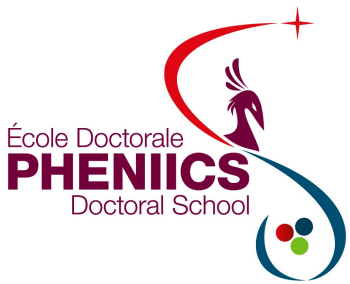
# $B^0 \to K^{*0} e^+ e^-$ angular analysis at LHCb

## An indirect search for New Physics

Fabrice Desse

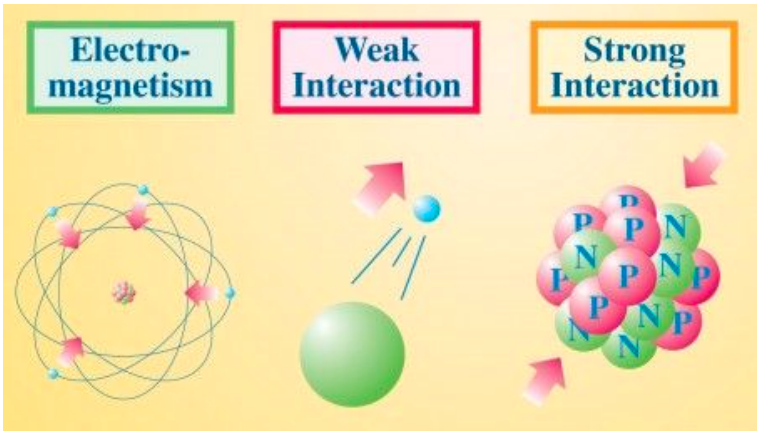
Laboratoire de l'Accelerateur Lineaire / University of Paris Saclay
Orsay, France



# Why New Physics ?

**The Standard Model works very well**




Its actually the best physics theory of all time !

**But ...**

- It has no dark matter candidates
- It cannot explain the matter/anti-matter asymmetry of the Universe
- It is incompatible with General Relativity
- ...

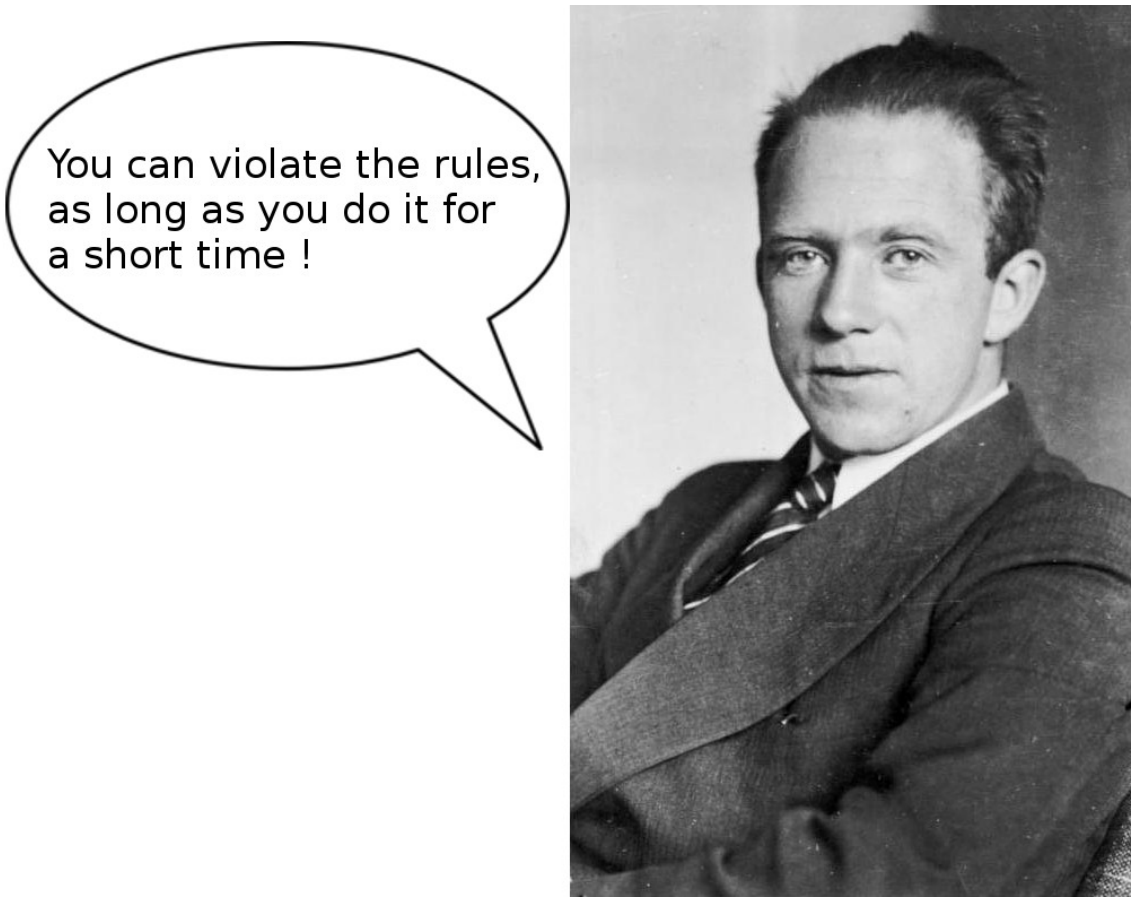
**Need New Physics = new particles/new interactions**

# How to create these new particles ?

$$E = mc^2$$

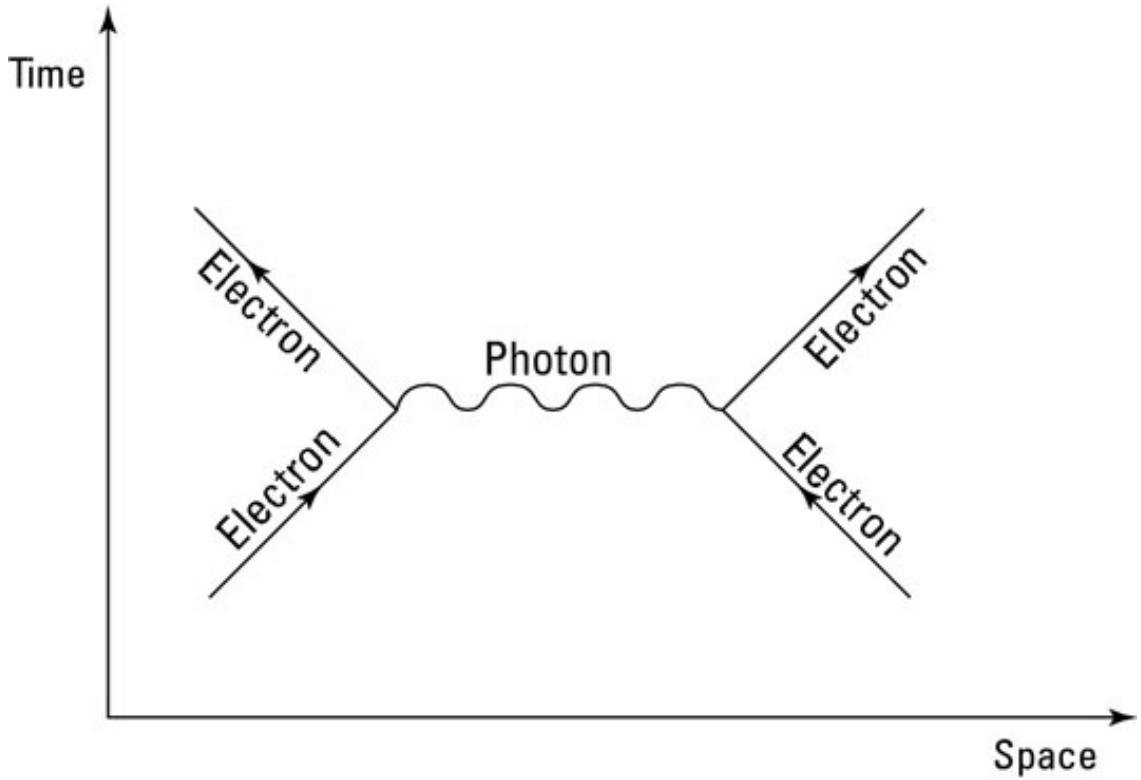

But what if $m_{NP} > \frac{E}{c^2}$ ??

# That good old friend quantum mechanics




$$\Delta E \Delta t \geq \frac{\hbar}{2}$$

# The concept of virtual particle

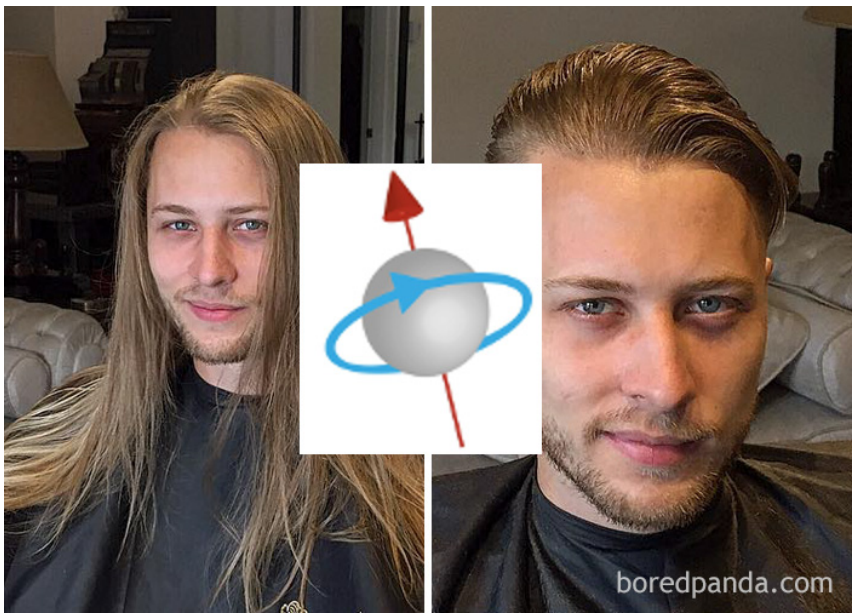



- Because it lives for a very short time, the mass of the photon can be non zero !
- We found a way to create a (virtual) particle which has more energy (mass) than the initial/final state !

# So what ?

Annnoying guy: "Maybe you can create a new physics particle, but its lifetime is so short that you'll never observe it ..."

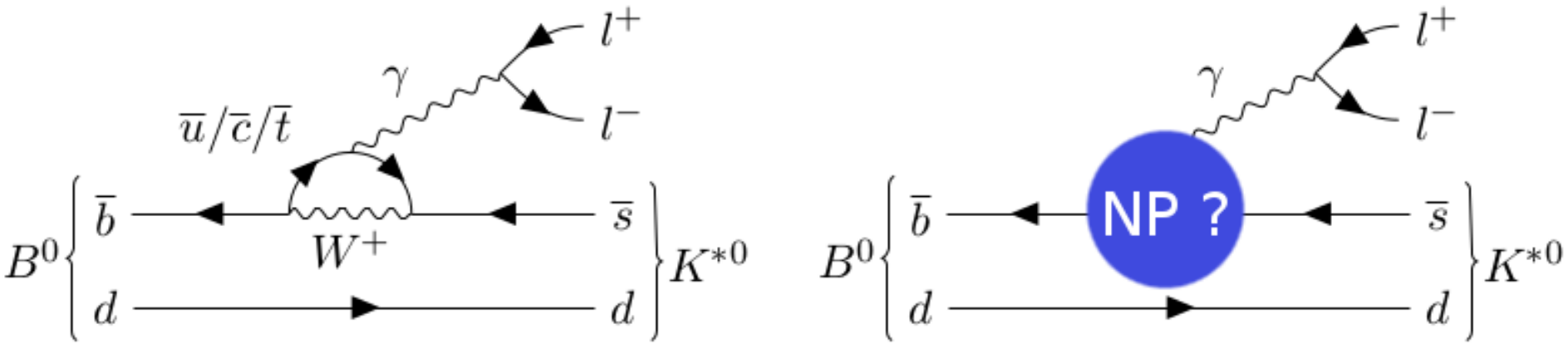
The spin structure of the new physics particle affects the angular distribution of final states particles




New Physics in the loop

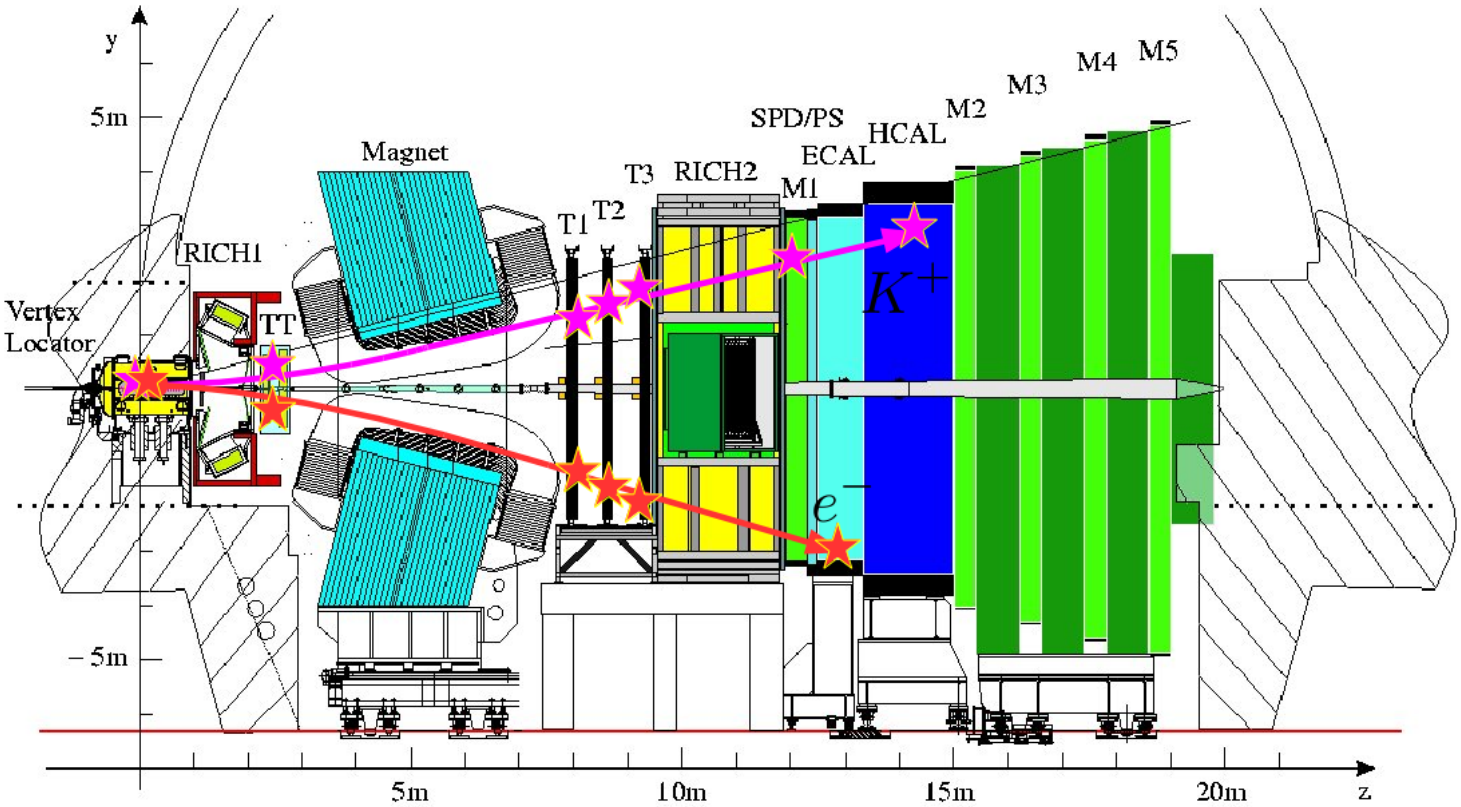
No new physics in the loop

# Why $B^0 \to K^{*0} e^+ e^-$ ?




- Quantum loop of virtual particles: possible presence of New Physics
- $b \to s$ transitions suppressed in the SM: clear signature of New Physics
- $K^{*0} \to K^+ \pi^-$, thus all final states ($e^+ e^- K^+ \pi^-$) particles are charged: easy to reconstruct in the detector

# In real life

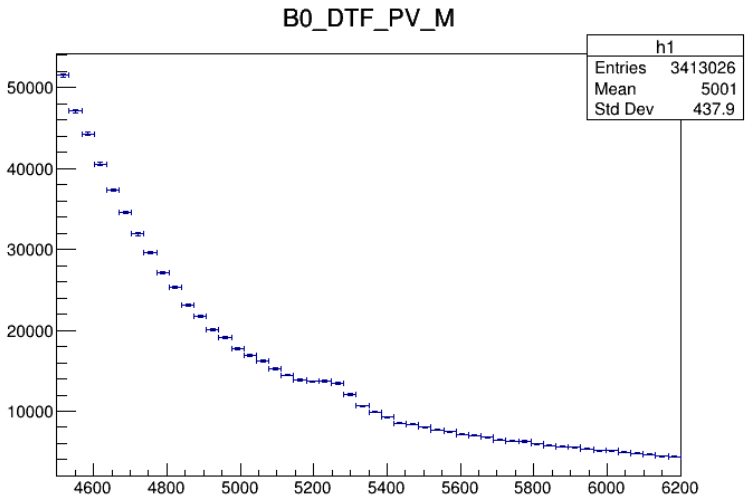



Measure the 4-momentum of all final states particles

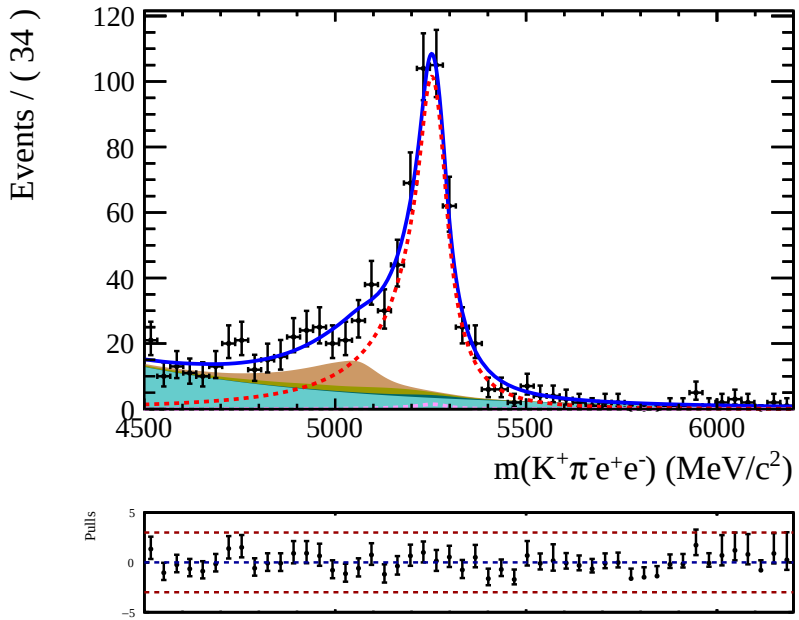
# Looking for the needle in the haystack

$$m(K^+\pi^-e^+e^-) \text{ should be } = m(B^0) = 5280\,\mathrm{MeV}/c^2$$

Before the selection




After the selection

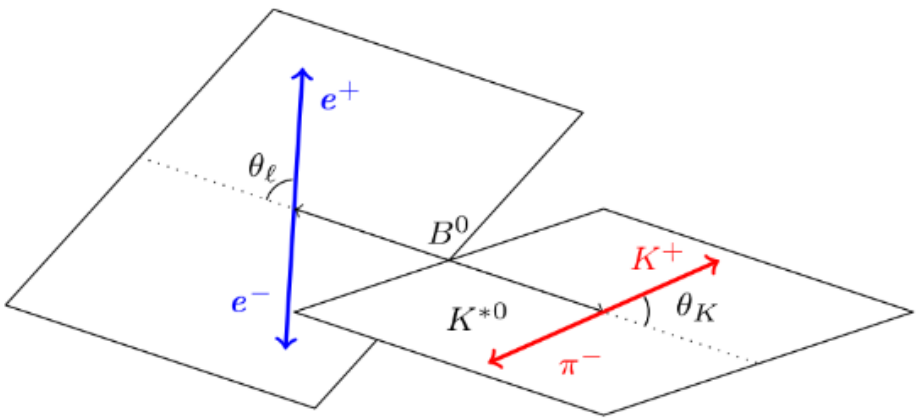


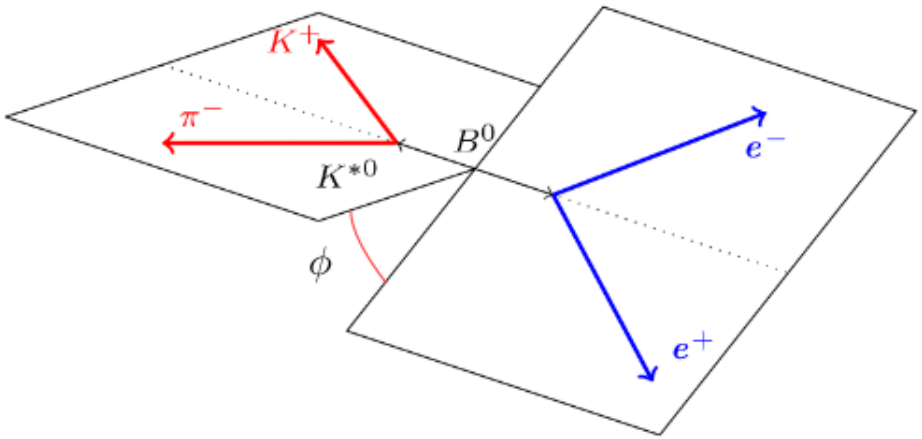

$\Rightarrow$ Tow years of my life $\Rightarrow$

# Defition of the angles

$$d^4\Gamma\left(B^0 \to K^{*0} e^+ e^-\right) = [\text{Probability density}] \times [d\text{Volume}] \quad ,$$

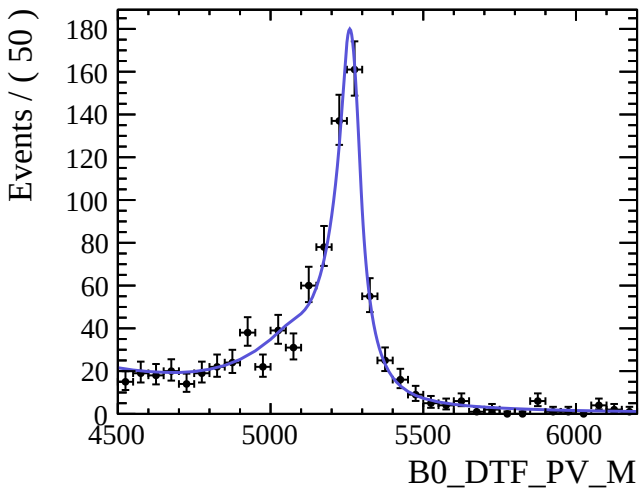
$$d\text{Volume} = dq^2 \times d\Omega = dq^2 \times d(\cos\theta_l) d(\cos\theta_k) d\phi$$

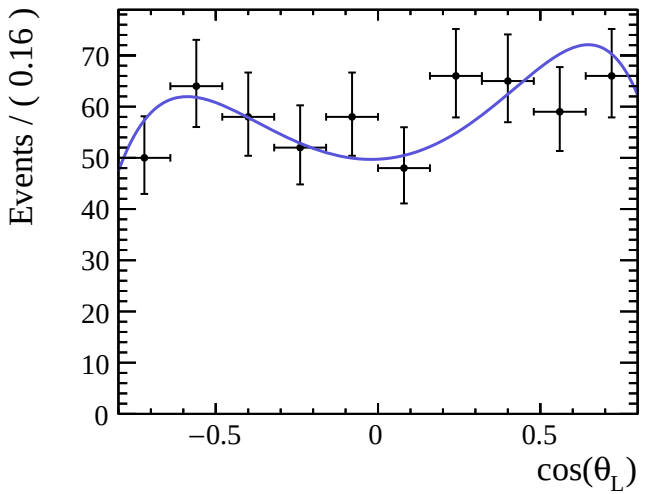


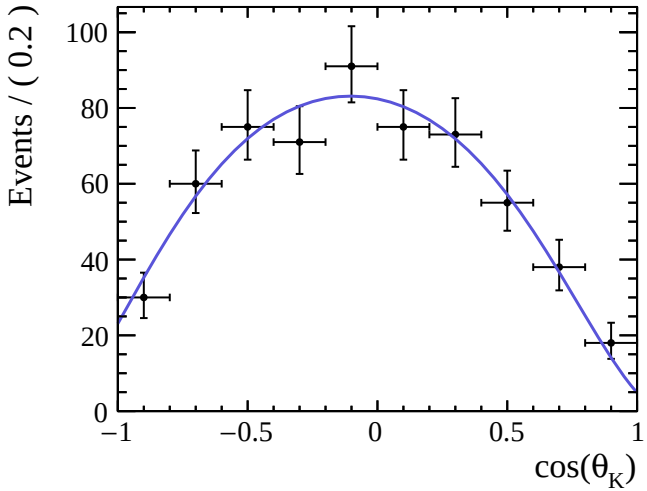



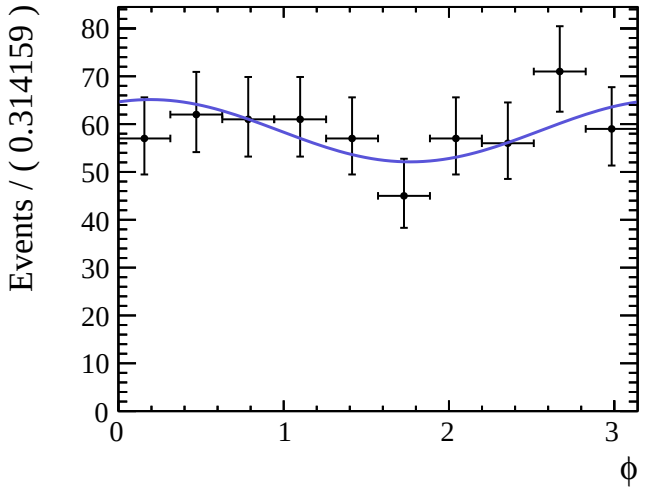
# Fitting the angles

## Toy data (simulation with SM values)



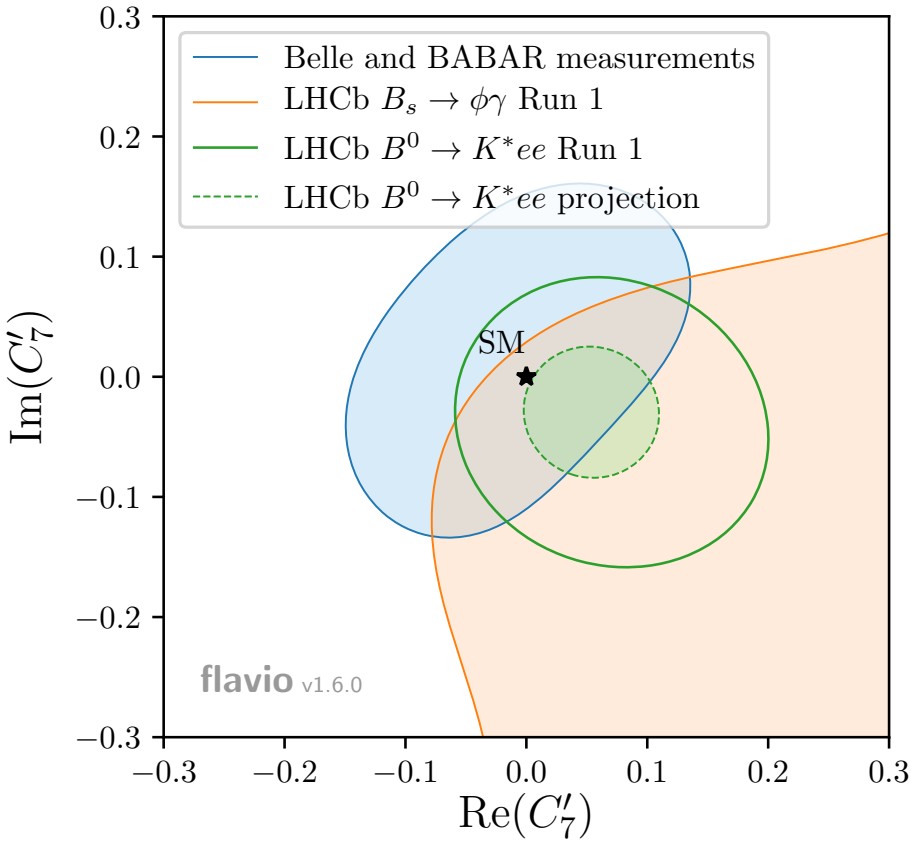



# Conclusion

- New Physics (NP) beyond the standard model is needed
- One can look for NP particles occuring in quantum loop: can probe a much higher scale than direct searches
- The spin structure of NP particles affects the angular distributions of the final state particles
- $B^0 \to K^{*0} e^+ e^-$ is particularly well suited:
  - has a loop where NP can occur
  - is suppressed in the SM
  - is sensitive to only one Wilson coefficient at very low $q^2$



# Backup