

# Current Trends in Flavor Physics



## France in Belle II: When & What ?

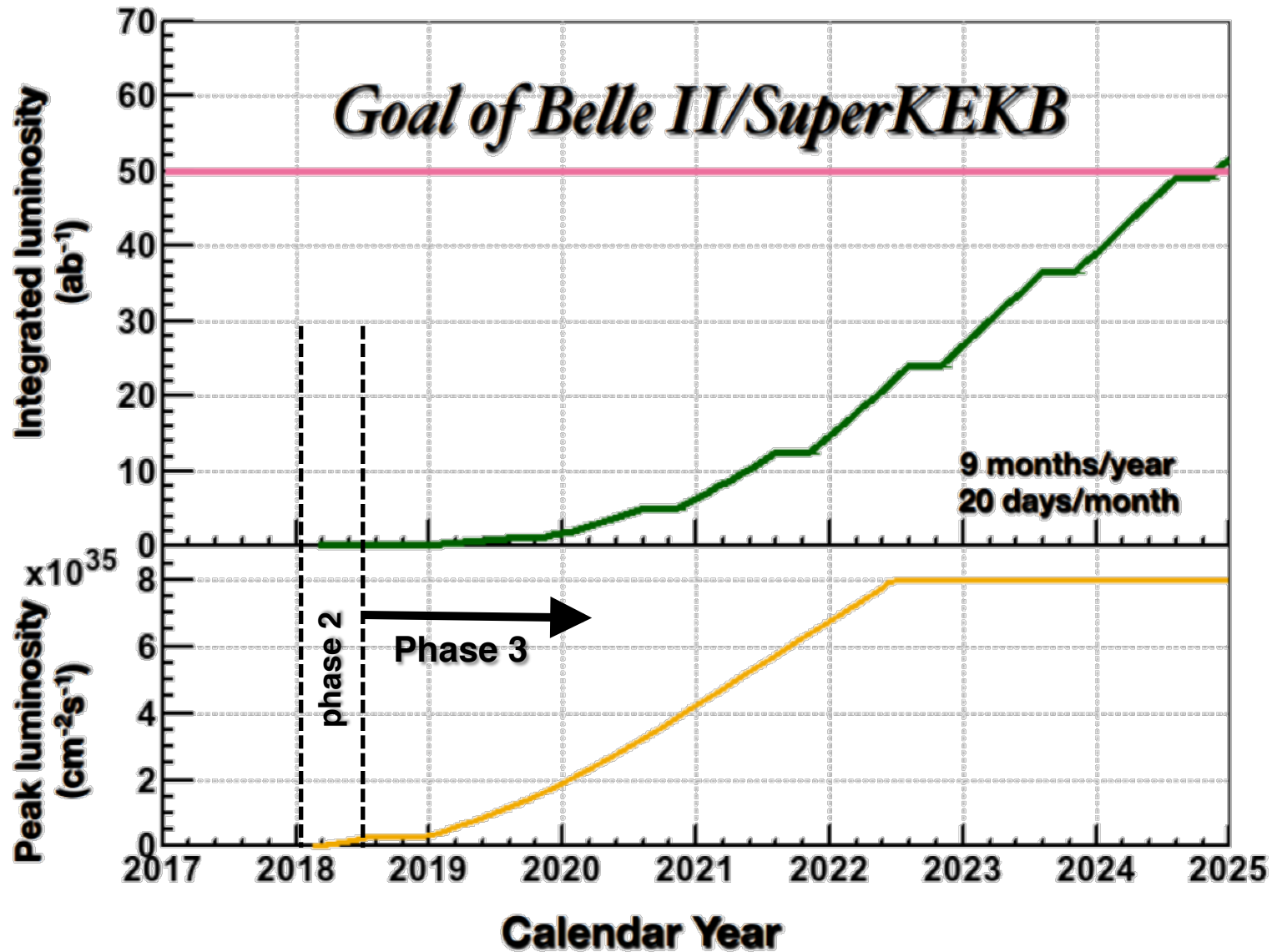
Jerome Baudot  
on behalf of the IPHC & LAL groups

GDR Intensity Frontier  
2017 March 29-31



- The SuperKEKB & Belle II projects
- Highlights on physics observables
- IPHC & LAL groups
- Radiative B decays
- France to join Belle II this year!

# It's mostly about luminosity...



# The collider

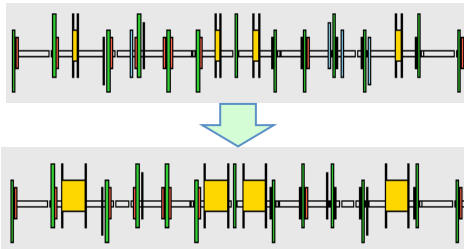
**$e^+$  4GeV 3.6 A**  
 **$e^-$  7GeV 2.6 A**

SuperKEKB

Target:  $L = 8 \times 10^{35} / \text{cm}^2 / \text{s}$

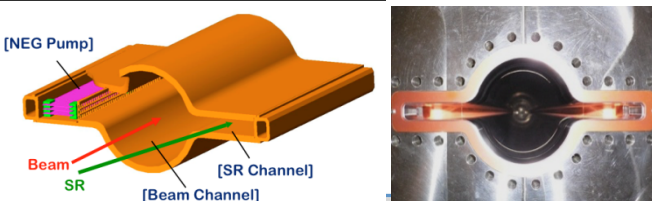
New superconducting / permanent  
final focusing quads near the IP  
New IR  
Colliding bunches

Replace short dipoles  
with longer ones (LER)



Redesign the lattices of HER & LER  
to squeeze the emittance

TiN-coated beam pipe with antechambers  
Cu for wigglers and Al alloy for the rest



Damping ring

@1.1 GeV  
To inject low emittance positrons

Low emittance gun

To inject low emittance electrons

$$L = \frac{\gamma_{\pm}}{2e r_e} \left( 1 + \frac{\sigma_y^*}{\sigma_x^*} \right) \frac{I_{\pm} \xi_{\pm y}}{\beta_v^*} \left( \frac{R_L}{R_y} \right)$$

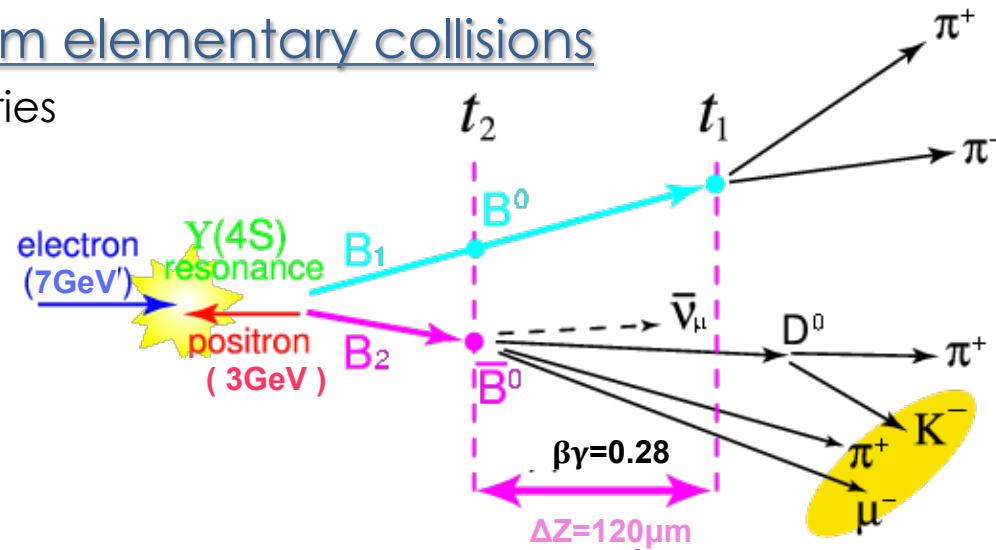


Positron source  
New positron target /  
capture section

# ...It's also about cleanness!

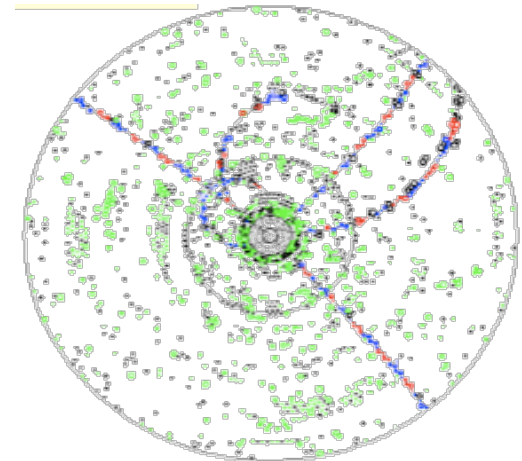
## Clean events from elementary collisions

- Usual for B factories



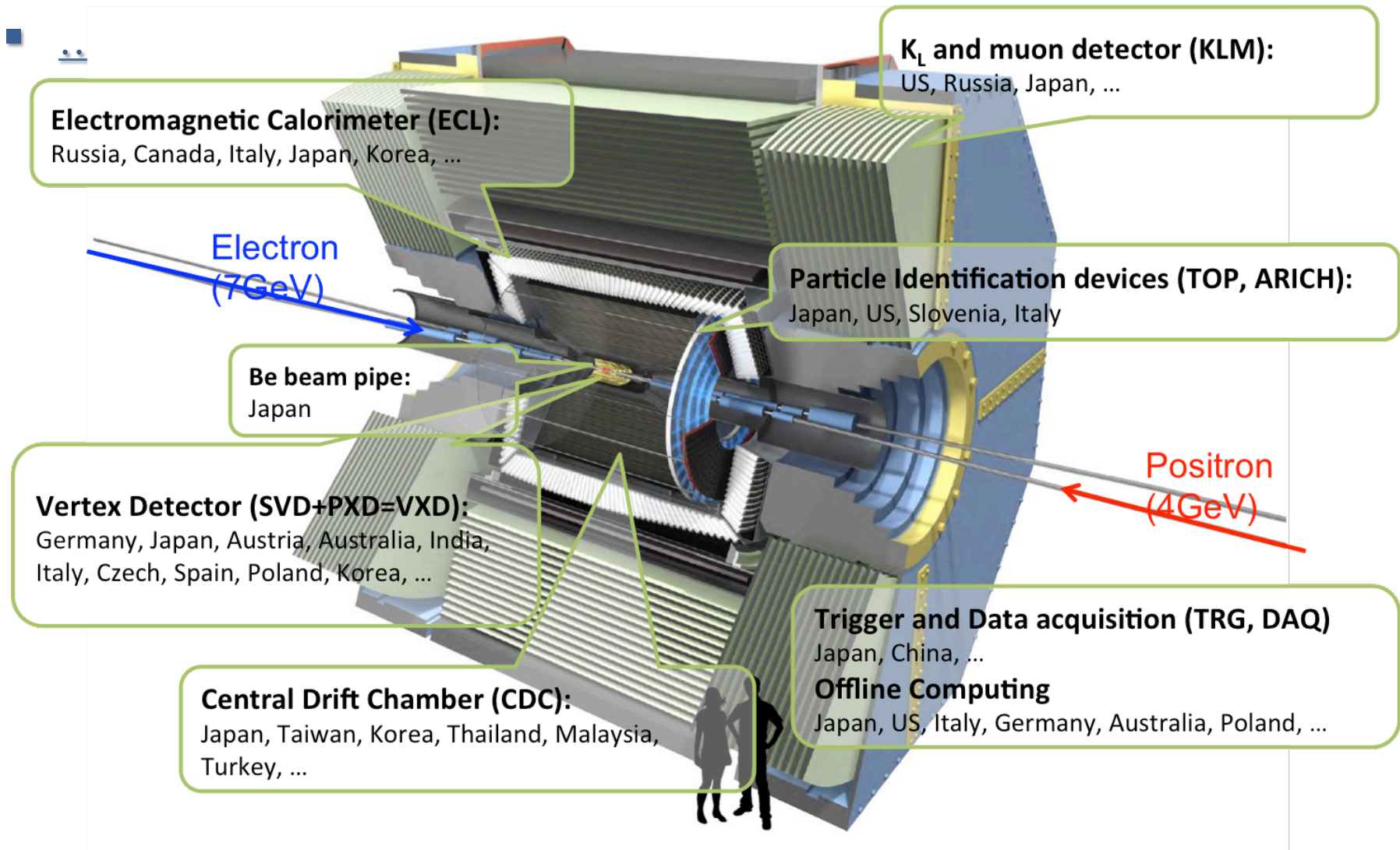
## Large luminosity means beam background

- ~50% of ECAL energy
  - dominates occupancy in vertex detector
- See [A.Zupanc](#) talk on Thursday





# The Detector



# Highlight of physics observable

## ■ Statistics expected for 50 ab<sup>-1</sup>

- 55 x 10<sup>9</sup> B $\bar{B}$
- 65 x 10<sup>9</sup> c $\bar{c}$
- 65 x 10<sup>9</sup>  $\tau^+\tau^-$

## ■ Time dependent CP asymmetries

→ [S. Wehle](#) talk on Wednesday

## ■ Semileptonic & leptonic decays

→ [A. Zupanc](#) talk on Wednesday

## ■ Rare decays

→ [J. Brodziska](#) talk on Wednesday

## ■ Dark sector

- Invisible decays

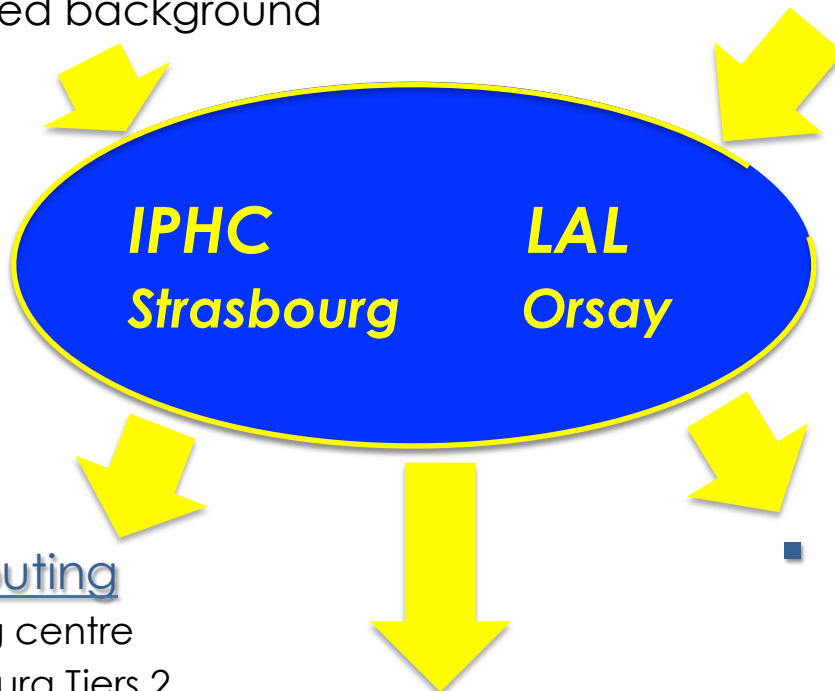
# 2 French groups so far...

## ■ Common start @ SuperKEKB

- Luminosity
- Beam-induced background

## ■ Inputs from theory

- E.Kou @ LAL
- B2TIP  
[confluence.desy.de/  
display/BI/B2TiP+WebHome](http://confluence.desy.de/display/BI/B2TiP+WebHome)



## ■ Common computing

- Lyon computing centre
- Orsay & Strasbourg Tiers 2

## ■ Belle II commissioning

- ARICH
- VXD (BEAST)

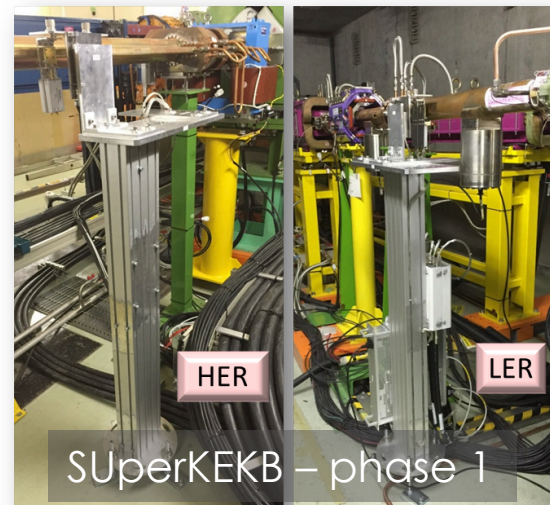
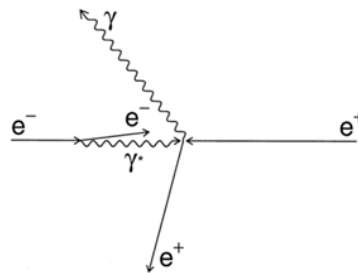
## ■ Common analysis

- Radiative B decays  
→  $\gamma$  polarisation

# Luminosity & Background

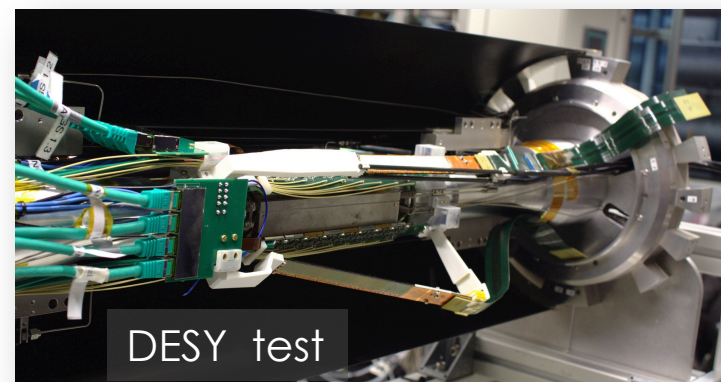
## Luminometer (LAL)

- Radiative Bhabha at vanishing photon angle
- Fast feedback / each bunchX
- $\sigma_L/L \approx 10^{-2}$  to  $10^{-3}$  in 1 to 10 ms
- Diamond sensors + fast charge amplifier located on beam pipe @ +30 & -12 m from IP
- already tested during phase 1 (2016)



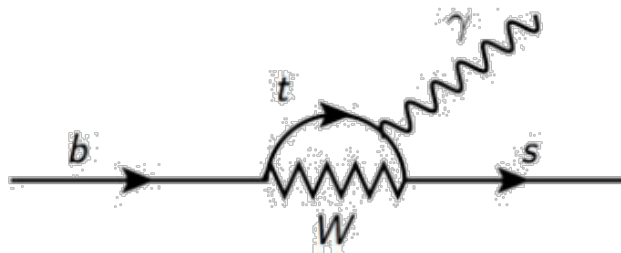
## Beam-induced background measurement or BEAST (IPHC)

- Planned for phase 2 (Feb.-Jun. 2018)
  - Up to  $\mathcal{L} = 10^{34} \text{ cm}^{-2} \cdot \text{s}^{-1}$
- Dedicated instrumentation before final VTX
  - monitor background rate
  - cross-check / simulation
- PLUME Silicon mini tracker (16M pixels)
- Disentangle various bckgrnd particle sources
  - Single-beam / beam-beam





# Radiative B decays



See [O.Deschamps](#) talk for LHCb on Wednesday

## ■ Standard Model

- V-A coupling + Prob(helicity flip)  $\sim m_f$

$$\tan \psi = \left| \frac{A(b_L \rightarrow s_R \gamma_R)}{A(b_R \rightarrow s_L \gamma_L)} \right| \approx \frac{m_s}{m_b}$$

B ( $\bar{B}$ ) almost only to  $\gamma_R$  ( $\gamma_L$ )

## ■ New physics

- New heavy right-handed fermion

$$\left| \frac{A(b_L \rightarrow s_R \gamma_R)}{A(b_R \rightarrow s_L \gamma_L)} \right| \approx \frac{m_{f_{heavy}}}{m_b}$$

Atwood, Gronau, Soni  
PRL79('97)

# Accessing the photon polarization

## ■ Direct measurement

- $B^+ \rightarrow f^+ \gamma_R$
- $\gamma$  helicity meas. requires  $f$  as a 3 body states

Gronau, Grossman,  
Pirjol, Ryd  
PRL88('01)

$$B^+ \rightarrow K_1 \gamma$$

$$\hookrightarrow K^+ \pi^+ \pi^- \gamma$$

- Interferences of various resonances within  $K_1$  decays

E.Kou, F.Le Diberder  
in preparation

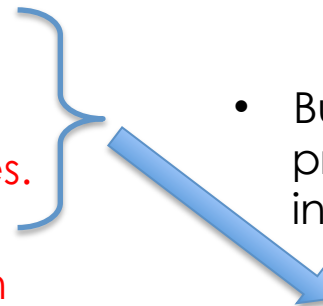
Dalitz analysis

⊗

Correlation between res.



Fit to extract polarization



## ■ Testing NP hypothesis

- CPV through mixing = 0 in SM
- No interference due to  $\gamma$  polar

$$B^0 \rightarrow f_{CP} \gamma_R / \bar{B}^0 \rightarrow f_{CP} \gamma_L$$

$$B^0 \rightarrow K_1 \gamma$$

$$\hookrightarrow K_S^0 \pi^+ \pi^- \gamma$$

- $S_{CP} \neq 0 \Rightarrow C'_7$  not negligible!

$$S_{CP} \approx \sin 2\psi \times \sin 2\beta$$

- But polarization extraction requires proper account of resonance interferences

dilution factor

S.Akar et al.  
to be submitted

## ■ Current situation ~ null result

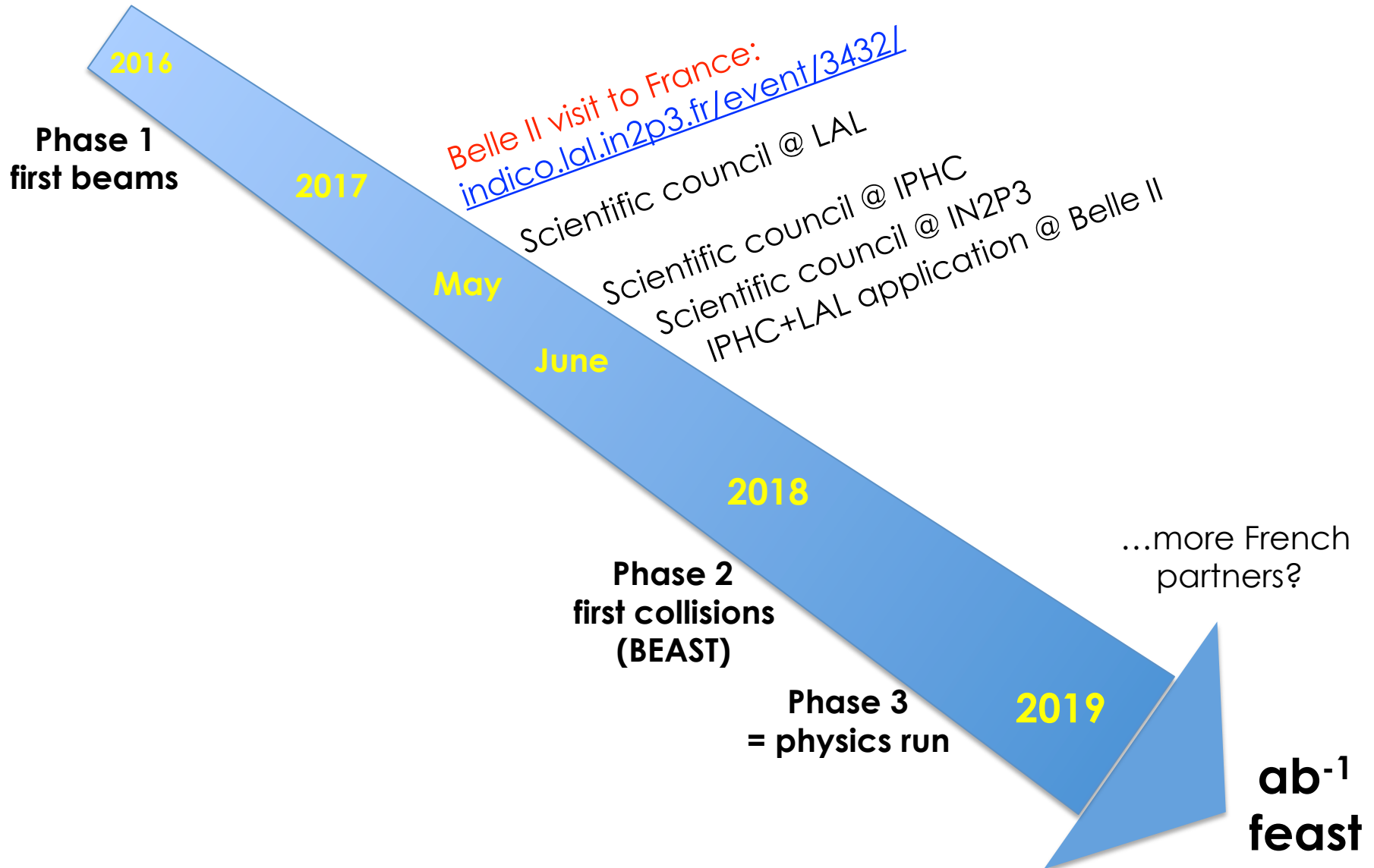
- BaBar PRD78 (2008)
  - 0.427  $\text{ab}^{-1}$  analysed
  - $S_{K_S \pi^0 \gamma} = -0.78 \pm 0.59 \pm 0.09$
- Belle PRD74 (2006)
  - Only 0.495  $\text{ab}^{-1}$  analysed
  - $S_{K_S \pi^0 \gamma} = -0.10 \pm 0.31 \pm 0.07$
- BaBar PRD93 (2015)
  - Already 0.605  $\text{ab}^{-1}$  analysed
  - $S_{K_S \pi^+ \pi^- \gamma} = 0.14 \pm 0.25 \pm 0.03$
- Belle PRL101 (2008)
  - Already 0.605  $\text{ab}^{-1}$  analysed
  - $S_{K_S \pi^+ \pi^- \gamma} = 0.09 \pm 0.27 \pm 0.07$

## ■ Prospect with Belle II

- With 5  $\text{ab}^{-1}$   
→  $\pm 0.10$
- With 50  $\text{ab}^{-1}$   
→  $\pm 0.03$

**Not to forget LHCb:**  
see [O.Deschamps](#) talk

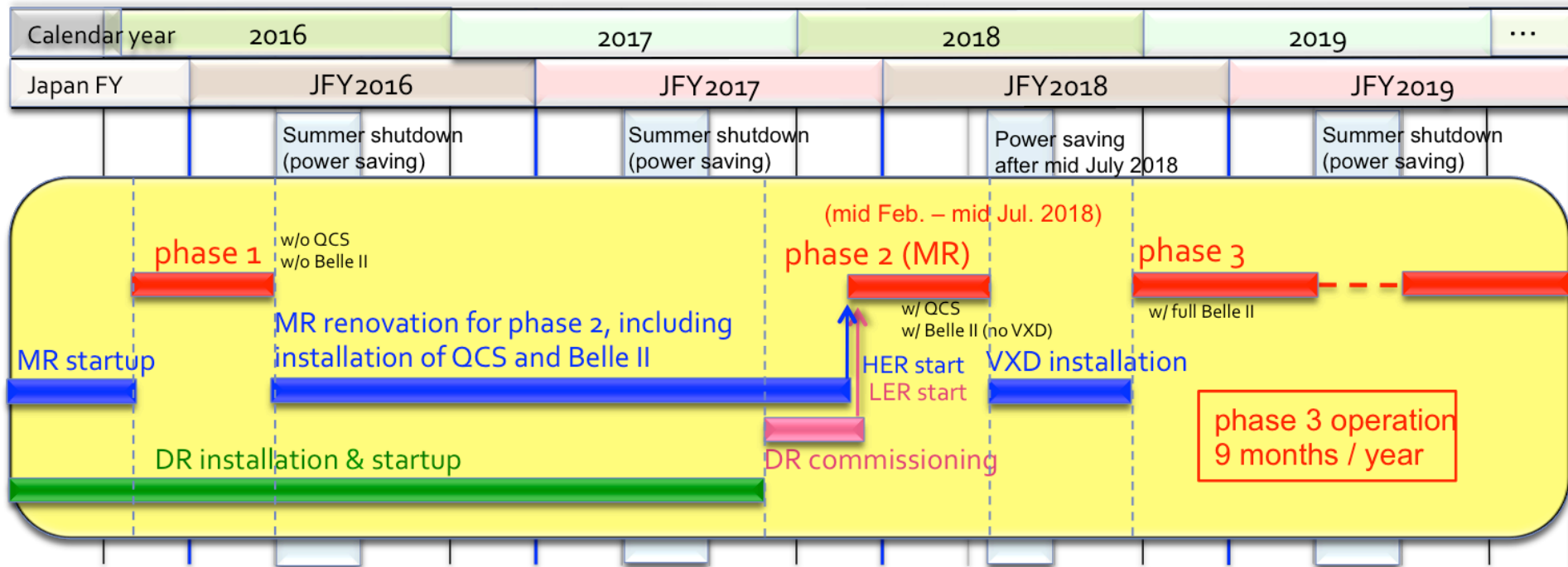
# When ?







# Belle II plan



# $b \rightarrow s \gamma S_{CP}$

**HFAG**  
Summer 2016

France   
soon in Belle II

