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R2E Annual Meeting

DEC, 11-12TH | CERN, 774/R-013

Handling and analysis of radiation data sets, the **advantages** of automated calculations and **fast accessibility** of radiation measurements

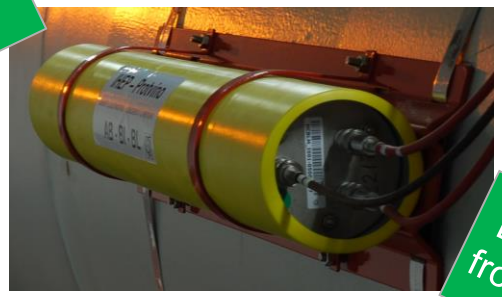
Kacper Bilko

(EN-EA-PE, Monitoring and Calculation Working Group)

Dose detection and analysis (LHC BLMs)

Accelerator operation leads to continuous slight losses, thus the radiation.

Losses



Ionising radiation is detected by Beam Loss Monitoring system.

Dose rate from CALS

LHC parameters

MCWG's analysis

Other input

…

Although it is not the primary purpose, can be used as **distributed dosimetry** system

Dose detection and analysis (LHC BLMs)

Accelerator
leads t
slig
rad

Data from >**3500 BLMs** used

→

HUNDREDS OF GB

of data to analyse

Although it is not the primary purpose, can be used as **distributed dosimetry** system

Other input

MCWG's analysis

…

Limitations in the past…

Every radiation request handled <u>manually</u>

→ slow, time-consuming

<u>Slow access</u> to CERN Accelerator Logging Service (CALS) via Timber

Timber → processing (i.e. “excel”) → results

Usage of the <u>non-offset corrected data</u>

→ BLM beam-not-present baseline contribution to the dose

So **sluggish**!

Took ages to obtain results

Download hourly integrated data via Timber (manually)

Summing

Providing the results

Overestimations for low dose environments (ARC sections)

Manual, slow, time-consuming, inconsistent

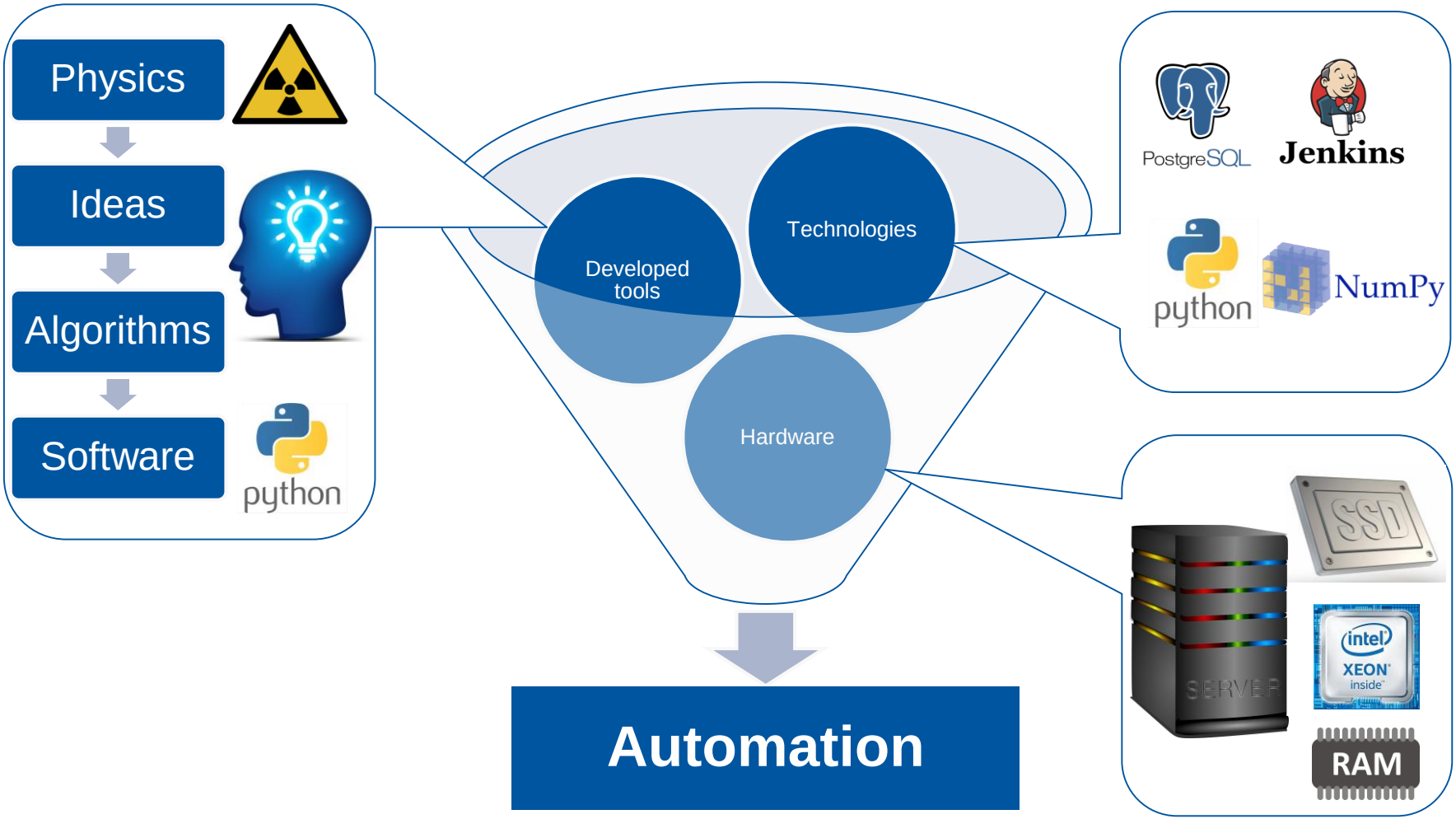
Not efficient!

Reliable analysis impossible…

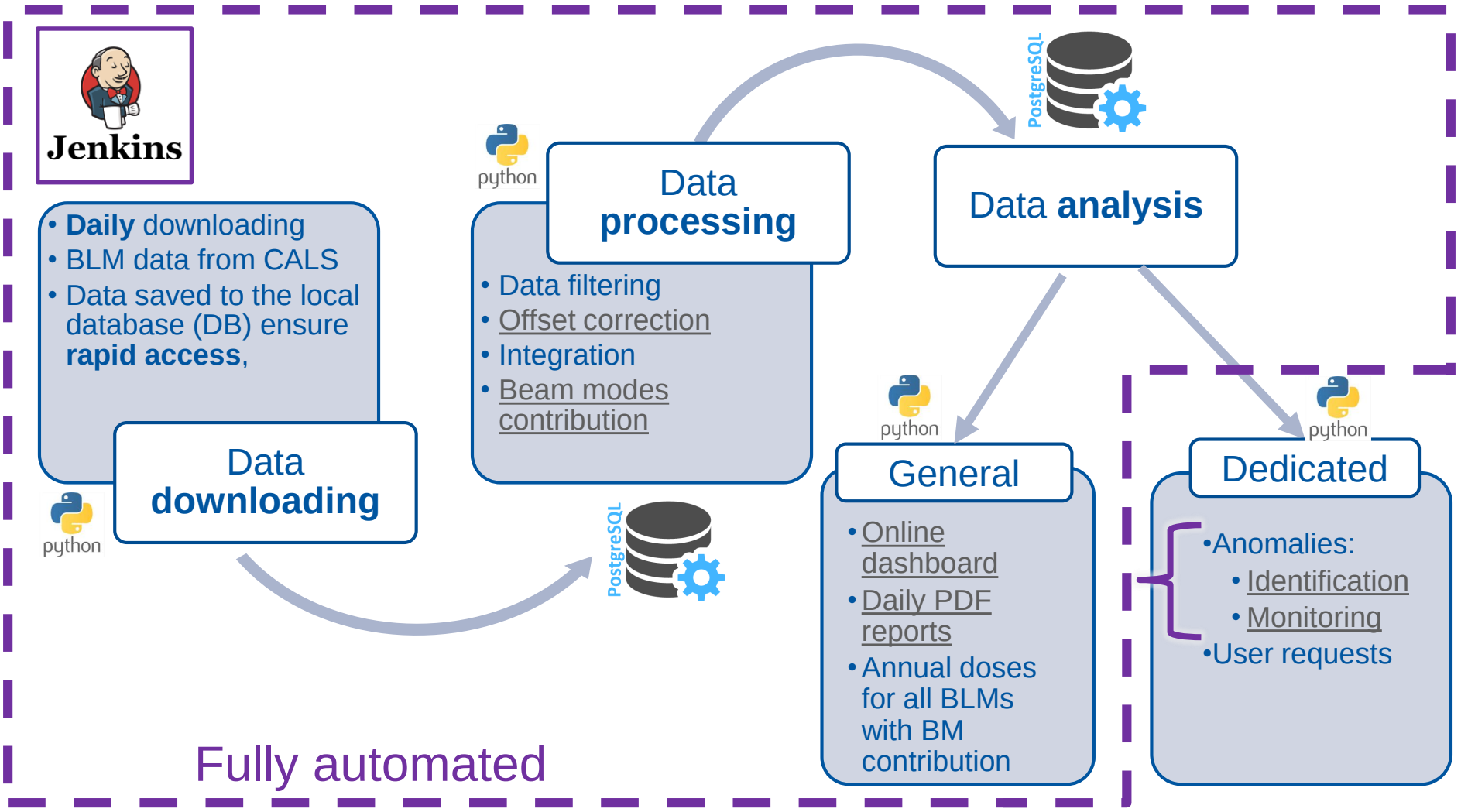
How to **improve** it?

The only **solution**: **AUTOMATION**

How to **automate**?



Automation of the analysis



Data **downloading**

Download accelerator parameters

- Intensities
- Beam modes
- Beam present flags
- Different accelerator parameters (fill number, ...)

Download BLM data

- LOSS_RS12 (dose rate averaged over ~ 84 s integration time)
- From ~3600 BLMs

Save to local DB

- Save to **rapid** and **efficient** local database → **cross platform,**
- **Easy access** by all MCWG users → no need to store or download data on multiple workstations,

Daily basis

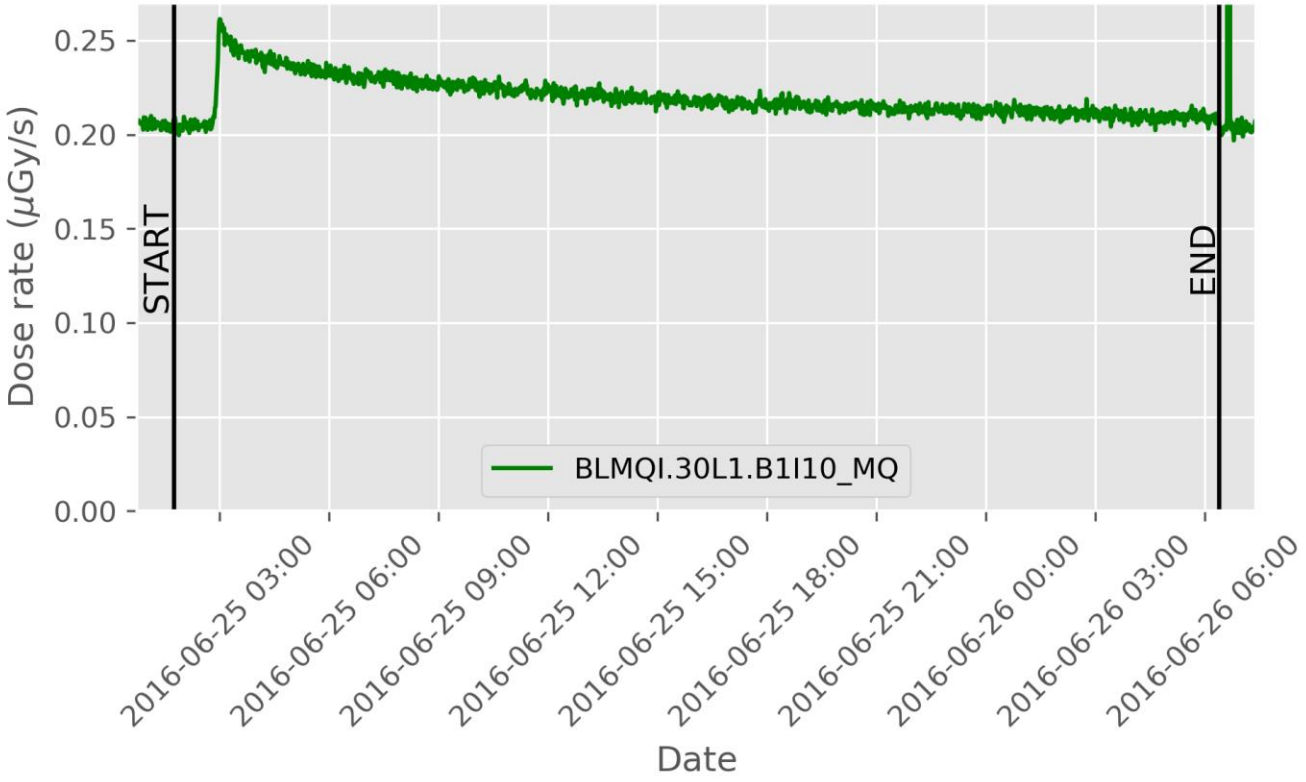
Not only **automated**,
But also **parallelised**

Data **processing**

Data filtering

- Consider periods **only when beam was in the LHC** (*interval*)

34 188 296
BLM intervals in the DB



Data **processing**

Data filtering

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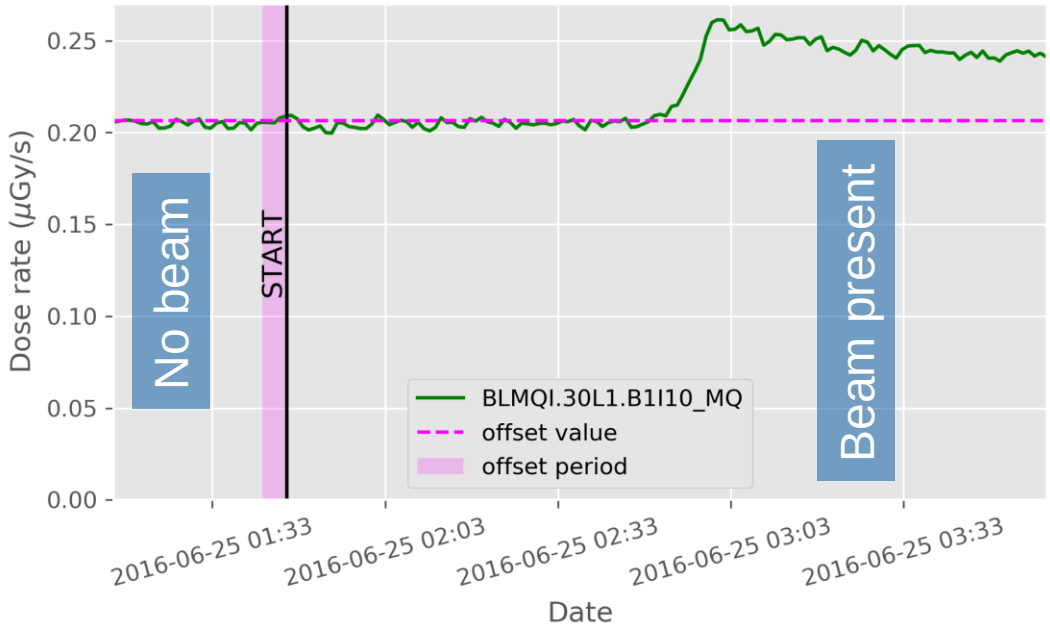
Offset correction

- **Each BLM separately**,
- **Fill-by-fill** basis,
- Subtract beam-not-present baseline from the data.



Data **processing**

Data filtering

- Consider periods **only when beam was in the LHC** (*interval*)

Offset correction

- **Each BLM separately**,
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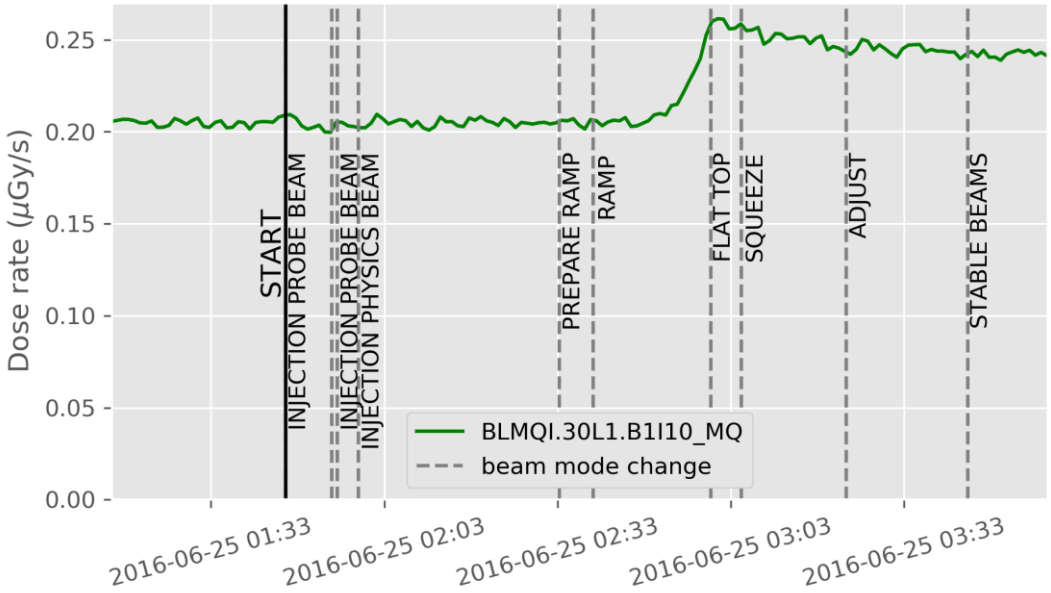
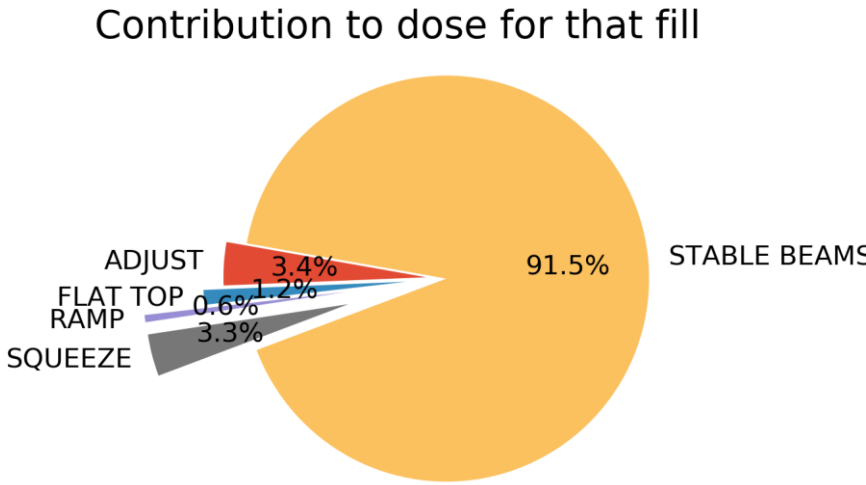
Integration

- Besides integration, calculate **contribution of different beam modes,**

100 328 374
BLM subintervals in the DB





Data **processing**

Data filtering
- Consider periods **only when beam was in the LHC** (*interval*)

Offset correction
- **Each BLM separately**,
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- Subtract beam-not-present baseline from the data.

Integration
- Besides integration, calculate **contribution of different beam modes**,

Save to local DB
- Offsets, fill-by-fill doses, BM contributions, times are saved to DB

Daily basis

Not only **automated**,
But also **parallelised**

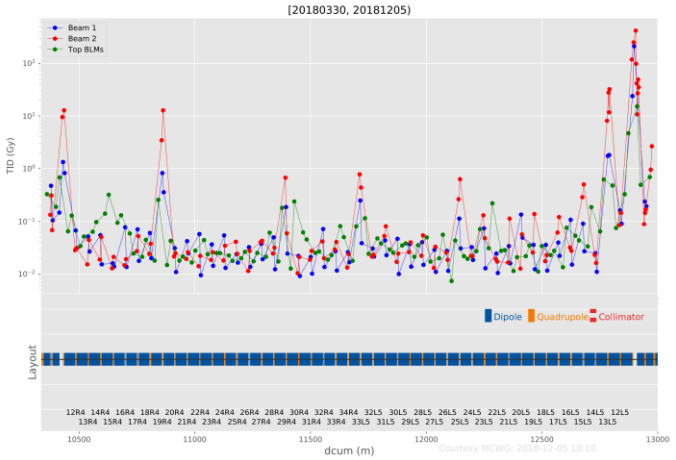
Data analysis → results

Online Monitoring Dashboard

Daily radiation reports

3.4 ARC45

3.4.1 Plot



10 hottest BLMs

	dcum	tid
BLMEI.11L5.B2E22_LEFL	12904.80	4.17e+02
BLMQI.11L5.B2E10_MQ	12895.70	2.49e+02
BLMQI.11L5.B1I30_MQ	12898.20	2.11e+02
BLMQI.11L5.B2E30_MQ	12887.95	1.18e+02
BLMEI.11L5.B2E21_LEFL	12906.90	9.83e+01
BLMAI.11L5.B2E22_MBA	12915.30	4.94e+01
BLMEI.11L5.B2E30_LEFL	12909.00	4.16e+01
BLMAI.11L5.B2E21_MBA	12917.40	3.52e+01
BLMAI.13L5.B2E21_MBA	12791.70	3.23e+01
BLMQI.13L5.B2E10_MQ	12787.55	2.78e+01

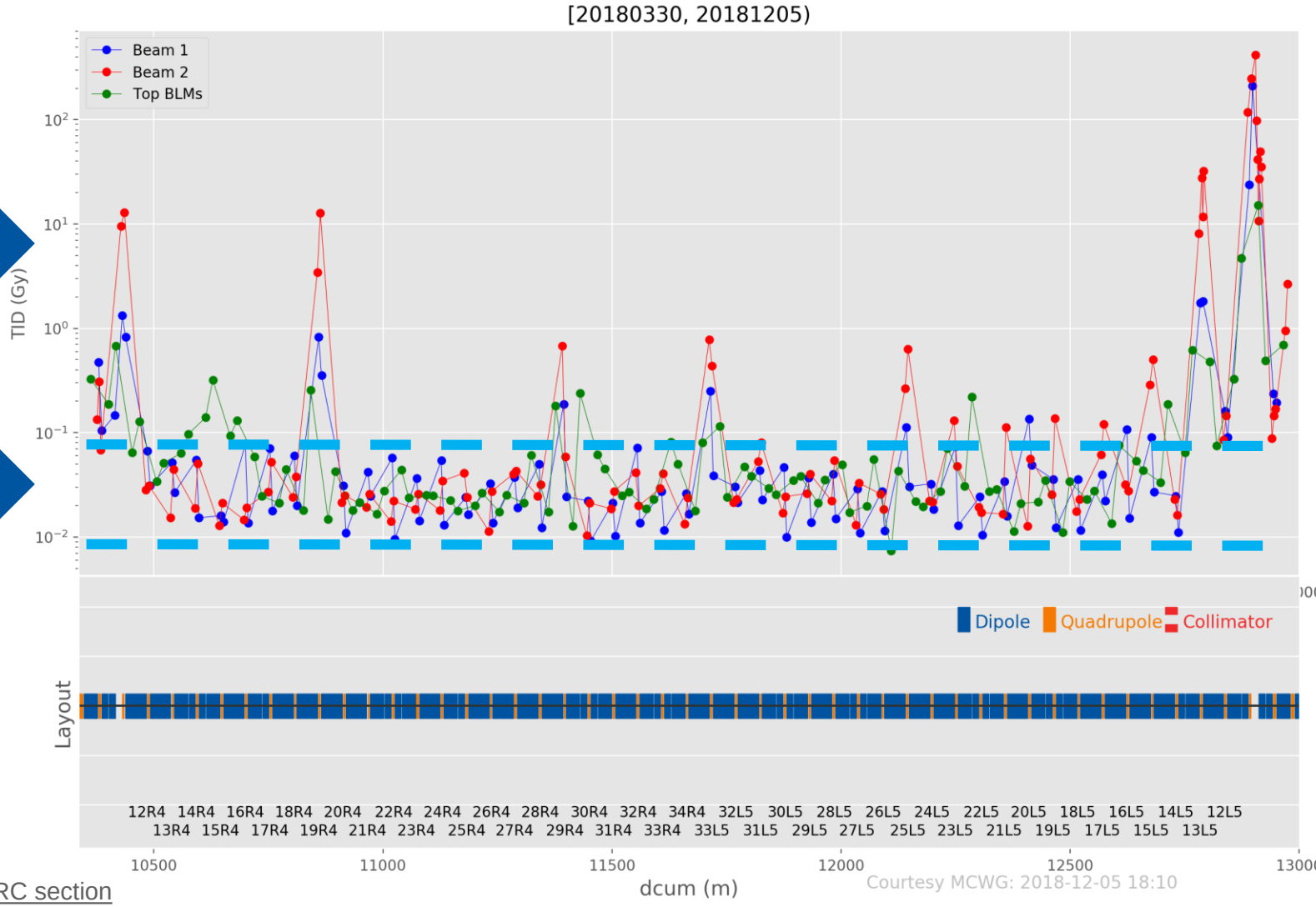
15

Mission impossible
without
full automation!!!

Example: daily report - ARC 45, 2018

Anomalies ("**spikes**")

Baselines[1]



Courtesy MCWG: 2018-12-05 18:10

[1] 6 baselines for each ARC section

Spikes exceed baseline up to 3 orders of magnitude

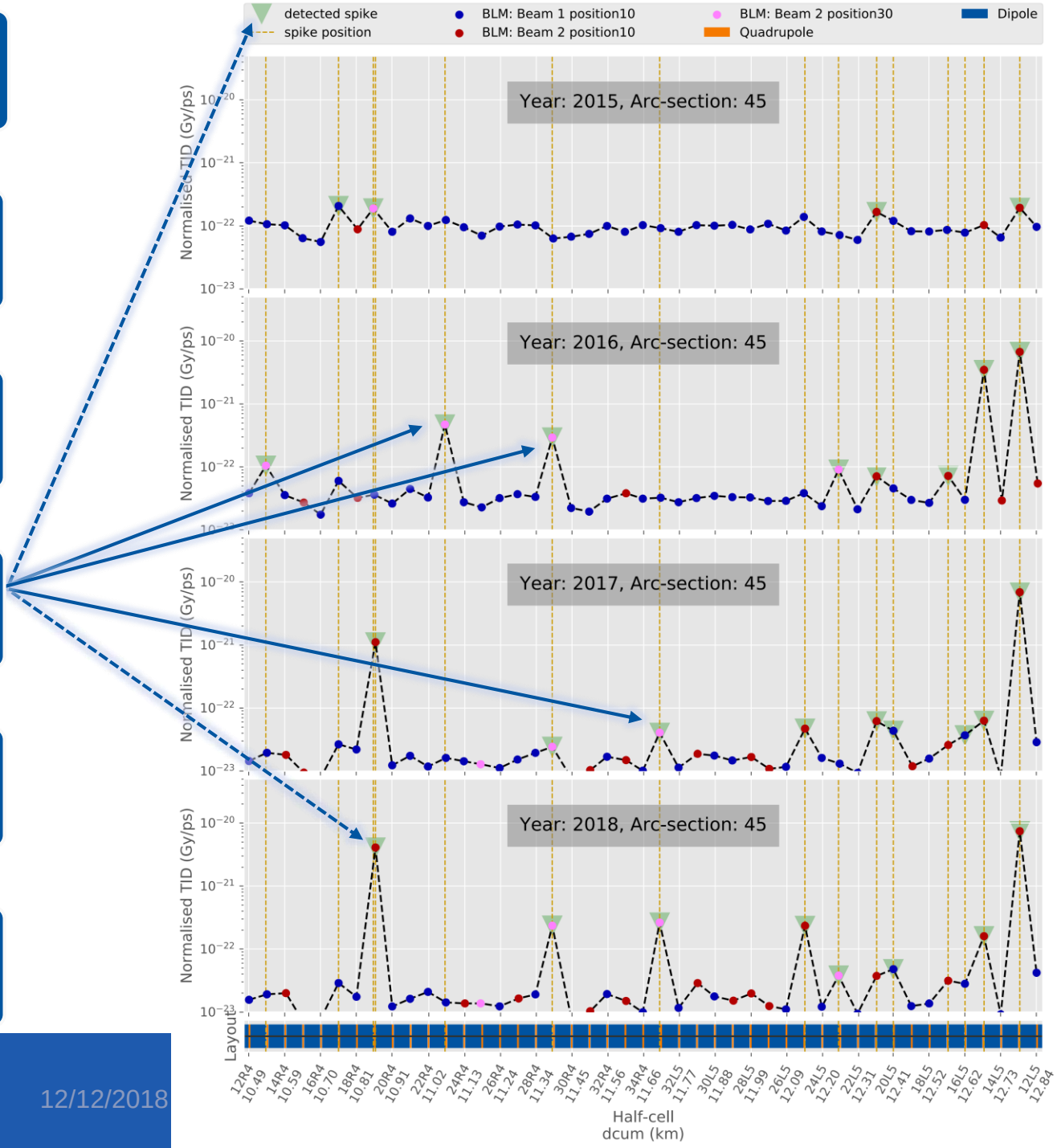
Potentially dangerous

Identification and monitoring is critical

Spikes identification algorithm

Dynamic behavior

Need of **detailed analysis**…

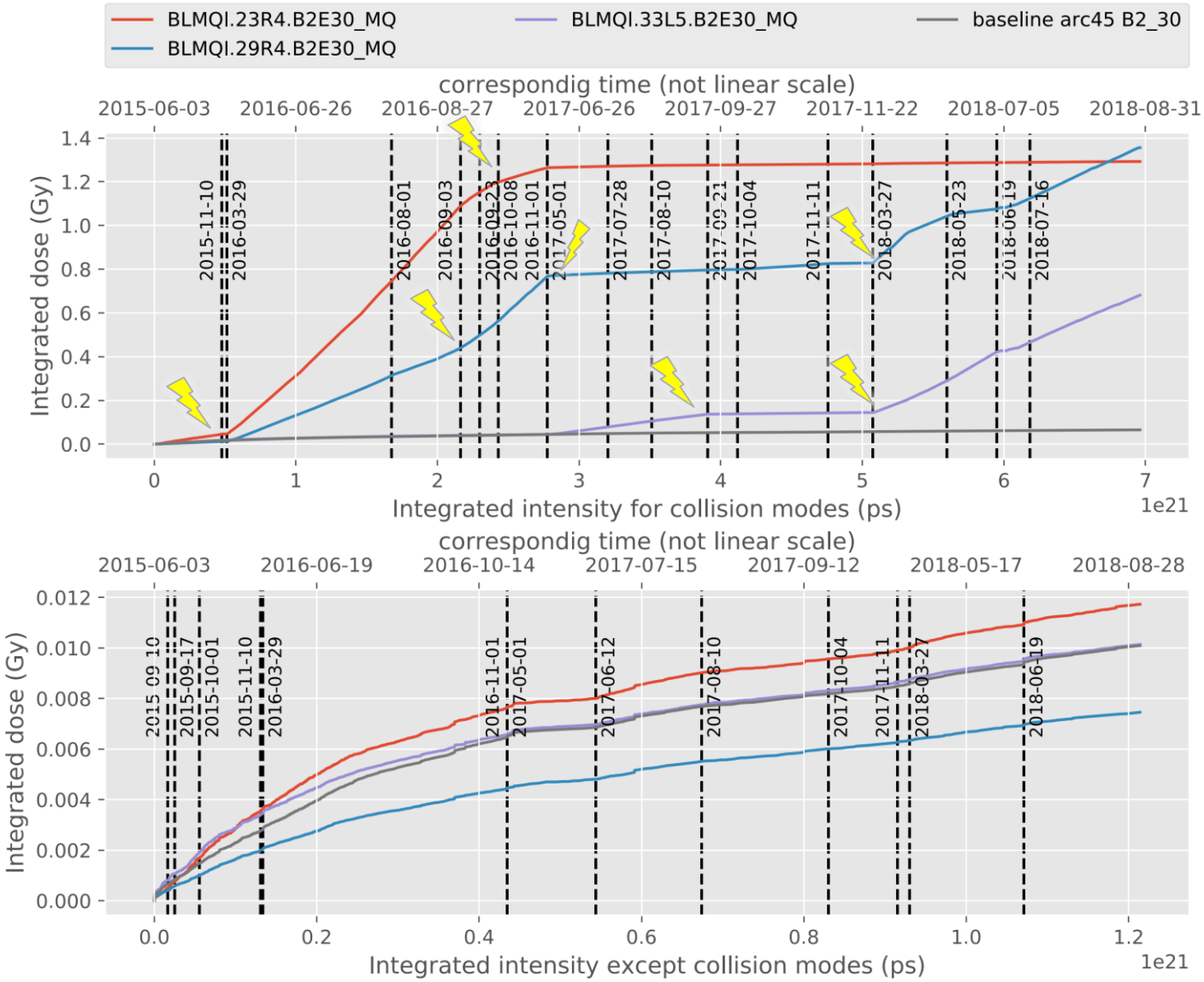


Detailed spikes analysis

Always comparing with the corresponding baseline

Detection of evolution changes

Correlation with the accelerator parameters changes



Current capabilities

Up-to-date radiation levels → **following the operation**

Daily radiation reports

Online monitoring dashboard

Required **human actions limited to minimum**

→ availability to **handle more requests**

Systematic approach

→ results are **reproducible** and can be compared

Future…

LHC BLMs based dose analysis – almost complete

Full automation of spikes and baseline analysis + implementation in the daily reports

Full automation of analysis for different radiation monitors

Full automation of radiation monitoring in Injector Chain and Transfer Lines

More sophisticated analysis

Machine Learning usage for detecting correlation between accelerator settings and dose distributions

Further development and maintenance

Thank you for your attention!

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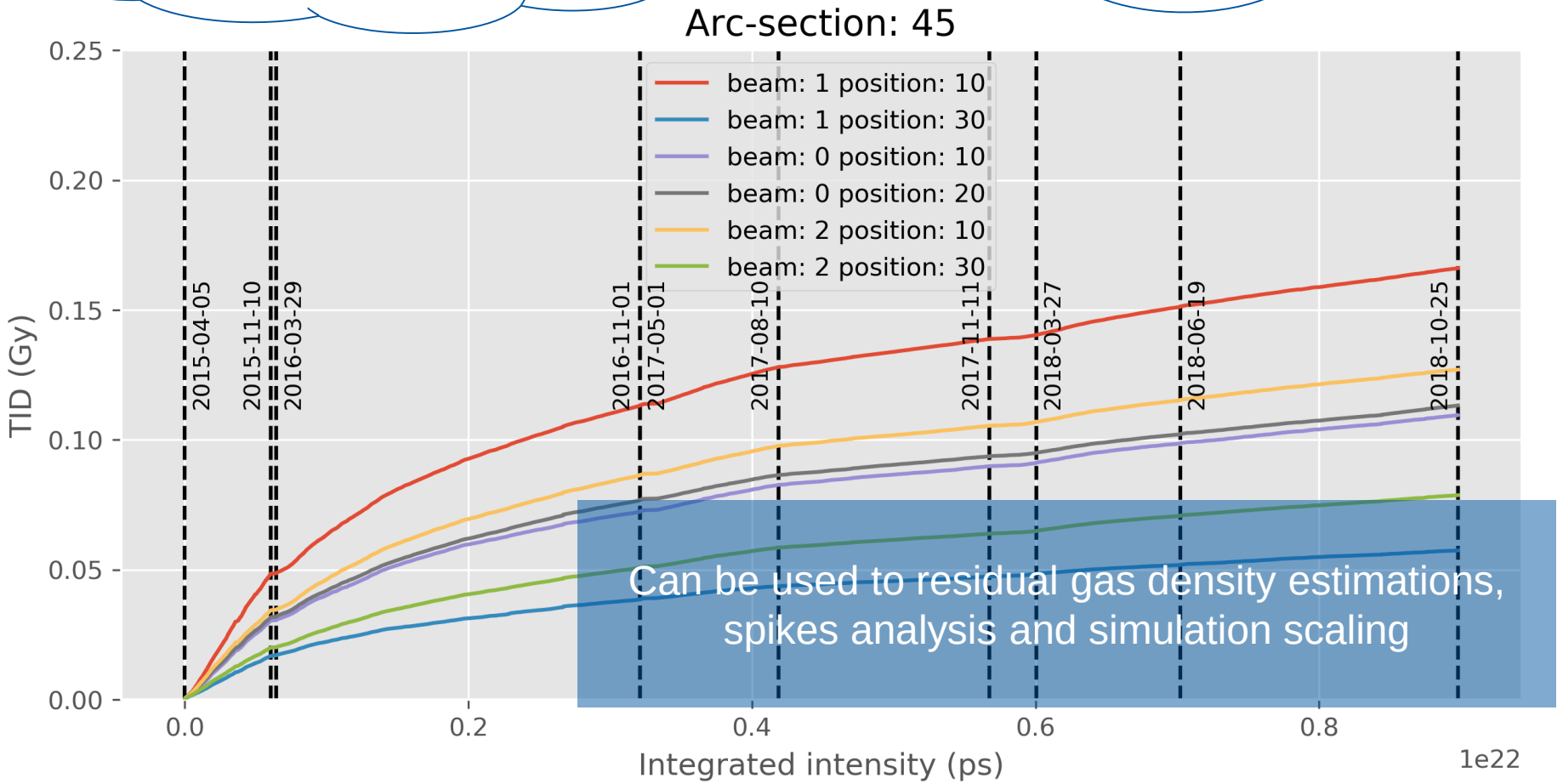
Backup slides

ARC baseline analysis

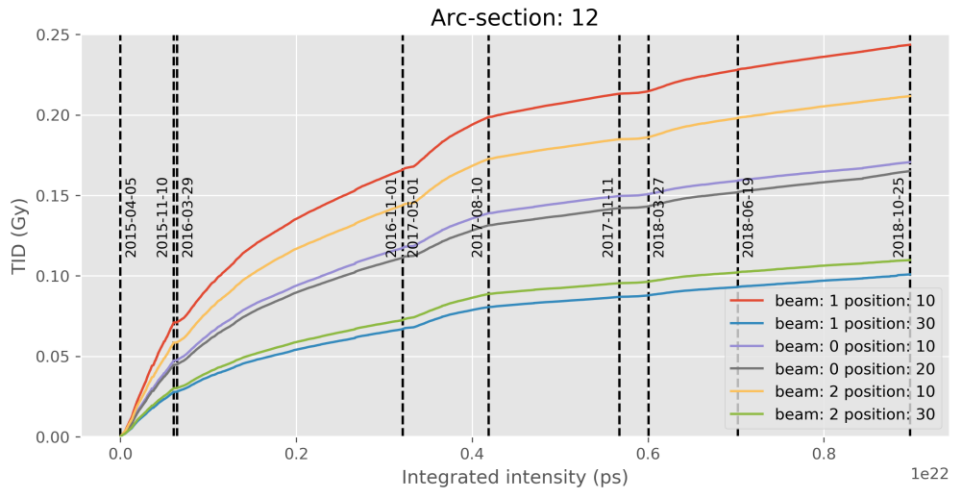
Based on the multiple BLMs in each arc section

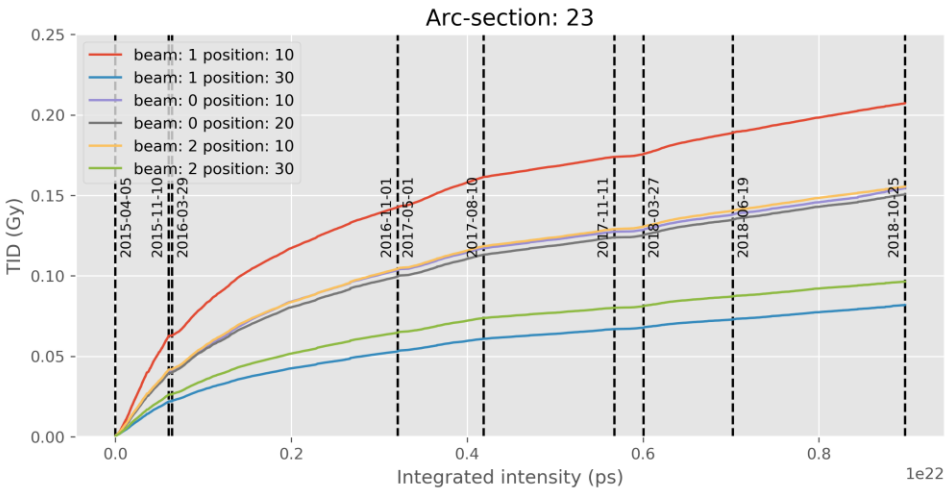
Very low doses! → the highest baseline dose for pp operation **0.25 Gy/Run 2**

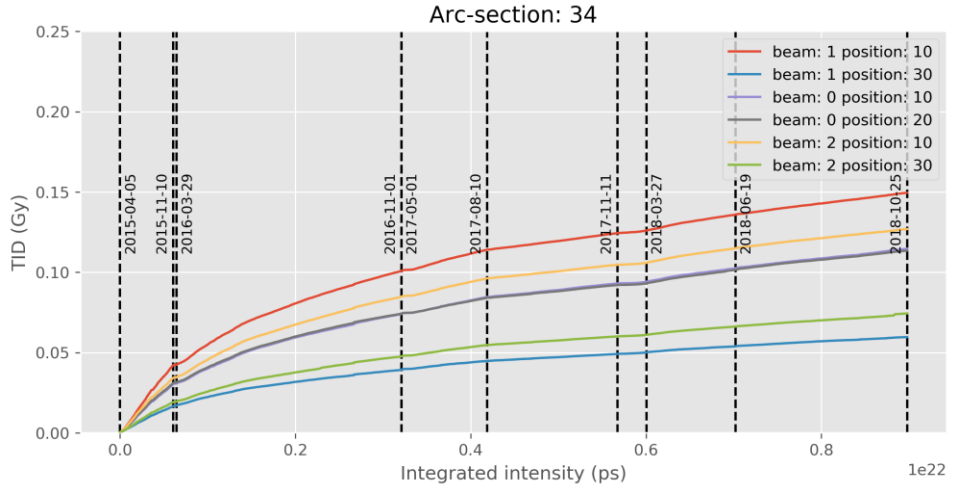


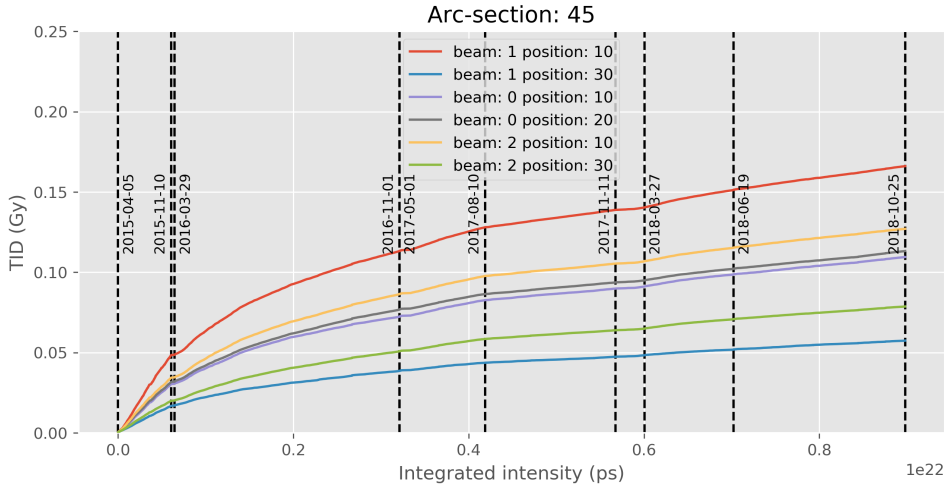
Can be used to residual gas density estimations, spikes analysis and simulation scaling

Evolution of baseline doses over the integrated intensity for all beam modes (proton-proton operation only)









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