Physics with muons on LHCB. First experimental muon spectra. Perspectives for $B_s \rightarrow 2\mu$ and $\tau \rightarrow 3\mu$ searches.

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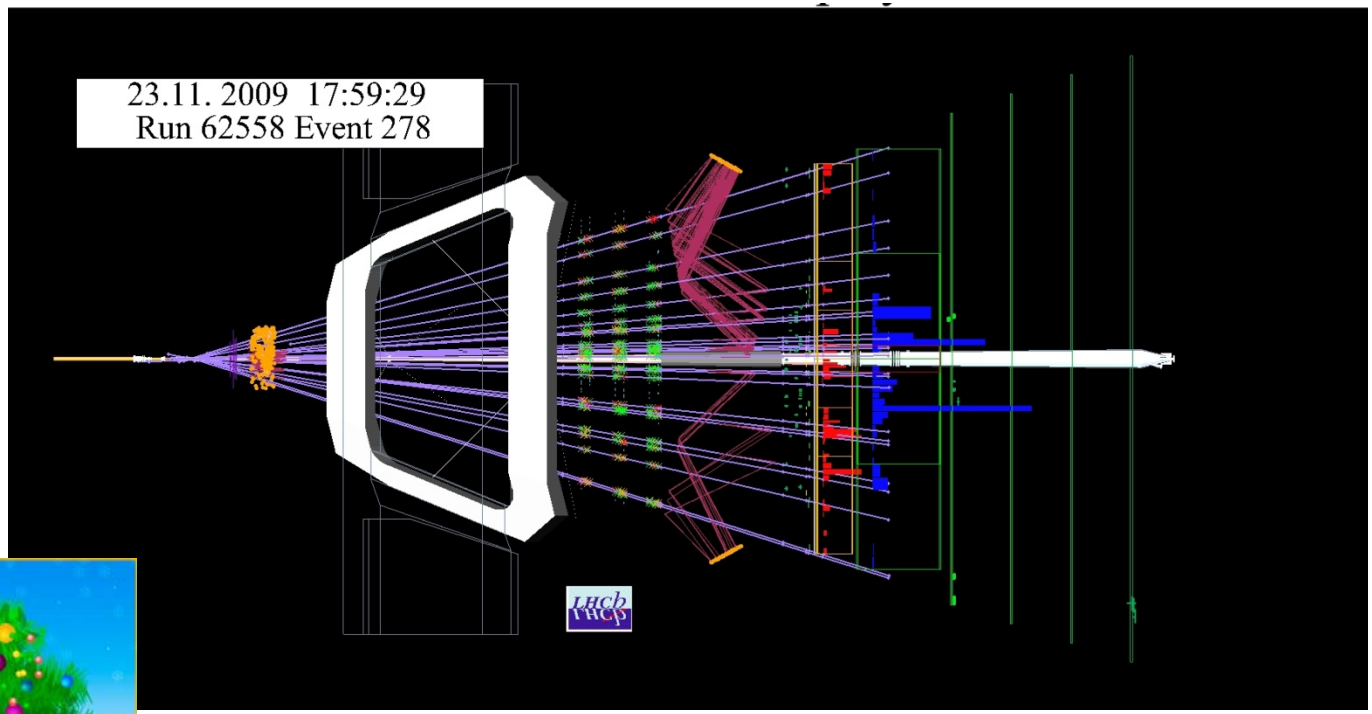
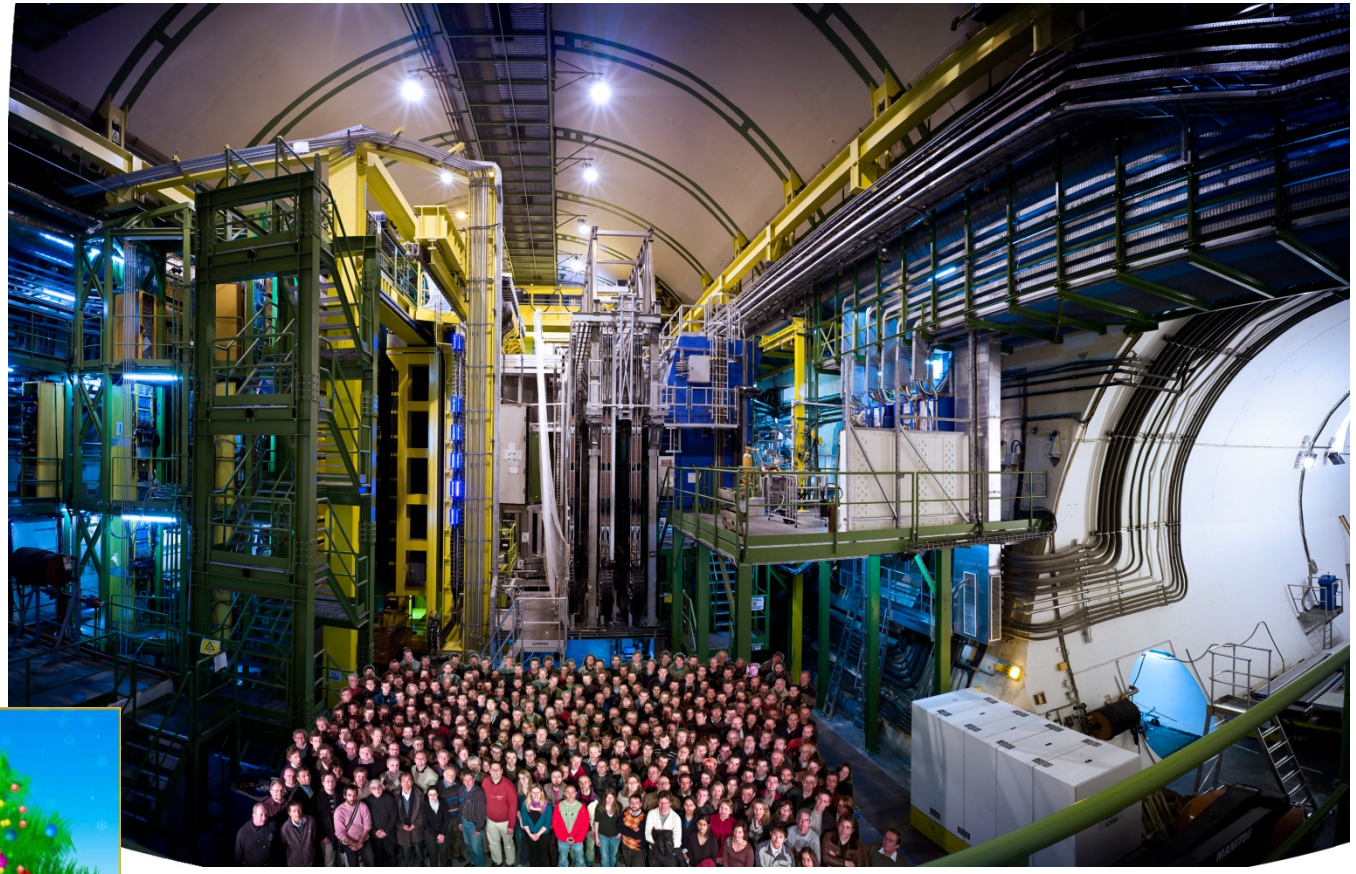
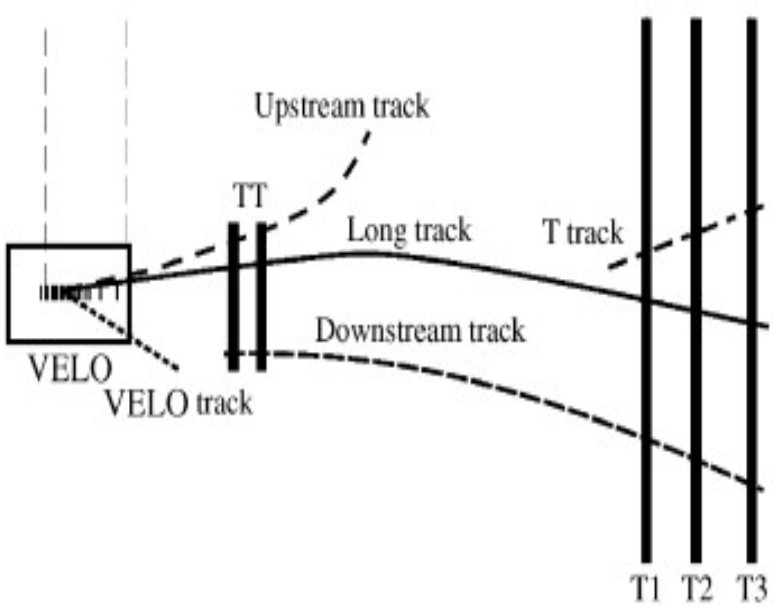


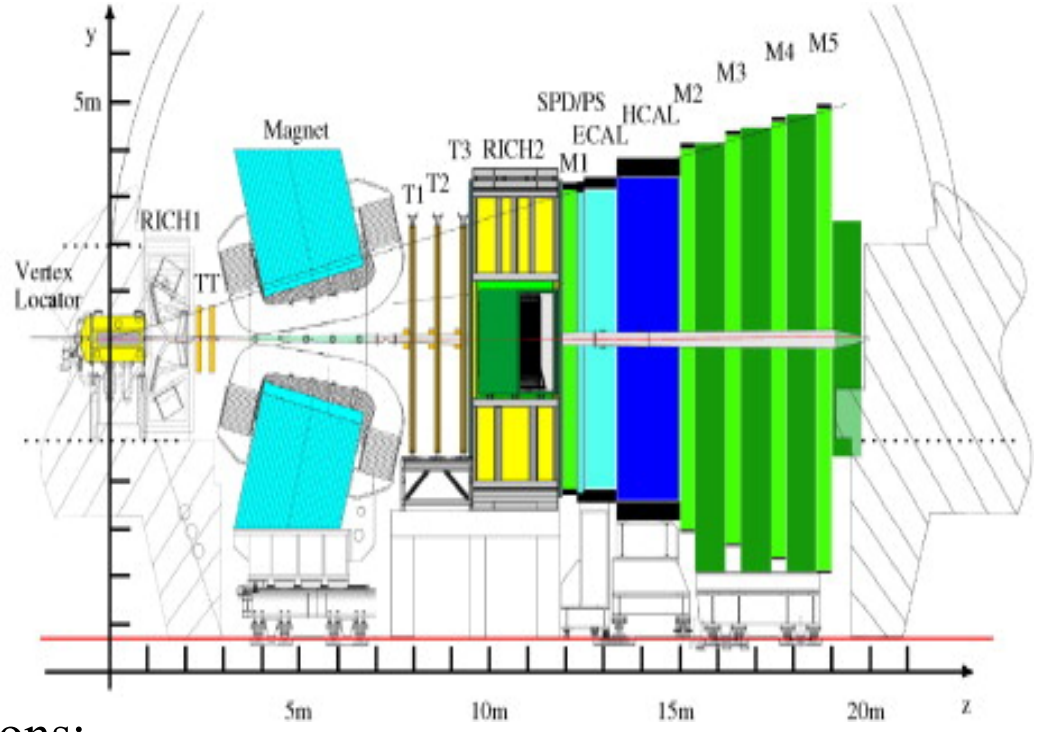
LHCB collaboration

LHCB - 800 members , 15 countries, 54 institutes



LHCb detector

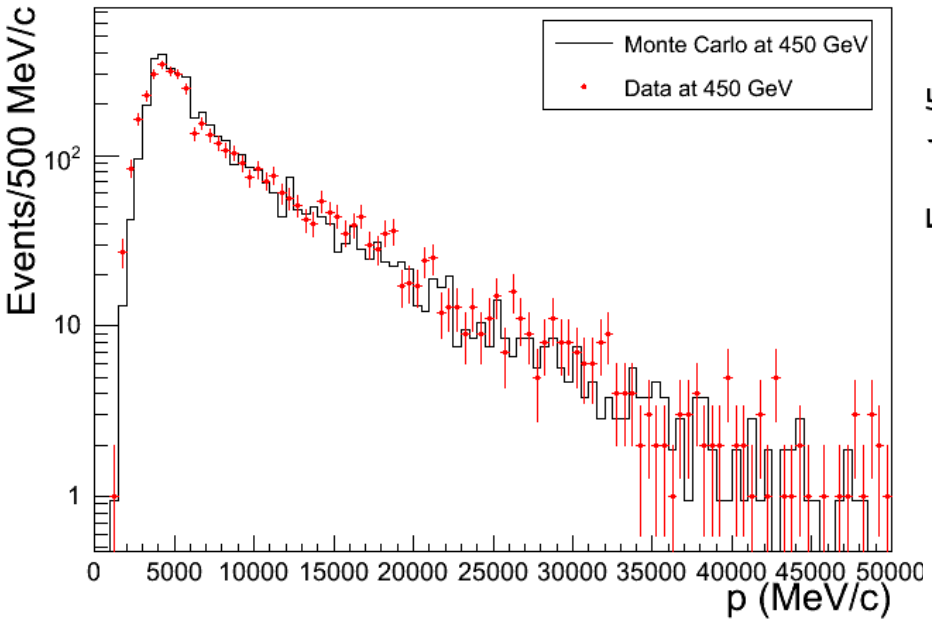


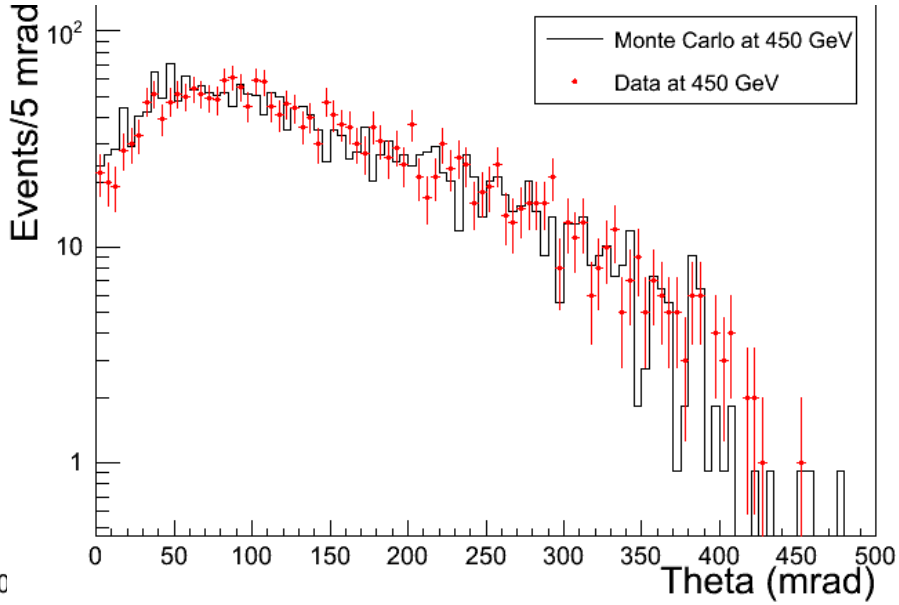


M1, M2, M3, M4, M5 – muon stations;
RICH1, RICH2 – Cherenkov detectors;
TT, T1,T2,T3 – tracking stations;
VELO (Vertex Locator) – vertex detector;

First LHCB experimental muon spectra

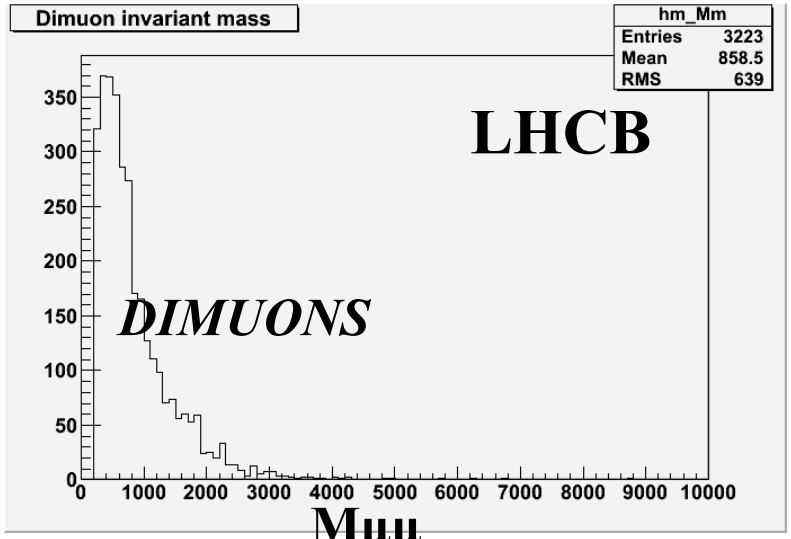
- pp -interactions 450 GeV + 450 GeV, 4x4 bunches



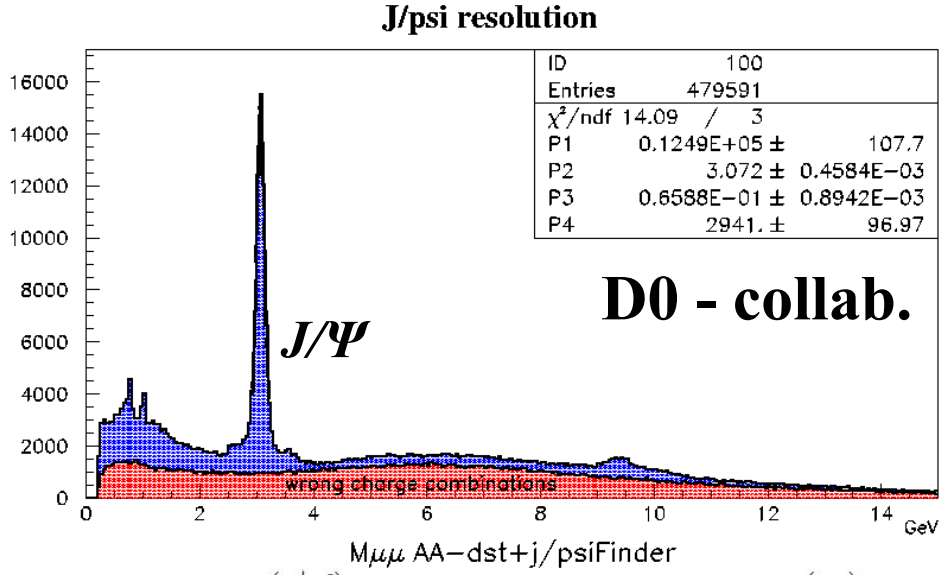


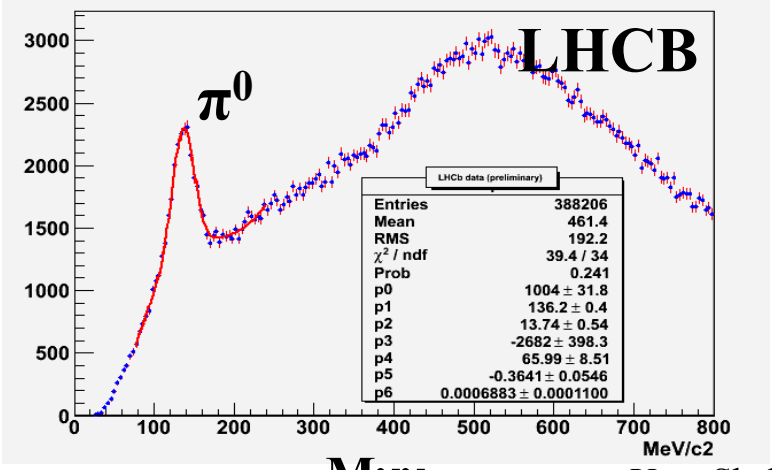
- Very good agreement MC and Data !

LHCB experimental invariant mass spectra

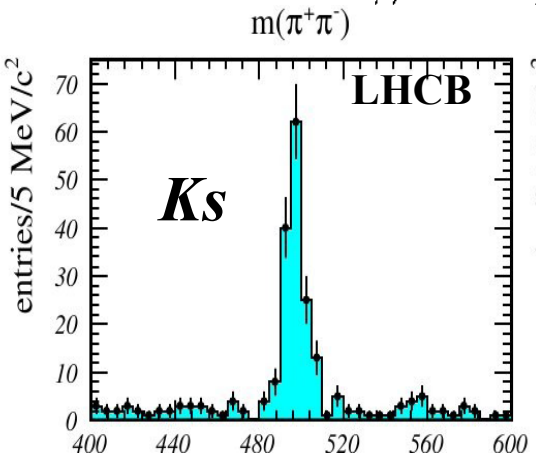


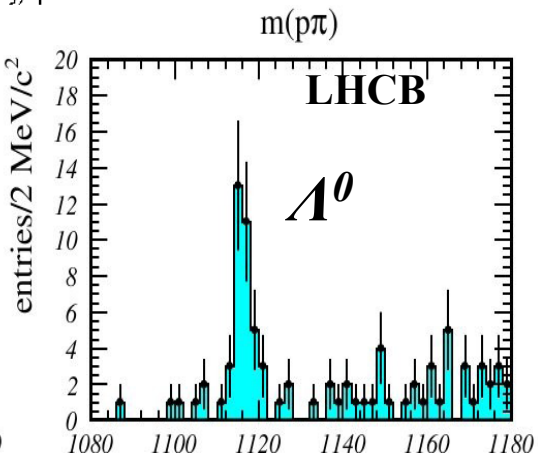
Mμμ





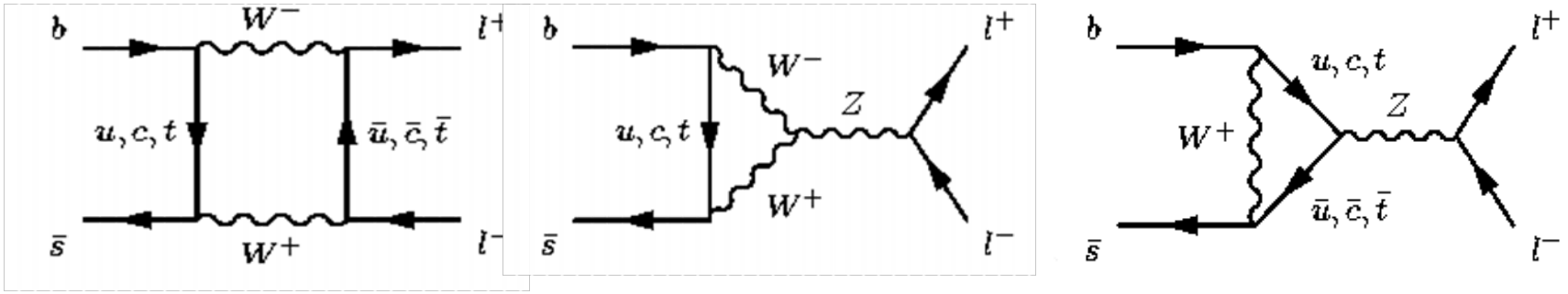
Mγγ





Standard Model diagrams for $B_s \to \mu^+\mu^-$. Existing upper limits for $B_s \to 2\mu$ and $\tau \to 3\mu$ - decays

- We are looking for some evidence of possible Standard Model enhancements (MSSM, SUSY etc). Standard model diagrams



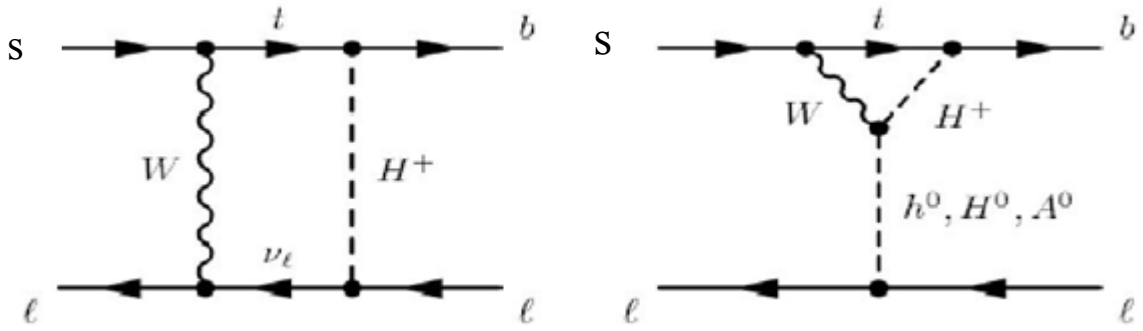
- **$B_s \to 2\mu$** decay strongly suppressed in SM all possible $B_s \to 2\mu$ SM diagrams give branch ratio **$(3.35 \pm 0.32) \cdot 10^{-9}$**

- existing upper limits **now** (L = 3.7 fb^{-1}) CDF Br ($B_s \to 2\mu$) < $4.3 \cdot 10^{-8}$ (95% C.L.) ; **D0** expected limit at L = 5 fb^{-1} : Br ($B_s \to 2\mu$) < $4.3 \cdot 10^{-8}$ (95% C.L.)

- **$\tau \to 3\mu$**

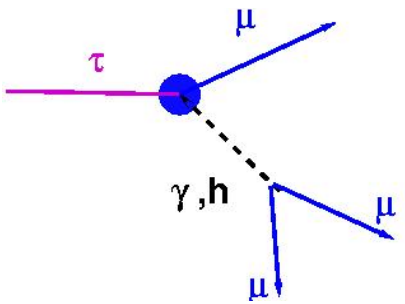
- $\tau \to 3\mu$ forbidden in Standard model
- Present limit : BR($\tau \to 3\mu$) < $4 \cdot 10^{-8}$ (Belle)

Two-Higgs doublet model diagrams

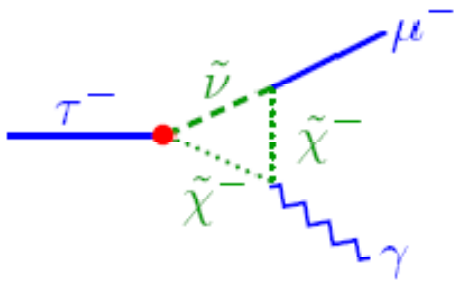


LFV processes - signature for new physics

$\tau \rightarrow \mu\mu\mu$

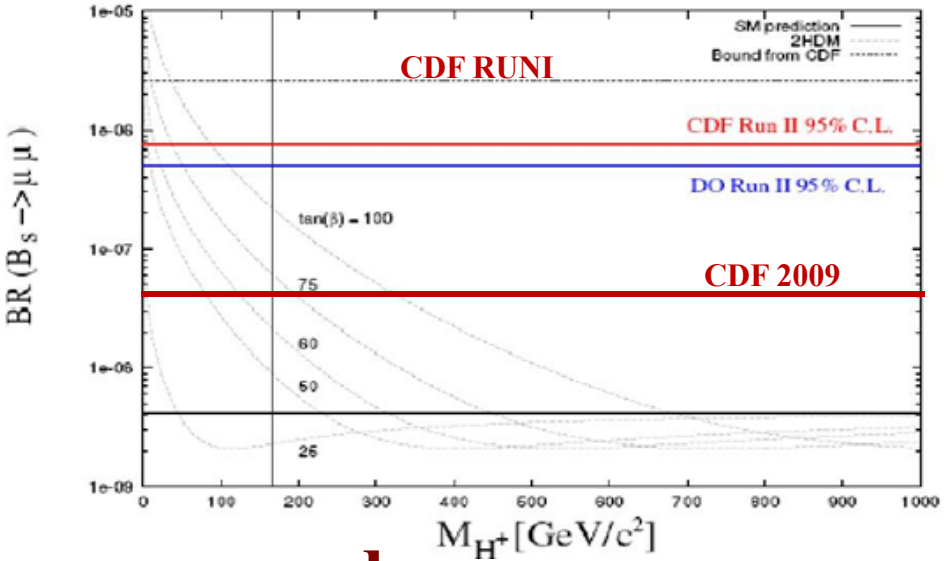


$\tau \rightarrow \mu\,\gamma$



Prediction for parameters of the Two-Higgs doublet model

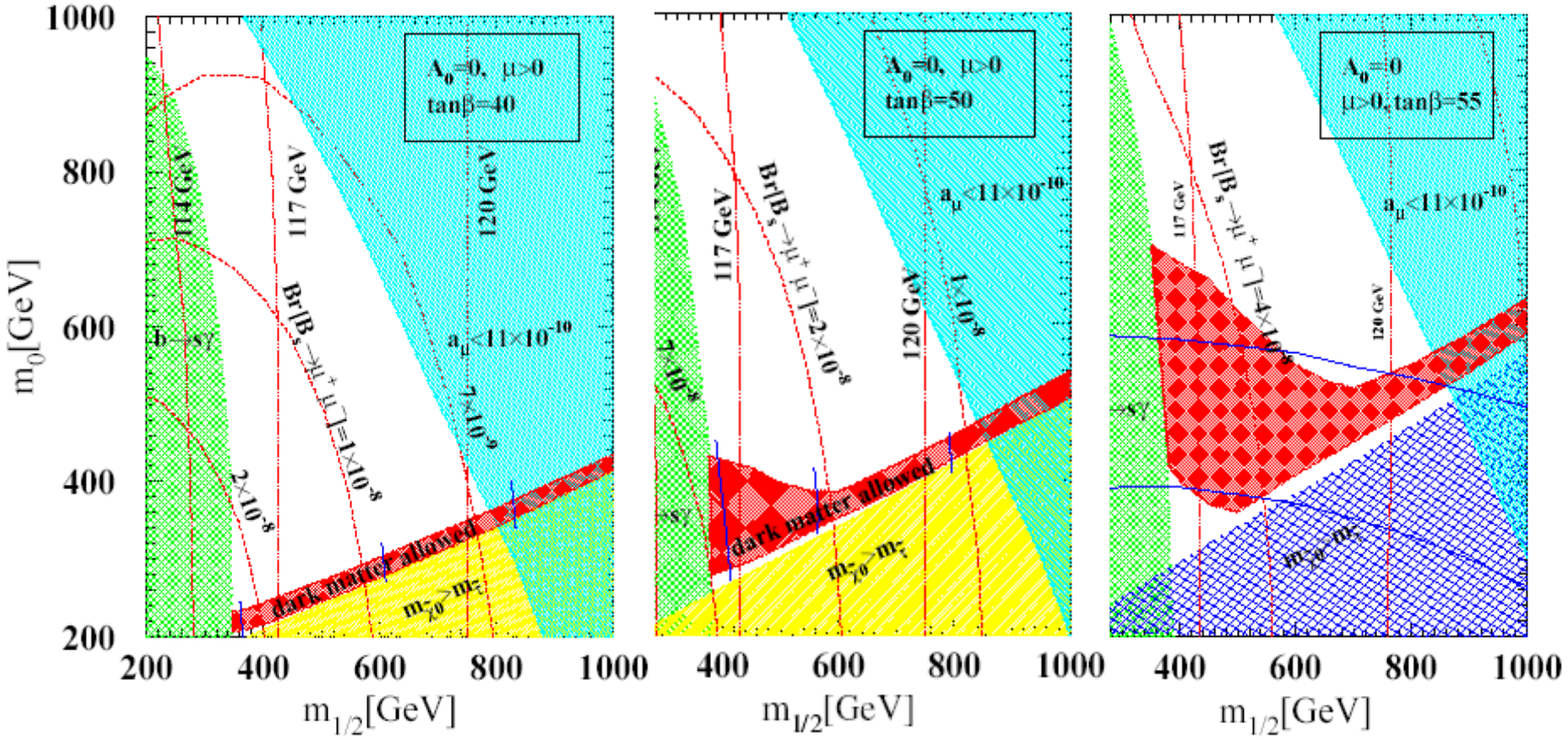
$$BR(SUSY) \propto BR(SM) \cdot \frac{m_b^4 \cdot (\tan\beta)^6}{m_{H^0}^4}$$



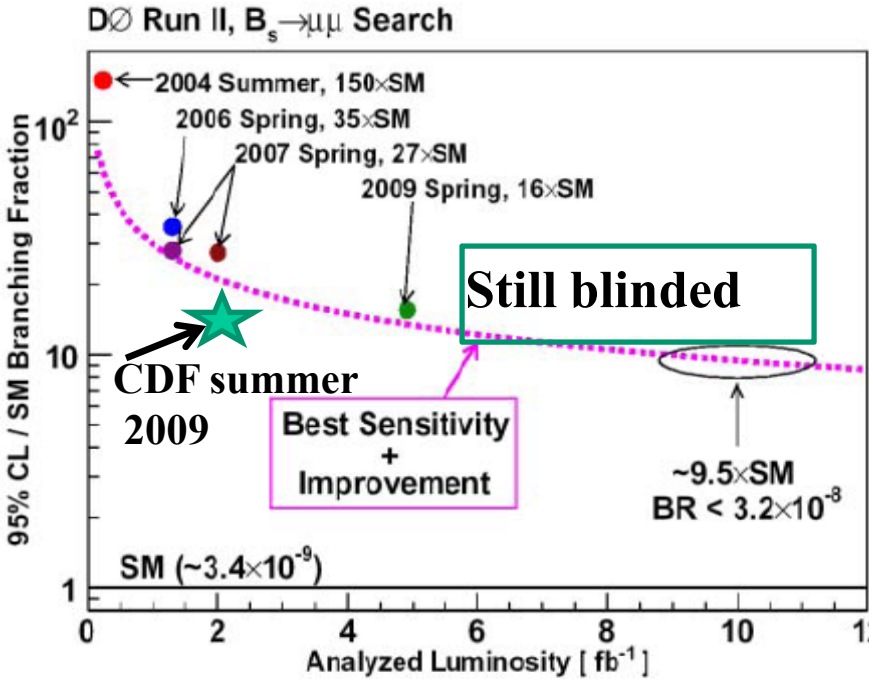
Branching predictions for $\tau \to \mu\gamma$ and $\tau \to \mu\mu\mu$

mSUGRA+seesaw	10^{-7}	10^{-9}
Non-universal Z'	10^{-9}	10^{-8}
SUSY+Higgs	10^{-10}	10^{-7}

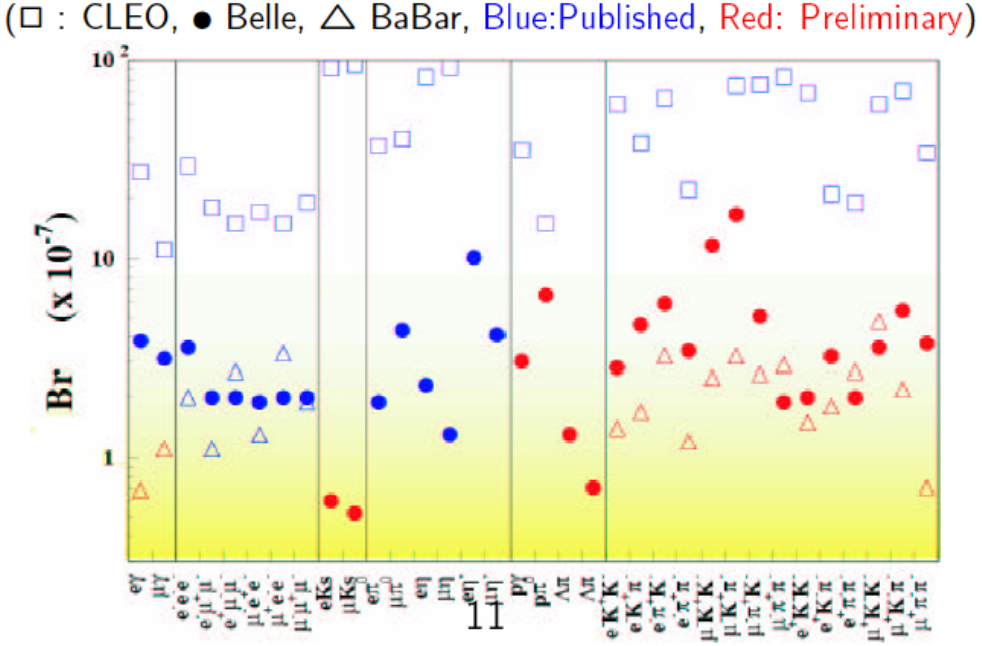
$B_s \to 2\mu$ and mSUGRA model



Upper limits improvements history



LFV processes



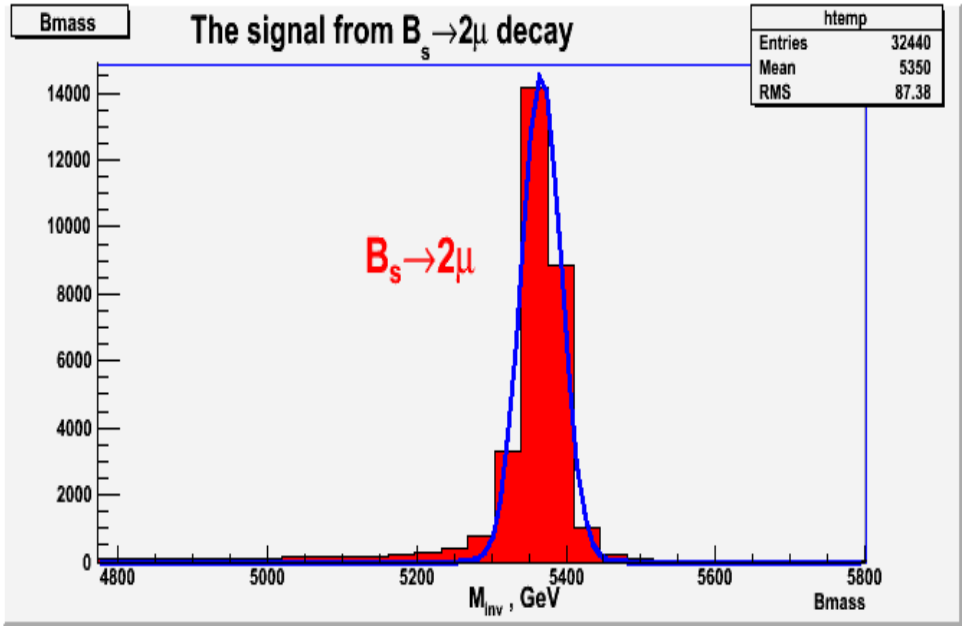
Last 15 years: exp. limit improved from 2.6×10^{-6} (CDF) to 4.3×10^{-8} (CDF) at 95% CL

Last 30 years: exp. limits improved from 10^{-3} (MARKII) to 1.9×10^{-7} (BaBar) and 4×10^{-8} (BELLE) at 90% CL

The MC signal from $B_s \rightarrow 2\mu$ and $\tau \rightarrow 3\mu$ decays

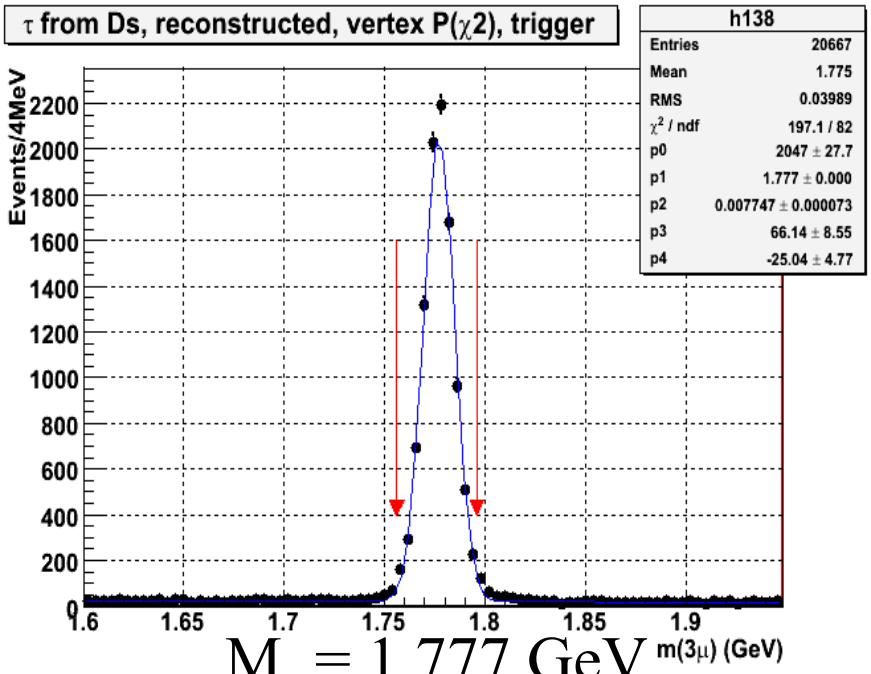
The source of B_s at LHC are produced in b quarks fragmentation

Main source of τ at LHC are: $D_s \rightarrow \tau\ \nu_\tau X$ (Br ~ 7.5 %) and $b \rightarrow \tau$



$M_{Bs} = 5.367$ GeV

$B_s \rightarrow 2\mu$ ~ 78k events



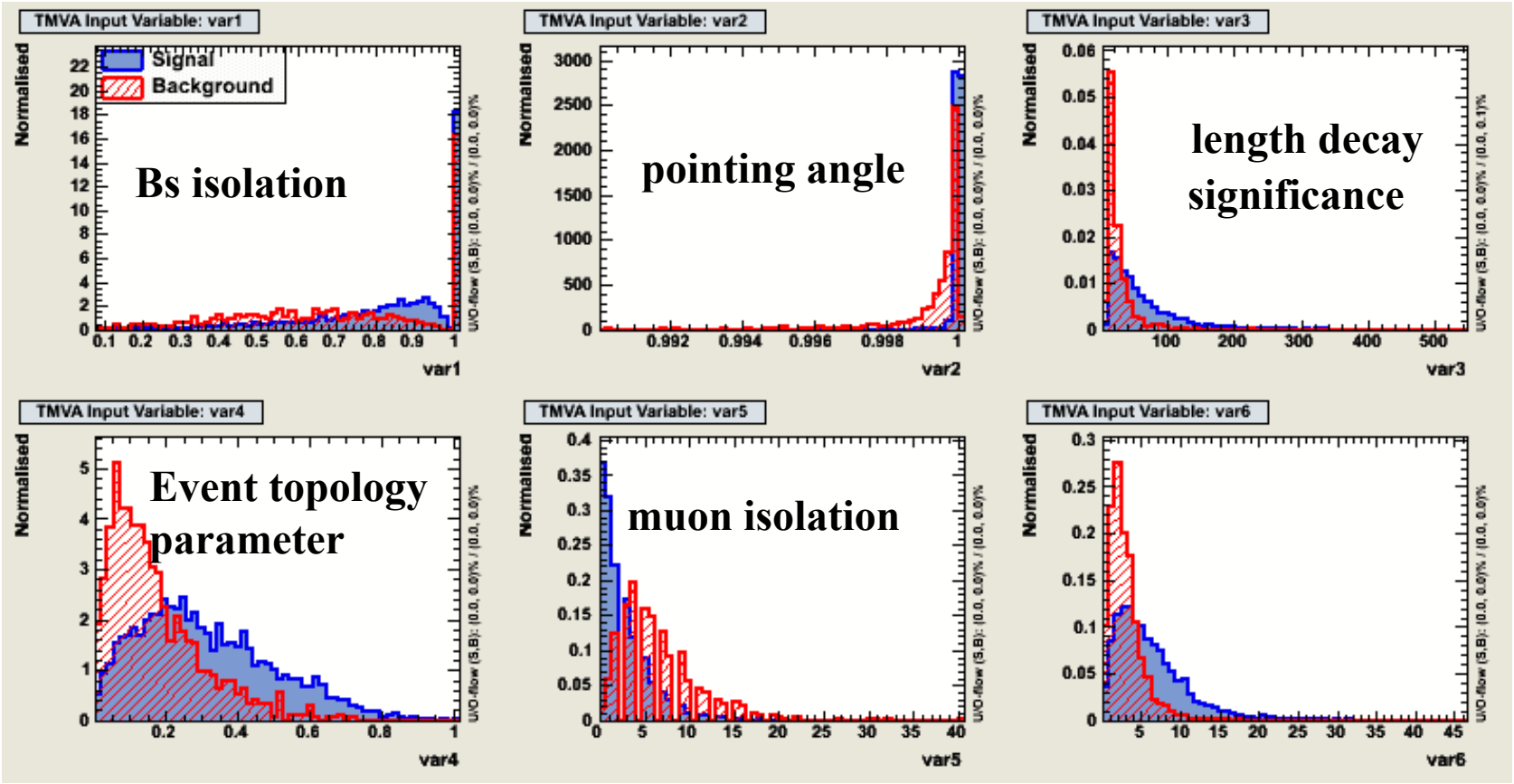
$M_\tau = 1.777$ GeV

$\tau \rightarrow 3\mu$ ~50k events

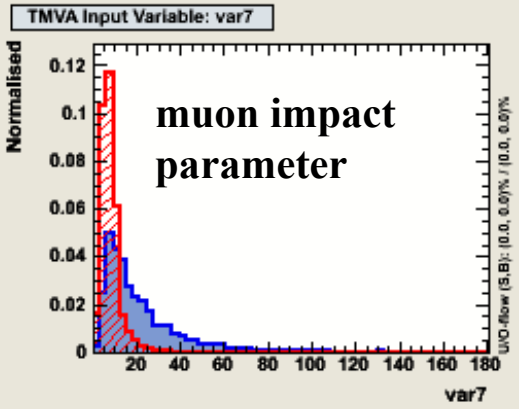
Background events - inclusive B dimuon sample ~ 20M events

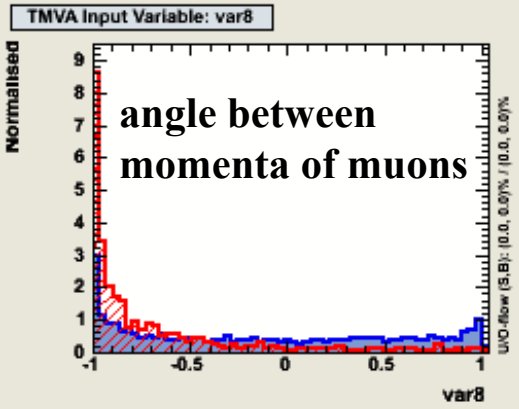
2μ -3.3 k events m(Bs) ±500 MeV. **3μ** -15 k events in m(τ) ±120 MeV

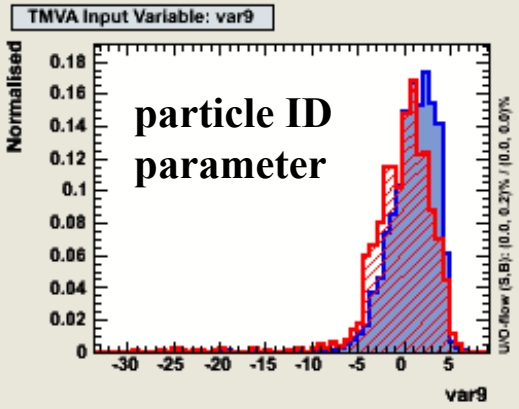
Input variables for Multivariate Data Analysis (LHCB Monte Carlo)

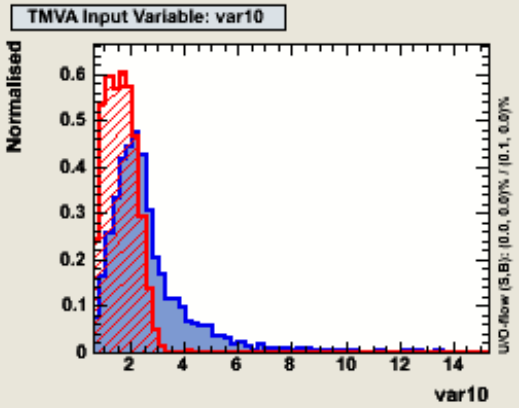


Input variables for Multivariate Data Analysis (LHCB Monte Carlo)









var1 - Bs isolation
var2 - pointing angle
var3 - length decay significance
var4 - Event topology parameter
var5 - muon isolation
var7 - muon impact parameter
var8 - angle between momenta of muons
var9 - particle ID parameter

$\tau \rightarrow 3\mu$. Step-by-step cut application

Backgound after stripping cuts **Nbg = 16144**

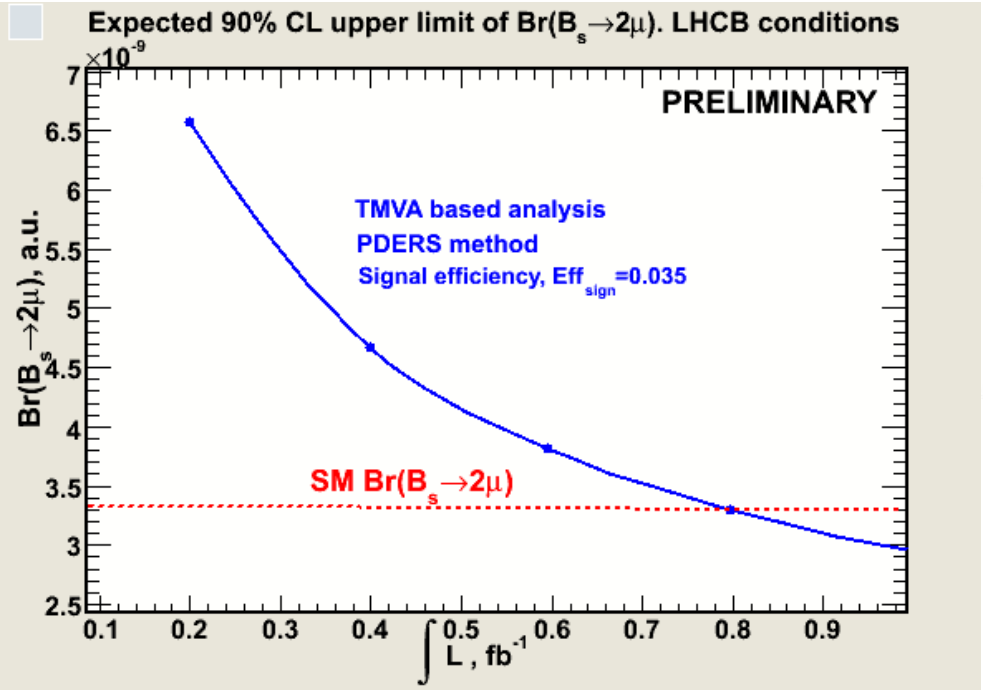
Ds sample with stripping cuts applied **Nsg = 2012**

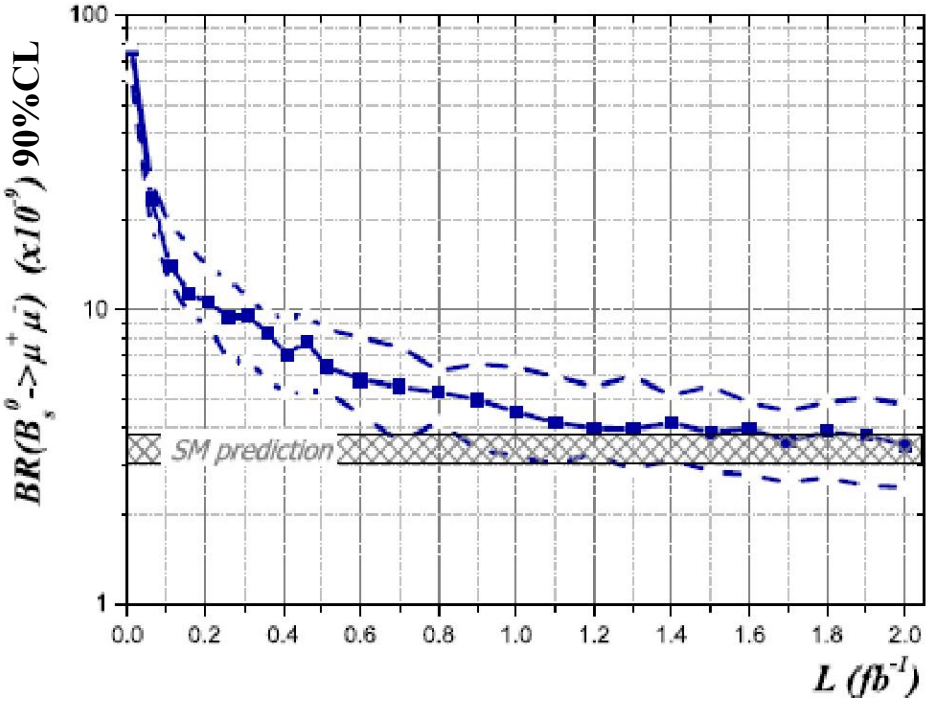
	Variable	Nbg	Nsg	Backg. Rej.	Signal Eff.[%]
1	Minmass(2μ) > 250 Mev	5976	2000	2.7	99.4
2	dLL (μ) > -3	1910	1620	8.5	80.5
3	0 <IPS(τ) < 10	112	1361	144	67.7
4	Cos(dira) > 0.99999	41	957	394	47.6
5	0.07 < tdot < 1.0	39	954	414	47.4
6	13GeV < maxP (μ) < 100GeV	31	845	521	42
7	0.3GeV < minPT (μ) < 5GeV	8	721	2018	35.8
8	L0	1	625	16144	31

Nbg – number of BG in mass window m_τ ±120 MeV

Nsg – number of signals in mass window m_τ ±30 MeV after BG subtraction

$B_s \rightarrow 2\mu$ preliminary result for the expected 90% CL limit





The predictions for the 90% CL upper limit for $B_s \rightarrow 2\mu$ decay. We can reach the level of the SM branching at 1 fb^{-1} (***PNPI group result***)

The predictions for the 90% CL upper limit for $B_s \rightarrow 2\mu$ decay (***LHCb collaboration***)

Expected 90% CL limit for τ→3μ

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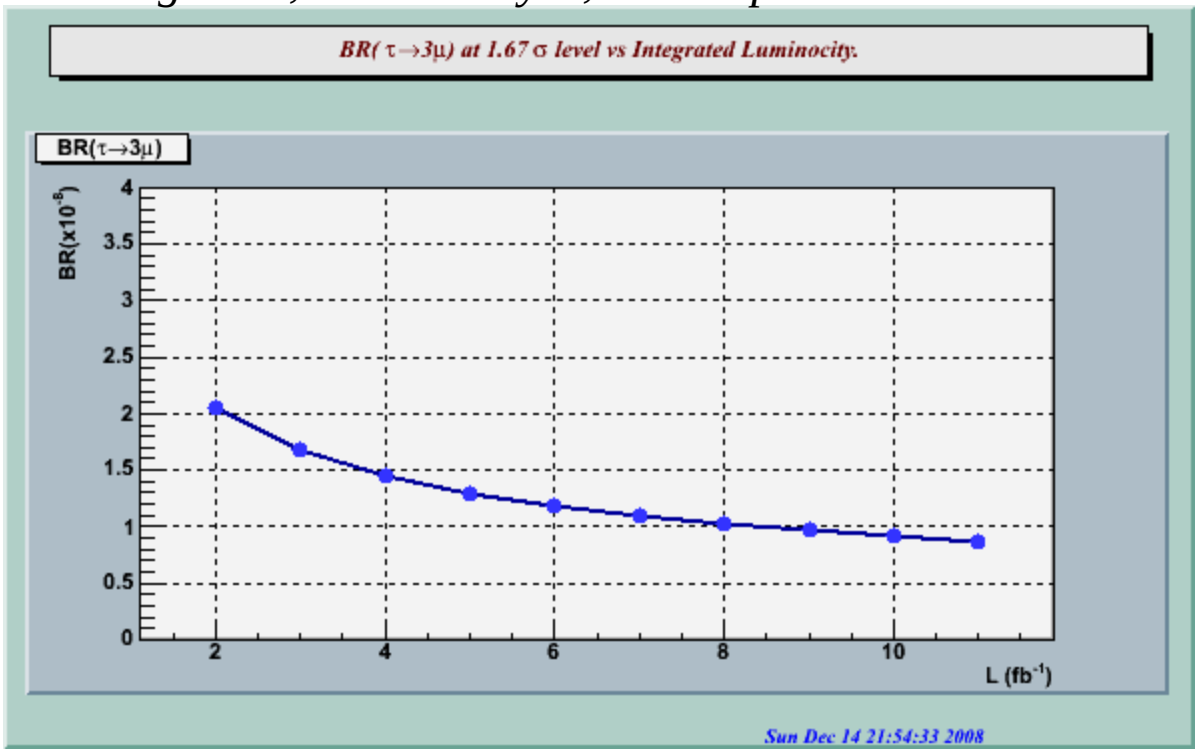

The analysis shows that the LHCB can reach sensitivity up to

$BR(\tau\to 3\mu) = 10^{-8}$ 90% CL at L = 5-8 fb^{-1}

Conclusions

- LHCB collaboration has a good shape and ready for data analysis
- New estimation for the expected upper limit of $Br(B_s \to \mu^+ \mu^-)$ was done by PNPI group . Results are consistent with previous LHCb collaboration studies. Some improvements can be done by comparison with the previous LHCB collaboration studies
- Search for $\tau \to 3\mu$ decay has a good potential to continue
- We are waiting for real data from the LHCb detector

Спасибо и с наступающим Новым 2010 годом!