



**LATTICE MEETS EXPERIMENT: (G-2)**

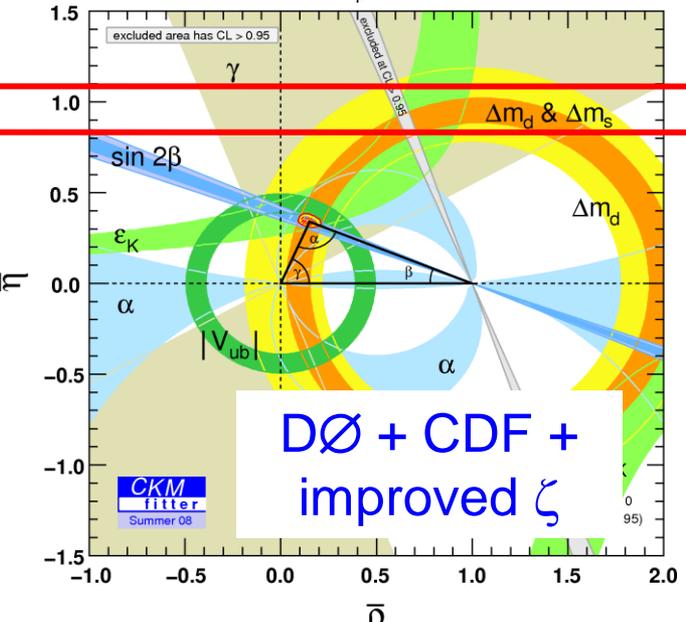
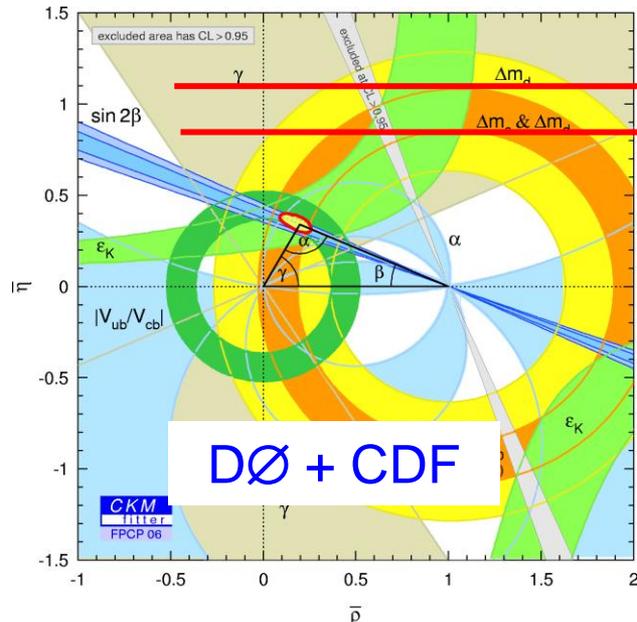
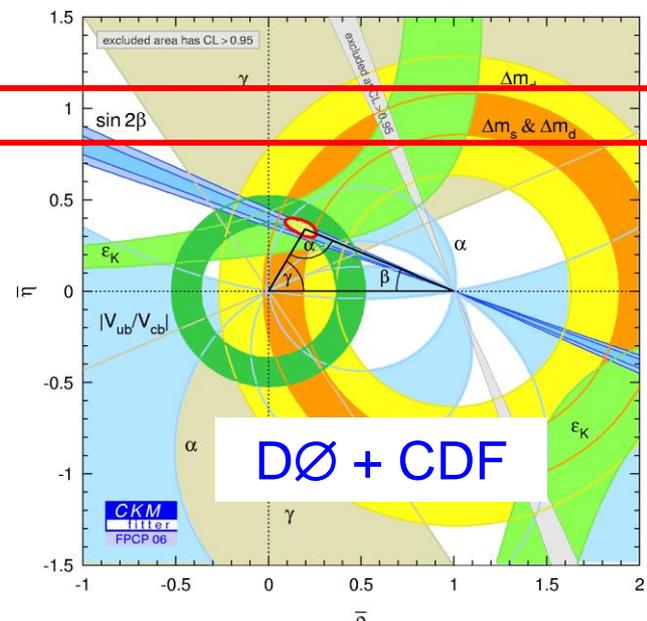
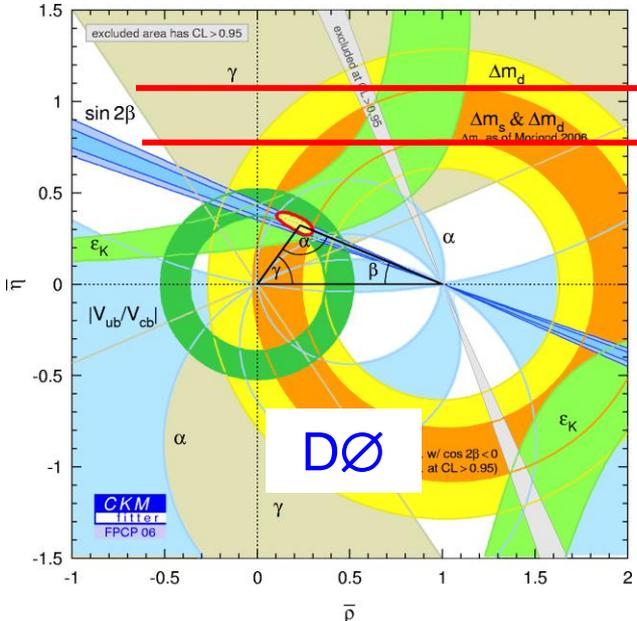
**Brendan Casey, Fermilab**

# CONCLUSIONS

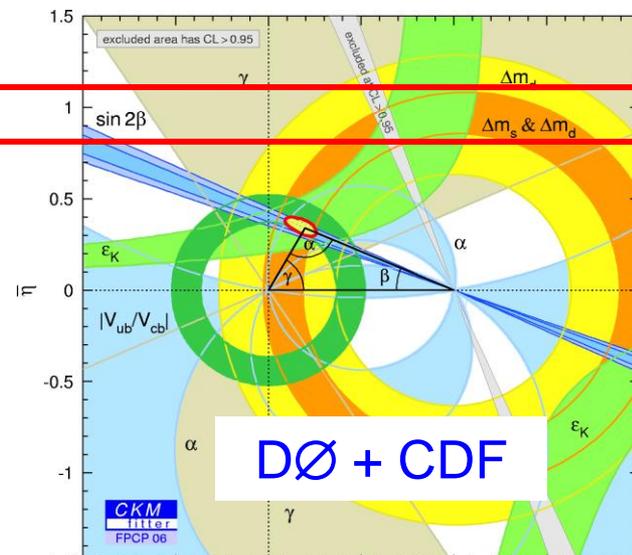
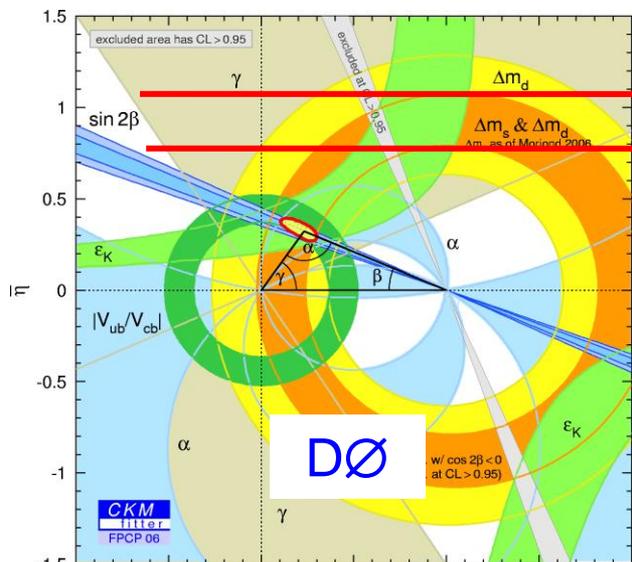
- The determination of  $(g-2)_\mu$  to 0.54 ppm has yet to be confirmed
  - Therefore we can't believe it
- The 0.44 ppm error in the predicted value is dominated by non-perturbative QCD
  - Therefore we can't believe it
- We need to re-determine  $(g-2)_\mu$  of the muon to higher precision with a new experiment
  - Goal is 0.14 ppm
- We need a rigorous, non-perturbative calculation that predicts the value of  $(g-2)_\mu$  that can be verified using independent data.
  - Goal is set by experimental precision

- Was on the organizing committee of Lattice meets experiment 2010 workshop at Fermilab
- Was asked to give a ‘perspectives from an experimentalist’s point of view’ at this all hands meeting
- In both cases, I agreed if I would be allowed to shamelessly plug the new g-2 experiment
- I would like to give my impressions and get people motivated to work on g-2

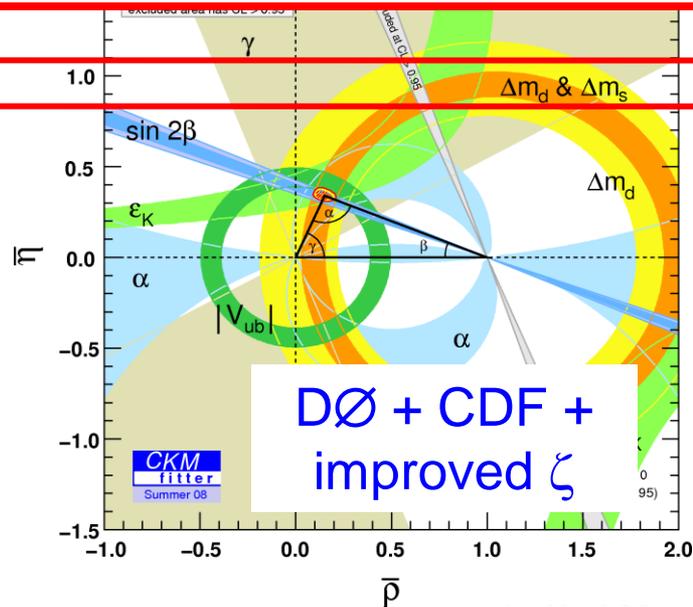
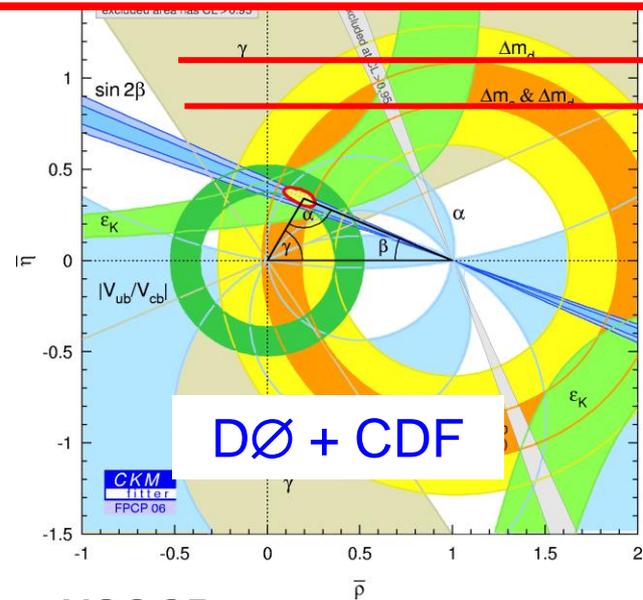
# IMPRESSIONS: Bs MIXING



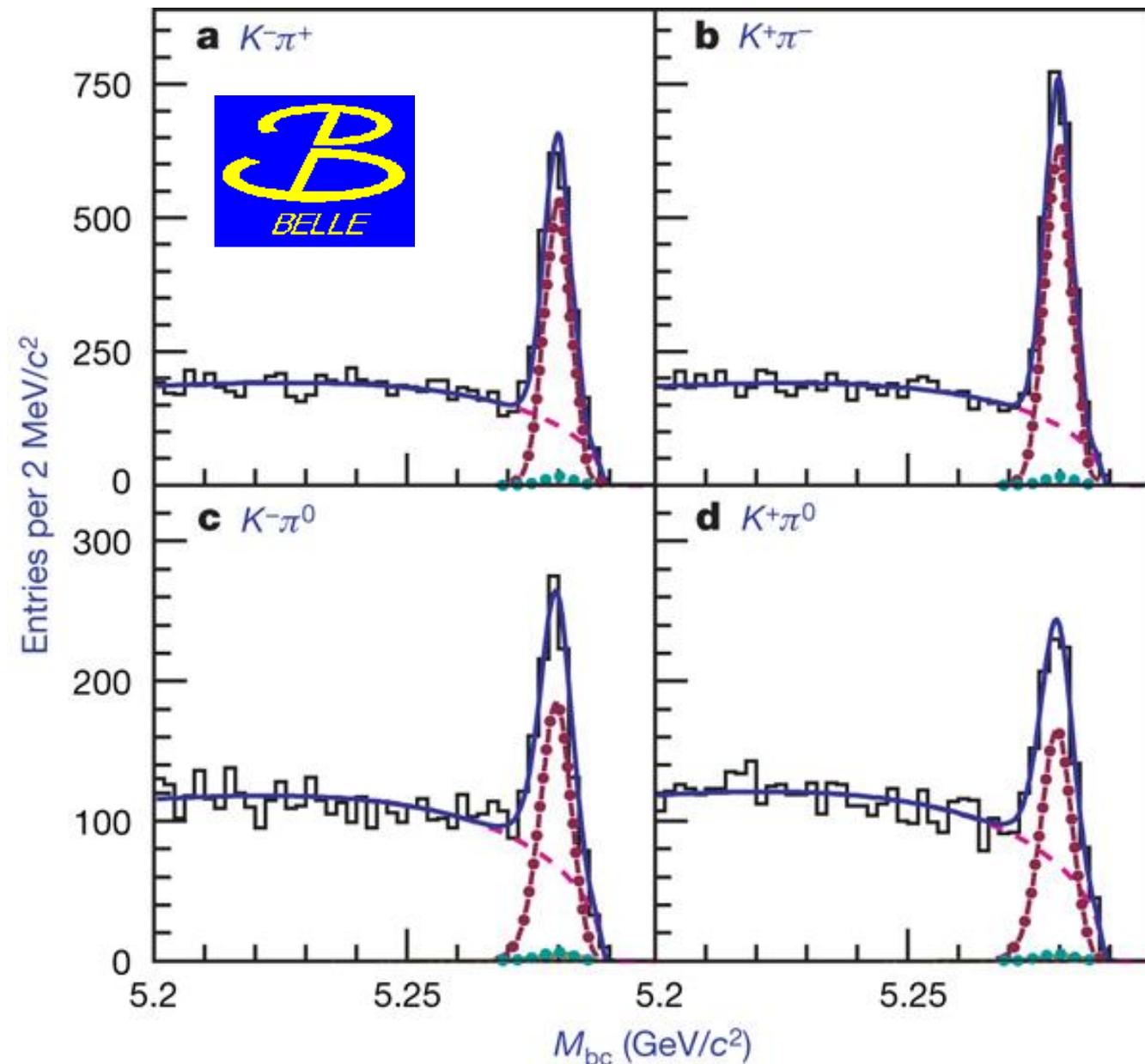
# IMPRESSIONS: Bs MIXING



Lesson learned: Lattice is just as important as experiment



# IMPRESSIONS: $K\pi$ PUZZLE



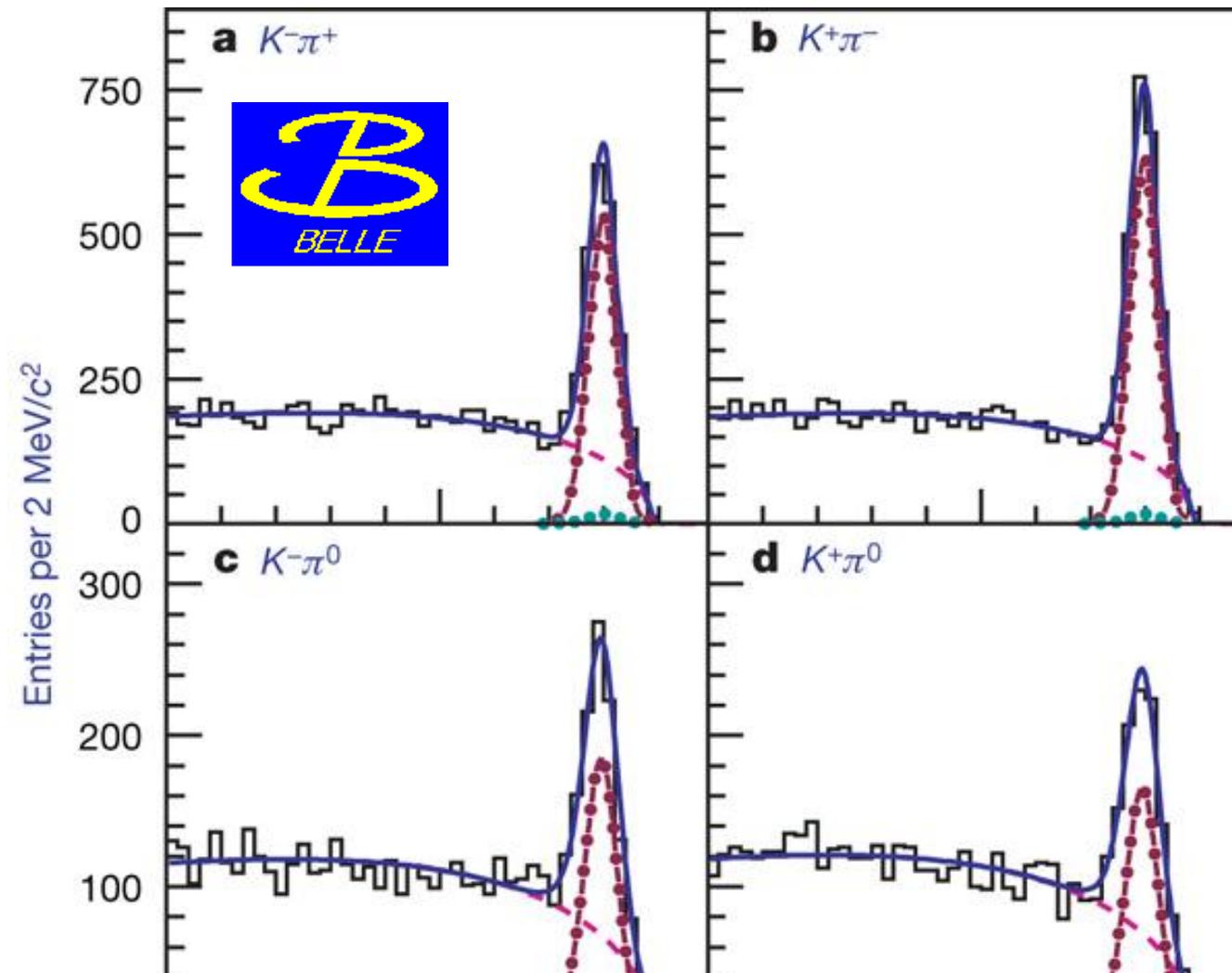
5  $\sigma$  difference  
between CPV in  
 $K^+\pi^-$  and  $K^+\pi^0$

Basically useless  
because no solid  
prediction

Similar situation for  
g-2

“In principle....”

# IMPRESSIONS: $K\pi$ PUZZLE



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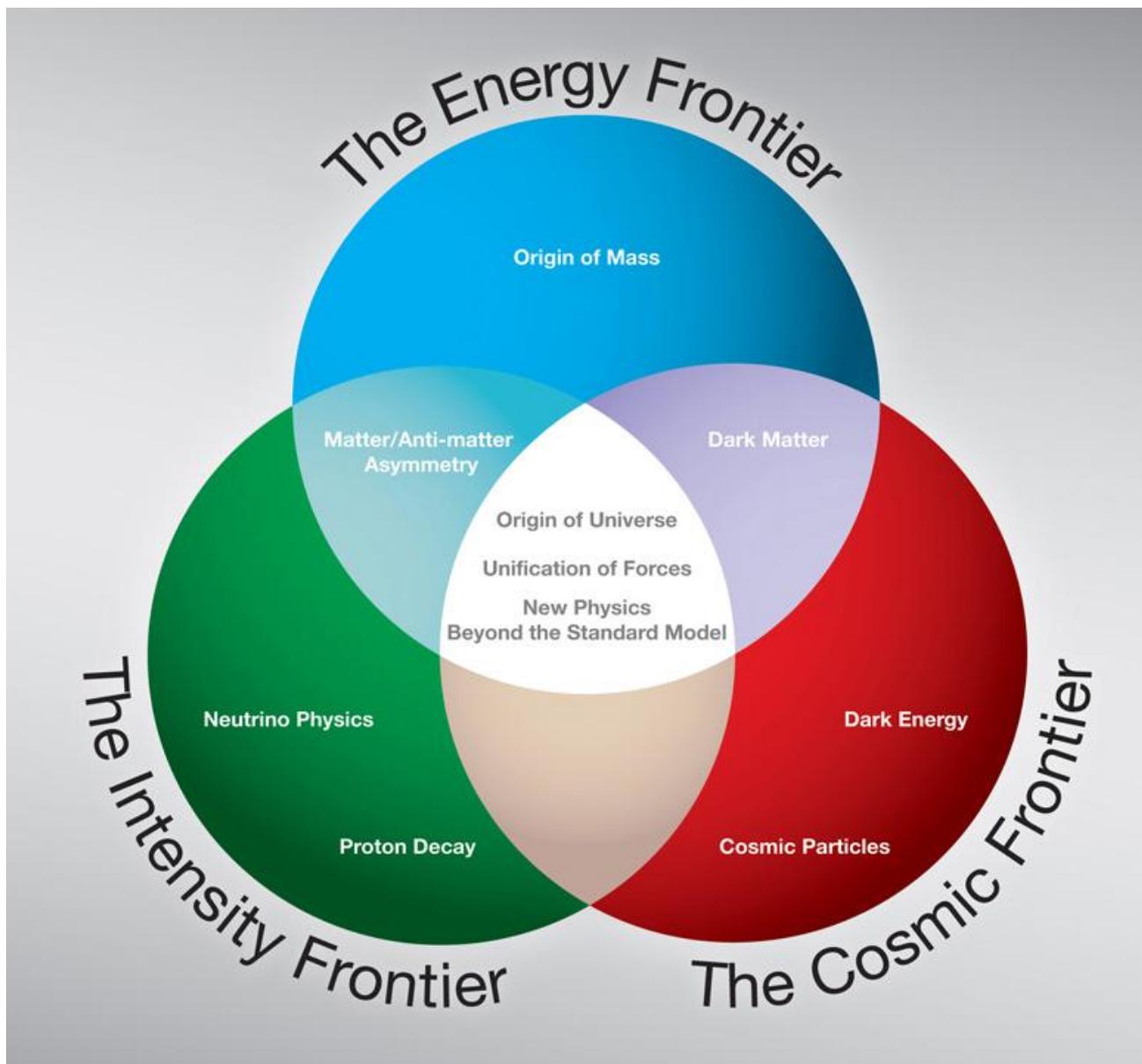
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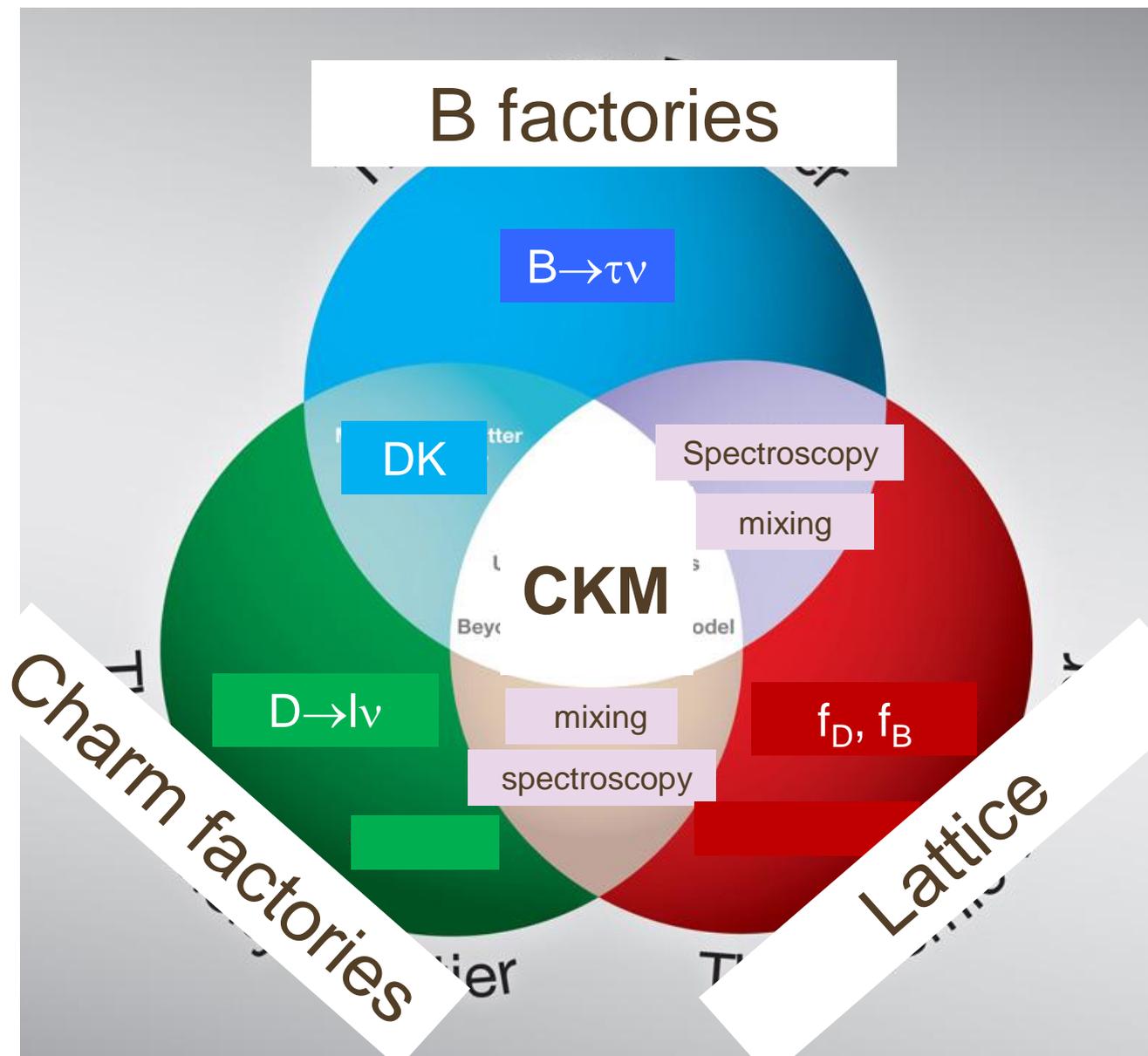
Similar situation for  
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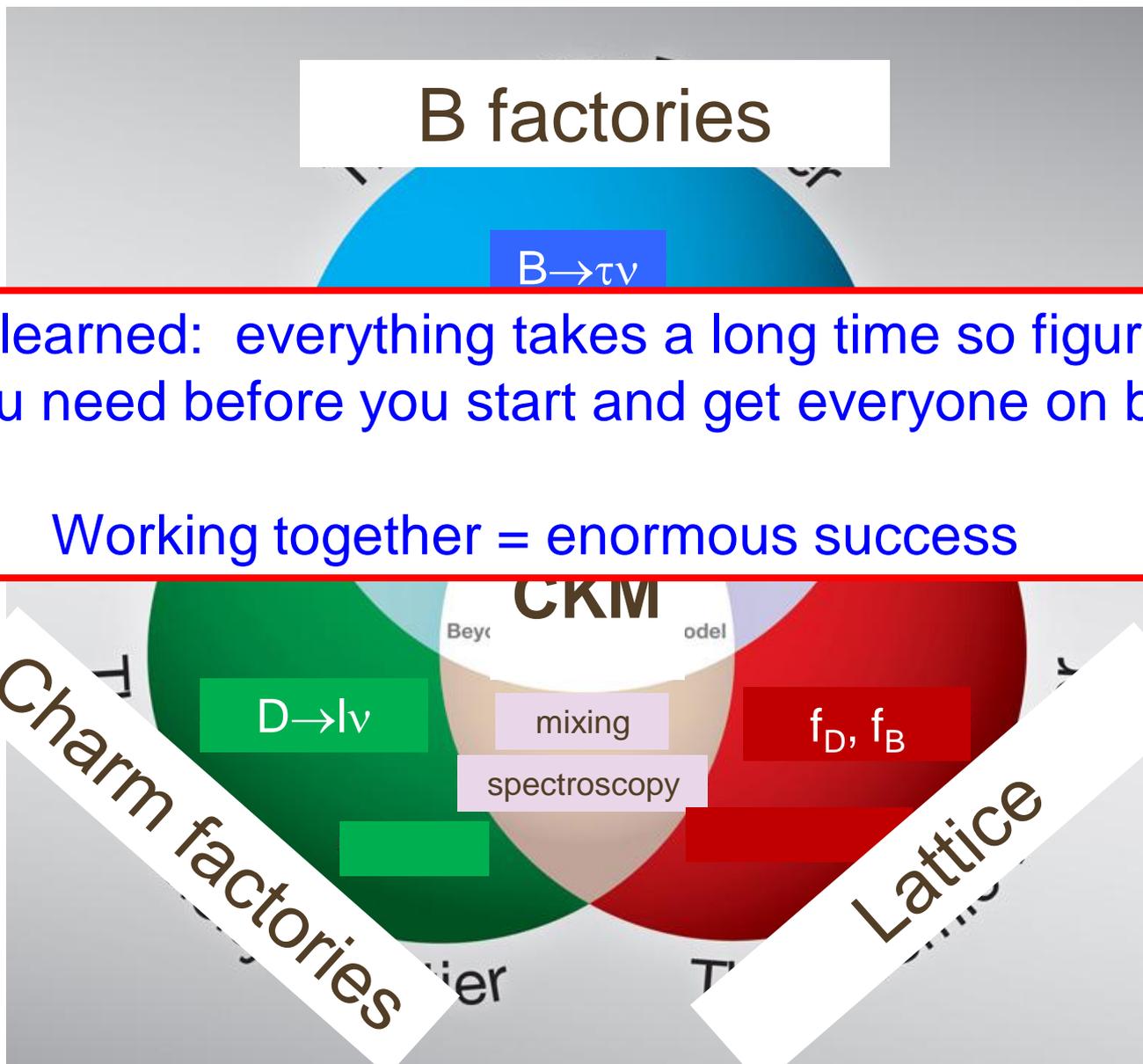
“In principle....”

Lesson learned: estimates, models, and symmetries are great until you disagree with what you expect

# IMPRESSIONS: $F_B$







- “We just don’t understand QCD at that level.”
  - This is almost a community wide consensus
- LO effects like vacuum polarization can be taken from data. But higher order effects like hLbL so far cant.
  - hLbL is predicted to be the dominant error in the next round. Apparently a ‘killer’ for prioritization committees.
    - No lattice people on P5!
- Spin is fundamental. QCD is fundamental. “We just don’t understand” is completely unacceptable.
  - You have to add “yet”
- Electron g-2 is considered the crowning achievement of QED
  - Muon g-2 could be the crowning achievement for QCD

# G-2 STATUS

- BNL measurement to 0.54 ppm
- Fermilab expects 0.14 ppm
- Dominant sys:
  - Backgrounds from  $\pi$ 's
    - 10x longer decay channel
  - Pileup in the calorimeters
    - Finer segmentation
- Stats:
  - Booster rep rate  $\gg$  AGS rep rate
    - Fermilab = 20x total BNL stats in about 1 year
- The experiment is mostly built, the collaboration exists, the director loves it, and the DOE is on board.
  - This is happening

Dear Lee and Dave,

Following the recommendation of the PAC and discussions with the Department of Energy on funding projections over the period when we could run the New g-2 Experiment, I grant Stage I approval to g-2. Of course, there is still a lot of work to do to develop a detailed plan for the funding and various further approval processes which will be required to execute the experiment.

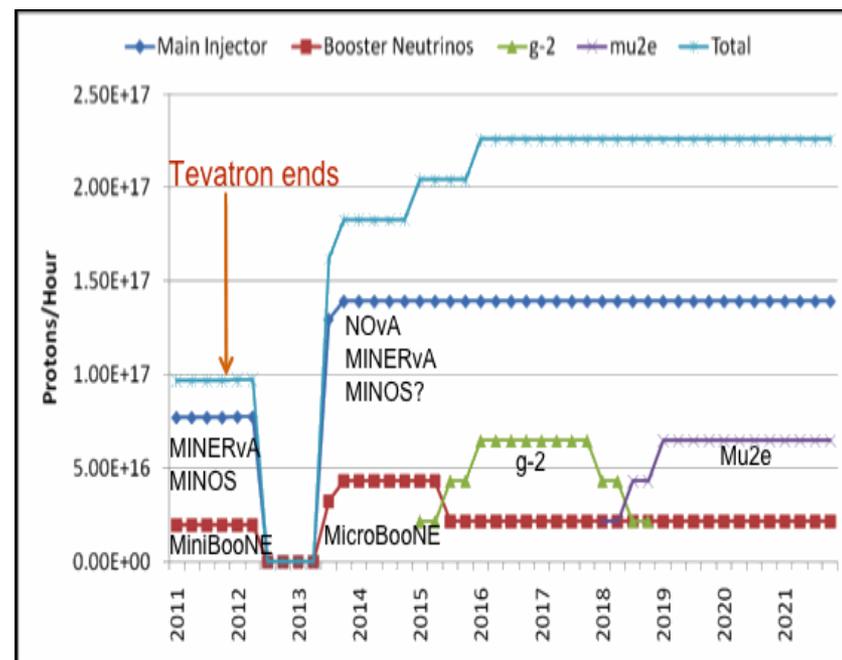
We will consider the experiment ready for the Stage II approval when we determine that the available funding is sufficient for the proposal scope of the experiment and there is a detailed MOU between Fermilab and the experiment.

Despite the cautionary words, we are very pleased that your experiment has met a rather high standard, and we very much hope that this approval can lead to establishment of a soundly based plan. If there is any way we can be of assistance in this, please let us know.

Sincerely,



Piernaria Oddone



# PROGRAM: G-2

- Fermilab:
  - Same as BNL but better
- JPARC:
  - Completely different technique, competitive precision
- KEK, INFN:
  - Possible to do  $g-2$  of  $\tau$  via  $\tau^+\tau^-$  spin correlations

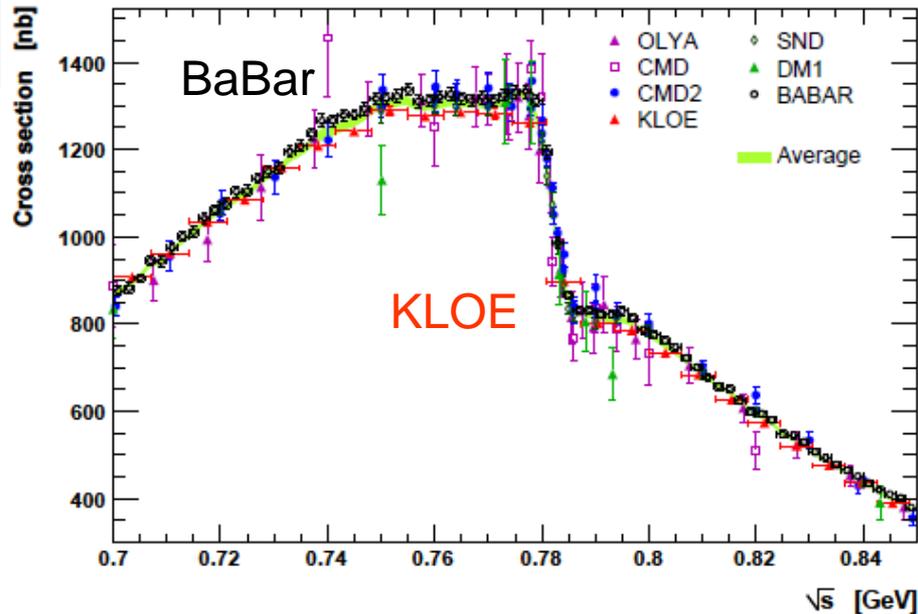
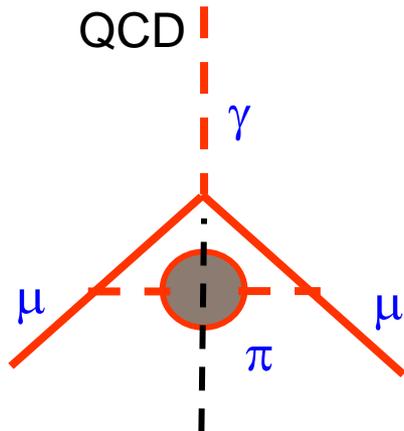


図1 : オープンMRI装置の概観図

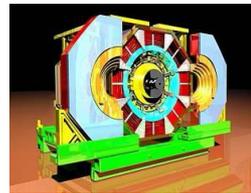
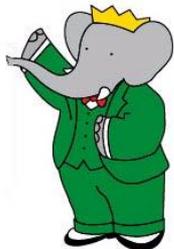
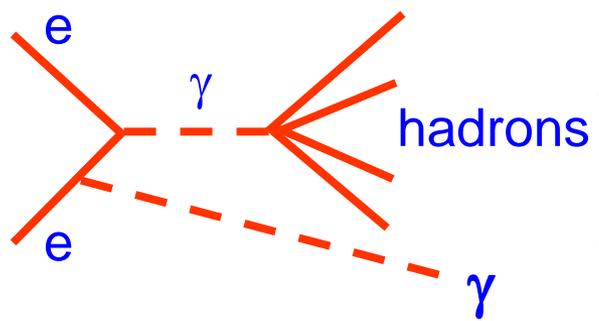
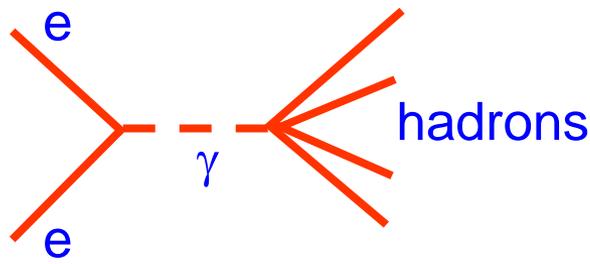
@ 75  $ab^{-1}$ :  $\sigma(a_\tau) \sim 5 \times 10^{-6}$

Bernabau, Gonzalez-Sprinberg, Videl JHEP 0901:062 (2009)

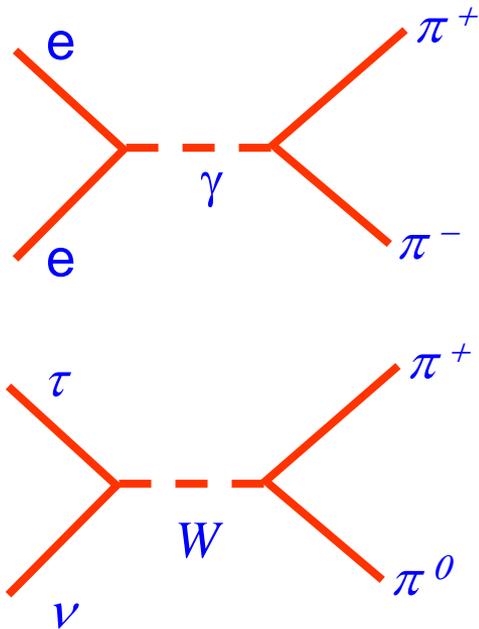
# PROGRAM: $E^+E^-$



## New experiments this decade

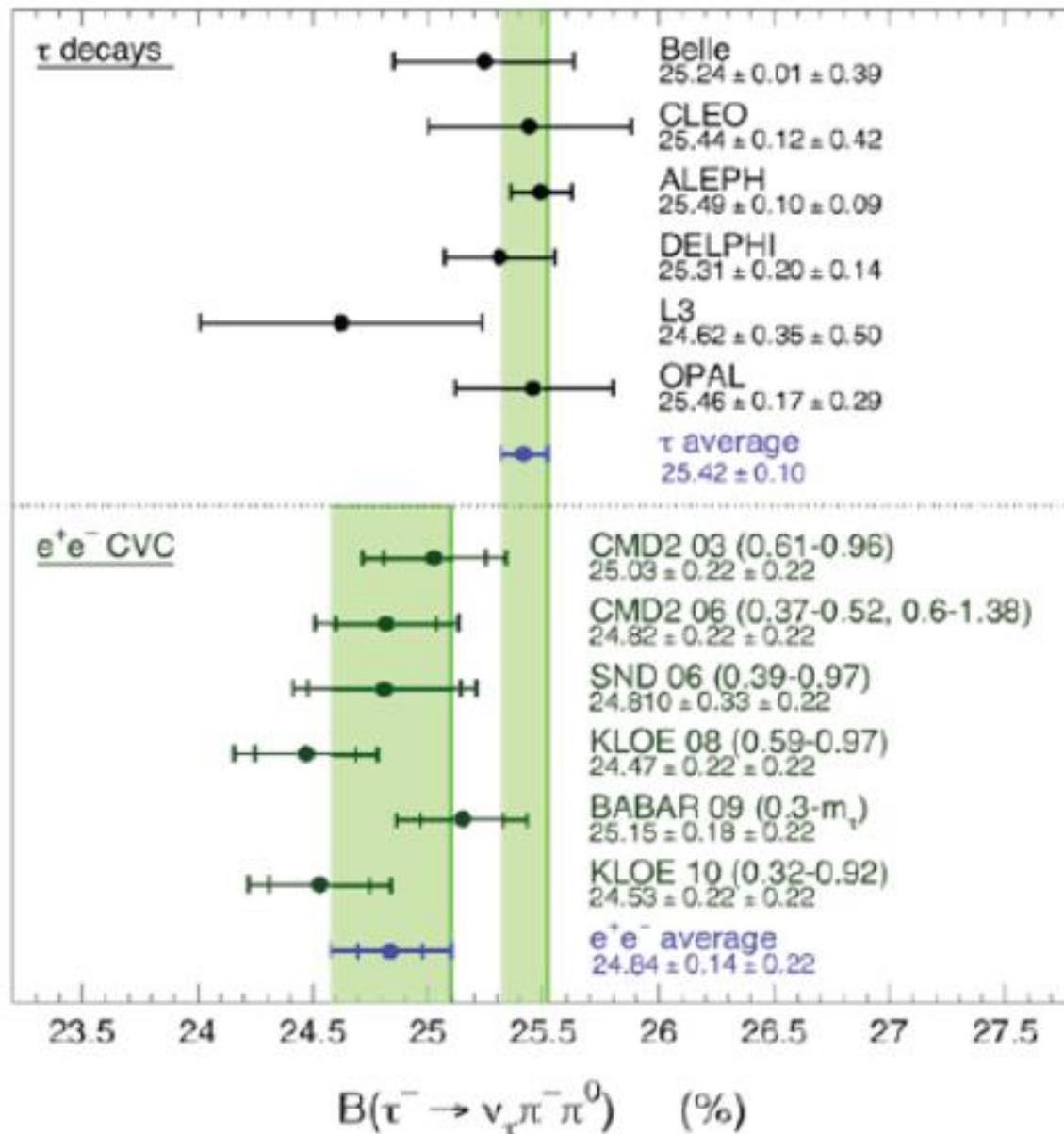


# PROGRAM: TAU

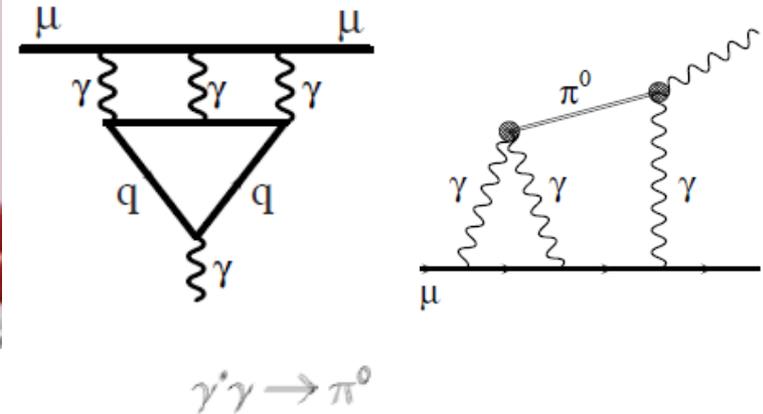
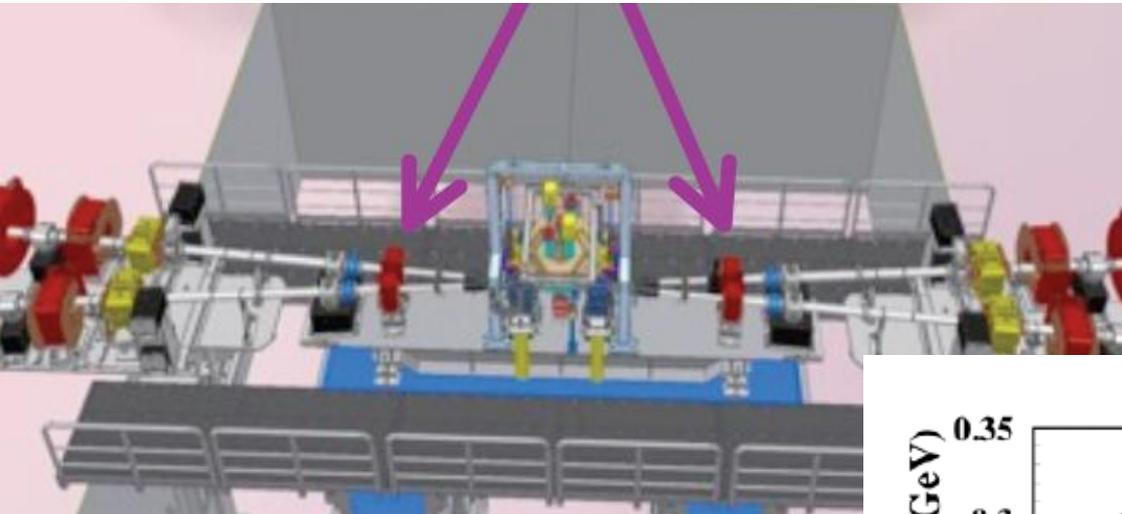


tau and  $e^+e^-$  data are converging with time.  
 $\sim 3\sigma$  difference now  $\sim 2\sigma$

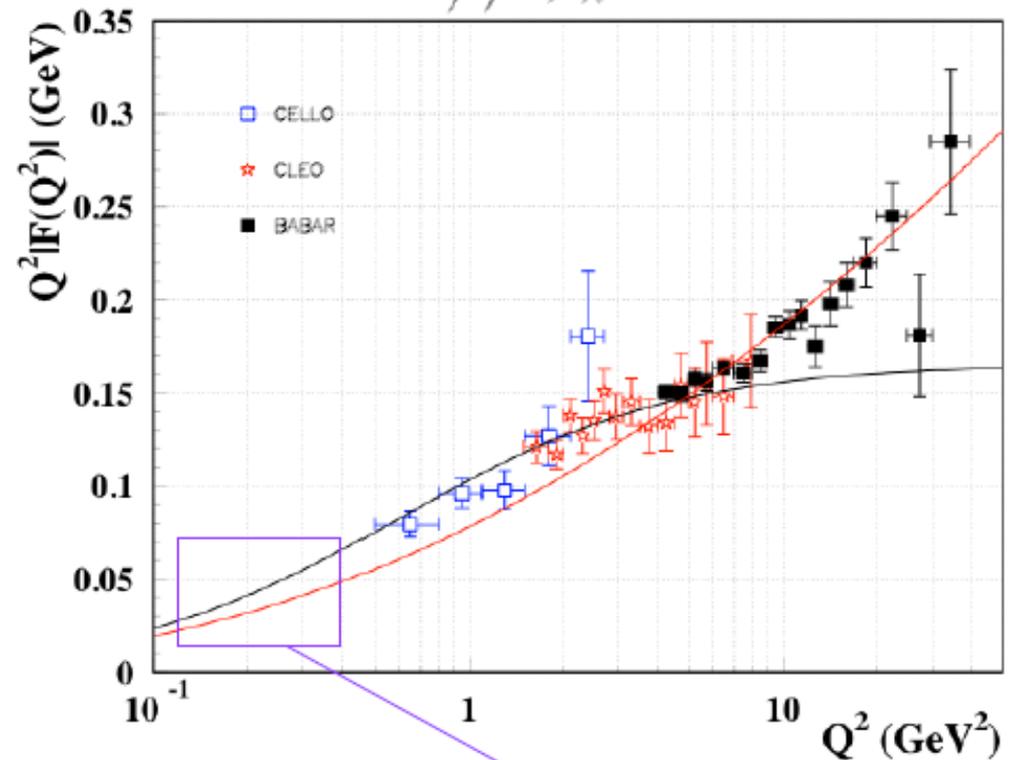
$\tau$  data set will increase by more than a factor of 100 this decade compared to published results



# PROGRAM: $\gamma\gamma$

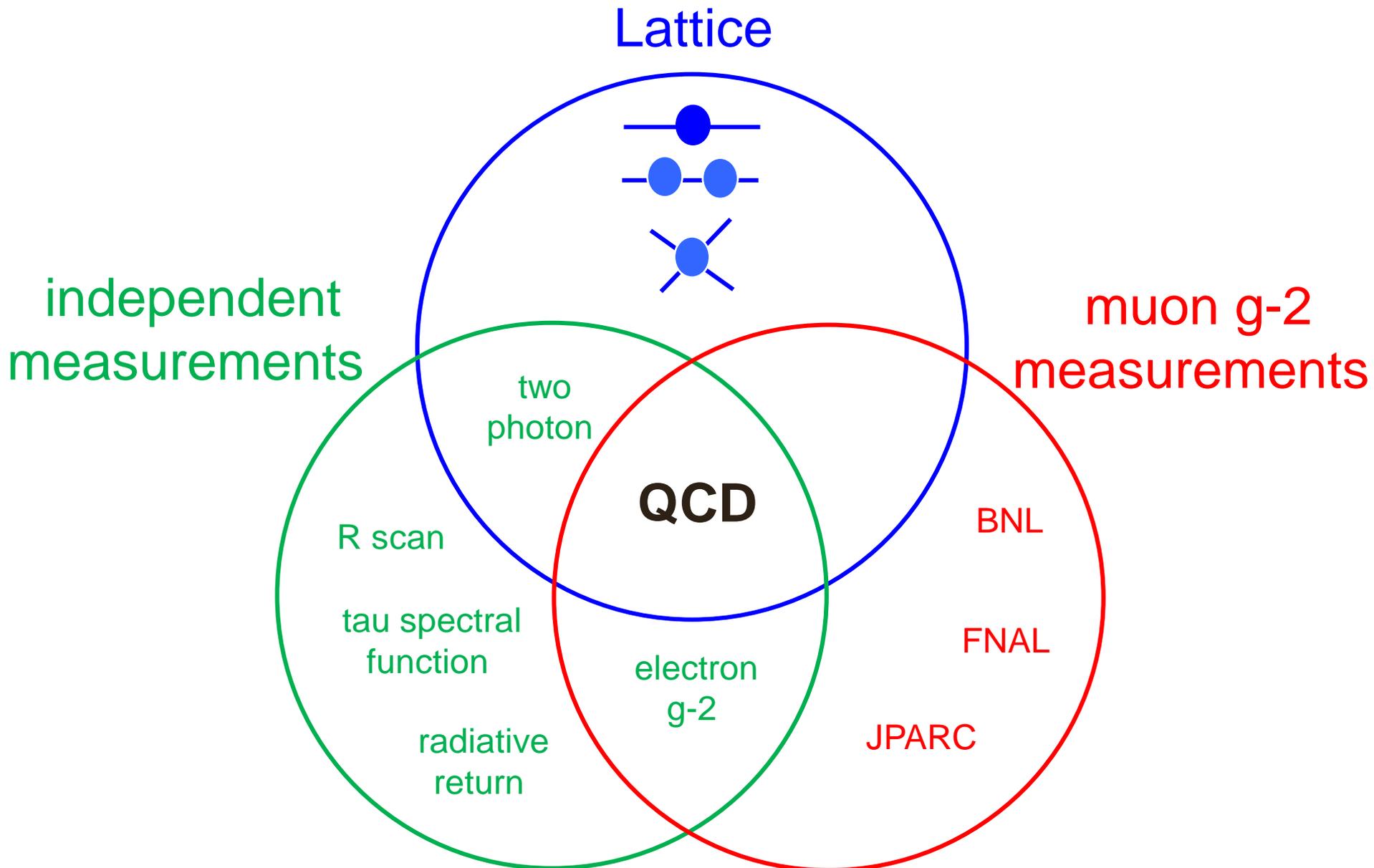


KLOE has added detectors down-stream of the collision point to tag outgoing  $e^+$  and  $e^-$  from two photon collisions



KLOE-2

# POSSIBLE COMBINED PROGRAM



# CONCLUSIONS

- The determination of  $(g-2)_\mu$  to 0.54 ppm has yet to be confirmed
  - Unacceptable
- The 0.44 ppm error in the predicted value is dominated by non-perturbative QCD
  - Unacceptable
- We need to re-determine  $(g-2)_\mu$  of the muon to higher precision with a new experiment
  - Short term goal is 0.14 ppm
- We need a rigorous, non-perturbative calculation that predicts the value of  $(g-2)_\mu$  that can be verified using independent data.
  - ~~In principle~~ we can do this.