Laboratoire d'Annecy-le-Vieux
de Physique des Particules

ICRC 2017 - plans

LAPP Phys Group

Vendredi 05 mai 2017

cnrs

UNIVERSITÉ
SAVOIE
MONT BLANC

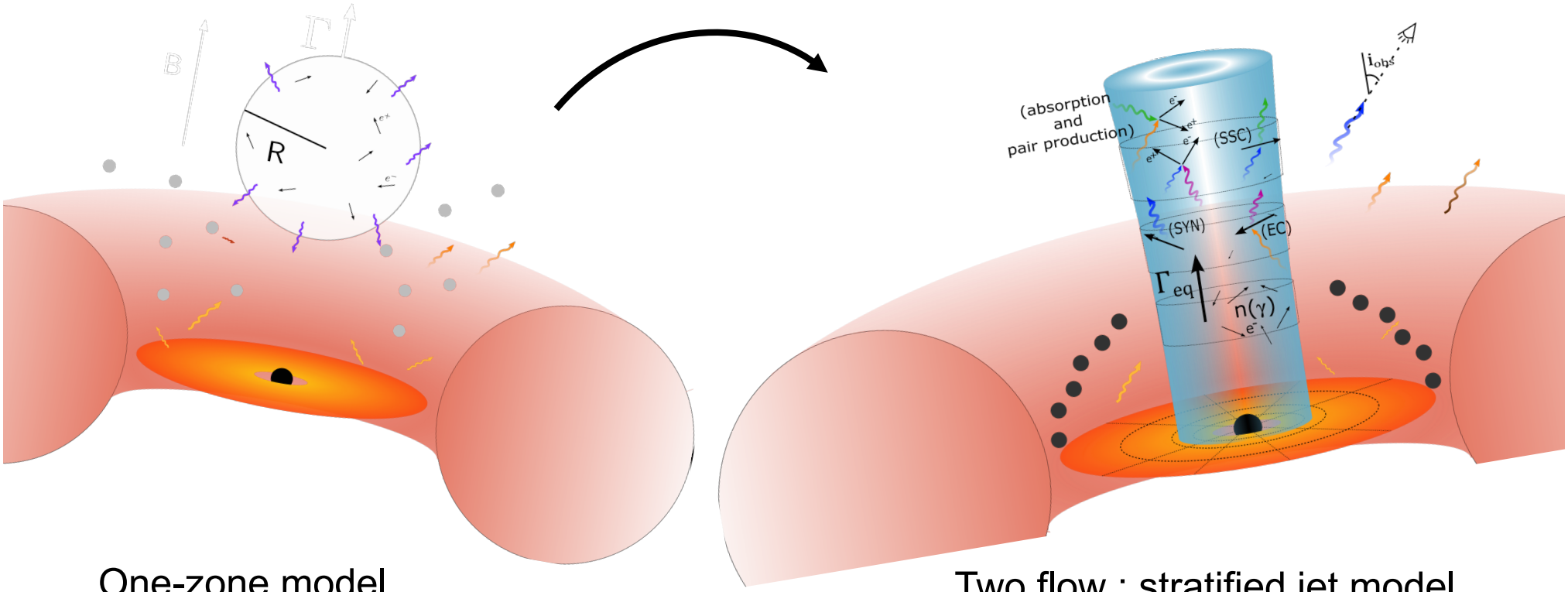
- 3 submissions:
  1. Talk : An inhomogenous jet model for the broad band emission of radio loud AGNs
  2. Talk or poster : High Performance Computing algorithms for Atmospheric Cherenkov Telescopes
  3. Poster : PS^{3}CHIT ! – A Python package for the Simulation of atmoSpheric Showers and Cherenkov Imaging Telescopes

I. An inhomogenous jet model for the broad band emission of radio loud AGNs

– Work done during PhD -- still not published

  - Needed some code updates – done and does not change conclusions

I. An inhomogenous jet model for the broad band emission of radio loud AGNs



One-zone model

Two flow : stratified jet model

I. One-zone modeling

- a single set of parameters $n_e(\gamma)$, B, R, Γ
- Unique speed
  vs velocity discrepancy & unification
  (Henri & Sauge 06, Chiaberge et al 00)
- Single localization
  vs several emission zones
  (Aharonian et al 09, Barres de Almeida 10)
- Correlated variability only
  vs X-ray/TeV uncorrelated
  (Aharonian et al 09, Aleksic et al 15)
- No link with jet dynamics
- No global understanding of jets

$\Rightarrow$ Physically limited and unsatisfactory

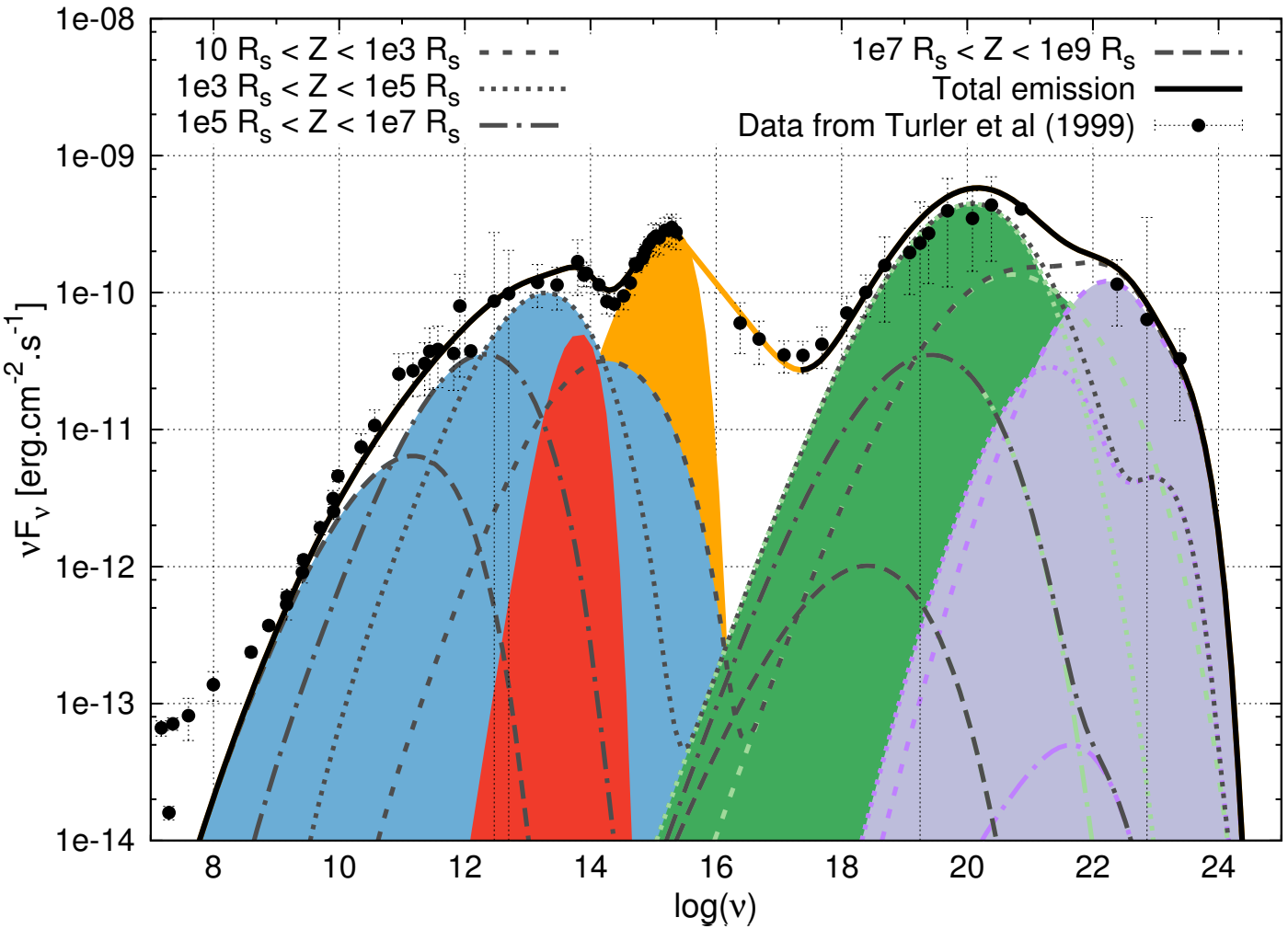
$\Rightarrow$ Need more complex models !

I. Inhomogeneous modeling in the two-flow paradigm

- ~~a single set of parameters $n_e(\gamma)$, B, R, Γ~~
  - Self-computed from initial conditions at the jet base
- ~~Unique speed~~
  - Imposed by external sources
- ~~Single localization~~
  - stratified
- ~~Correlated variability only~~
  - Potential de-correlated variability
- ~~No link with jet dynamics~~
  - Compton rocket
- ~~No global understanding of jets~~

$\Rightarrow$ Much deeper understanding of jets emission

I. Inhomogeneous modeling in the two-flow paradigm



Standard Accretion disc

Dusty torus

Synchrotron

Synchrotron self-Compton

External Compton

— Hot corona modelled by a power-law between 5e15 and 5e19 Hz (Haardt et al 98)

II. HPC algorithms for IACT (not CTA specific)

- compression algorithm (APC)
- HPC library (low level algorithms) applied to the Hillas parameters calculation
- New reconstruction method based on Single Value Decompositions (SVD)

II. HPC algorithms for IACT (not CTA specific)

- compression algorithm (APC)

	Compression ratio	Time (file = 100MB)
LZMA (7z)	4.84	> 7 min
APC	3.74	< 4s
APC + LZMA	4.84	< 25s

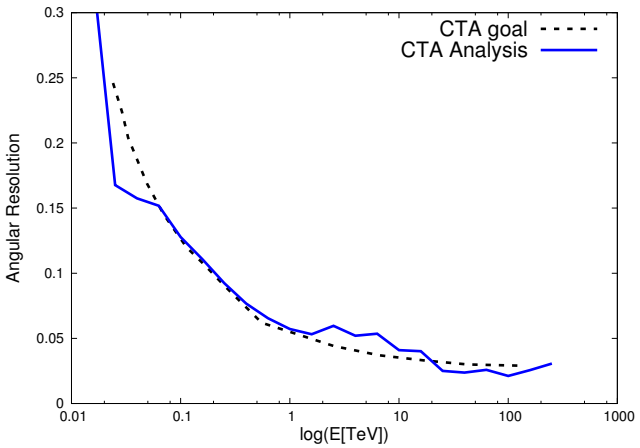
II. HPC algorithms for IACT (not CTA specific)

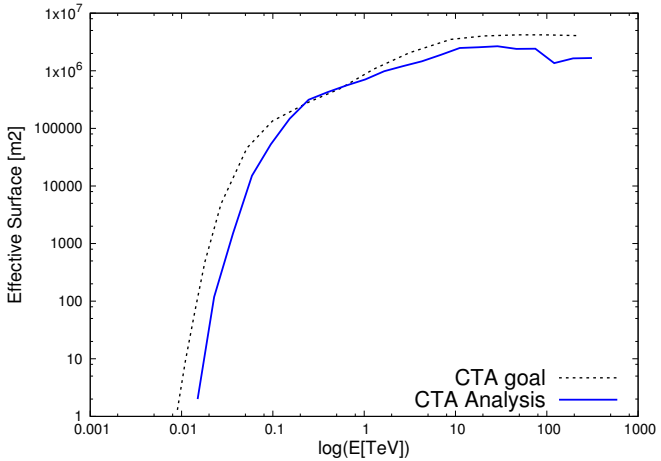
- HPC library (low level algorithms) : example of a reduction

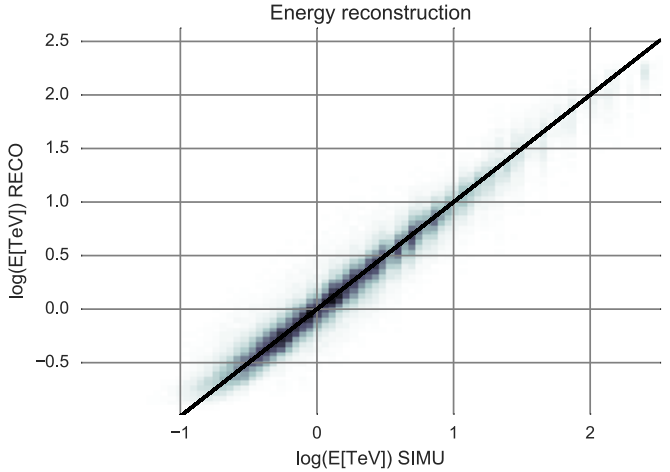
	Speed (cy/el)	Speed up
Non optimized algo + standard data format	2125.5	1
New data format	53.14	40
+ vectorization SSE4	6.40	332
+ vectorization AVX	2.99	712

II. HPC algorithms for IACT (not CTA specific)

- HPC library (low level algorithms) : physics results (under improvements)





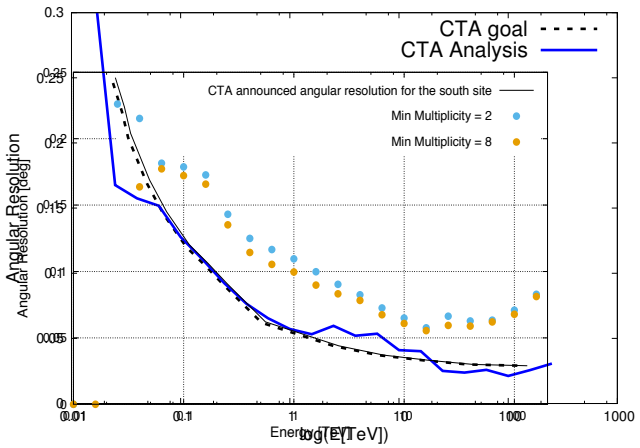


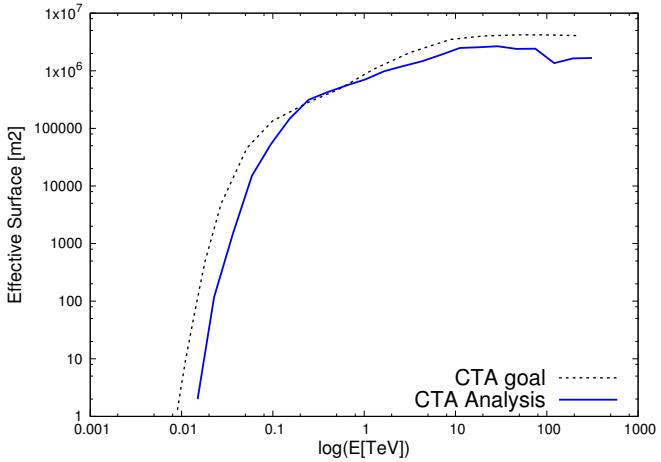
1.7GB (1e6 simulated events) on 5 files analyzed in less than 40s (loading included) on 1 core

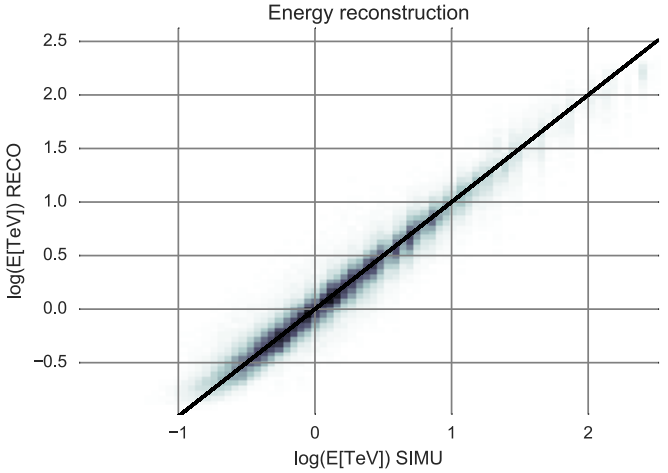
TO BE DISCUSSED

II. HPC algorithms for IACT (not CTA specific)

- HPC library (low level algorithms) : physics results (under improvements)



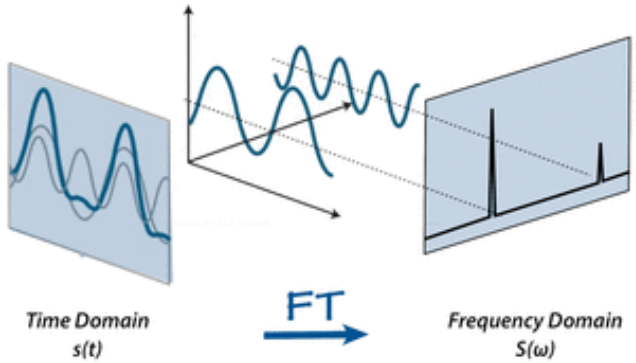


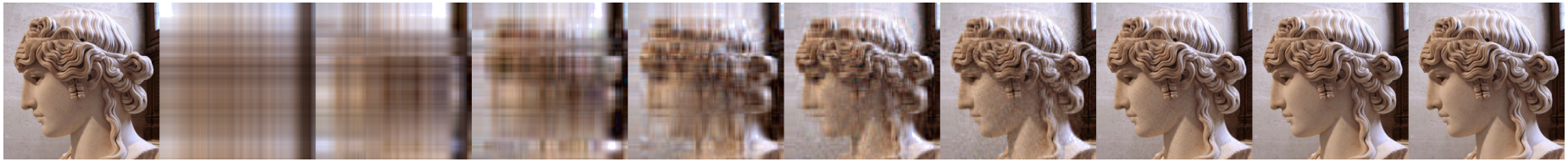


1.7GB (1e6 simulated events) on 5 files analyzed in less than 40s (loading included) on 1 core

II. HPC algorithms for IACT (not CTA specific)

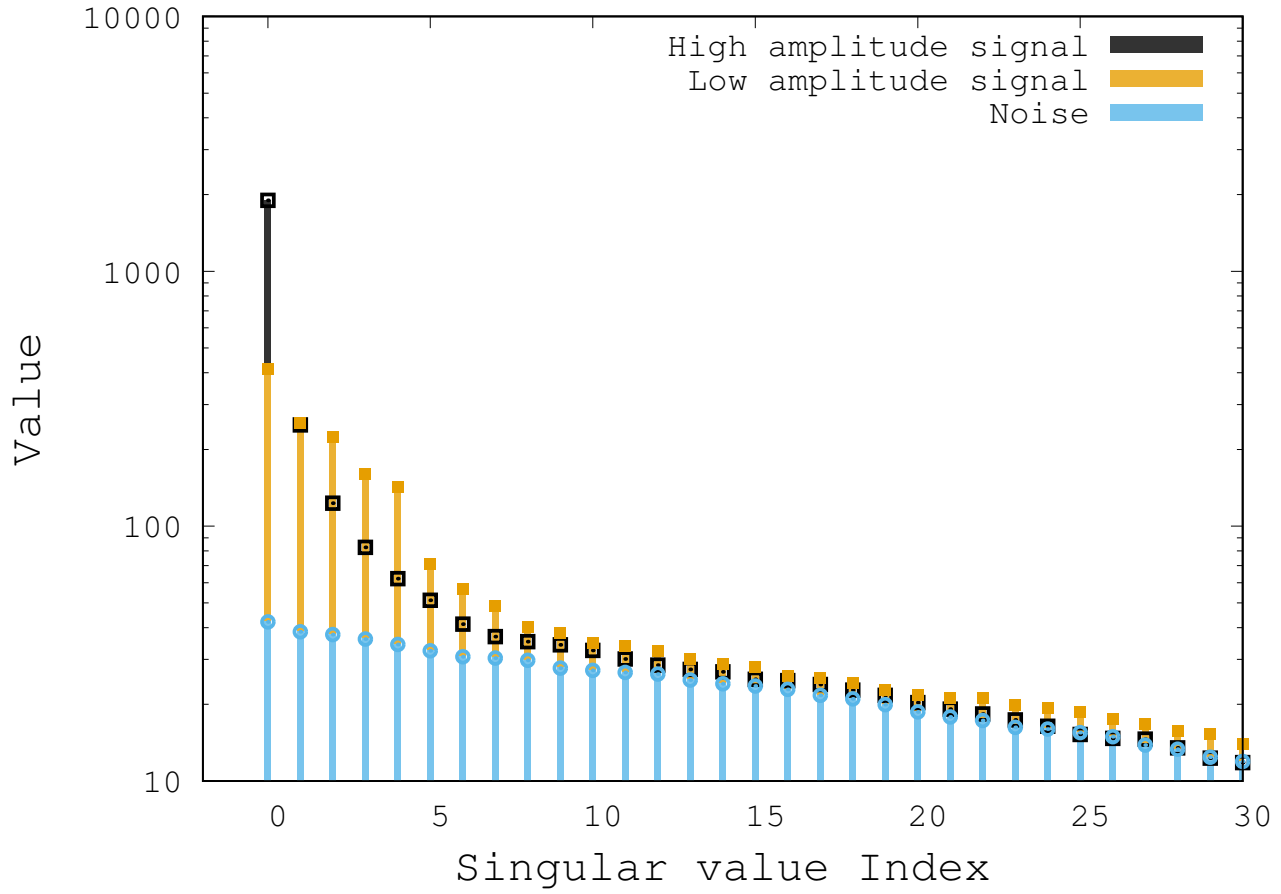
- Singular Value Decomposition
  - Because stereoscopy using directly images is not possible for expected data volumes in CTA
  - Need images projection in smaller spaces ex: Fourier Transform
  - SVD corresponds to the eigenvalues of a rectangular matrix
  - Reversible process
    - Example with 1, 2, 4, 8, 16, 32, 64, 128 and all singular values:



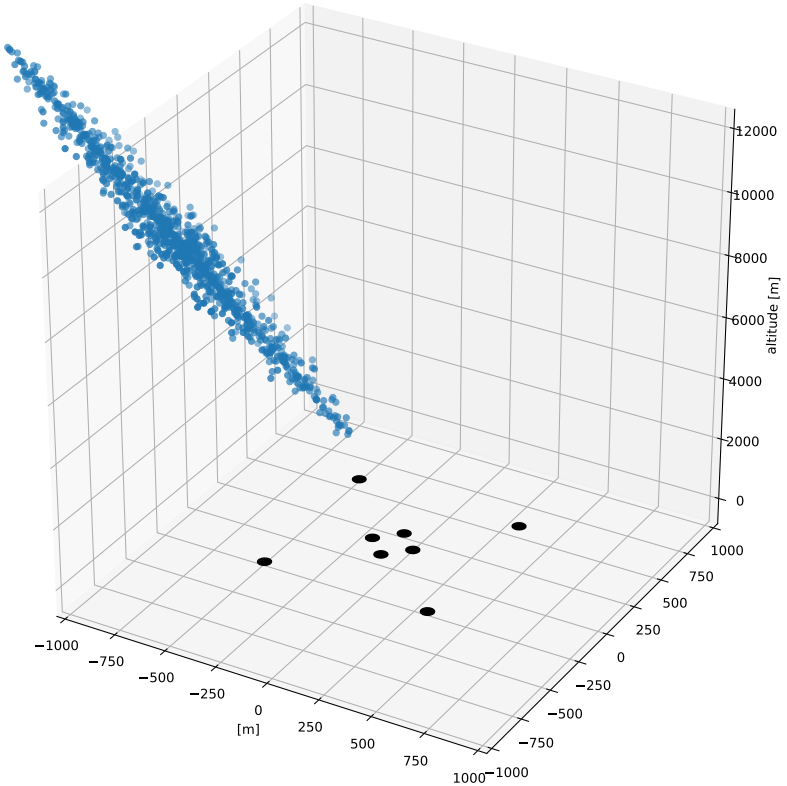


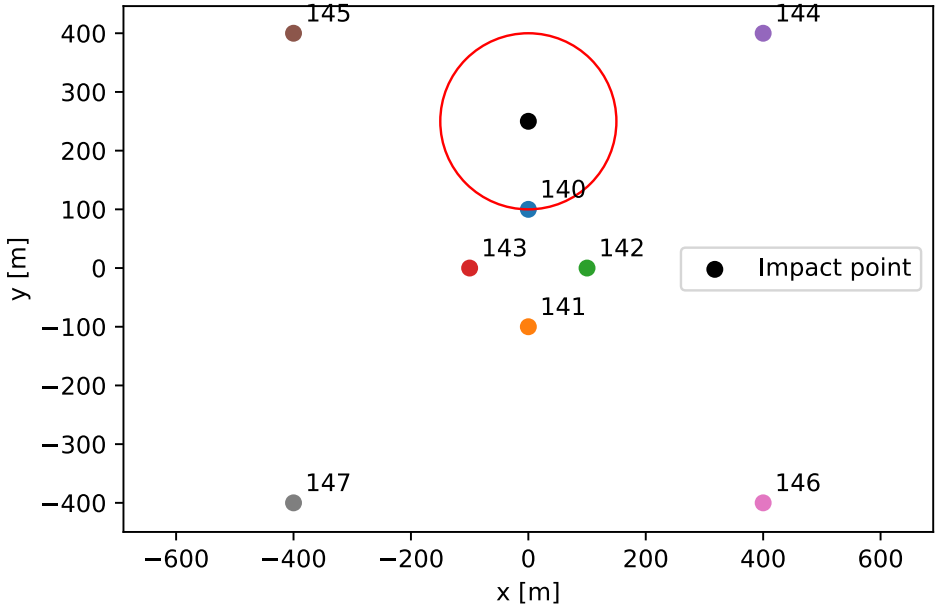
II. HPC algorithms for IACT (not CTA specific)

- Singular Value Decomposition
  - Example on camera images:



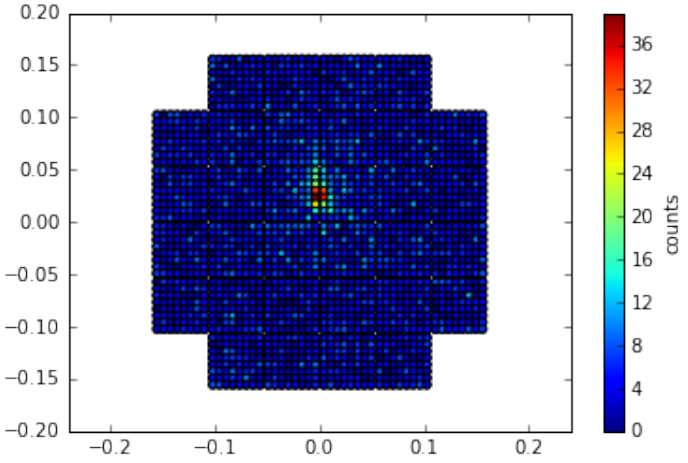
III. PS³CHIT ! – A Python package for the Simulation of atmoSpheric Showers and Cherenkov Imaging Telescopes

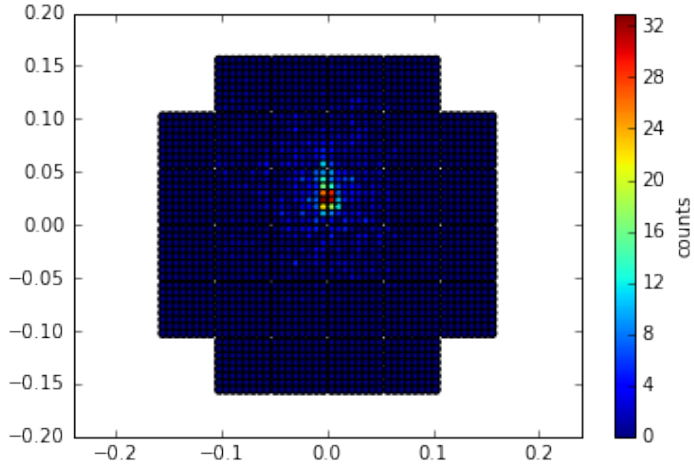


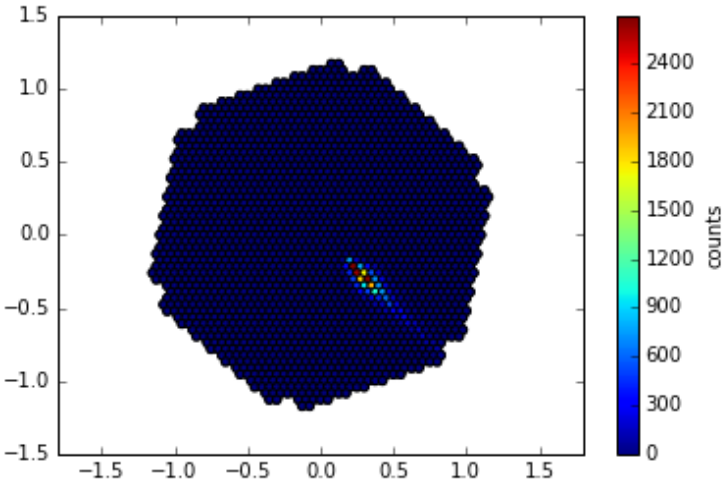


III. PS^{3}CHIT !

- Cameras images



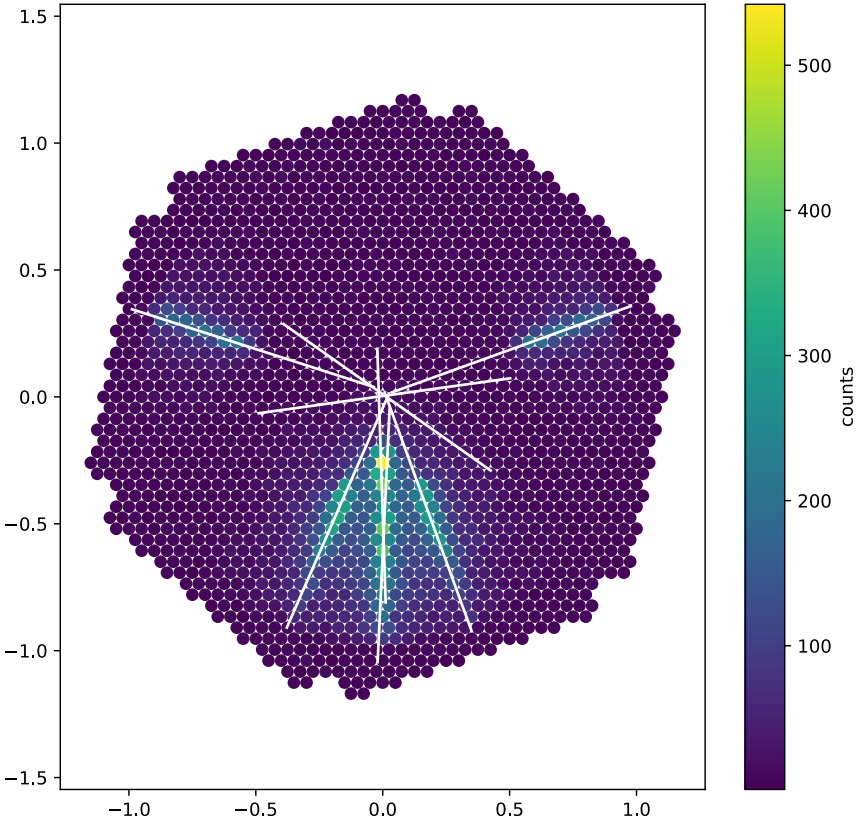




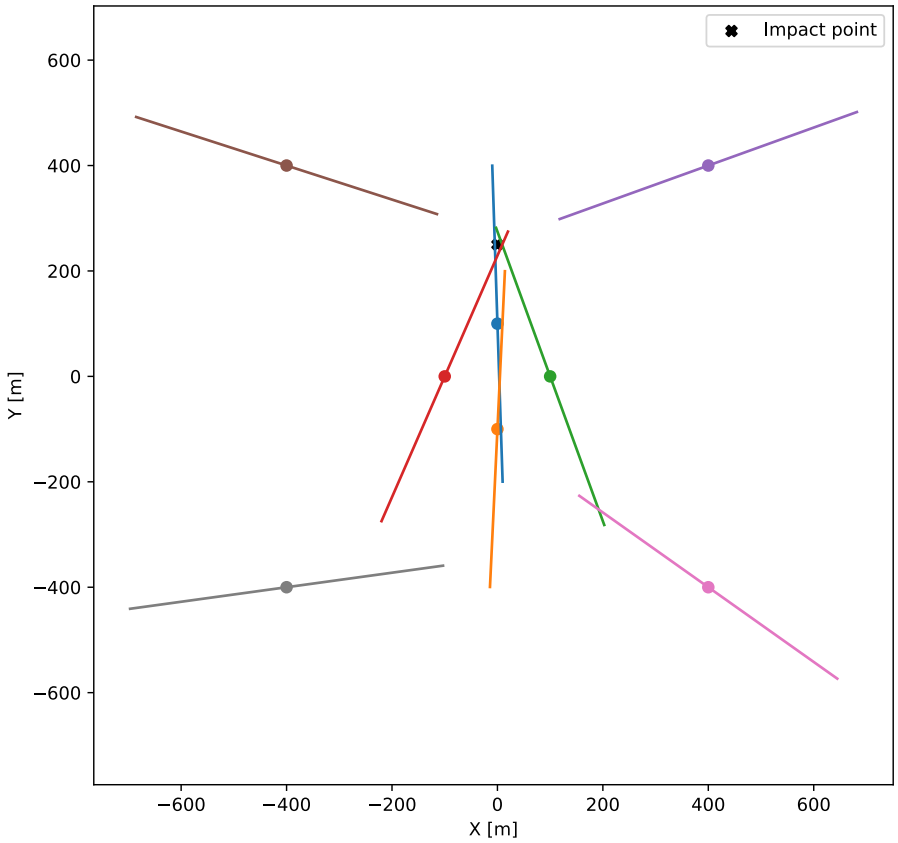
III. PS^{3}CHIT !

- Reconstruction from Hillas parameters

Camera's space



CTA Site



III. PS³CHIT !

- Improvements (hopefully before ICRC)
  - Trigger and detection
    - Cherenkov cone too sharp →
    - Absorption coef

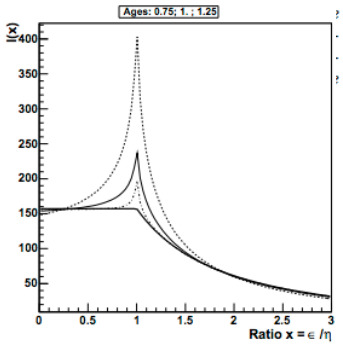


Figure 9.9: *Probabilité d'emission de photons Tcherenkov par unité d'angle solide en fonction de l'angle ε par rapport à l'axe de la gerbe. La distribution est calculée pour une gerbe d'énergie comprise entre 500 GeV et 1 TeV pour trois différents âges de developpement : 0.75, 1.0 et 1.25. L'abscisse représente le rapport $x = \varepsilon/\eta$, où η est l'angle Tcherenkov maximum à l'altitude considérée. La fonction $I(\varepsilon)$ utilisée pour le Modèle 3D est dessinée en gras.*

  - Primary particle energy
  - More accurate shower geometry
    - Already coded but needs above improvements to have any meaning

III. PS^{3}CHIT !

- Used now:
  - For discovery
  - For tests

- Aim:
  - Have a tool to quickly compute the average response of CTA
  - Produce stereoscopic fake images
    - Today ctapipe has only fake single images with simple gaussian
  - Test divergent pointing
  - Inception for Model3D ?