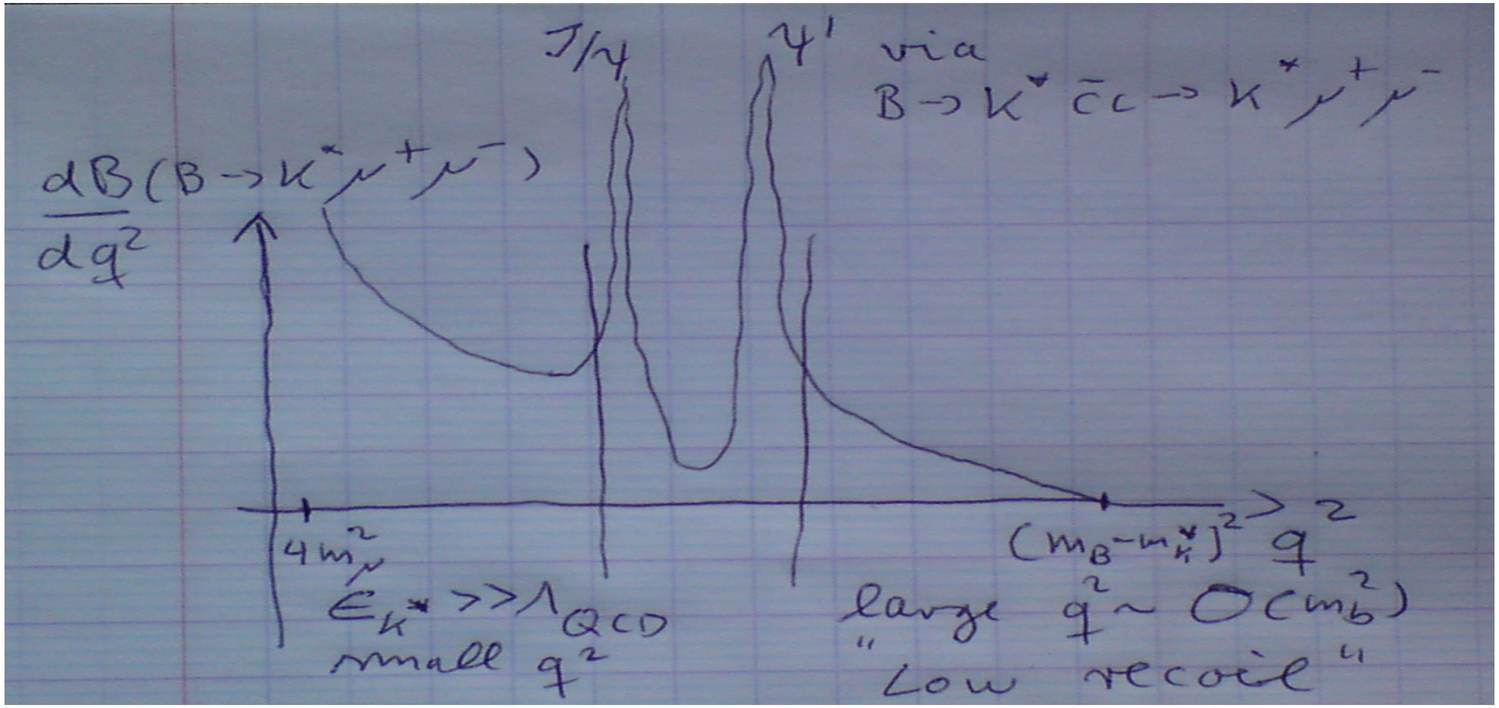
Opportunities & Interplay

(two comments)

Last Talk of the Workshop, September 11, 2012

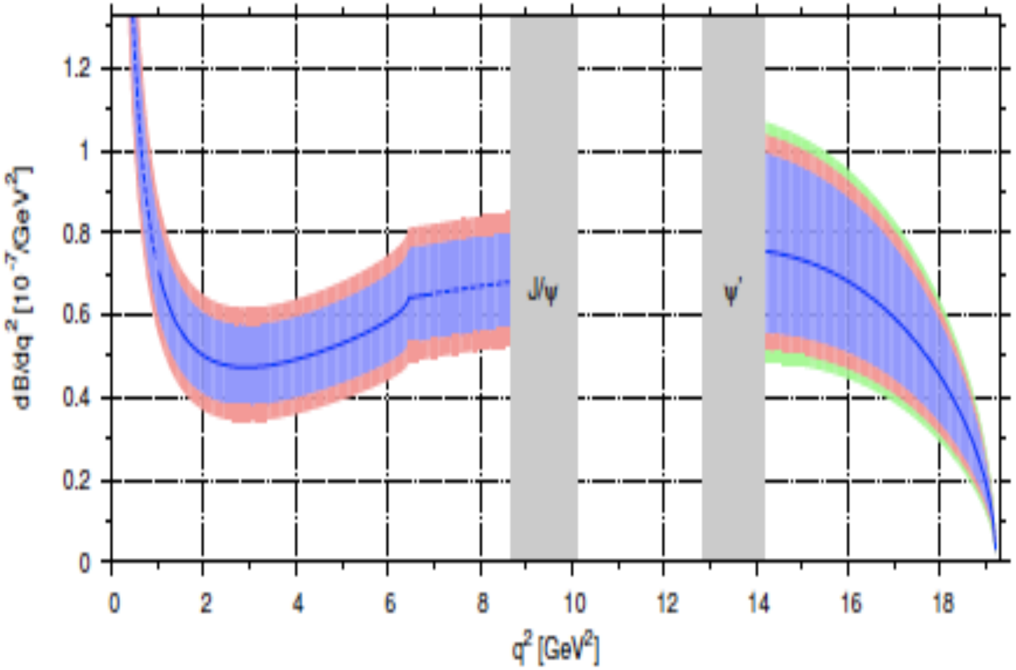
Gudrun Hiller, Dortmund

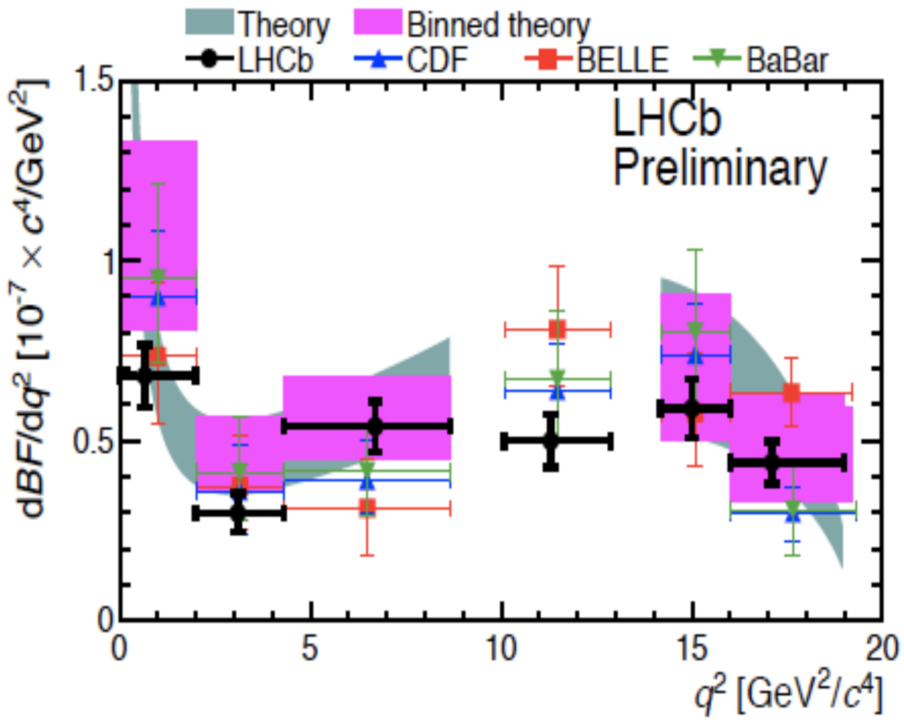
Opportunity: Different Kinematics/Theory



Different TH at low q^2 QCDF; BBNS, Beneke, Feldmann, Seidel'01,04 and high q^2/low recoil OPE in $1/m_b$ Grinstein,Pirjol '04, Beylich, Buchalla,Feldmann'11; Low recoil $B \to K^{(*)} \mu^+ \mu^-$ predictions/pheno Bobeth,GH,vanDyk, Wacker '10,11 Binned data needed. New developments at low recoil in theory pheno+lattice greatly support exploitation of todays and tomorrows data. E.g., Preliminary unquenched lattice $B \to K^{(*)}$ form factors by Liu et al 1101.2726 [hep-ph].

Dilepton Mass Spectra in $B \to K^* \mu^+ \mu^-$





left-hand Fig. from 1006.5013 [hep-ph] Blue band: form factor uncertainties, red: $1/m_b$ right-hand Fig. from LHCb-CONF-2012-008

Biggest source of TH uncertainty: the $B \to K^*$ form factors.

Opportunity: Angular Analysis $B \to V(\to PP)\mu^+\mu^-$

$$d\Gamma^4 \sim J dq^2 d\cos\Theta_l d\cos\Theta_{K^*} d\Phi$$ hep-ph/9907386

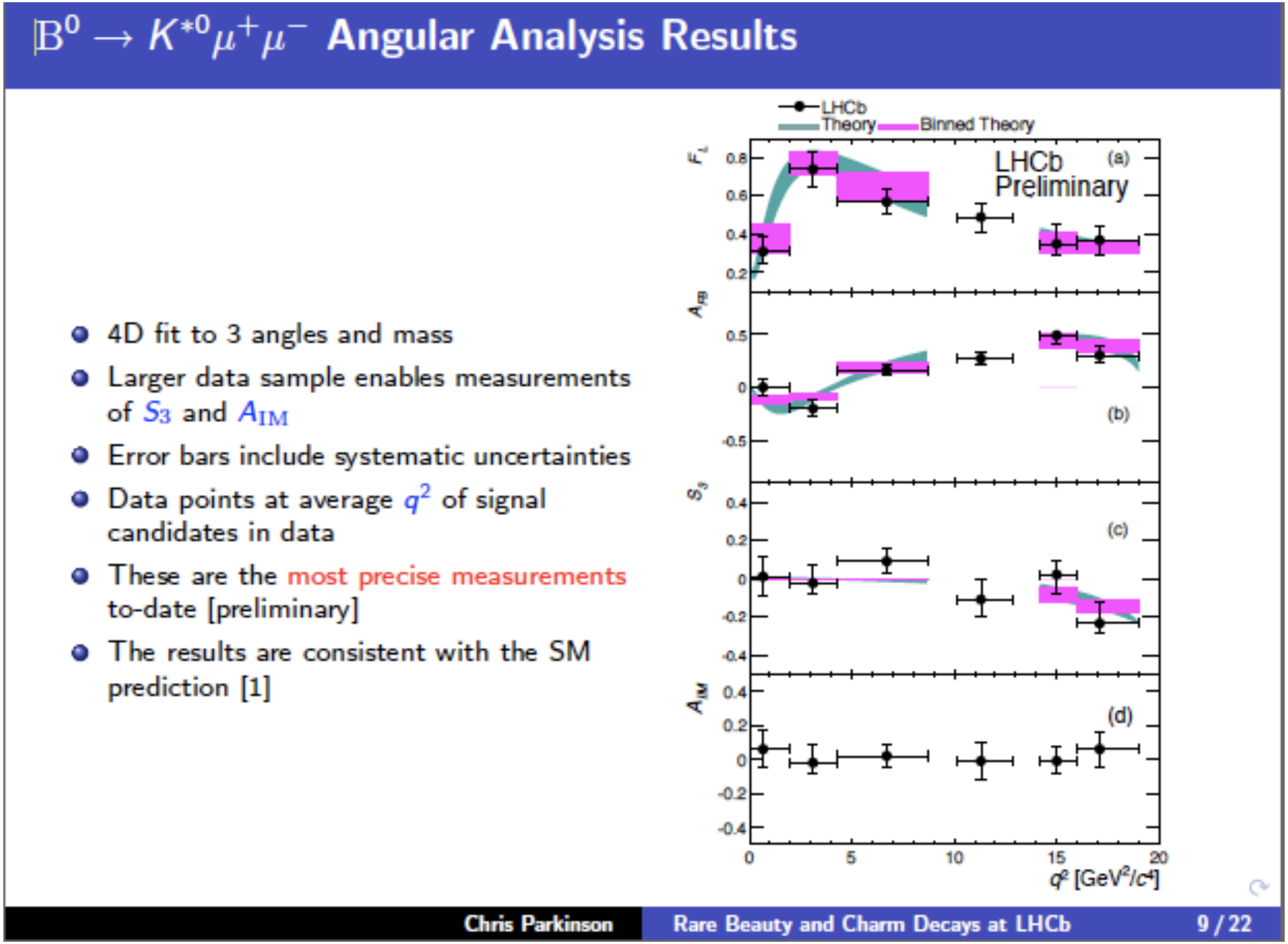
$$\begin{aligned} J(q^2, \theta_l, \theta_{K^*}, \phi) = & J_1^s \sin^2\theta_{K^*} + J_1^c \cos^2\theta_{K^*} + (J_2^s \sin^2\theta_{K^*} + J_2^c \cos^2\theta_{K^*}) \cos 2\theta_l \\ & + J_3 \sin^2\theta_{K^*} \sin^2\theta_l \cos 2\phi + J_4 \sin 2\theta_{K^*} \sin 2\theta_l \cos\phi + J_5 \sin 2\theta_{K^*} \sin\theta_l \cos\phi \\ & + J_6 \sin^2\theta_{K^*} \cos\theta_l + J_7 \sin 2\theta_{K^*} \sin\theta_l \sin\phi \\ & + J_8 \sin 2\theta_{K^*} \sin 2\theta_l \sin\phi + J_9 \sin^2\theta_{K^*} \sin^2\theta_l \sin 2\phi, \qquad (2.3) \end{aligned}$$

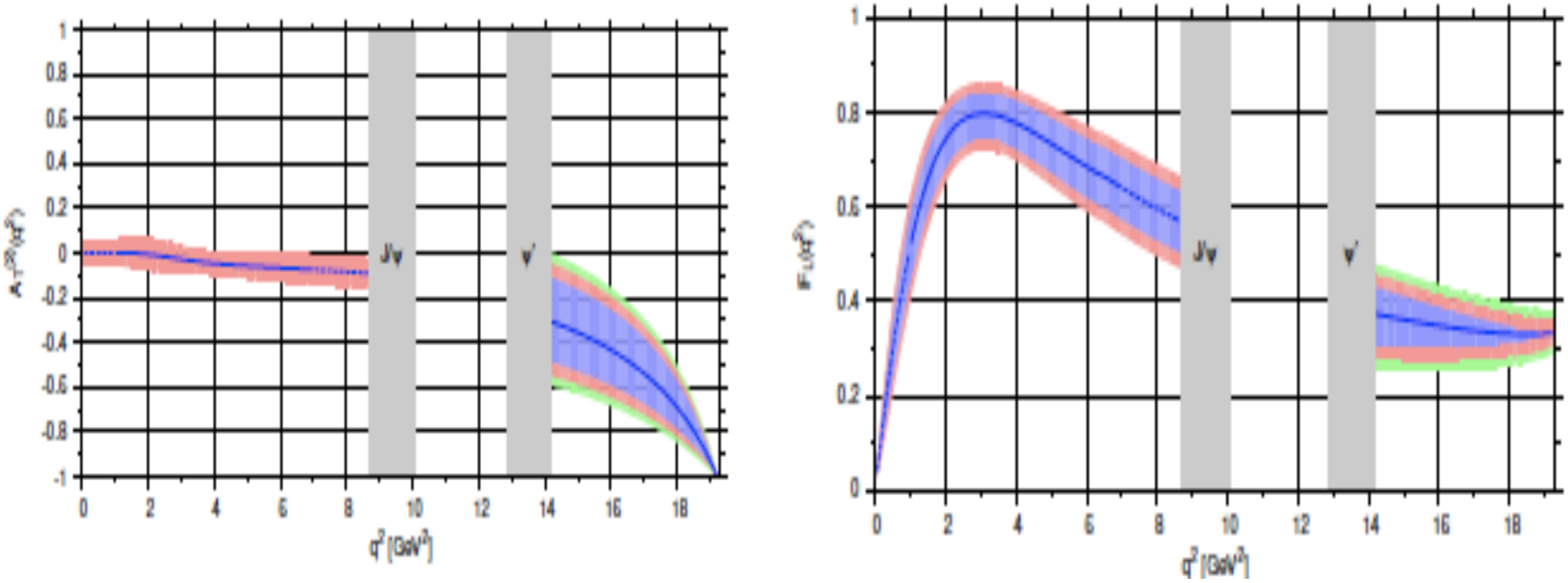
Θ_l: angle between l^- and $\bar{B}$ in dilepton CMS (warning: different conventions in literature)

Θ_{K^*}: angle between K and $\bar{B}$ in K^*-CMS

Φ: angle between normals of the $K\pi$ and l^+l^- plane

More angular distributions avaliable 2012





Figs. from 1006.5013 [hep-ph] Blue band: form factor uncertainties, red: $1/m_b$

At low hadronic recoil: OPE in $1/m_b$ Grinstein, Pirjol '04, Beylich et al '10

$$A_i^{L,R} \propto C^{L,R} f_i + \mathcal{O}(\alpha_s \Lambda/m_b, C_7/C_9 1/m_b), \qquad i = \perp, ||, 0$$ Bobeth et al '10

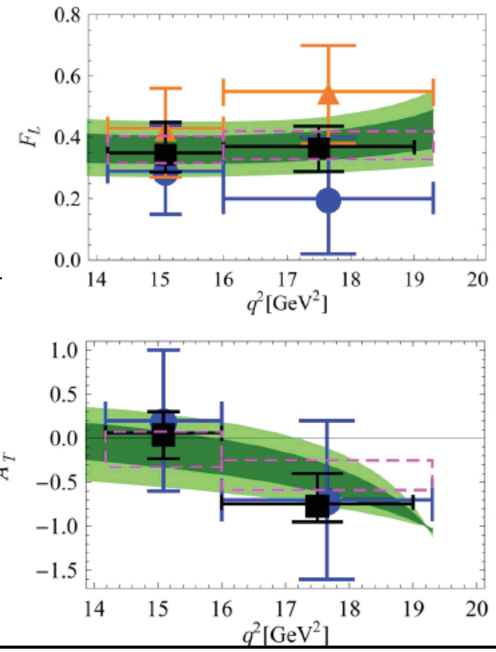
$C^{L,R}$: universal short-dist.-physics; $C^{L,R} = (C_9^{\rm eff} \mp C_{10}) + \kappa \frac{2\hat{m}_b}{\hat{s}} C_7^{\rm eff}$

f_i: generalized form factors: $f_\perp \propto V$, $f_{||} \propto A_1$, $f_0 \sim A_1, \lambda_{kin} A_2$

$C^{L,R}$ drops out in ratios:

$$F_L = \frac{|A_0^L|^2 + |A_0^R|^2}{\sum_{X=L,R}(|A_0^X|^2 + |A_\perp^X|^2 + |A_{||}^X|^2)} = \frac{f_0^2}{f_0^2 + f_\perp^2 + f_{||}^2}$$

$$A_T^{(2)} = \frac{|A_\perp^L|^2 + |A_\perp^R|^2 - |A_{||}^L|^2 - |A_{||}^R|^2}{|A_\perp^L|^2 + |A_\perp^R|^2 + |A_{||}^L|^2 + |A_{||}^R|^2} = \frac{f_\perp^2 - f_{||}^2}{f_\perp^2 + f_{||}^2}$$

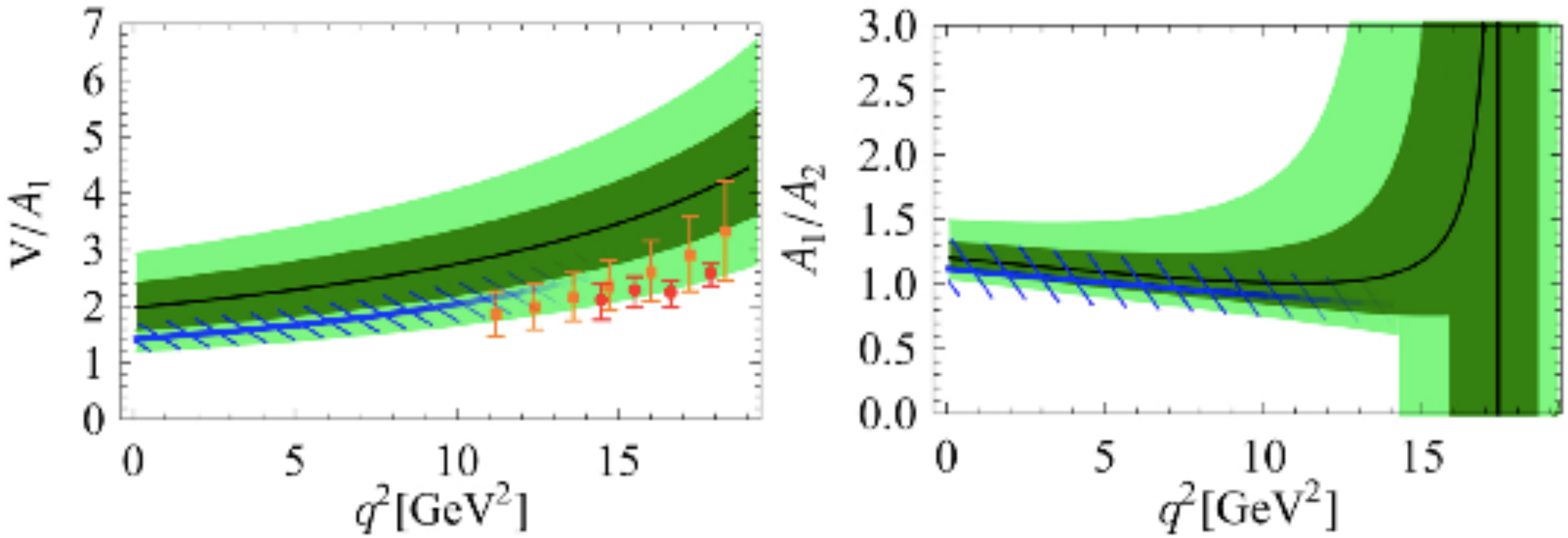


Extracting $B \to K^*$ form factors from data

Series expansion $z(t) \equiv z(t, t_0) = \frac{\sqrt{t_+ - t} - \sqrt{t_+ - t_0}}{\sqrt{t_+ - t} + \sqrt{t_+ - t_0}}$,

$$\hat{f}_i(t) = \frac{(\sqrt{-z(t,0)})^m (\sqrt{z(t,t_-)})^l}{B(t)\,\varphi_f(t)} \sum_k \alpha_{i,k}\, z^k(t)\,,$$

The best-fit results: $\alpha_\parallel/\alpha_\perp = 0.43^{+0.11}_{-0.08}$, $\alpha_0/\alpha_\perp = 0.15^{+0.03}_{-0.02}$



Yellow, red points; lattice QCD; blue bands: QCD sum rules Ball, Zwicky ’05: green bands: $1, 2\sigma$ fit 1204.4444 [hep-ph], PRL’12

1. Its great to have (even more) data.

2. With (even one) more bins the sensitivity in the fits to the q^2-shape increases.

3. If you(lattice, sum rules,..) calculate form factors, please provide also ratios (with uncertainties)

Interplay

Precision tests from global fits C_7, C_9, C_{10}

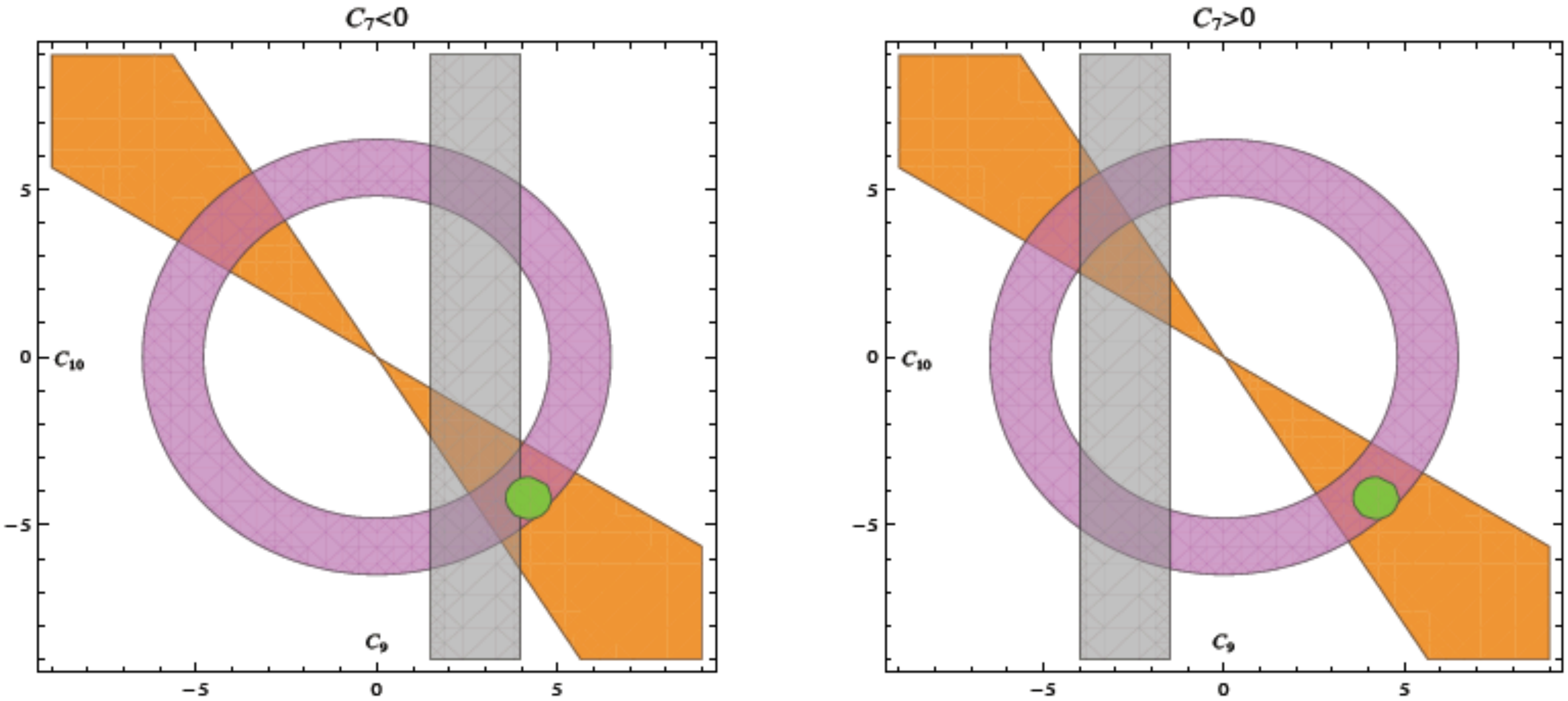
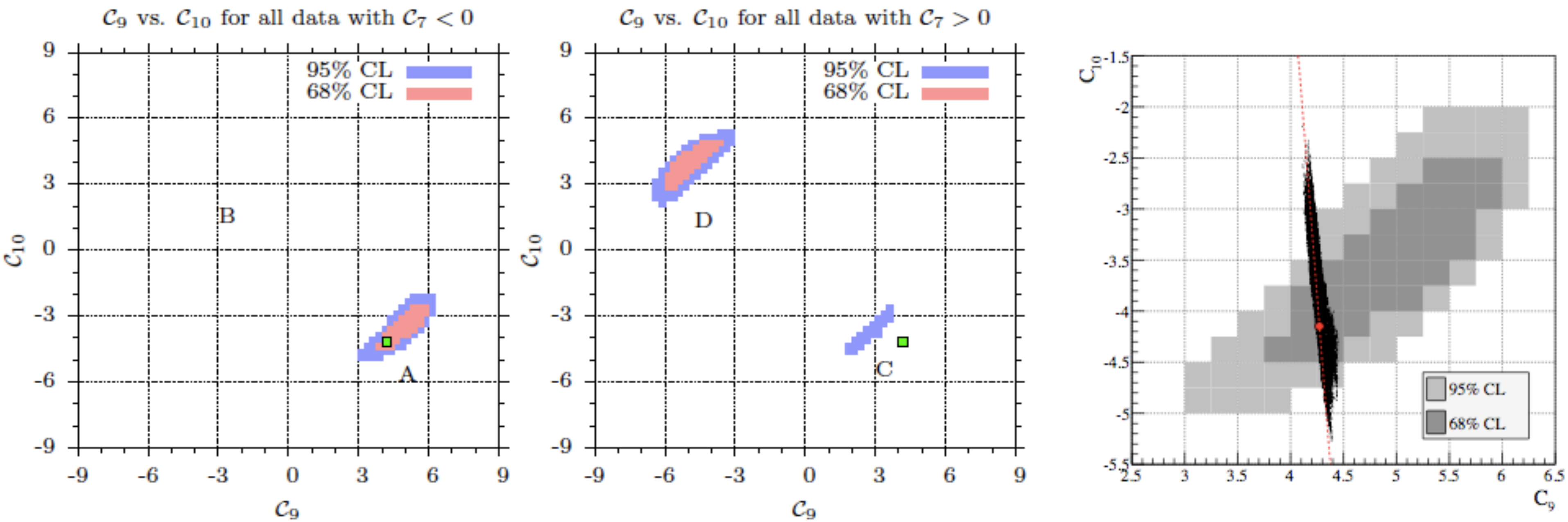


Figure 3: Future scenario of the model-independent bounds on real-valued C_9, C_{10} from $b \to s\mu^+\mu^-$ decays for $C_7 \simeq C_7^{\rm SM} < 0$ (left-handed plot) and $C_7 \simeq -C_7^{\rm SM} > 0$ (right-handed plot). The grey vertical bands denote the constraints arising if an $A_{\rm FB}$ zero at low q^2 could be established. There remain two allowed disconnected regions.

schematic from 1106.1547 [hep-ph]. Orange: AFB at lo reco $A_{FB} \propto C_9 C_{10}$, pink: $Br \propto C_9^2 + C_{10}^2$, grey $q_0^2 \propto -C_7/C_9$. Green point: SM

Precision tests from global fits C_7, C_9, C_{10}

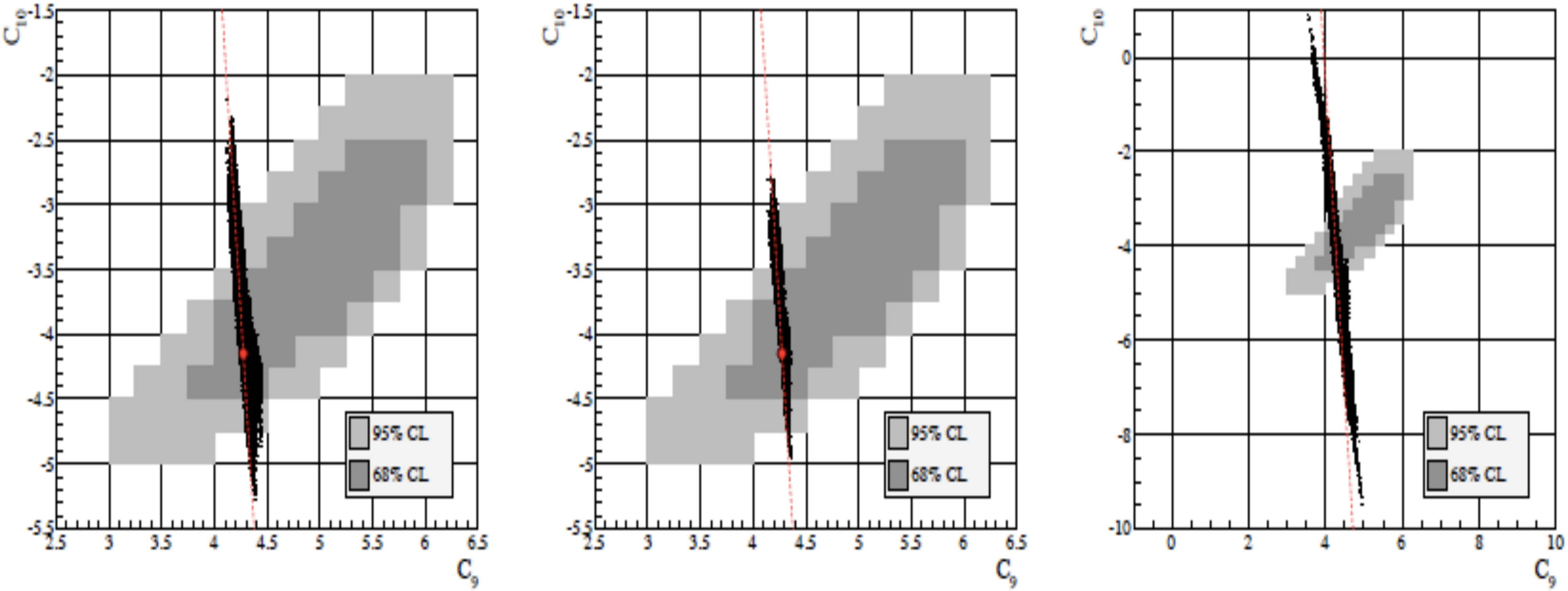


left: global analysis 1111.2558 [hep-ph], also Altmannshofer et al '11 ; solution C is ruled out by AFB-zero. right: red dot: SM; grey areas: allowed by $b \to s$ data; black points: SUSY model with squark flavor mixing 1205.1500 [hep-ph]

flavor suppression with NP at $\Lambda_{NP} = 1$ TeV: $|\tilde{c}_{10}| < 5 \cdot 10^{-4} (4 \cdot 10^{-3})$

limit on scale iff no suppression $\tilde{c}_{10} = 1$: $\Lambda_{NP} >$ 44 TeV (16 TeV)

Flavor Interplay with Higgs Physics (in SUSY)



left: from 1205.1500 [hep-ph] with $m_{h^0} > 114.4$ GeV, right and mid: courtesy of Stefan Schacht, Talk given at FLASY'12, Dortmund; right: no Higgs constraint, mid: 120 $< m_{h^0} < 130$GeV; Higgs mass calculated with FeynHiggs 2.9.0-beta