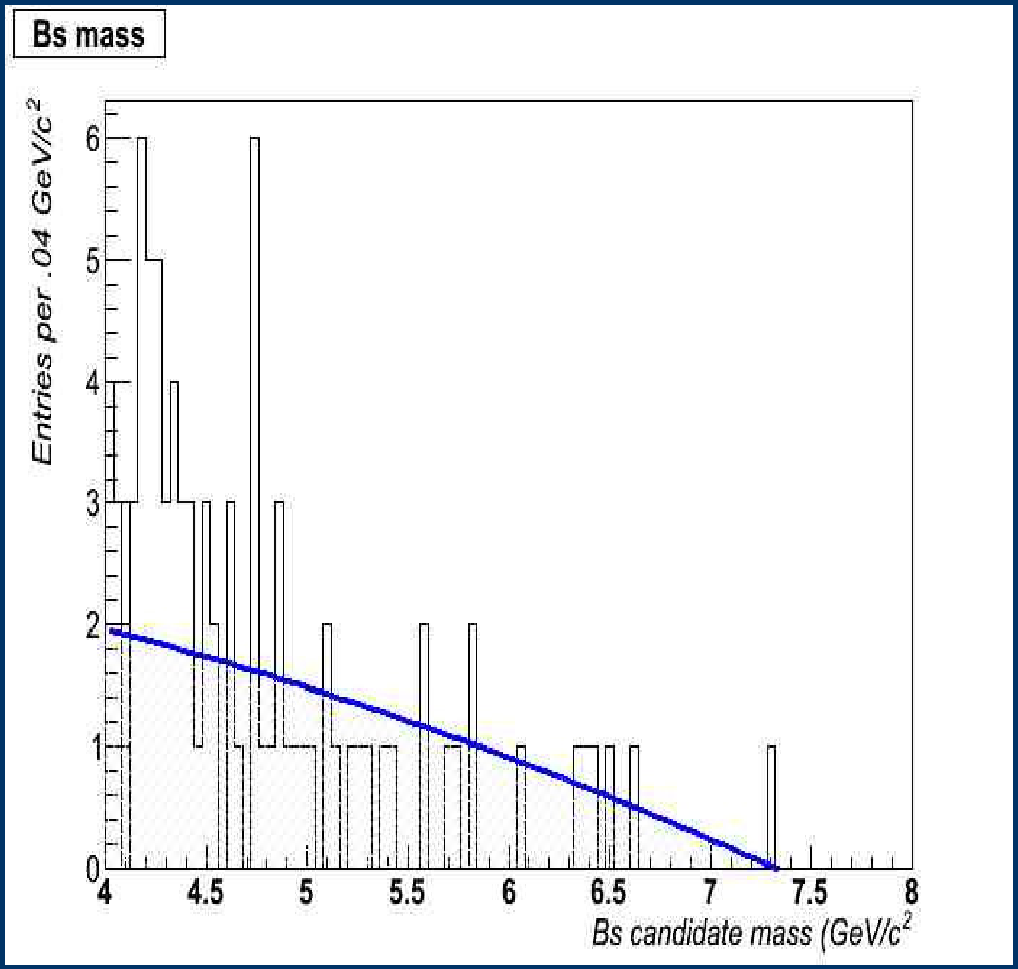


Optimization of cuts

- We maximize a function very similar to function representing the signal to noise ratio.
- The Function is given by $F(x)=\varepsilon/1.5+\sqrt{(B)}$
- Efficiency is the obtained from the number of events that survive the cuts in Monte Carlo

After Cuts

- The plot looks very random and there is no peak in the mass region.
- Therefore we set an upper limit for the Branching fraction

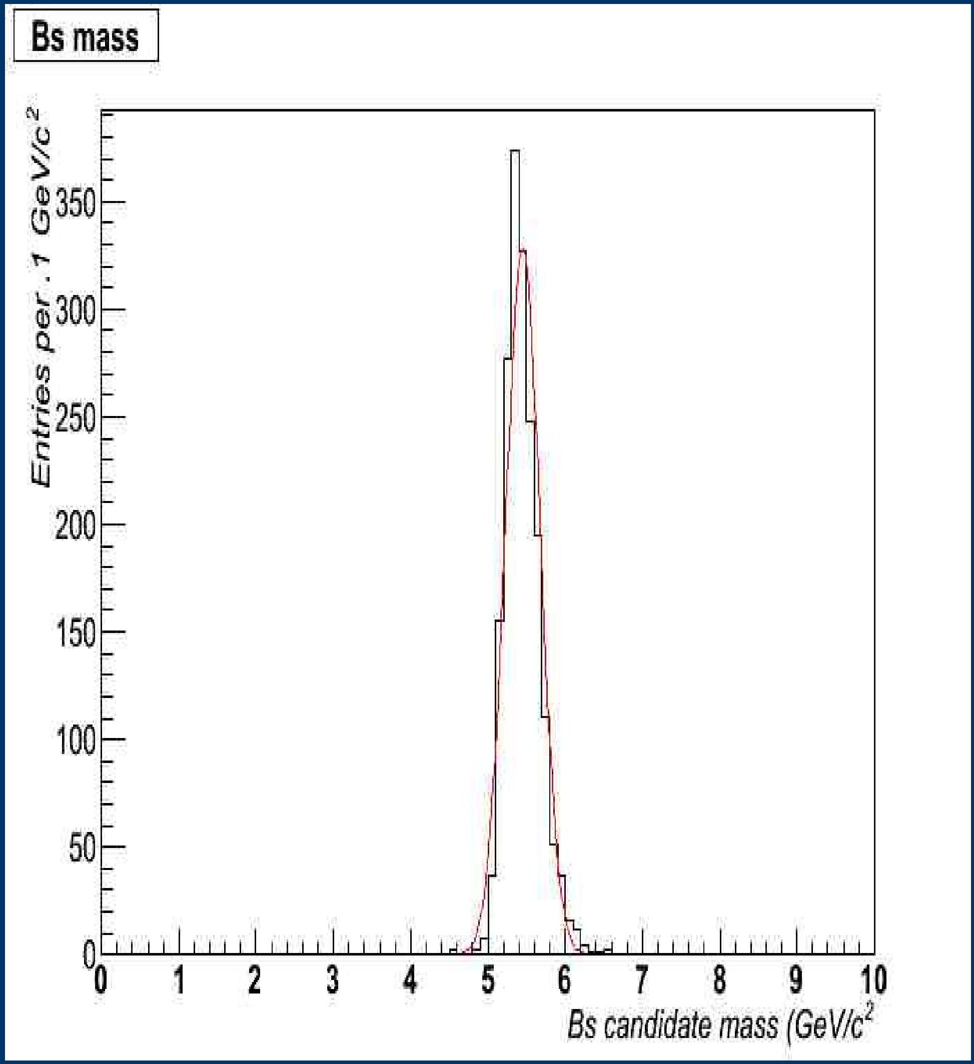


What is left out

- Most of the events that survived all the cuts are mostly other B-decays involving J/ Ψ
- Many of which could be partially reconstructed B-decay combined with many other real or fake photons from various decays

What about the efficiency

- We assume the events in the Monte Carlo would simulate the effect of various cuts on data.
- Initially there were about hundred thousand events and at the final stage there is about two thousand events, hence an efficiency of 1.7%



Normalization

- We normalize using $J/\Psi K^+$ data.
- Because the numbers are more reliable and the math is easier, since there is more statistics.
- We set an upper limit on the number of events for a confidence of about 90%
- N(upper limit)= N(signal)+1.29*Uncertainity

Significance

- The value that I get for the branching fraction after all the data analysis is, $5*10^{-5}$ which is about 35 times bigger that the bigger limit (1.395e-6).
- But there is lot of room for setting a better limit or even measuring the actual branching fraction if we have more data (which we do have)
- B-Decays are very sensitive to any kind of new physics beyond the standard model, so if a theorist comes with a theory and as a result of which the branching fraction would increase above the limit then we can dismiss it

How can we improve

- 10 times more data can improve the limit by a factor of 3
- Looking into events with γ decay into e^+e^- could improve the limit by a factor of 2
- Involving more variables to cut on could improve the limit by a factor of 2

How competitive are the results

- There are results published on a similar decay of B_d
- The predicted value for this decay is about $5.4*10^{-8}$ about 30 times smaller than the experimental limit set
- The limit we calculated is about 35 times bigger than the predicted value
- With more data and some more further analysis , the limit would shrink very rapidly and we may in fact see the decay

Why is this interesting

- If we ever observe it, then we would be the first to observe it
- Secondly it would be the first time ever somebody has reconstructed a B decay involving photons reconstruction in a hadron collider
- The decay process has only one hadron in its initial and final state, which makes the calculations predicting its properties relatively simple. And hence can be used to confirm or dismiss theories

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