Heavy quarks in the Randall-Sundrum model

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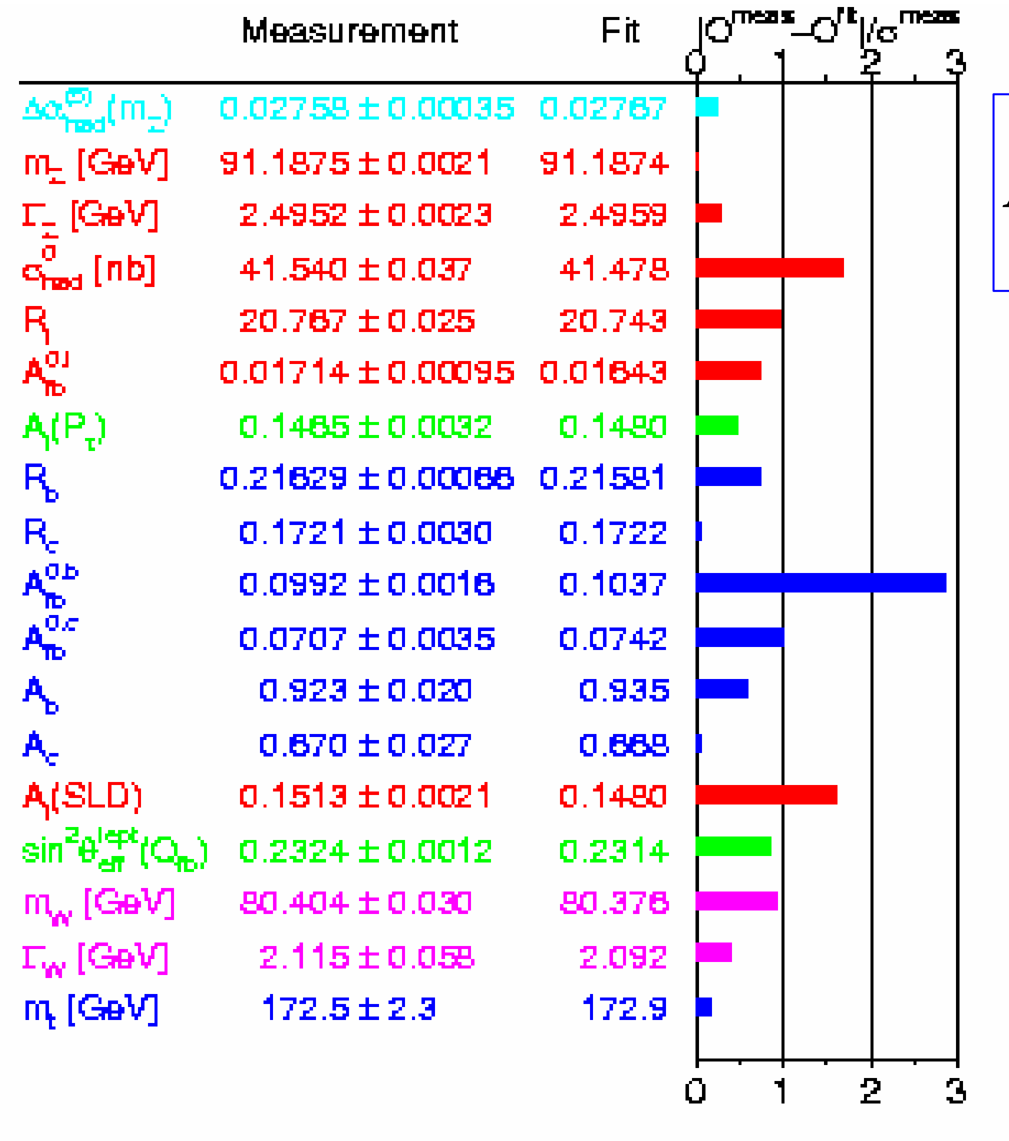
international linear collider

ECFA Study

Physics and Detectors for a Linear Collider

New Physics in the b sector ?



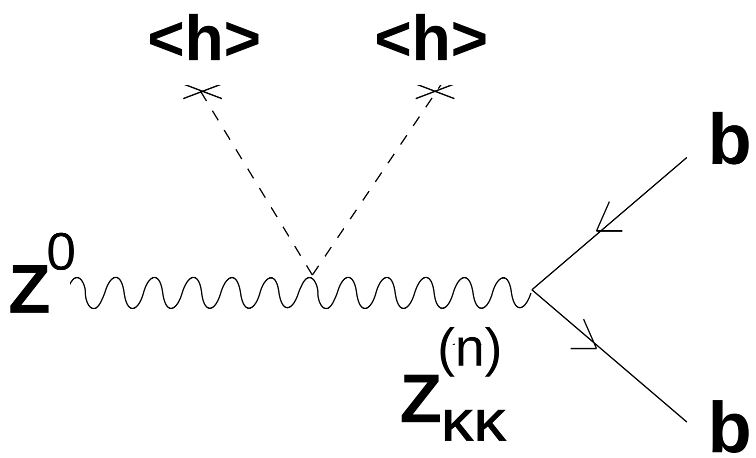
$$A_{FB}^{b}(\text{pôle}) \equiv \frac{\int_0^{+1}\sigma_\theta d\cos\theta - \int_{-1}^{0}\sigma_\theta d\cos\theta}{\sigma_0(e^+e^- \to \gamma/Z \to b\bar{b})}$$

$$= \frac{3}{4}\,\frac{(Q_Z^{e\,L})^2 - (Q_Z^{e\,R})^2}{(Q_Z^{e\,L})^2 + (Q_Z^{e\,R})^2}\,\frac{(Q_Z^{b\,L})^2 - (Q_Z^{b\,R})^2}{(Q_Z^{b\,L})^2 + (Q_Z^{b\,R})^2}$$

$$R_b \equiv \frac{\Gamma(Z \to b\bar{b})}{\Gamma(Z \to hadrons)}$$

$$= \frac{(Q_Z^{b\,L})^2 + (Q_Z^{b\,R})^2}{\sum_{q \neq t}[(Q_Z^{q\,L})^2 + (Q_Z^{q\,R})^2]}$$

Interpretation in an extra-dimensional model…



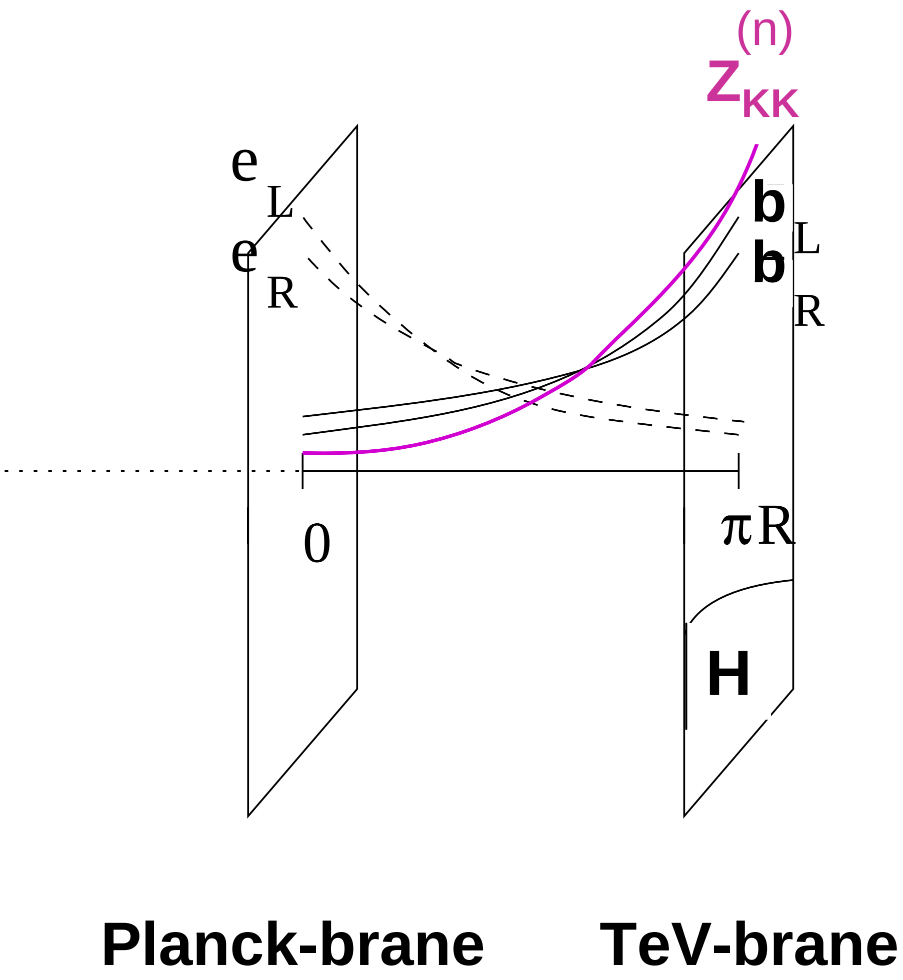
$$\left|\delta Q_Z^{f_l}\right| \approx 1\,{}^0\!/_{00} \quad << \quad \left|\delta Q_Z^{b_{L;R}}\right| \approx 1;\,30\,{}^0\!/_0$$

$$\text{Coupling } Z_{KK}^{(n)} f_l \overline{f_l} \;<<\; \text{Coupling } Z_{KK}^{(n)} b\bar{b}$$

$$\Downarrow$$

Natural condition within the RS model

The RS model :



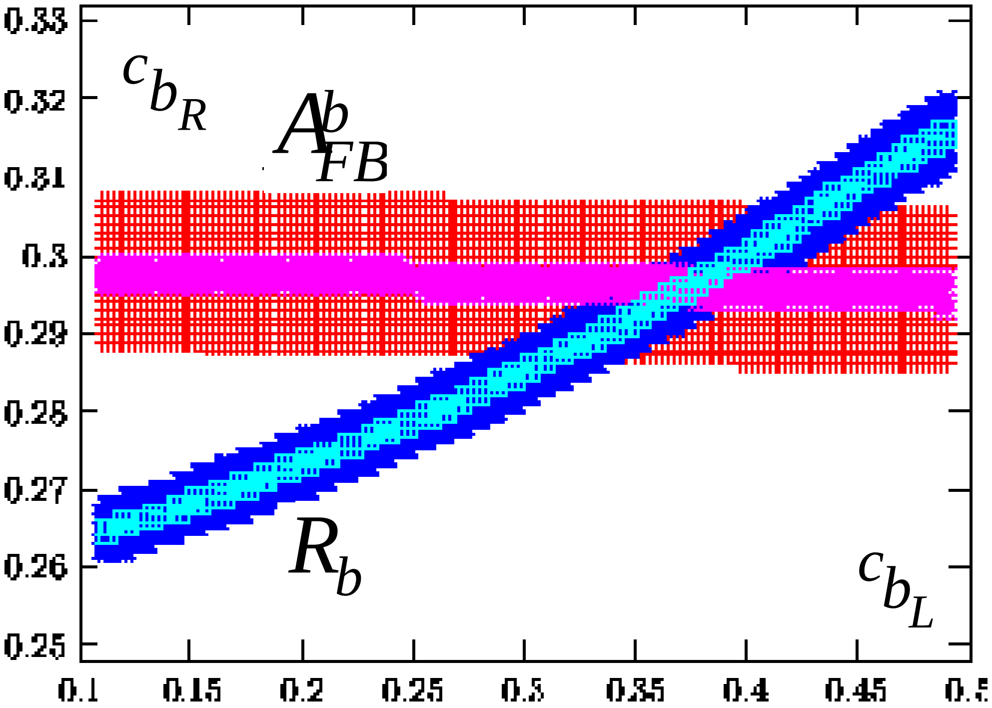
• **RS addresses the gauge *hierarchy* :**

$$M_* \approx 1\,\mathrm{TeV} \approx Q_{EW}$$

• **RS generates the mass *hierarchies* :**

$$m_e \ll m_b$$

…our results



$c_{f_l} >> 0.5$

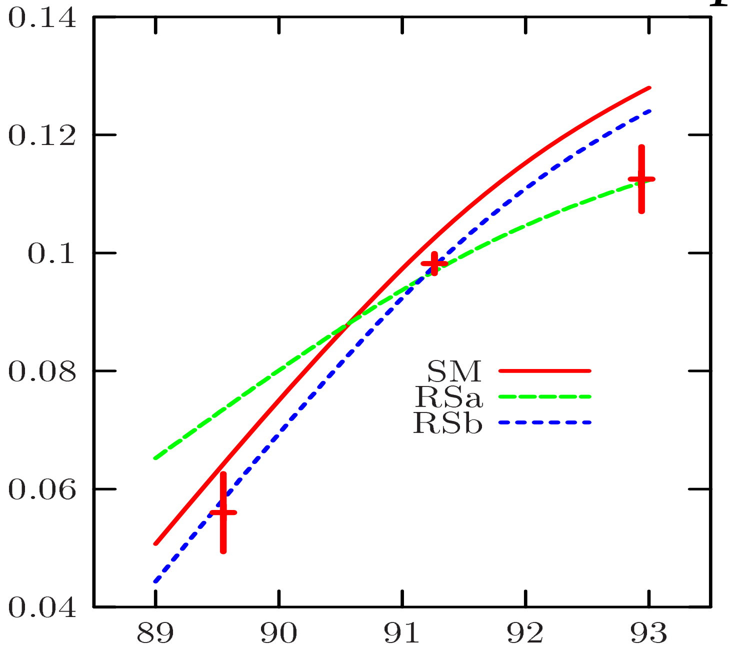
$$\begin{cases} M_{KK} = 3\,\text{TeV} \\ g_{Z'} = \sqrt{4\pi} \\ kR_c = 10.11 \end{cases}$$

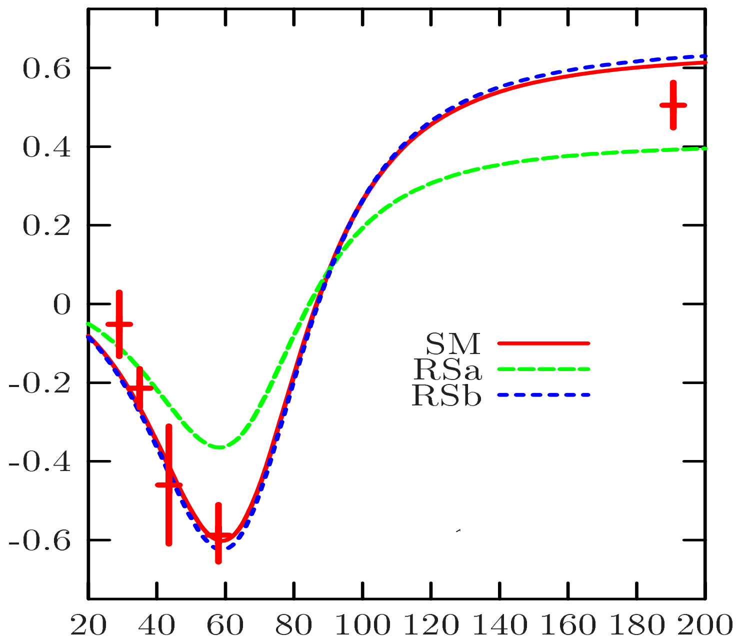
$A^b_{FB}(pole)$ and R_b exactly reproduced!

+ the off-pole measurements…

Fit $A_{FB}^{b}(\sqrt{s})$ and R_b SM: $\chi^2 = 24$ RSa: $\chi^2 = 20$ RSb: $\chi^2 = 14$

$A_{FB}^{b}(\sqrt{s}\,[\mathrm{GeV}])$





$\mathrm{b_R}$ under $SU(2)_L \times SU(2)_R \times U(1)_X$: $\begin{cases} Q_X = (B-L)/2 \Rightarrow I_R^3 = -1/2 & \text{RSa} \\ Q_X = -5/6 \Rightarrow I_R^3 = +1/2 & \text{RSb} \end{cases}$

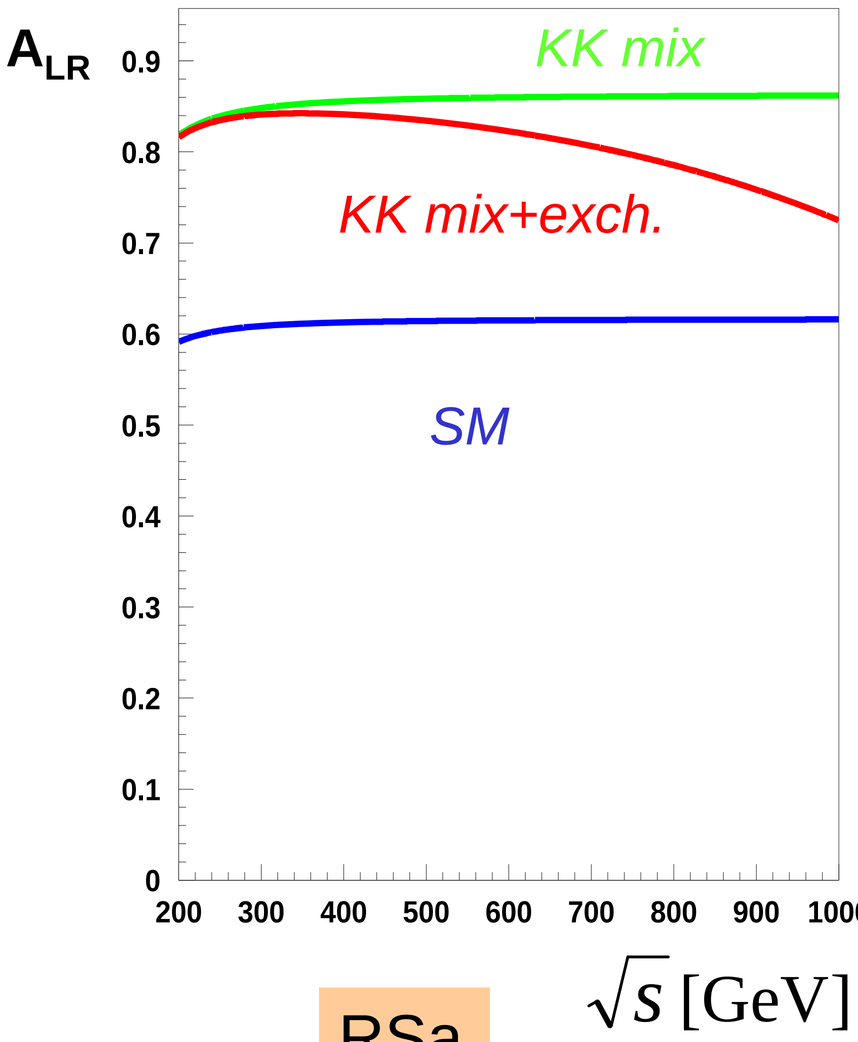
Implications @ ILC :

$$\text{Best signature: } e^+e^- \to \gamma / Z_{KK}^{(n)} \to b\bar{b}, t\bar{t}$$

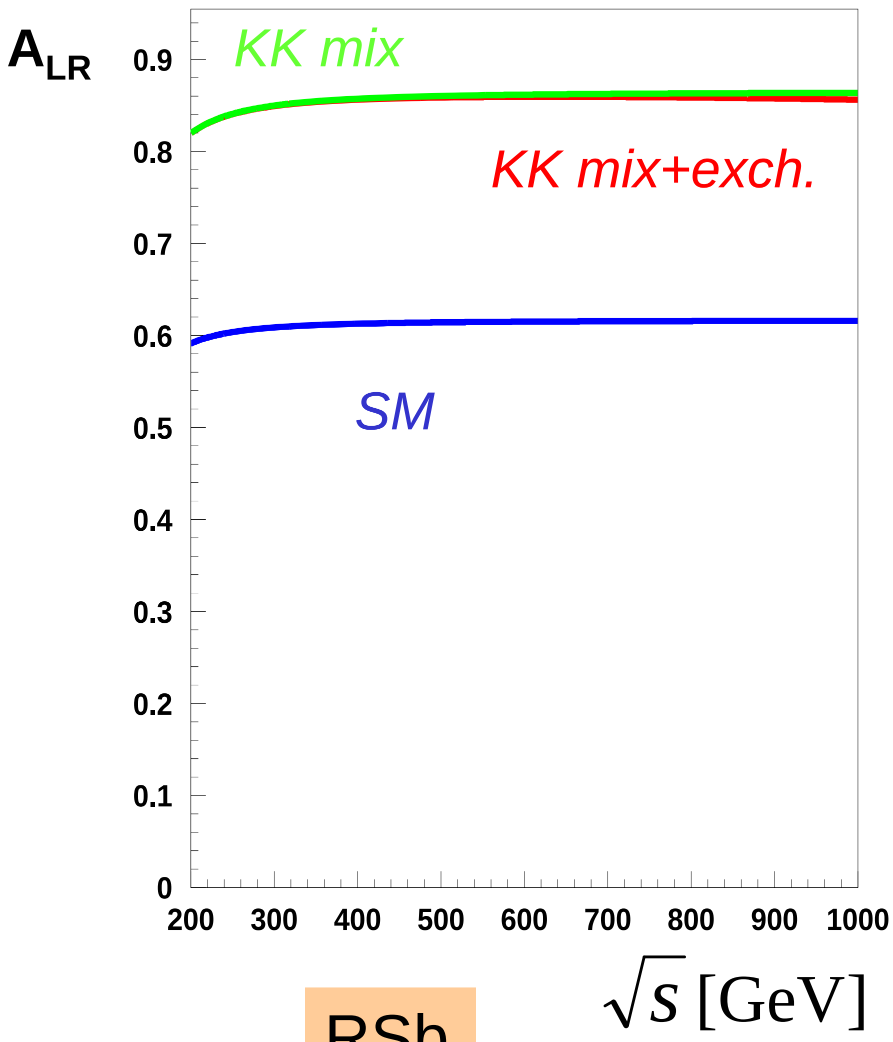
$$(\text{b, t couplings until} \times \sqrt{2\pi\, \text{kR}_{\text{c}}} \approx 8)$$

In particular, A_{LR} allows to distinguish between the ***RSa*** and ***RSb*** models…

bottom

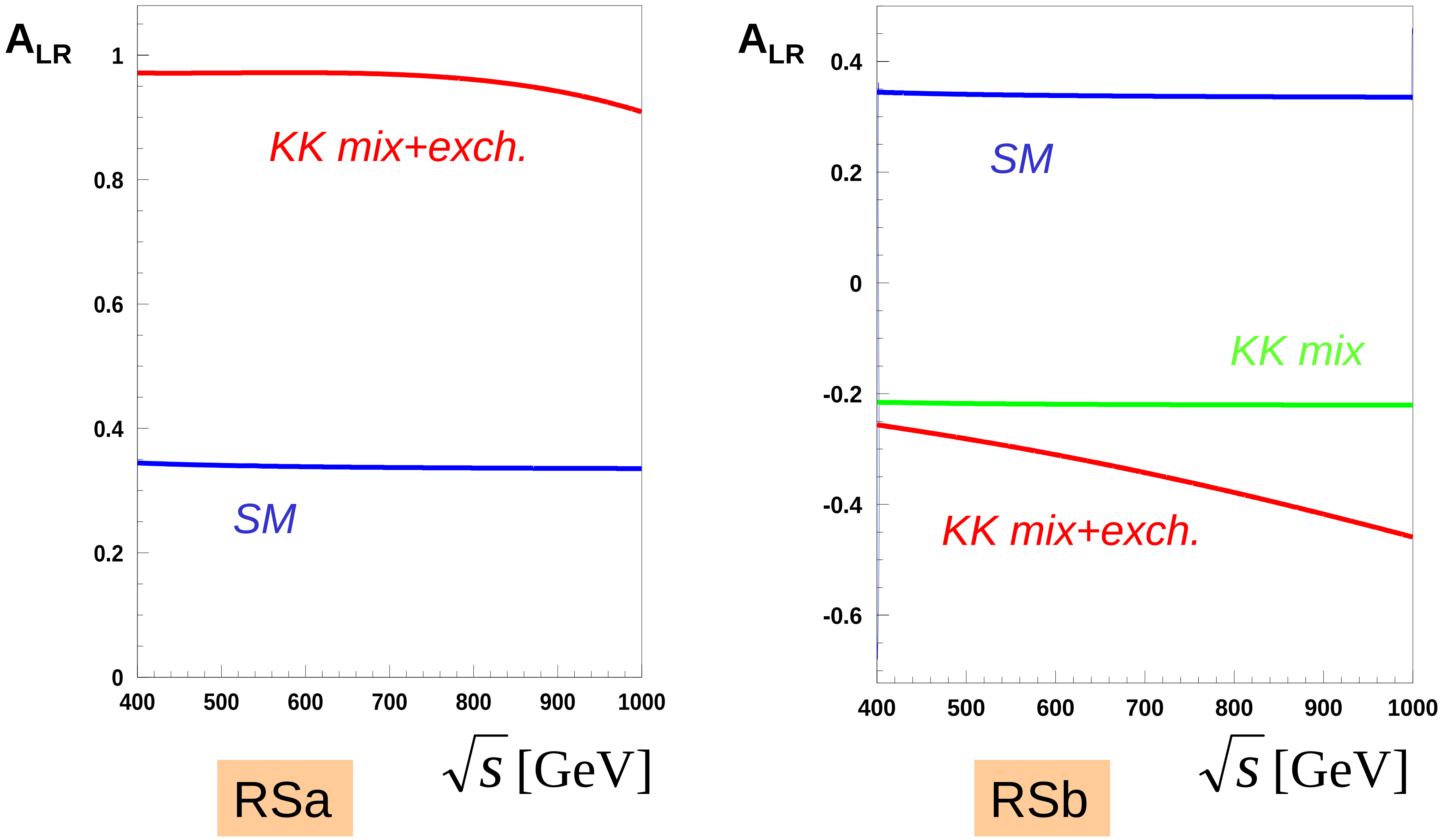


RSa



RSb

top



A_LR
1
0.8
0.6
0.4
0.2
0
KK mix+exch.
SM
400
500
600
700
800
900
1000
√s [GeV]
RSa
A_LR
0.4
0.2
0
-0.2
-0.4
-0.6
SM
KK mix
KK mix+exch.
400
500
600
700
800
900
1000
√s [GeV]
RSb

Conclusion

The effects of the Kaluza-Klein excitations, in the Randall-Sundrum scenario, are most important in the **b,t** sector

(or, via the AdS/CFT correspondance, the resonance effects appear for the composite fields of a strongly coupled theory).

$\Downarrow$

Motivation for the precision tests
on ***heavy*** quarks at linear colliders…