Why and How we should measure A_u with the CMS

Few preliminary thoughts

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Definition

- $|B_{H/L}> = p|B^0> \pm q|\bar{B}^0>$
- $|q/p| \neq 1 \Rightarrow$ mixing induced CP violation
- measured through the dilepton asymmetry :

$$\mathcal{A}_{ll} = \frac{\mathcal{N}(B^0B^0) - \mathcal{N}(\bar{B}^0\bar{B}^0)}{\mathcal{N}(B^0B^0) + \mathcal{N}(\bar{B}^0\bar{B}^0)}$$

$$= \frac{\mathcal{N}(l^+l^+) - \mathcal{N}(l^-l^-)}{\mathcal{N}(l^+l^+) + \mathcal{N}(l^-l^-)}$$

$$\simeq 2\ (1 - \left|\frac{q}{p}\right|)$$

$$\mathcal{A}_{ll} \neq 0 \Rightarrow \quad CP \text{ violation}$$

Reminder

- At colliders, both B_d and B_s are produced
- B_d : large production rate (f_d~0.4) , small mixing rate (χ_d~0.18)
- B_s : small production rate (f_s~0.1) , large mixing rate (χ_s~0.5)
- B_d and B_s equally contribute to the asymmetry

Expectations & Results

- Standard Model predicts very small CP violation both for B_d and for B_s :

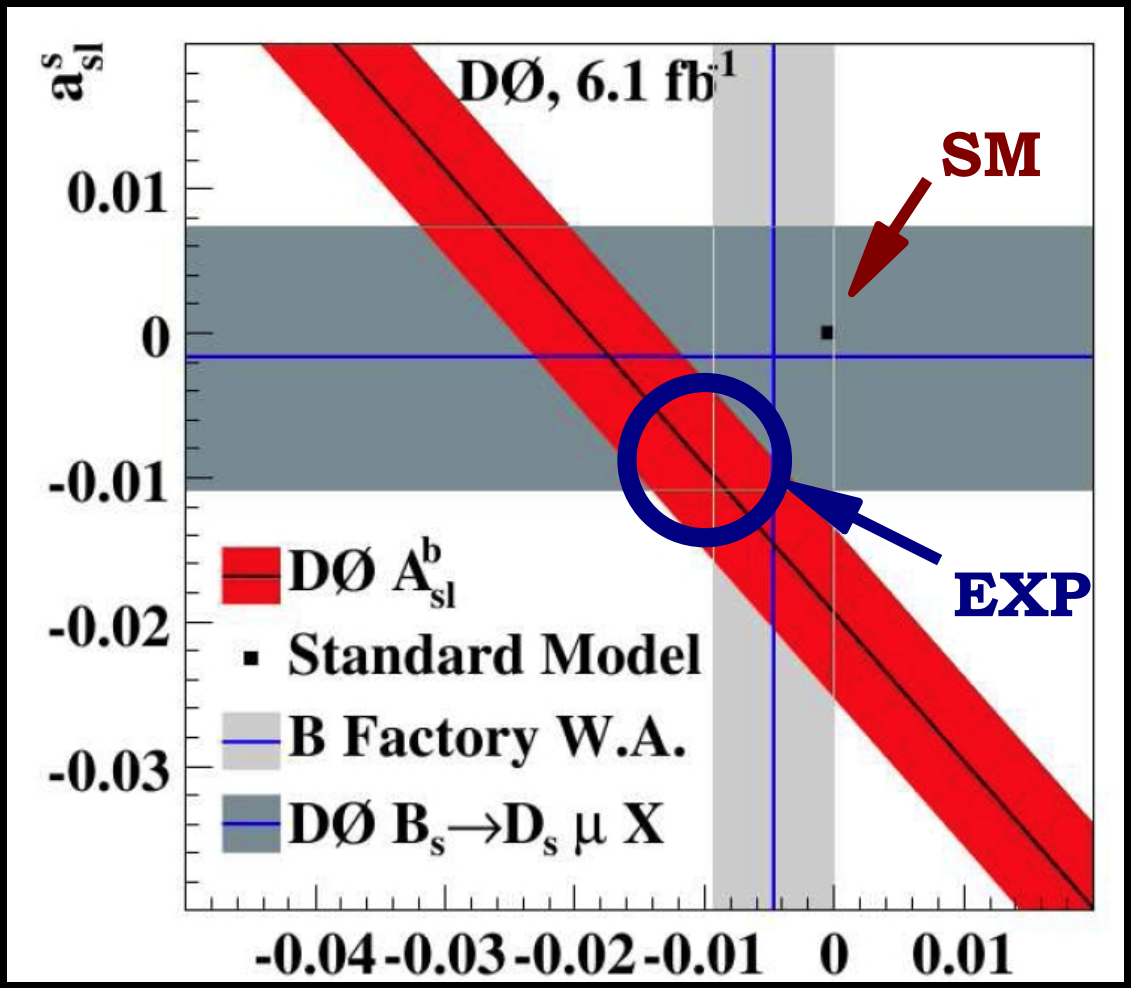
$$|q/p| < 10^{-3}$$

- Any positive observation with the sensitivity of the existing experiments would be a signal for new Phyisics !
- Status (HFAG 2009) :
  - B_d : $\mathcal{A}_{ll}^d$ = -0.0047 +- 0.0046 (Belle+Babar)
  - Colliders : next slide

A_{ll} @ DZERO

- Result presented – and much discussed – at ICHEP
- Combine single and di-muon tag asymmetry to reduce the systematic error due to artificial, detector induced charge asymmetry
- Use control samples to subtract (large) asymmetry induced by fake muons, $K \to \mu\nu$, $\pi \to \mu\nu$.
- Find ~ 3σ deviation from 0 :

$$A_{\ell\ell}^{b} = -0.00957 \pm 0.00251\ (\text{stat}) \pm 0.00146\ (\text{syst})$$



Among the largest cracks in the SM
- if confirmed -

Future Perspectives ?

- B-factories
- SuperB factories
- Tevatron
- LHCb
- Atlas-CMS

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B_d only (too few events collected @ Y(5S) ! Cannot test the B_s contribution

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High statistics run @ Y(5S) not foreseen at present.

Still a long way before data taking

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- "Due to track occupancy problem, we do not plan to make inclusive dimuon analyses"

Gaia Lanfranchi on behalf of LHCb @ the annual experimental review of the Commisione Nazionale Gruppo 1 – INFN – Parma 23/09/10

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… or nobody else !

Facts

- The measurement is challenging:
  - need ~ 1 per mille statistical precision
    - 1 million dimuons from B-mixed events
      - several millions triggers
  - high control of the background
    - fits to p_t^{rel}, d_{xyz} spectra
    - use anti-btagged sample
  - high control of detector induced asymmetries
    - compare several samples
      - with/without lifetime cuts
      - equal and opposite charges
      - single tags – if available

The most delicate question

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  - One hertz rate ~ 100 000 events per / day
  - 10 M evts per year
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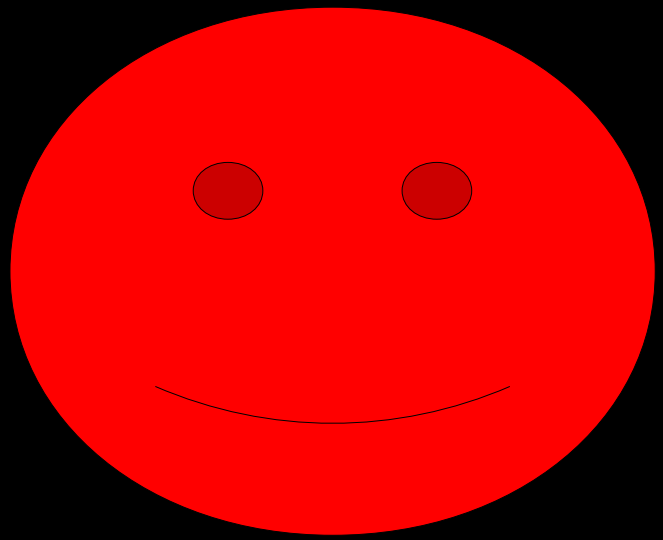

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  - 2010 dilepton trigger by far too loose
  - muon/event cuts reject 97% of the triggered events
  - statistical error would be too large even at the end of 2012 and the result meaningless

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- For this analysis dilepton trigger must be reconsidered
- … maybe in conjunction also with other teams (EXOTICA?)

Conclusion

- I am convince that $\mathcal{A}_{ll}$ is a MUST not only of B-physics group, not only of CMS, but of the HEP community
- We must seriously consider if it is in the reach of CMS, and, if so, support this measurement
- I will prepare soon a brief written document discussing the details of the analysis and its potential reach, including the trigger issue

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