ÉCOLE POLYTECHNIQUE
FÉDÉRALE DE LAUSANNE

Study of the photon polarization in $B \to K\pi\pi\gamma$

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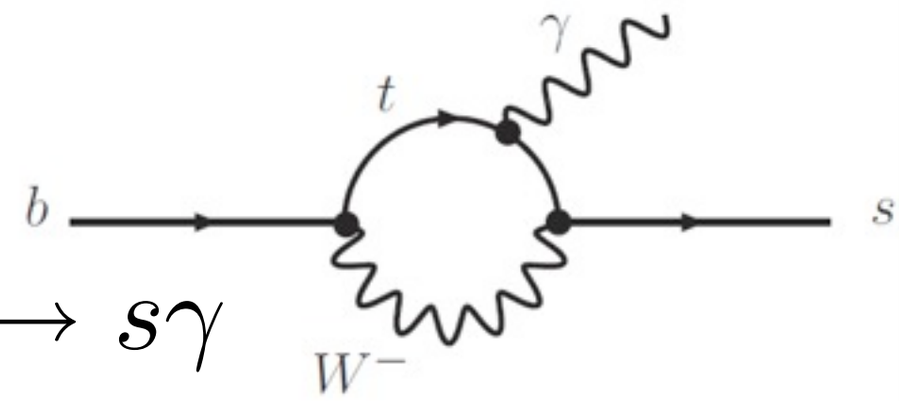


- SM predicts the photon emitted in $b \longrightarrow s\gamma$ decays to be predominantly left-handed

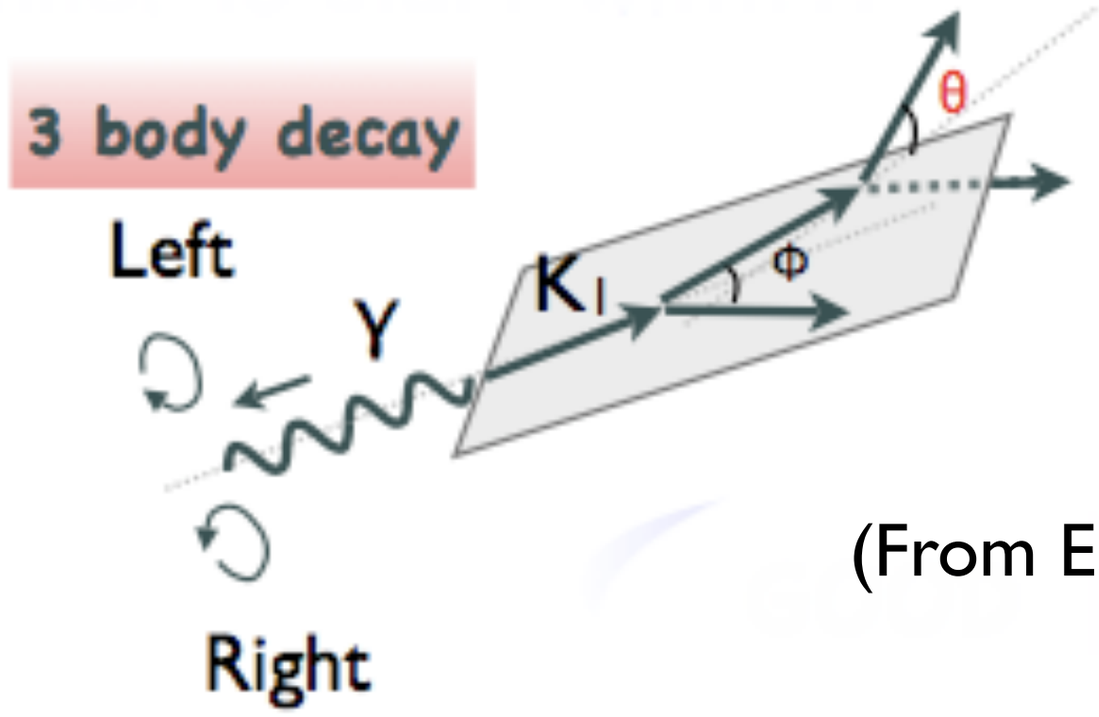
- Non-SM photon polarization may be observed in exclusive radiative decays

- Several models BSM predict the photon to acquire a significant right-handed contribution

- Photon helicity will be investigated in the three-body decay channel $B \rightarrow K_1(1270)\gamma \rightarrow K\pi\pi\gamma$

  - already observed by Belle (*Ref.* H. Yang *et al.*, The Belle collaboration, **hep-ex/0412039v2** (2005)
  - large BR (1.5k events per fb^{-1} expected)

- Photon polarization can be inferred from the kinematic distribution of the K_1 three-body decay



(From E.Kou)

- It requires three bodies to form a parity-odd triple product
- The sign of the triple product identifies the photon polarization

- From the theory

$$\frac{d\Gamma}{ds_{13}ds_{23}d\cos\theta} \propto$$

$$|\vec{J}|^2(1+\cos^2\theta) + \lambda_\gamma 2\mathrm{Im}\left(\hat{n}\cdot(\vec{J}\times\vec{J}^*)\right)\cos\theta$$

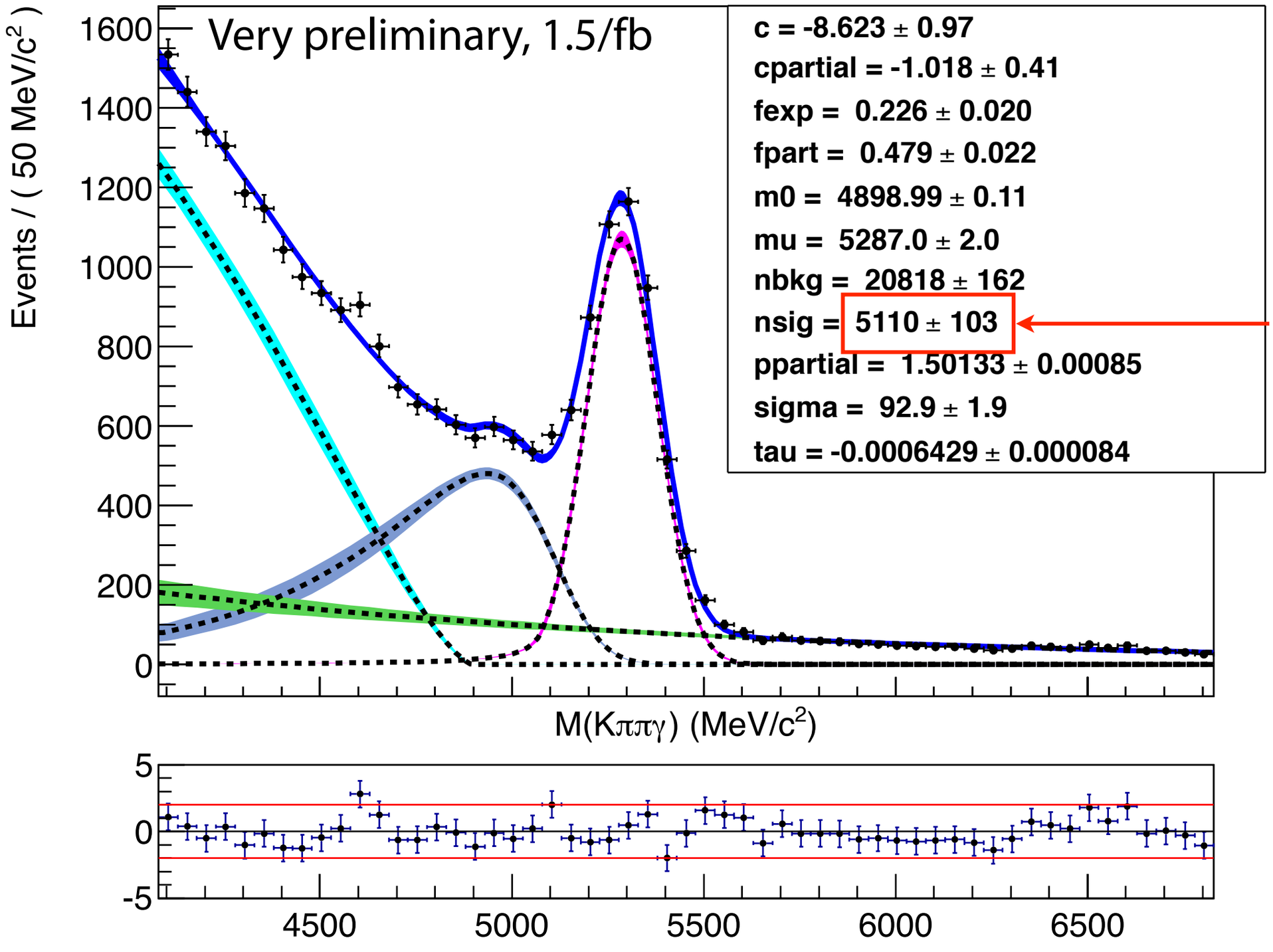
where J is the helicity amplitude
p_i = final state particles momenta
$s_{ij} = (p_i+p_j)^2$
$s = (p_1+p_2+p_3)^2$
cos θ from triple product $\cos\theta \equiv \left(\frac{\vec{p}_1\times\vec{p}_2}{|\vec{p}_1\times\vec{p}_2|}\right)_z$
λ_γ is the photon polarization

- An angular analysis is needed for cos θ

- The helicity amplitude has to be extracted from the Dalitz

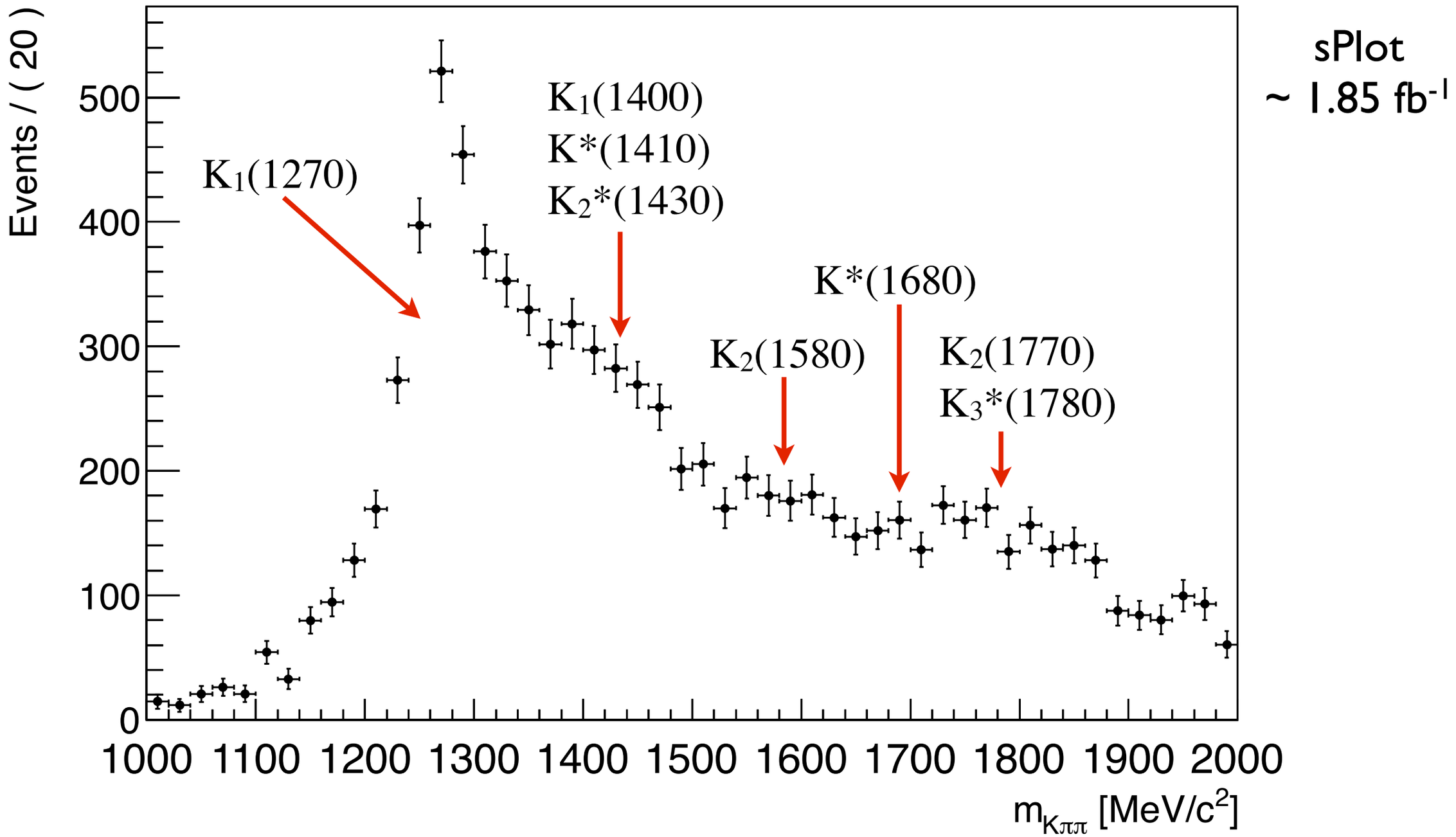
Ref. M. Gronau, Y. Grossman, D. Pirjol, A. Ryd, **hep-ph/0107254** (2002)

- Define a selection and fit B mass



BR ~ (29±9)x10^{-6}

- Extract background subtracted Kππ spectrum (*sPlot* technique)

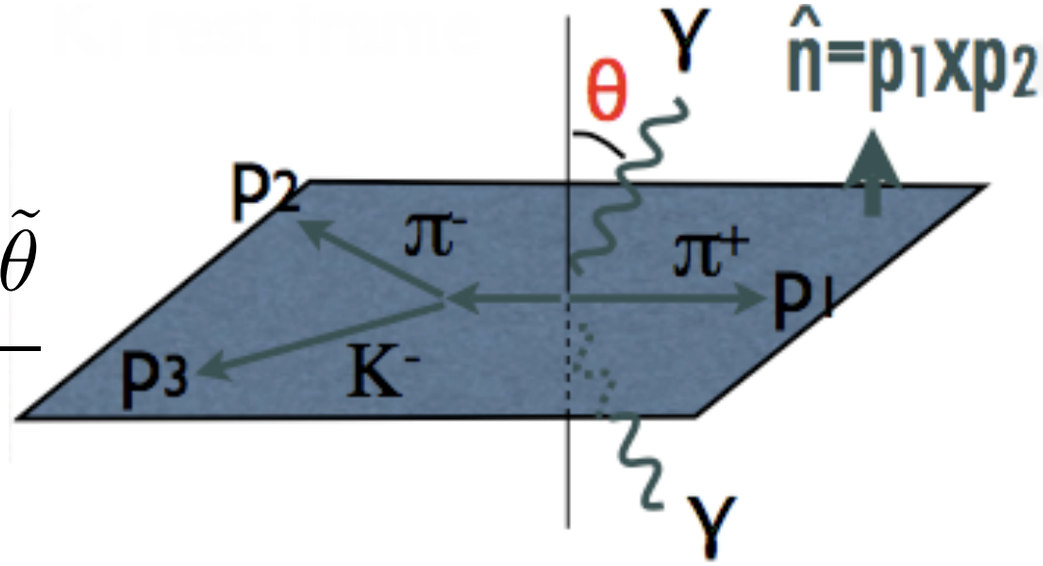


sPlot
~ 1.85 fb^{-1}

- Identify resonances and relative contamination

- Study the up-down asymmetry

$$\mathcal{A} = \frac{\int_0^{\pi/2} \frac{d\Gamma}{d\cos\tilde{\theta}} d\cos\tilde{\theta} - \int_{\pi/2}^{\pi} \frac{d\Gamma}{d\cos\tilde{\theta}} d\cos\tilde{\theta}}{\int_0^{\pi} \frac{d\Gamma}{d\cos\tilde{\theta}} d\cos\tilde{\theta}}$$



Ref. M. Gronau, Y. Grossman, D. Pirjol, A. Ryd, **hep-ph/0107254** (2002)

- Full angular and Dalitz analysis
  - This method consists in exploiting the full angular and Dalitz analysis of the K_1 resonances
  - It is expected to be more sensitive than up-down asymmetry to photon polarization
  - It requires the $K_1(1400)$ resonance contribution to the $K\pi\pi\gamma$ mass distribution to be negligible wrt the K1(1270) (otherwise hadronic uncertainties can't be cancelled from calculations)