Simulation for HESS 2
Part 2: detector simulation and MC analysis

H.E.S.S. workshop
Non-standard Approach to HESS Data Processing
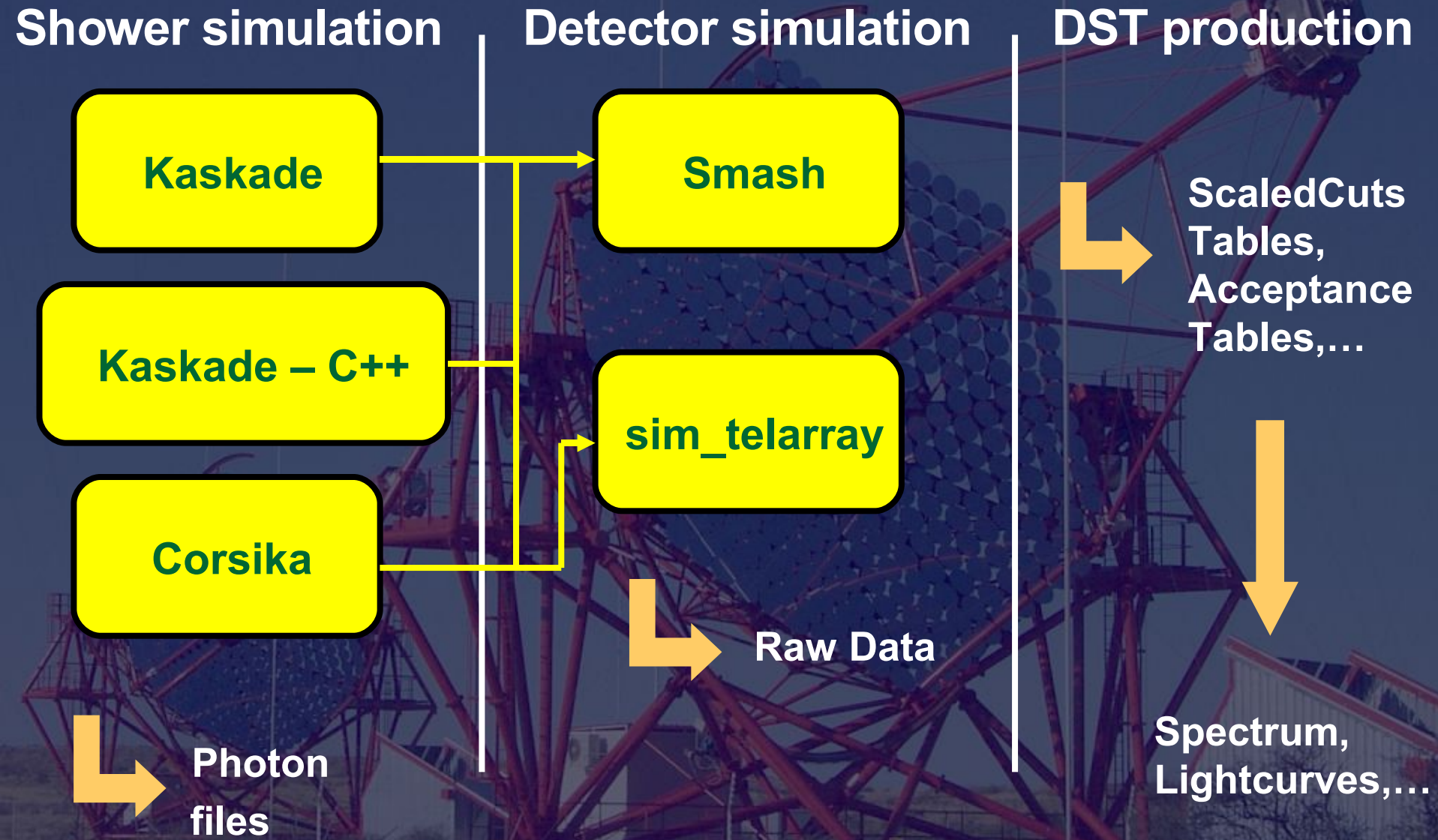## and Interpretation

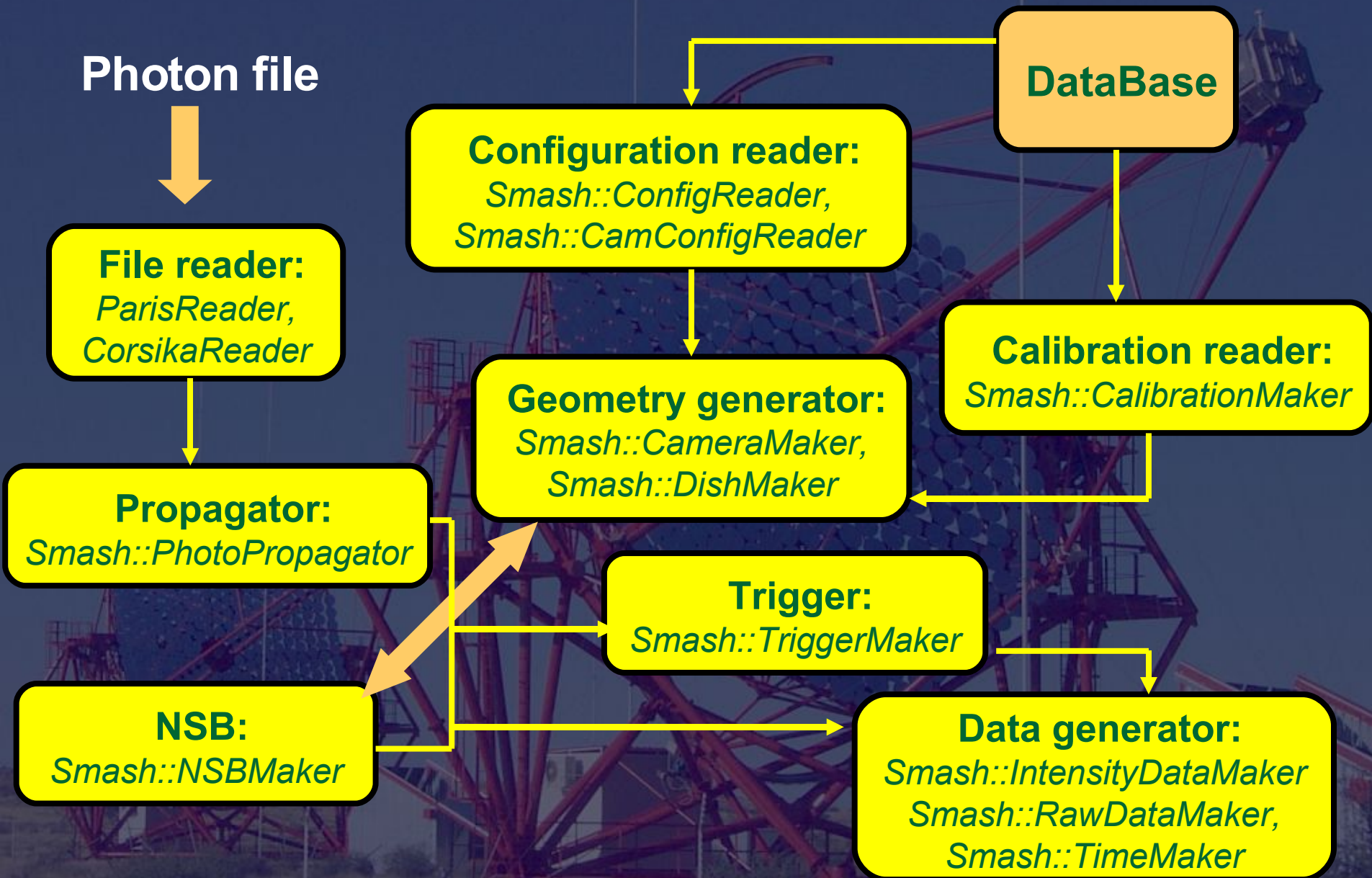Nicolaus Copernicus Astronomical Center

Warsaw

19 - 21 November, 2007

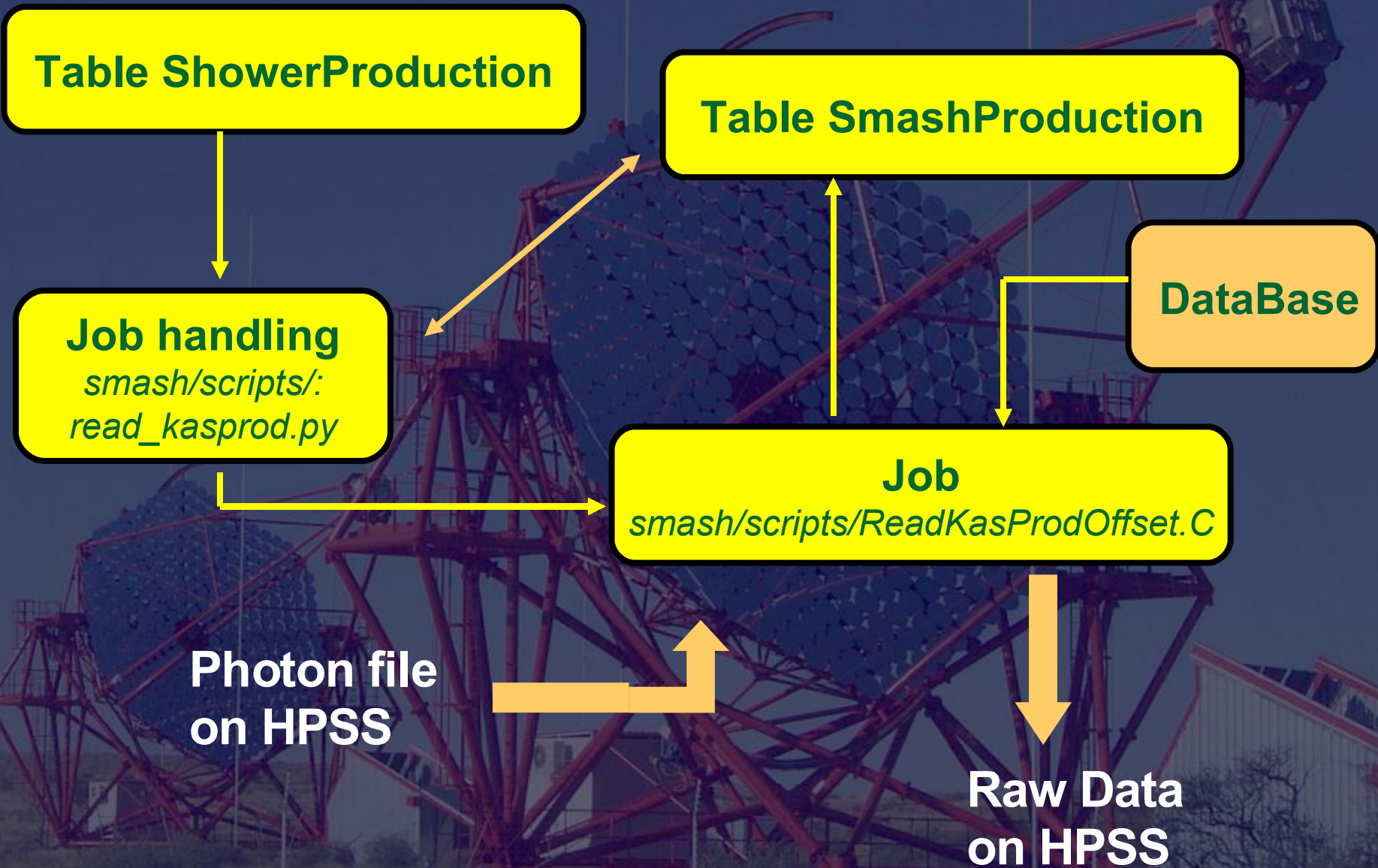sponsored by LEA Astro-PF

Emmanuel Moulin

DAPNIA - Saclay

Organization of the simulation
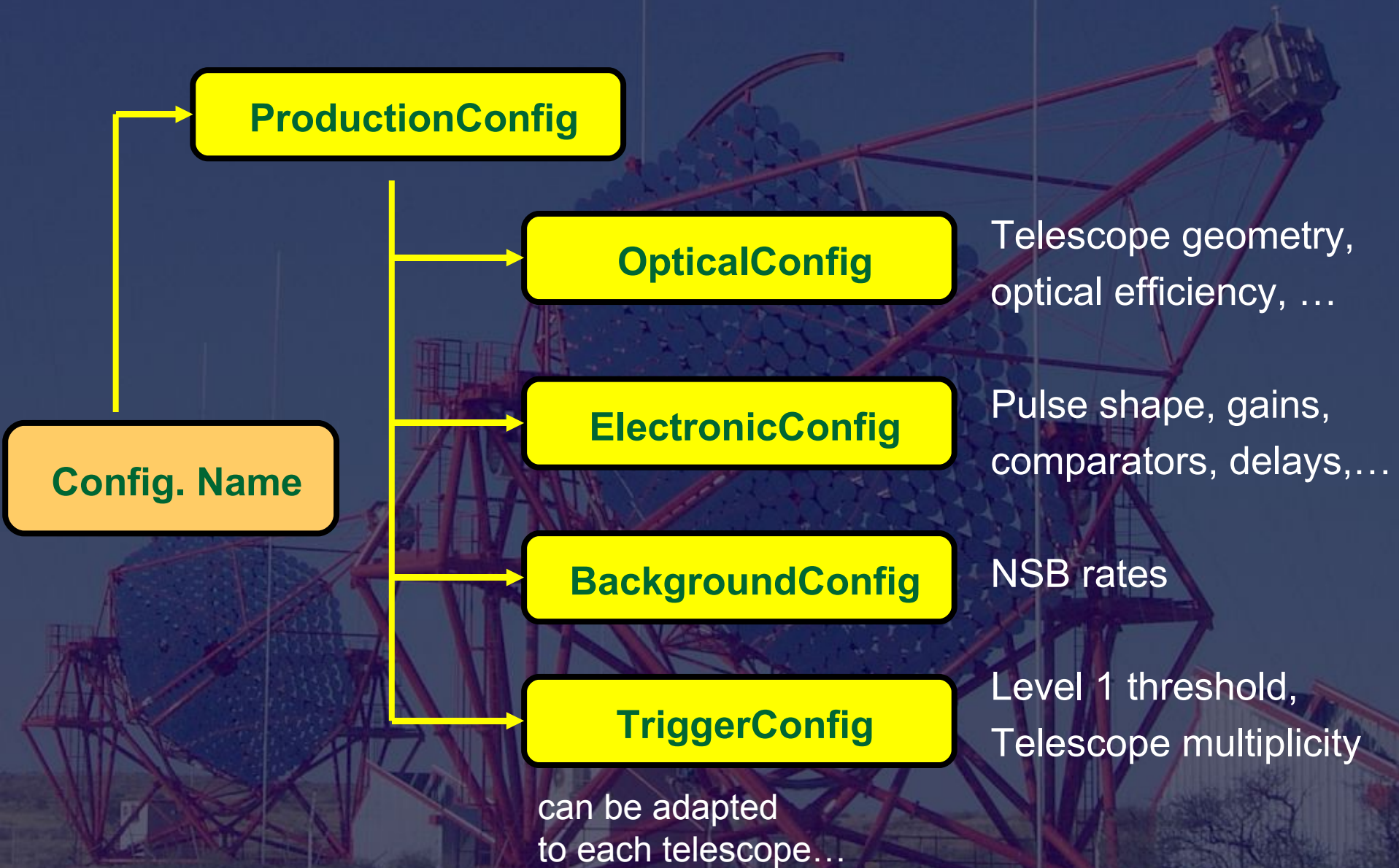
Shower simulation | Detector simulation | DST production

Kaskade → **Smash**

Kaskade – C++

Corsika → **sim_telarray**

ScaledCuts Tables, Acceptance Tables,…

Raw Data

Photon files

Spectrum, Lightcurves,…

Detector simulation: Smash

Photon file

DataBase

Configuration reader:
Smash::ConfigReader,
Smash::CamConfigReader

File reader:
ParisReader,
CorsikaReader

Calibration reader:
Smash::CalibrationMaker

Geometry generator:
Smash::CameraMaker,
Smash::DishMaker

Propagator:
Smash::PhotoPropagator

Trigger:
Smash::TriggerMaker

NSB:
Smash::NSBMaker

Data generator:
Smash::IntensityDataMaker
Smash::RawDataMaker,
Smash::TimeMaker

Detector simulation handling

Table ShowerProduction

Table SmashProduction

Job handling
smash/scripts/:
read_kasprod.py

DataBase

Job
smash/scripts/ReadKasProdOffset.C

Photon file on HPSS

Raw Data on HPSS

Detector simulation configuration

ProductionConfig

Config. Name

OpticalConfig — Telescope geometry, optical efficiency, …

ElectronicConfig — Pulse shape, gains, comparators, delays,…

BackgroundConfig — NSB rates

TriggerConfig — Level 1 threshold, Telescope multiplicity

can be adapted to each telescope…

Configuration for HESS 2

❑ **Configuration:**

 ○ **5 telescopes (CT5 at the centre)**   { **CT1 → 4 : Davis Cotton**
                     CT5 : Parabolic

 ○ **C++ simulation version 0-8-8-8**
 ○ **Desert atmosphere in Kaskade**
 ○ **Electronics for HESS 2 in Smash not yet implemented!**
 ○ **Perfect cameras**
 ○ **Nominal optical efficiency**

❑ **Detector configuration:**

 ○ **HybridCamOptimal_hwtrig**
 → 3 pixels above 4 pe, 2 telescopes at least
 ○ **HybridCamOptimal**
 → 4 pixels above 5 pe

Shower productions for HESS 2

http://lpnp90.in2p3.fr/~denauroi/protected/hessphp/showsimuprods.php

Nom	Type	Description	Total Size	Showers	Runs
gFixedEnergy_paris_0-8-8-8	PRODUCTION	Gammas, Energies fixes, HESS II	10 TB	$32 \ 10^6$	10946
gSpectrum_paris_0-8-8-8	PRODUCTION	Spectres (Index -1.8 -> -3,4), HESS II	3 TB	$190 \ 10^6$	3723
eSpectrum_paris_0-8-8-8	PRODUCTION	Spectres Electrons (Index -2.6, -3, -3.6), HESS II	90 GB	$7 \ 10^6$	90
pSpectrum_paris_0-8-8-8	PRODUCTION	Spectres Protons 2.7, 0°, 26°, 46° HESS II	220 GB	$120 \ 10^6$	300
gSpectrumFortran_paris_0-8-8-8	TEST	Spectres (Index -2) Simulation Fortran 0°=>70° HESS II	58 GB	$2.8 \ 10^6$	112

Smash productions for HESS 2

http://lpnp90.in2p3.fr/~denauroi/protected/hessphp/showsimuprods.php

Shower Production	Simulation Config	Description	Total Size	Number of runs
gFixedEnergy_paris_0-8-8-8	HybridCamOptimal_hwtrig	Energies Fixes, HESS II, 2 tels / 5, zenith cameras parfaites	10 GB	610
pSpectrum_paris_0-8-8-8	HybridCamOptimal_hwtrig,	Spectres Protons	29 GB	300
gSpectrum_paris_0-8-8-8	HybridCamOptimal_hwtrig,	Spectres Gammas, zenith et 18°	72 GB	693

→ **enough to start analysis for HESS 2**

Nomenclature

http://lpnp90.in2p3.fr/~denauroi/protected/Doc/sashfile/group__SashFile__DST.html

Run number PAZZTEEEXX
- ☐ **P : Primary type (1 = gamma, 4 = protons,...)**
- ☐ **A : Azimuth (7 values, 0 = North, no 45°)**
- ☐ **ZZ : Zenith Angle, 14 predetermined values (0 → 70°)**
- ☐ **T : Offset Angle, 9 values (0 → 4,5°)**
- ☐ **EEE : Energy/ Spectral index**
  - **0EE : Power law spectrum**
    - *000 : index 1,8 → 010 : index 3,8*
    - **099 : index1,6**
  - **1EE : Fixed Energy**
    - *100 : 12,5 GeV → 120 : 125 TeV*, **121 : 200 TeV**
    - *199 : 8 GeV, 198 : 5 GeV, 197 : 3 GeV*
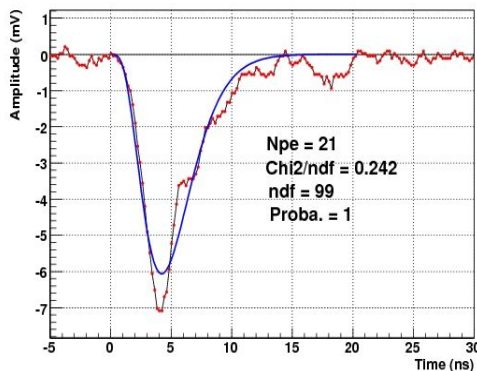
→ Extension towards lower energies!

Pulse shape fit

Pulse fitted with: $f(t) = A.t^{\alpha} e^{\beta .t}$
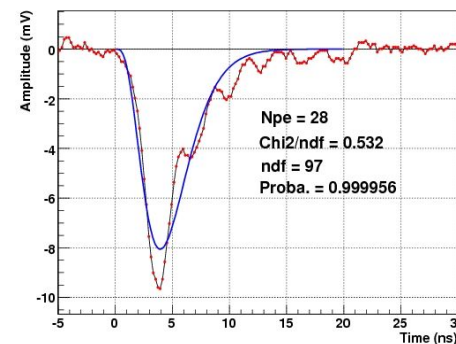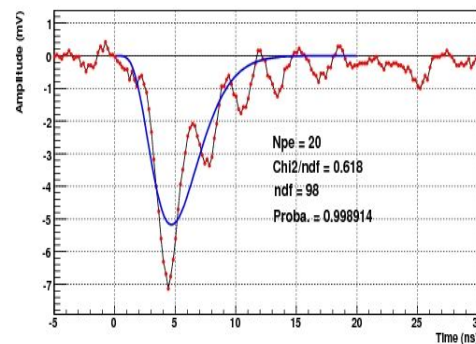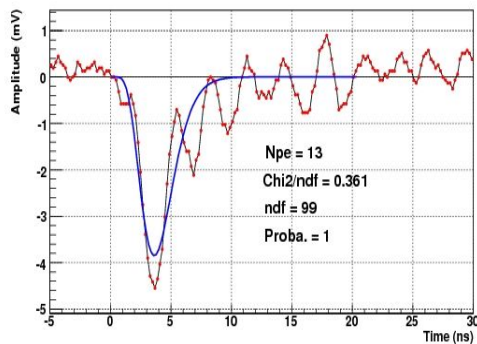
HESS 1
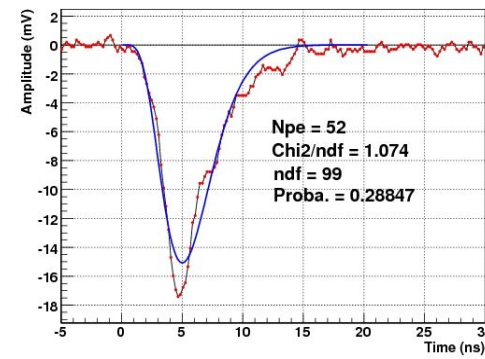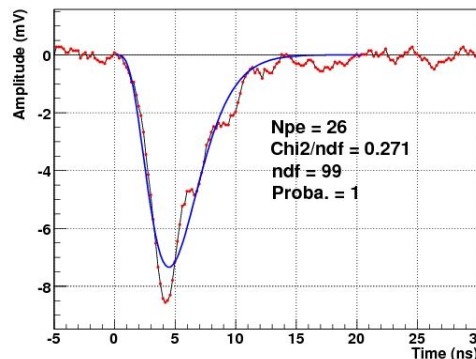
HESS 2

- **Width of pulse well reproduced**
- **Amplitude : impact on the simulation is ongoing**

M. Ahrouaz

Exploiting simulations

Main steps:

- **Developments on the Hillas stereo analysis**
- **Study focused towards the low energy range : 0.05 → 1.25 TeV**
- **Performances on the Hillas stereo analysis**
- **Optimization of the cuts**
- **Definition of efficiency and rejection factor**

Investigations have already started

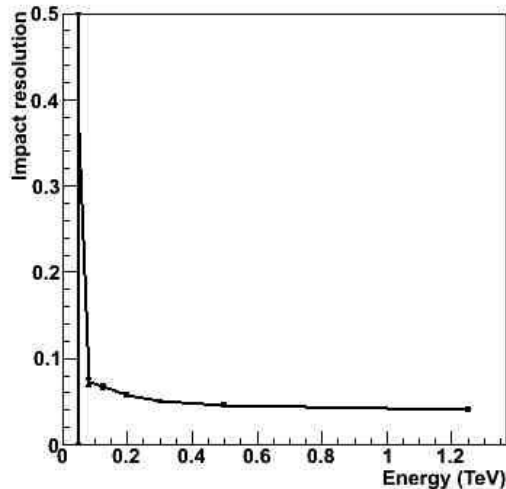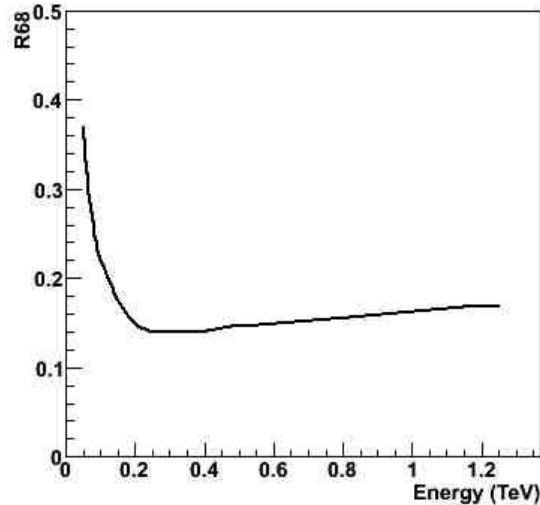**- Image cleaning : 5/10 pe**
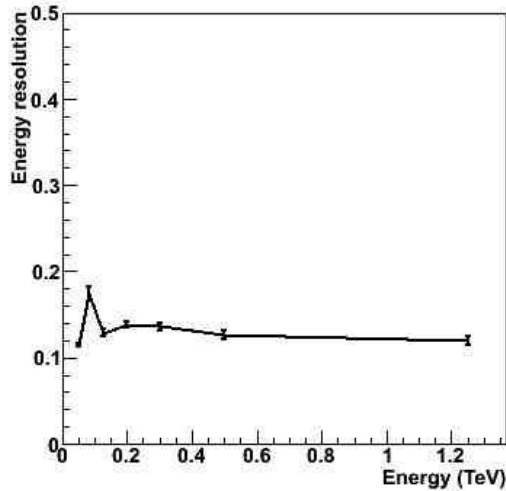
- Set of cuts: *not yet optimized for HESS 2 !*

- **charge ≥ 60 pe**
- **nominal distance ≤ 2.5 deg.**
- **$theta^2$ ≤ 0.0125 deg.^{2}**
- **-2 ≤ MSS ≤ 0.9**

Stereo Hillas analysis performances
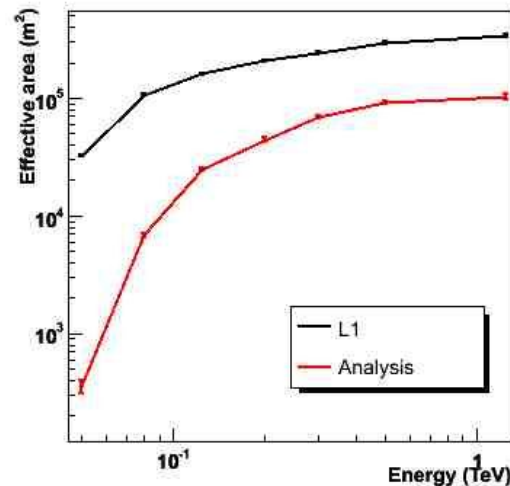
- **Development of the stereo analysis including CT5**

- **We are testing the analysis chain**

Energy resolution: ~ 14%
R68 (80 GeV) = 0.25 deg.

- **HESS 1 analysis cut → to be optimized**
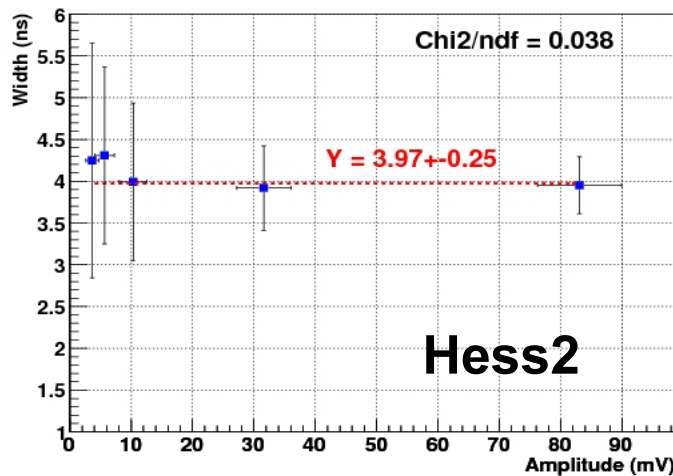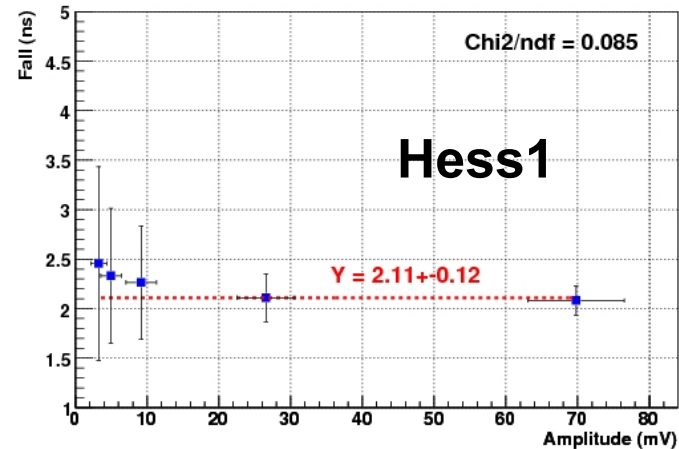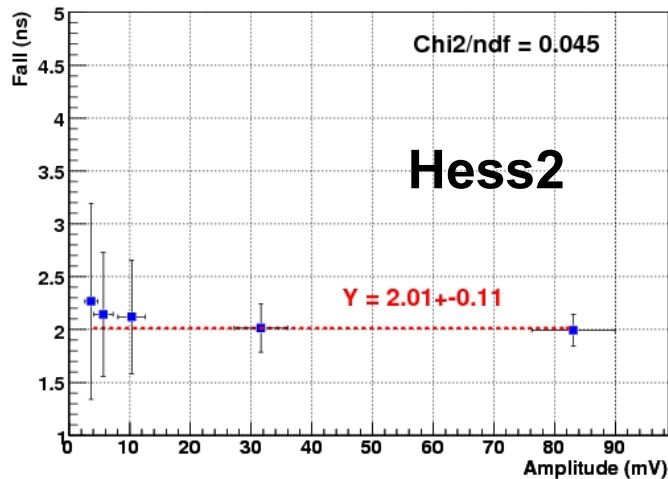
Work in progress…

Future plans

- **Impact of the HESS 2 electronics parameters on the simulation is ongoing**

- **Study of the performance of the Hillas analysis in stereo mode have started**

Next steps:

- **Developments of the Hillas analysis for CT5 in the mono telescope mode**

- **Developments of the Model analysis for CT5 mono**

Pulse shape: fall time and width
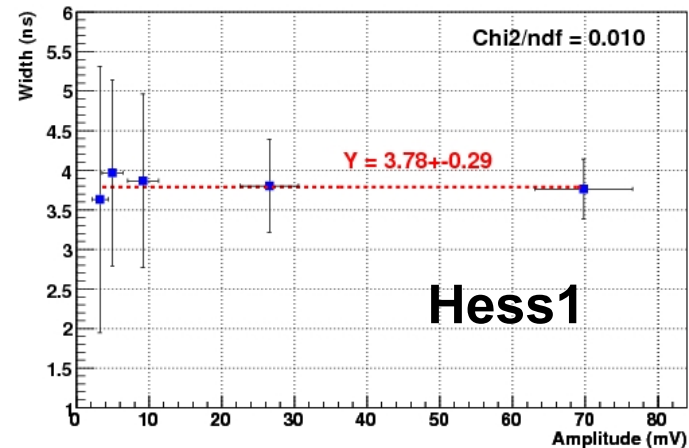
Linear behaviour
Improvement in HESS 2