

# **[FJPPN-HEP\_17] A path toward the discovery of the Higgs-pair production in ATLAS (ATLAS HH)**

## **Introduction to the Japan team**



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Yu Nakahama (KEK), Tatsuya Masubuchi (Osaka)

Thank very much Marco and Nicolas for the kind invitation to LAPP and host of this first in-person gathering.

# Our original proposal: TYL HEP\_17 project


- Partners
  - including 3 first PDs and 3 PhD students
  - good for joint training.

France 	Japan 
Marco Delmastro (LAPP, PI)	Yu Nakahama (KEK, PI)
Nicolas Berger (LAPP)	Tatsuya Masubuchi (Osaka)
Zhibo Wu (LAPP, PD)	Louis Vaslin (KEK, PD)
Djamel Boumediene (LPC)	Newly recruited (KEK, PD)
Louis D'Eramo (LPC)	Lakmin Wickremasinghe (Osaka, PhD st.)
Arthur Lafarge (LPC, PhD st.)	Newly recruited (Osaka, PhD st.)

- Program in JFY2024 Apr-Mar
  - Current work on  $HH \rightarrow b\bar{b} \gamma \gamma$  and combination (LAPP, LPC) and  $HH \rightarrow b\bar{b} \tau \tau$  (KEK, Osaka).
  - Coherent developments for timely ramp-up of two harmonized analyses with EM and Hadronic final states, discussing together in-person to settle analysis details with complementary expertise.
    - analysis framework (LPC), trigger strategy, tau reconstruction (KEK), photon reconstruction, statistics treatments (LAPP), and heavy-flavour-jet tagging (Osaka).
  - A few Zoom meetings, and two face-to-face meetings and student/PD stays in partner group.
- Request of TYL support: 2 travels/stays to KEK & 2 travels/stays to LAPP & LPC.

# Current situation: TYL HEP\_17 project

- JP members

Japan 
Yu Nakahama (KEK, PI)
Tatsuya Masubuchi (Osaka)
Louis Vaslin (KEK, PD) → Focused on Anomaly Detection tool development
Newly recruited (KEK, PD) → Missed for bbtatau, but got another one for bbyy
Lakmin Wickremasinghe (Osaka, PhD st.) → Graduated with VH→cc and f-tag
Newly recruited (Osaka, PhD st.) → Kugo for bbbb

- Actual program in JFY2024

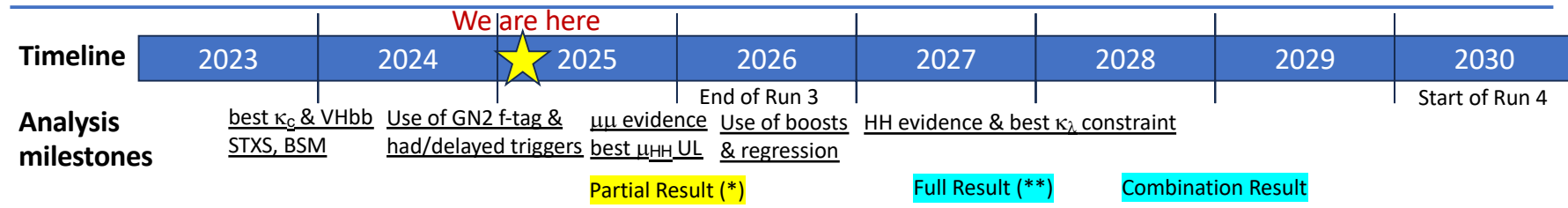
- Work in ramp-up on HH→bbyy (KEK, Tsukuba), HH→bbbb (Osaka) and HH→bbtau (Tokyo), in the context of the ATLAS Japan Higgs group
- Two face-to-face meetings and student visit in partner group (I'll come back here).

- In this meeting, Sayuka and Rina give status report on bbyy and bbbb, respectively.

# Analysis list in the ATLAS Japan Higgs group

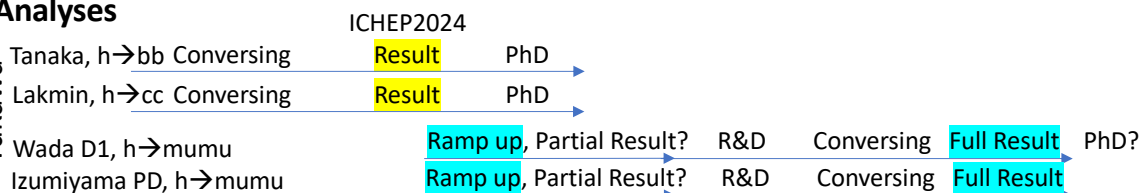
The team in ATLAS Japan has been evolving sustainably, anticipating continuous achievements.

→ We meet every week to realise these

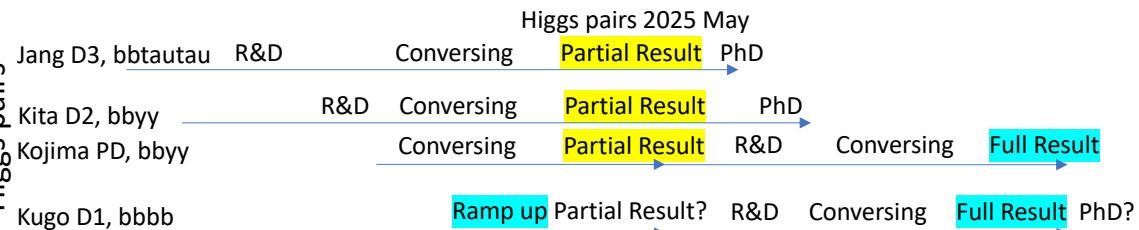


## Analyses

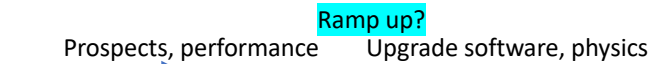
Yukawa



Higgs pairs



HL-LHC preparation



**(\*) Partial Result:**  
Run 2 (140 fb<sup>-1</sup>) + partial Run 3  
(2022-2023 60 fb<sup>-1</sup> or 2022-2024 160 fb<sup>-1</sup>)

**(\*\*) Full Result:**  
Run 2 + Run 3 400-500 fb<sup>-1</sup>

**Almost integrated to ATLAS analysis**

**During ramp up**

# Research milestones<sup>5</sup> in a path towards discovery



*We are on track given partial  
Run3 analysis is converging?*

## JFY 2024

- ramp-up and consolidate individual analyses
- prepare **harmonized** analysis framework, study trigger usage, and, establish reconstructions of boosted or soft objects using novel machine learning

## JFY 2025

- establish the methodology to measure self-coupling, and **make public results with a partial dataset**

## JFY 2026

- **conclude the publications of individual analyses with the full dataset**

## JFY 2027

- combine the results of the ATLAS  $b\bar{b}\gamma$  and  $b\bar{b}\tau$  analyses with the  $b\bar{b}b$  one, and
- initiate the combination with corresponding results in CMS, **to conclude on the HH search and Higgs self-coupling constraint at LHC Run 3.**

# Funding use in JFY2024

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- Focused on in-person interactions with the French colleagues in this network
  - Tatsuya during 2024 Sep 22-26
    - Travel (JP→FR) and participation to Higgs Hunting in Paris & Orsay, as organising committee together and for discussing in-person
  - Rina during 2025 Feb 22-24
    - Travel (JP→FR) and this meeting at LAPP