

# LumiBelle2

Anass Chaabi  
Supervisors: Philip Bamade

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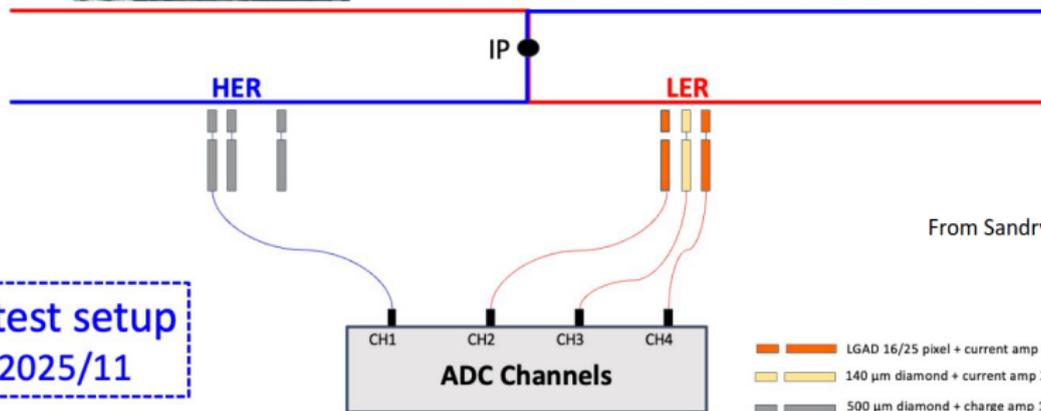
The logo of the University of Paris-Saclay, featuring the text "université" in a lowercase serif font and "PARIS-SACLAY" in a bold, uppercase sans-serif font, both in white on a dark red background. A small white dot is positioned above the "i" in "université".

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PARIS-SACLAY

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# LumiBelle2 : latest setup (2025/11)

## LumiBelle2 setup during 2025c operation



From Sandry, Philip

latest setup  
2025/11

Figure : LumiBelle2 setup during 2025c operation (from Sandry, Philip).

# Channels summary

<b>Channel</b>	<b>Sensor</b>
CH1	500 $\mu\text{m}$ diamond [ <b>HER</b> ]
CH2	LGAD 16/25 pixel [ <b>LER</b> ]
CH3	140 $\mu\text{m}$ diamond [ <b>LER</b> ]
CH4	LGAD 16/25 pixel [ <b>LER</b> ]

**simple-all-PV files**

```
graph TD; A[simple-all-PV files] --> B[1 Hz]
```

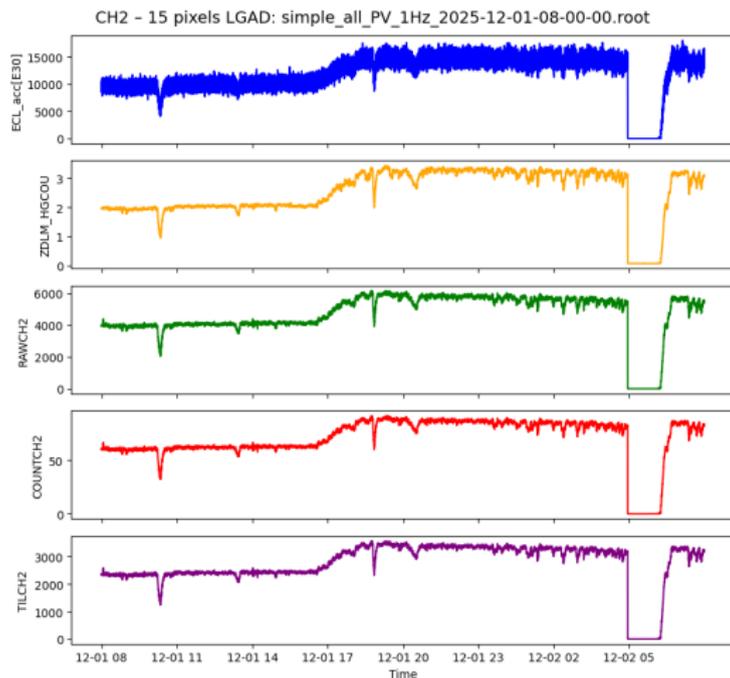
**1 Hz**

**TIL files**

```
graph TD; C[TIL files] --> D[1 kHz]
```

**1 kHz**

# simple-all-PV example (1 Hz) — CH2 (LGAD)



**Figure** – Time evolution of key PV variables for CH2 (LGAD) from the 1 Hz simple-all-PV ROOT file for the 2025-12-01 .

## Stable regions : goal

The PV time series contains : ramps, injection effects, spikes, and quiet plateaus.

### Why stability matters

Precision estimates are meaningful only in regions without strong trends or transitions.

## Method : stability metrics

Slope (linear trend in a window)

$$a = \frac{\sum_i (i - \bar{i})(y_i - \bar{y})}{\sum_i (i - \bar{i})^2}$$

RMS (absolute fluctuations)

$$\text{RMS} = \sqrt{\frac{1}{N} \sum_{i=1}^N (y_i - \bar{y})^2}$$

RSD (relative fluctuations)

$$\text{RSD} = \frac{\text{RMS}}{\bar{y}}$$

## Method : window score

### Score (window ranking)

$$S = \left[ W_{\text{RSD}} \left( \frac{\text{RSD}}{\text{RSD}_{\text{STABLE}}} \right)^2 + W_{\text{SLOPE}} \left( \frac{|a|}{\text{SLOPE}_{\text{MAX}}} \right)^2 \right] \left( \frac{L_{\text{ref}}}{|\bar{y}| + \varepsilon} \right)^{W_{\text{ECL}}}$$

First factor : stability penalty (small RSD and small  $|a|$  are favored)

Second factor : luminosity preference (higher  $|\bar{y}| \Rightarrow$  smaller score)

$\varepsilon$  avoids division by zero

### Parameters used in this study

$$W_{\text{RSD}} = 1, \quad W_{\text{SLOPE}} = 1, \quad W_{\text{ECL}} = 2$$

Lower score = better window.

## Algorithm : stable window selection (1/2)

### 1) Load PV and time (Tokyo)

Read `B2_nsm_get_ECL_LUM_MON_lum_accel` and build a time-indexed series in Asia/Tokyo.

### 2) Beam-off / no-signal rejection

Keep only positive points  $x > 0$ . We define :

$$df_{\text{sig}} = \{x(t) \mid x(t) > 0\}.$$

### 3) Windowing and metrics

Split  $df_{\text{sig}}$  into fixed windows of  $W = 120$  s. For each window compute : mean  $\bar{x}$ , std, RSD, slope  $a$ , and score  $S$ .

## Algorithm : stable window selection (2/2)

### 4) Stability cuts

very-stable if  $|a| < VSLOPE_{MAX}$  and  $RSD < RSD_{VSTABLE}$ .

stable if  $|a| < SLOPE_{MAX}$  and  $RSD < RSD_{STABLE}$

### 5) Candidate selection and merging

If very-stable windows exist : keep all.

Else : require at least 2 stable windows ; rank by  $S$  and keep 3 windows.

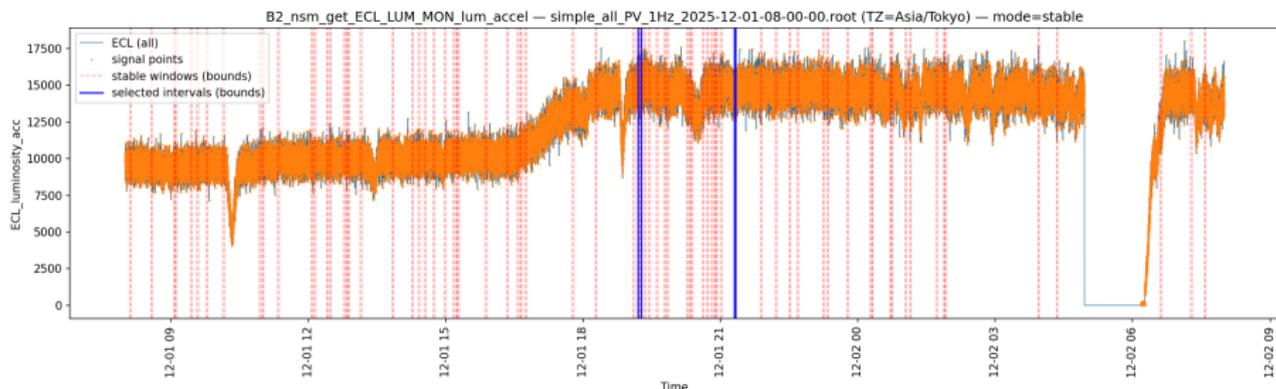
Merge adjacent candidate windows ( $gap \leq 2$  s) into final stable intervals.

### Parameters used

$SLOPE_{MAX} = 0.4$ ,  $RSD_{STABLE} = 0.2$ .

$VSLOPE_{MAX} = 0.4$ ,  $RSD_{VSTABLE} = 0.2$ .

# Stable windows and selected intervals for the 2025-12-01

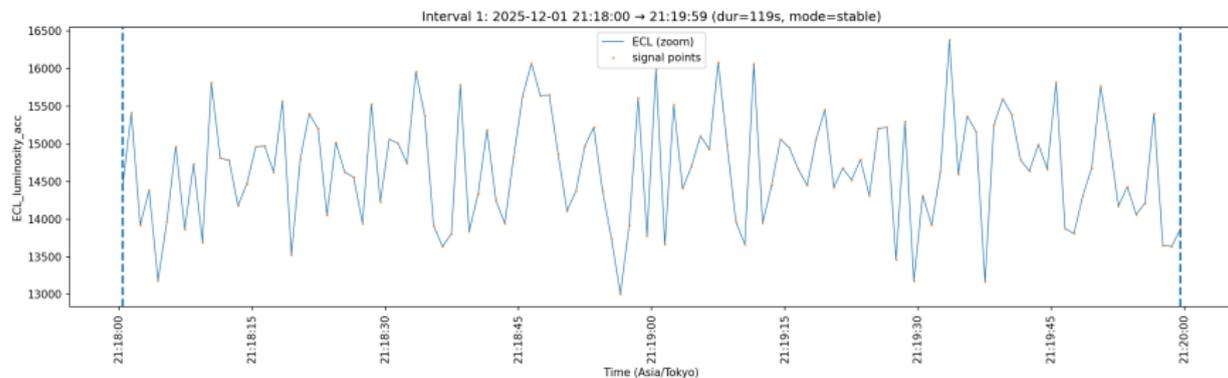
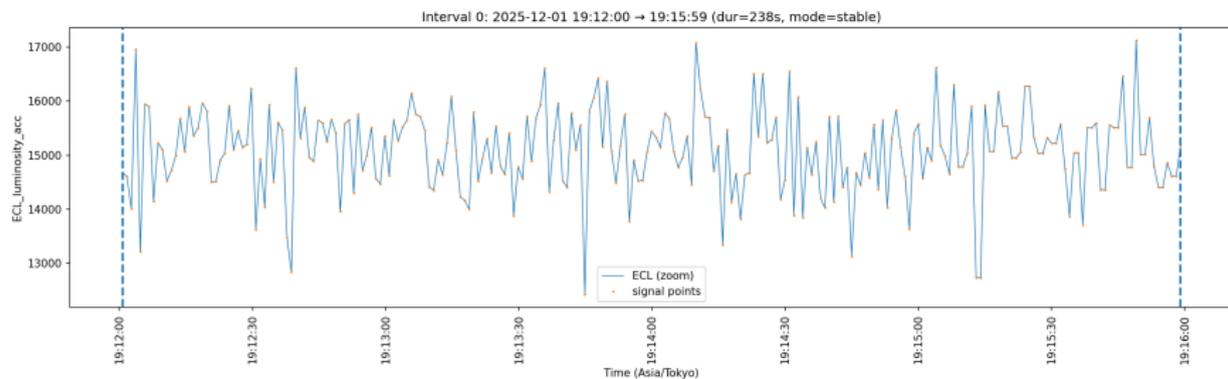


**Orange points** : beam-on-like signal points.

**Red dashed lines** : boundaries of stable windows (120 s).

**Blue lines** : final selected stable intervals (after ranking + merging).

# Selected stable intervals (zoom)



## Definitions (per time bin $\Delta t$ )

**COUNT rate (Hz) :**

$$\text{COUNT} \equiv \frac{N_{\text{count}}}{\Delta t}$$

**Measured counts in the bin :**

$$N_{\text{count}} = \text{COUNT} \Delta t$$

**Expected events from luminosity :**

$$N_{\text{lum}} = L \sigma_{\text{eff}} \Delta t$$

# Count method : sensitivity vs luminosity expectation

## Poisson counting statistics $\Rightarrow$ precision

Assuming Poisson statistics :

$$\text{Var}(N_{\text{count}}) = N_{\text{count}} \quad \Rightarrow \quad \sigma(N_{\text{count}}) = \sqrt{N_{\text{count}}}.$$

Relative statistical precision :

$$\frac{\sigma(N_{\text{count}})}{N_{\text{count}}} = \frac{1}{\sqrt{N_{\text{count}}}}$$

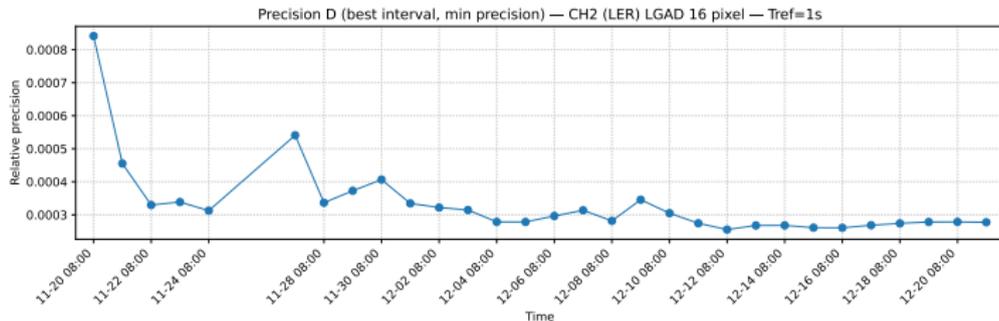
## Sensitivity factor

We define the (dimensionless) sensitivity :

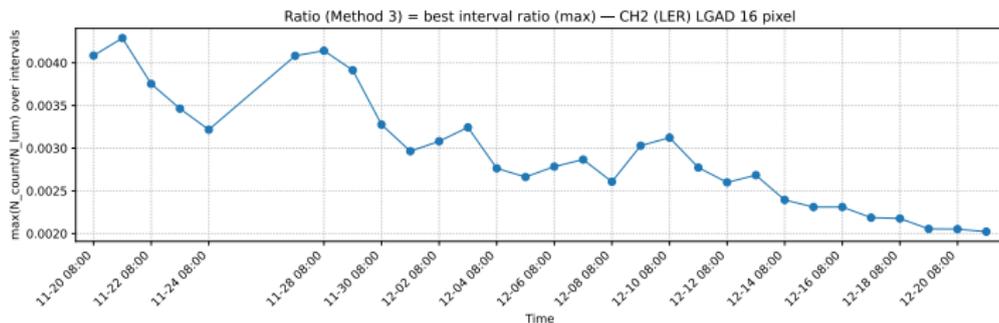
$$\mathcal{S} \equiv \frac{N_{\text{count}}}{N_{\text{lum}}} = \frac{N_{\text{count}}}{L \sigma_{\text{eff}} \Delta t}.$$

# LGAD CH2 : precision (1 s) and sensitivity

## Precision at 1 s (best stable intervals)

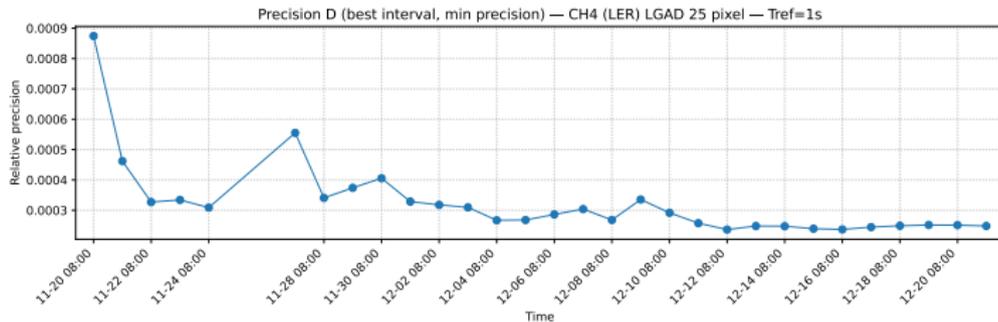


## Sensitivity

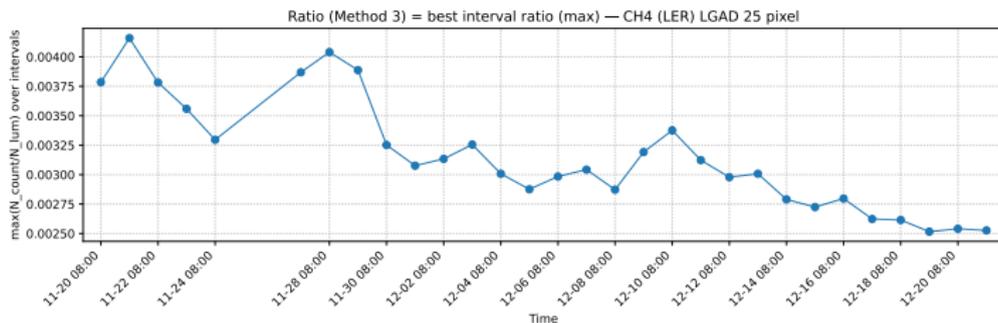


# LGAD CH4 : precision (1 s) and sensitivity

## Precision at 1 s (best stable intervals)

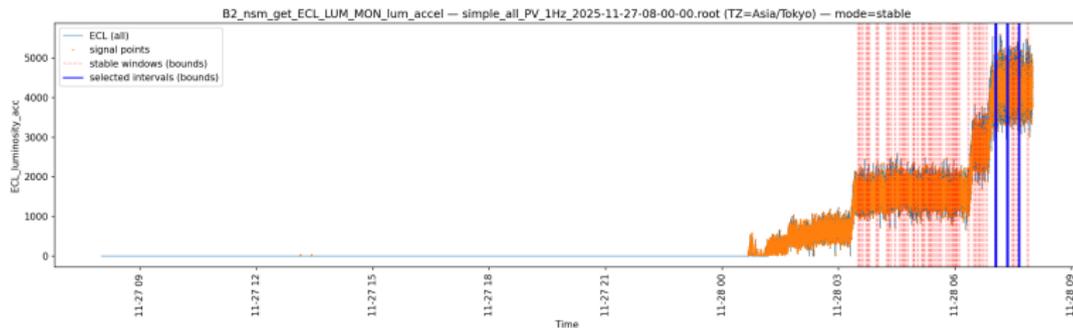


## Sensitivity

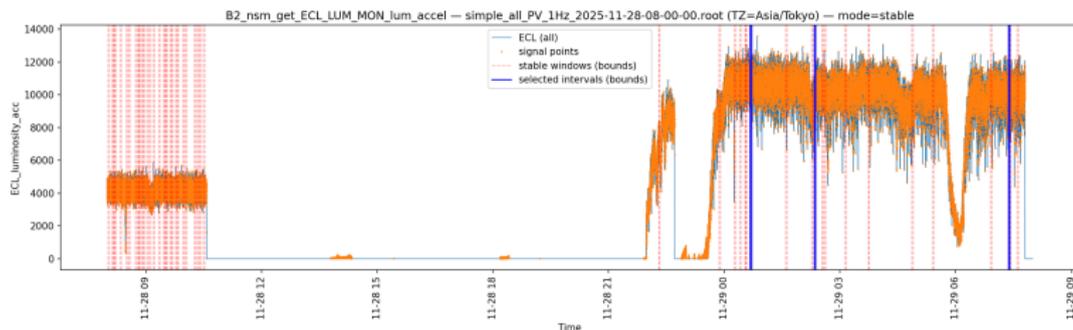


# Algorithm improvements : stable-interval selection

## Dav 2025-11-27



## Dav 2025-11-28



# TIL : normalized RSD from Gaussian fit

## Stable windows from 1PV

We reuse the stable intervals selected with the ECL PV algorithm and apply the same time cuts to the TIL signal.

## Gaussian fit of the TIL distribution

From the selected points, we build the histogram of the TIL signal and fit it with :

$$f(x) = A \exp\left(-\frac{(x - \mu)^2}{2\sigma^2}\right).$$

## RSD (from fit parameters)

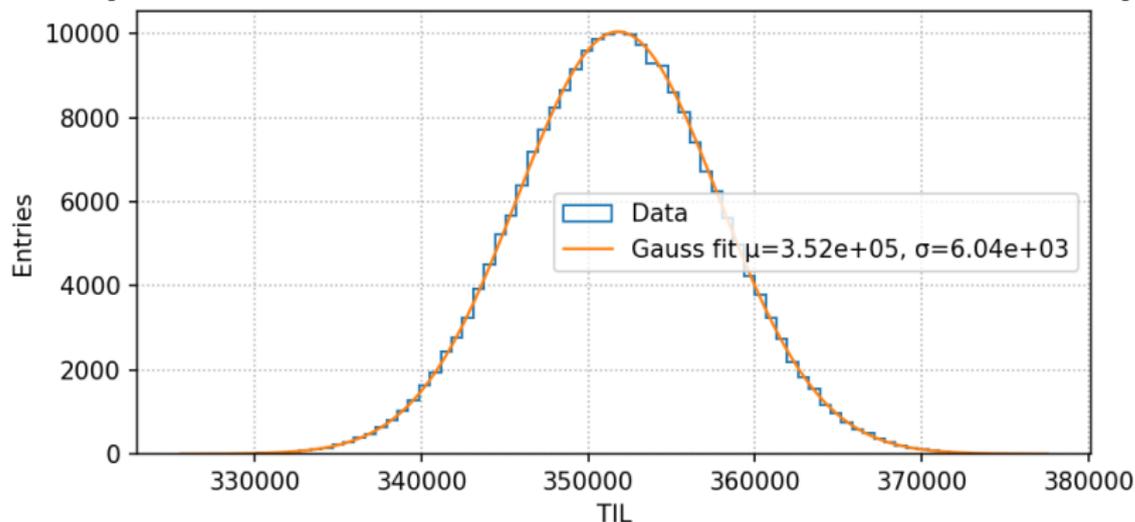
$$\text{RSD}_{\text{fit}} \equiv \frac{\sigma}{|\mu|}$$

# TIL CH2 : Gaussian fit on selected stable window

## Histogram of TIL points (ECL-stable interval) + Gaussian fit

2025-12-01 19 :12 :00 → 19 :15 :59 (Tokyo)

TIL CH2 [2025-12-01 19:12:00.687154531 → 2025-12-01 19:15:59.087707996] (Tokyo)

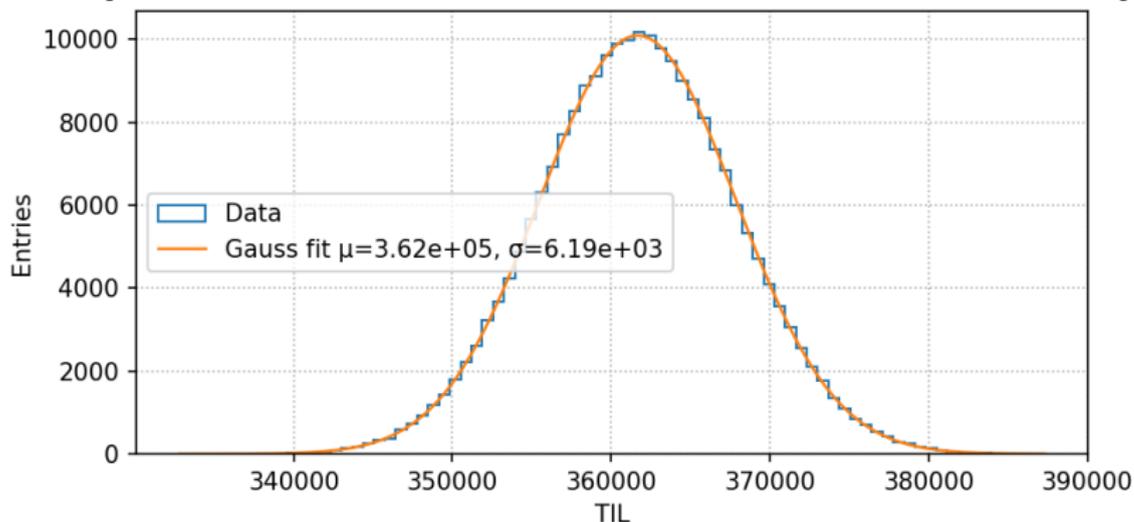


# TIL CH4 : Gaussian fit on selected stable window

## Histogram of TIL points (ECL-stable interval) + Gaussian fit

2025-12-02 21 :56 :00 → 21 :57 :59 (Tokyo)

TIL CH4 [2025-12-01 19:12:00.687154531 → 2025-12-01 19:15:59.087707996] (Tokyo)

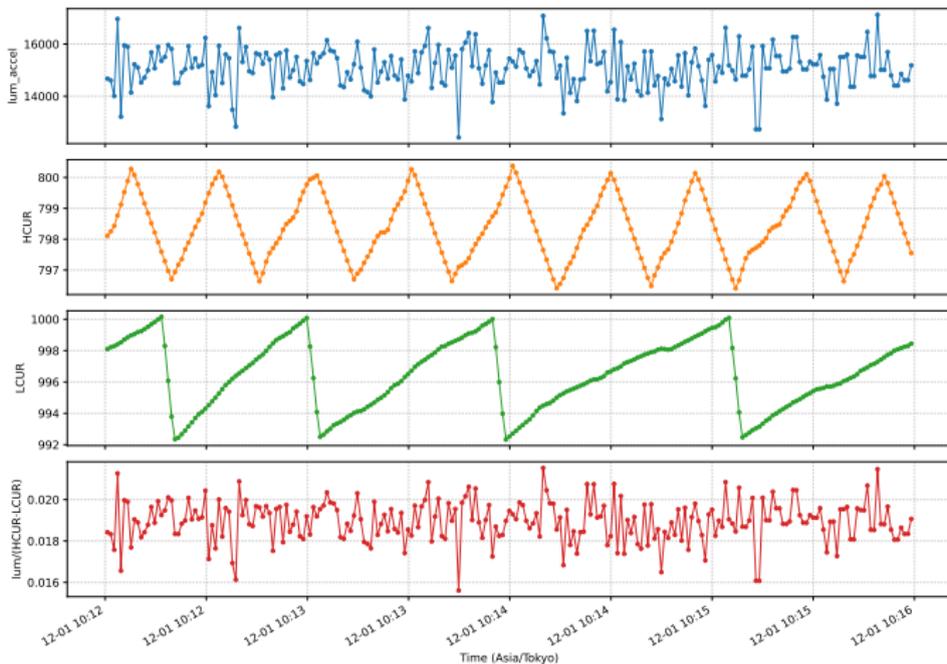


# TIL : best (minimum) RSD per day from Gaussian fit

Day	Start	End	CH2		CH4	
			RSD	precis_rel_1s_inter	RSD	precis_rel_1s_inter
2025-12-01	19 :12 :00	19 :15 :59	0.01717	0.000334	0.01712	0.000329
2025-12-02	22 :18 :00	22 :19 :59	0.01706	0.000322	0.01720	0.000318
2025-12-13	20 :08 :00	20 :09 :59	0.01677	0.000300	0.01689	0.000284
2025-12-14	01 :48 :00	01 :49 :59	0.01577	0.000271	0.01591	0.000252

## Example of a selected stable interval : luminosity and beam currents

simple\_all\_PV\_1Hz\_2025-12-01-08-00-00.root — interval 1 — 2025-12-01 19:12:00 → 2025-12-01 19:15:59



# Conclusion