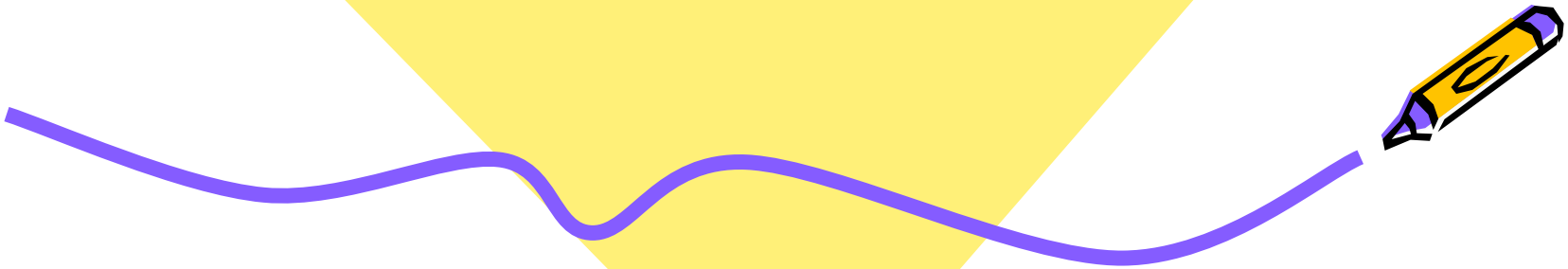
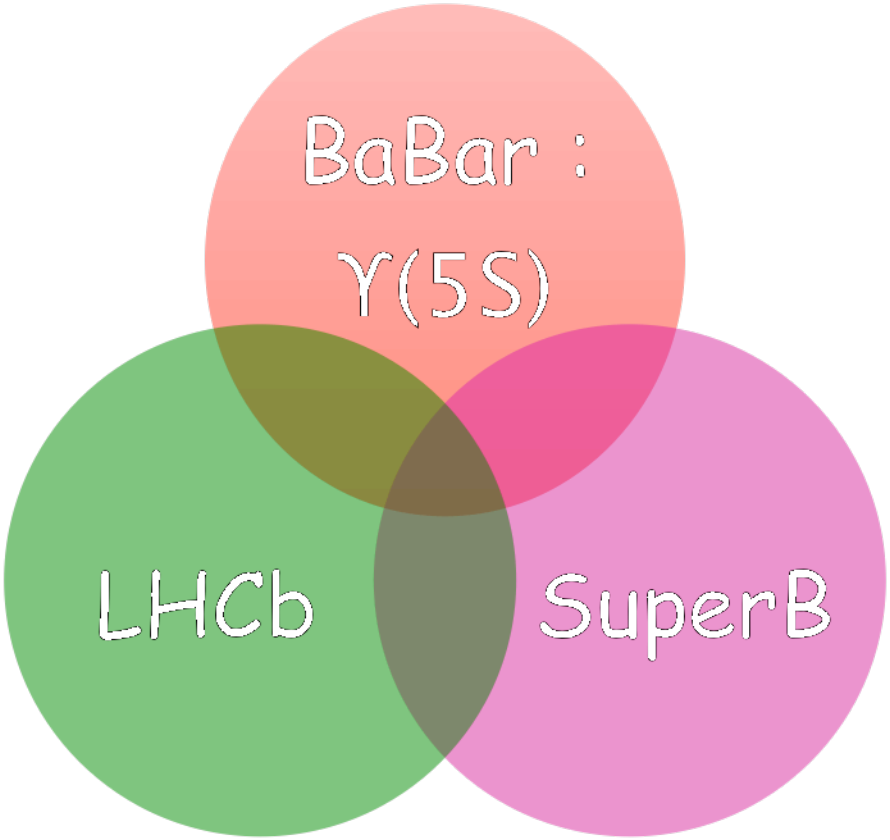
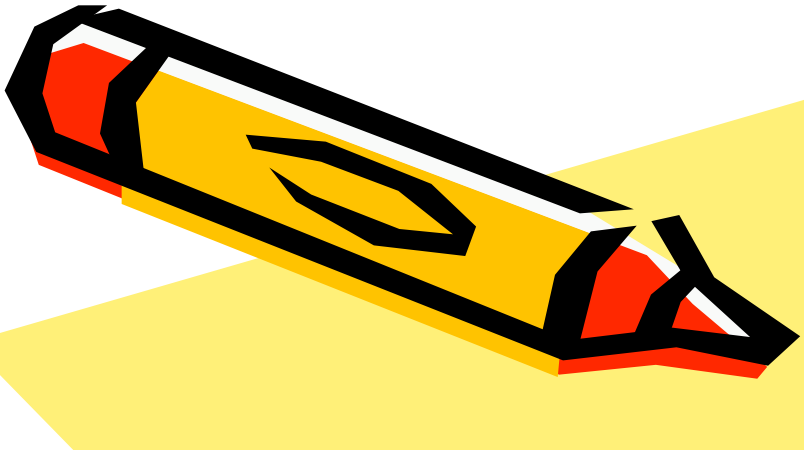
Next generation of B physics experiments

Riccardo Faccini

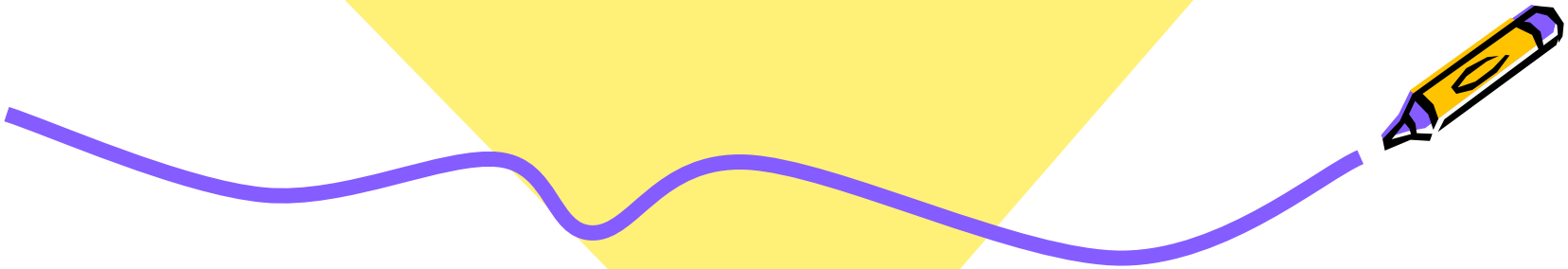




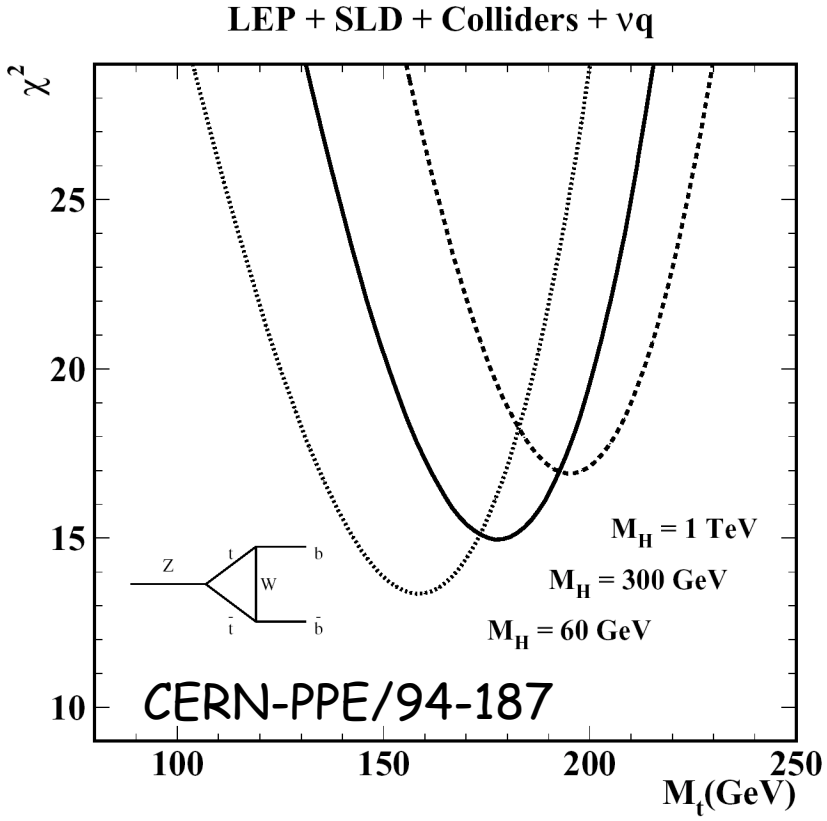
- Flavour physics in the LHC Era
- Planned experiments
- Activities in Rome

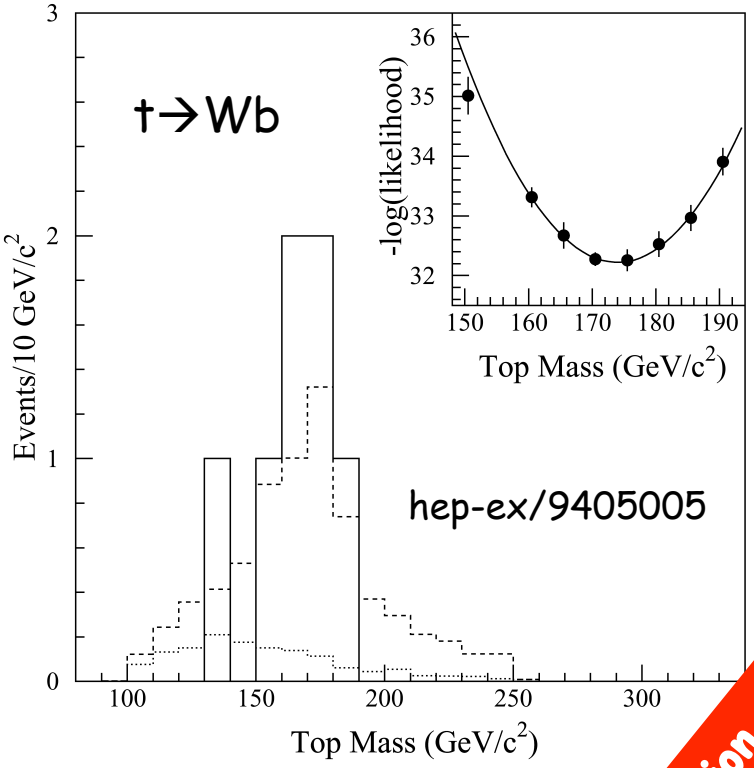


Flavour Physics in the LHC Era



The two paths to New Physics



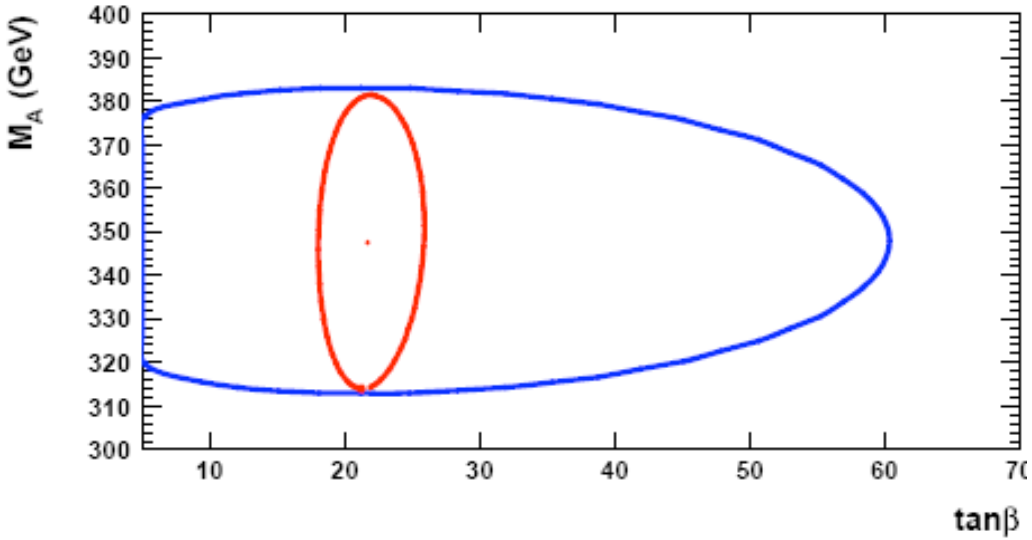


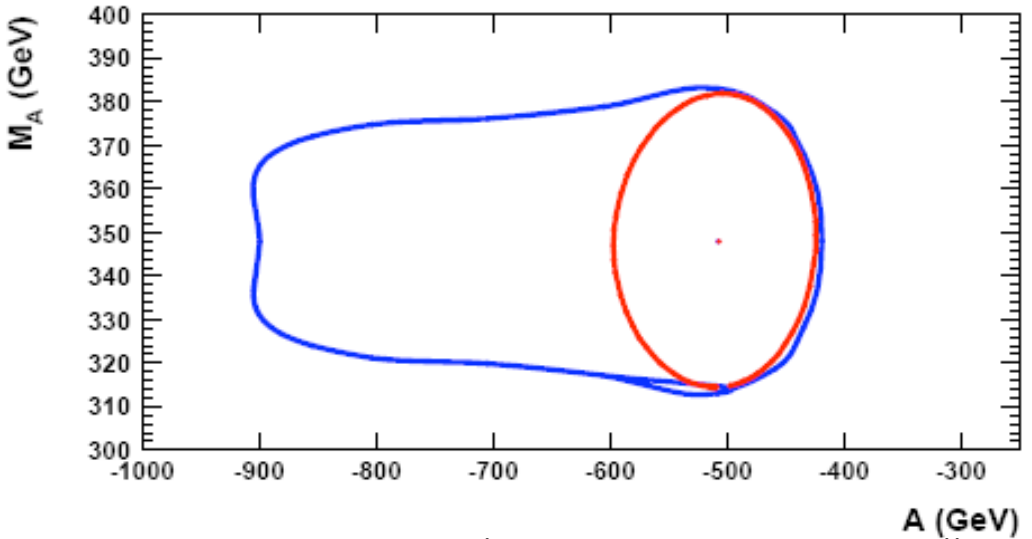
Next generation of B experiments is the LEP of Flavour

Flavour & NP Searches: complementarity:

- Don't trust a discovery till you see the particle
- Don't understand the new physics until you don't explore its behaviour

COMPLEMENTARY: LHC and Flavour with 75 ab^{-1}



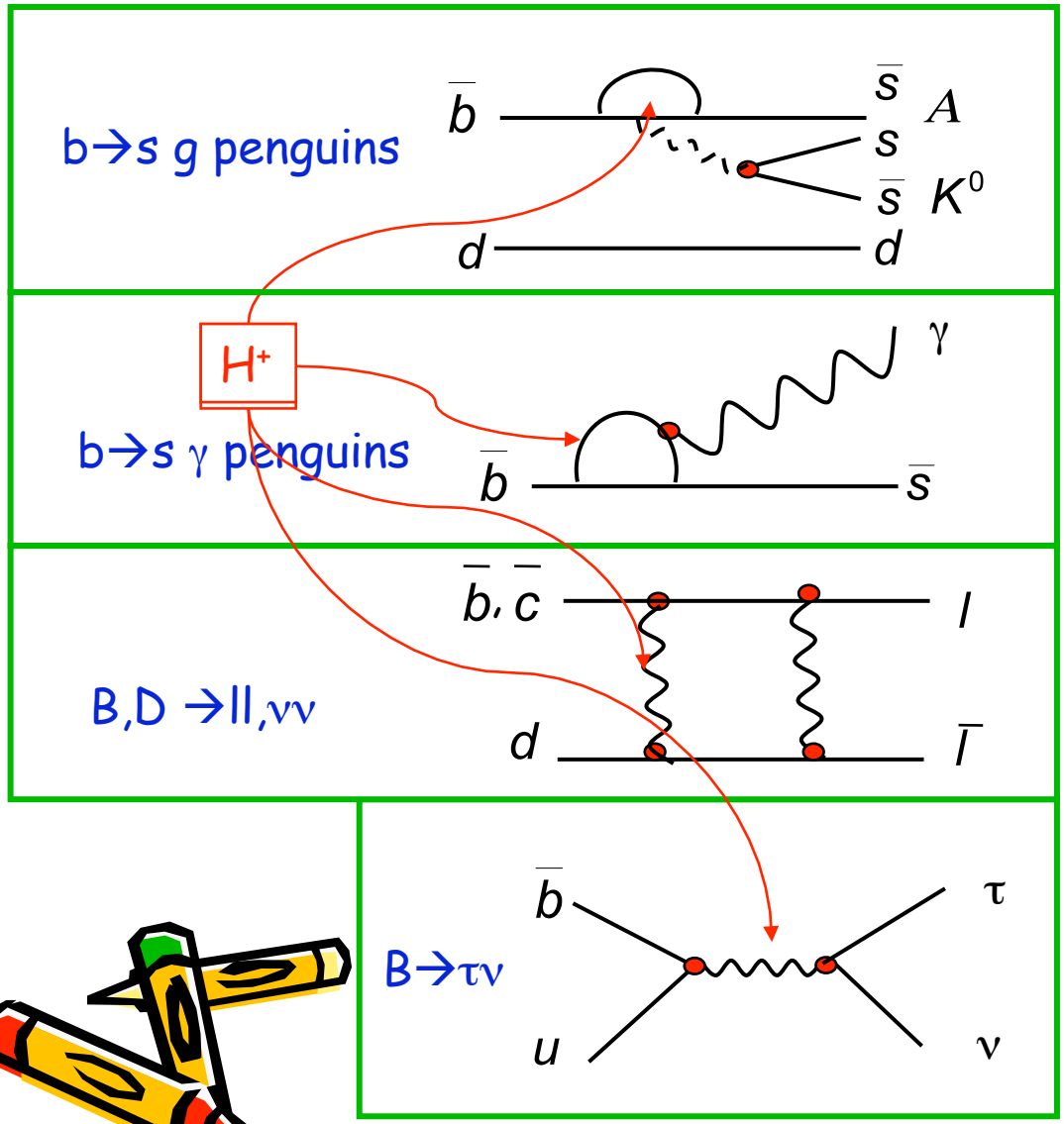


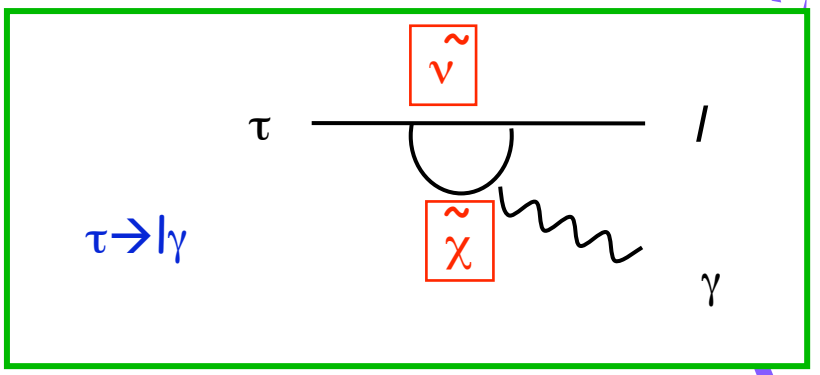
IF LHC DISCOVERS SUPERSYMMETRY

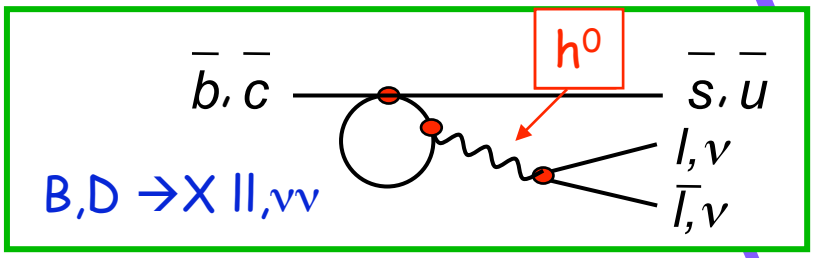
Red are LHC+EW constraints +

Blue is LHC alone

New Physics for Experimentalists

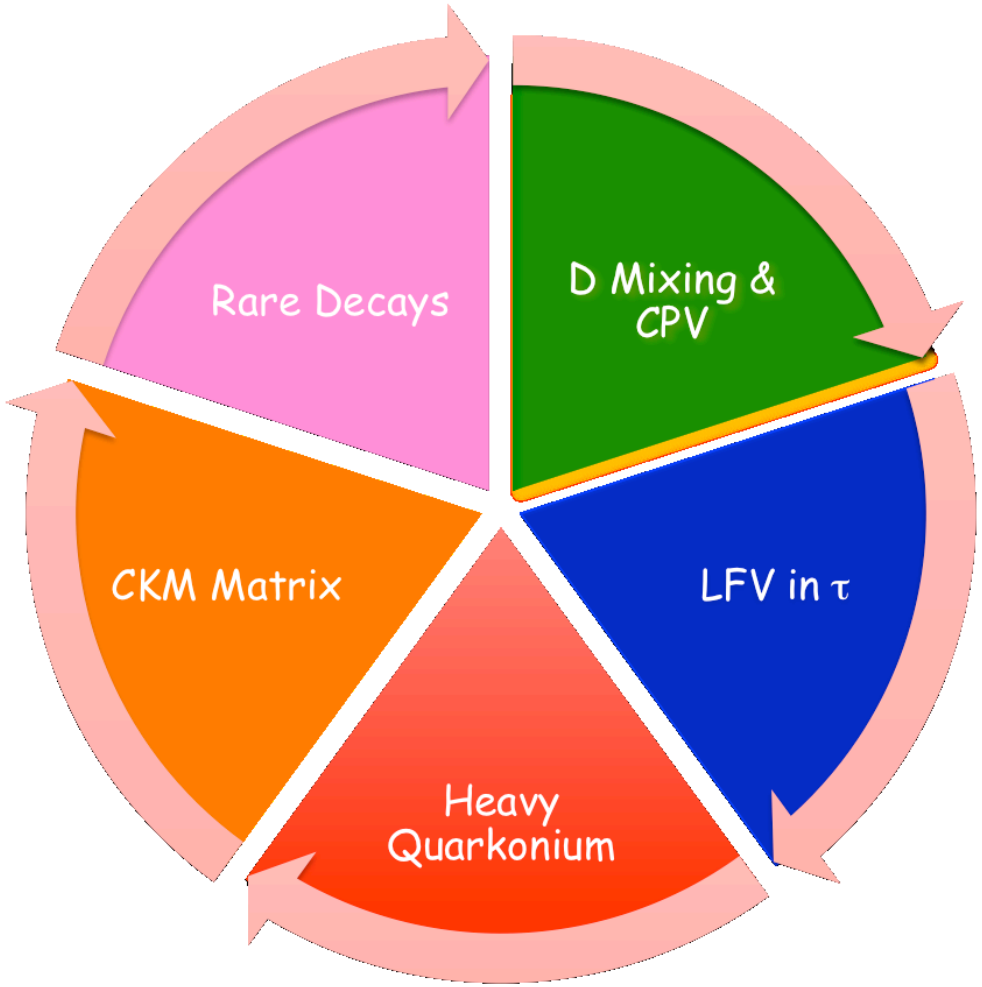






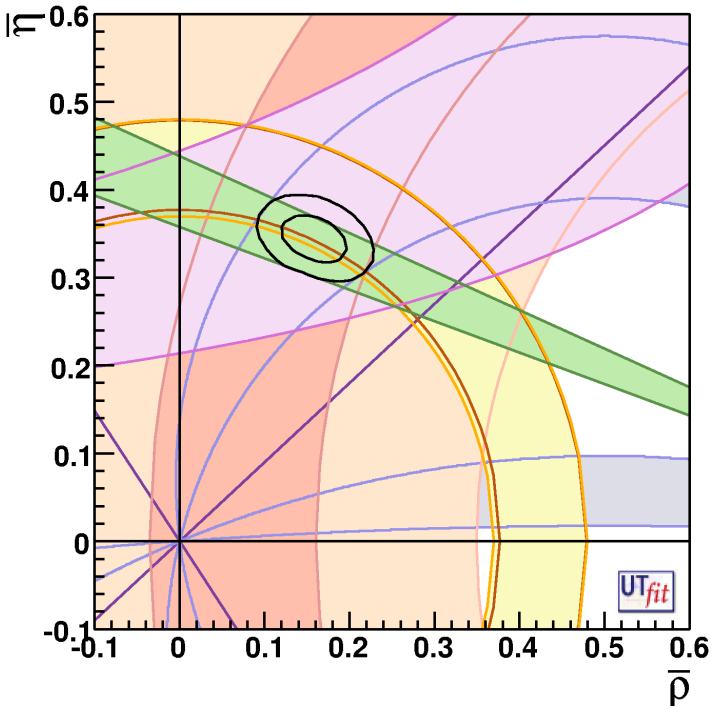
MSSM/THDM

Not a single flagship analysis

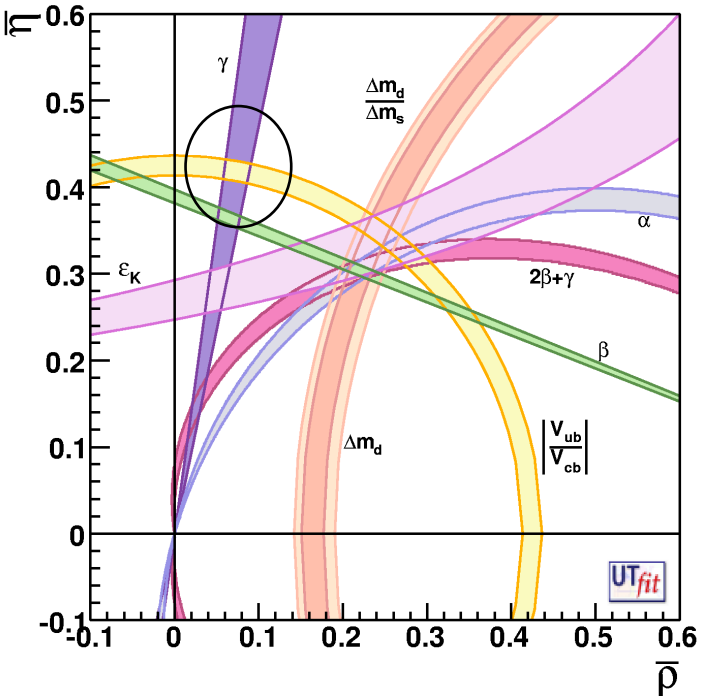


CKM matrix

Today



SuperB+Lattice improvements



$\rho = 0.163 \pm 0.028$
$\eta = 0.344 \pm 0.016$

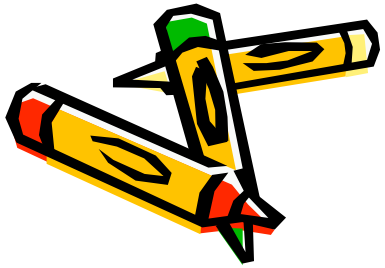
$\rho = \pm 0.0028$
$\eta = \pm 0.0024$

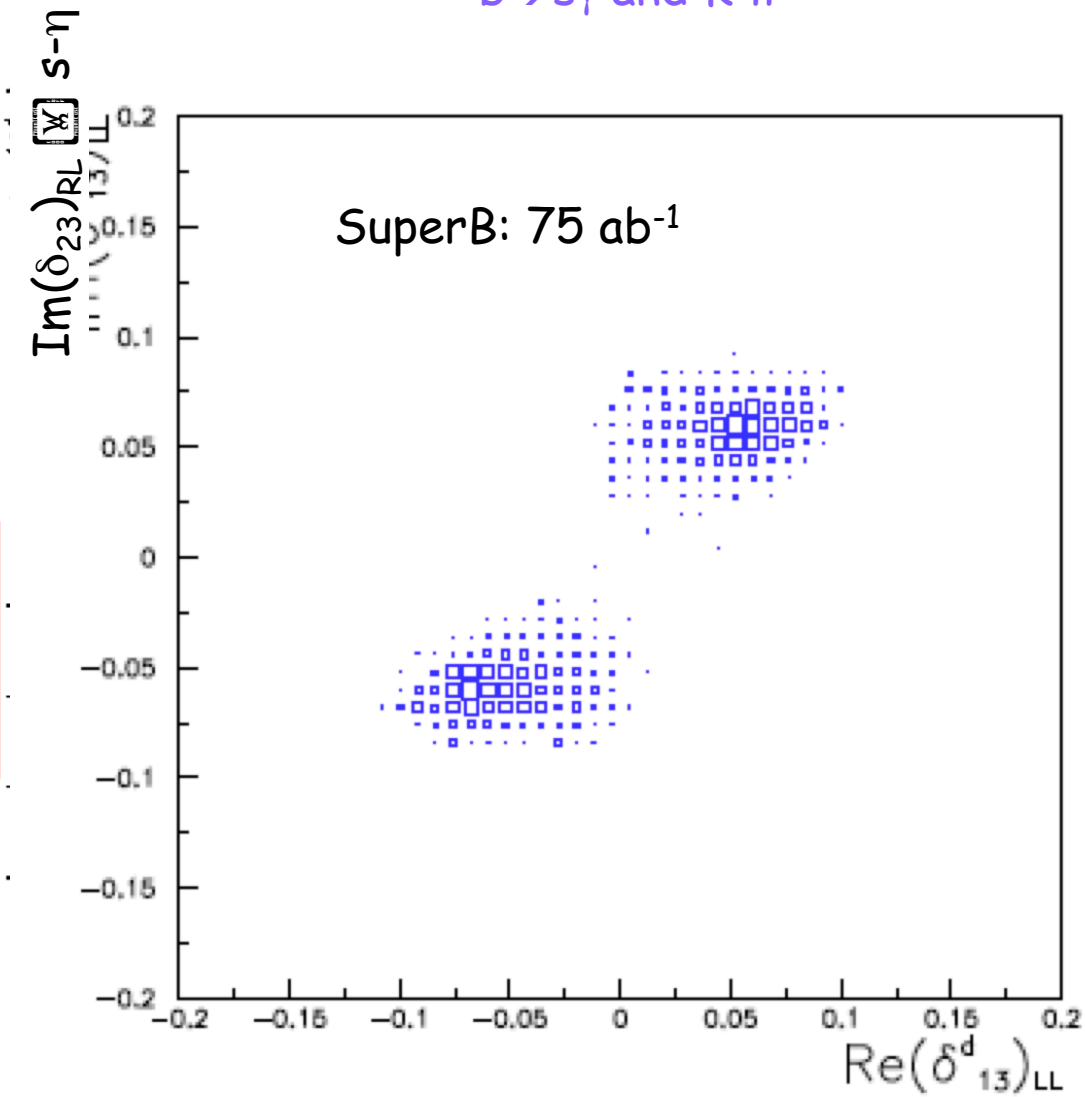
The (ρ,η) plane in the SUSY era

Allowed by ΔS b→sg
Allowed including also b→sγ and K*ll

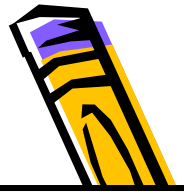
Investigating NP phases

$(\delta_{ij})_{RL}$ = s-quark rotation matrix (gauge fixed by CKM matrix)
➔ s-CKM matrix





Rare decays

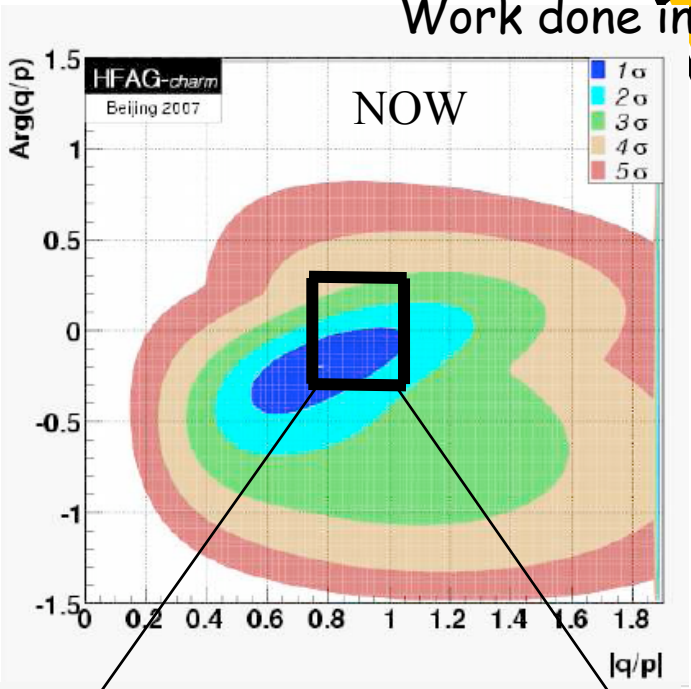


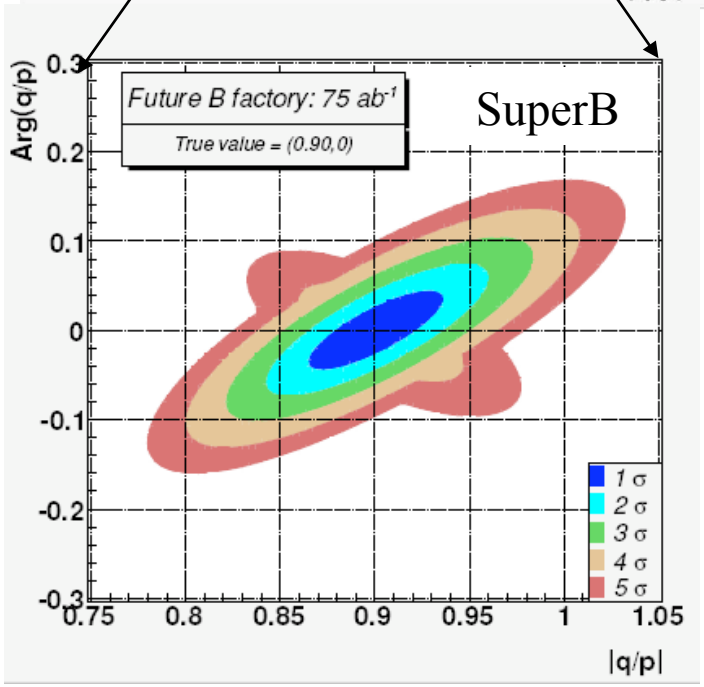
Mode	BR_{SM}	Notes on NP
$b \to s\gamma$	~3 10^{-4}	BF, $A_{CP,}$ and A_{FB} important
$b \to sg$	~10^{-5} each	BF not critical. Need events to measure S_{CP}
$B \to Xll$	~10^{-6} each	BF, $A_{CP,}$ and A_{FB} important
$B \to X\nu\nu$	~10^{-6} each	Up to 10^{-5} each
$D \to Xll$	~10^{-6} each	Up to 10^{-5} each
$B \to \tau\nu$	~10^{-4}	Experiments close to SM sensitivity
$\tau \to l\gamma$	~10^{-40}	Up to 10^{-8}
$B \to ll$	<10^{-11}	Up to 10^{-5}
$D \to ll$	<10^{-9}	Up to 10^{-6}

CP Violation in charm

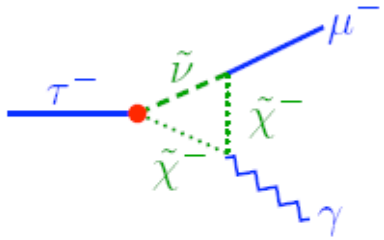
Work done in Valencia

Mode	Observable	$\Upsilon(4S)$ ($75\ \text{ab}^{-1}$)	$\psi(3770)$ ($300\ \text{fb}^{-1}$)
$D^0 \to K^+\pi^-$	x'^2	3×10^{-5}	
	y'	7×10^{-4}	
$D^0 \to K^+K^-$	y_{CP}	5×10^{-4}	
$D^0 \to K^0_S\pi^+\pi^-$	x	4.9×10^{-4}	
	y	3.5×10^{-4}	
	$\lvert q/p\rvert$	3×10^{-2}	
	ϕ	2°	
$\psi(3770) \to D^0\overline{D}^0$	x^2		$(1-2) \times 10^{-5}$
	y		$(1-2) \times 10^{-3}$
	$\cos\delta$		$(0.01-0.02)$



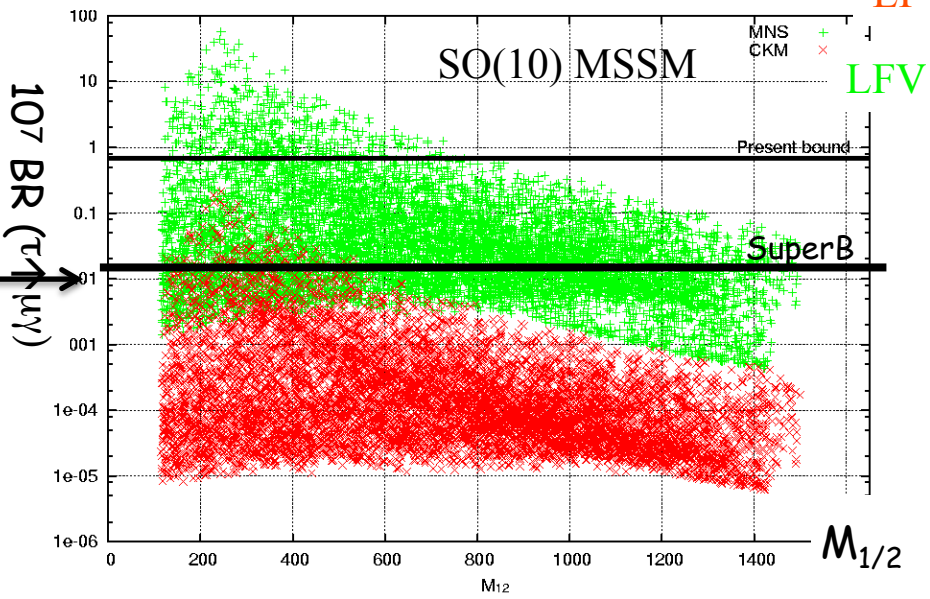


Lepton Flavour Violation $\tau \rightarrow \mu\gamma$. We can gain a very important order of magnitude $10^{-8} \rightarrow 10^{-9}$
Complementarity with $\mu \rightarrow e\gamma$



Process	Sensitivity
$\mathcal{B}(\tau \rightarrow \mu\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \rightarrow e\gamma)$	2×10^{-9}
$\mathcal{B}(\tau \rightarrow \mu\mu\mu)$	2×10^{-10}
$\mathcal{B}(\tau \rightarrow eee)$	2×10^{-10}
$\mathcal{B}(\tau \rightarrow \mu\eta)$	4×10^{-10}
$\mathcal{B}(\tau \rightarrow e\eta)$	6×10^{-10}
$\mathcal{B}(\tau \rightarrow \ell K_S^0)$	2×10^{-10}

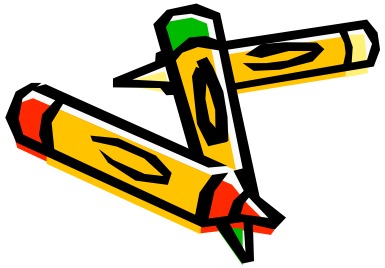
SuperB



LFV from CKM

LFV from PMNS

MEG sensitivity $\mu \rightarrow e\gamma$ $\sim 10^{-13}$

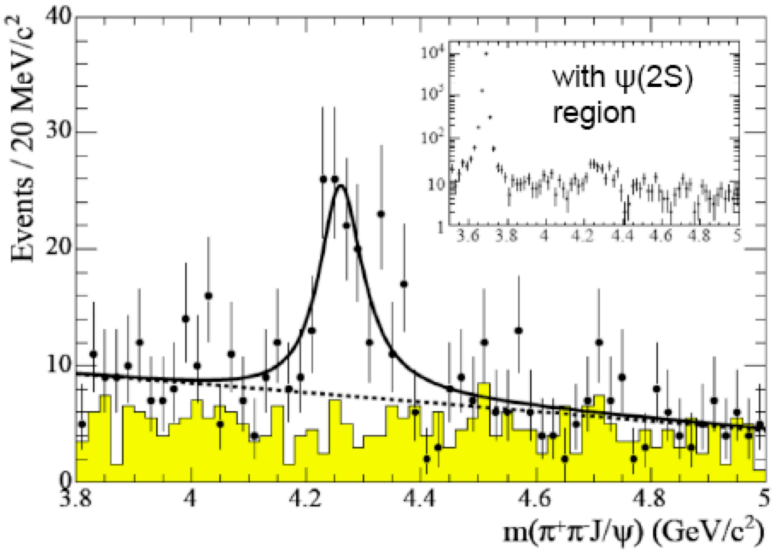


Polarized beams allow also measurement of electric dipole moments and $(g-2)_\tau$.[FIRST TIME]

Spectroscopy

a) Low stat of signals

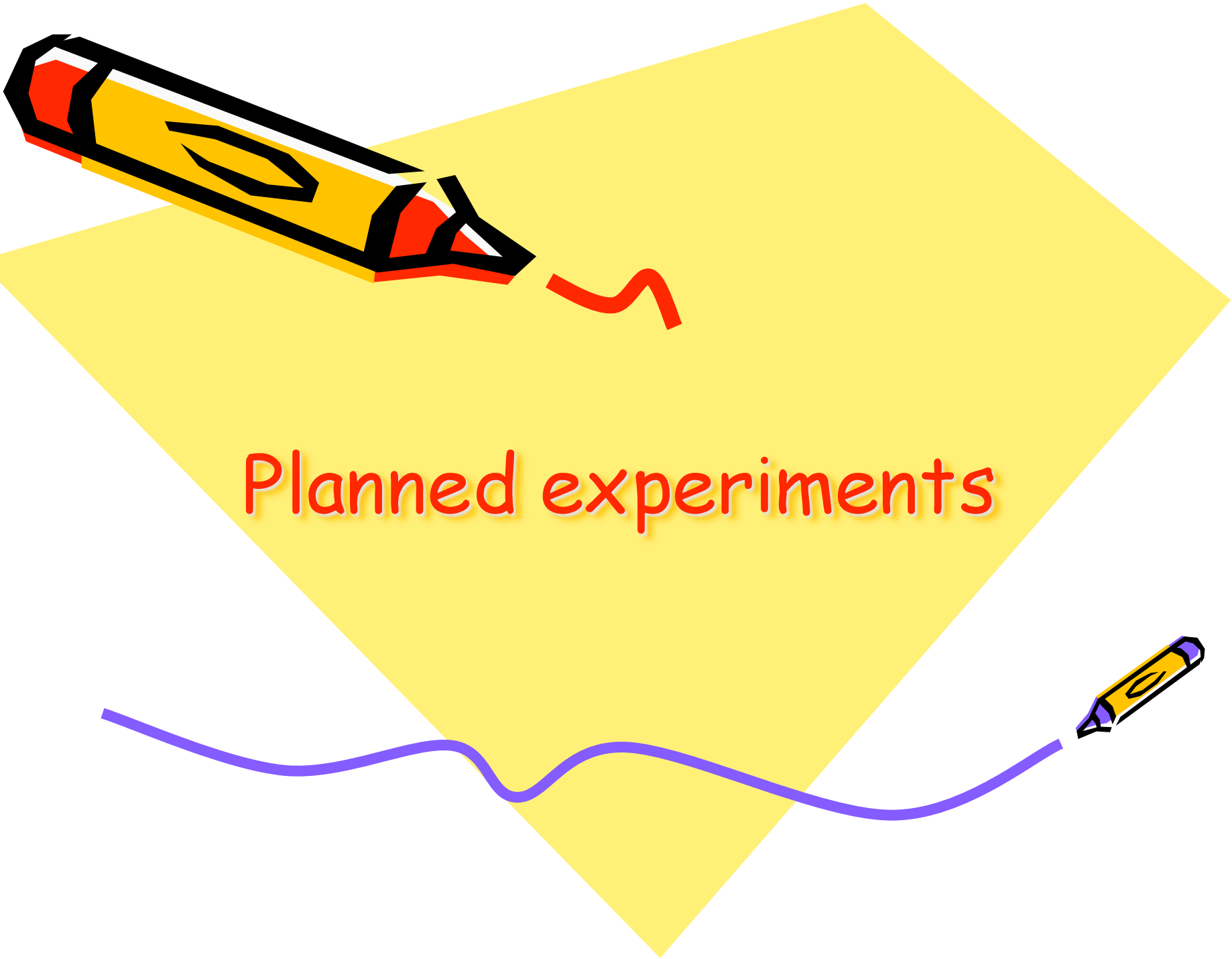
b) Only one mode observed per state



- Need x10 stat
- In modes with x10 smaller ε_{BF}

x100 in luminosity

Importance of energy scan


Planned experiments

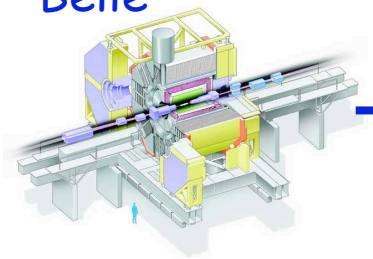
Experiments:timeline

BaBar

Υ(nS) running

B-Factories ~10^8 B/year

Belle

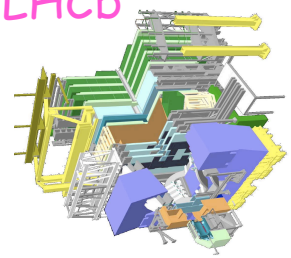


Υ(nS) running

Upgrade to $10^{35}cm^{-2}s^{-1}$?

2008 2010 2015 2020

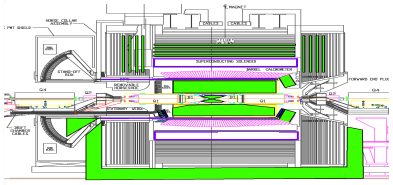
LHCb



10^5 B/s

Upgrade to $10^{33}cm^{-2}s^{-1}$

SuperB



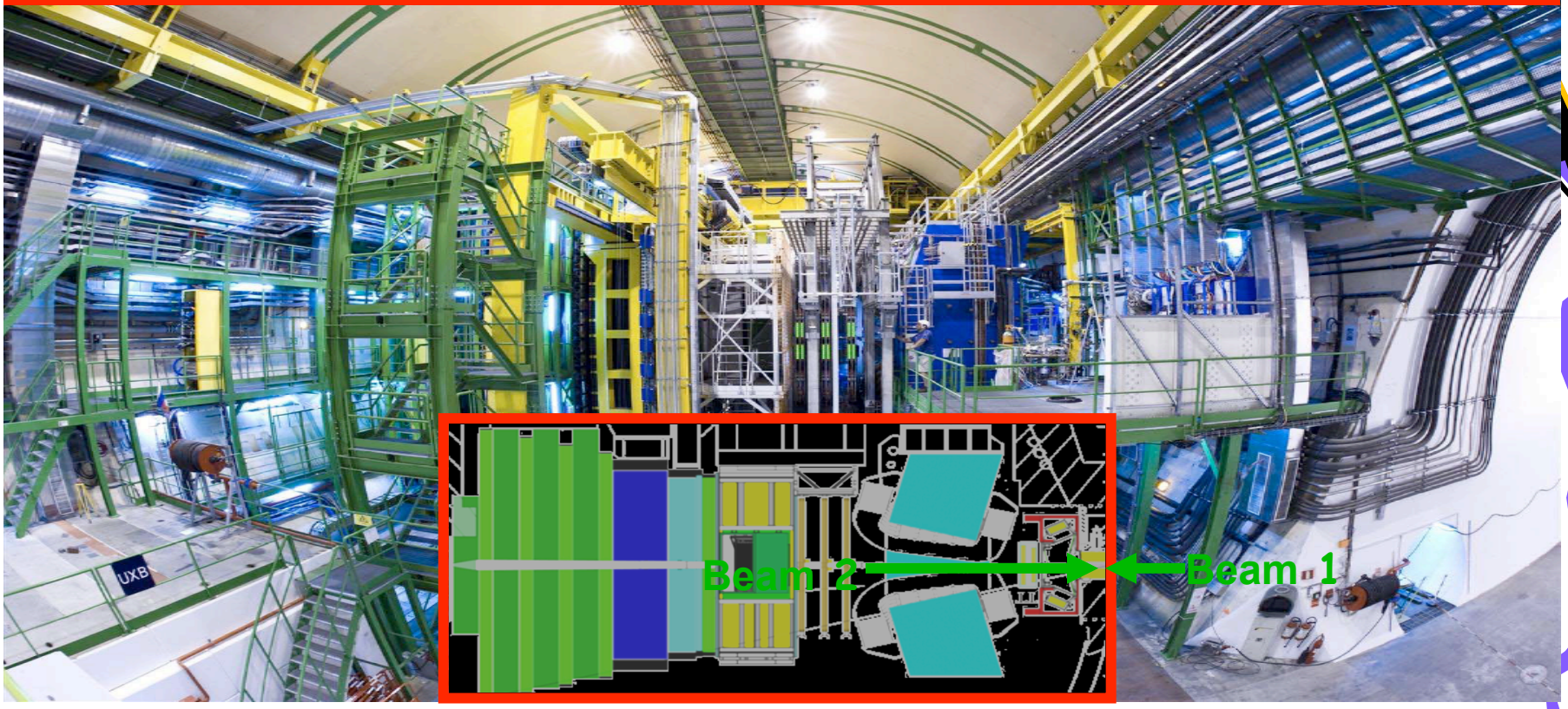
10^{10} B/year

LHCb

- LHC environment:
  - pp collider at 14 TeV
  - bb xsection ~0.5mb
  - $L \sim 10^{32}\ cm^{-2}s^{-1}$ ($L_{year} \sim 2fb^{-1}$)
    - 10^5 b/s
  - Large boost (γ~10-100)
    - Time dependent measurements
- Large background and trigger difficulties
  - Unbeatable in exclusive modes with charged tracks

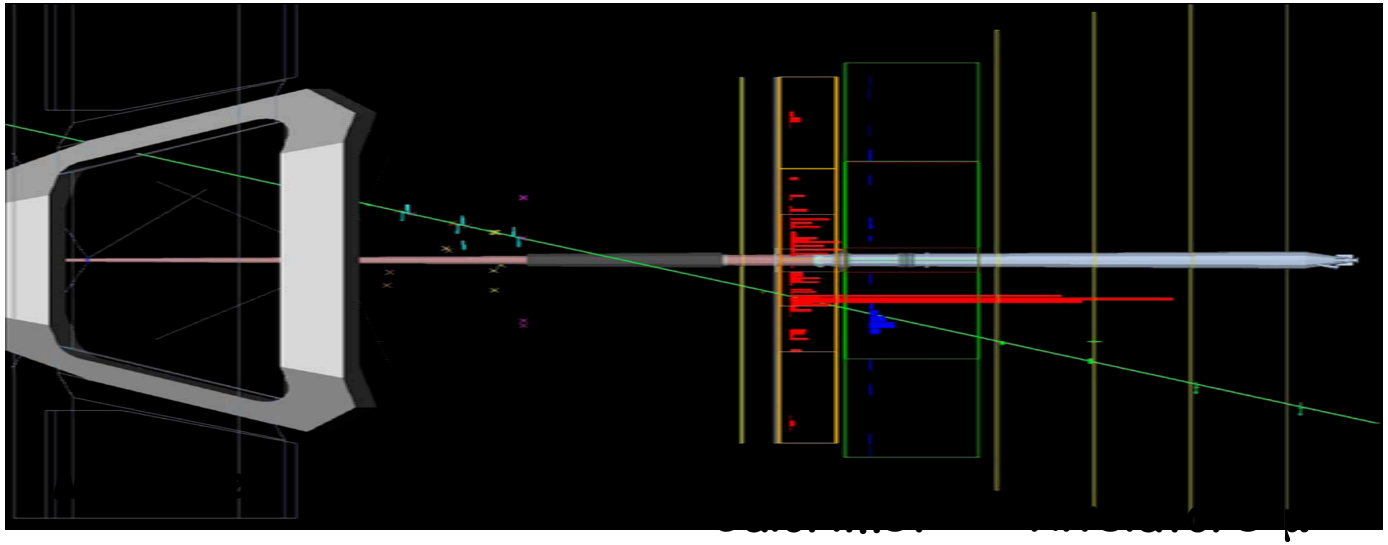
Il rivelatore LHCb

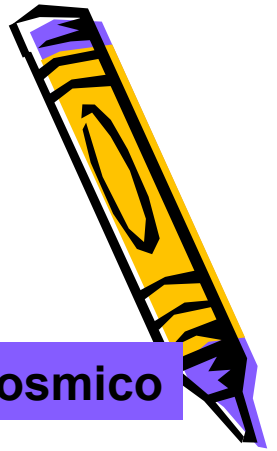
Spettrometro “single arm” specializzato per lo studio della beauty



- Rivelatore pressoche’ completo, l’installazione dell’ultima parte della prima stazione m terminera’ entro il 15 luglio
- Messa in opera di tutti i subdetector grazie soprattutto agli eventi cosmici acquisiti a partire dall’estate scorsa (nonostante la geometria sfavorevole!)
- Il trigger e l’acquisizione globale del rivelatore testati con successo nel corso di numerose “commissioning weeks”

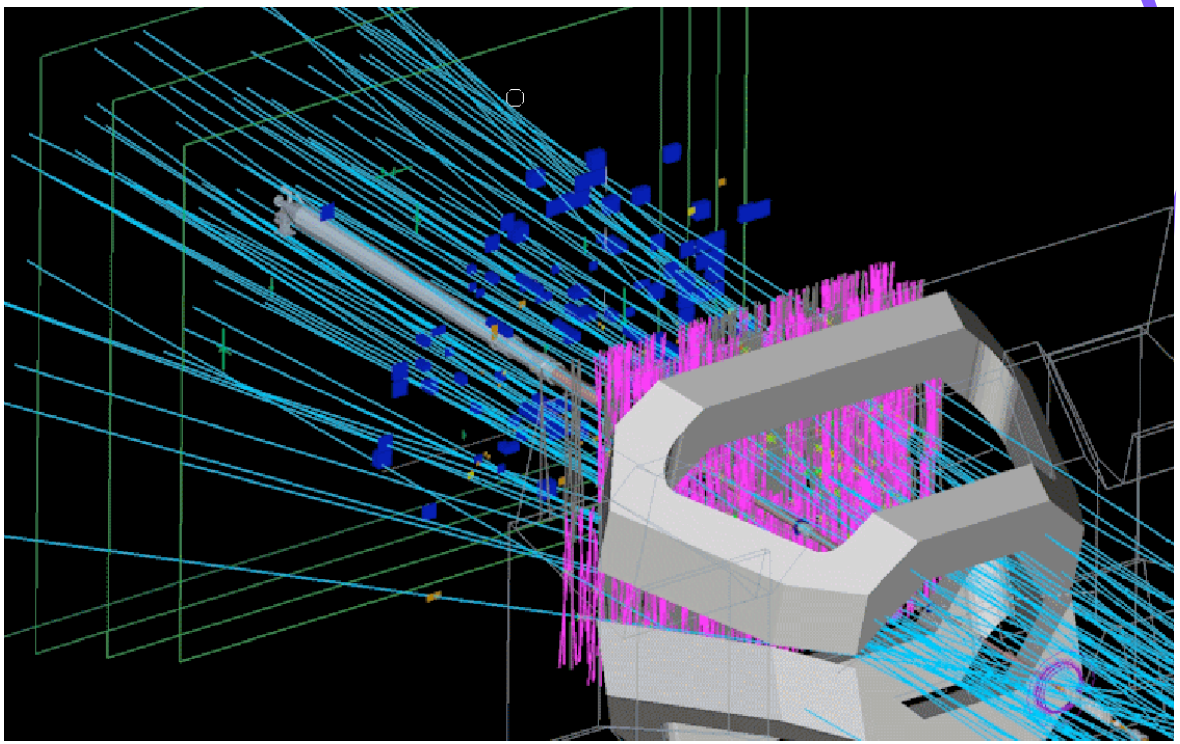
Eventi in LHCb

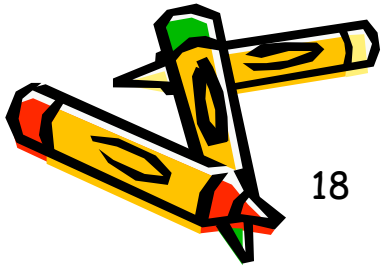




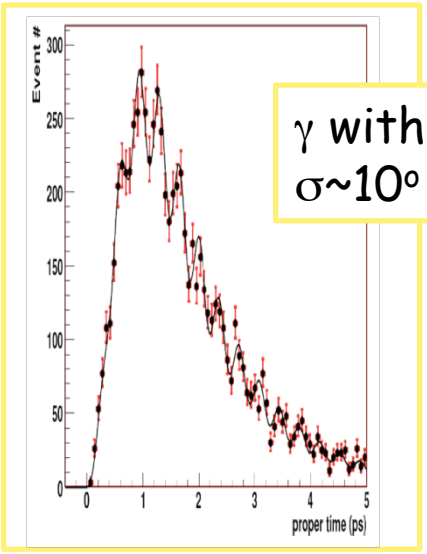
Cosmico

Interazione su collimatore del beam 1 (direzione "giusta" per LHCb), 10 settembre 2008

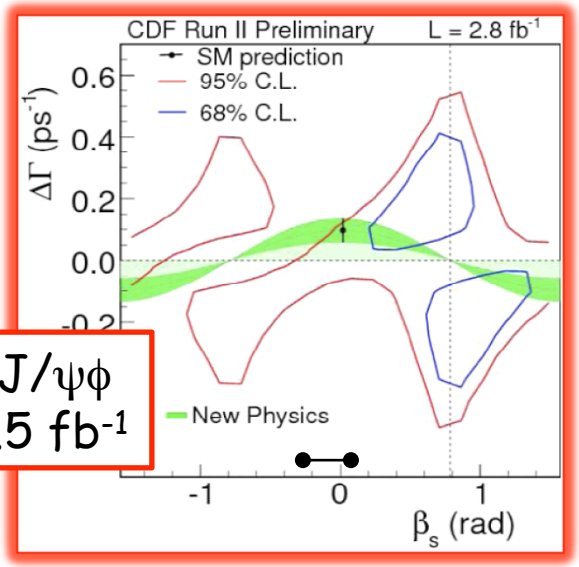




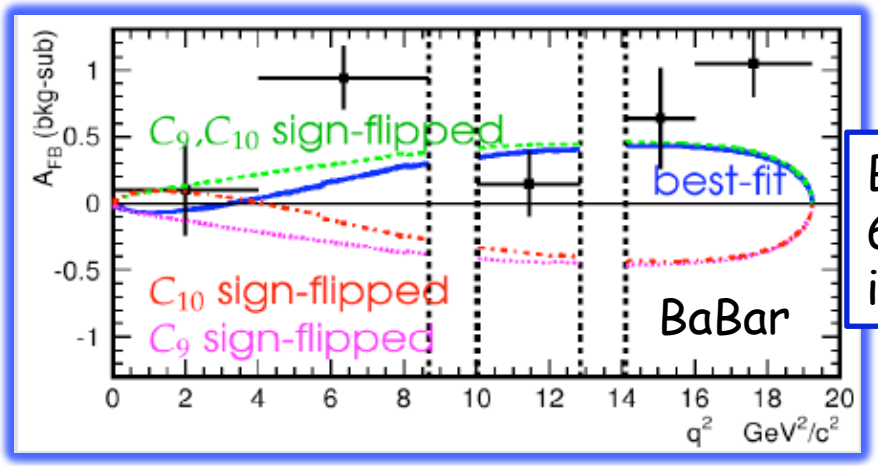
LHCb flagship analyses



γ with $B_s \to D_s K$
$\sigma \sim 10^o$ in 2 fb^{-1}



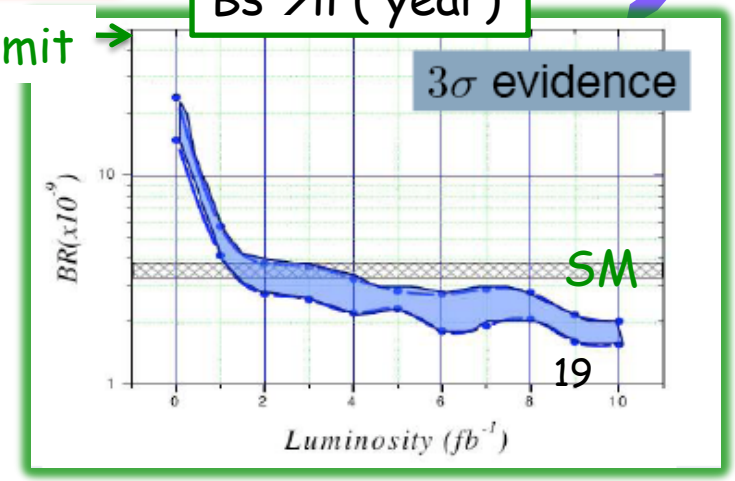
ϕ_s with $B_s \to J/\psi\phi$
$\sigma \sim 0.06$ in 0.5 fb^{-1}



B→Kll
60x the evts
in 1 year

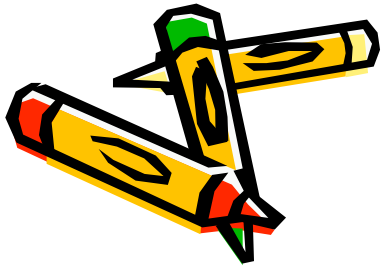
Bs→ll (year)

CDF limit →



SuperB

- Luminosity…
  - Goal is to integrate 50-100 ab^{-1} (100 times current dataset) in ~5 years
  - This means $L \sim 10^{36}\ cm^{-2}\ s^{-1}$
- … but not only!!
  - Polarized beams (?) for τ physics
  - Energy scan for Charm Mixing and Spectroscopy



SuperB Flagship analyses

All those described (weaker on the LHCb ones → complementarity)

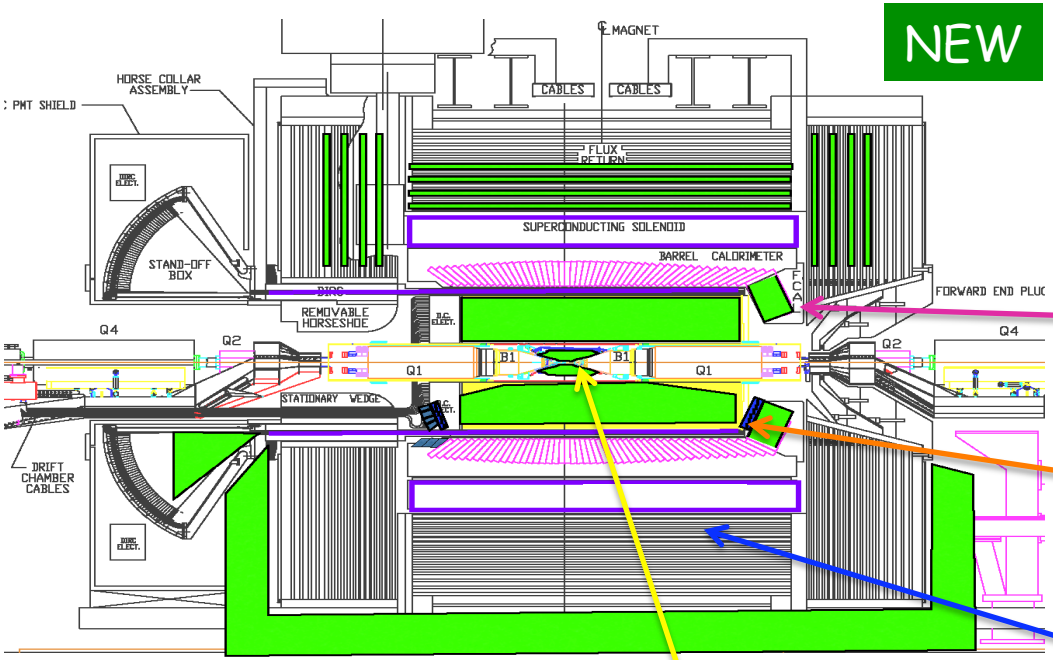
Each NP model has his own golden mode

	H^+ high tanβ	Minimal FV	Non-Minimal FV (1-3)	Non-Minimal FV (2-3)	NP Z-penguins	Right-Handed currents
$\mathcal{B}(B \to X_s\gamma)$		X		O		O
$A_{CP}(B \to X_s\gamma)$				X		O
$\mathcal{B}(B \to \tau\nu)$	X-CKM					
$\mathcal{B}(B \to X_s l^+ l^-)$				O	O	O
$\mathcal{B}(B \to K\nu\overline{\nu})$				O	X	
$S(K_S\pi^0\gamma)$						X
β			X-CKM			X

+ τ, charm and spectroscopy

SuperB detector

NEW

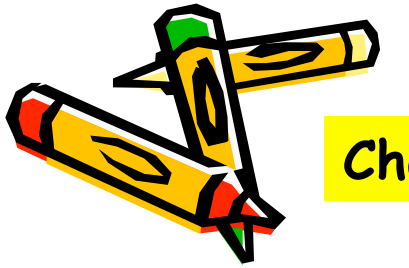


Faster, rad hard, and more segmented forward calorimeter (LYSO)

Possible forward PID

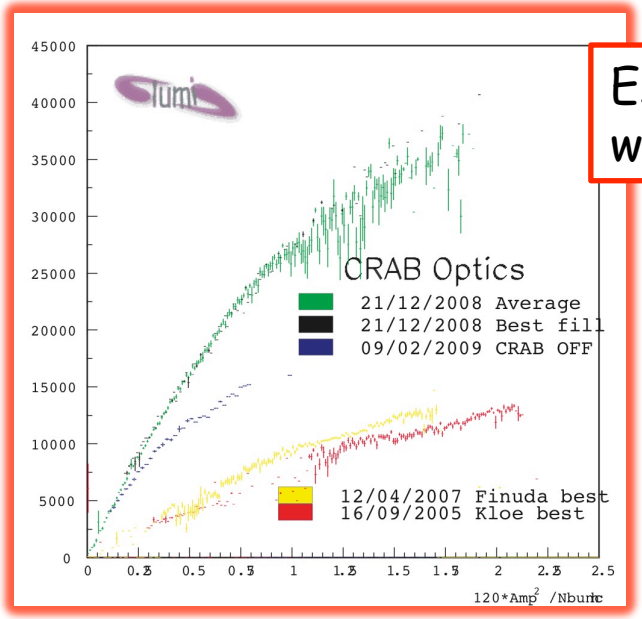
Faster, more reliable and less segmented IFR

Possible SVT layer 0



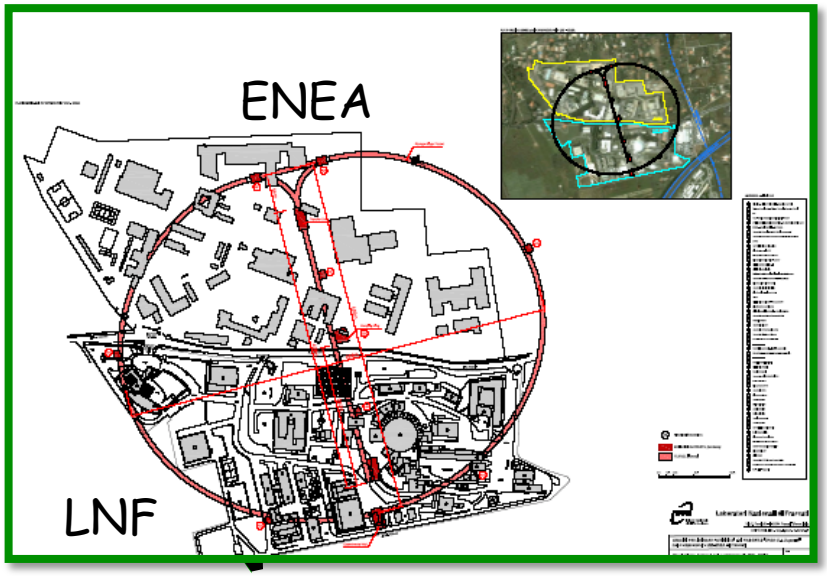
Challenges: smaller boost, larger machine backgrounds

Status of the project



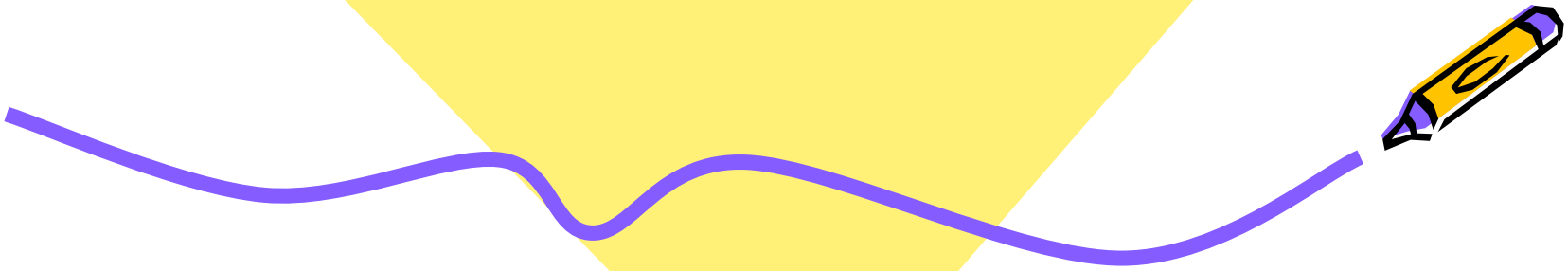
Expected impact of crab waist technique proven

Star of TDR phase
- aim at end 2010
- financed by Lazio

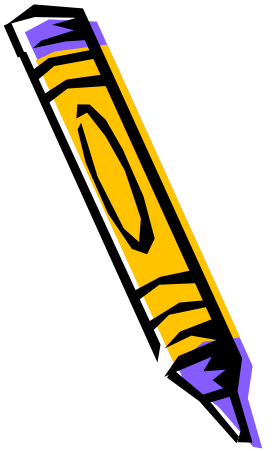


Difficulties in identifying the site

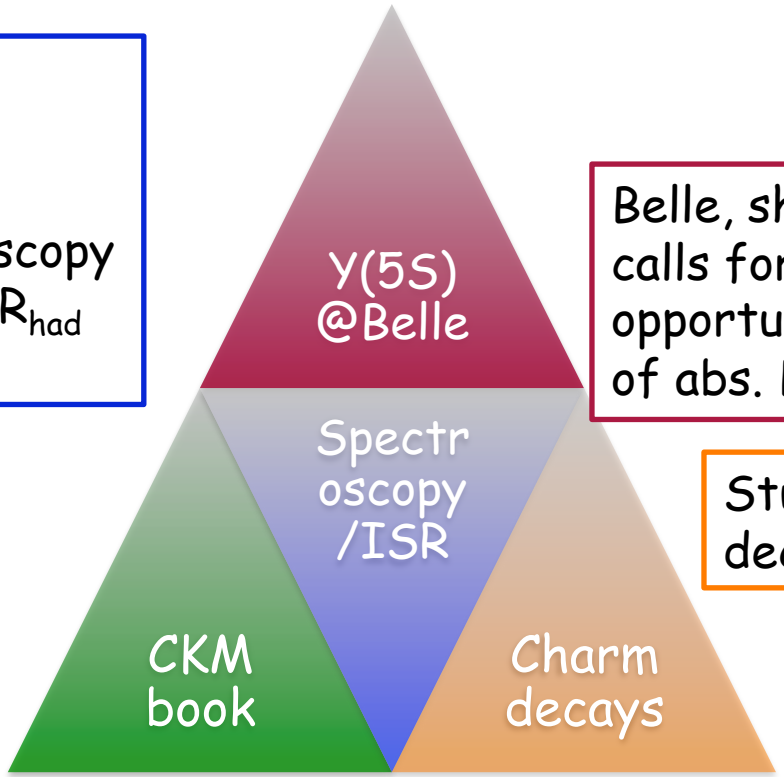
Activities in Rome



BaBar-Roma1: Activities

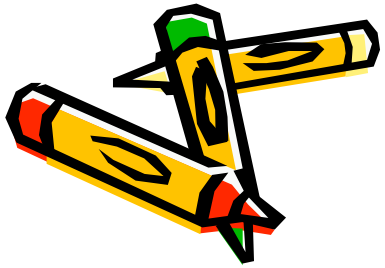


- Exclusive analysis of 2008 energy scan (proposed by Rome)
- Light meson spectroscopy and measurements of R_{had} via ISR



Belle, short of manpower, calls for help. Thesis opportunity on measurement of abs. BF!

Study of S-waves in D decays – 1 analysis

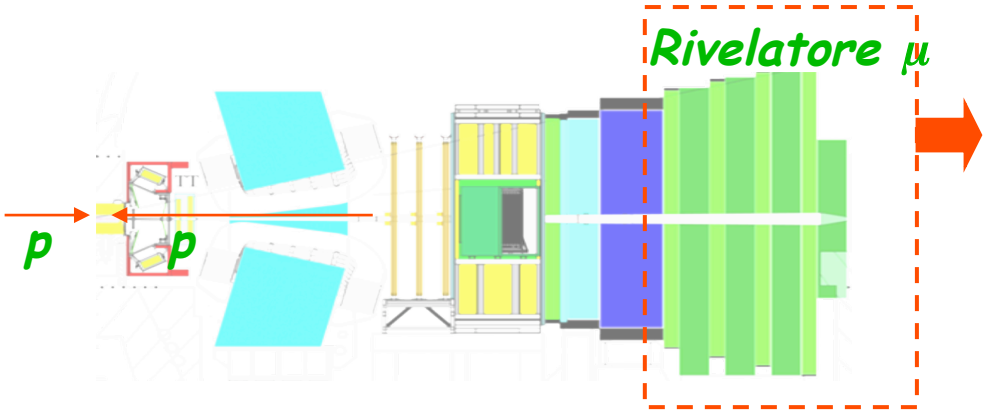


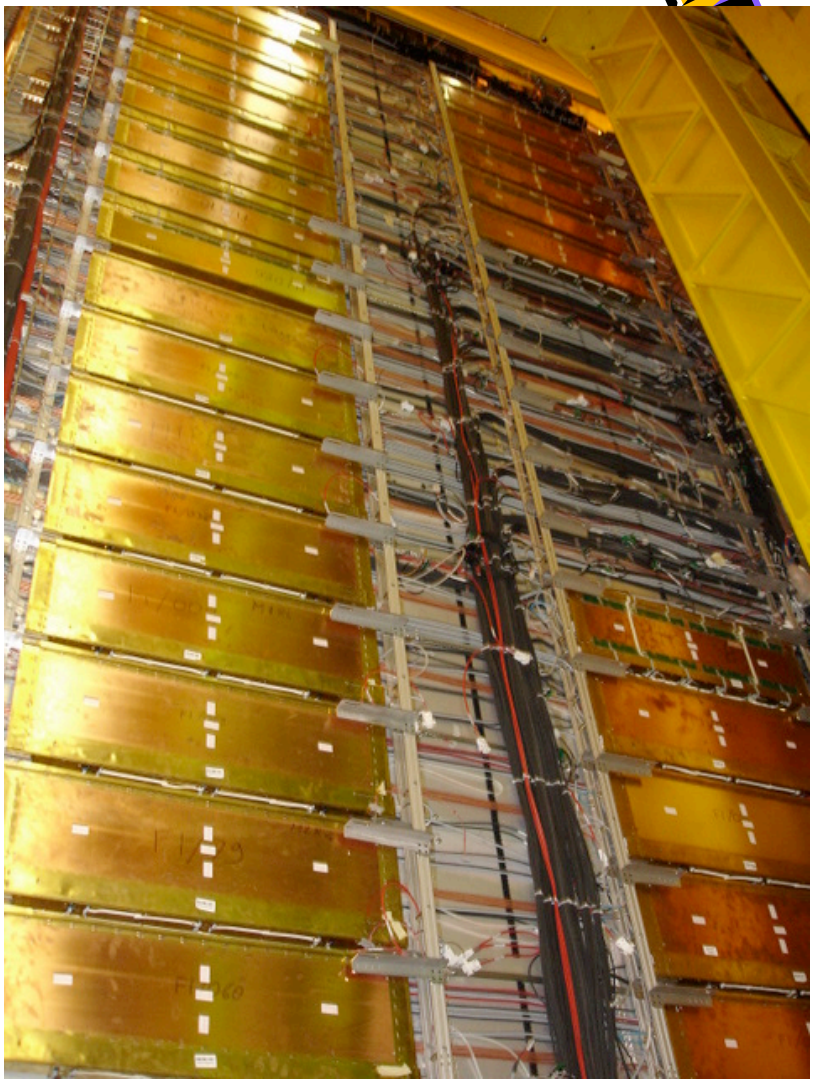
Editor in chief of The report on flavour physics of last generation

LHCb-Roma

V.Bocci,G.Martellotti,G.Penso,D.Pinci,R.Santacesaria – G.Auriemma.C.Satriano (Potenza)

Attivita' concentrata sul rivelatore di muoni (1380 camere a fili & GEM)





Contributo alla costruzione

- disegno e realizzazione dell'elettronica di controllo e dei circuiti "spark protection"
- prelavorazione dei materiali per la costruzione delle camere
- test di qualita' della produzione delle camere,caratterizzazione delle prestazioni, test di qualita' dell'elettronica di lettura

Attivita' Concluse/In corso

Software

- Sviluppo del MC di simulazione del rivelatore
- Ricostruzione dei muoni
- Ottimizzazione del trigger di livello 0
- Sviluppo software per il sistema di controllo rivelatore **m**
- Analisi degli eventi cosmici per debugging e determinazione delle condizioni di lavoro ottimali delle camere

Fisica

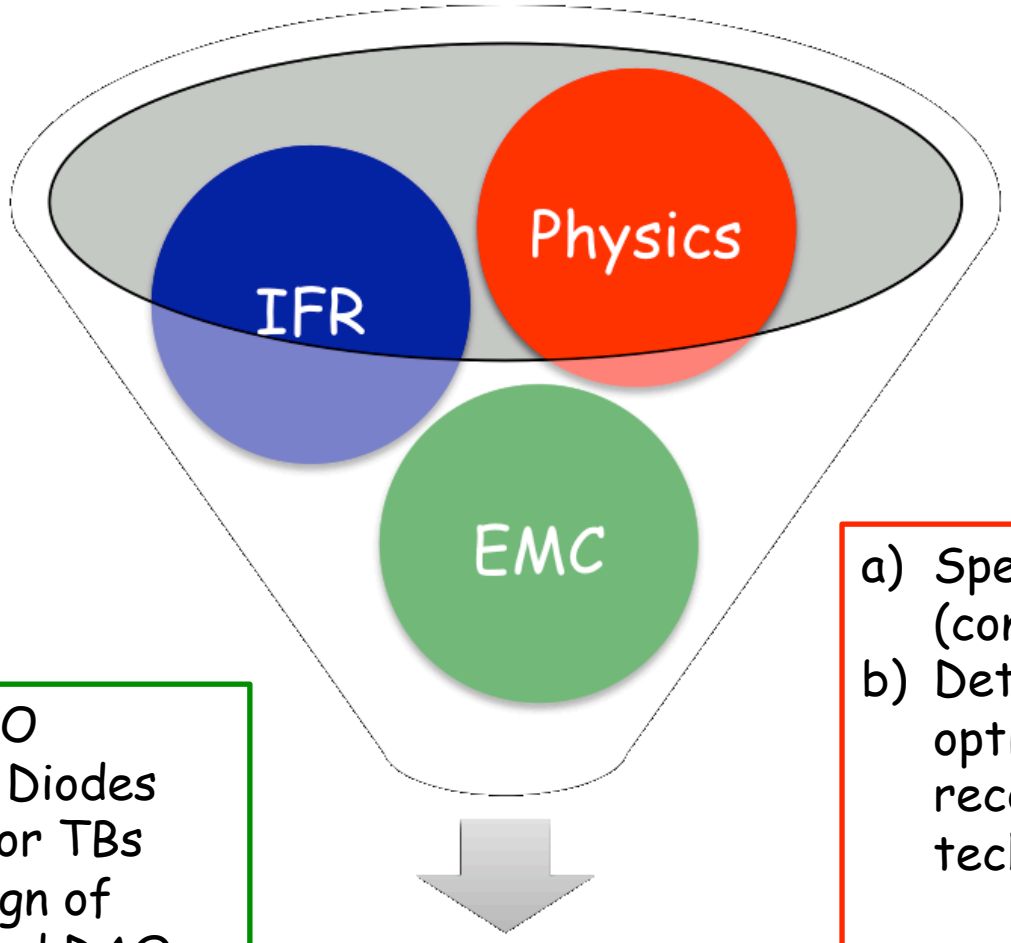
- $B_S \rightarrow J/\Psi(\mu^+\mu^-)f(K^+K^-)$
- decadimenti rari ($D^0 \rightarrow \mu^+\mu^-$)
- interazioni p-p in 2 jet

Possibile upgrade del rivelatore (2015??)

- Modifiche/riprogettazione dell'elettronica

SuperB-Roma1: Activities

Radiation hardness of SiPM @ENEA Frascati (winding down)



Forward LYSO
a) Setup Pin Diodes readout for TBs
b) TDR design of readout and DAQ

a) Spectroscopy (convenership)
b) Detector optimization in recoil techniques

TDR

Conclusions

Flavour physics has still a lot to say:

- Next generation of B physics experiments not 'yet another BF'
- From the "discovery phase" to precision machine
- Super Flavour Factories are future generation not only of the BF, but also of LFV, Spectroscopy, Charm-τ factories …

Ifs game:
• if LHC sees NP you want to know the impact on flavour
• if LHC does not see NP, it might have a mass visible only in flavour
• if LHCb sees NP you want confirmation in e+e-

→ SuperB & LHCb wanted anyhow