cherenkov telescope array

INFN PADOVA
Istituto Nazionale di Fisica Nucleare
Sezione di Padova

lstchain developments

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INFN Padova, 30/06/20
INFN Analysis meeting

Fellini
Fellowship for Innovation at INFN

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cta-lstchain

- cta-lstchain (https://github.com/cta-observatory/cta-lstchain):
  - ctapipe-based pipeline that includes all the tools for LST data processing from R1 up to DL2.

- This presentation: Updates in the new software release

cta-lstchain recap

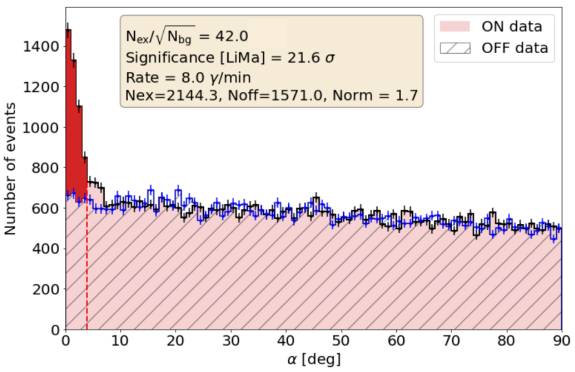
- **R1 ⟹ DL1** (from camera raw waveforms to calibrated & parametrized images)
  - Low level (DRS4) waveform corrections.
  - Pulse integration & calibration (pixel-wise charge in p.e., time in ns)
  - Image cleaning & parametrization ⟹ DL1
  - Identification and muon analysis

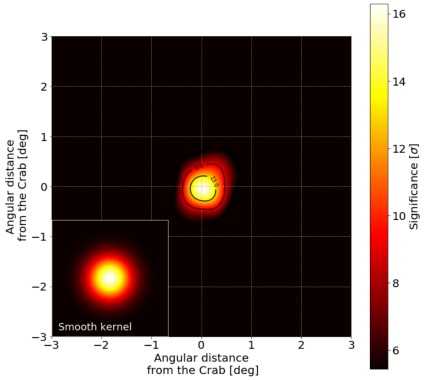
  Notes:
  - currently R1 is stored permanently (all pixels, all waveforms)
  - no official DL0 data format & model yet
  - no lossy data reduction scheme established yet
- **DL1 ⟹ DL2**

  Use scikit-learn's Random Forest, trained on MC, for gamma/hadron separation and direction and energy reconstruction
- **DL2 ⟹ DL3**

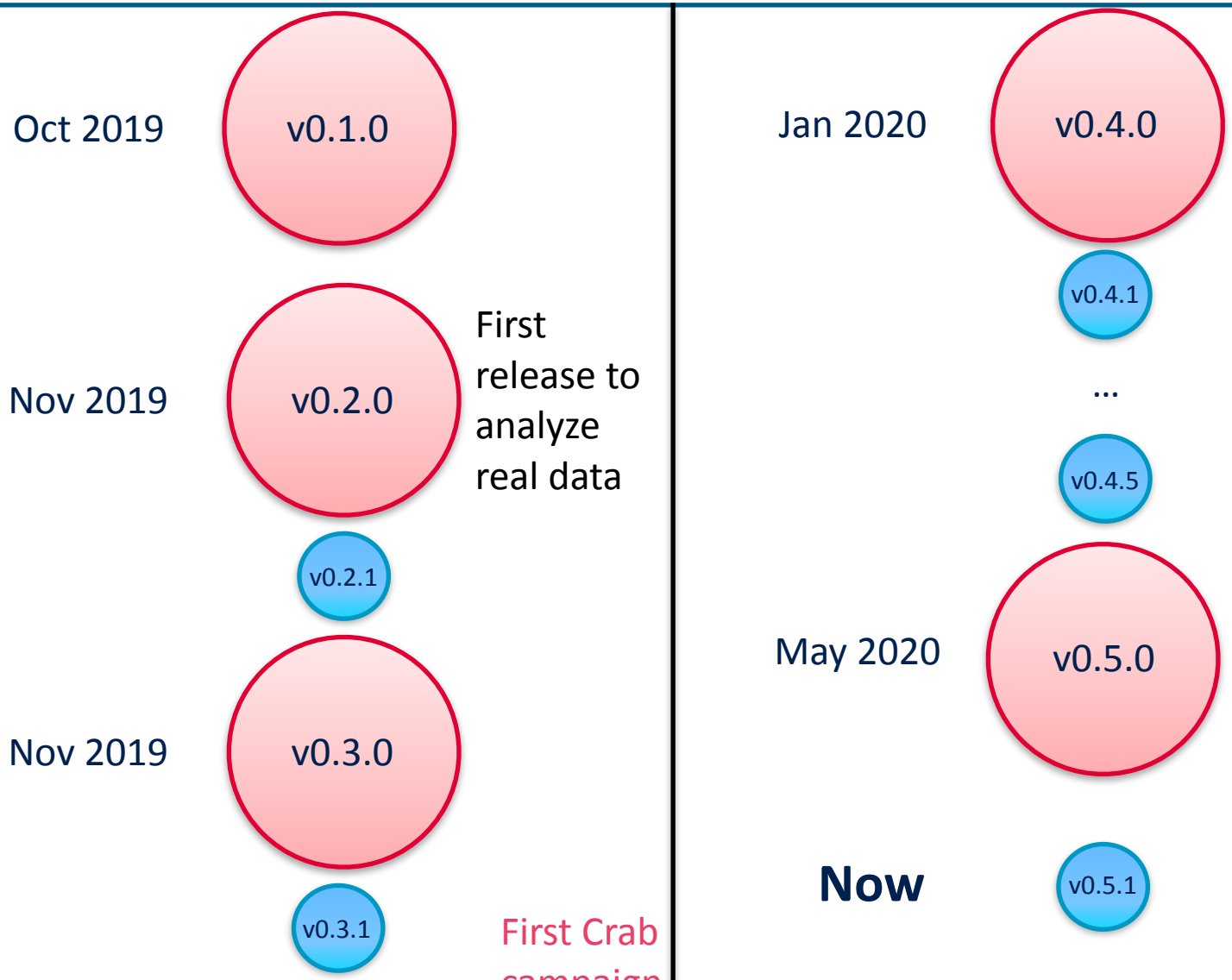
  apply gammaness and direction cut to produce list of gamma candidates

First Crab LST detection
December 2019



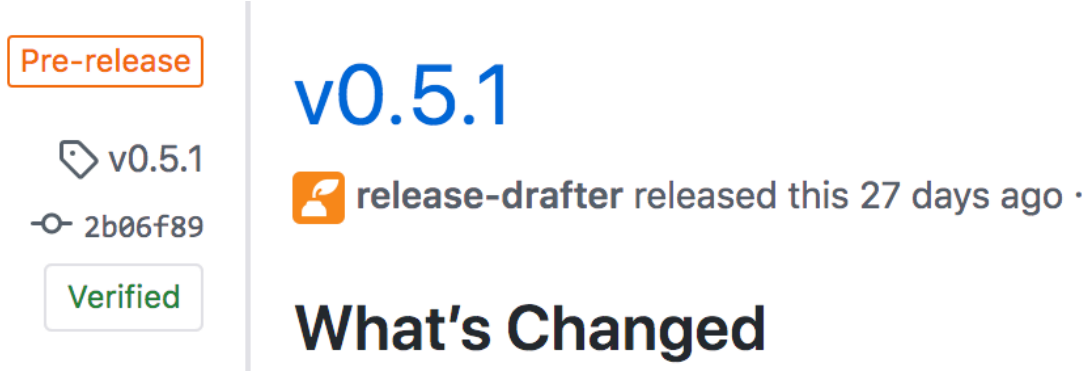


lstchain evolution



Current version

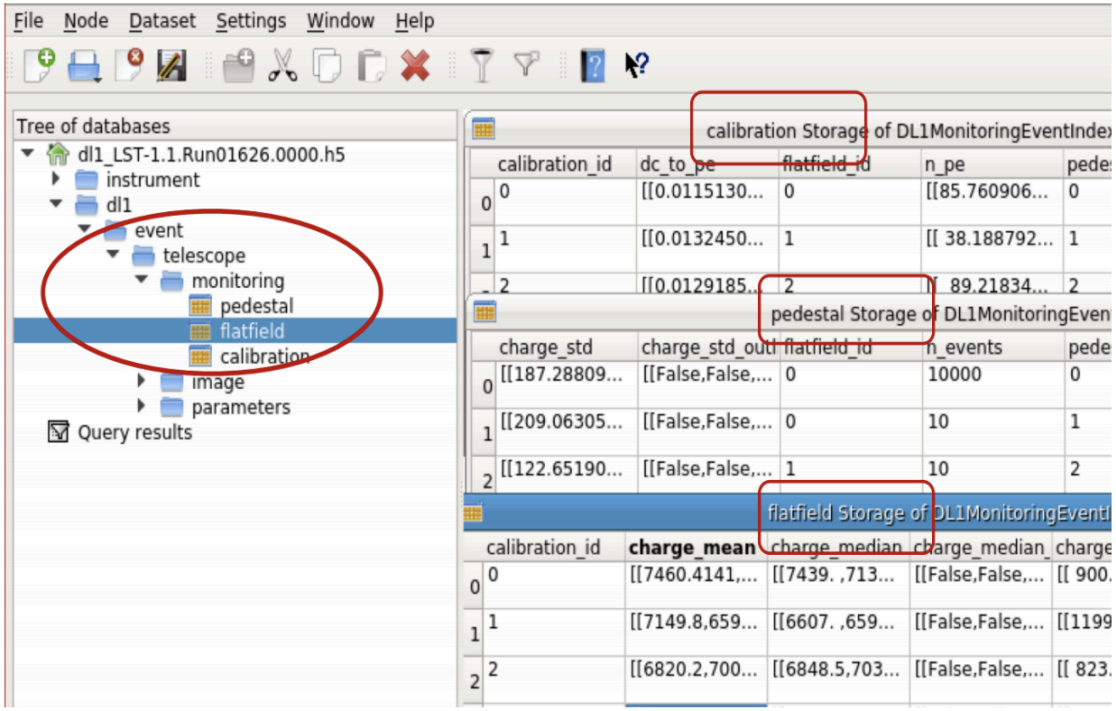
- lstchain v0.5.0 released a few weeks ago:
  - Many code and repo improvements.
  - Volume reduction.
  - Improved muon analysis.
  - Usage of interleaved information in the calibration.
  - Integrated datacheck for data at different data levels.
  - Source-dependent analysis.
  - Proper timing and pointing information from DL1 level on.

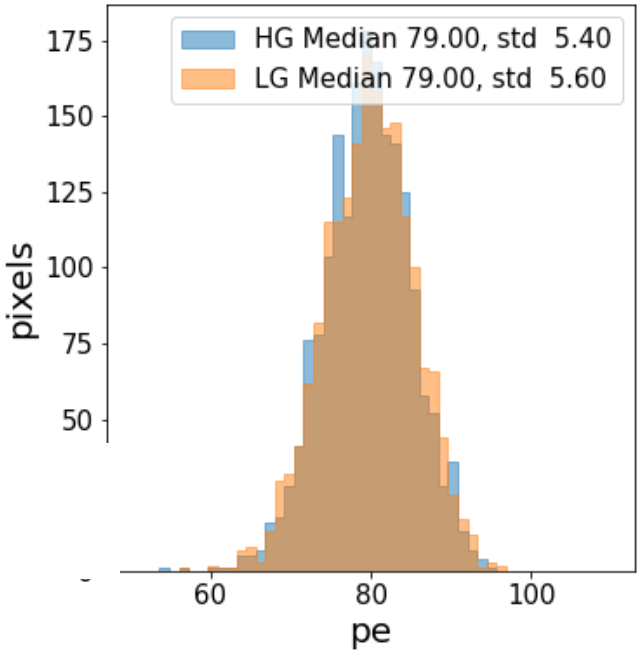


Currently following **v0.5.1** after a few bugfix es

Calibration

- Interleaved information included in the DLx files now (F. Cassol)
  - Unfortunately tagging information of current interleaved data is mostly non reliable.
- HG vs LG agreement pretty good after the implementation of the latest low level correction curves. (Pawel, Yukiho, Seiya, Mitsunari...)
  -

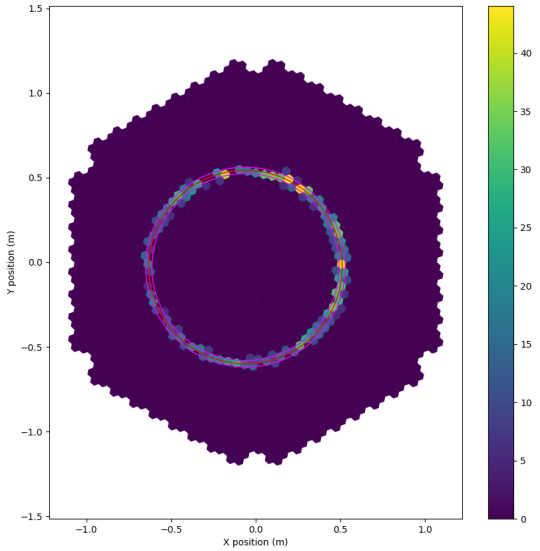


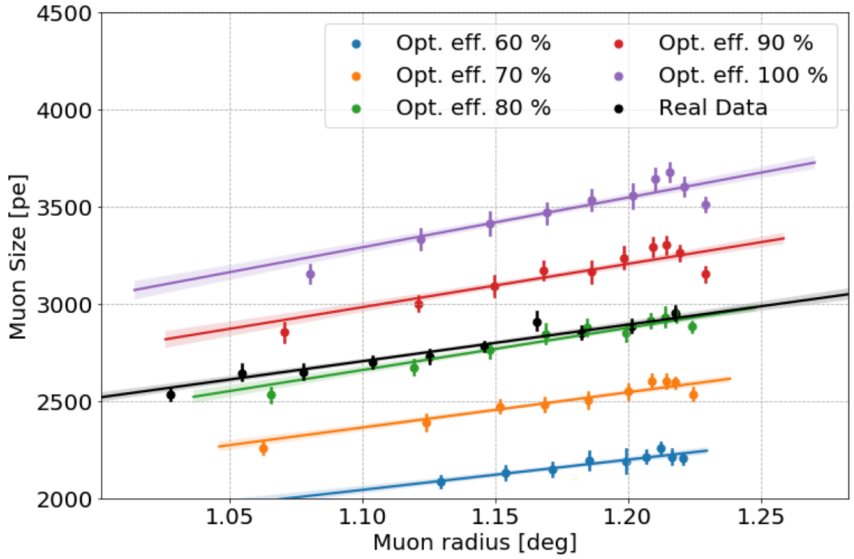


HG/LG comparison

Muon analysis

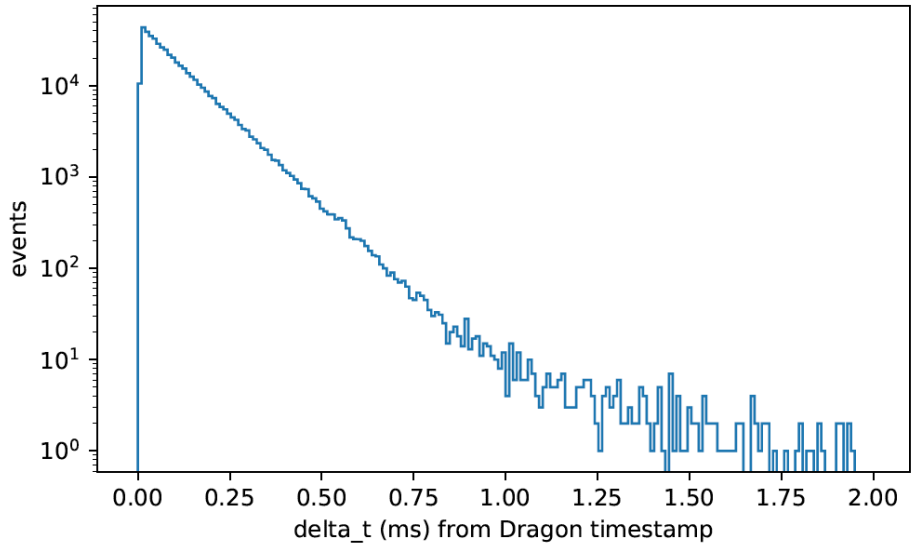
- Now performed together with with the R1 -> DL1 step (no significant increase in processing time) (A. Moralejo)
  - To avoid signal extraction biases, the GlobalPeakWindowSum is now used.
  - At the moment, an ~80% overall Optical efficiency is reached using the same signal integration for Data/MC, with respect to Prod3b simulations -> currently working on more realistic, measured parameters for Prod5.





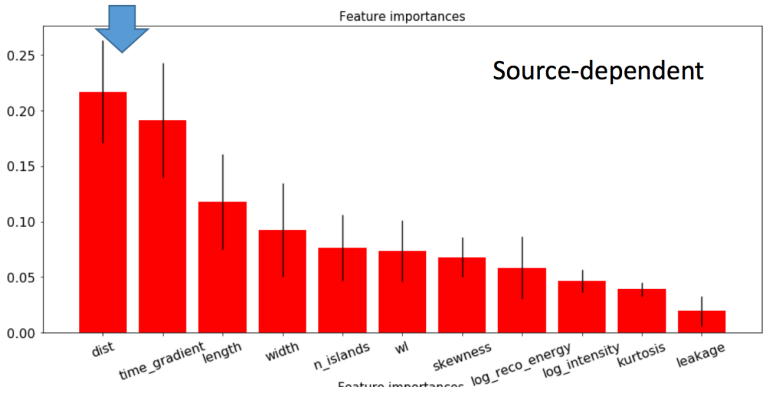
DL1 Datacheck

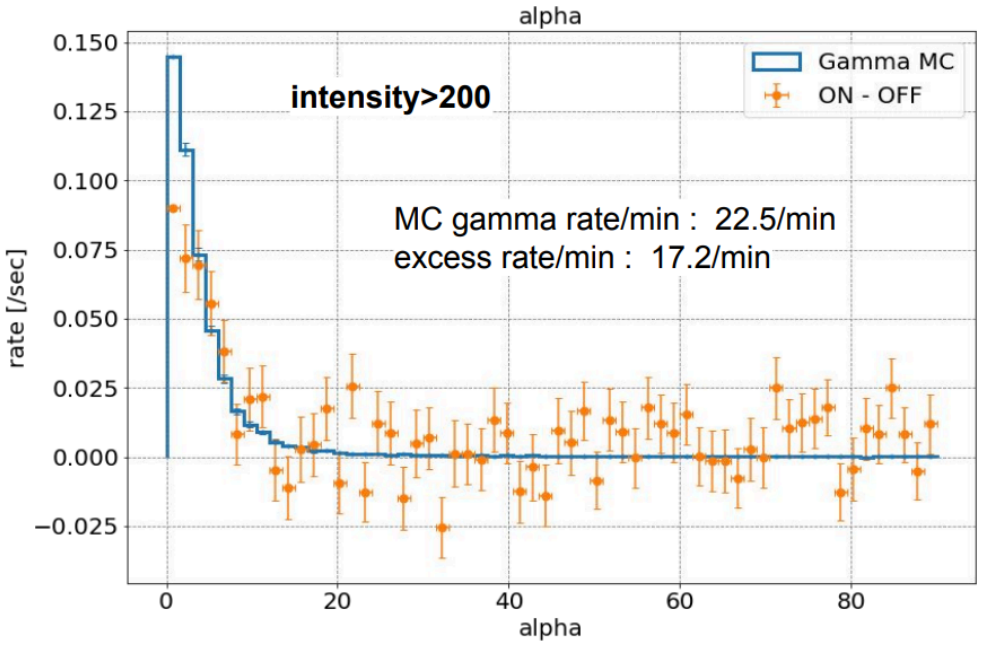
- Quantities to be checked are written into an h5 file per subrun analyzed -> Later merged and plotted together per run (A. Moralejo)
  - Many checks currently implemented -> necessary to spot data problems the day after the data taking.
  - Includes rates, timestamps, flatfield, pedestal, cosmic and muon event checks.



Source-dependent analysis

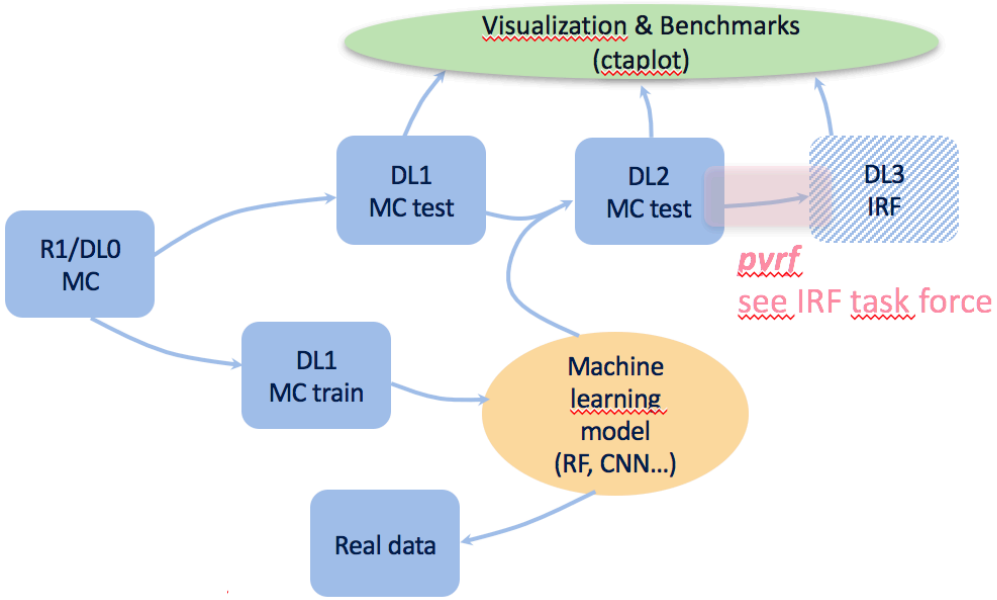
- Single telescope source dependent analysis (S. Nozaki)
  - Usage of the information of the assumed location of the source in the analysis.
  - Source-dependent parameters as “dist” are very useful for image reconstruction





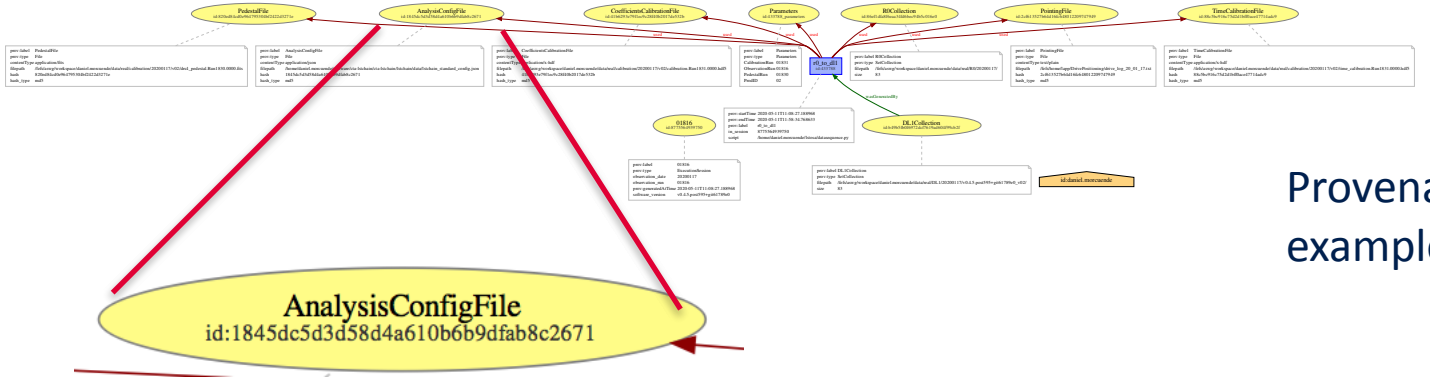
High level analysis

- Automatized training of RF models after software releases (T. Vuillaume, E. Garcia)
  - Preliminary results of training using real data as OFF to improve gamma/hadron separation (A. Baquero).
  - Standard analysis uses models trained on MC (Gammas/Protons).
  - IRF production:
    - Currently custom-made formats.
    - Development of pyIRF within the IRF working group to produce IRFs in FITS format to be analyzed with standard high level software (T. Vuillaume).



R1 -> DL2 automatic processing

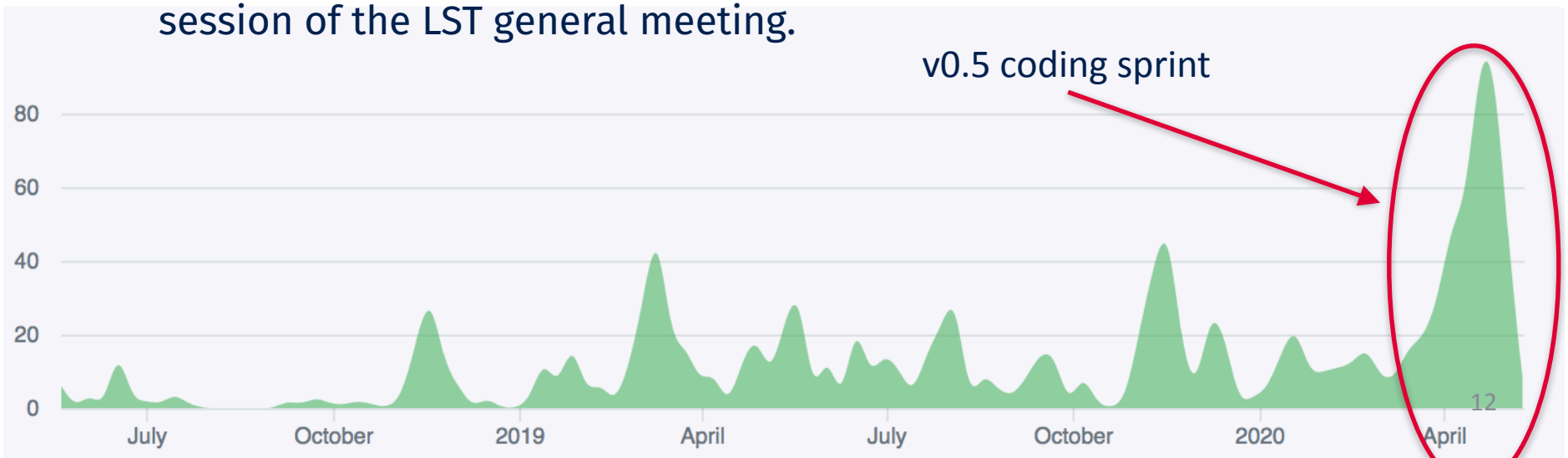
- LSTOSA (OnSite Analysis) (D. Morcuende, J.L. Contreras, A. Baquero)
  - Automatic production of low level DRS4 correction files, calibration and time-calibration files.
  - R1-> DL1
    - Provenance implemented to keep track of the configuration files, version and auxiliary files used in the analysis (J.E. Ruiz)
  - DL1 -> DL2: model application



Provenance graph example

Future

- Towards lstchain v0.6
  - Follow ctapipe v0.8.0 -> Many changes expected (possibly a remote coding sprint needed?)
  - Implement latest low level calibration corrections
  - Optimize cleaning levels using interleaved information.
  - Update calibration constants using interleaved information.
  - Implement the same signal extraction for MC and Data.
  - Start thinking on new, fine tuned MC production.
- News on data analysis using all these new tools shown in the software session of the LST general meeting.

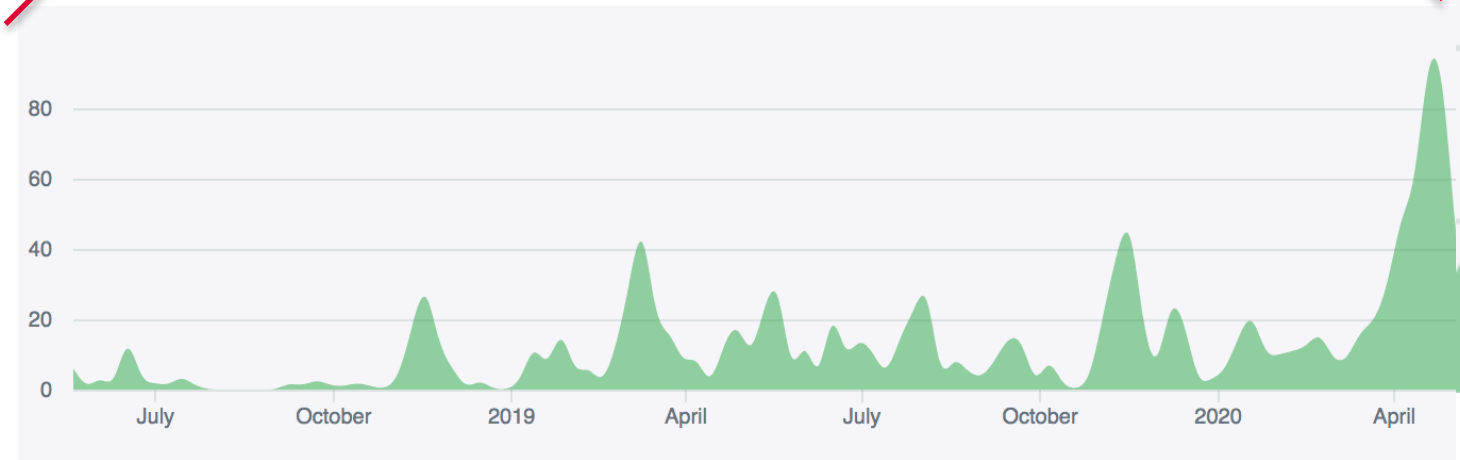


Coding sprint week 6-10 July

- If you want to contribute, save this week in your agendas
  - mainly experts will be working on adapting the code to ctapipe 0.6. See list: https://github.com/cta-observatory/cta-lstchain/issues/357
  - if you are not a lstchain expert you can:
    - start with small implementations.
    - review code.
    - write test units, documentation…

Simulation

Real Data



July 6-10

Contributors