Summary Talk on Experiments

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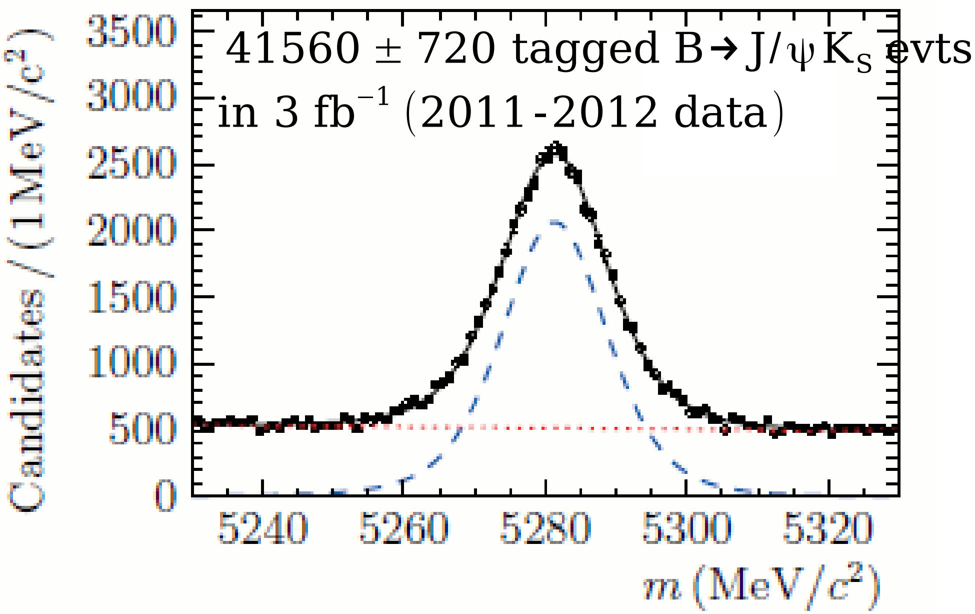
Disclaimer:
very partial summary... m(_ _)m

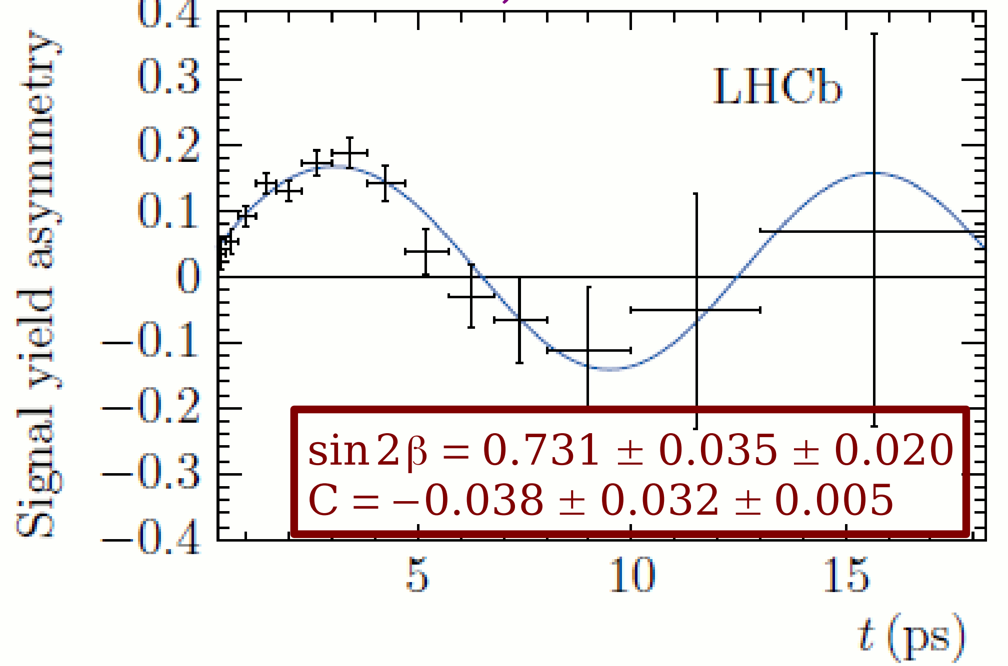
Nagoya, May 29th 2015

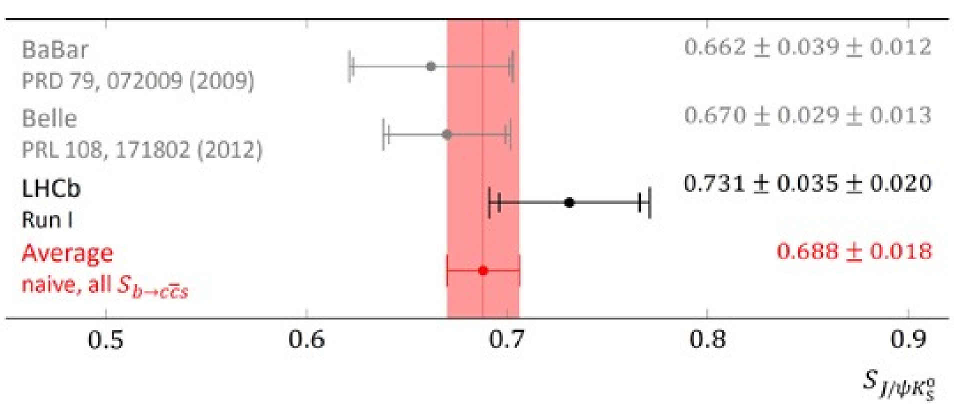
$\sin 2\beta$ with $B \to J/\psi K_S^0$ at LHCb

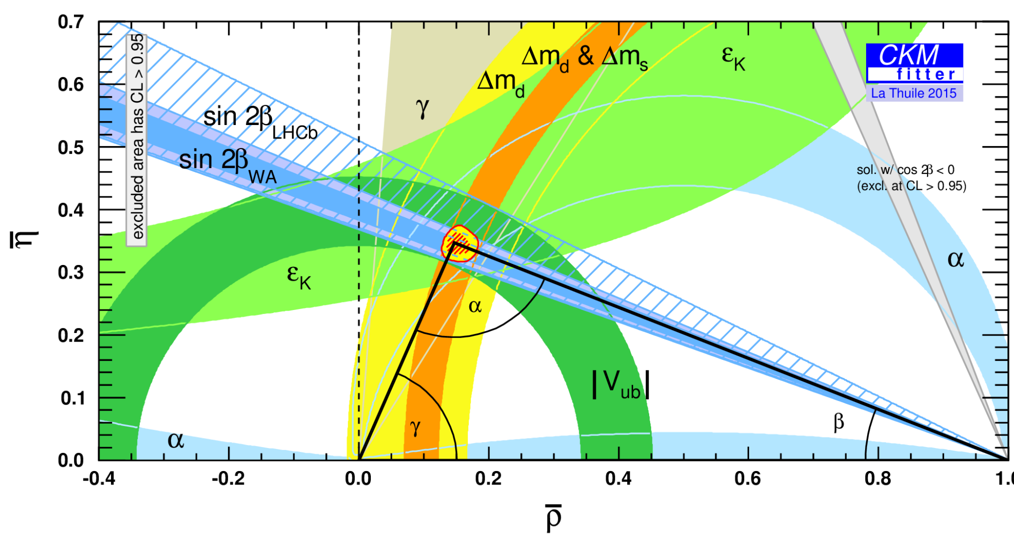
[Kenkichi Miyabayashi]



3 fb^{-1}, arXiv:1503.07089





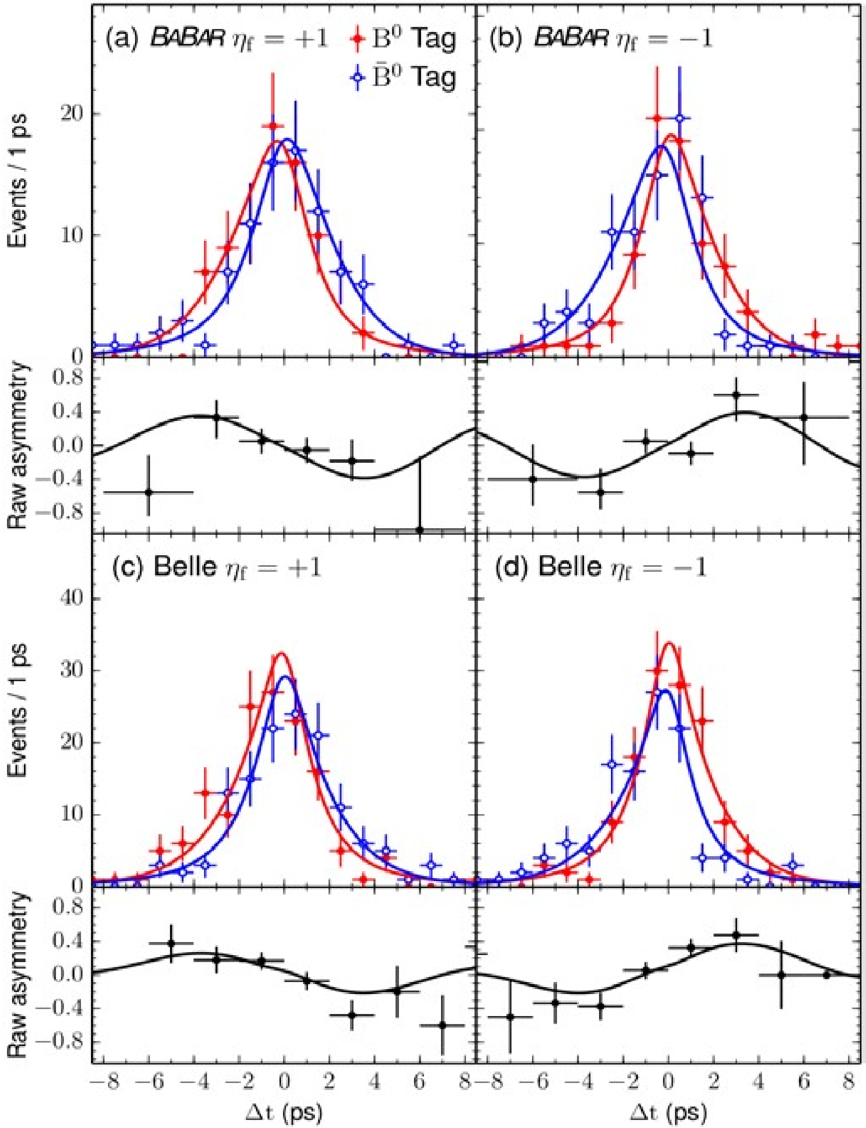


$\boxed{\beta = (21.9 \pm 0.7)^\circ}$ **WA 2015**

Combined BaBar and Belle analysis of $B \to D^{(*)}_{CP} h^0$

[Markus Rohrken]

- mediated only by tree-level amplitude
- can provide a SM reference of $\sin 2\beta$



- First combined BaBar-Belle analysis
- Access to 1.1 ab^{-1}

$$\ln \mathcal{L} = \sum_i \ln \mathcal{P}_i^{BABAR} + \sum_j \ln \mathcal{P}_j^{\text{Belle}}$$

- $h^0 = \pi^0, \eta$ and $D \to K^+K^-, K^0_S\pi^0, K^0_S\omega, D^* \to D\pi^0$
- Low B and D_{CP} branching fractions
- Low reconstruction efficiencies
- Significant background

arXiv:1505.04147

$$\boxed{\begin{array}{l} \sin 2\beta = 0.66 \pm 0.10 \pm 0.06 \\ C = -0.02 \pm 0.07 \pm 0.03 \end{array}}$$

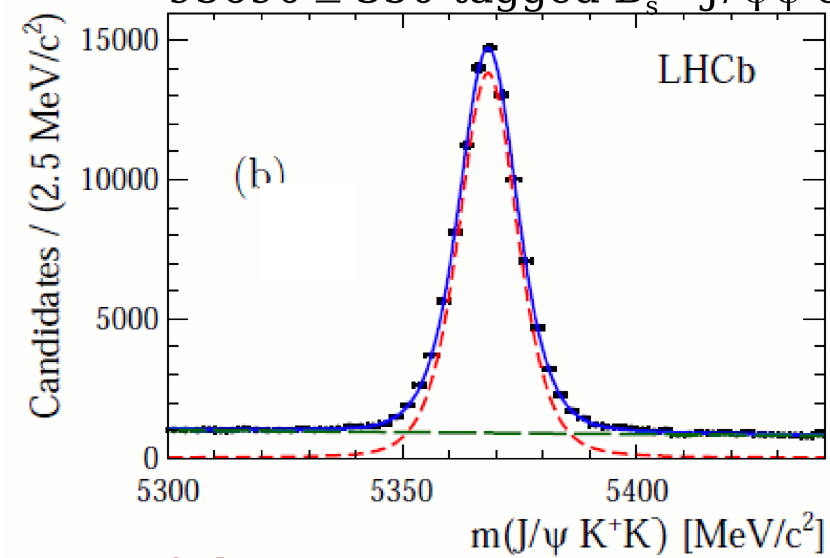
– First observation of CPV for this mode (5.4σ)
– $\sin 2\beta_{c\bar{c}s} = 0.691 \pm 0.017$

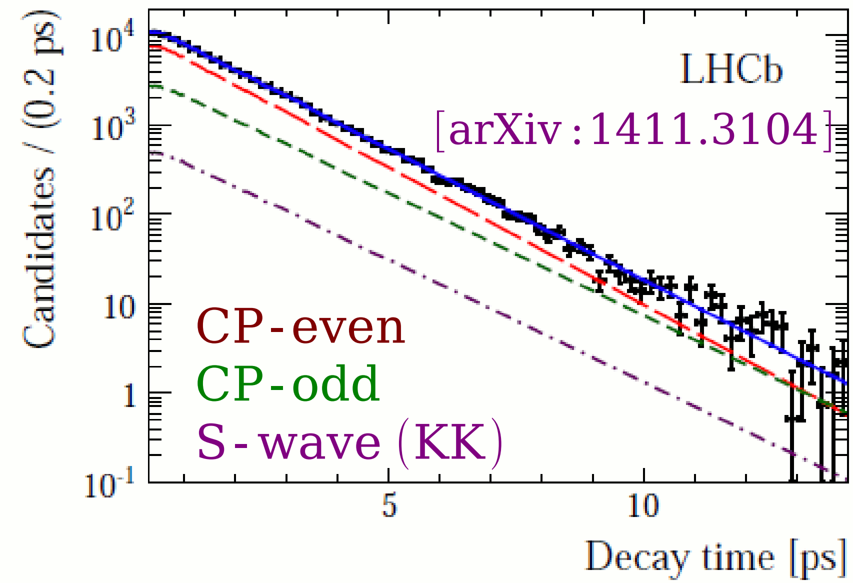
Results for φ_s

[Simon Akar]

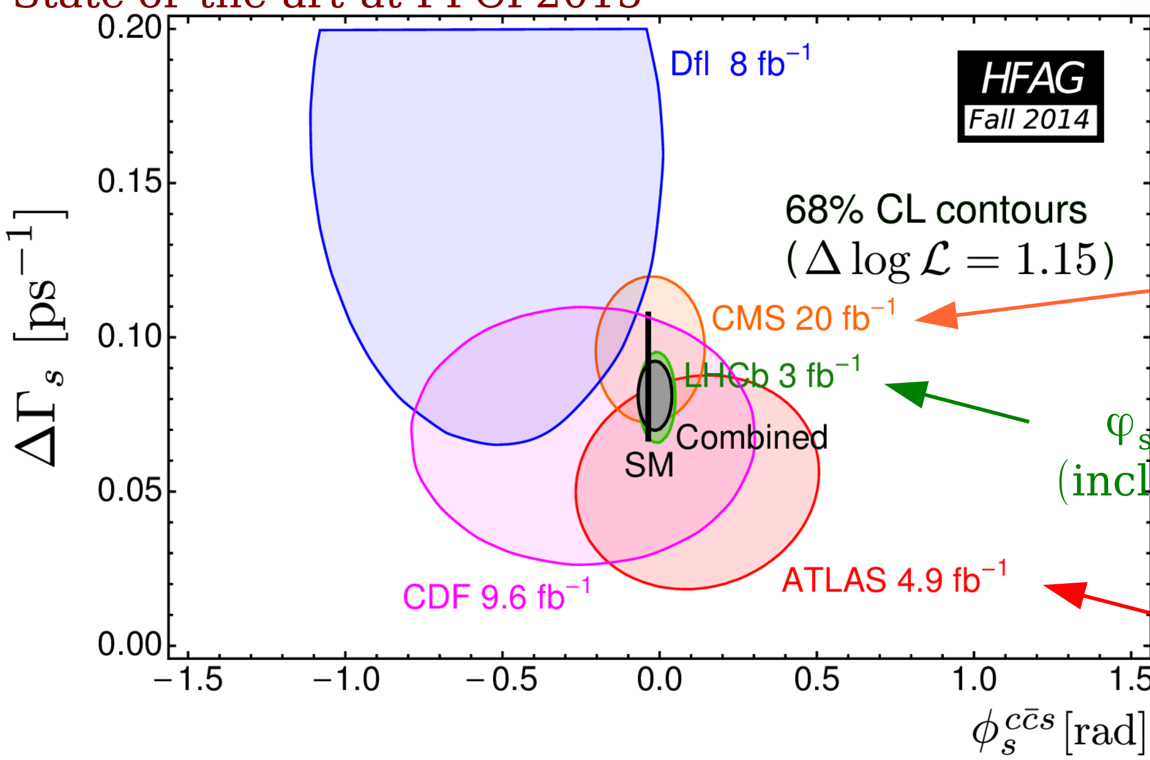
In SM, CPV phase is small $\varphi_s \sim -0.04$ rd $(\Delta\Gamma_s(\mathrm{SM}) = 0.087 \pm 0.021\ \mathrm{ps}^{-1})$

95690 ± 350 tagged $B_s \to J/\psi\varphi$ evts in 3 fb^{-1}





"State of the art at FPCP2015"



$\varphi_s = -0.058 \pm 0.049 \pm 0.006$ rad

$\Delta\Gamma_s = 0.0805 \pm 0.0091 \pm 0.0032\ \mathrm{ps}^{-1}$

$\varphi_s = -0.03 \pm 0.11 \pm 0.03$ rad

$\varphi_s = -0.010 \pm 0.039$ rad

(include $B_s \to J/\psi KK$ and $J/\psi\pi\pi$)

[arXiv:1405.4140]

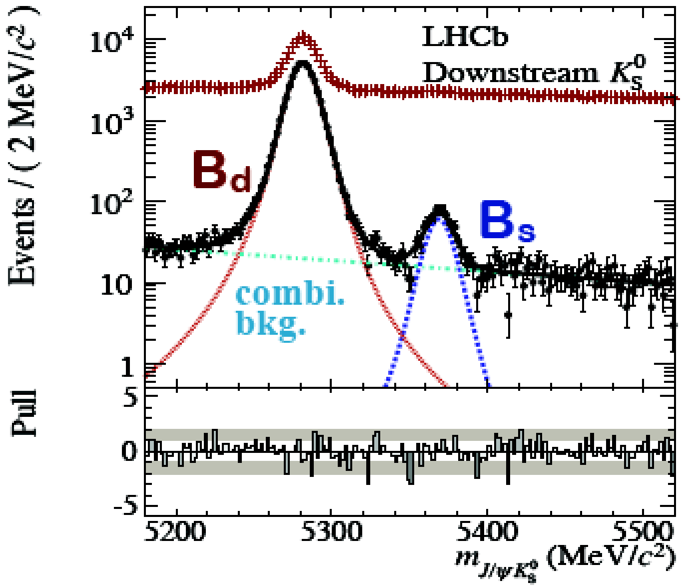
Expect update soon with 2012 data

Penguin pollution

[Simon Akar]

⇒ modes which can be used to estimate the penguin effects in $\sin 2\beta$ / φ_s

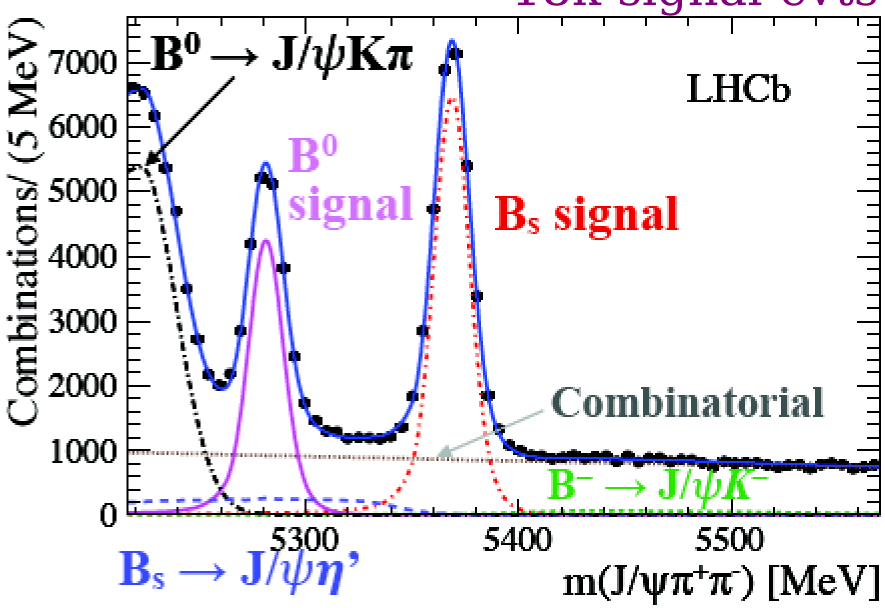
$B_s \to J/\psi K^0_S$



arXiv:1503.07055

$$\mathcal{A}_{\Delta\Gamma}\left(B^0_s \to J/\psi K^0_S\right) = 0.49 \pm {}^{0.77}_{0.65}\,(\text{stat}) \pm 0.06\,(\text{syst})$$
$$C_{\text{dir}}\left(B^0_s \to J/\psi K^0_S\right) = -0.28 \pm 0.41\,(\text{stat}) \pm 0.08\,(\text{syst})$$
$$S_{\text{mix}}\left(B^0_s \to J/\psi K^0_S\right) = -0.08 \pm 0.40\,(\text{stat}) \pm 0.08\,(\text{syst})$$

18k signal evts



arXiv:1411.1634

$$2\beta^{\text{eff}}(B^0 \to J/\psi\rho^0) = (41.7 \pm 9.6(\text{stat})^{+2.8}_{-6.3}(\text{syst}))^\circ$$
$$\alpha_{CP}(B^0 \to J/\psi\rho^0) = -(32 \pm 28(\text{stat})^{+7}_{-9}(\text{syst})) \times 10^{-3}$$

assuming SU(3):

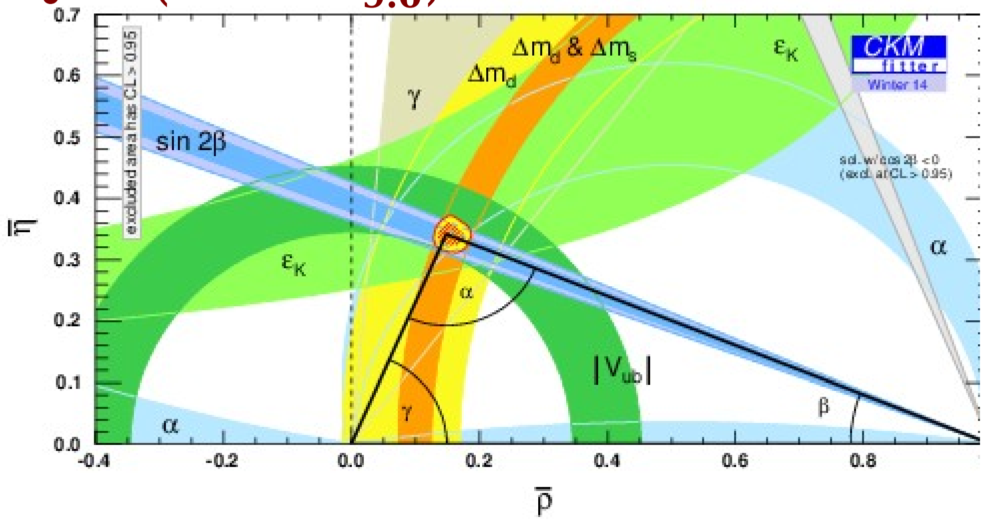
$$\Delta 2\beta = \left(2\beta^{J/\psi\rho} - 2\beta^{J/\psi K^0_S}\right)$$
$$= (-0.9 \pm 9.7(\text{stat})^{+2.8}_{-6.3}(\text{syst}))^\circ$$

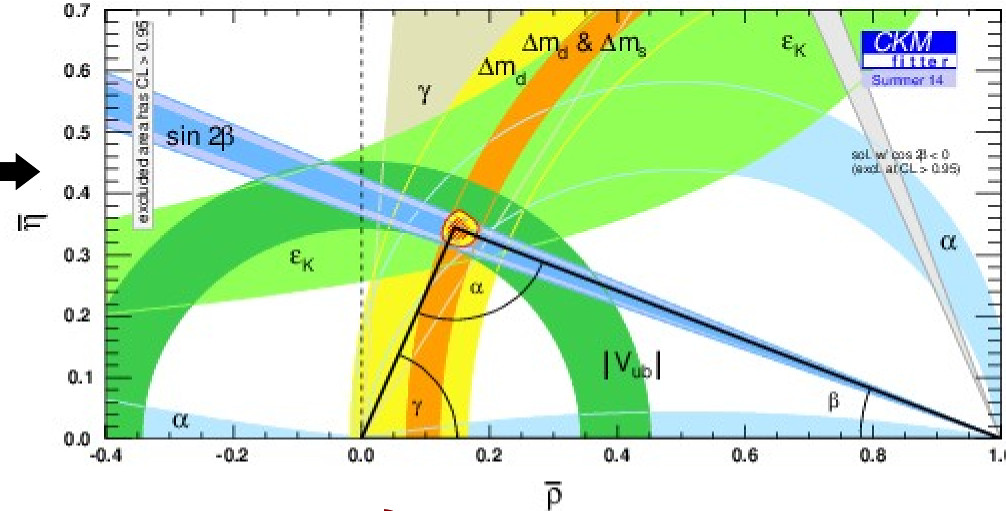
$$\Delta\phi_s \sim -\epsilon\Delta 2\beta$$

$$\Delta\phi_s \in [-1.05^\circ, 1.18^\circ] \text{ at } 95\% \text{ C.L.}$$

γ determination

$\gamma = (70.0^{+7.7}_{-9.0})^\circ$





mostly from charged $B \to D^{(*)}K$:

$\gamma_{\mathrm{BaBar}} = (70 \pm 18)^\circ$

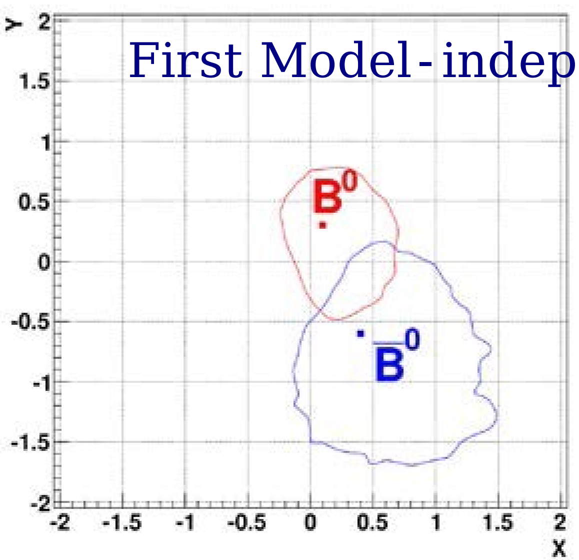
$\gamma_{\mathrm{Belle}} = (73\,^{+13}_{-15})^\circ$

$\gamma_{\mathrm{LHCb}} = (75 \pm 9)^\circ$

$\boldsymbol{\gamma = (73.2^{+6.3}_{-7.0})^\circ}$

$r_B = 0.0970 \pm 0.0063$

from neutral $B \to DK^*$: [Markus Rohrken]



First Model-independent GGSZ by Belle

[arXiv:1505.07550]

$$r_S^2 = \frac{\int A^2_{b\to u}(p)dp}{\int A^2_{b\to c}(p)dp}$$

$r_S < 0.87$ at 68% CL

GLW+ADS by LHCb

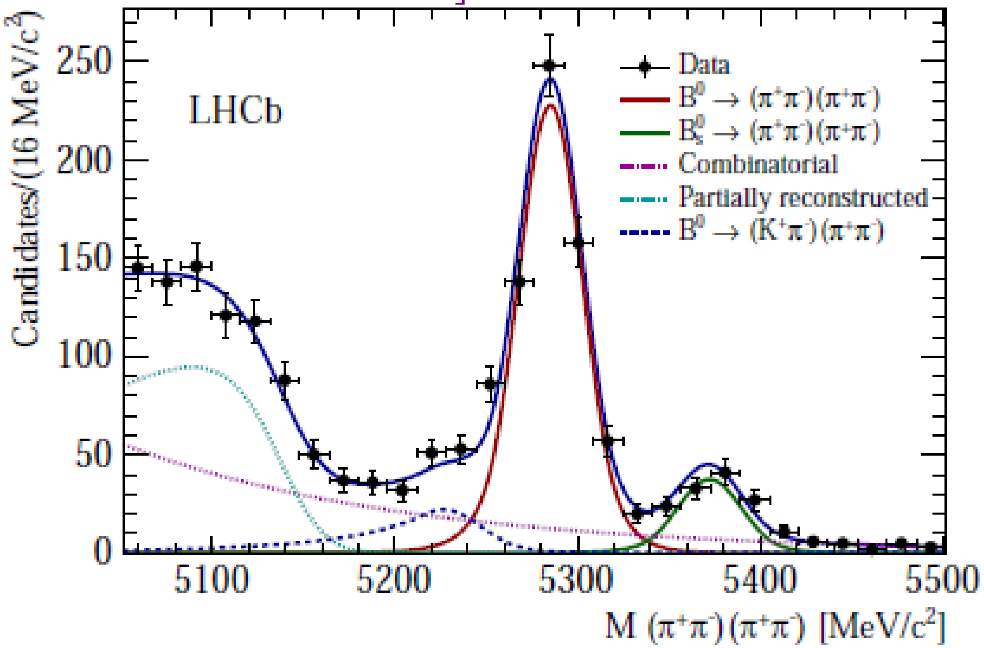
[arXiv:1407.8136]

$r_S = 0.236^{+0.043}_{-0.052}$

$B \to \rho^0 \rho^0$ and α determination

[YoungMoon Goh]

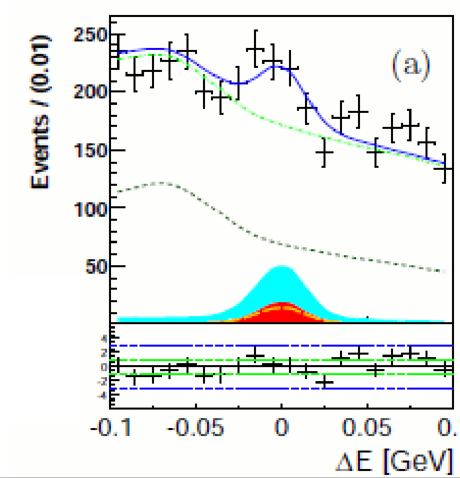
[arXiv:1503.07770]



BR of $B \to \rho^0 \rho^0$

[PRD 89 (2014) 072008]

772M $B\bar{B}$

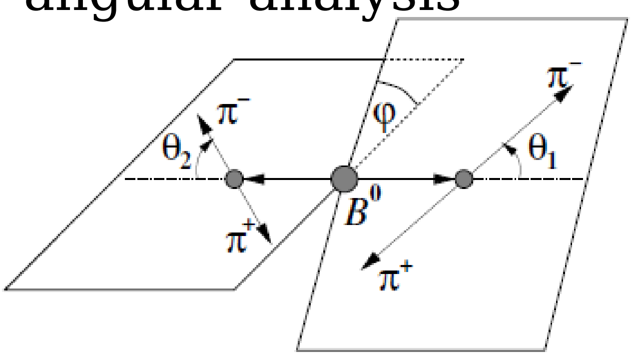


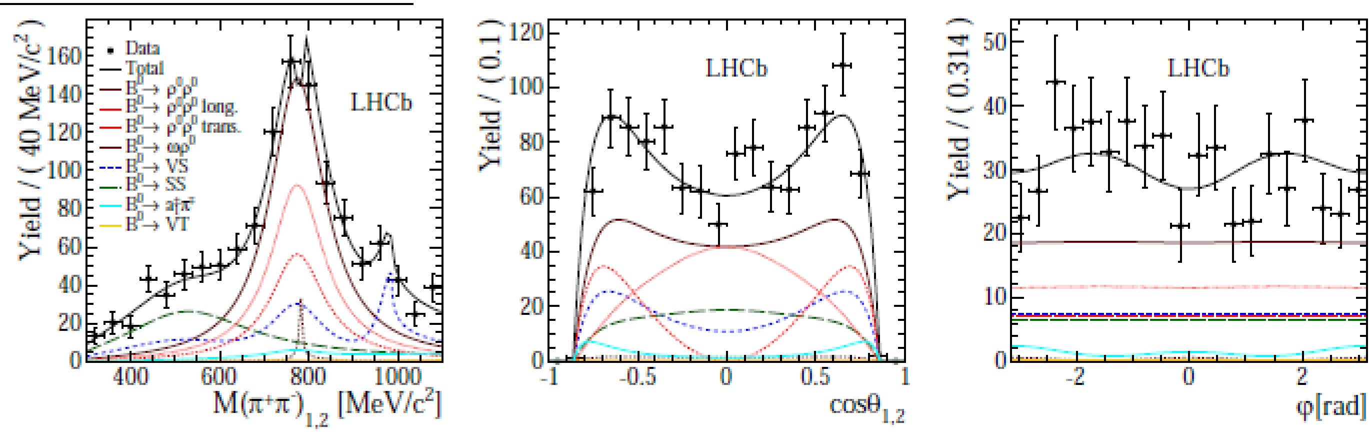
Decay mode	Signal yields 2011	Signal yields 2012
$B^0 \to (\pi^+\pi^-)(\pi^+\pi^-)$	$185 \pm 15 \pm 4$	$449 \pm 24 \pm 7$
$B^0 \to (K^+\pi^-)(\pi^+\pi^-)$	$1610 \pm 42 \pm 5$	$3478 \pm 62 \pm 10$
$B^0 \to (K^+K^-)(K^+\pi^-)$	$1513 \pm 40 \pm 8$	$3602 \pm 62 \pm 10$
$B_s^0 \to (\pi^+\pi^-)(\pi^+\pi^-)$	$30 \pm 7 \pm 1$	$71 \pm 11 \pm 1$
$B_s^0 \to (K^-\pi^+)(\pi^+\pi^-)$	$40 \pm 10 \pm 3$	$96 \pm 14 \pm 6$
$B_s^0 \to (K^+K^-)(K^-\pi^+)$	$42 \pm 10 \pm 3$	$66 \pm 13 \pm 4$

$\Rightarrow$ 600 signal $4\pi^{\pm}$ events

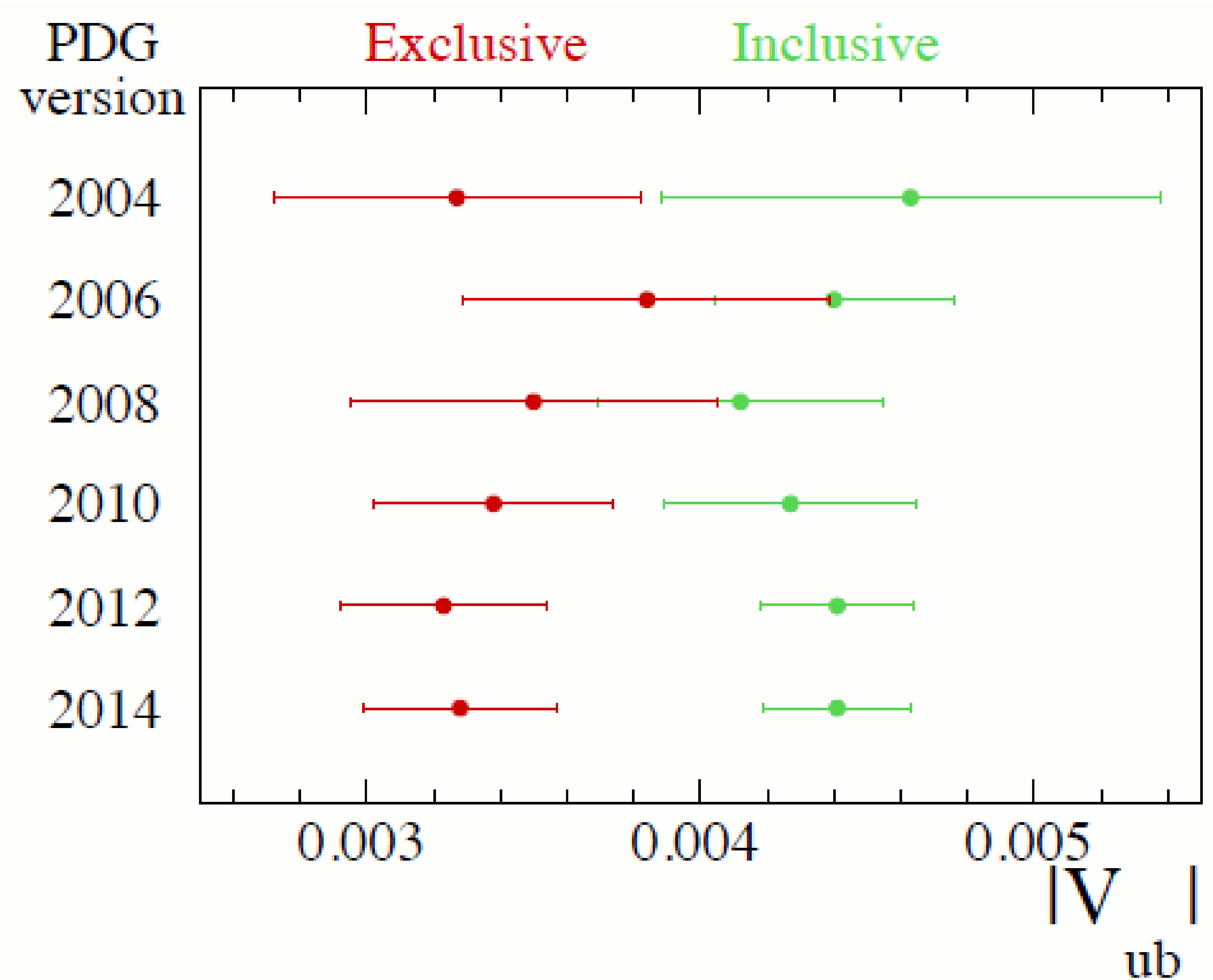
$$\mathcal{B}(B \to \rho^0\rho^0) = (0.94 \pm 0.17 \pm 0.09 \pm 0.06) \times 10^{-6}$$
$$f_L = 0.745\ ^{+0.048}_{-0.058} \pm 0.034$$

angular analysis





$|V_{ub}|$ has been a "problem" for a while



$|V_{ub}|$ with $\Lambda_b^0 \to p\mu\nu$ at LHCb

[Greg Ciezarek]
[Nicola Neri]

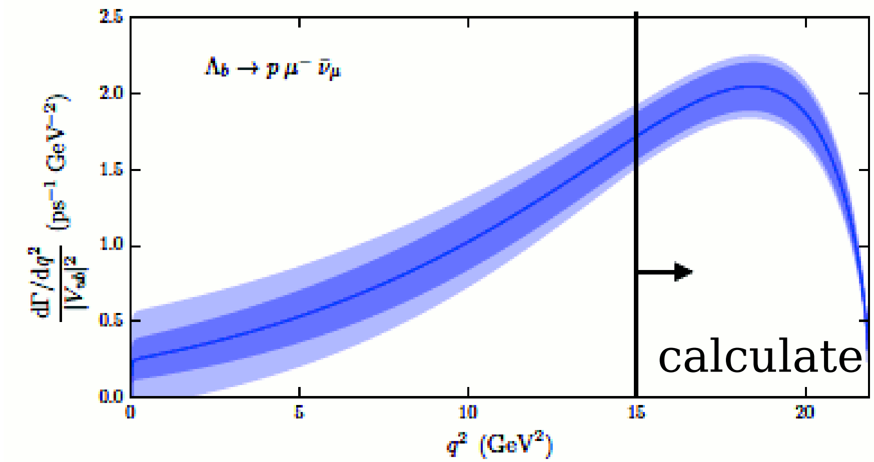
''be prepared to be surprised...''

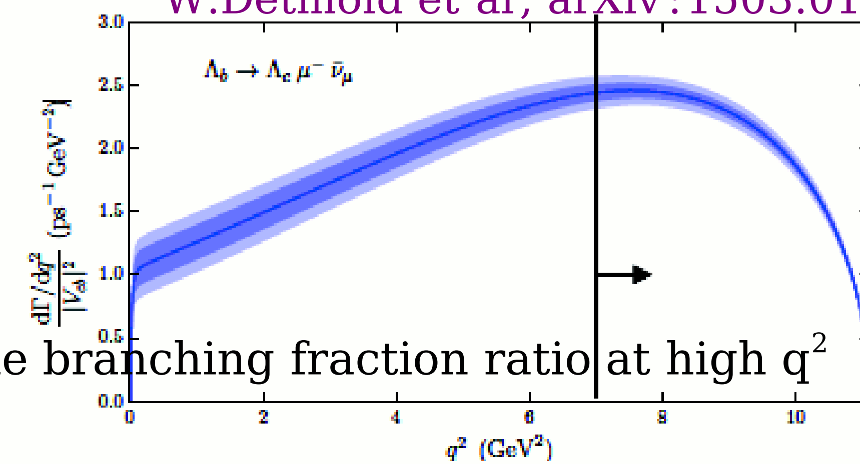
baryonic version of $B \to \pi l \nu$, cleaner at LHCb as protons are rarer than kaons/pions

◦ Normalize signal yield to V_{cb} decay, $\Lambda_b^0 \to \Lambda_c \mu\nu$

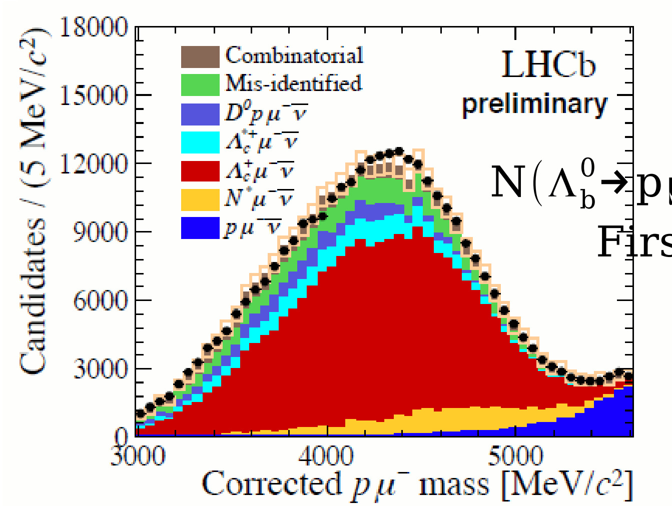
⇒ Cancel many systematic uncertainties (e.g the production rate of Λ_b)

W.Detmold et al, arXiv:1503.01421





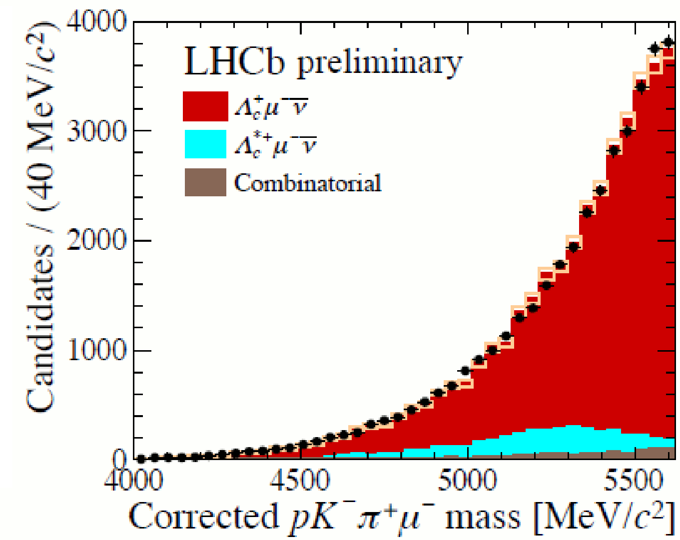
calculate the branching fraction ratio at high q^2



arXiv:1504.01568

$N(\Lambda_b^0 \to p\mu\nu) = 17{,}687 \pm 733$

First observation



$$\frac{\mathcal{B}(\Lambda_b \to p\mu^-\overline{\nu}_\mu)_{q^2>15\,\mathrm{GeV}^2/c^4}}{\mathcal{B}(\Lambda_b \to \Lambda_c\mu\nu)_{q^2>7\,\mathrm{GeV}^2/c^4}} = (1.00 \pm 0.04(stat) \pm 0.08(syst)) \times 10^{-2}$$

$B(\Lambda_c \to pK\pi)$ from Belle, soon BESIII ? [Qingnian Xu]

Determining $|V_{ub}|/|V_{cb}|$

[Greg Ciezarek]
[Nicola Neri]
arXiv:1504.01568

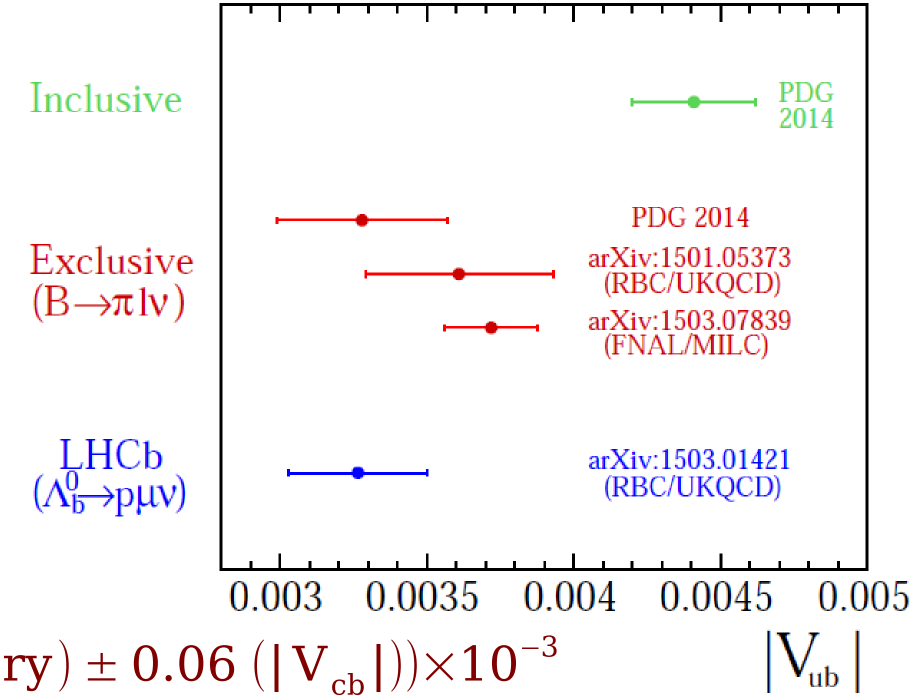
- Use ratio of differential rates from lattice calculations to calculate the ratio of CKM elements squared:

$$\frac{|V_{ub}|^2}{|V_{cb}|^2} = \frac{\int_{15\,\mathrm{GeV}^2}^{q^2_{\max}} \frac{\mathrm{d}\Gamma(\Lambda_b \to p\,\mu^- \bar{\nu}_\mu)}{\mathrm{d}q^2}\mathrm{d}q^2}{\int_{7\,\mathrm{GeV}^2}^{q^2_{\max}} \frac{\mathrm{d}\Gamma(\Lambda_b \to \Lambda_c\,\mu^- \bar{\nu}_\mu)}{\mathrm{d}q^2}\mathrm{d}q^2}(0.68 \pm 0.07)$$

- leads to:

W.Detmold et al, arXiv:1503.01421

$$\frac{|V_{ub}|}{|V_{cb}|} = 0.083 \pm 0.004\,(\mathrm{exp}) \pm 0.004\,(\mathrm{LQCD})$$



$$|V_{ub}| = (3.27 \pm 0.15\,(\mathrm{exp}) \pm 0.17\,(\mathrm{theory}) \pm 0.06\,(|V_{cb}|))\times 10^{-3}$$

New $|V_{ub}|$ related observables

(to be soon included in the global fit)

$\Lambda_b^0 \to p\mu\nu$ result from LHCb

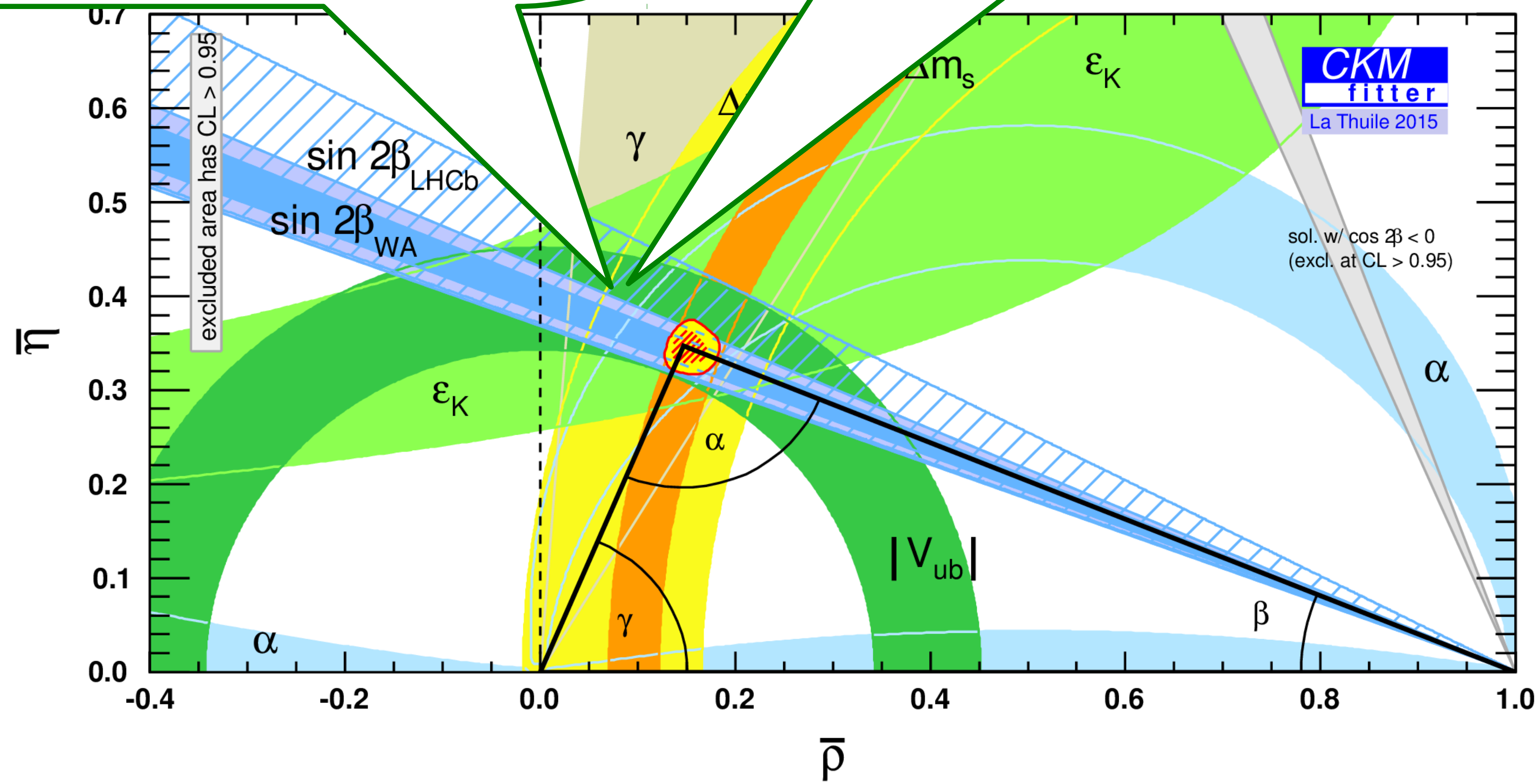
arXiv:1504.01568

$$\frac{|V_{ub}|}{|V_{cb}|} = 0.083 \pm 0.004\,(\mathrm{exp}) \pm 0.004\,(\mathrm{LQCD})$$

$B \to \pi l \nu$ result from FNAL-MILC

arXiv:1503.07839

$$|V_{ub}| = (3.72 \pm 0.16) \times 10^{-3}$$

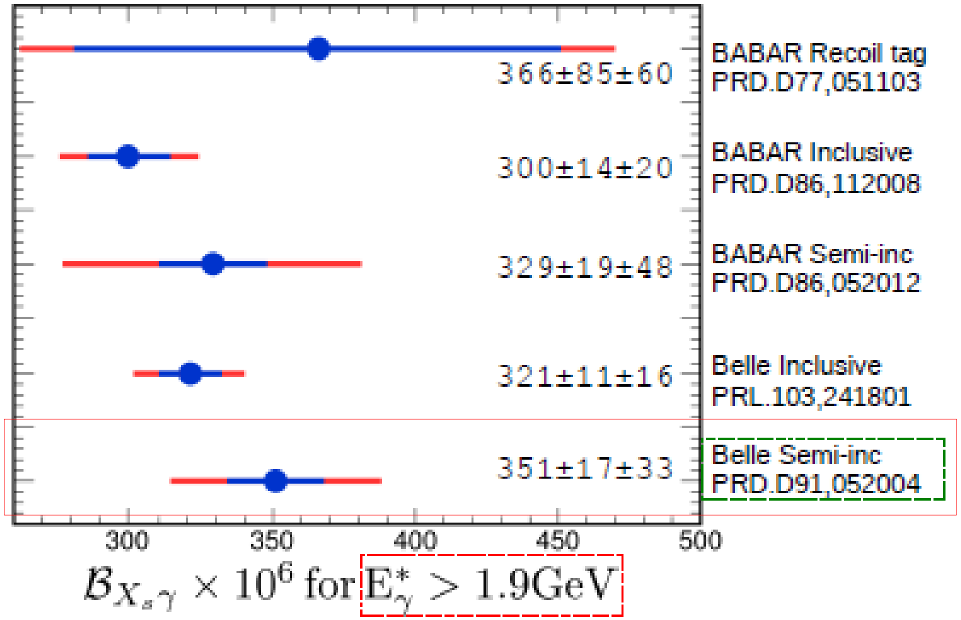


$B \to X_s \gamma$

[Luis Pesantez]

◦ SM (complete NNLO calculation): $\mathcal{B}(B \to X_s \gamma) = (336 \pm 23) \times 10^{-6}$

[Misiak et al, arXiv:1503.01789] (central value increased by 6.4% compared to 2006 value)

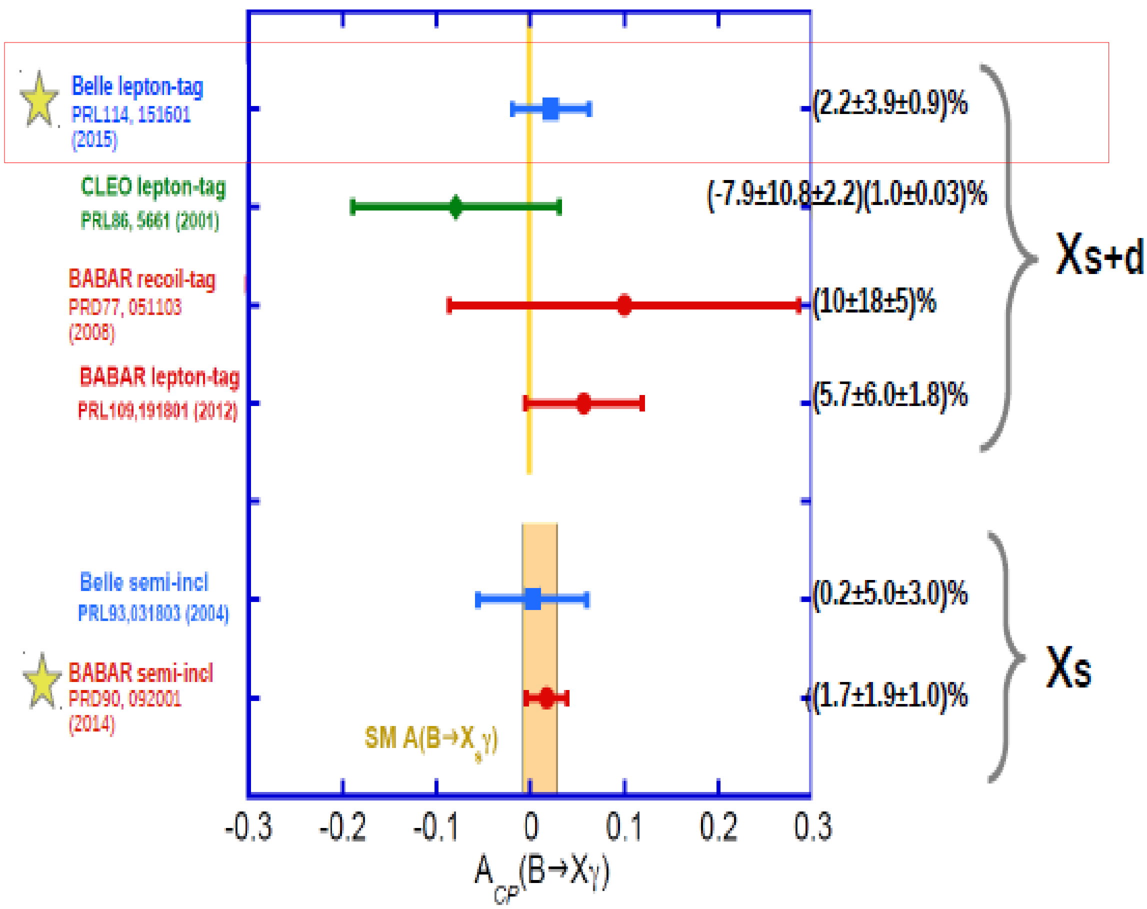


at $E_\gamma > 1.6$ GeV:

$\boldsymbol{\mathcal{B}(B \to X_s \gamma) = (341 \pm 15 \pm 4\ (\text{extrap})) \times 10^{-6}}$

For charged Higgs in 2HDM Type II
$M(H^-) > 540$ GeV at 95% CL

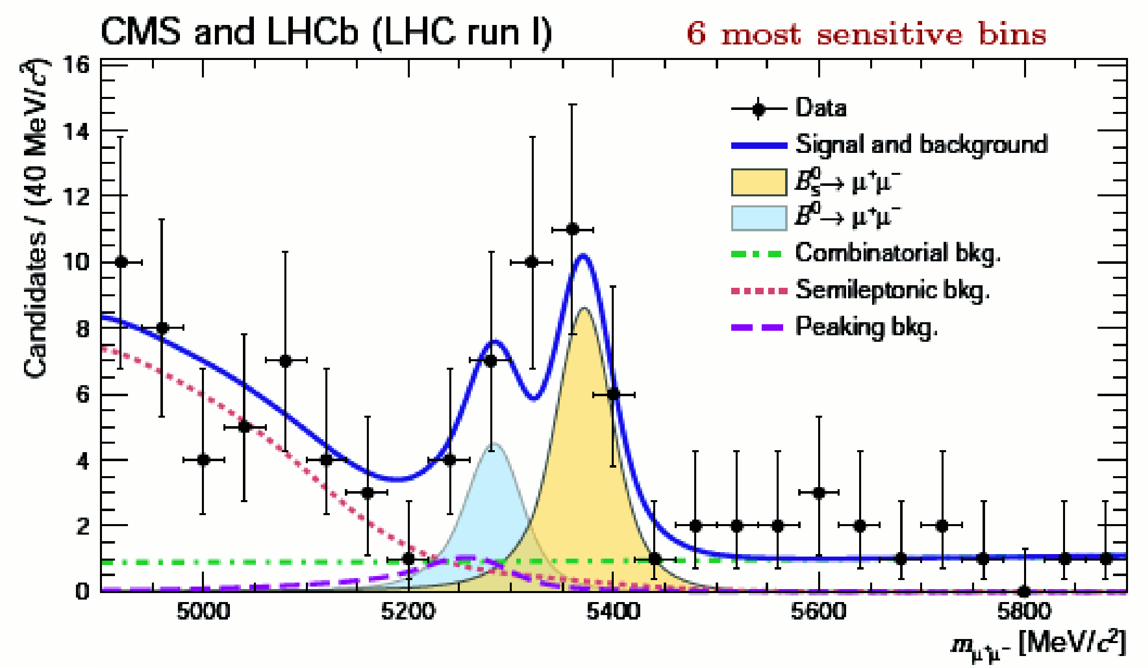
$A_{CP}(B \to X \gamma)$



⇒ **limited by statistics: Belle II...**

Combination results $B_s \to \mu^+ \mu^-$

[Christian Linn]



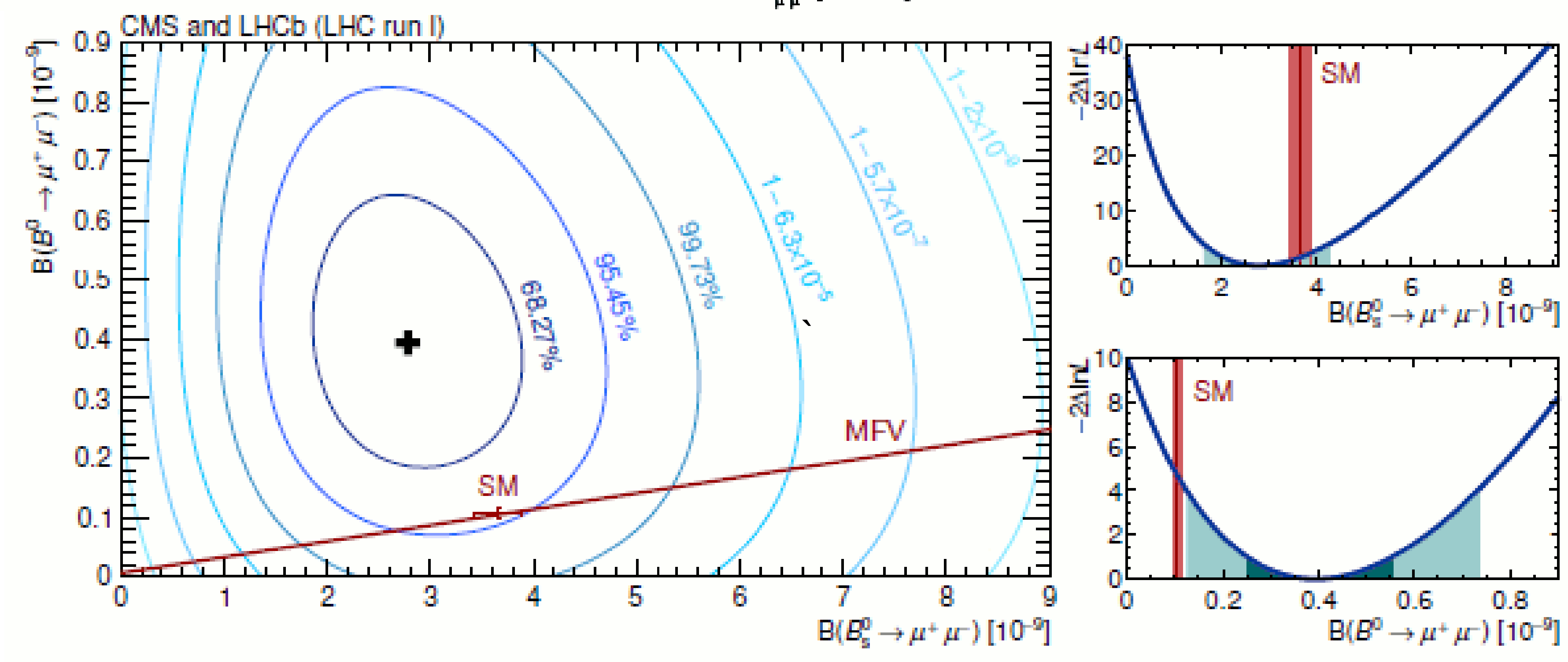
[arXiv:1411.4413]
submitted to Nature

$$\mathcal{B}(B^0_s \to \mu^+\mu^-) = (2.8\,^{+0.7}_{-0.6}) \times 10^{-9}$$

first observation: 6.2σ significance

$$\mathcal{B}(B^0 \to \mu^+\mu^-) = (3.9\,^{+1.6}_{-1.4}) \times 10^{-10}$$

first evidence: 3.0σ significance

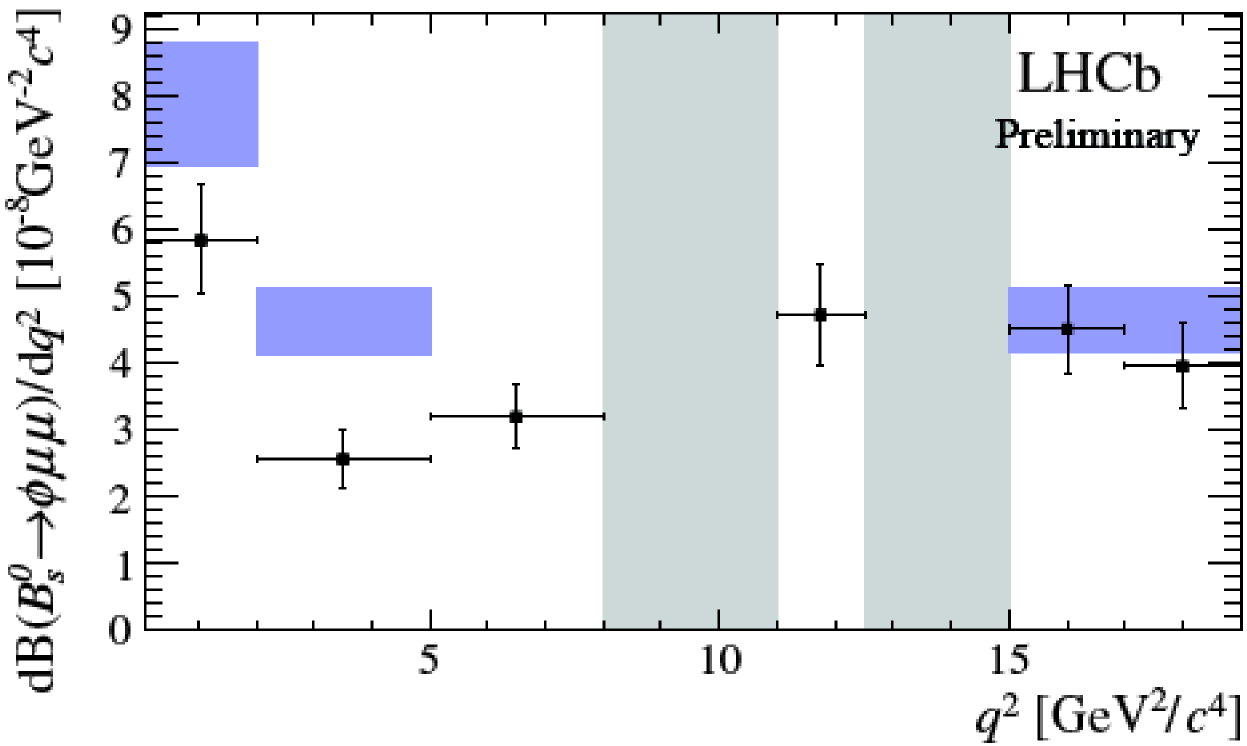


Branching fractions of $B_{(s)} \to X_s l l$

[Christian Linn]

branching fractions tend to lie below SM predictions
$B \to K\mu\mu$, $B \to K^*\mu\mu$, $B_s \to \varphi\mu\mu$ (high q^2 range)

LHCb-PAPER-2015-023



theory prediction:
arXiv:1411.3161,
arXiv:1503.05534

In $1 < q^2 < 6$ GeV^2 : 3.5σ tension to prediction based on SM

also angular analysis !!

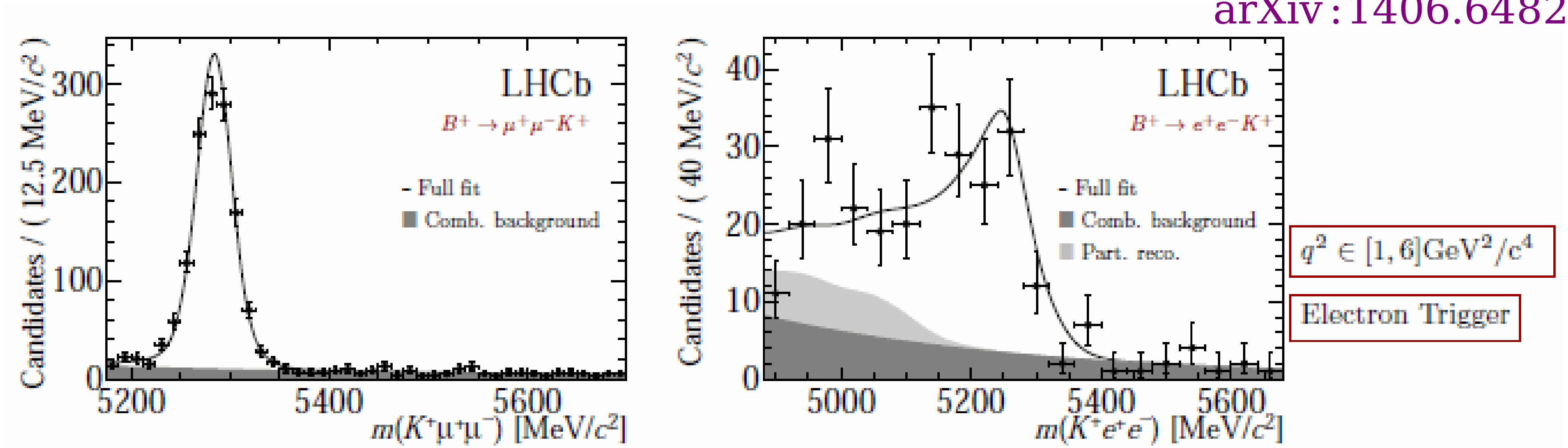
Test of lepton universality using $B^+ \to K^+ l^+ l^-$ decays

[Christian Linn]

branching fractions tend to lie below SM predictions

$B \to K\mu\mu$, $B \to K^*\mu\mu$, $B_s \to \varphi\mu\mu$ (high q^2 range)

arXiv:1406.6482

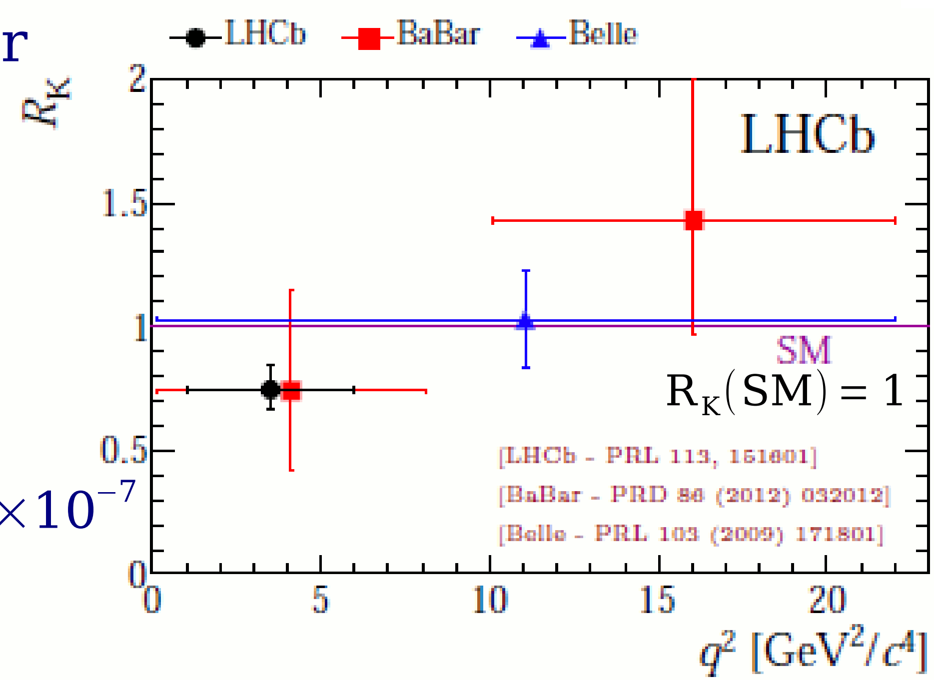


- The combination of the various trigger channels gives:

$$R_K = 0.745\,^{+0.090}_{-0.074}(\text{stat}) \pm 0.036(\text{syst})$$

- Most precise measurement to date, compatible with SM at 2.6σ level

$\Rightarrow$ $\mathcal{B}(B^+ \to e^+e^-K^+) = (1.56\,^{+0.19}_{-0.15}(\text{stat})\,^{+0.06}_{-0.05}(\text{syst})) \times 10^{-7}$ compatible with SM predictions



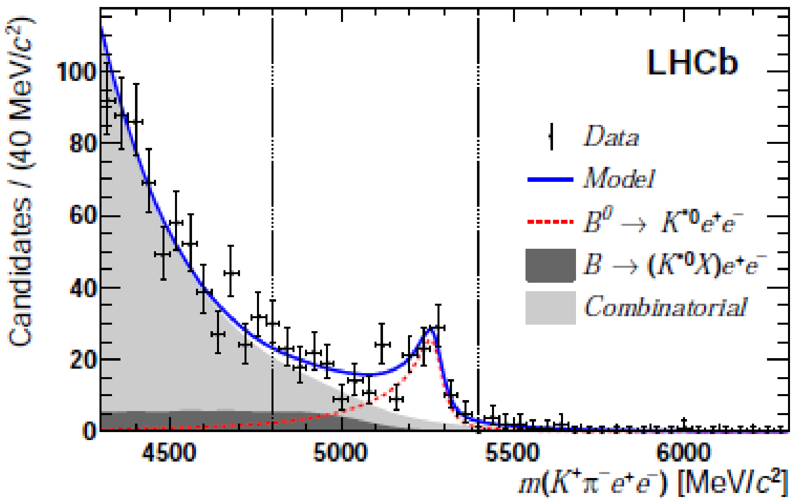
BSM LFNU and effect is in $\mu\mu$, not ee

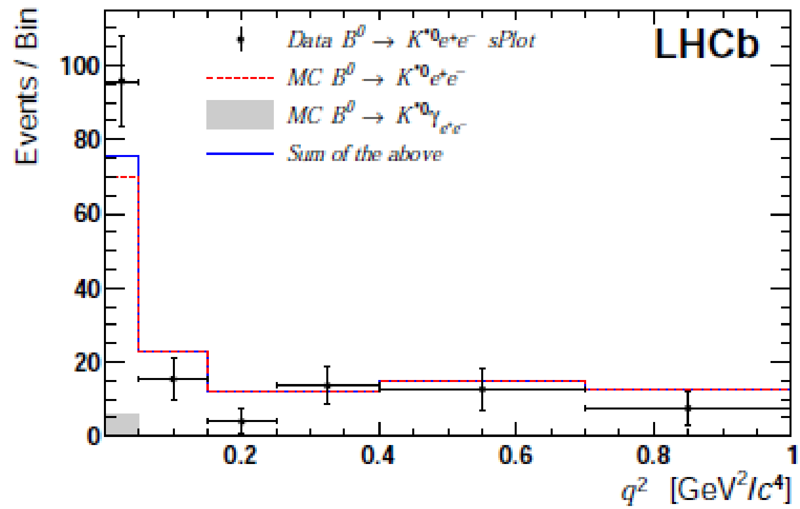
$B_d^0 \to K^* e^+ e^-$ decays at LHCb

[Christian Linn]

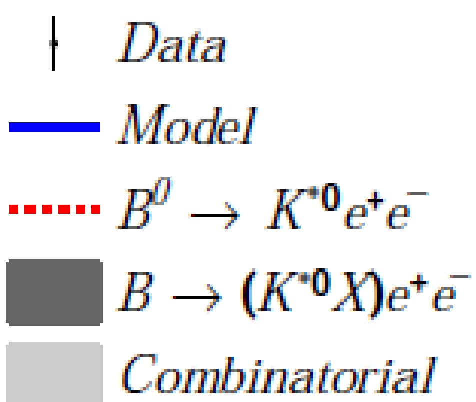
[arXiv:1501.03038]

- Angular analysis of $B_d^0 \to K^* e^+ e^-$ at very low q^2 ($\in [0.002, 1.120]\ \mathrm{GeV}^2$)
- Folded angular observables ($\varphi = \varphi + \pi$ if $\varphi < 0$)
- Measurement of F_L, $A_T^{(2)}$, $A_T^{(Im)}$, $A_T^{(Re)}$, sensitive to C_7' as $q^2 \to 0$





$$A_T^{(Re)} = \frac{4}{3} A_{FB}/(1 - F_L),\quad A_T^{(2)} = \frac{1}{2} S_3/(1 - F_L) \text{ and } A_T = \frac{1}{2} S_9/(1 - F_L)$$



Observable	Measurement	SM prediction†
F_L	$+0.16 \pm 0.06 \pm 0.03$	$+0.10^{+0.11}_{-0.05}$
$A_T^{(2)}$	$-0.23 \pm 0.23 \pm 0.05$	$0.03^{+0.05}_{-0.04}$
A_T^{Re}	$+0.10 \pm 0.18 \pm 0.05$	$-0.15^{+0.04}_{-0.03}$
A_T^{Im}	$+0.14 \pm 0.22 \pm 0.05$	$(-0.2^{+1.2}_{-1.2}) \times 10^{-4}$

S.Jager, J.M.Camalich [arXiv:1412.3283]

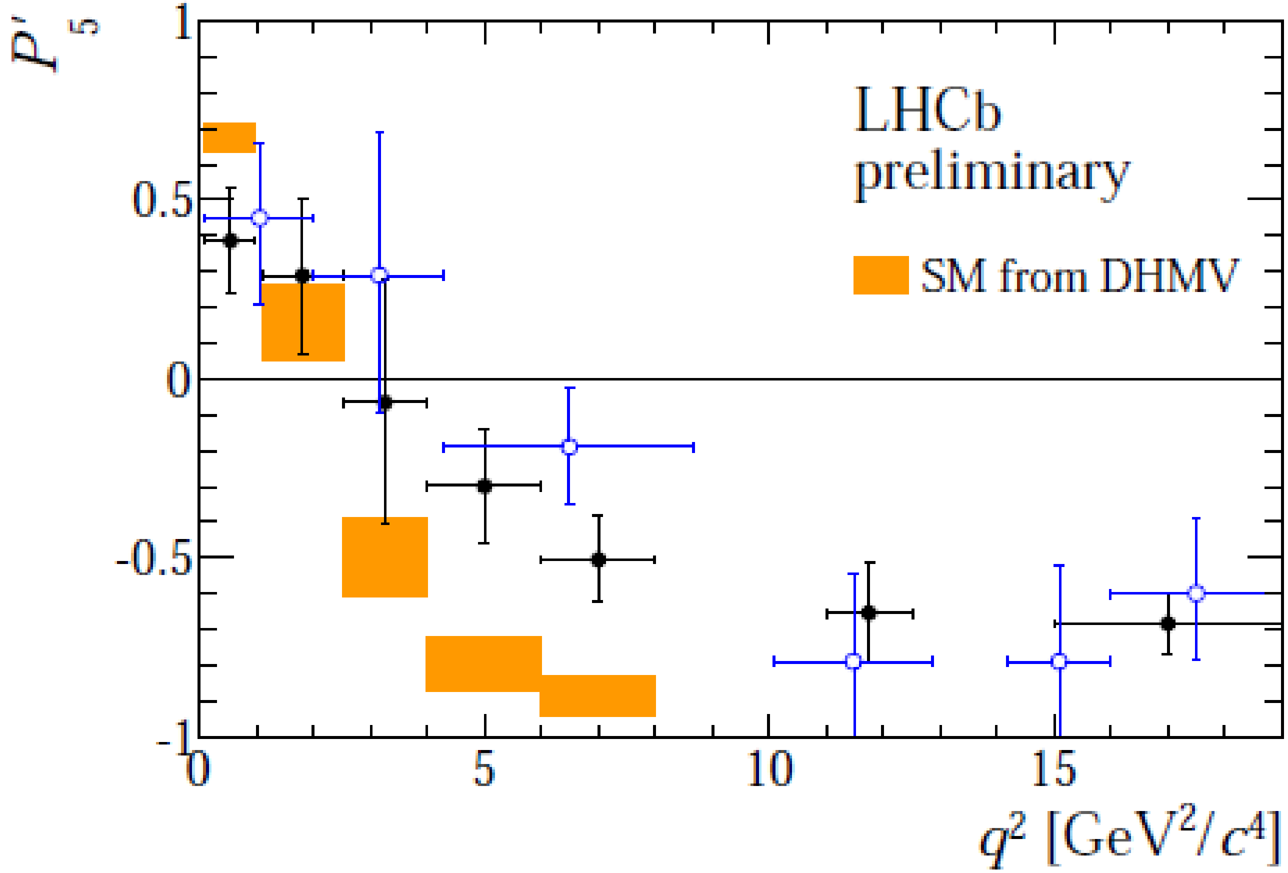
- Measurements well in agreement with SM predictions
- Constraints on C_7' in complementary with radiative decays

[Christian Linn]

Angular analysis of $B_d^0 \rightarrow K^* \mu^+ \mu^-$ decays

LHCb-CONF-2015-002

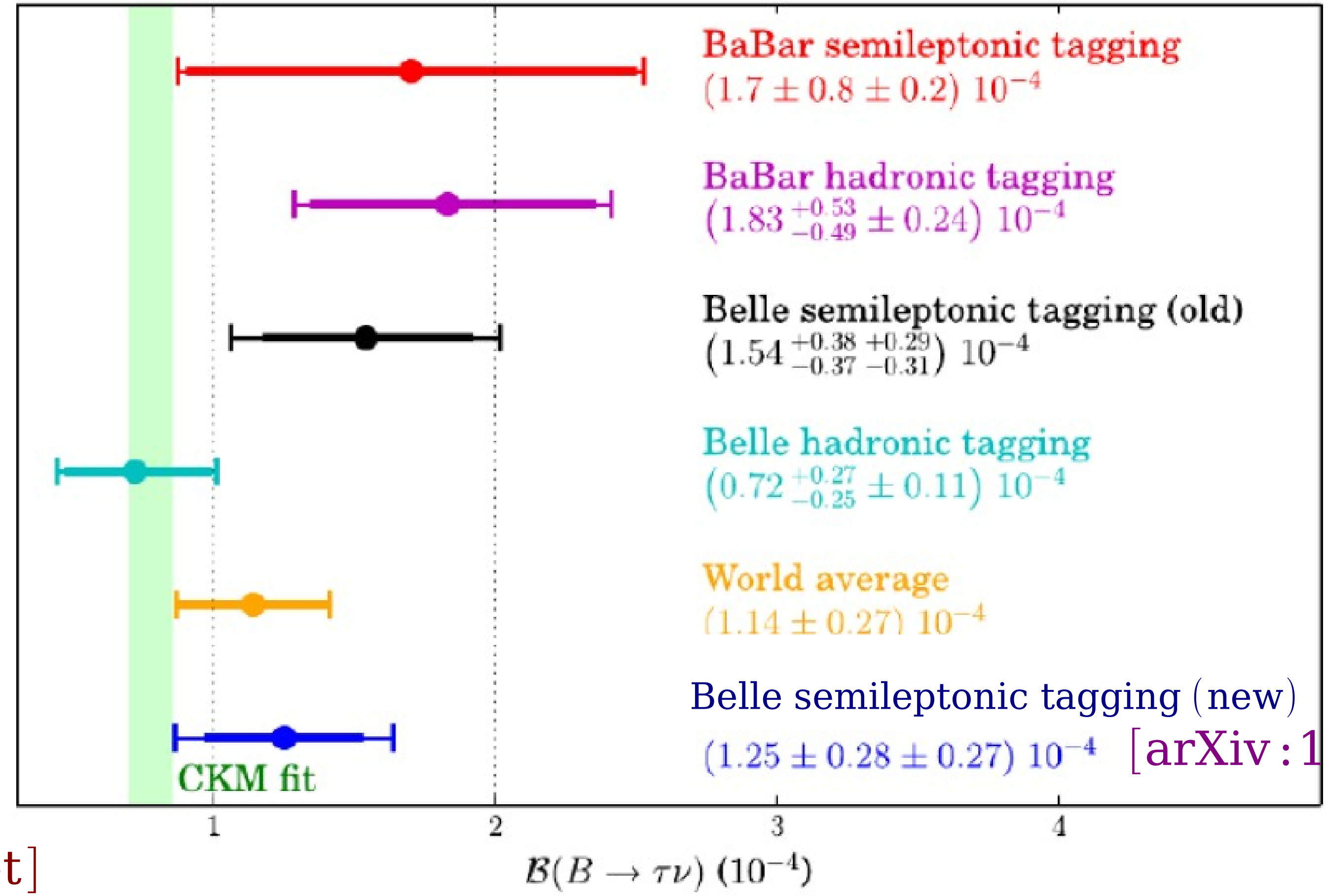
- Less form-factor dependent observable: $P'_5 = \frac{S_5}{\sqrt{F_L(1-F_L)}}$



- Tension in P'_5 seen with $1\,\mathrm{fb}^{-1}$ is confirmed
- Local deviations of 2.9σ and 3.0σ for $q^2 \in [4.0, 6.0]$ and $[6.0, 8.0]$ GeV^2
- Naive combination of the two gives local significance of 3.7σ

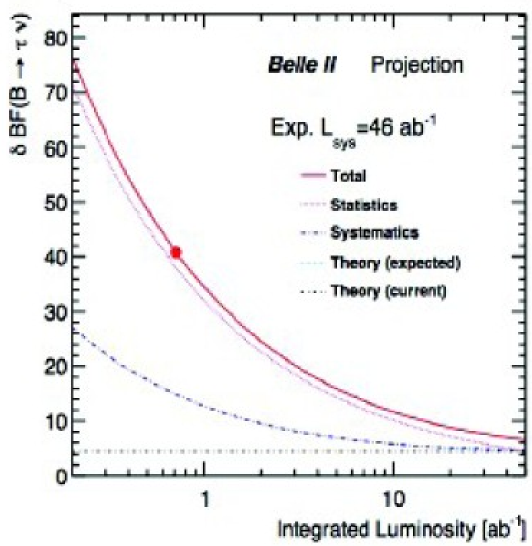
$B \to \tau\nu$ status

[Chanseok Park]



[arXiv:1503.05613]

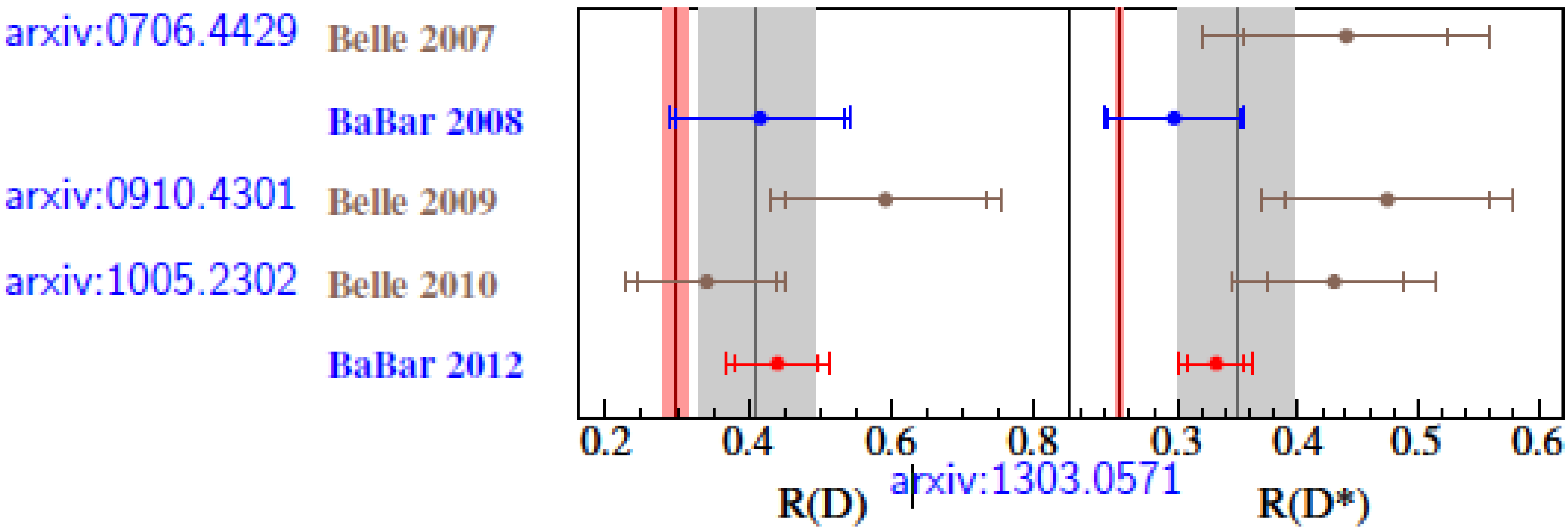
[Matt Barret]



Belle II	Statistical	Systematic (reducible, irreducible)	Total Exp	Theory	Total
$\lvert V_{ub}\rvert$ $B \to \tau\nu$ (had. tagged)					
711 fb^{-1}	19.0	(7.1, 2.2)	20.4	2.5	20.5
5 ab^{-1}	7.2	(2.7, 2.2)	7.9	1.5	8.1
50 ab^{-1}	2.3	(0.8, 2.2)	3.2	1.0	3.4
$\lvert V_{ub}\rvert$ $B \to \tau\nu$ (SL tagged)					
605 fb^{-1}	12.4	$(9.0,\ ^{+3.0}_{-4.8})$	$^{+15.6}_{-16.1}$	2.5	$^{+15.8}_{-16.2}$
5 ab^{-1}	4.3	$(3.1,\ ^{+3.0}_{-4.8})$	$^{+6.1}_{-7.2}$	1.5	$^{+6.3}_{-7.3}$
50 ab^{-1}	1.4	$(1.0,\ ^{+3.0}_{-4.8})$	$^{+3.4}_{-5.1}$	1.0	$^{+3.6}_{-5.2}$

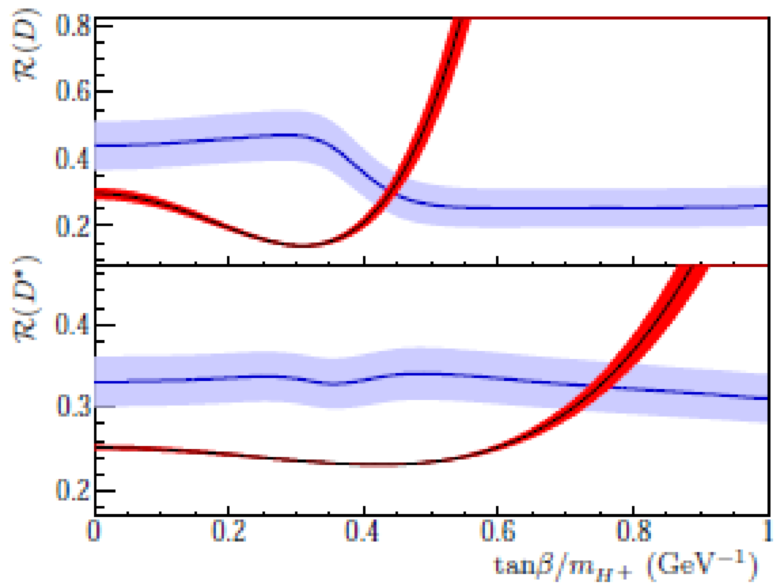
$B \to D^{(*)} \tau \nu$

Situation pre-FPCP2015



BaBar (arXiv:1303.0571) observes a 3.4σ excess over SM expectation

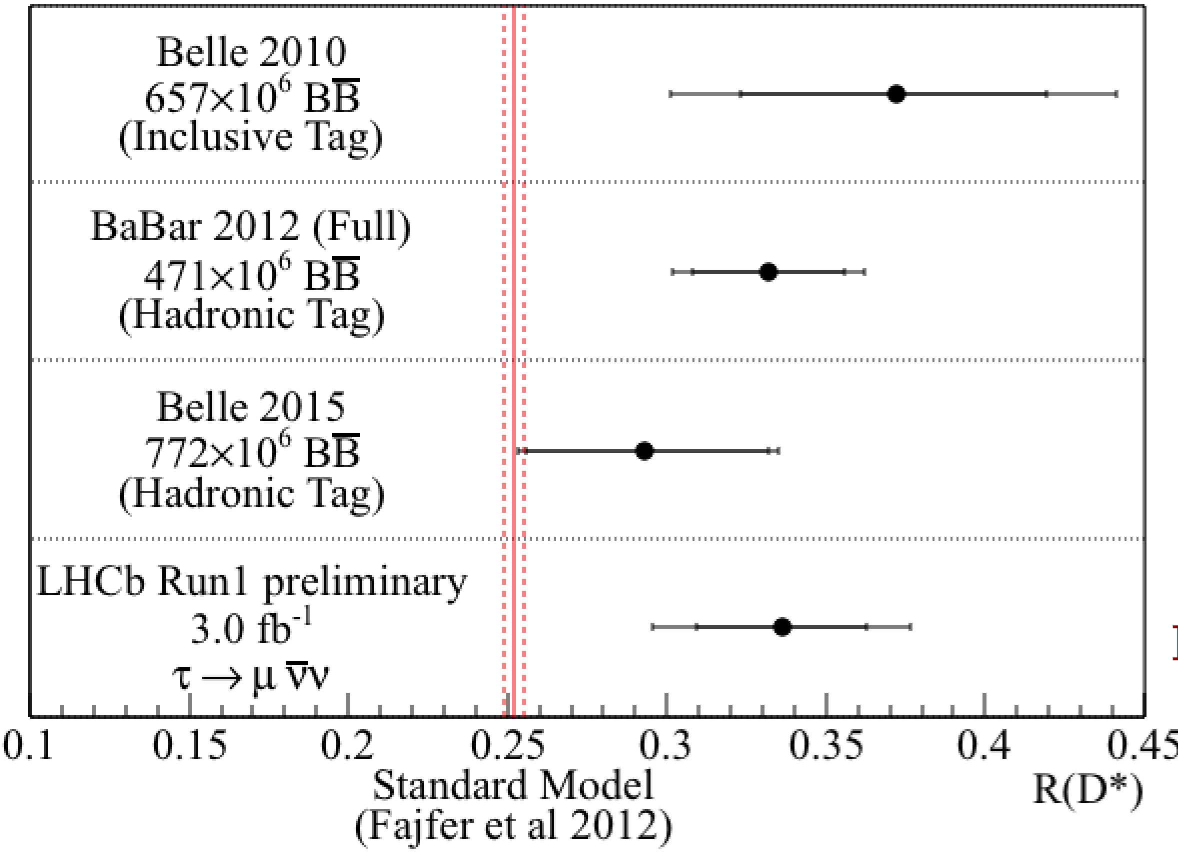
''This excess cannot be explained by a charged Higgs boson in the 2HDM type II''



$B \to D^{(*)} \tau \nu$

[Greg Ciezarek]

[Thomas Kuhr]

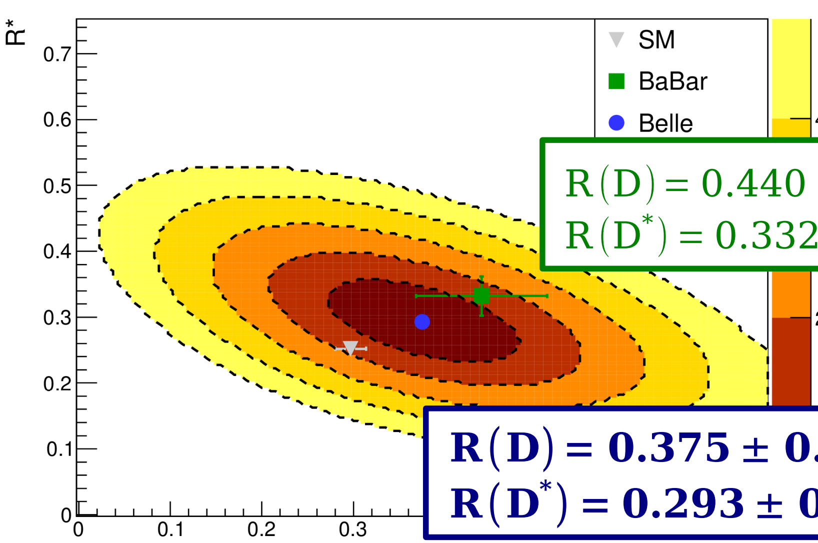


$R(D^*) = 0.332 \pm 0.024 \pm 0.018$

$\mathbf{R(D^*) = 0.293 \pm 0.039 \pm 0.015}$

$\mathbf{R(D^*) = 0.336 \pm 0.027 \pm 0.030}$

[agreement with SM at 2.1 σ]



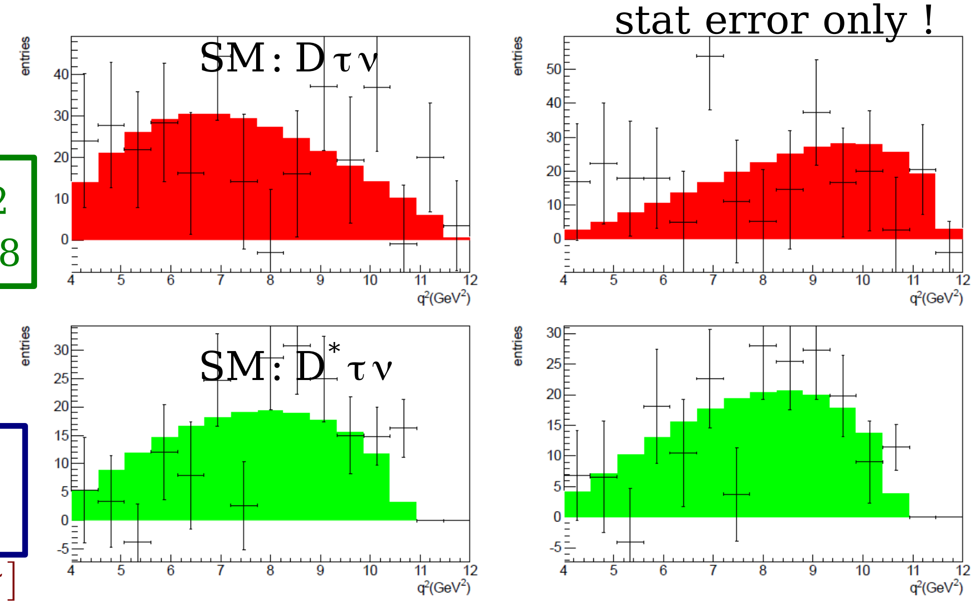
$R(D) = 0.440 \pm 0.058 \pm 0.042$

$R(D^*) = 0.332 \pm 0.024 \pm 0.018$

$\mathbf{R(D) = 0.375 \pm 0.064 \pm 0.026}$

$\mathbf{R(D^*) = 0.293 \pm 0.039 \pm 0.015}$

[agreement with SM at 1.5 σ]

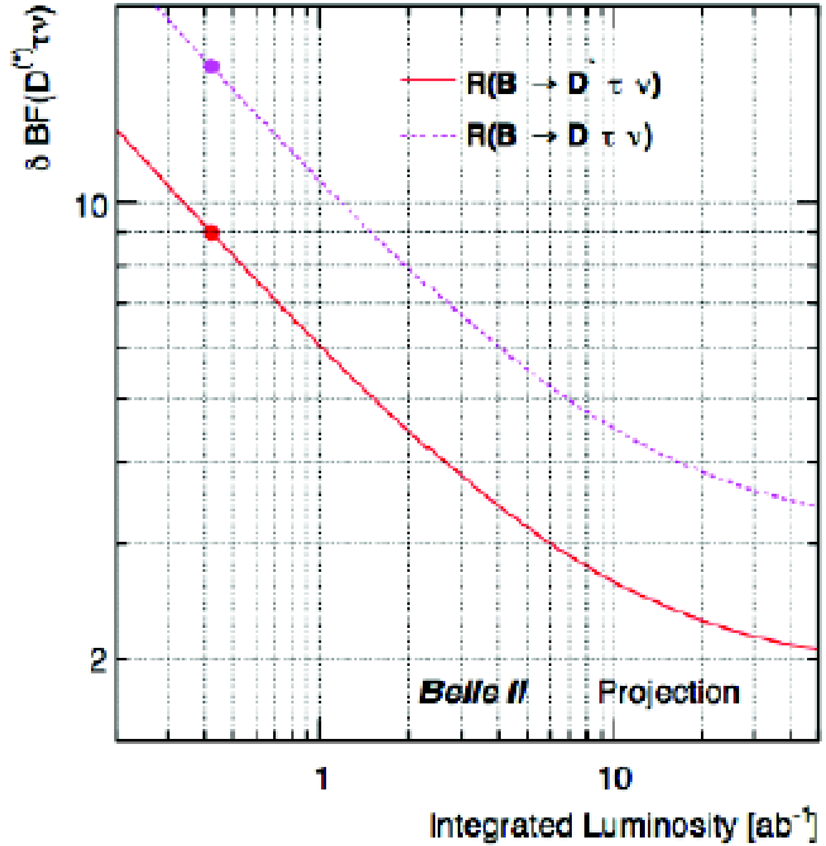


Prospects on $B \to D^{(*)} \tau \nu$

[Belle II]

[%]	Statistical	Systematic (reducible, irreducible)	Total Exp
$R(D)$			
5 ab^{-1}	3.8	(2.6, 3.1)	5.6
50 ab^{-1}	1.2	(0.8, 3.1)	3.4
$R(D^*)$			
5 ab^{-1}	2.1	(1.5, 1.9)	3.2
50 ab^{-1}	0.7	(0.5, 1.9)	2.1

[Matt Barrett]

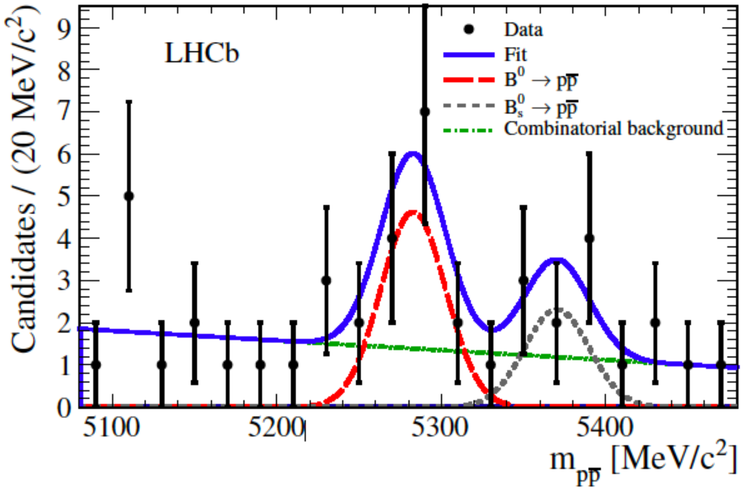


and of course LHCb (upgrade) !

Hadronic B decays

[Marcello Rotondo]

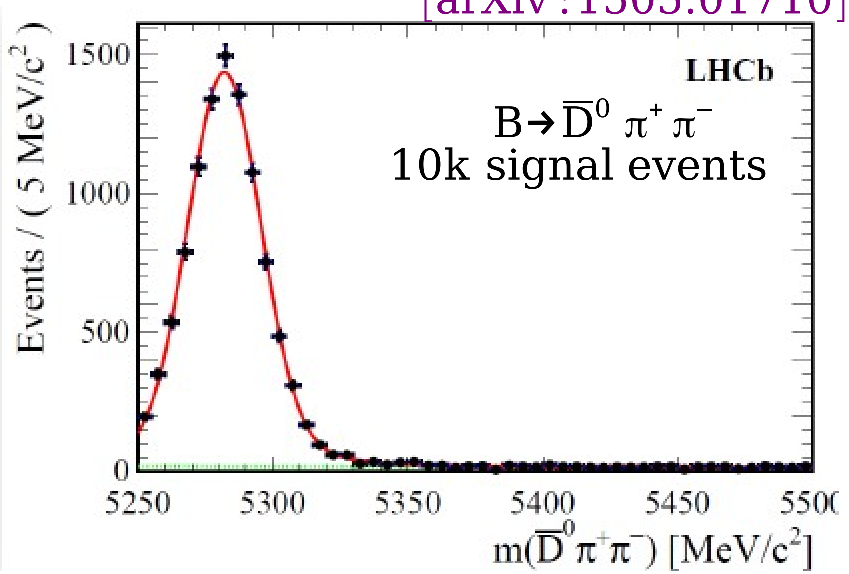
Two-body baryonic decays are (even more) suppressed, still...



$$\mathcal{B}(B^0 \to p\overline{p}) = \left(1.47\,^{+0.62}_{-0.51}\,^{+0.35}_{-0.14}\right) \times 10^{-8}$$

$$\mathcal{B}(B_s^0 \to p\overline{p}) = \left(2.84\,^{+2.03}_{-1.68}\,^{+0.85}_{-0.18}\right) \times 10^{-8}$$

[arXiv:1505.01710]

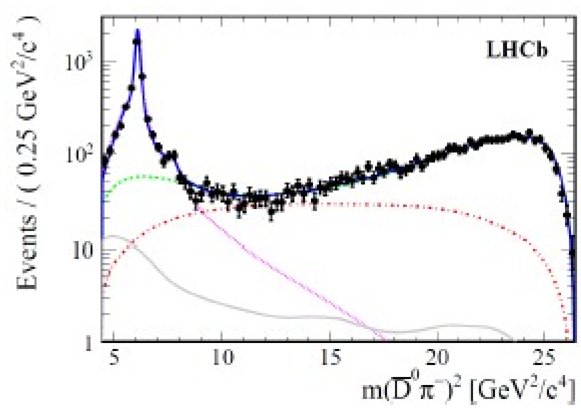


see also

$B^- \to D^+ K^- \pi^-$ [arXiv:1503.02995]

$B^0 \to \overline{D}^0 K^+ \pi^-$ [arXiv:1505.01505]

[Eduardo Rodrigues]



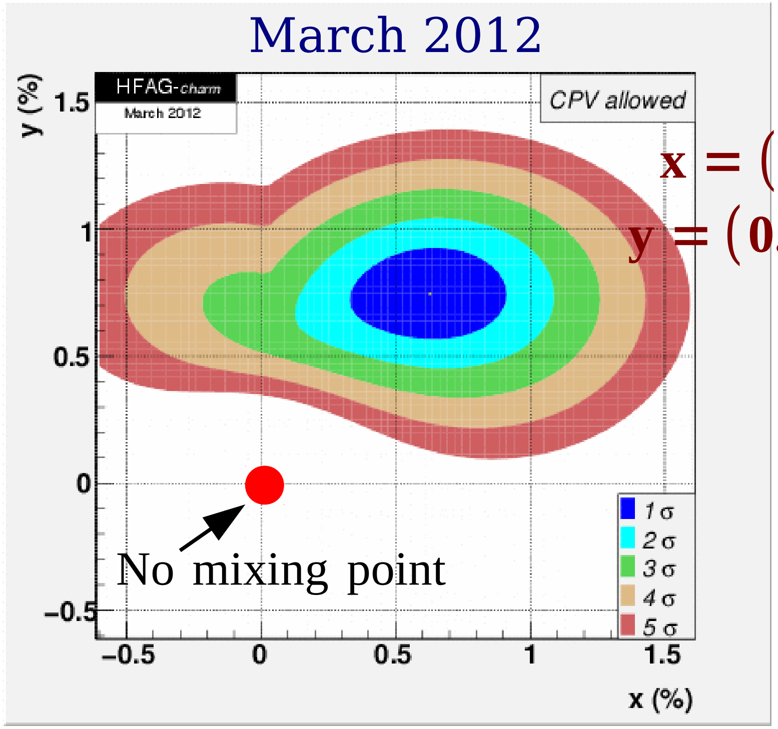
Dalitz analysis ⇒ properties of D^{**} in $D\pi$ (mass, width)

		Isobar	K-matrix
$D_0^*(2400)$	m	$2349 \pm 6 \pm 1 \pm 4$	$2354 \pm 7 \pm 11 \pm 2$
	Γ	$217 \pm 13 \pm 5 \pm 12$	$230 \pm 15 \pm 18 \pm 11$
$D_2^*(2460)$	m	$2468.6 \pm 0.6 \pm 0.0 \pm 0.3$	$2468.1 \pm 0.6 \pm 0.4 \pm 0.3$
	Γ	$47.3 \pm 1.5 \pm 0.3 \pm 0.6$	$46.0 \pm 1.4 \pm 1.7 \pm 0.4$
$D_3^*(2760)$	m	$2798 \pm 7 \pm 1 \pm 7$	$2802 \pm 11 \pm 10 \pm 3$
	Γ	$105 \pm 18 \pm 6 \pm 23$	$154 \pm 27 \pm 13 \pm 9$

Charm physics

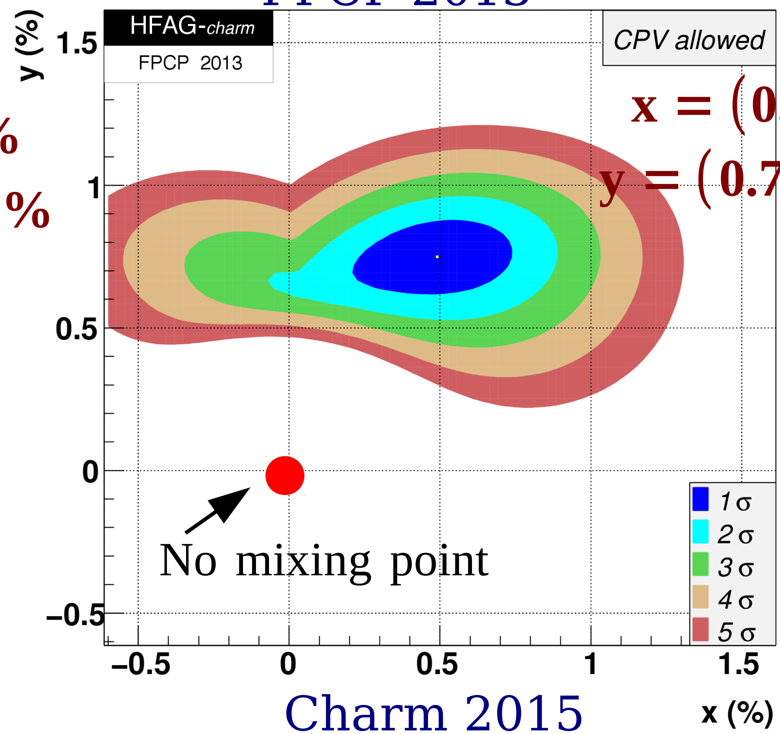
[Fabrizio Bianchi]

March 2012



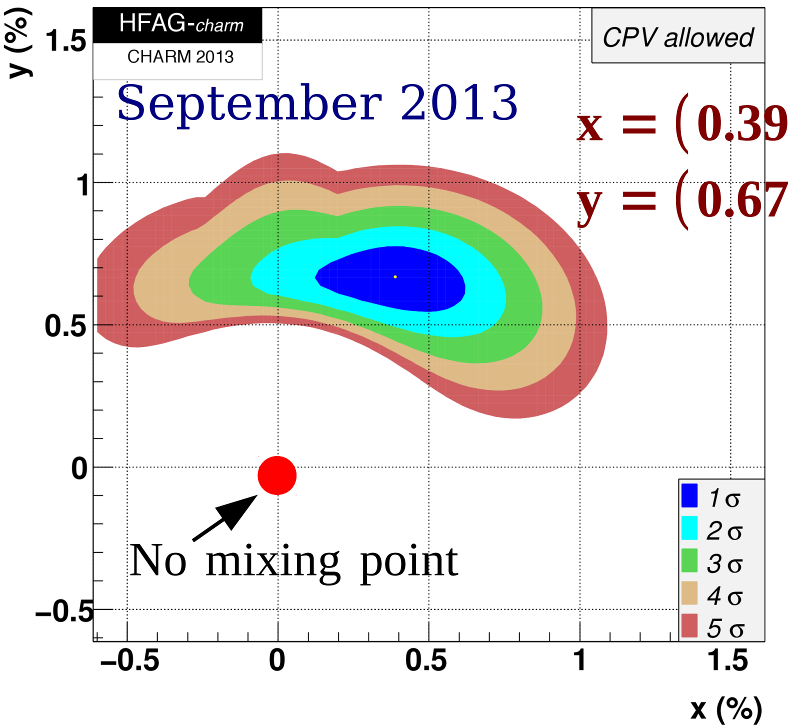
$$x = \left(0.63\,^{+0.19}_{-0.20}\right)\%$$
$$y = \left(0.75 \pm 0.12\right)\%$$

FPCP 2013



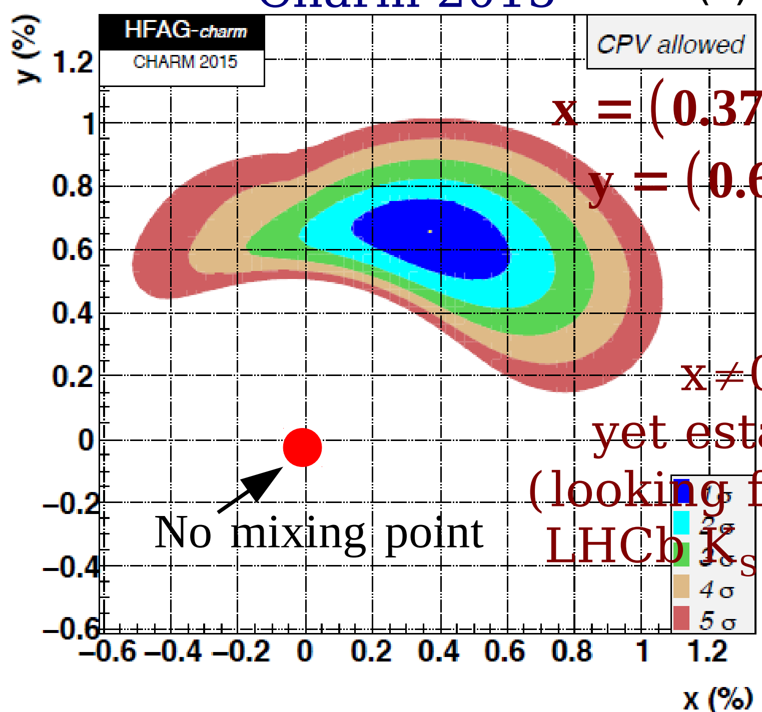
$$x = \left(0.49\,^{+0.17}_{-0.18}\right)\%$$
$$y = \left(0.75 \pm 0.09\right)\%$$

September 2013



$$x = \left(0.39\,^{+0.16}_{-0.17}\right)\%$$
$$y = \left(0.67\,^{+0.07}_{-0.08}\right)\%$$

Charm 2015



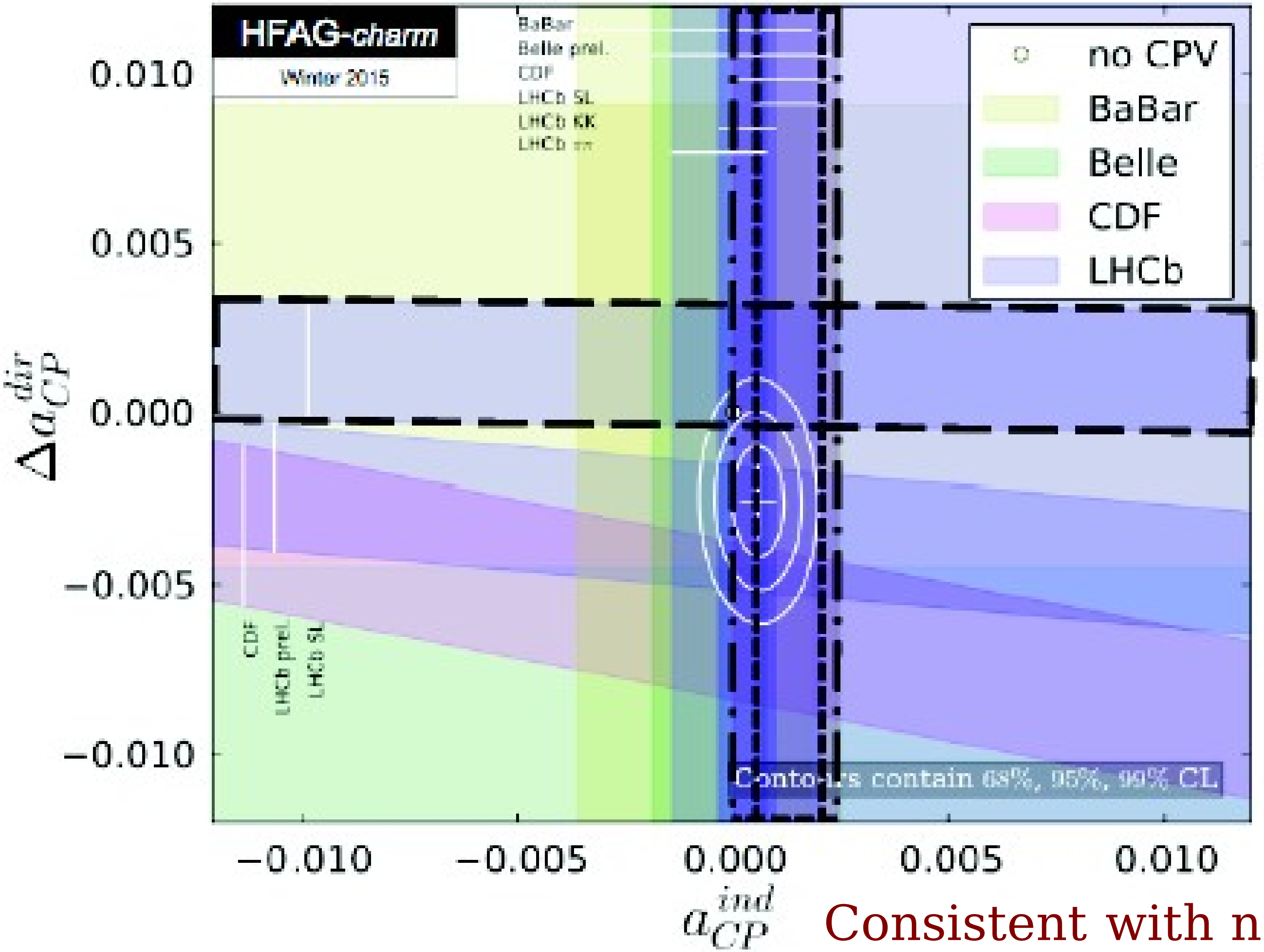
$$x = \left(0.37 \pm 0.16\right)\%$$
$$y = \left(0.66\,^{+0.07}_{-0.10}\right)\%$$

$x \neq 0$ not yet established (looking forward for LHCb $K_S\pi\pi$ result)

Charm physics

[Stefano Perazzini]
Thank you !

Direct and indirect CPV



ΔA_{CP} SL

A_Γ SL

A_Γ D*-prompt

Consistent with no CPV at 1.8% CL

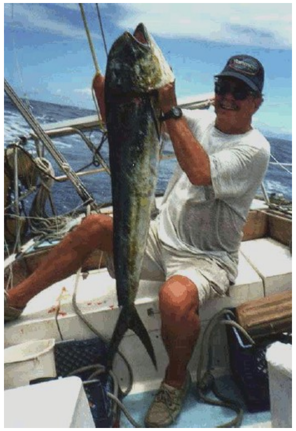
⇒ looking forward for LHCb result (prompt D^*) with 3 fb^{-1}

⇒ Many new results on semi-leptonic D decays ($V_{cd(s)}$) [Gang Rong]

X(3872), charmonium (like) particle

[Peter M.Lewis]

what a catch, Steve !

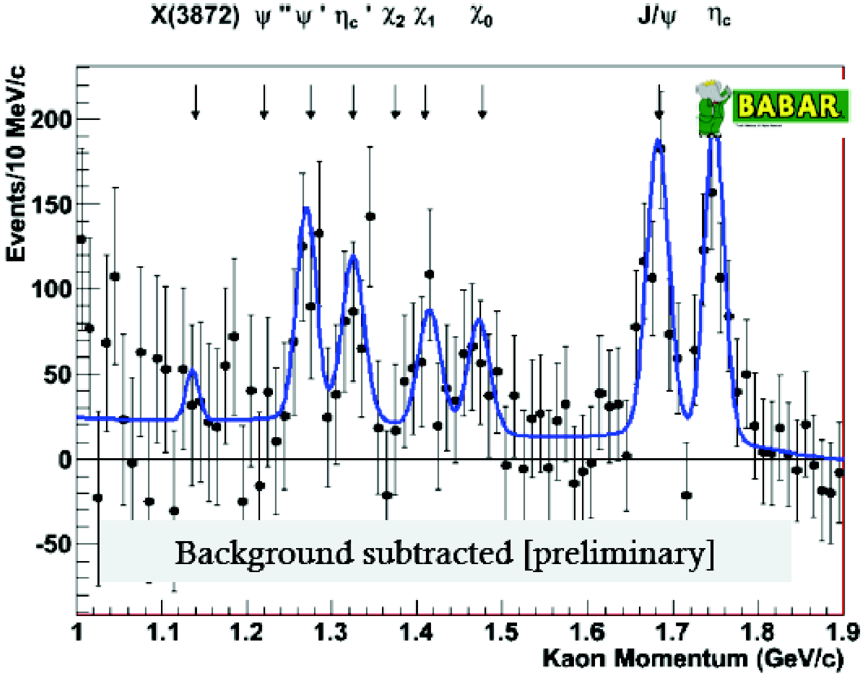


Direct measurement/limit of branching fraction

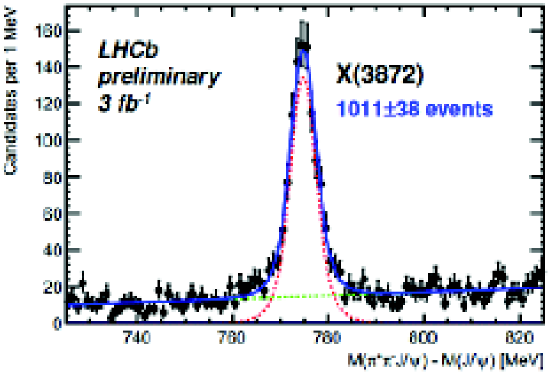
$B(B \to X(3872)K^{\pm})$

Particle	Yield	Peak Position	Width	BF(10^{-4})
J/ψ	516±67			9.6±1.2(sta)±0.8(sys)
η_c	655±77	2982±5	<43	18.3±1.8(stat)±0.4(sys)±0.3(ref)
χ_{c0}	218±76			4.4±0.9
χ_{c1}	192±35			7.0±1.3(stat)±1.0(sys)
χ_{c2}	0±32			<1.2
η_c (2S)	283±94	3632±0.007	<33	6.0±2.1(stat)±0.4(sys)
ψ'	293±90			6.2±2(stat)±0.6(sys)
$\psi(3770)$	0±49			<2.0
X(3872)	75±81			1.4±1.5 or < 4.4

PRELIMINARY



- LHCb data (3/fb)



[Sheldon Stone]

LHCb 2015

Many more amplitudes to fit

CDF 2007

LHCb 2013

J^{PC}	all L	minimal L
0^{-+}	B_{11}	B_{11}
0^{++}	B_{00}, B_{22}	B_{00}
1^{-+}	$B_{10}, B_{11}, B_{12}, B_{32}$	B_{10}, B_{11}, B_{12}
1^{++}	B_{01}, B_{21}, B_{22}	B_{01}
2^{-+}	$B_{11}, B_{12}, B_{31}, B_{32}$	B_{11}, B_{12}
2^{++}	$B_{02}, B_{20}, B_{21}, B_{22}, B_{42}$	B_{02}
3^{-+}	$B_{12}, B_{30}, B_{31}, B_{32}, B_{33}$	B_{12}
3^{++}	$B_{21}, B_{22}, B_{41}, B_{42}$	B_{21}, B_{22}
4^{-+}	$B_{31}, B_{32}, B_{51}, B_{52}$	B_{31}, B_{32}
4^{++}	$B_{22}, B_{40}, B_{41}, B_{42}, B_{62}$	B_{22}

LS amplitudes to be determined from the data

- State is only 1^{++} with mainly S-wave decay [arXiv:1504.06339]

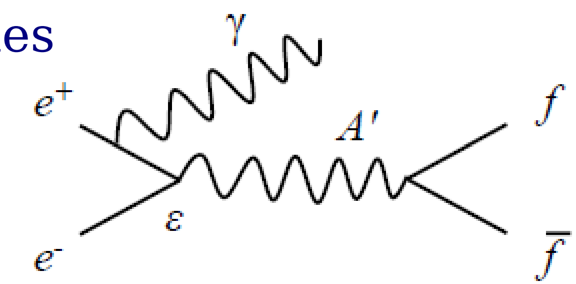
More on exotics in leptonic machines [Zhiqing Liu]

Light Higgs & Dark Gauge Bosons

[Abi Soffer]

''portals'' between SM sector and dark sector

e.g. Dark photon searches



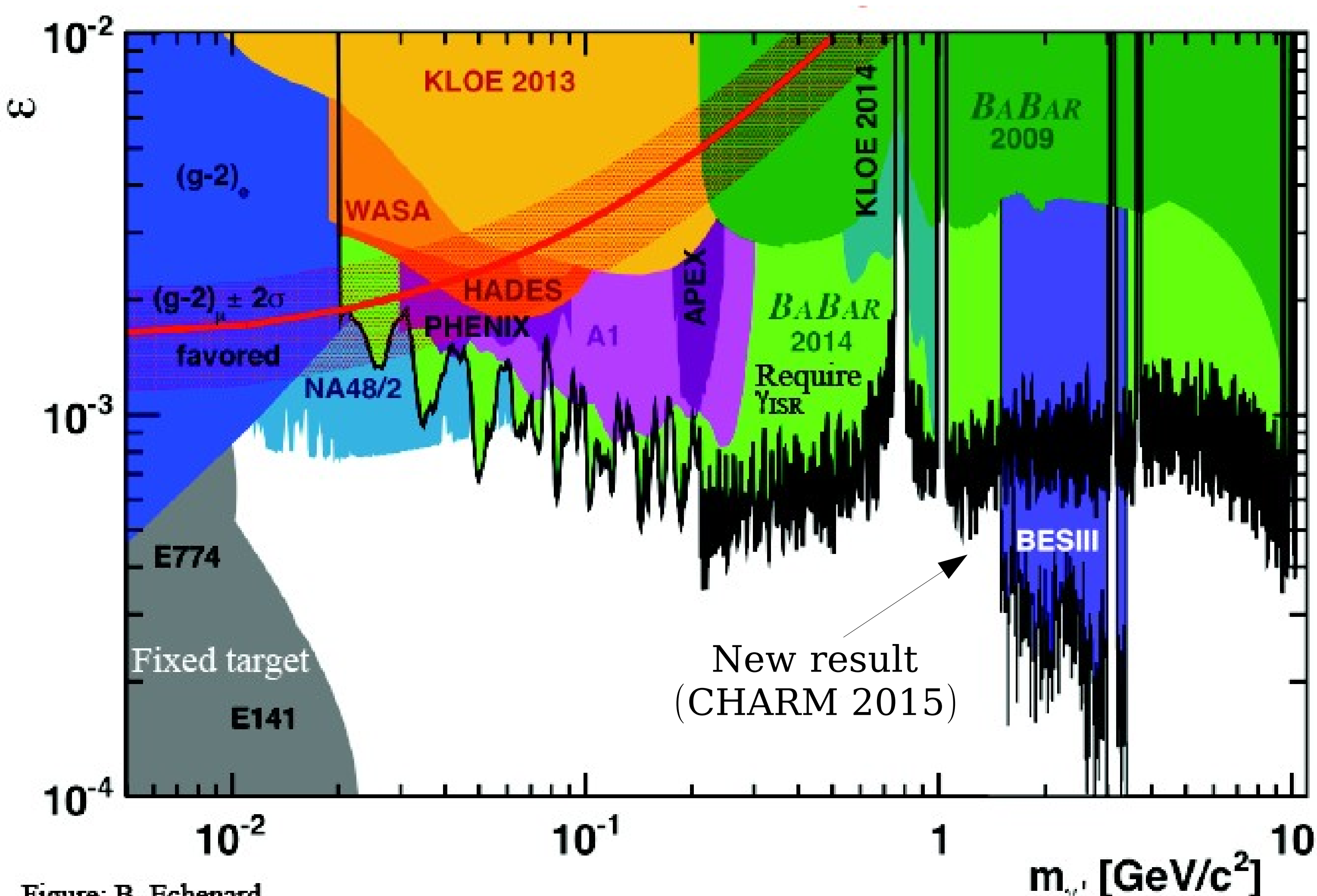
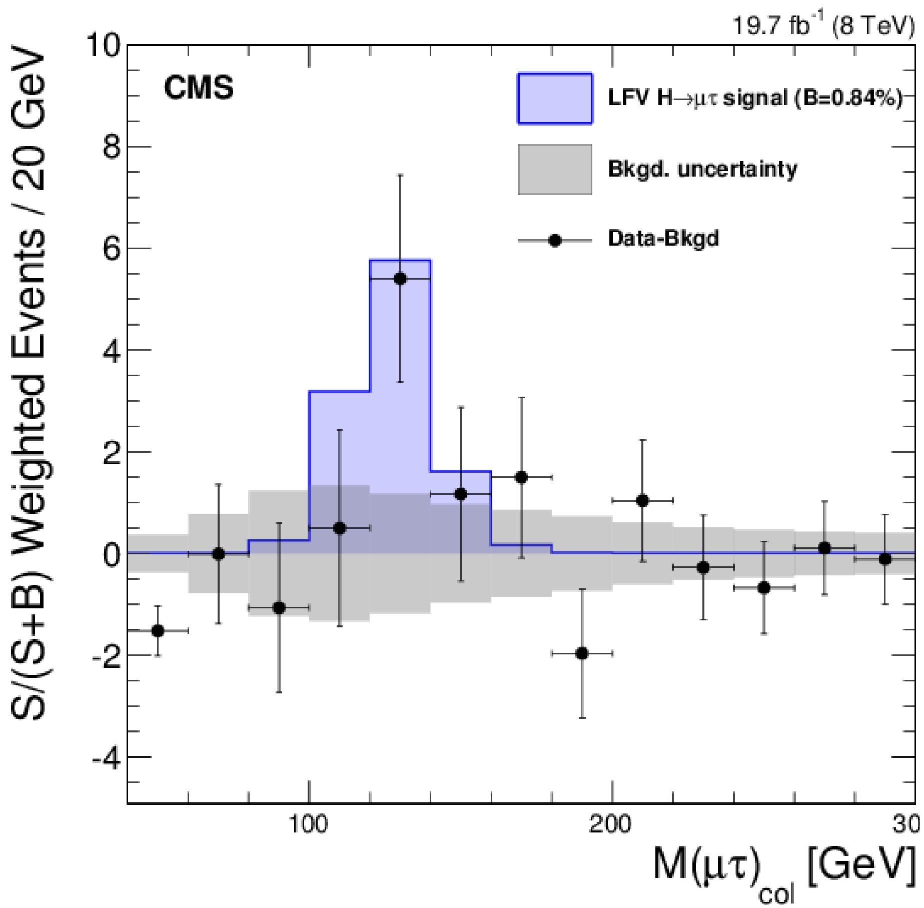


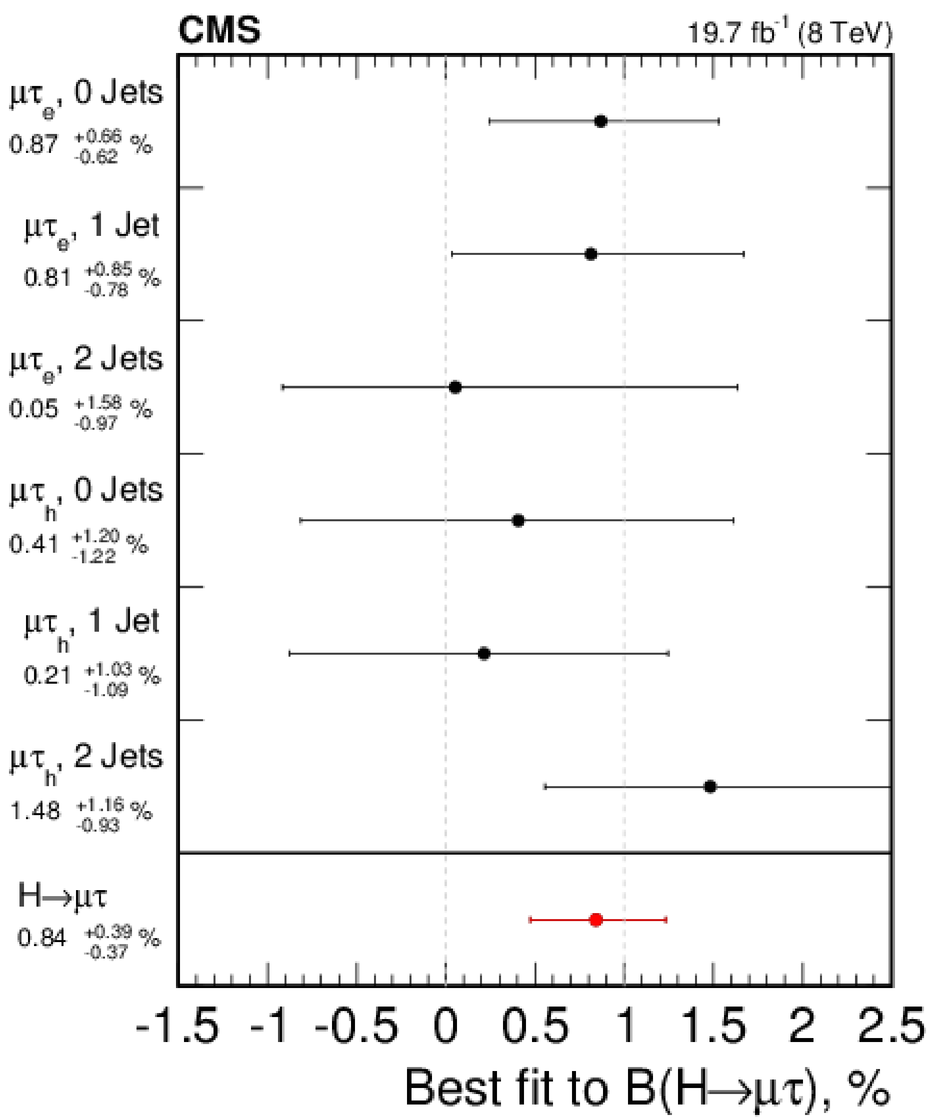
Figure: B. Echenard

Higgs Boson couplings and Searches

[Peter Onyisi]

Look for H→τμ, τ→eνν or τ→hadrons
slight excess of events





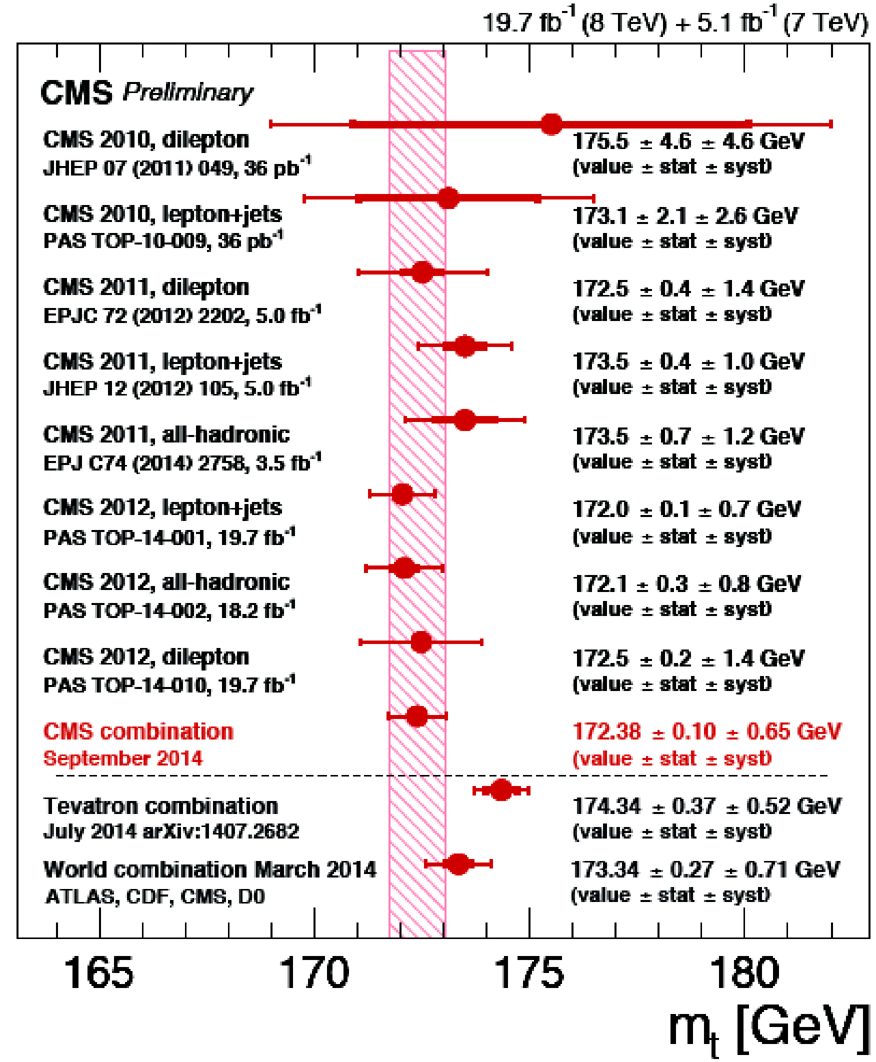
best fit 0.84%, B(H→μτ) < 1.51%
⇒ soon ATLAS result ?

- Searches for H^+→τν, cs and tb
  - decays cover different regions of tan β

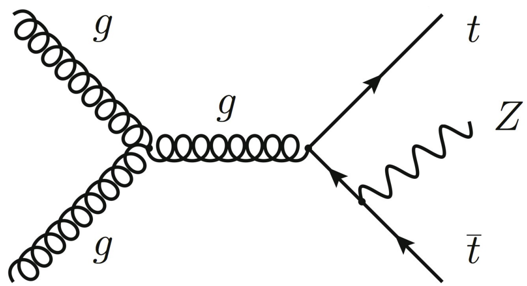
Top quark properties

[Jacob Linacre]

- LHC is a top factory
  - LHC at 8 TeV 700 times more top quark pairs per hour than Tevatron



$t\bar{t}Z$ provides first experimental measurement of top-Z coupling



ttW and ttZ measurements	ttW				ttZ			
	Cross section		Significance		Cross section		Significance	
	Theory* (fb)	Observed (fb)	Expected	Observed	Theory* (fb)	Observed (fb)	Expected	Observed
ATLAS	203	300	2.3σ	3.1σ	206	150	3.4σ	3.1σ
CMS (prelim.)		382	3.5σ	4.8σ		242	5.7σ	6.4σ

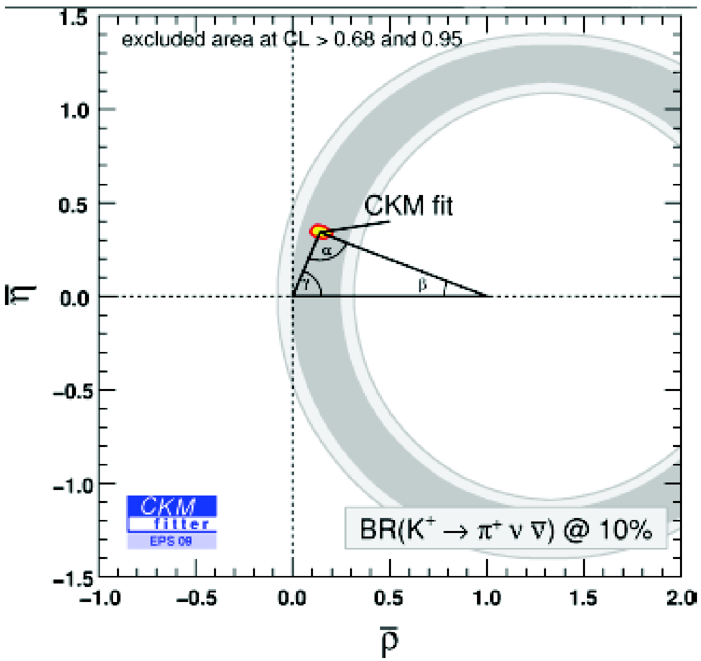
CMS observes $t\bar{t}Z$, both experiments see evidence of $t\bar{t}W$

$$\mathrm{CMS}: m_t = 172.38 \pm 0.66\ \mathrm{GeV}\ \ (0.4\,\%)$$

$$\mathrm{ATLAS}: m_t = 172.99 \pm 0.91\ \mathrm{GeV}\ \ (0.5\,\%)$$

Rare Kaon Decays

[Tadashi Nomura]

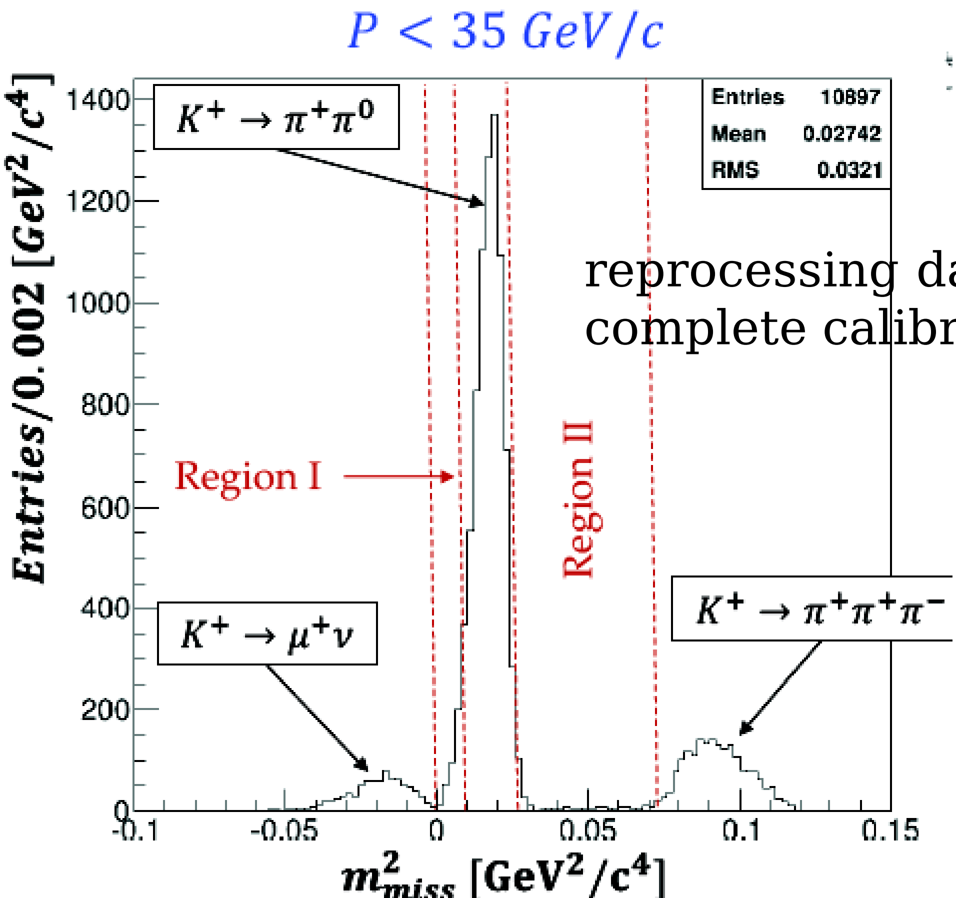


$$B_{SM}(K^+ \to \pi^+ \nu \bar{\nu}) = 9 \times 10^{-11}$$

CERN NA62 status

Aim to collect o(100) events in 2 years of data
⇒ 10% precision

2014 pilot run (Oct-Dec 2014)
5-20% of nominal beam intensity
almost all detectors installed

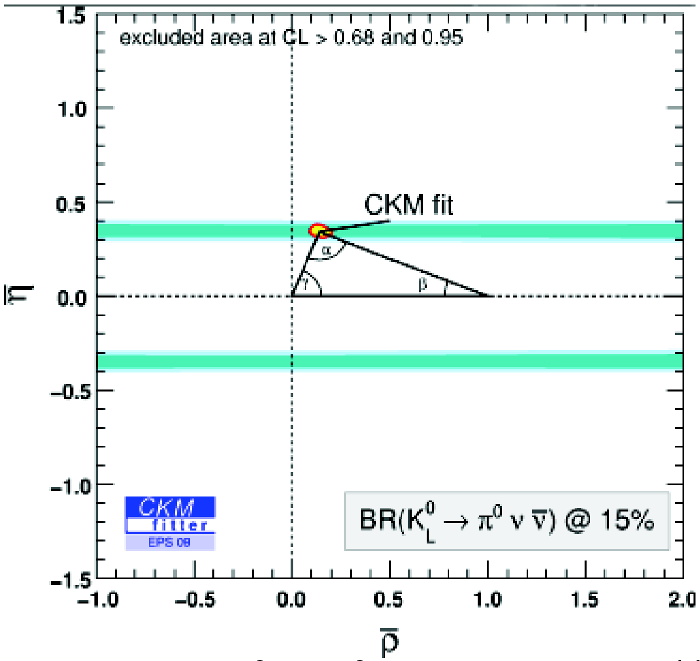


reprocessing data with
complete calibration

⇒ 2015 run: July to November

Rare Kaon Decays

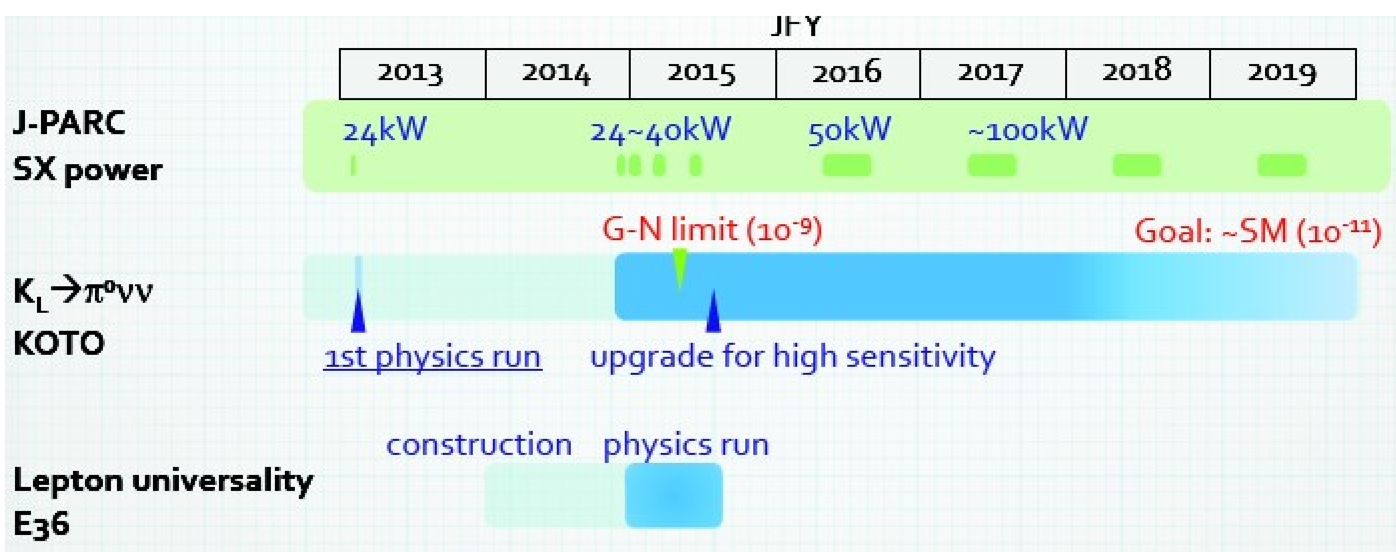
[Tadashi Nomura]



$$B_{SM}(K_L^0 \to \pi^0 \nu \bar{\nu}) = 3 \times 10^{-11}$$

KOTO status

1st physics run in May 2013
100 hours of data taking, 24 kW
1 evt observed (consistent with BG) [CKM2014]
upgraded to reduce background,
⇒ took data (April 2015), 27 kW
Target sensitivity: o(10^{-9}), Grossman Nir limit



Lepton Flavour Violation

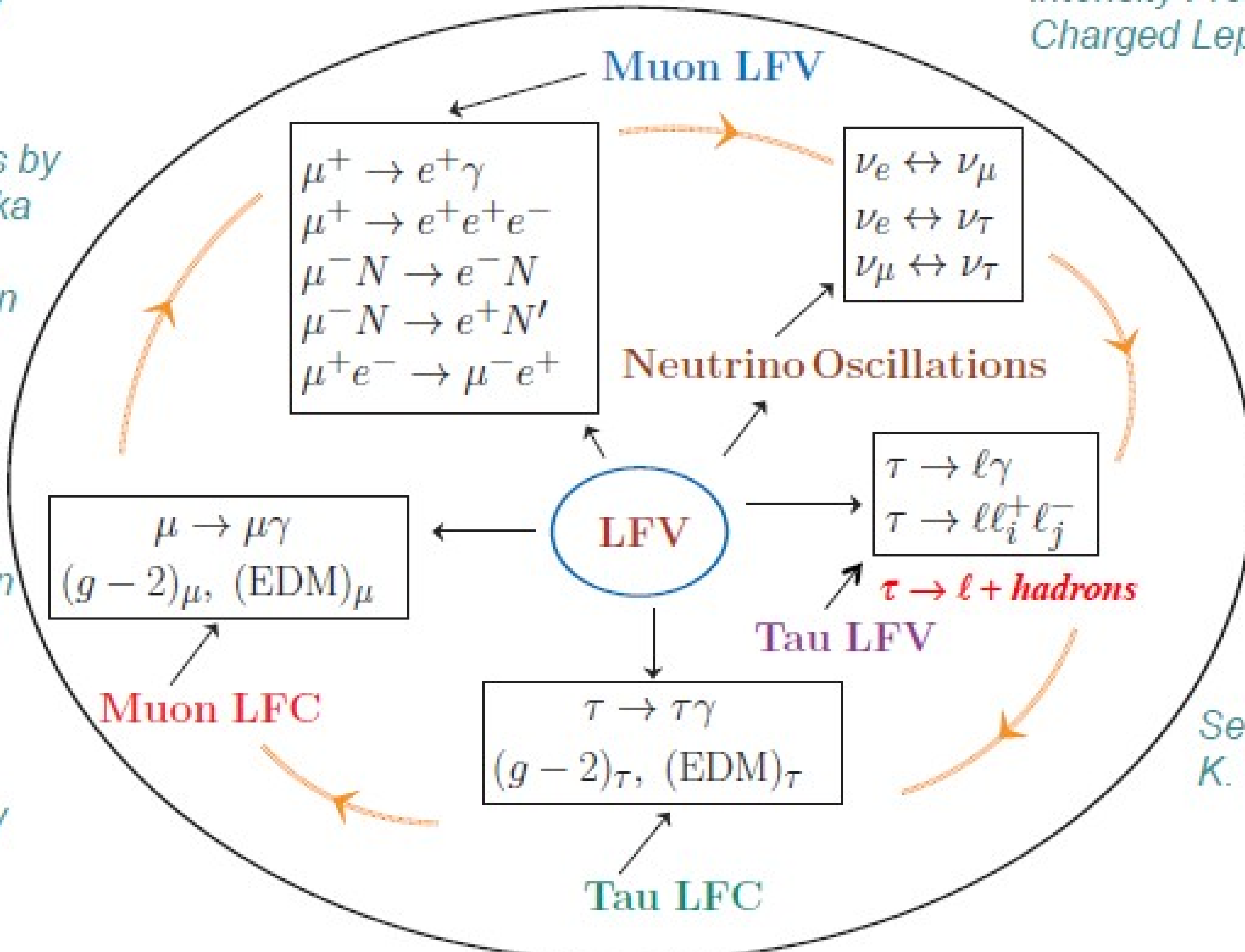
The Program

See talks by
S. Mihara
A. Sato

See Posters by
M. Yamanaka
Y. Uesaka
M. Roehrken
S. Ogawa
K. Oshida
T. Wong
N. Yu,
M. Wong
T.M, Nguyen
N.Teshima
T. Nagao

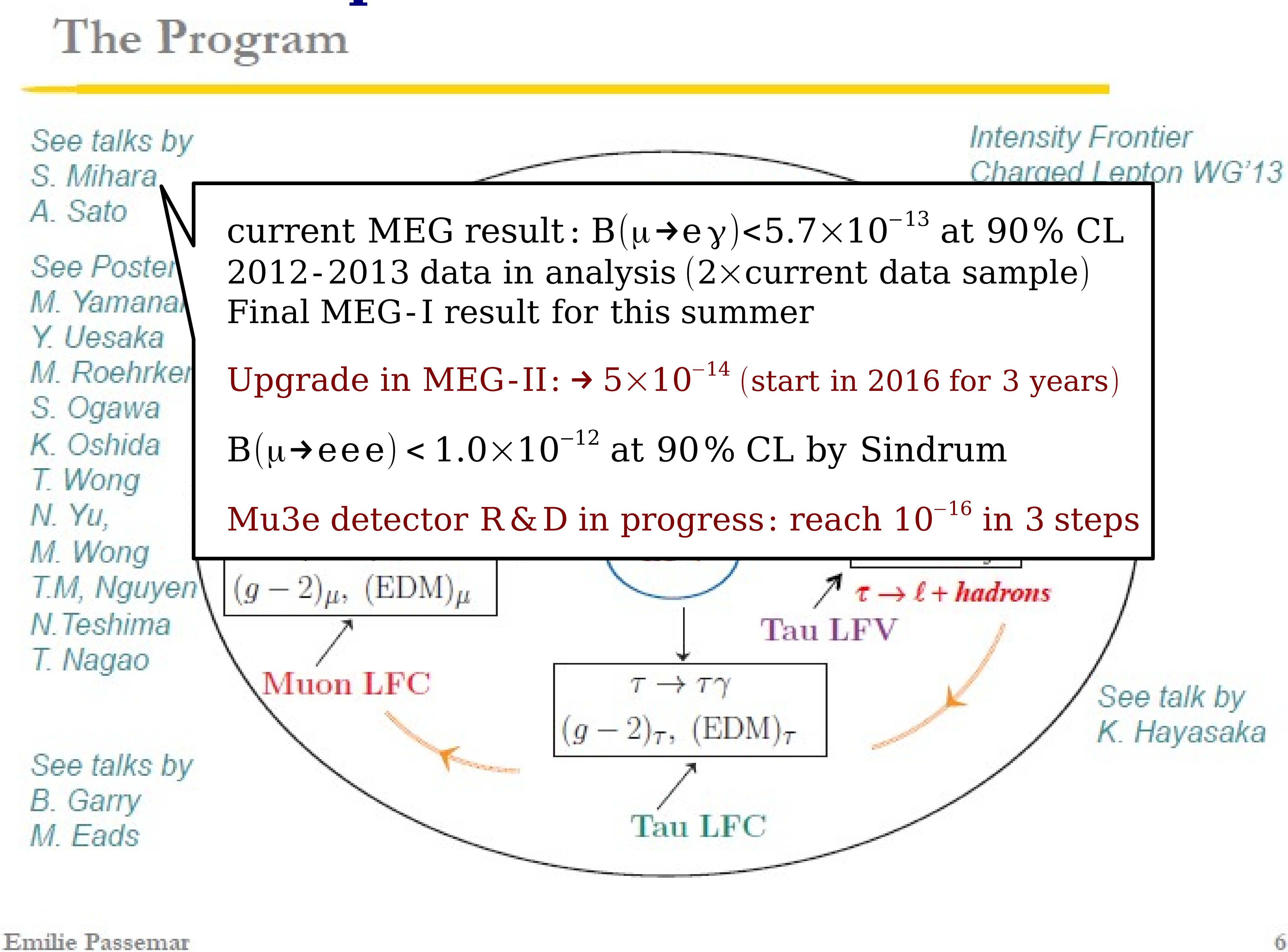
See talks by
B. Garry
M. Eads

Intensity Frontier
Charged Lepton WG'13



See talk by
K. Hayasaka

Lepton Flavour Violation



current MEG result: $B(\mu \to e\gamma) < 5.7\times10^{-13}$ at 90% CL
2012-2013 data in analysis (2×current data sample)
Final MEG-I result for this summer

Upgrade in MEG-II: → 5×10^{-14} (start in 2016 for 3 years)

$B(\mu \to eee) < 1.0\times10^{-12}$ at 90% CL by Sindrum

Mu3e detector R&D in progress: reach 10^{-16} in 3 steps

Lepton Flavour Violation

The Program

See talks by
S. Mihara
A. Sato

See Po[...]
M. Yam[...]
Y. Uesa[...]
M. Roeh[...]
S. Ogaw[...]
K. Oshid[...]
T. Wong
N. Yu,
M. Wong
T.M, Nguy[...]
N. Teshim[...]
T. Nagao

See talks
B. Garry
M. Eads

Intensity Frontier
Charged Lepton WG'13

μ-e conversion search

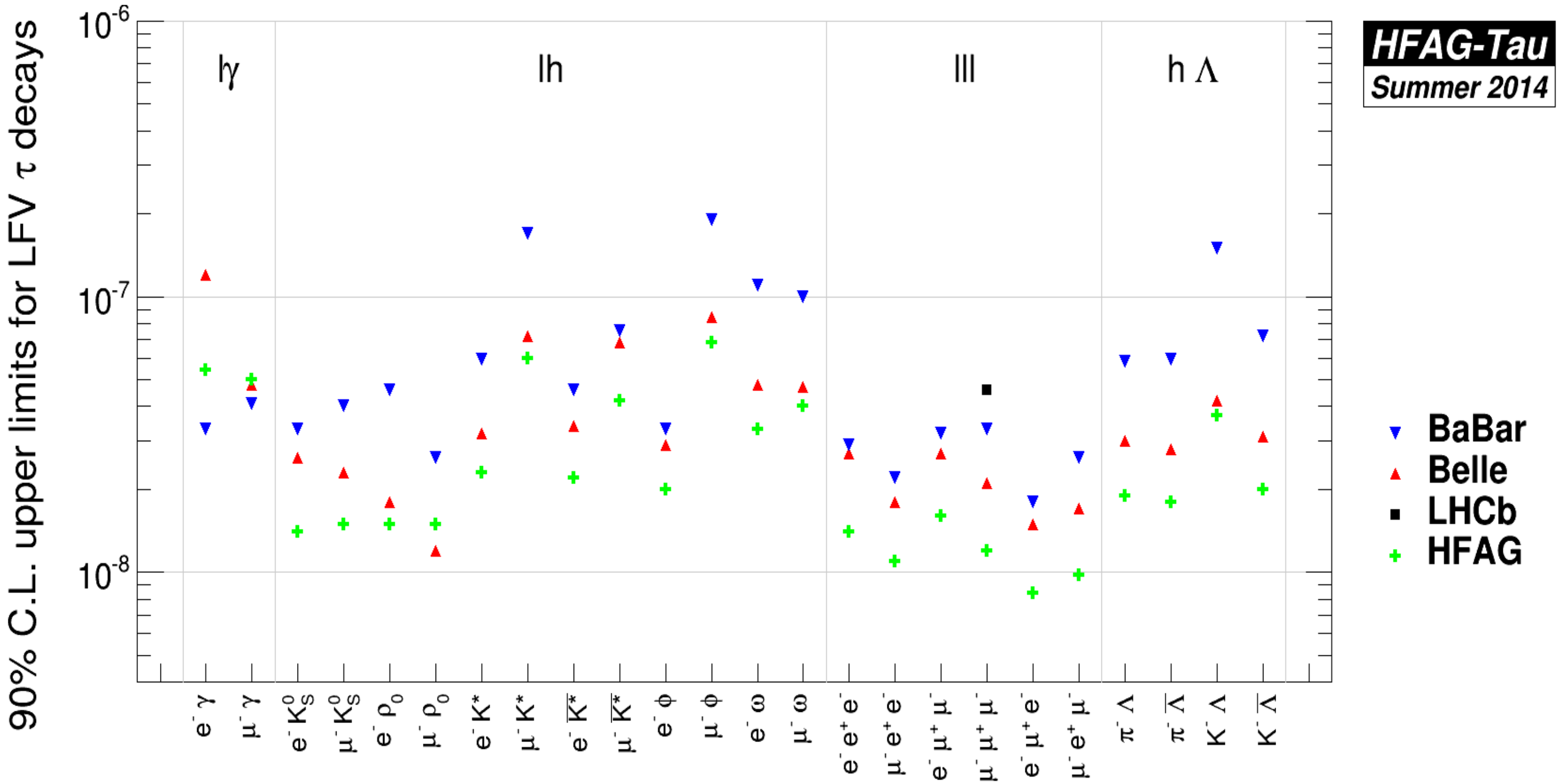
Muon LFV

- **Current limits** (90% CL)
  - BR(μ^-Au→e^-Au) < 7×10^{-13} (SINDRUM-II@PSI)
  - BR(μ^-Ti→e^-Ti) < 4.3×10^{-12} (SINDRUM-II@PSI)
  - BR(μ^-Ti→e^-Ti) < 4.6×10^{-12} (TRIUMF)
- **Precision of coming measurements** (90% CL)
  - BR(μ^-C→e^-C) < 2.3×10^{-13} (DeeMe@J-PARC-MLF)
    - 2016~
  - BR(μ^-Al→e^-Al) < 7×10^{-15} (COMET Phase-I@J-PARC-HardonH)
    - 2017~
  - BR(μ^-Al→e^-Al) < 6×10^{-17} (COMET Phase-I@J-PARC-HadronH)
    - 2020~
  - BR(μ^-Al→e^-Al) < 6×10^{-17} (Mu2e@FNAL)
    - 2020~

[...]ee talk by
[...] Hayasaka

Lepton Flavour Violation

The Program



(see also Matt Barrett's talk for Belle II)

Frontier

Lepton WG'13

See talk by
K. Hayasaka

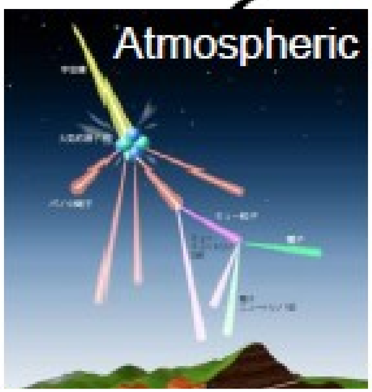
See talks by
B. Garry
M. Eads

Tau LFC

Neutrinos

$$U_{PMNS} = \begin{pmatrix} 1 & 0 & 0 \\ 0 & +c_{23} & +s_{23} \\ 0 & -s_{23} & +c_{23} \end{pmatrix} \begin{pmatrix} +c_{13} & 0 & +s_{13}e^{-i\delta} \\ 0 & 1 & 0 \\ -s_{13}e^{i\delta} & 0 & +c_{13} \end{pmatrix} \begin{pmatrix} +c_{12} & +s_{12} & 0 \\ -s_{12} & +c_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

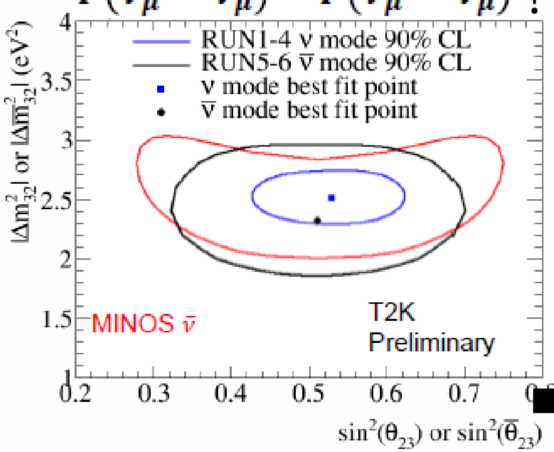
$\theta_{23,}|\Delta m^2_{32}|$ $\theta_{13,}\delta_{CP}$(, MO) $\theta_{13,}|\Delta m^2_{32}|$(,MO) $\theta_{12,}\Delta m^2_{21}$



[Atsuko Ichikawa]

Long baseline ν expts
K2K, MINOS, OPERA, ICARUS, **T2K**, **NovA**

$P(\nu_\mu \to \nu_\mu) = P(\bar{\nu}_\mu \to \bar{\nu}_\mu)$?

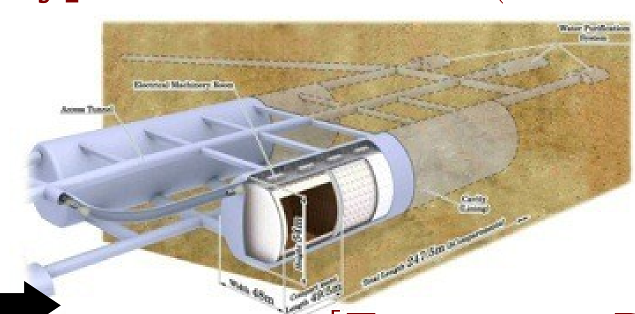


Reactor ν experiments
Double Chooz, RENO, Daya Bay

$\sin^2\theta_{13} = 0.084 \pm 0.005$

[Seon-Hee Seo]

Hyper-Kamiokande (202?-)



[Francesca Di Lodovico]

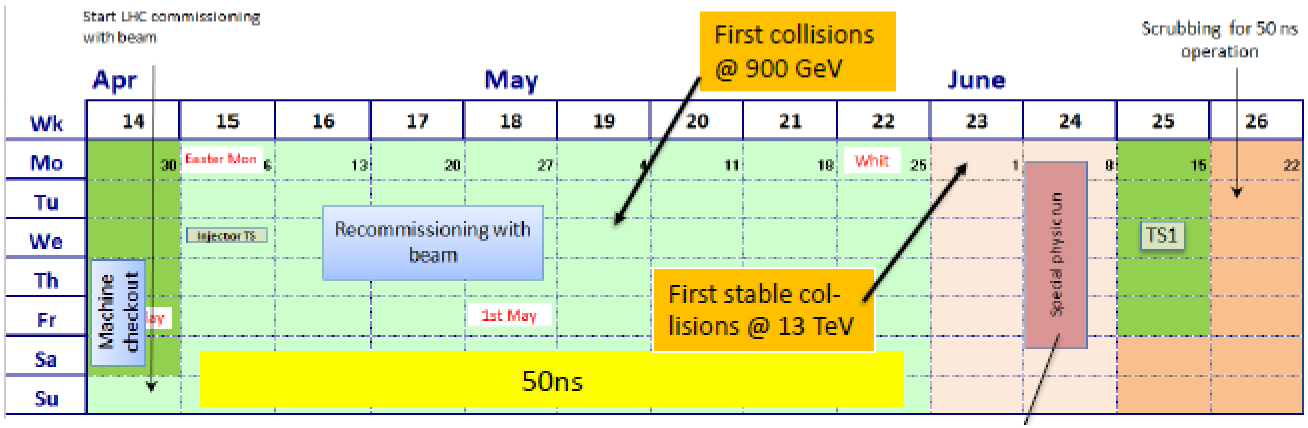
⇒ neutron EDMs [H.Shimizu], g−2 experiments [Bill Gary, Michael Eads]

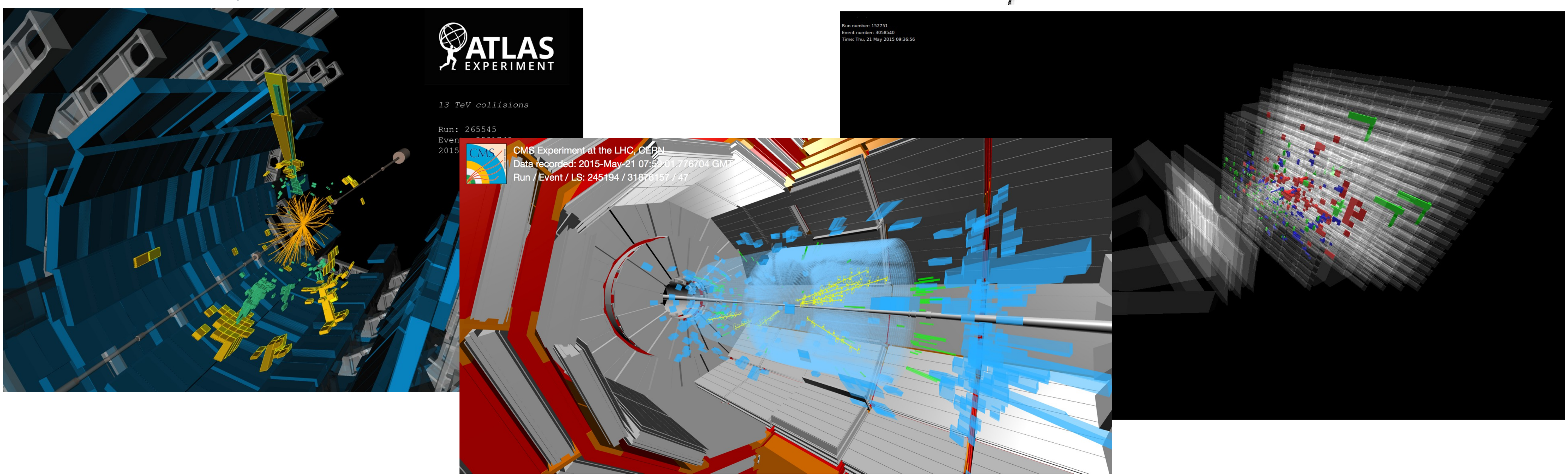
Message from Tom Browder

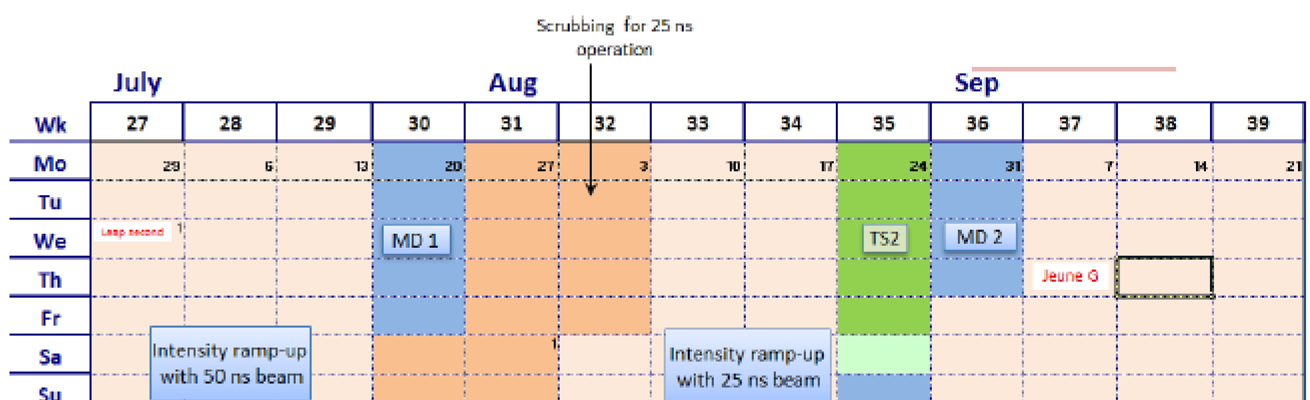
Red Hot Flavor Physics

LHC restarted

[Stephanie Zimmermann]



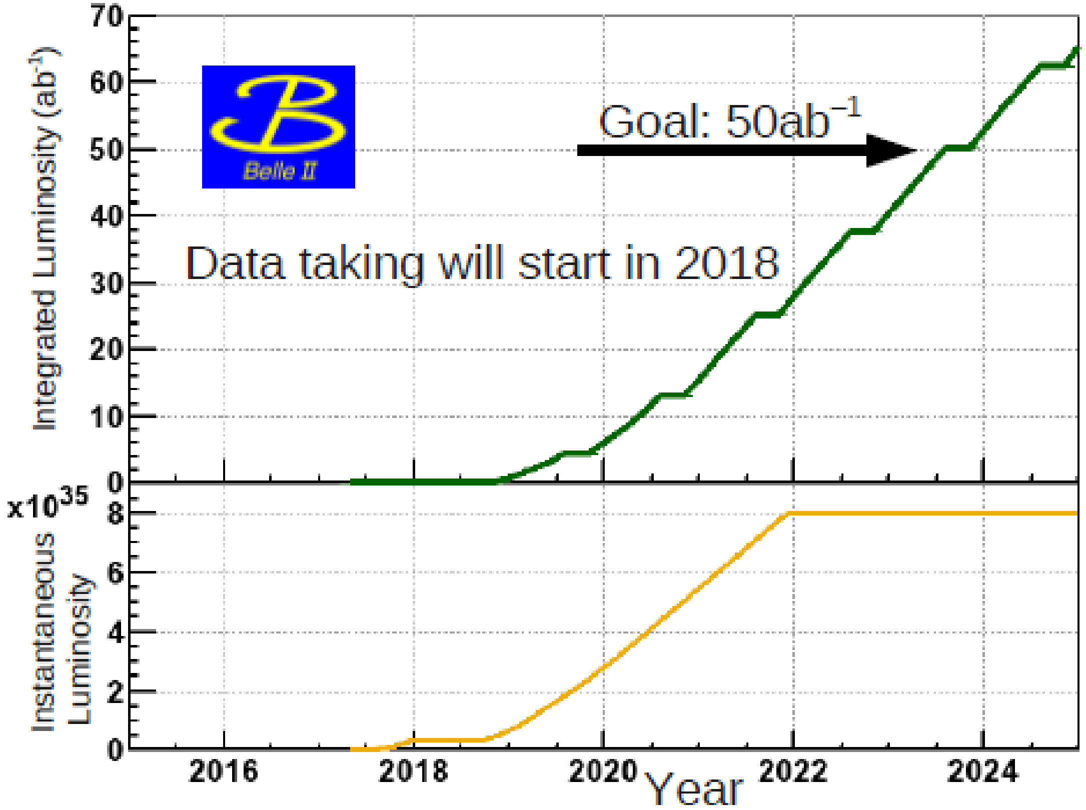




Future B experiments

LHC era			HL-LHC era	
Run 1 (2010-12)	Run 2 (2015-18)	Run 3 (2020-22)	Run 4 (2025-28)	Run 5+ (2030+)
3 fb^{-1}	8 fb^{-1}	23 fb^{-1}	46 fb^{-1}	100 fb^{-1}

[Umberto Marconi]



Matt Barrett]