

CTA SUSS requirements workshop summary for the Gammapy developers

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Overview

- SUSS level B requirements workshop in Bologna Dec 4-6
- Materials: <https://indico.cta-observatory.org/event/2070/>
Soon: <https://jama.cta-observatory.org>
- For Gammapy the parts that are most interesting are:
 - “Data analysis options” in the “User options” doc which talks about event classes and quality types
 - Requirements on “science user tools” (all of interest)
 - Requirements on “Data Processing and Products” (some of interest)
 - Requirements on “Dissemination and User Interaction” (a few of interest)
- Next steps: SUSS level B requirements go in JAMA; more review and discussions; then work on level C requirements in 2019. Probably a workshop on DL3 in early 2019.
- No official timeline / delivery dates for ST or any items yet

Discussions

- Many interesting discussions e.g. on scope and functionality of science tools, especially on:
 - B-SUSS-1670, Time Domain Analysis
The SUSS science tools must support the exploration of time domain information including: variability significance, burst search, power spectrum, search for periodicity and time lags.
 - B-SUSS-1750, Radiating Particle Models
The SUSS science tools must support fitting with models with free parameters associated with the spectrum of parent radiating protons or electrons, with user configurable radiation fields and density, for the single zone isotropic case stationary in the frame of the observer.
- Good discussions, no agreement or decision, on what functionality should be built-in or bundled or left to users / the community for the CTA science tools
- Basic modelling & fitting built-in in the CTA ST was not controversial:
 - B-SUSS-1710, Model Fitting
The SUSS science user tools must provide the capability to fit a spectral, spatial or 3D gamma-ray emission model to a region of interest, providing an estimate of goodness of fit and allowing statistical comparisons of the merit of different models and estimates of parameter errors and correlations.

Points on data

- Data levels
 - DL3 is what is given to users and interface between pipeline and ST
 - No discussion on content or format of DL3 or others at the workshop. Plan is to do that work in 2019, do a workshop on DL3
 - No clear definition or common understanding what DL4 / DL5 / DL6 is
 - Some discussion on new DL4 “binned”, which was added earlier this year. At this workshop agreement that DL4 are temporary data products by the science tools (e.g. an exposure map) and thus not so important, not focus of requirements.
 - Overall definition / discussion of data levels not useful for Gammapy, we should just participate in DL3 work and otherwise continue prototyping with whatever formats make sense e.g. for maps or reduced IRFs.
- Observation modes to support
 - Support for fixed ALT / AZ or “drift scan” observations probably needed. I expect a requirement to be added for this.
 - Analysis of data while slewing to a GRB target in DL3 and ST will probably be needed. Not clear how to support this, and if / what requirements will be added for this.

Points on science tools

- No requirement or suggestion of requirement for unbinned analysis.
- Requirement B-SUSS-1780 “Simulation Capability” discussed, will be extended to say that DL3 simulation / event sampling (like gtobssim) must be supported
- Some discussions on flexibility of modelling, so far no requirement for linked parameters or any requirement for sky model serialisation.
- Jean Ballet suggested adding a requirement that ST should support Bayesian priors on parameters. No opposition at the workshop, so presumably requirement will be added. We should start prototyping this in Gammapy in early 2019 ([Github issue #1923](#))
- External experts at the workshop were from ALMA. Apparently they have a generic container in the science tools that’s always 4D with (LON, LAT, ENERGY, TIME) and use one bin if some dimension isn’t present, e.g. in a 1D spectrum. If someone has time, it could be useful to look at their science tools and high-level data model / formats.

Event classes

- Science tool requirements for event classes
 - B-SUSS-1620, Event Classes
The SUSS science tools must support the user selection of event classifications both in terms of reconstruction quality and level of confidence in gamma-ray categorisation.
 - B-SUSS-1760, Fitting with Event Classes
The SUSS science tools must support the simultaneous fitting of different event classes.
- Section 5 “Data Analysis Options” of the new document by Jim “User Options for CTA Observations”
- Suggestion is to have an event (class, quality) matrix
 - event class = how likely to be a gamma ray?
 - event quality = how well reconstructed is the event?
- Sounds like one event list at DL3 with a categorical (or float?) EVENT_CLASS and EVENT_QUALITY column, and IRF given for each bin in the (class, quality) matrix.

Event classes

- No mention of multiple “configurations”, or multiple classification / quality numbers. Try to support all science use cases via a single reconstruction (probably merged best estimate out of many different reconstructions) and two numbers EVENT_CLASS & EVENT_QUALITY
- Similar to what Fermi-LAT does, but a bit different. Basically has never been done, especially not for IACTs. IRF production probably very challenging; if IRFs are good, this can work at the ST level and is nice for users
- This proposal is very new, many questions not discussed yet:
 - How to represent this in DL3?
 - How will class & quality change as we learn?
 - How to handle event class & quality in analysis?
 - Add class or quality axis to maps / IRFs, or only a single axis with a combined selection of bins in this 2D matrix that is made at the start?
 - How to expose the selection options to users?
- Need to prototype this approach in DL3 and ctapipe & Gammapy in 2019!

Event classes

Could define “**selections**” as sets of classes, e.g.:

- Transient = class A + B + C + D
- Source = class A + B + C
- Clean = class A + B
- Ultraclean = class A

Quality could be based
on event core location

	Class A	Class B	Class C	Class D
Quality 1				
Quality 2				
Quality 3			(C, 3)	
Quality 4				

Can we get good enough IRFs for each bin in the 2D matrix?

Summary

- Good workshop on SUSS level B requirements. Well prepared draft requirements, many good discussions and improvements at the workshop.
- Level B is mostly as expected, and too high-level to directly inform work in Gammapy. Exceptions: Bayesian priors wasn't on our radar, and a somewhat unexpected suggestion how to support event classes is now on the table.
- A lot of work ahead: many developments needed in Gammapy, as well as participation in the work with CTA on level C requirements and DL3 in 2019.
- Few if any adjustments of Gammapy roadmap needed?
Make support for event classes a high priority / development activity starting now (since it requires support in data, IRFs, analysis, ...)? Need to have a plan / active ctapipe / Gammapy collaboration.