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Strasbourg, France, 10-12 May 2017

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project: FLAV_01

Characterisation of the SuperKEKB induced background during the BEAST II commissioning of the Belle II experiment.

Outline:

- Scientific motivation of the project
- Achievements
- TYL/FJPPL support request for JFY-2017
- Prospects

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Scientific motivation of the project

- Belle II physics program: discover quantum manifestation of new physics through measurements of unprecedented precision in the quark and charged lepton sectors, in SuperKEKB e^+e^- collisions.
- SuperKEKB targets world record luminosity of 0.8×10^{36} cm^{-2} s^{-1}, based on a new nano-beam scheme, inducing a high background rate.
- This beam induced background may damage the detectors (radiation tolerance) and deteriorate experimental performances (detector occupancy).

It will be carefully studied during the Belle II commissioning, a.k.a. BEAST:

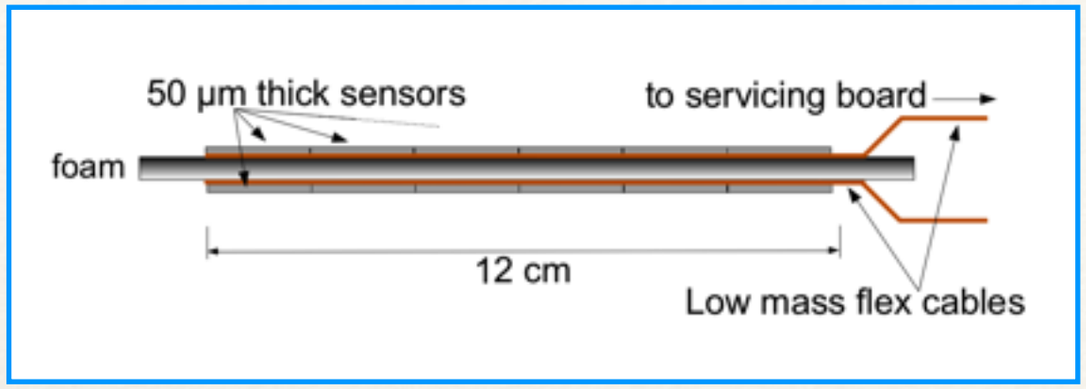
- Phase 1 (Jan.-June 2016): single beams.
- Phase 2 (Feb.-July 2018): e^+e^- collisions.

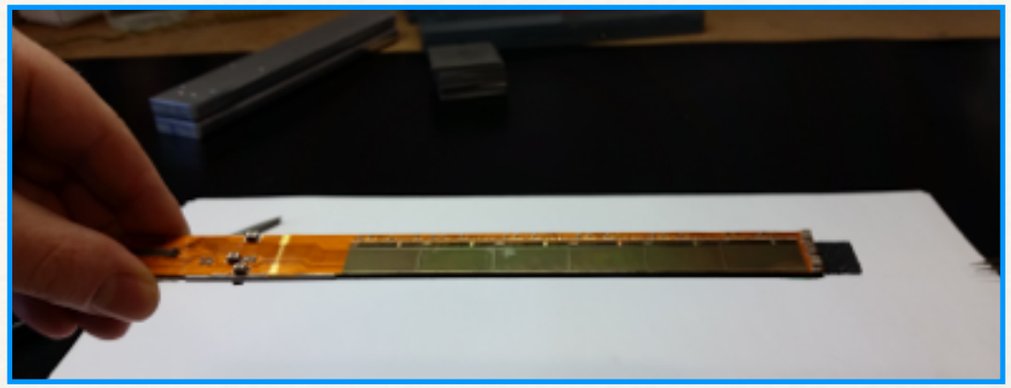
➛ This project: study the background induced in the inner tracker volume of Belle II using unique feature of the double-sided pixelated PLUME ladder.

Project in collaboration with TYL-FJPPL project A_RD_08: Fast luminosity monitoring and background measurements at SuperKEKB, with Cécile Rimbault, Philip Bambade *et al*.

Beam **E**xorcism for **A** **ST**able BELLE **II** experiment

The PLUME ladder





- R&D pursued for the ILC vertex detector.
- Double-sided CMOS pixel layer: 8×10^6 pixels, pitch 18.4×18.4 µm^2.
- Self-stiffened. Very light: record material budget 0.4 % X_0 for 2 measurement points.
- Pixel matrix read-out in 115 µs.
- For BEAST, 4 ladders were built (2 nominal + 2 spears):
  - MIMOSA-26 sensors provided by PICSEL group: cf. EUDET Beam Telescope, STAR PXL.

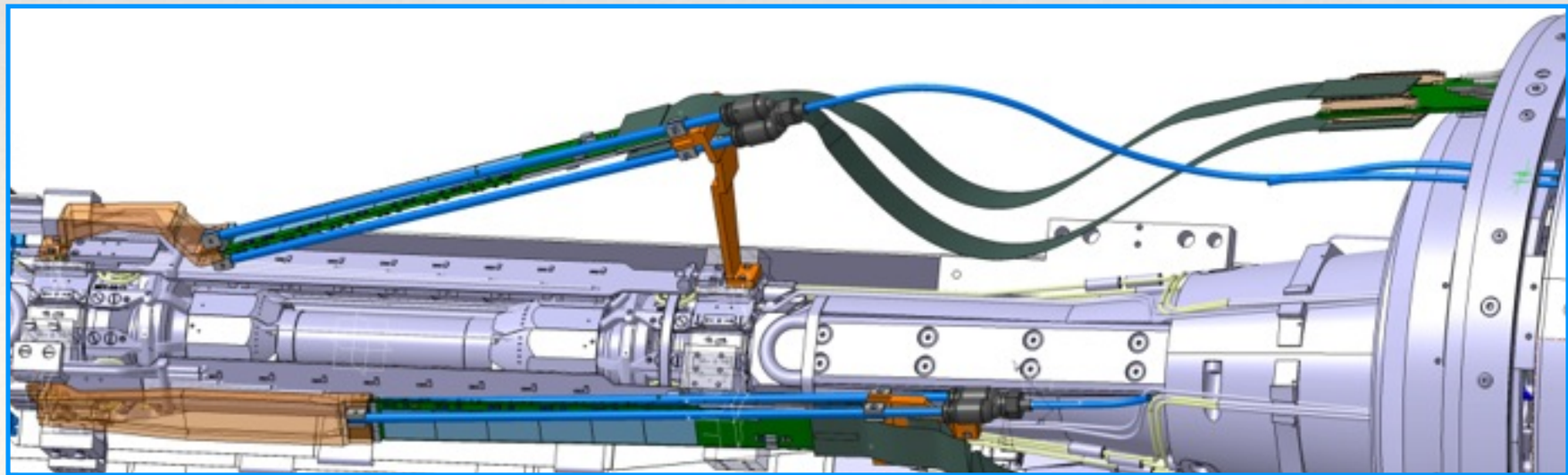
  - Ladders mounted by PLUME collaboration: R&D pursued for the ILC vertex detector by a collaboration between Bristol, DESY, Strasbourg.

SuperKEKB background study with PLUME

- Various detectors equip the inner tracker during BEAST: Belle II inner tracker (DEPFET pixels and silicon strips), ATLAS pixels, fast scintillators+SiPM, PLUME. All provide hit rates, either with good time granularity or space granularity.

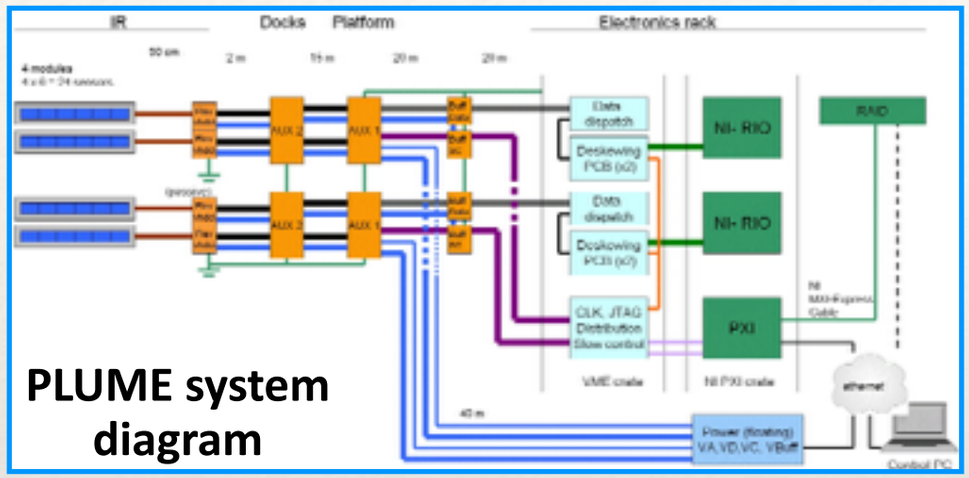
- PLUME is a standalone mini-tracker ➔ provides unique information to :
  - Disentangle on-line the different background processes: single beam background (Touschek, beam-gas, synchrotron), beam-beam interaction (radiative Bhabha, 2-photons e^+e^- production), continuous injection background.
  - Validate background simulation: extrapolation from BEAST Phase 2 (10^{34} cm^{-2} s^{-1}) to Belle II physics run (0.8×10^{36} $cm^{-2}s^{-1}$).

- IPHC detector system based on 2 PLUME ladders:
  - One is ~parallel to beam, to provide good sensitivity to helix track parameters.
  - One is inclined to scan background in the whole vertex detector volume.

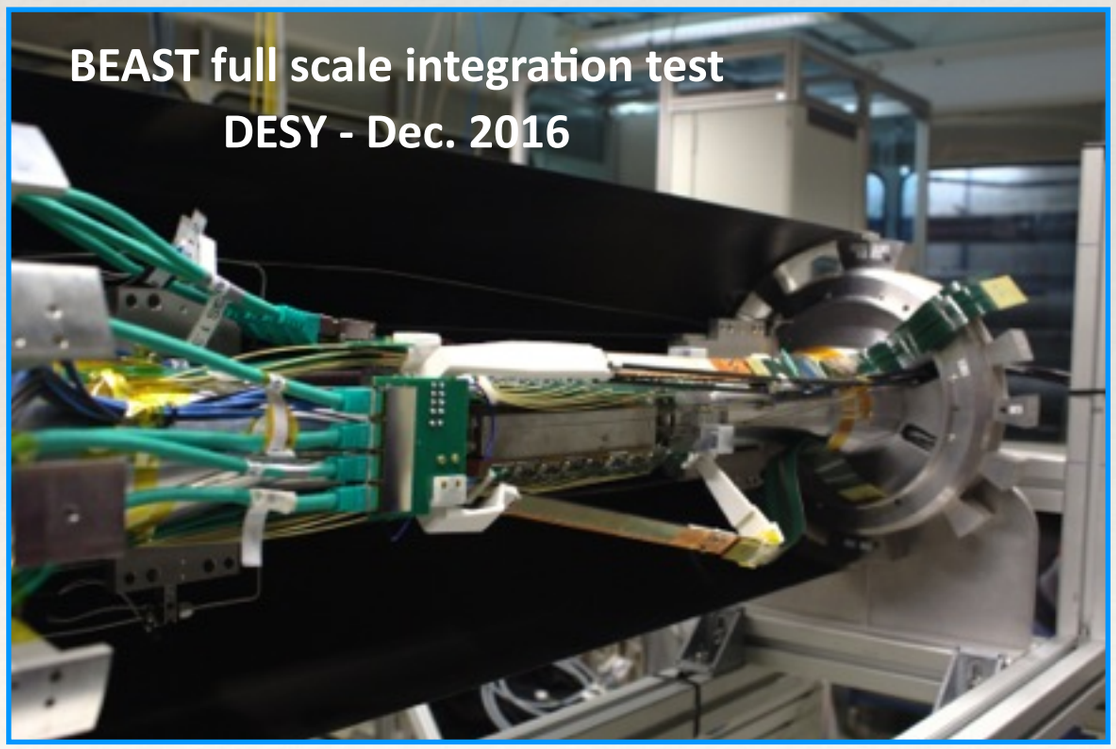


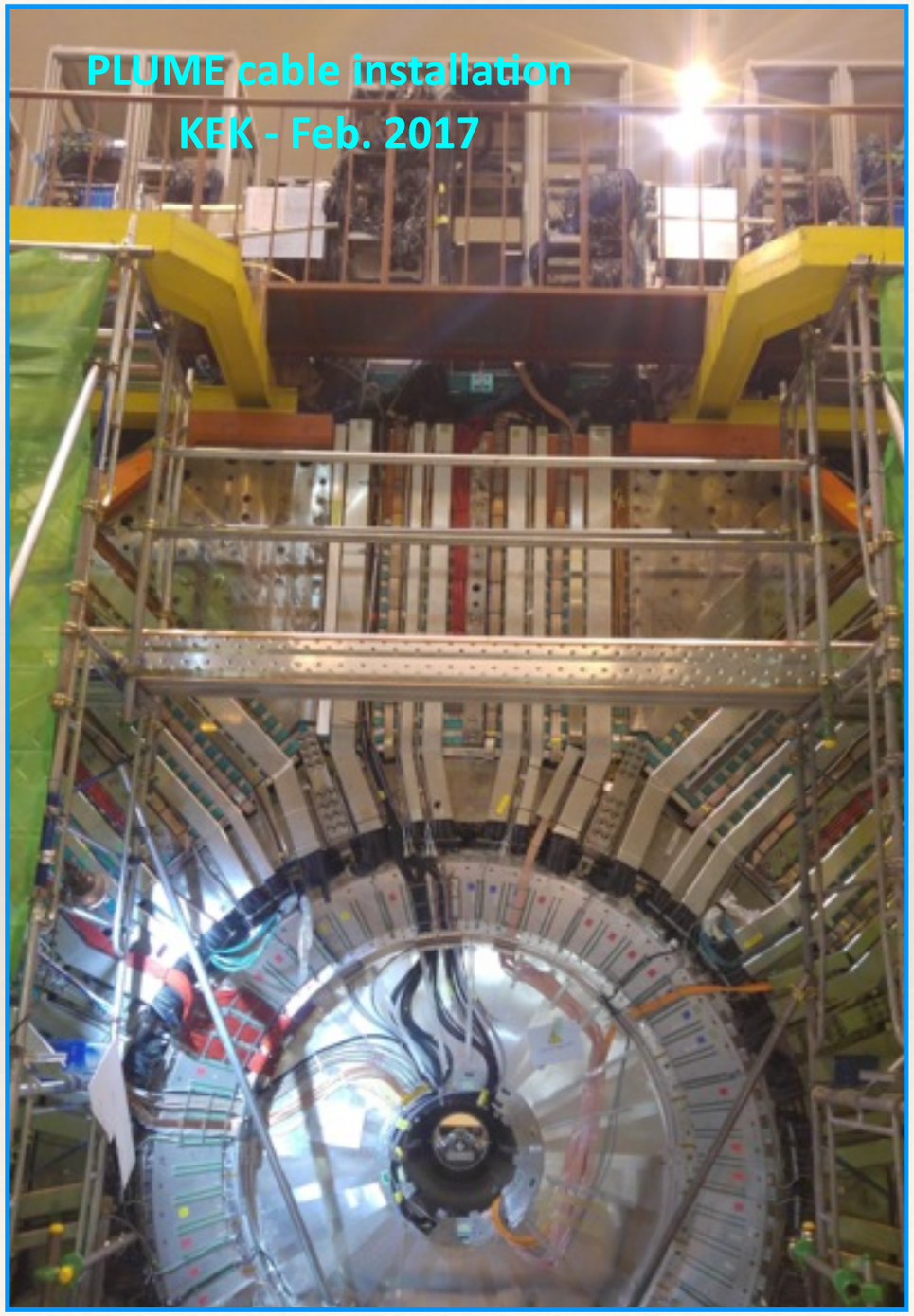
Achievements during JFY-2016 (1)

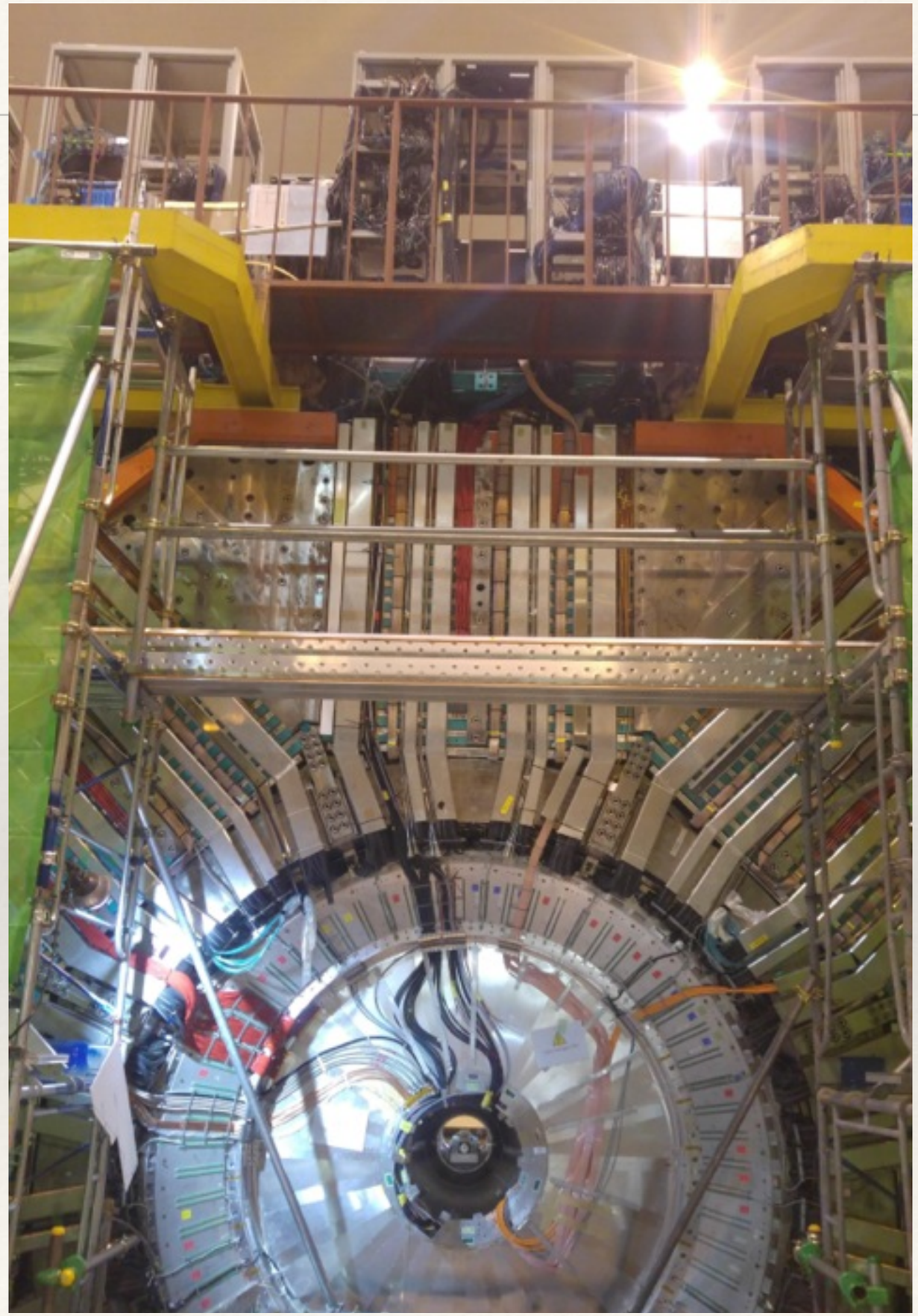
- **Design, construction and installation of the detector:** on-going work, with help of 8 IPHC engineers and 1 DESY postdoctoral fellow (J. Dreyling-Eschweiler).



PLUME system diagram

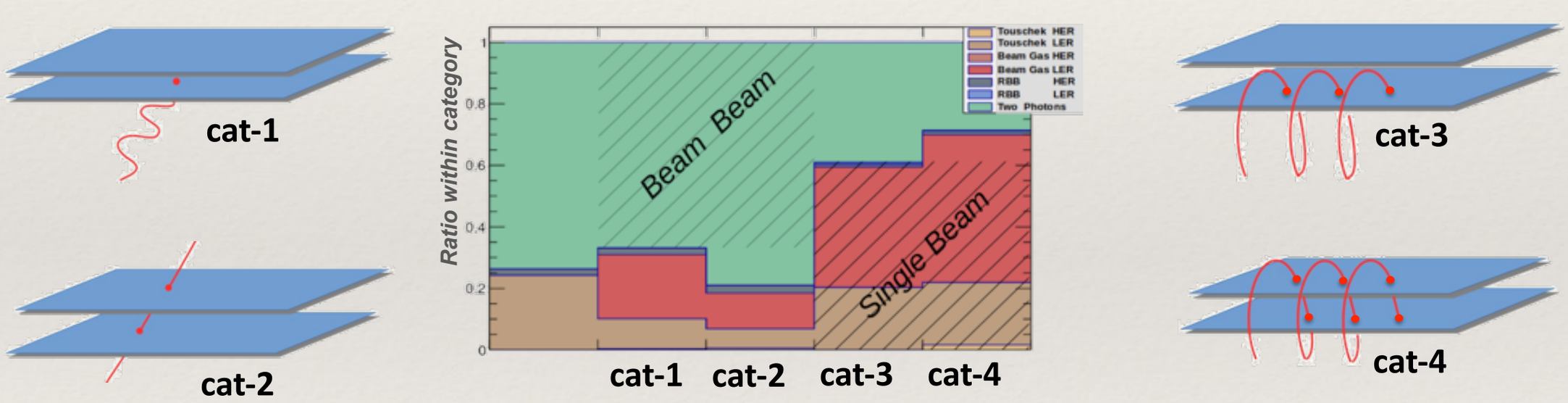






Achievements during JFY-2016 (2)

- Preparation of the data analysis: on-going work.
  - On-line fast analysis: Rate= f(z, R, t) provided to SuperKEKB with a 1 Hz- frequency as on-line feedback during machine parameter tuning.
  - Off-line multivariate analysis + track fitting: identification of the background process and measurement of track parameters (momentum, direction). Results correlated with other BEAST measurements and released once per day.
  - 2 master internship reports published in June 2016 (D. Cuesta, S. Hurier at University of Strasbourg).



- Reinforcement of the BEAST team at IPHC:
  - Daniel Cuesta: started his PhD thesis in Oct. 2016 on BEAST.
  - One new postdoctoral fellow to be recruited: 18 months starting in 2017, allocated by University of Strasbourg.

TYL JFY-2016 spending and JFY-2017 request

- **Spending of JFY-2016:**
  - IN2P3 funding: used for 2 travels to KEK (10 travels made).
  - KEK funding: used to participate to the Belle II information day in France in March 2017.

- **Requests for JFY-2017:**
  - To IN2P3: 6 k€
    - 3 travels France→Japan

      justification: 6 months of data taking scheduled, with 2 detector experts on site at KEK.
  - To KEK: 350 k¥
    - 1 travel Japan→France.

- **Additional supports obtained:**
  - IN2P3: SuperKEKB/BEAST master-project created in 2017.
  - H2020 RISE: 14 months of secondment at KEK from E-JADE. Painful to be spent.
  - University of Strasbourg (IdEx, state investments for the future program):
    - One PhD Grant: Oct. 2016 - Sept. 2019 (Daniel Cuesta).
    - One Postdoctoral Grant: 18 months starting end of 2017.

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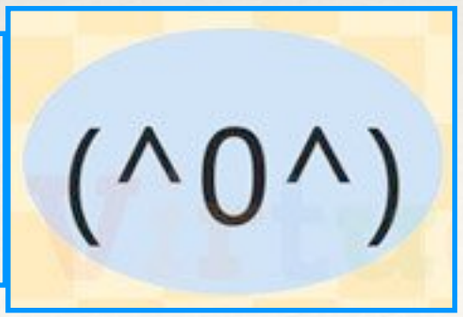
Conclusion and prospects

- SuperKEKB will deliver collisions with the highest instantaneous luminosity in the world.
- SuperKEKB commissioning started in 2016, colliding mode commissioning is scheduled in 2018 and physics run will start in Fall 2018.
- Belle II will play a crucial role in the search and the understanding of beyond SM physics, with a physics program complementary to energy frontier experiments, but also to LHCb and other intensity frontier experiments.
- Success of Belle II physics program (detector operation and experimental precision) relies on the knowledge of SuperKEKB induced background.
- This project will provide unique information on SuperKEKB background and unique skill for future e^+e^- collider experiments. It will be the first operation of CMOS pixels in e^+e^- collisions.
- Expected scientific production:
  - Belle II technical note on BEAST Phase 2 ➛ publication end of 2018.
  - Publication on PLUME operation end of 2018.

➛ Strasbourg and Orsay will apply to be member of the Belle II collaboration in June 2017.
This achievement has been made possible thanks to the TYL/FJPPL.



thank you for your attention