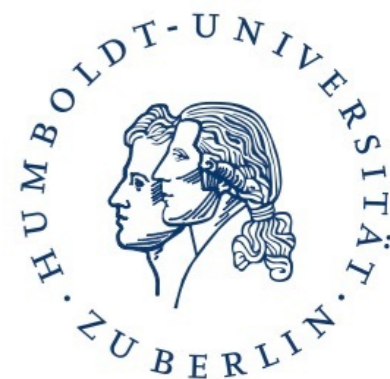# Status: ctools in HESS

Michael

HESS analysis structure

Raw Data → ParisAnalysis → DSTs, IRF → ParisAnalysis (high level)

Raw Data → HD-HAP → DSTs, IRF → HAP (high-level)

Reconstruction   Storage   Spectra, maps, …   independent cross-check
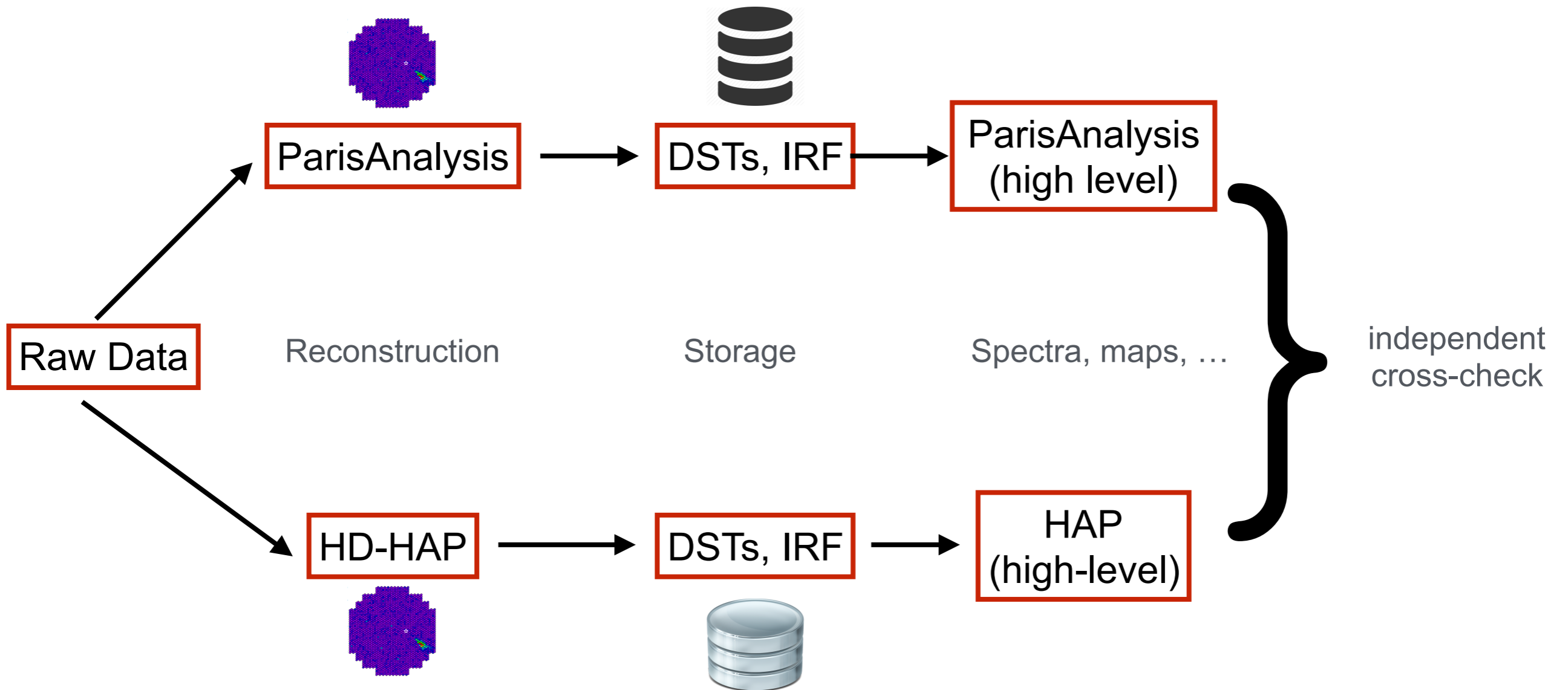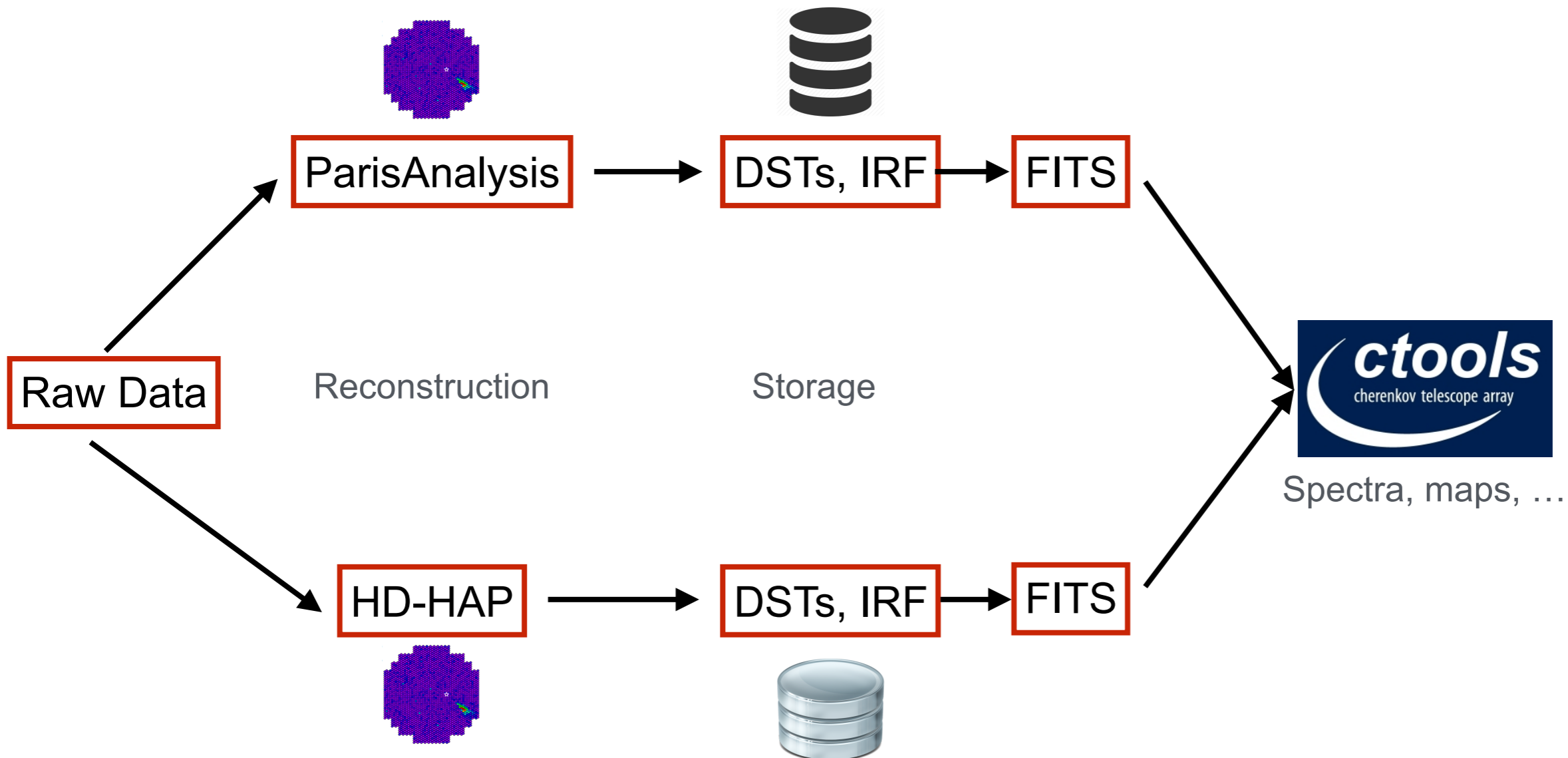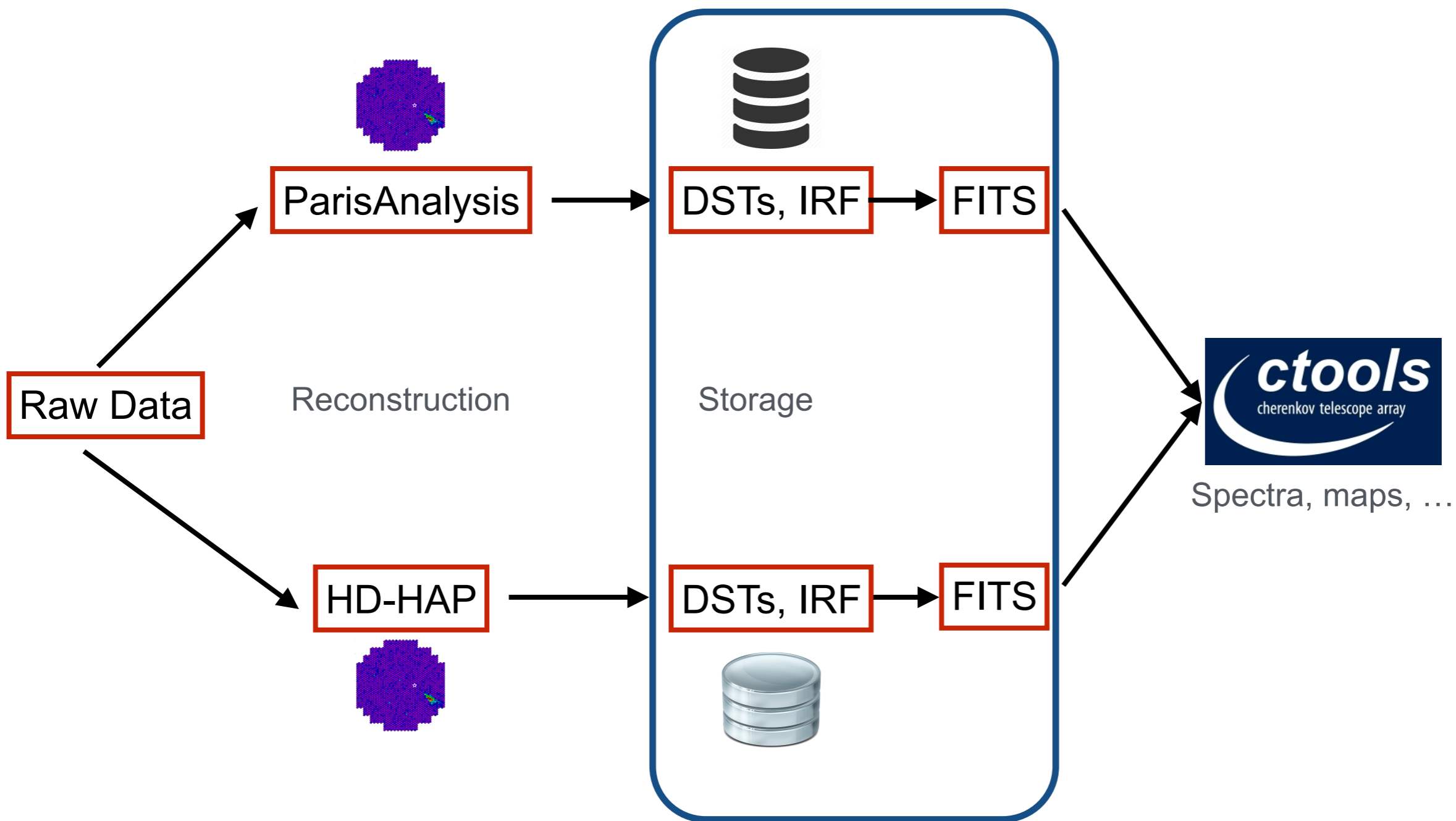
→ Incompatible file formats between the chains

Goal: additional branch

Raw Data → ParisAnalysis → DSTs, IRF → FITS → ctools

Reconstruction   Storage

Raw Data → HD-HAP → DSTs, IRF → FITS → ctools

Spectra, maps, …

→ X-check between chains wouldn't depend on high-level software

Goal: additional branch

Reconstruction   Storage

Raw Data → ParisAnalysis → DSTs, IRF → FITS → ctools

Raw Data → HD-HAP → DSTs, IRF → FITS → ctools

Spectra, maps, …

→ X-check between chains wouldn't depend on high-level software

FITS Exporter - Organisation

- Long running task (3 coordinators for individual analysis chains)

- Working on common data formats:

  http://gamma-astro-data-formats.readthedocs.org/en/latest/

- Mission:
  - provide all HESS data in FITS format to the collaboration
  - regular updates
  - keep up with software releases and reprocessed DSTs
  - follow evolving CTA event list and IRF data format
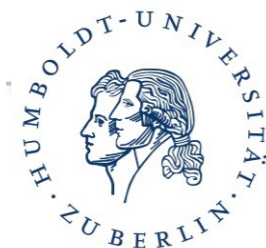
FITS Exporter - Status

- Included a ctools test script in the HESS software (run after export)

- ParisAnalysis (M++): First full versioned data release available
  - using King PSF
  - using background models from off data (produced by csbkgmodel - tbd in this coding sprint)
  - "hess-fits-pa-release-1.0-Prod26-MppStd" (… Faint/Loose/HiRes, too).

- HAP-HD: Larger diversity (people export with different objectives)
  - Erlangen group runs production for ctools
  - First release to collaboration is in the making

- HAP-Fr: Exporters still rudimentary
  - Work mainly done in Paris (APC) and Bordeaux
  - Plan to have full production ready soon

IACT tools

- csiactcopy
  - Copy data from one machine to another
  - Supports also copying only subsets of the data

- csiactdata
  - Shows the available data productions on the screen

- csfindobs
  - Create an ASCII list of observations matching user requirements
  - E.g. sky pointing, Zenith angle, etc…

- csiactobs
  - Create an observation XML file from an input runlist
  - Create a model XML file including all background models (following user parameters)
  - Input for all other ctools

Analysis using current IACT data

- Copying IACT data
  - Before you start
  - Mount remote file system
  - Copy data
  - Copy only a subset of the data
  - Troubleshooting
- Analysing IACT data
  - Check available FITS production
  - Find observations
  - Create an observation list
  - Example XML files
  - Run ctselect
  - Unbinned analysis
  - Stacked (binned) analysis
- High level analysis tools for IACT data
  - Inspecting observation definition files
  - Inspecting model XML files
  - Compute upper limit
  - Compute asymmetric errors
  - Compute spectral points
  - Compute light curves
  - Compute a residual map
  - Compute a test statistics (TS) map
- Simulating IACT data
  - Simulations for a specific observation container
  - Simulating observation time for a given set of IRFs
  - Create pull distributions
  - Visualise pull distributions
  - Create sensitivity curve
  - Visualise sensitivity curves
- Tips, Tricks and FAQs
  - Visualise observations
  - Plot zenith angle distribution of observations
  - Visualise models
  - Manipulating models in python
  - Retrieve likelihood values from `ctlike`
  - Speed up analysis
  - Compute excess maps
  - Compute flux maps
  - Speed up TS map computation
  - Creating a python analysis pipeline
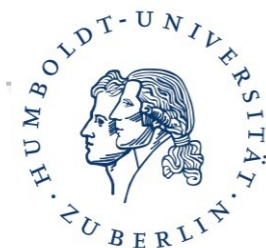
Documentation

Copying data

Analysis

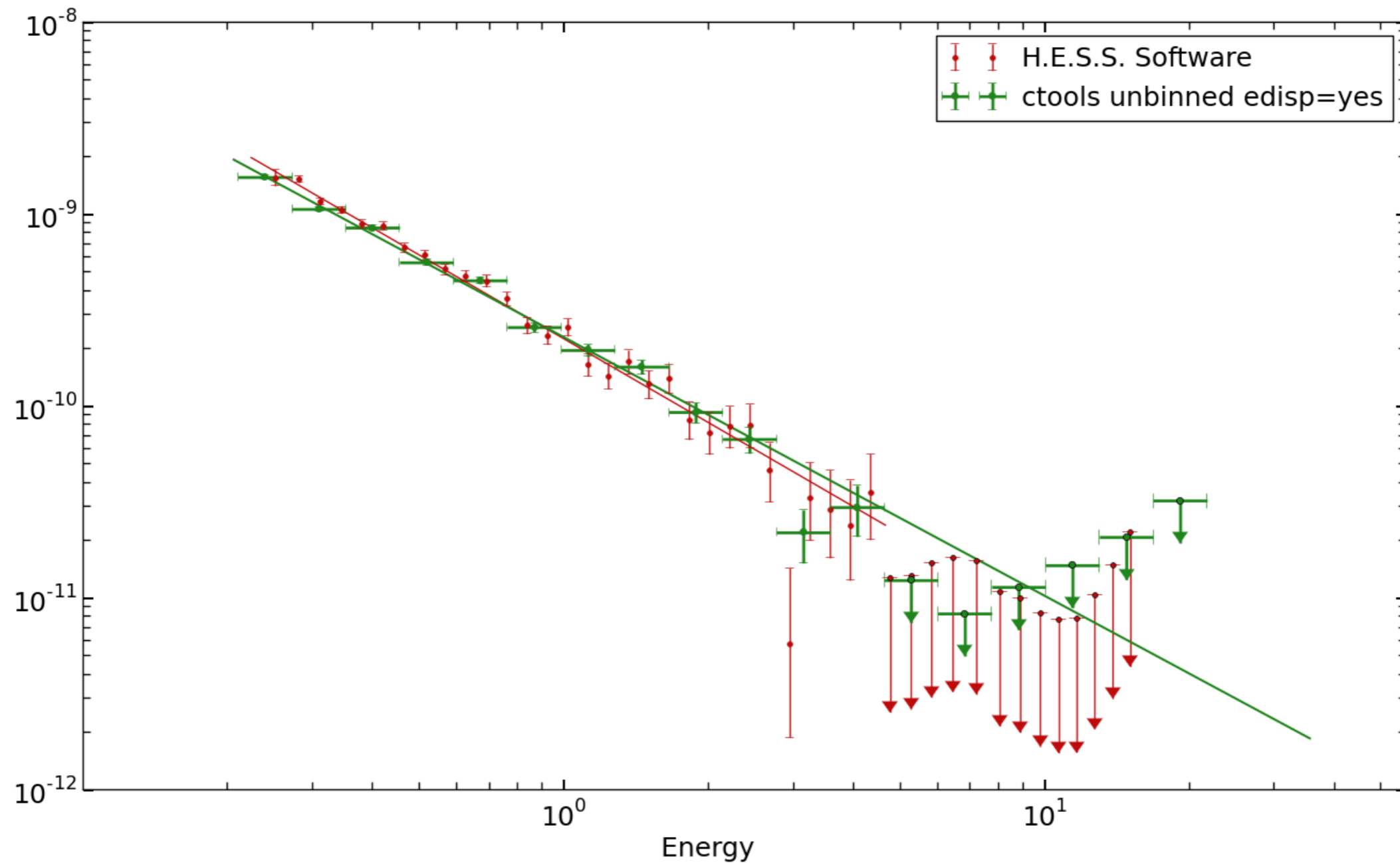High level tools

Simulation

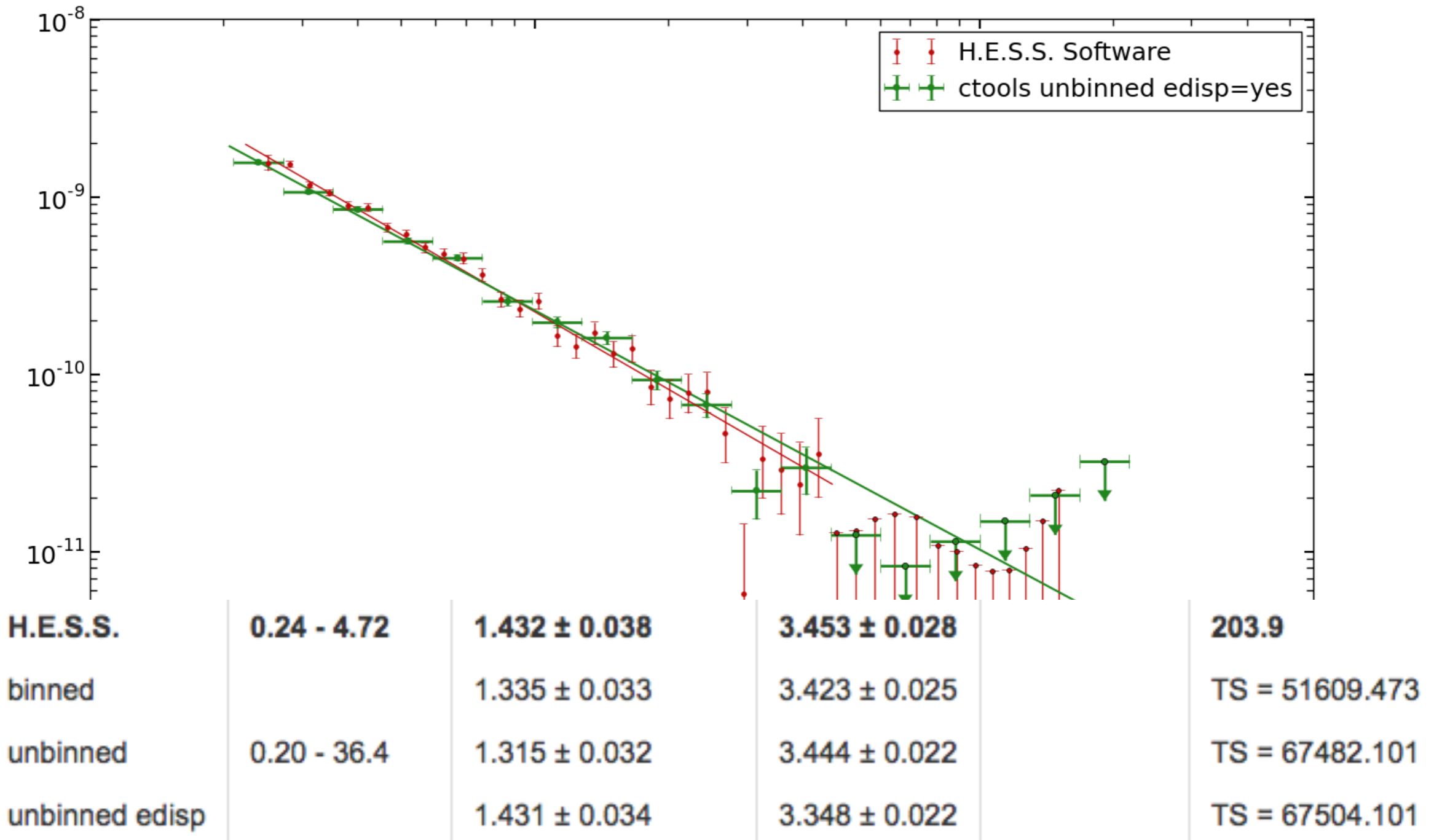Tips, Tricks

Summary ctools@HESS

- Getting more and more feedback from people using it

- Interesting science cases for which ctools provides new perspectives

- Recently added new IACT scripts to become completely independent of HESS Software

- Next FITS productions (including HESS II data) will accelerate this development

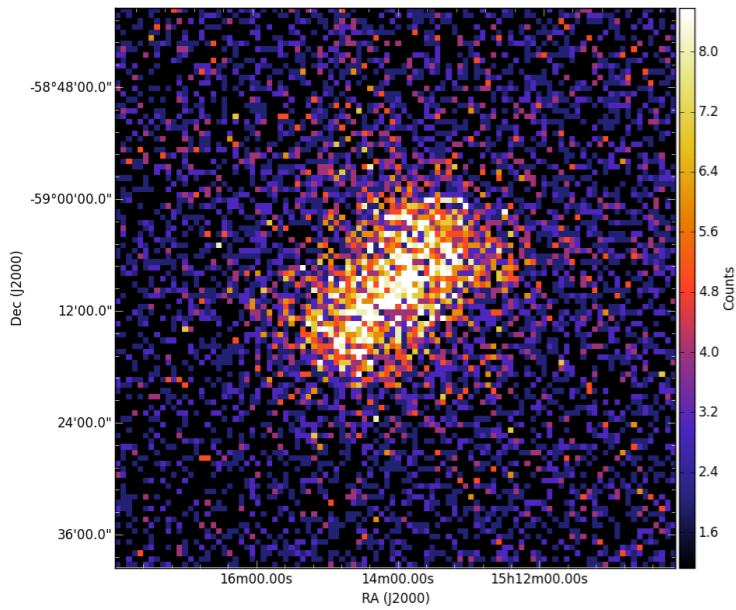H.E.S.S.

Verification: ctools vs HESS software
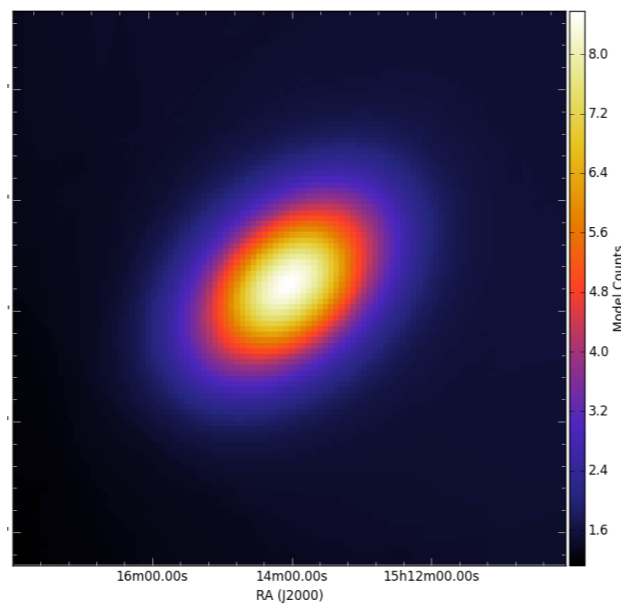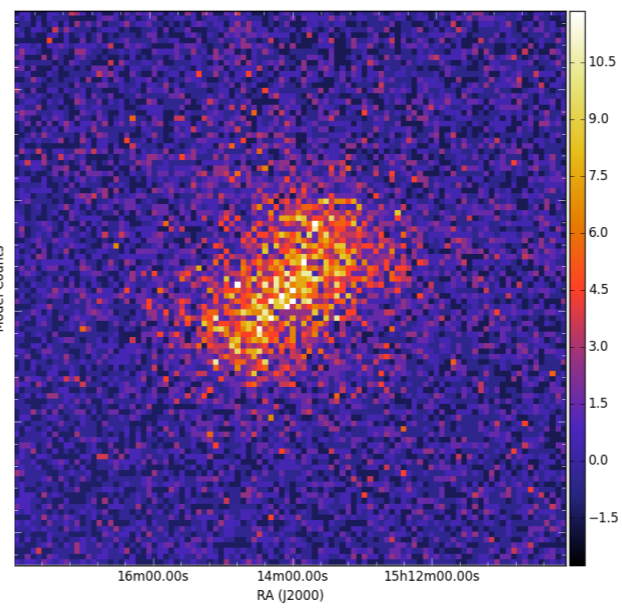
PKS 2155-304 Flare

PKS 2155-304 Flare

| H.E.S.S.	0.24 - 4.72	1.432 ± 0.038	3.453 ± 0.028	203.9
binned		1.335 ± 0.033	3.423 ± 0.025	TS = 51609.473
unbinned	0.20 - 36.4	1.315 ± 0.032	3.444 ± 0.022	TS = 67482.101
unbinned edisp		1.431 ± 0.034	3.348 ± 0.022	TS = 67504.101

MSH 15-52

count map	model map	excess map	residual map
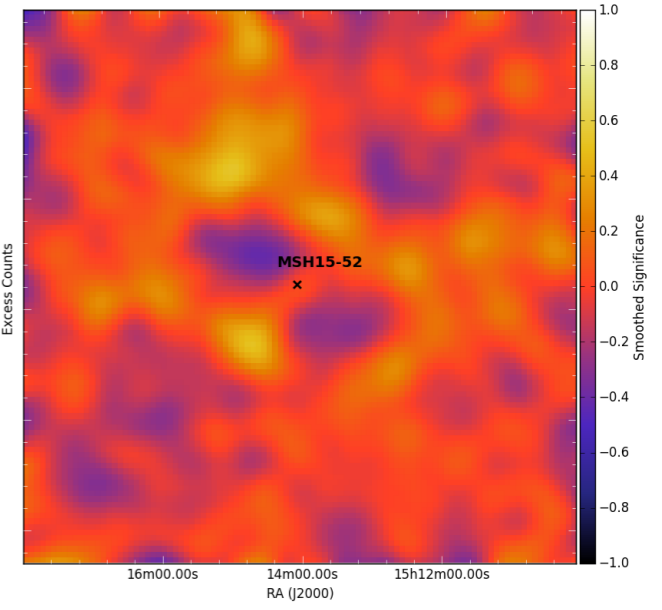
H.E.S.S.	**0.32 - 113.2**	**6.68 ± 0.30**	**1.79 ± 0.10**	**0.28 ± 0.06**	**31.2**
binned		7.34 ± 0.18	1.96 ± 0.03	0.19 ± 0.02	TS = 5369.827
unbinned	0.27- 41.4	6.76 ± 0.15	2.02 ± 0.03	0.17 ± 0.02	TS = 6926.241

edisp too time consuming

Tool	RA	DEC	Angle *	Sigma1	Sigma2
H.E.S.S.	**228.5159 ± 0.0049**	**-59.1567 ± 0.0024**	**314.033 ± 2.027**	**0.0748 ± 0.0021**	**0.1226 ± 0.0031**
ctools	228.5190 ± 0.0047	-59.1585 ± 0.0023	138.647 ± 1.871	0.0676 ± 0.0022	0.1176 ± 0.0030

* 318.647 (different angle definition)
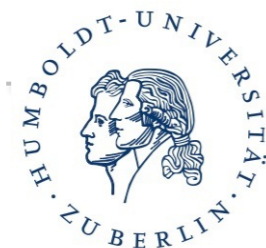
Results summary
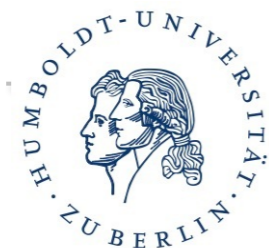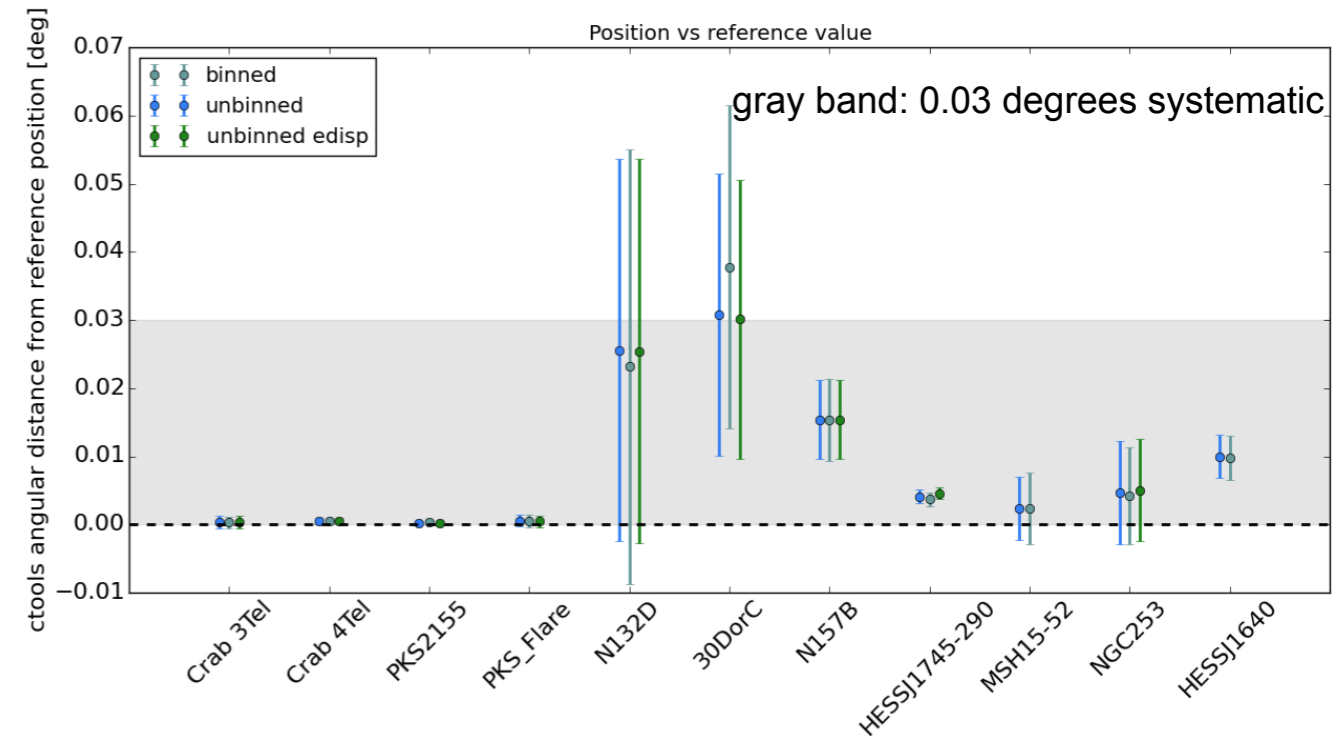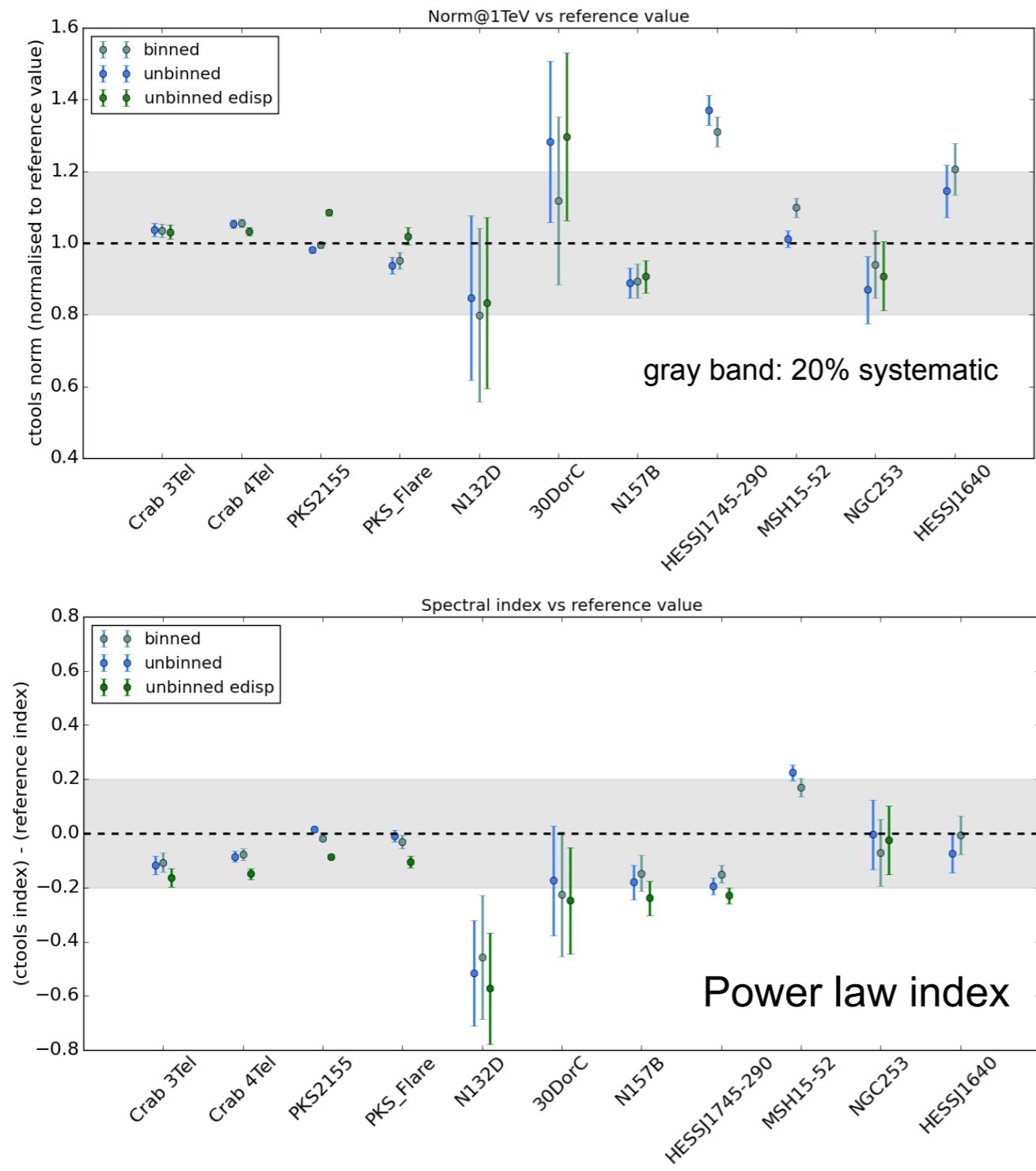
Summary

- FITS exporters are mostly ready but need more unification

- IACT scripts to easily run ctools analysis without any HESS software

- Full scientific validation ongoing and close to finish

- More and more people get involved and use ctools

- Will be able to publish science results using ctools soon