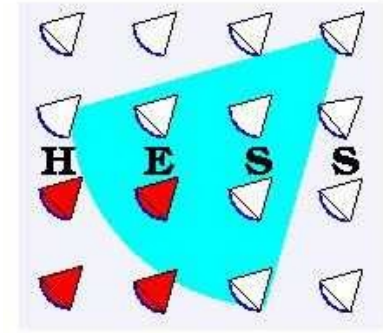




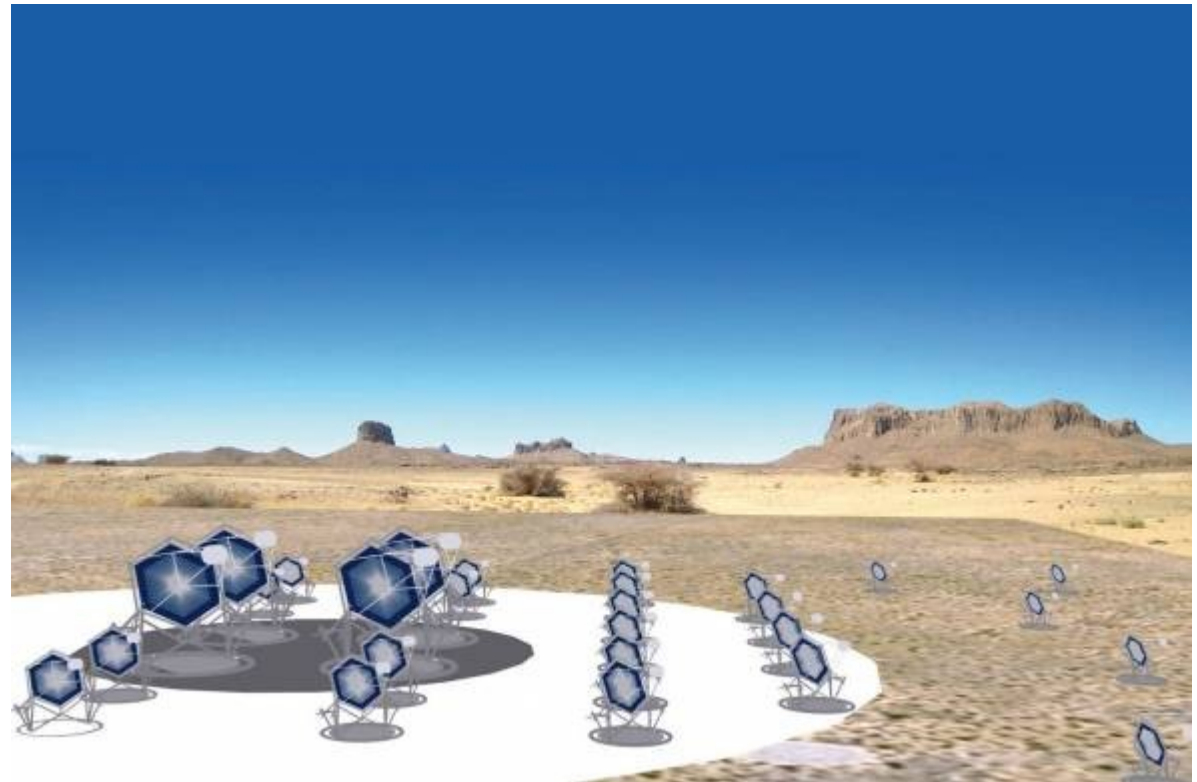
Une nouvelle stratégie d'analyse pour les réseaux Tcherenkov atmosphériques : performances, résultats sur HESS et application sur CTA

Yvonne Becherini

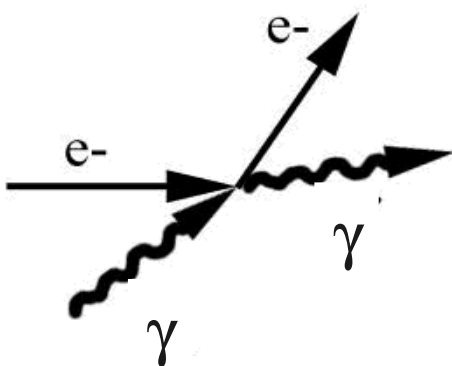
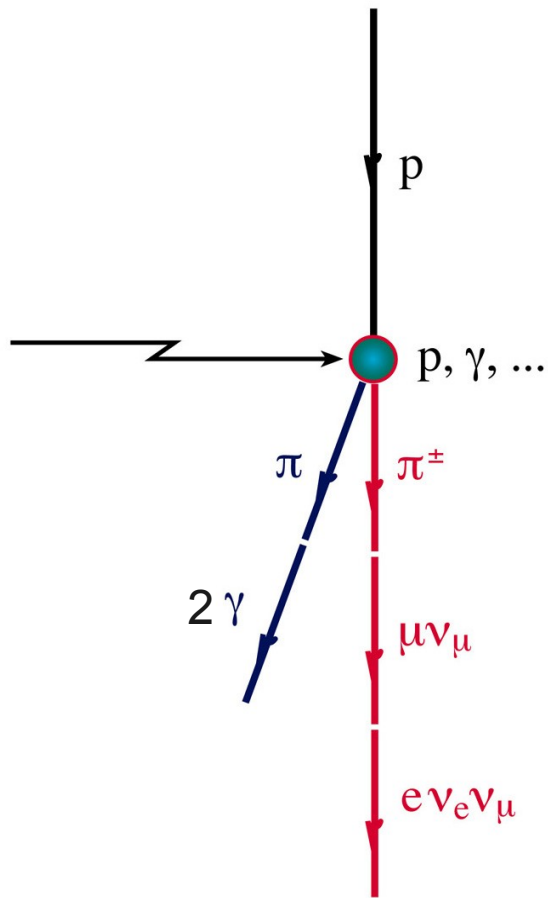
Astroparticule an Cosmologie (APC) et
Laboratoire Leprince-Ringuet (LLR)
CNRS/IN2P3



- Pourquoi une nouvelle stratégie d'analyse pour les réseaux Tcherenkov atmosphériques ?
- L'analyse « Paris-MVA » : structure, performance
- Analyse des sources extra-galactiques dans H.E.S.S.
- Application de l'analyse à un réseau candidat de CTA



Mécanismes hadroniques ou purement leptoniques ?

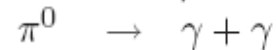
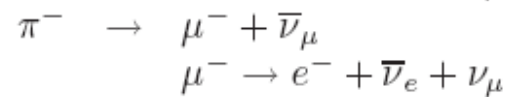
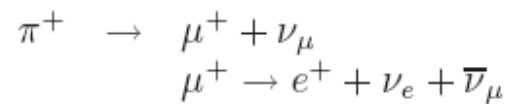
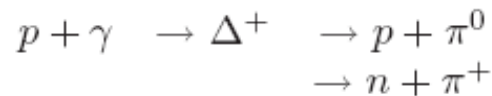
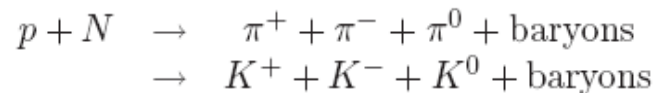


Mécanismes d'accélération :

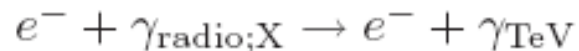
Ondes de choc (supernovæ, vents de pulsars, vents stellaires, jets). Pulsars

Mécanismes d'accrétion-éjection au voisinage d'un objet compact (étoile à neutron ou trou noir): Systèmes binaires X et microquasars, Noyaux actifs de galaxie

Si hadronique :



Si leptonique :



Si les γ sont créés à partir d'électrons :
corrélation avec le rayonnement synchrotron

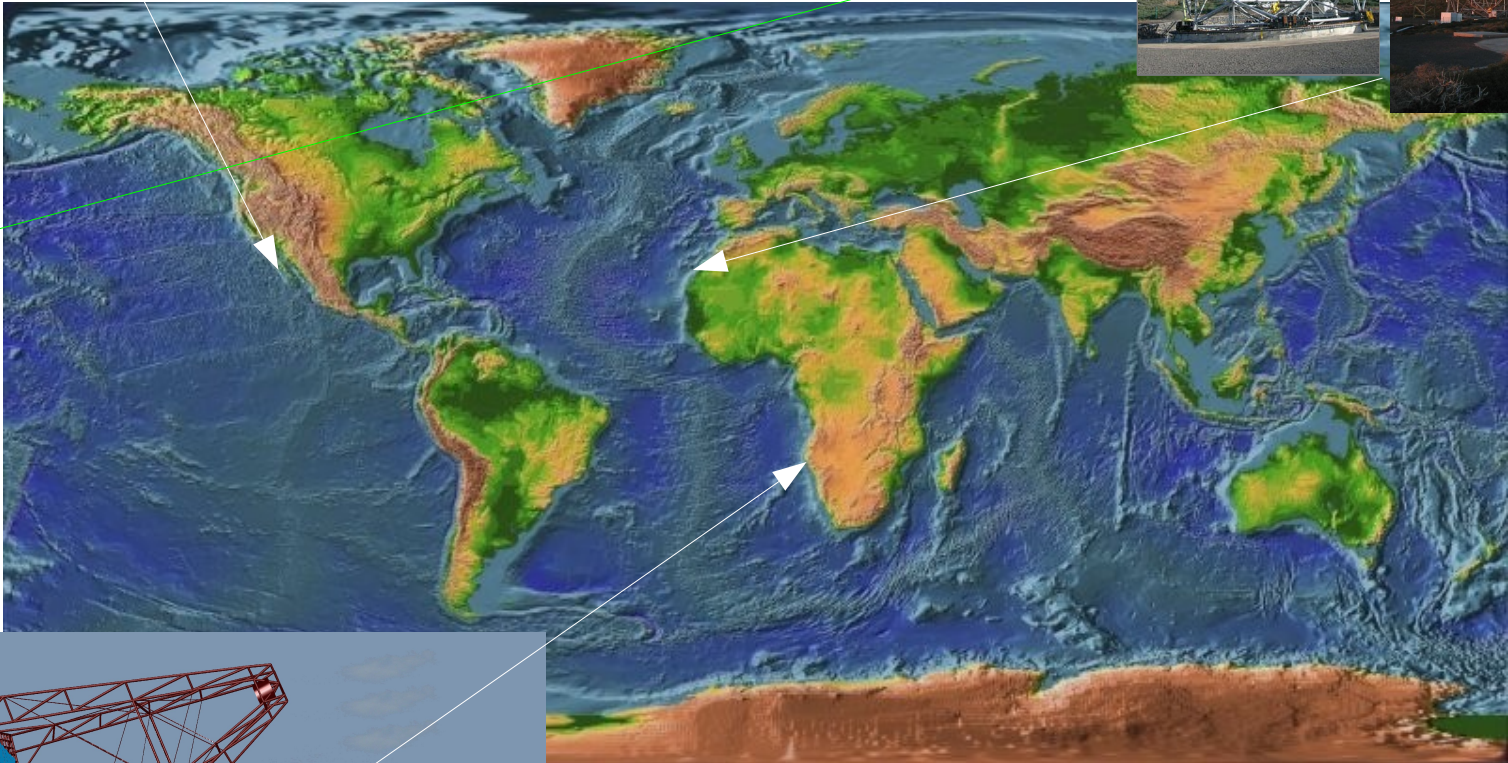
Diffusion Compton inverse

Télescopes gamma

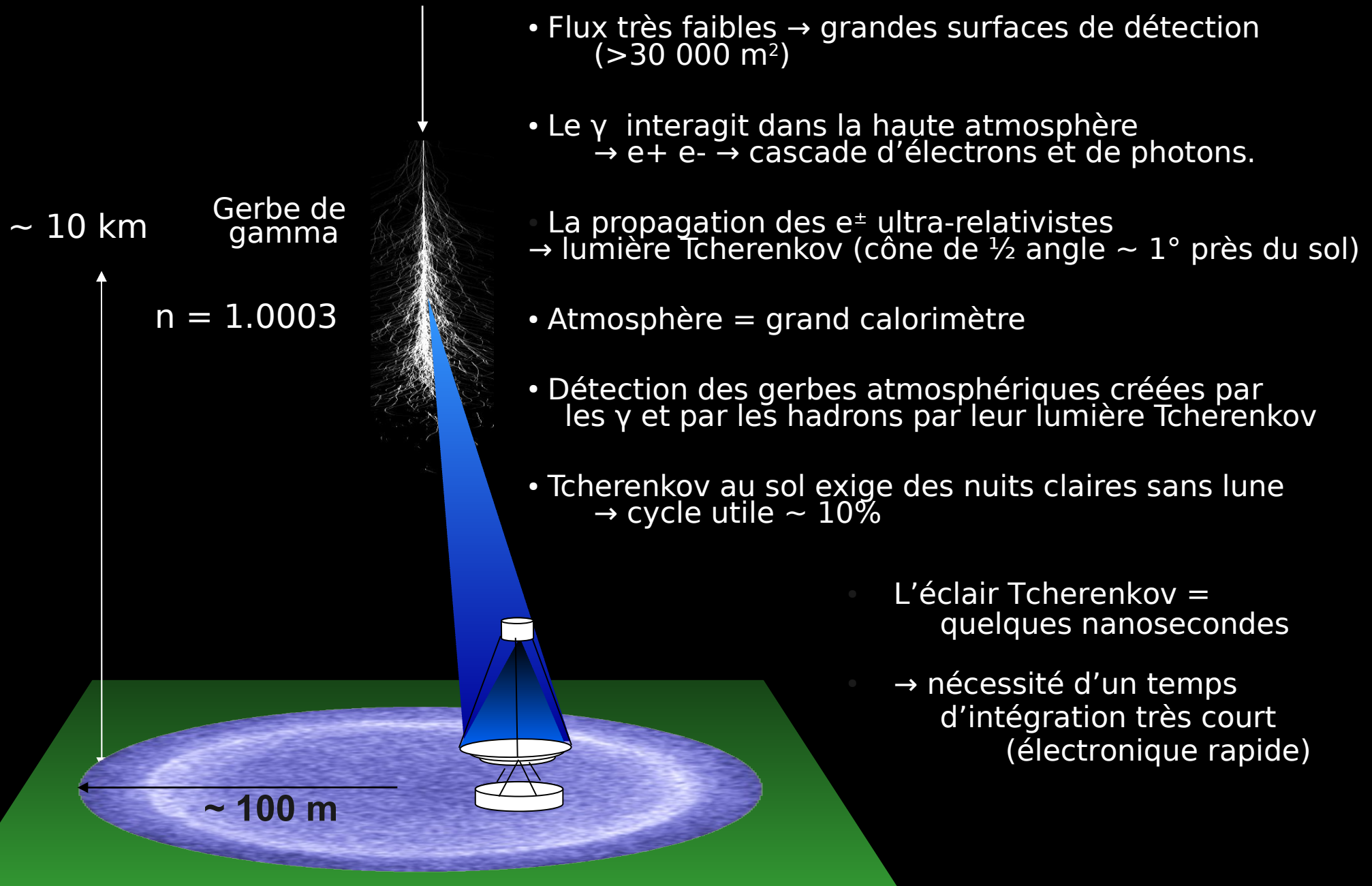


CTA

H.E.S.S.
HESS-II



Détection de gammas par les techniques Tcherenkov atmosphériques

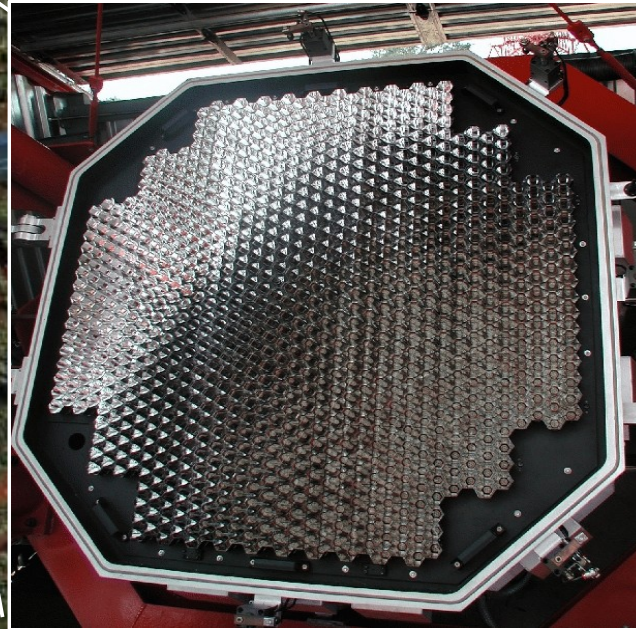


The High Energy Stereoscopic System H.E.S.S.

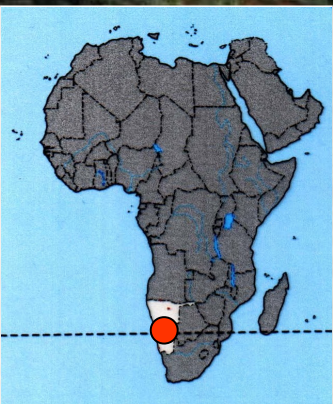
Situé en Namibie,
23°S, 15°E
Altitude : 1800 m

Surface d'un miroir :
107 m² (d = 12 m)
Longueur focale :
15 m

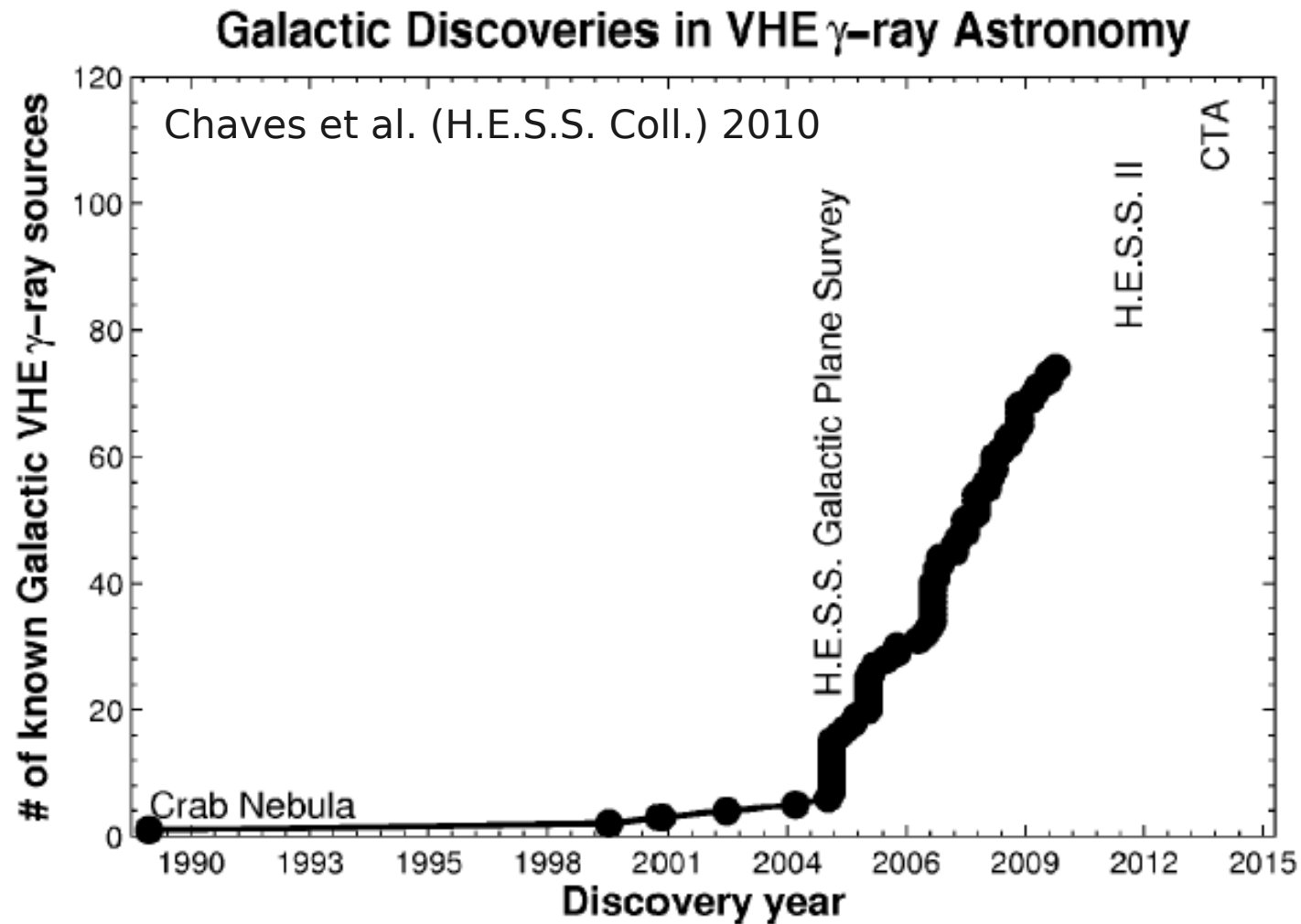
120 m

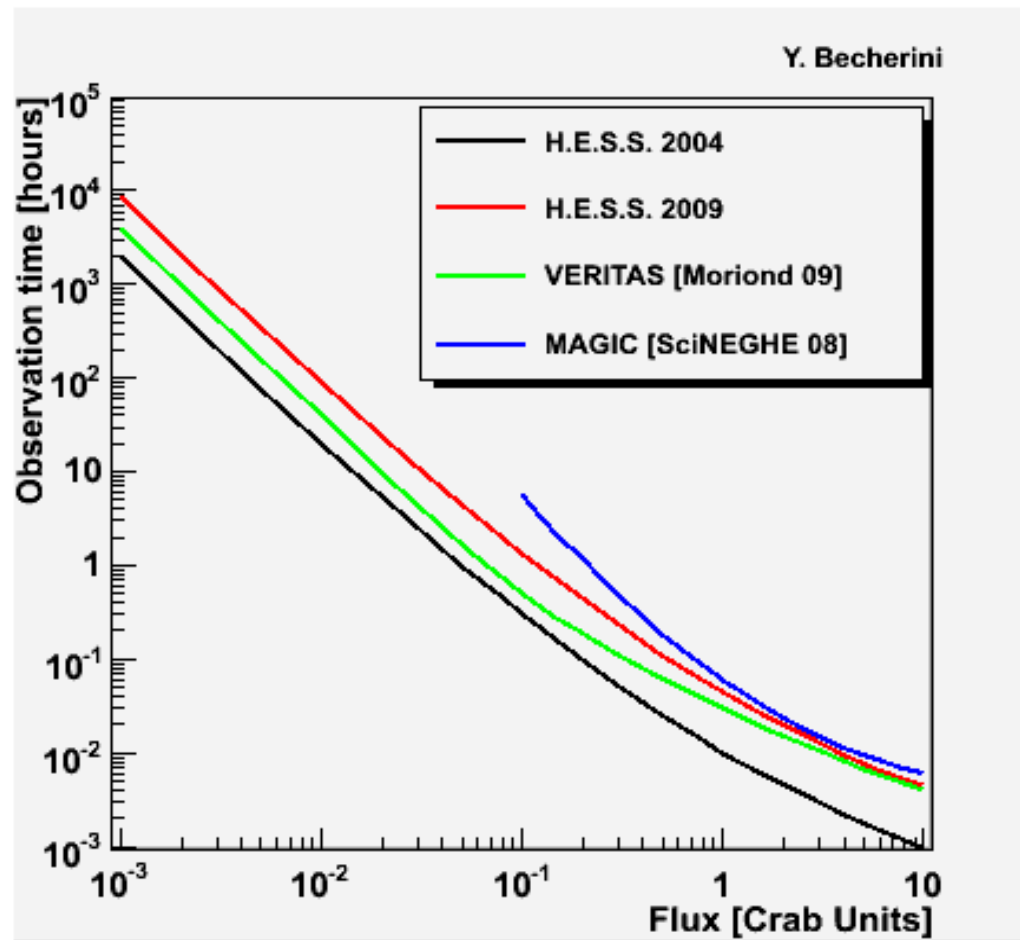


Caméra à haute
résolution 960 pixels
PMT 0.16°
Grand champ de vue 5°
(électronique du LPNHE)



Seuil au zénith ~ 160 GeV
Seuil à 40 deg ~ 300 GeV

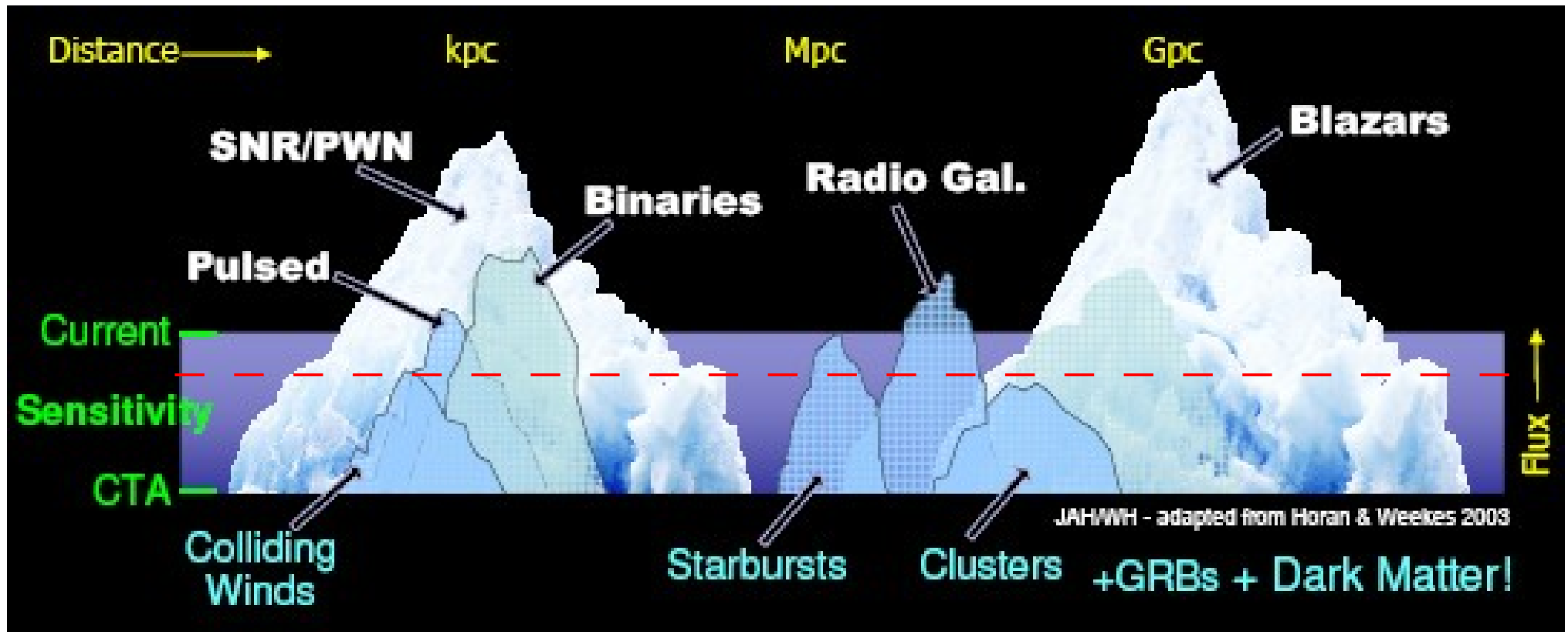




**0.01 Crabe ~ 100 h 2009 !
115 h Cen A, 130 h SN1006**

- La ré-aluminisation des miroirs de H.E.S.S. est en cours (2/4 sont déjà prêts)
- Prévue pour la mise en fonction de HESS-II

Sensibilités actuelles et futures



Comment augmenter la sensibilité des instruments actuels ?

Comment augmenter la sensibilité de H.E.S.S. : HESS-II



- Miroir parabolique, surface de 596 m², longueur focale de 36 m
- Camera de très haute résolution 2048 pixels (0.07°)
- 3.5° FoV
- Procédure automatique pour la focalisation sur le maximum de la gerbe
- Installation du télescope et premiers runs de prise de données ~ 2012
- Deux buts principaux : baisse du seuil à 30 GeV et sensibilité x 2

Autre façon d'augmenter la sensibilité d'un instrument

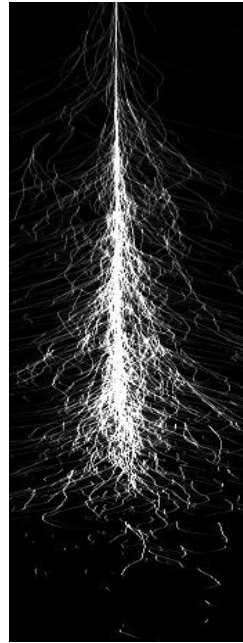
- Analyses des données plus développées
- Meilleure Point-Spread-Function (PSF)
et discrimination γ /hadron plus performante

Deux méthodes développées en France
qui sont utilisées dans la Collaboration H.E.S.S.

- de Naurois et Rolland, Astrop. Phys. 32, 2009, 231-252
 - Maximum de vraisemblance,
coupure de rejet de fond basée sur le goodness-of-fit
 - Nécessite une excellente connaissance
du détecteur et de sa calibration
- Becherini et al. (2010), submitted to Astrop. Phys.
 - Discrimination basée sur les « Boosted Decision Trees »

Une nouvelle méthode d'analyse rapide et flexible pour les réseaux Tcherenkov atmosphériques pour la détection des sources les plus faibles

Submitted to Astroparticle Physics



- Introduction a' l'analyse « Paris-MVA »
- Reconstruction stéréo + nouvelle méthode de reconstruction de l'énergie
- Variables discriminantes γ /hadron
- Analyse multi-variée
- Performance du classificateur et définition de coupure BDT
- Définition de coupures pour différents types de sources
- Fonctions d'instrument
- Performance sur quelques sources H.E.S.S.

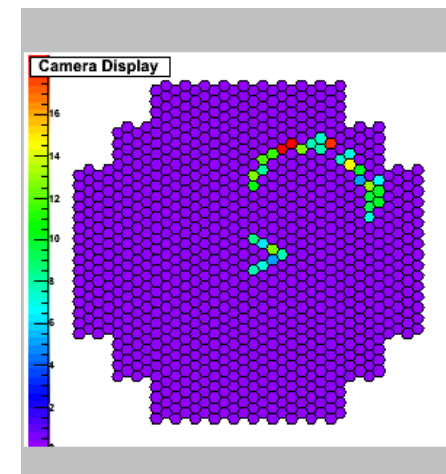
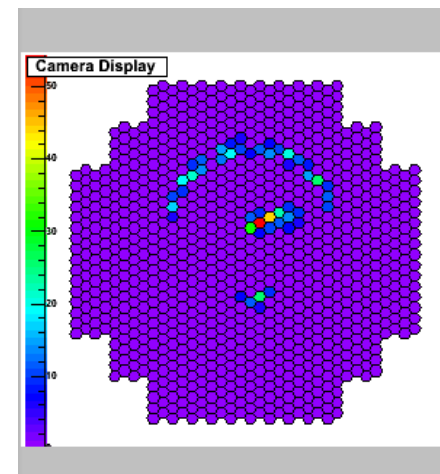
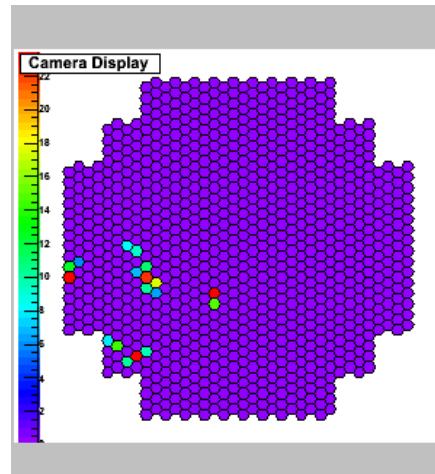
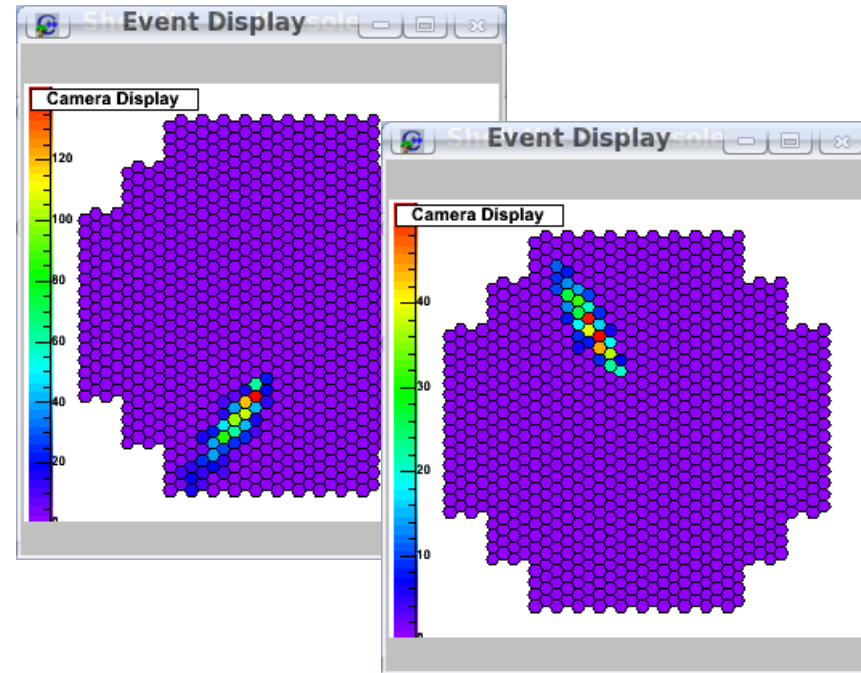
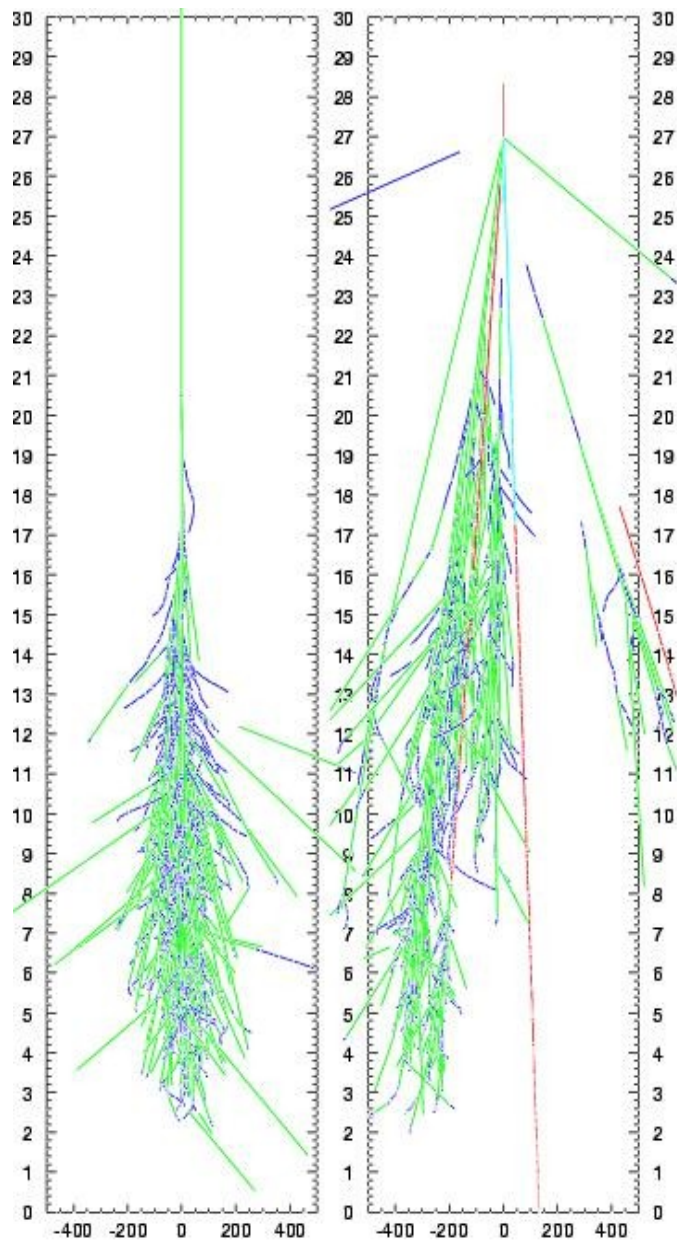
Y. Becherini et al.

A new fast and flexible analysis strategy for Imaging Atmospheric Cherenkov Telescopes for the faintest cosmic γ -ray sources

Submitted to Astroparticle Physics

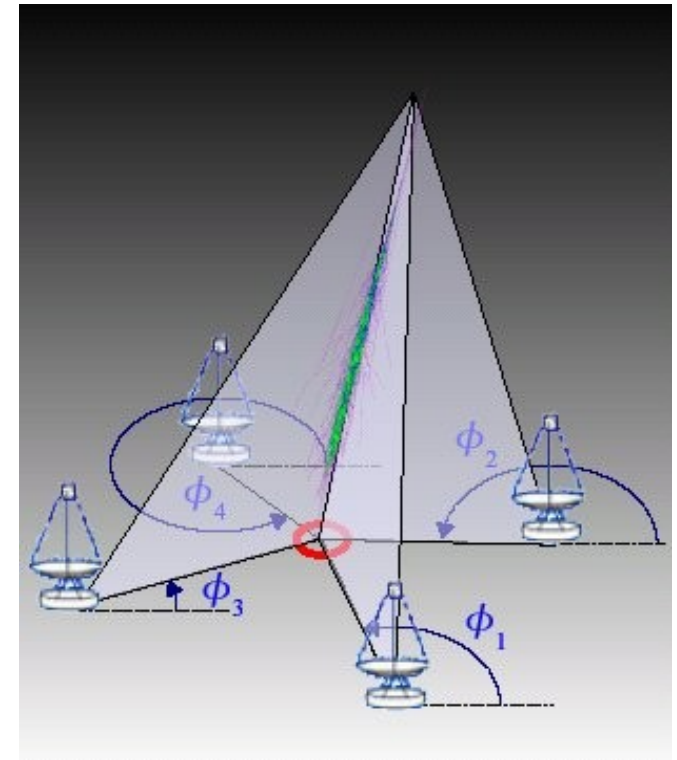
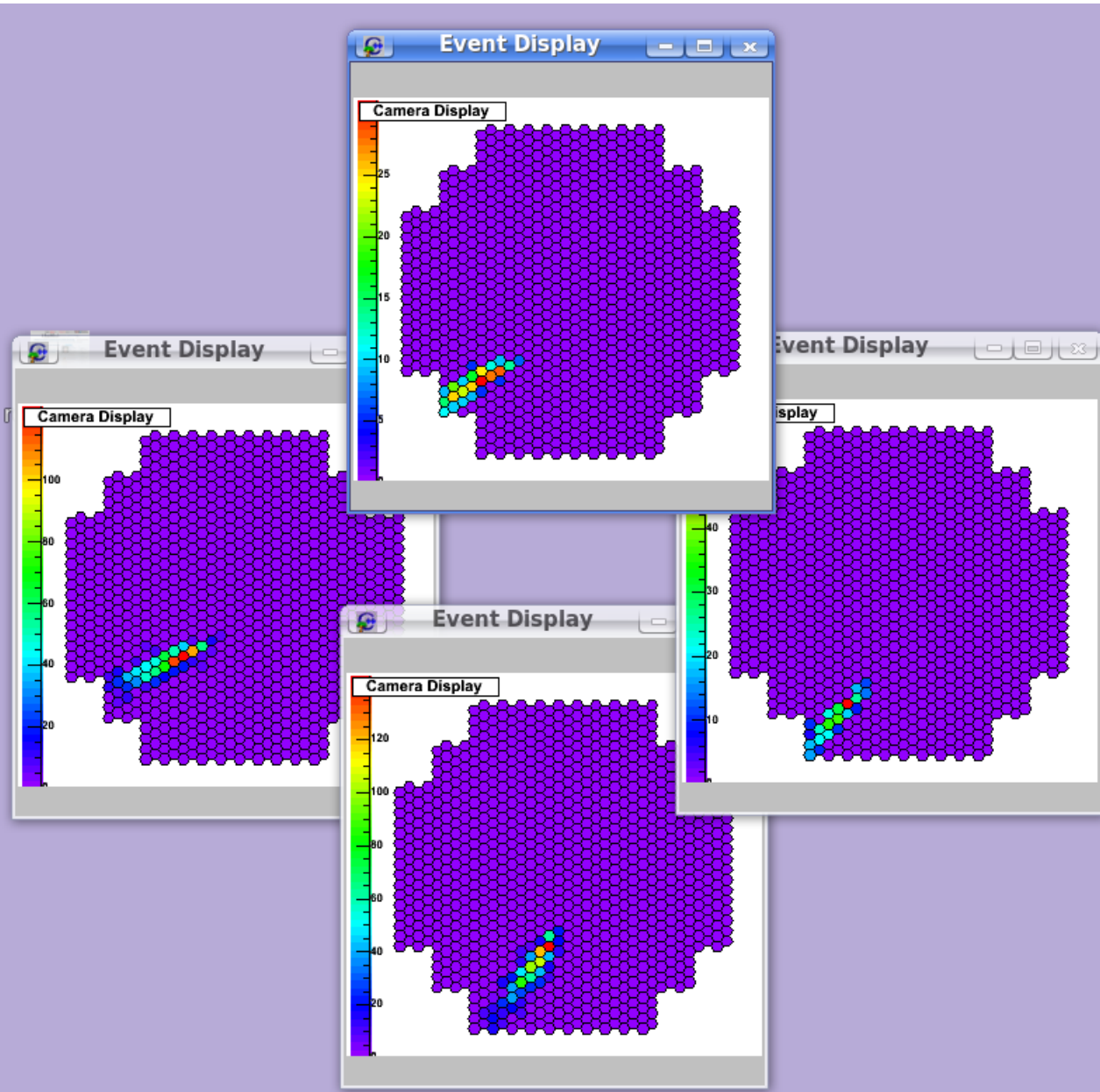
- Discrimination multi-variée
 - Basée sur les BDT
 - Test sensible à l'architecture des arbres de décision (profondeur, « pruning », etc.)
 - Training pour un grand ensemble de :
 - Angles zénithaux, Énergie/Nphot, offset (jusqu'à 2.7°), multiplicité de l'événement
 - Définition des coupures en utilisant des efficacités γ prédéfinies en fonction de l'énergie
- Configurations adaptées pour différents types de sources (spectre, niveau de flux)
- Choix de paramètres discriminants
 - Stabilité vs Night Sky Background (< 200 MHz)
 - Paramètres très peu corrélés
 - Pas de paramètres basés sur le Goodness-of-Fit
 - Nouveaux paramètres discriminants ; gain en performances de $\sim 20\%$
- Analyse optimisée pour les sources faibles
- Très flexible : facile à adapter à n'importe quel IACT

L'imagerie Tcherenkov

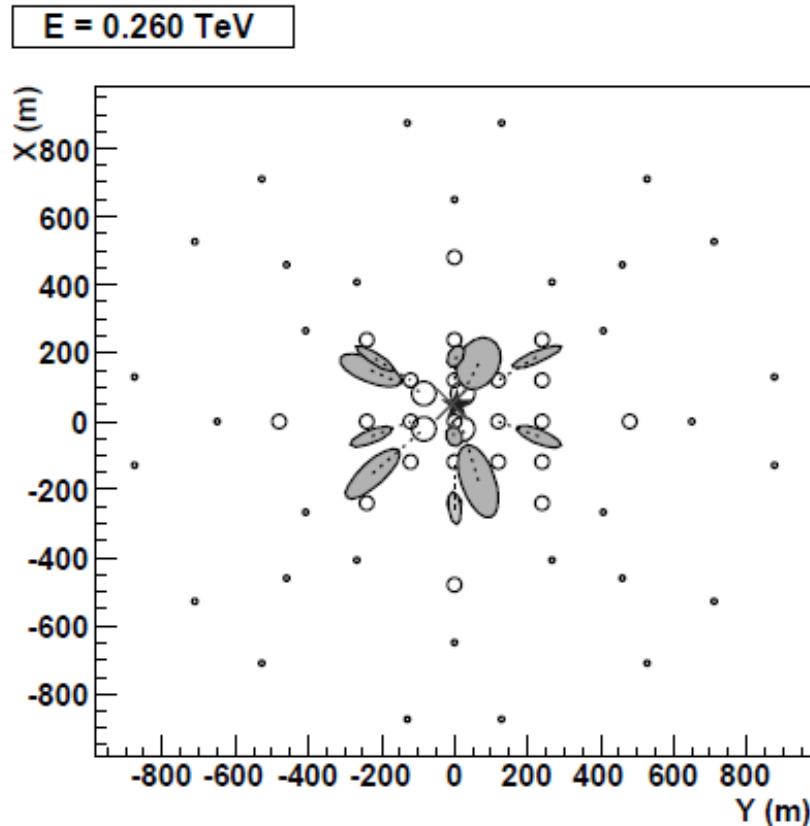


L'imagerie Tcherenkov stéréoscopique

- Grand facteur de rejet des hadrons
 - le trigger demande au moins 2 télescopes (rejet des muons isolés)
 - au niveau de l'analyse ensuite, 99% de rejet
- Origine du gamma et impact au sol



- Reconstruction des paramètres de la gerbe par la méthode de Hillas



« 3D-Model »

- Modèle 3-dimensionnel de la photosphère Tcherenkov
- Méthode de maximum de vraisemblance qui reproduit les charges attendues sur chaque pixel

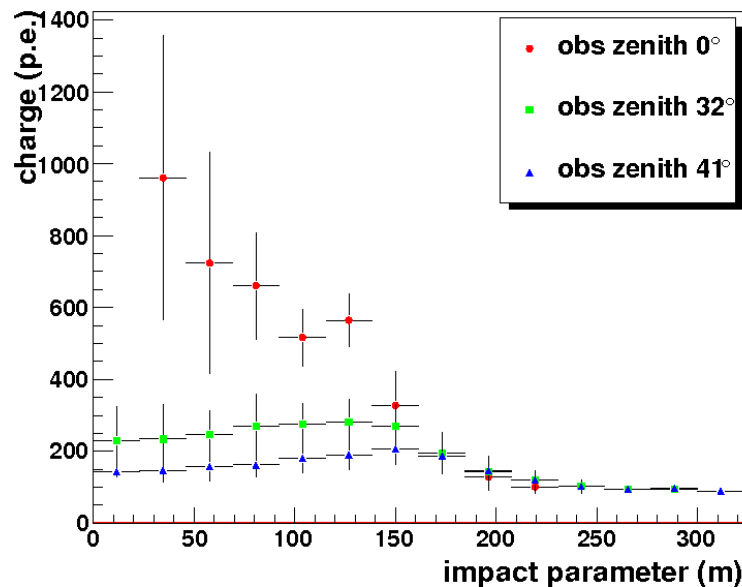
Lemoine-Goumard et al.

Astropart. Phys. 25 (2006) 195-211

- Largeur ajustée de la gerbe et son erreur associé et profondeur du maximum de la gerbe utilisés dans la nouvelle analyse

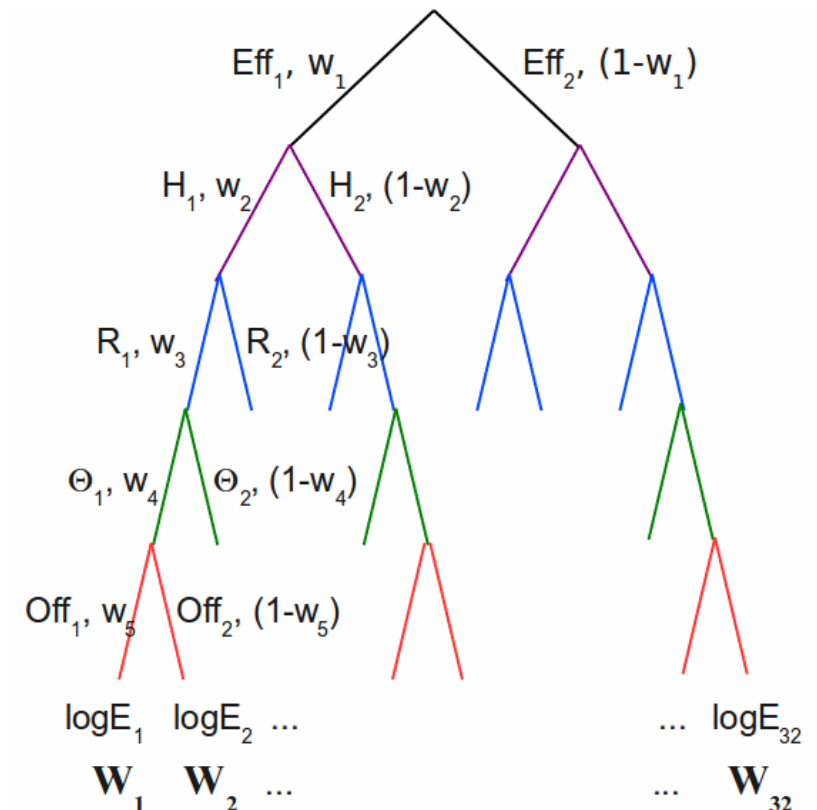
Reconstruction de l'énergie du γ

- Nouvelle méthode de calcul de l'énergie de la gerbe (*Oak*)
- 1ère phase: profiles de charges vs. paramètres d'impact, basés sur simulations Monte Carlo



$$E_{\text{event}} = \frac{1}{Q_{\text{tot}}} \sum_{i=1}^{N_{\text{Tels}}} [q_{\text{Tel}_i} \cdot E_{\text{Tel}_i}]$$

- 2ème phase : évaluation de l'énergie par un système de pondération
- La méthode de rec. de l'énergie est compatible avec les analyses standard Hillas et Model3D (mais plus rapide)



Variables discriminantes γ /hadron déjà connues

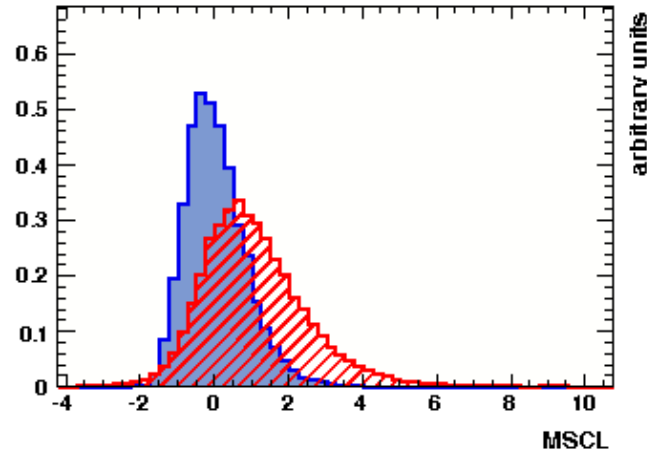
$$\text{MSCL} = \frac{1}{N_{\text{Tels}}} \sum_{i=1}^{N_{\text{Tels}}} \frac{\ell_i - \bar{\ell}_{q,x}}{\sigma_{\ell,q,x}}; \quad \text{MSCW} = \frac{1}{N_{\text{Tels}}} \sum_{i=1}^{N_{\text{Tels}}} \frac{w_i - \bar{w}_{q,x}}{\sigma_{w,q,x}}$$

Paramètres discriminants basés sur l'algorithme de Hillas

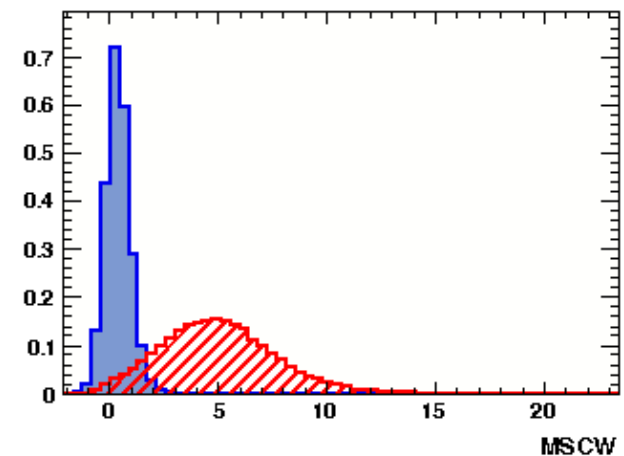
γ -rays vs. background

Paramètres discriminants basés sur l'algorithme Model3D

arbitrary units



arbitrary units

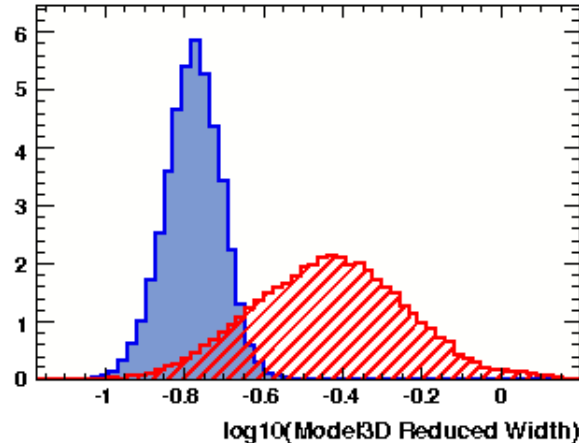


Reduced Width

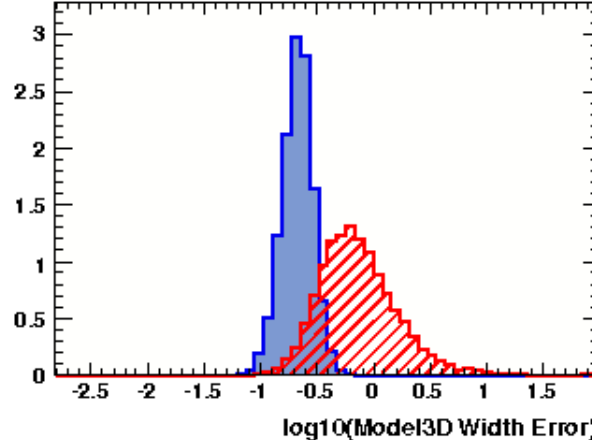
Error on Width

Depth of Shower Max

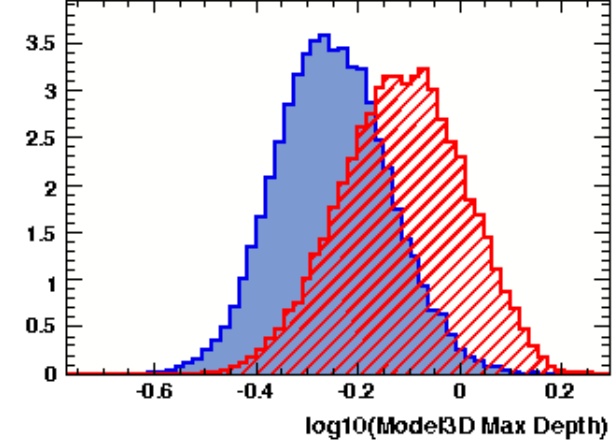
arbitrary units



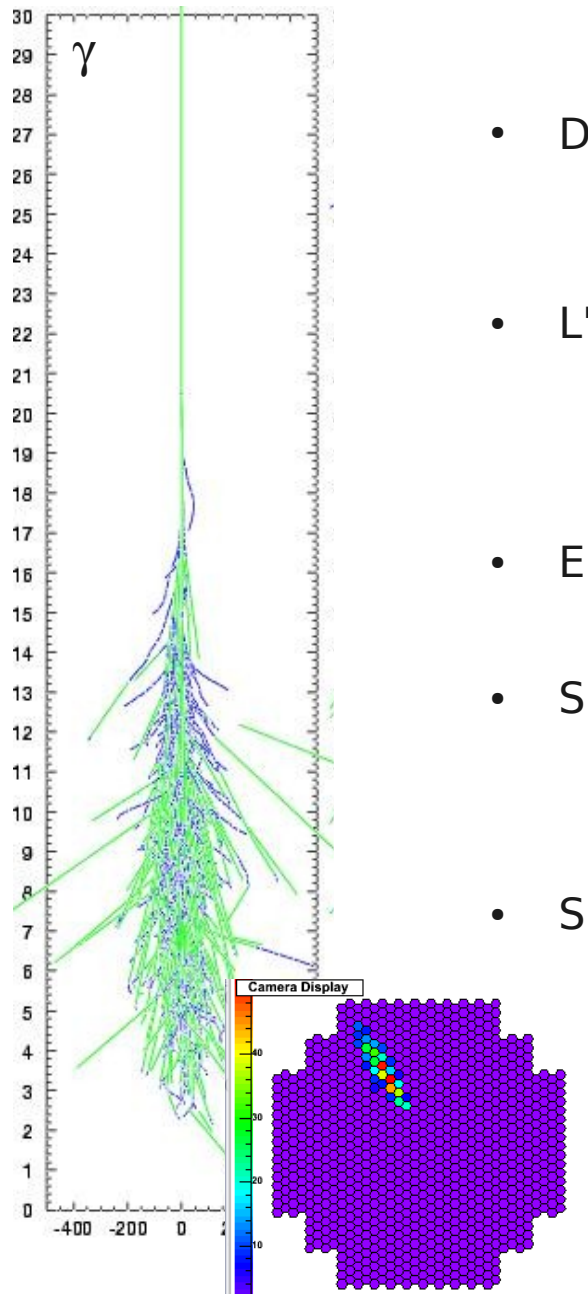
arbitrary units



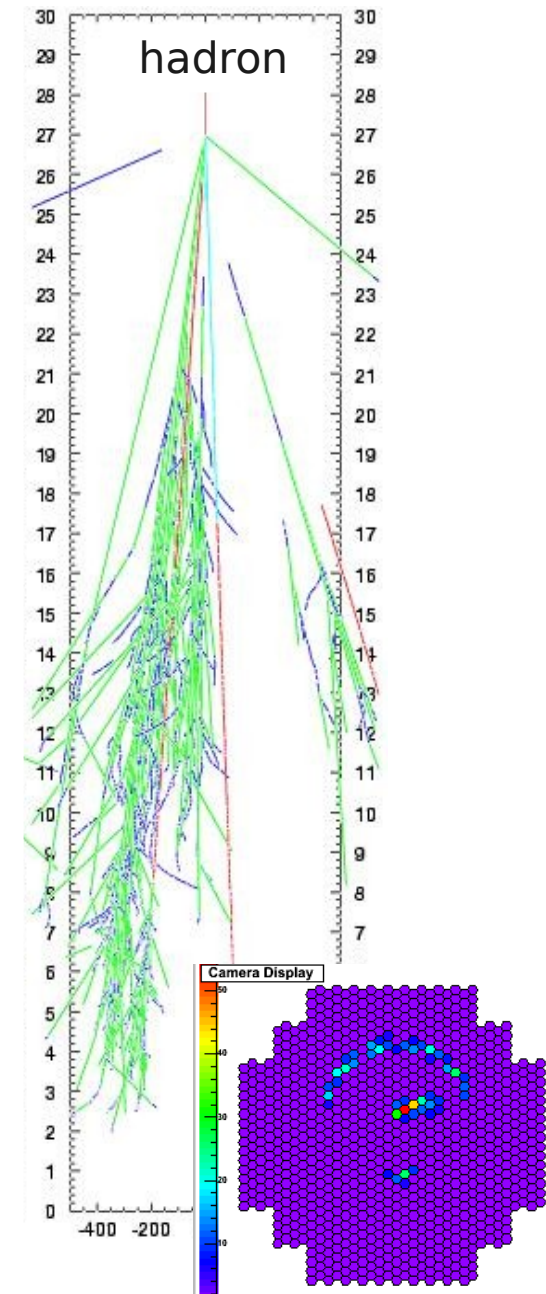
arbitrary units



A la recherche de nouveaux paramètres discriminants

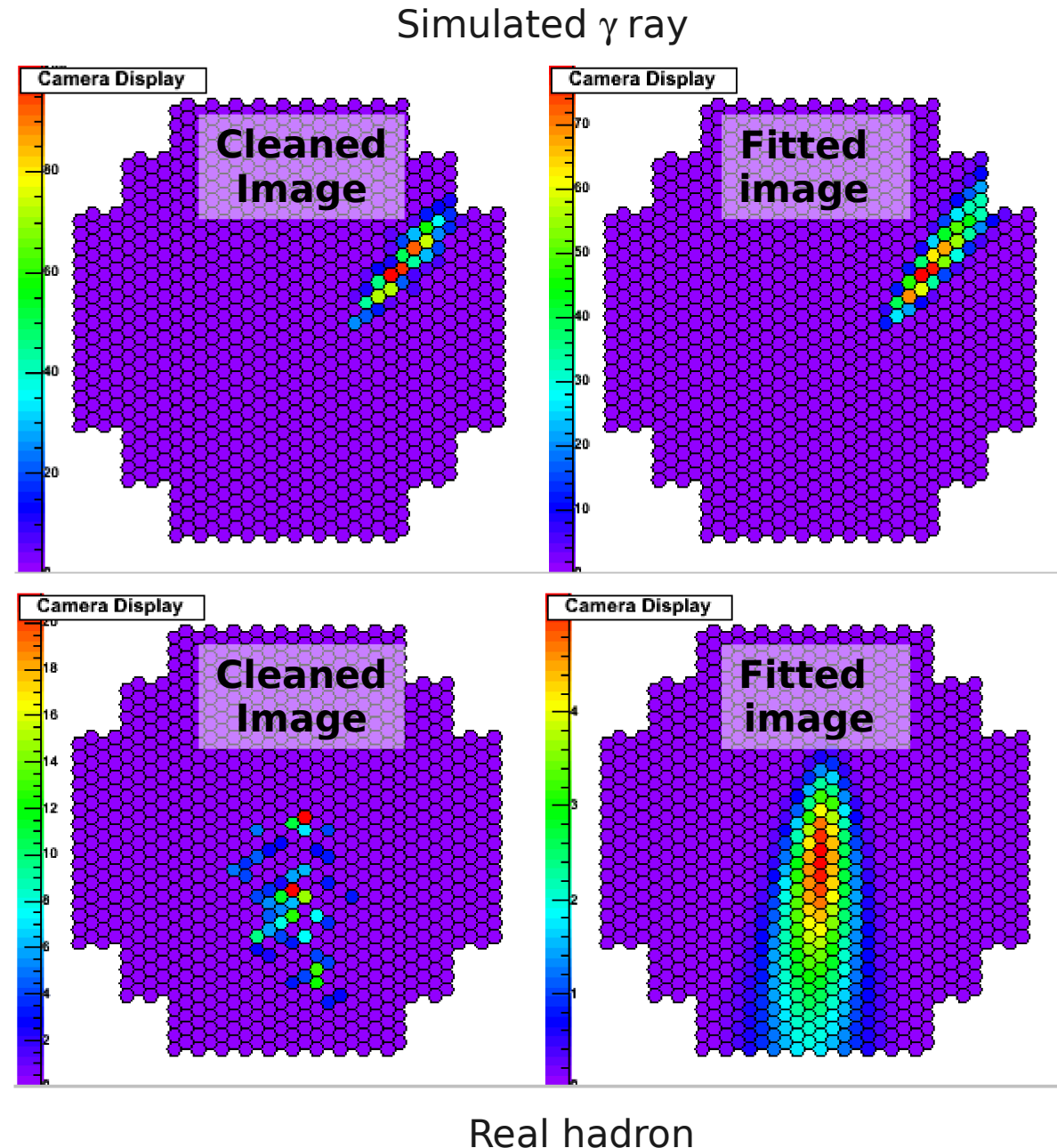


- Développement des gerbes γ et hadrons $\rightarrow$ symétrie azimutale pour les γ , asymétrie pour les hadrons
- L'ajustement d'une gerbe hadronique avec un modèle de gerbe de γ donne des incohérences qui peuvent être exploitées
- En utilisant l'information des images prédites par la minimisation du Model3D
- Si bon ajustement
 - Les images prédites sont très semblables à celles détectées
- Si mauvais ajustement
 - Les images prédites sont très différentes de celles détectées



A la recherche de nouveaux paramètres discriminants

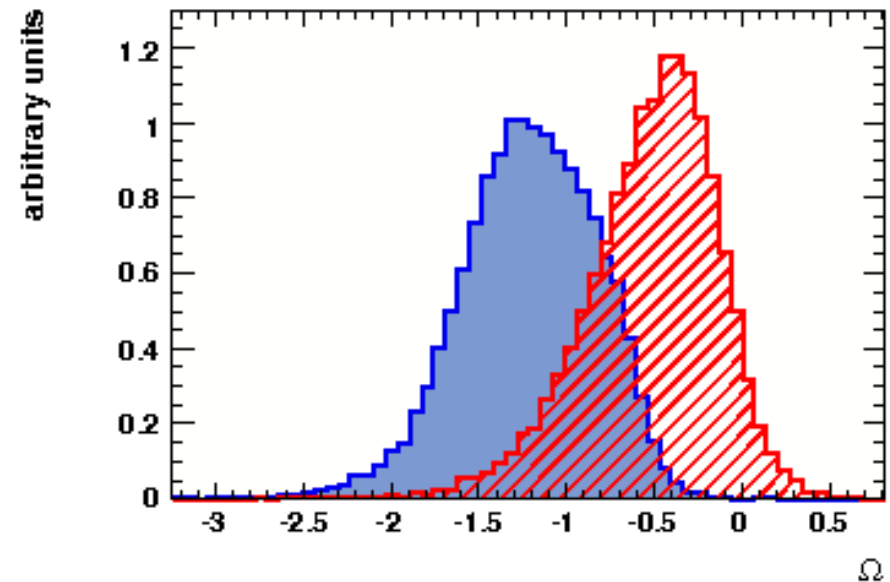
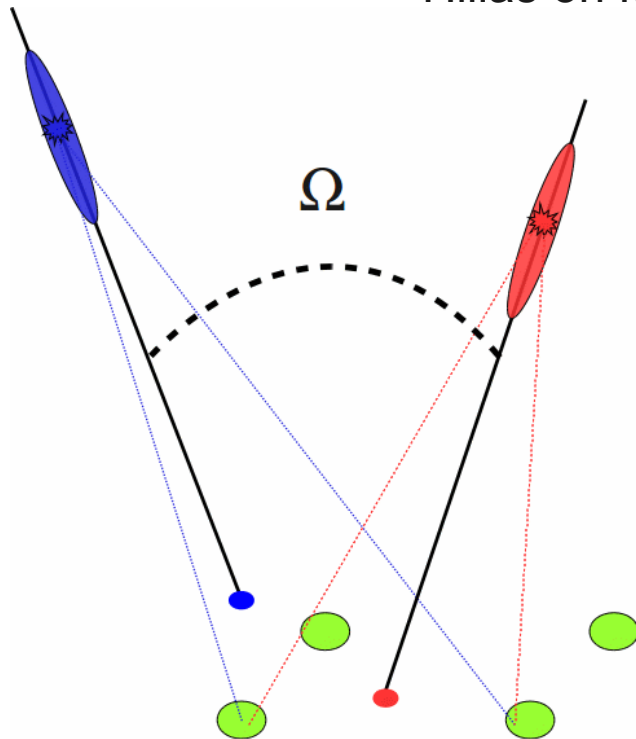
- Les images prédites par le Model3D sont utilisées pour reconstruire un nouveau set de paramètres Hillas (*HillasOnModel*)
- La direction de l'axe principale de ces nouveaux moments utilisée pour reconstruire une nouvelle direction de la gerbe → nouveau paramètres discriminant
- Les charges des images prédites sont utilisées pour la définition de 2 nouveaux paramètres de discrimination



Nouveaux paramètres de discrimination γ /hadron (#1)

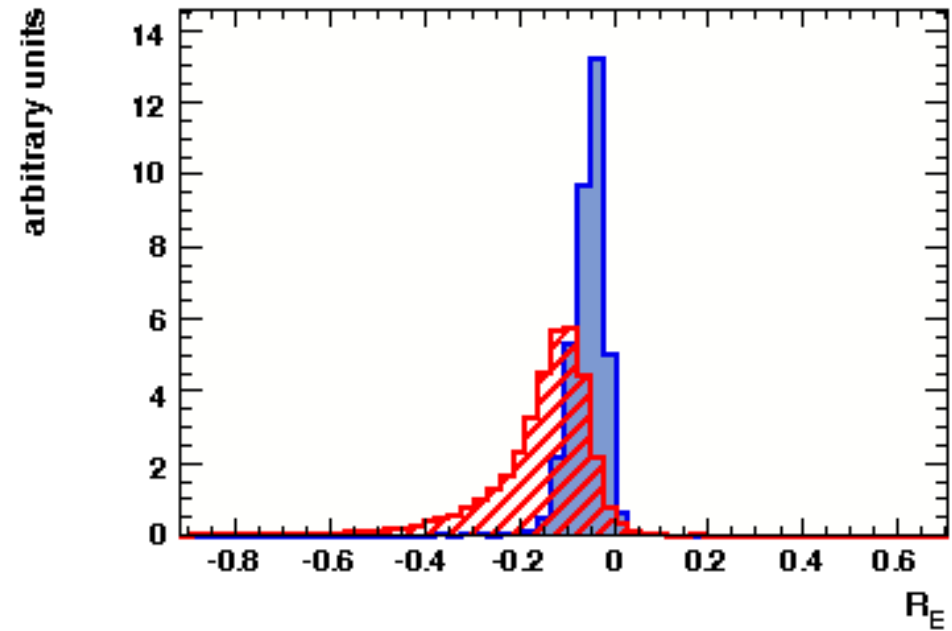
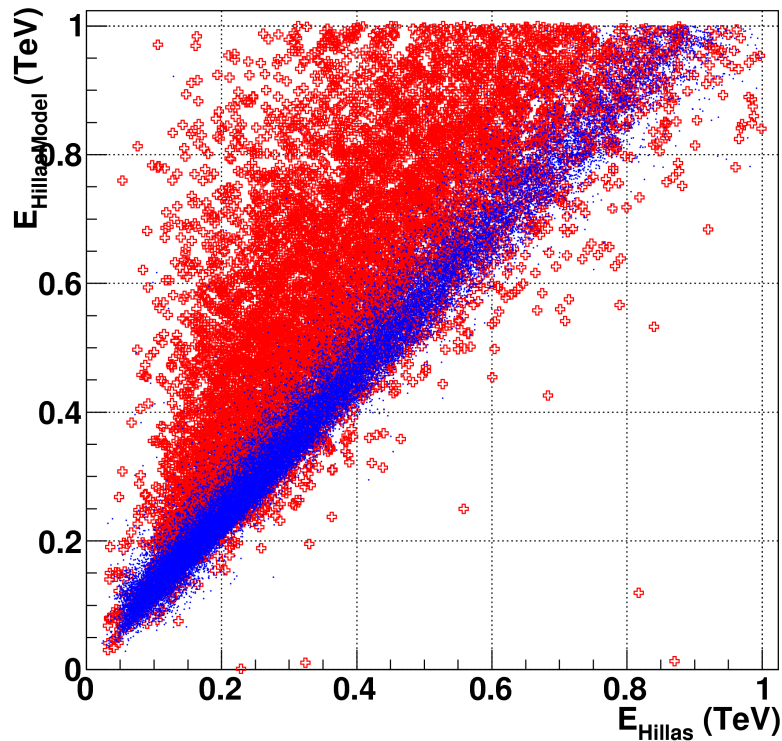
Hillas

Hillas on Model images



Nouveaux paramètres de discrimination γ /hadron (#2)

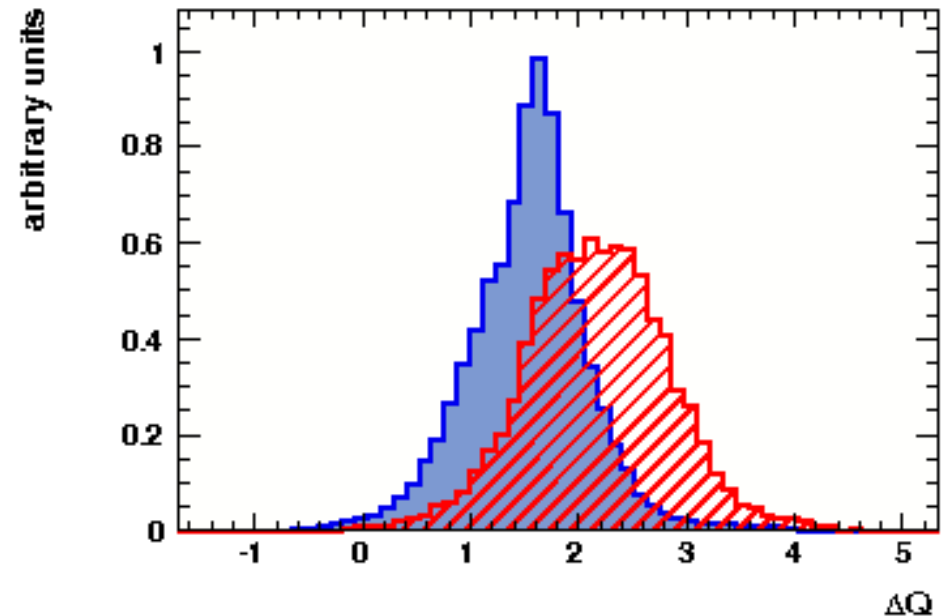
$$R_E = \log_{10} \left[\frac{E_{\text{Hillas}}}{E_{\text{HillasOnModel}}} \right]$$



Nouveaux parametres de discrimination γ /hadron (#3)

Sachant l'énergie reconstruite E_{Hillas} , et le paramètre d'impact de la gerbe la procédure de *Oak* peut être renversée pour « prédire » les charges des images attendues sur chaque télescope par simulation

$$\Delta Q = \frac{1}{Q_{\text{tot}}} \sum_{i=1}^{N_{\text{Tels}}} [q_{\text{exp}} - q_{\text{det}}]^2$$



Discrimination γ /hadron basée sur les 8 paramètres

Training data sample:

MC: 14 zenith angles
6 offsets (0-2.5)

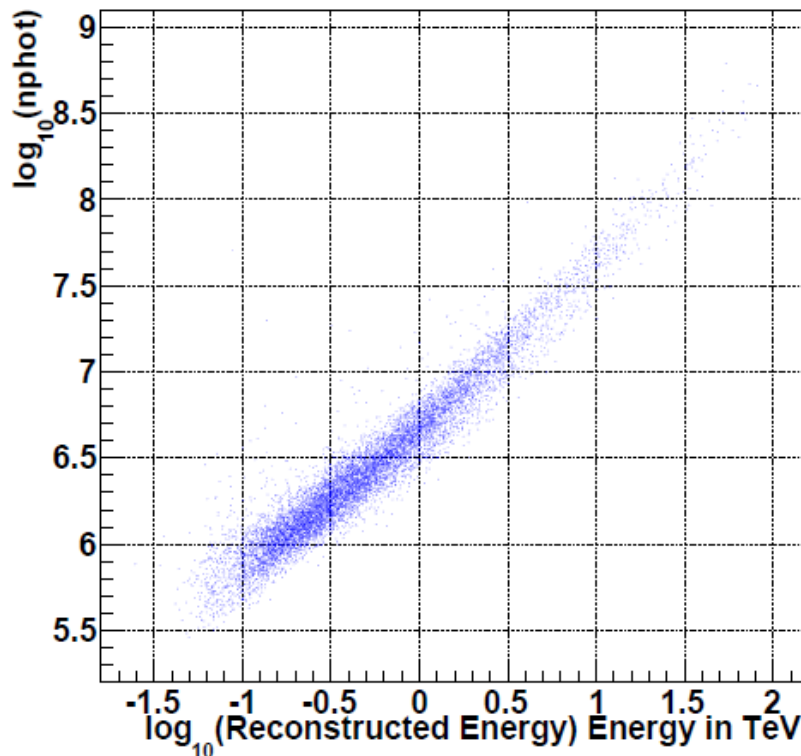
Bkg: X-gal observations
excluding source wedge

112 bins par configuration:

8 in Zenith
7 in Nphot
2 bins in multiplicity
→ 2 tel-events
→ 3/4 tel-events

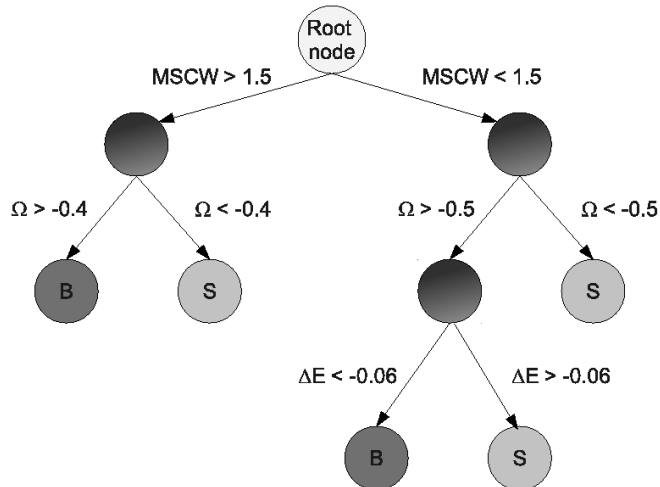
Bin	Interval in zenith angle
1	0° – 10°
2	10° – 20°
3	20° – 30°
4	30° – 40°
5	40° – 45°
6	45° – 50°
7	50° – 55°
8	55° – 90°

Use Nphot bins rather than Energy with this relation



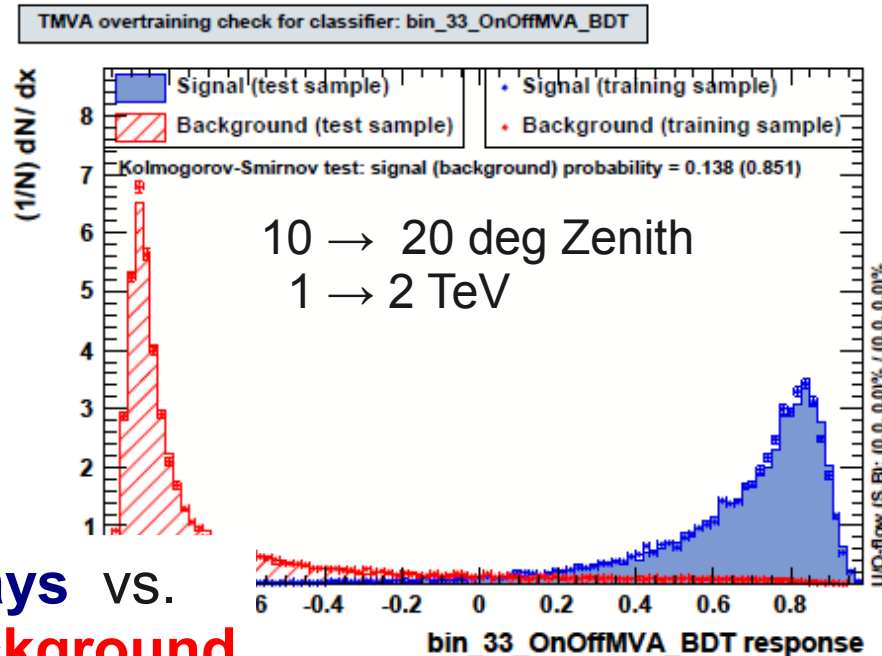
Bin	Interval in $\log_{10}(\text{nphot})$	Interval in E (TeV)
1	0.01 – 5.80	0.0 – 0.1
2	5.80 – 6.18	0.1 – 0.3
3	6.18 – 6.35	0.3 – 0.5
4	6.35 – 6.59	0.5 – 1.0
5	6.59 – 6.82	1.0 – 2.0
6	6.82 – 7.13	2.0 – 5.0
7	7.13 – 10.0	5.0 – 1e3

Exemple de performance du classificateur BDT



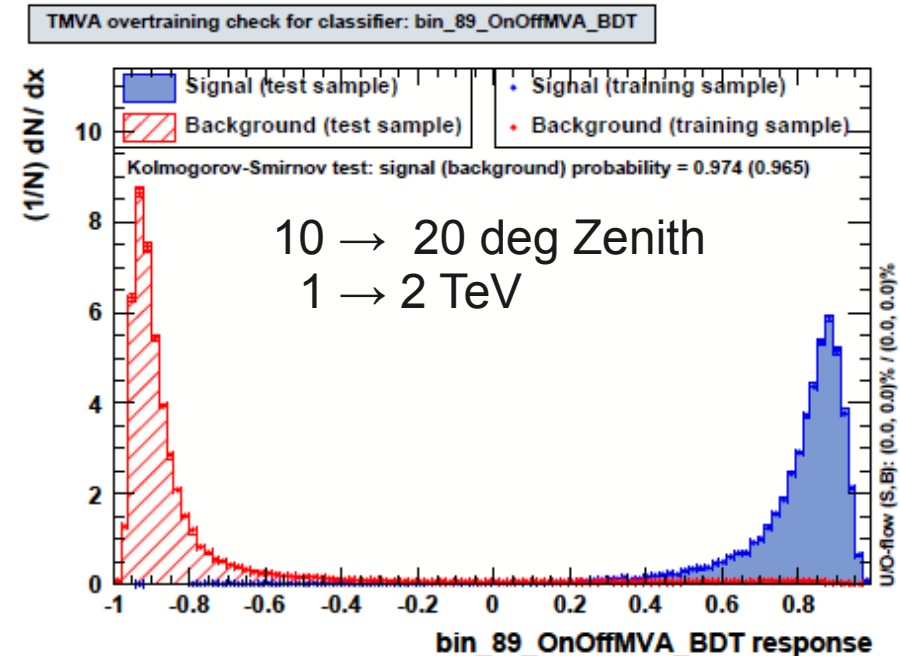
Parameter	Value
SeparationType	Gini index
MaxDepth	20
nEventsMin	30
nCuts	20
Max events for training	$1.2 \cdot 10^5$
trees/events	100/10000
Max events for test	$1.2 \cdot 10^5$
VarTransform	None
UseYesNoLeaf	True
BoostType	AdaBoost
UseWeightedTrees	True
PruneMethod	CostComplexity
PruneStrength	-1
NodePurityLimit	0.5

Événements à 2-télescopes



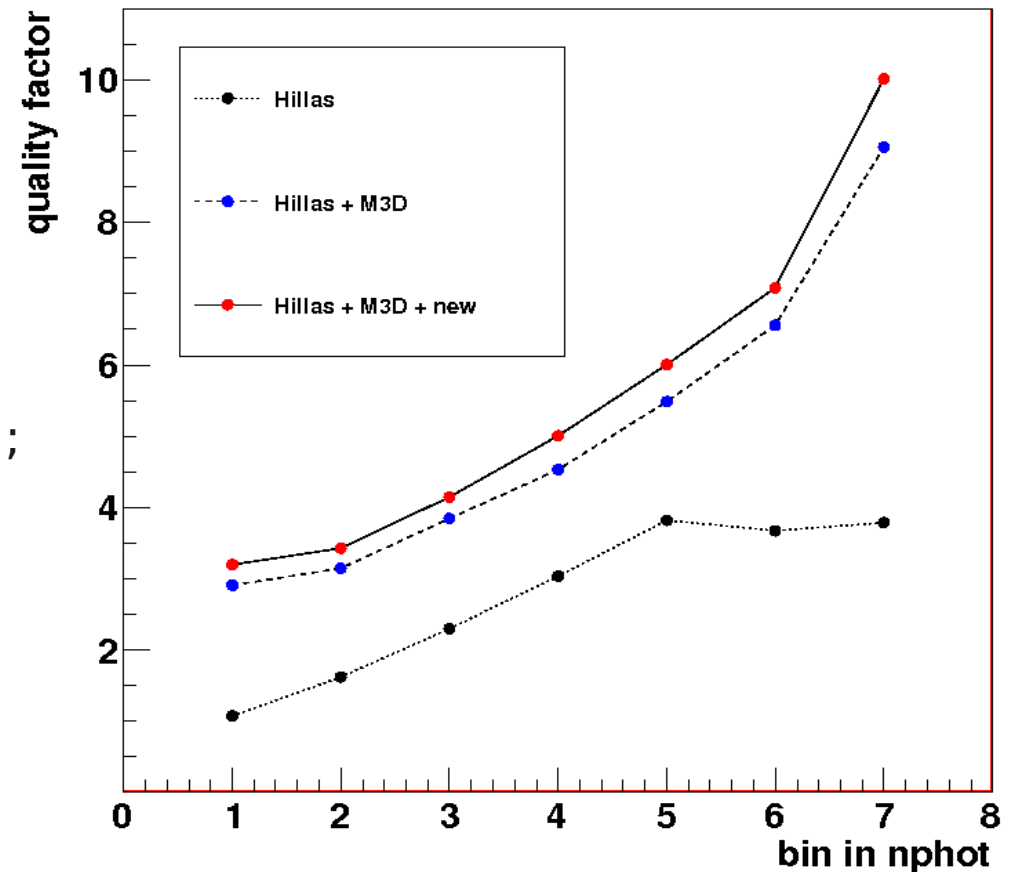
γ-rays vs.
background

Événements à 3 et 4 télescopes



Importance des paramètres de discrimination

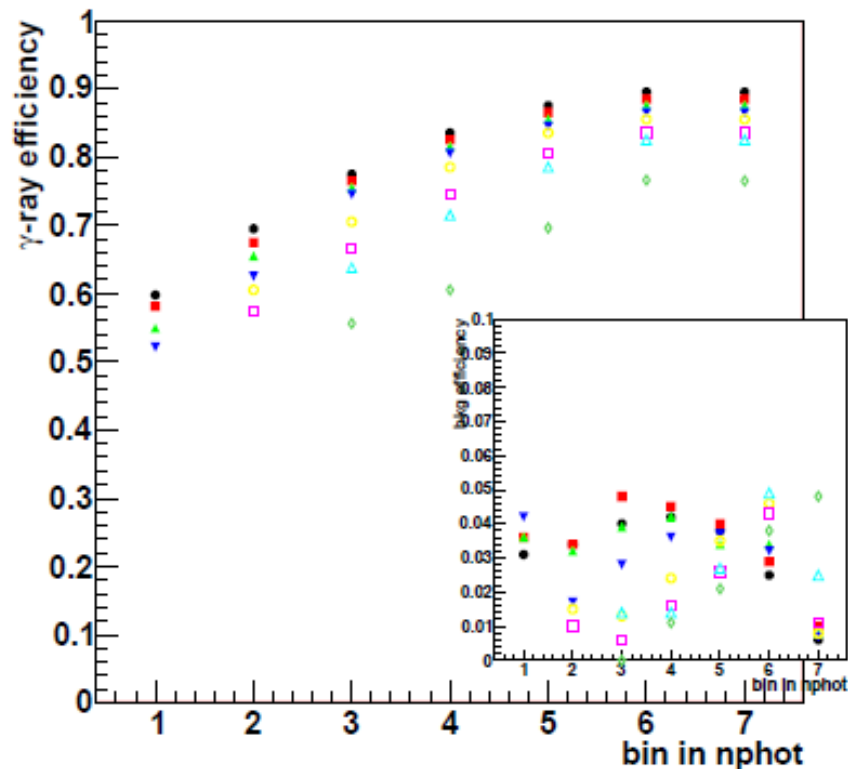
- Trois configurations :
 - 2 paramètres de Hillas
 - 2 Hillas + 3 Model3D
 - 2 Hillas + 3 Model3D + 3 nvls
- Ajout des 3 nouveaux paramètres ;
pouvoir de discrimination
augmente de 20%



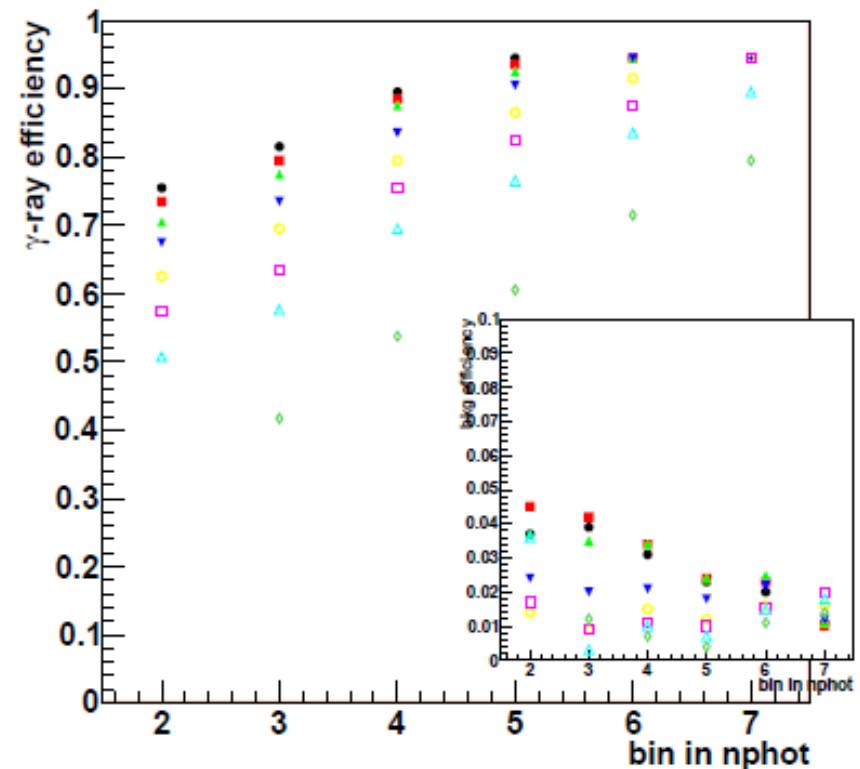
Exemple de définition de coupures

Given BDT variable definition,
use these predefined γ -ray efficiencies, rising smoothly in Nphot,
to set the cut level (giving corresponding hadron efficiencies)

2-telescope events



3/4 telescope events



*Different marker types for
different Zenith angle bins*

Coupures différentes pour différents types de sources

Spectres durs ($\Gamma < 2.7$)

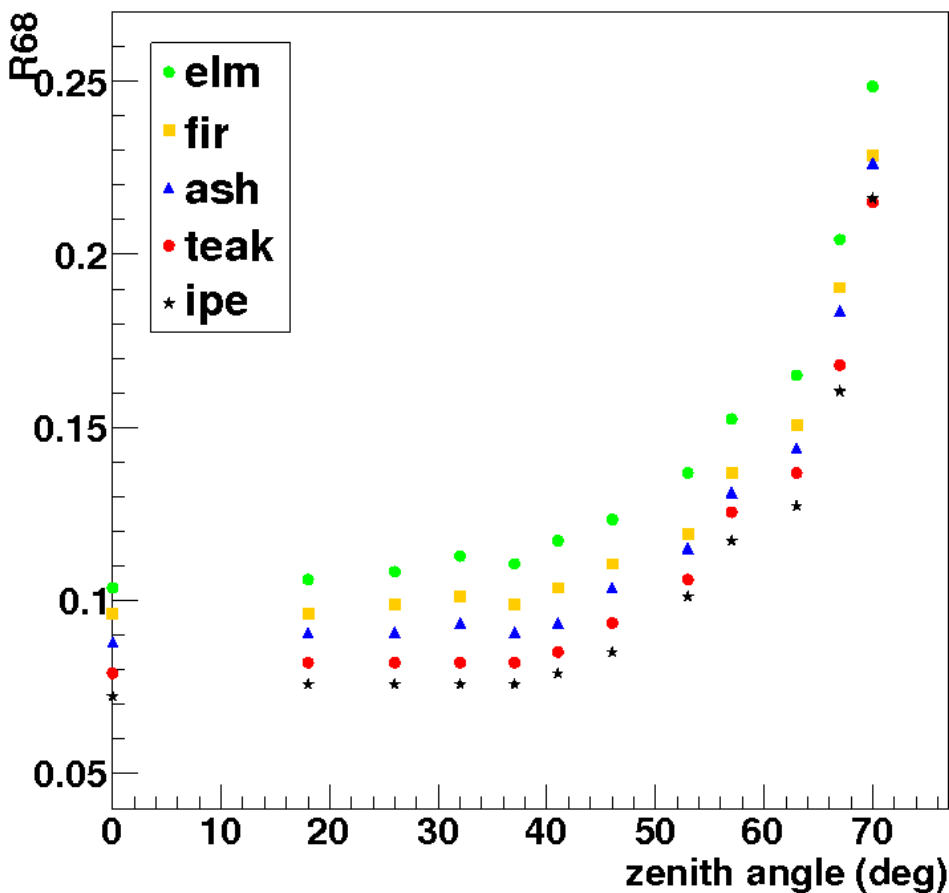
- *Ash:*
pour la plupart de sources
ayant un spectre dur
(60 et 80 p.e.)
- *Teak:*
Spectres durs, flux très faible
(110 p.e.)
- *lpe:*
Spectres durs, PSF améliorée
pour études morphologiques
(150 p.e.)

Spectres mous ($\Gamma > 2.7$)

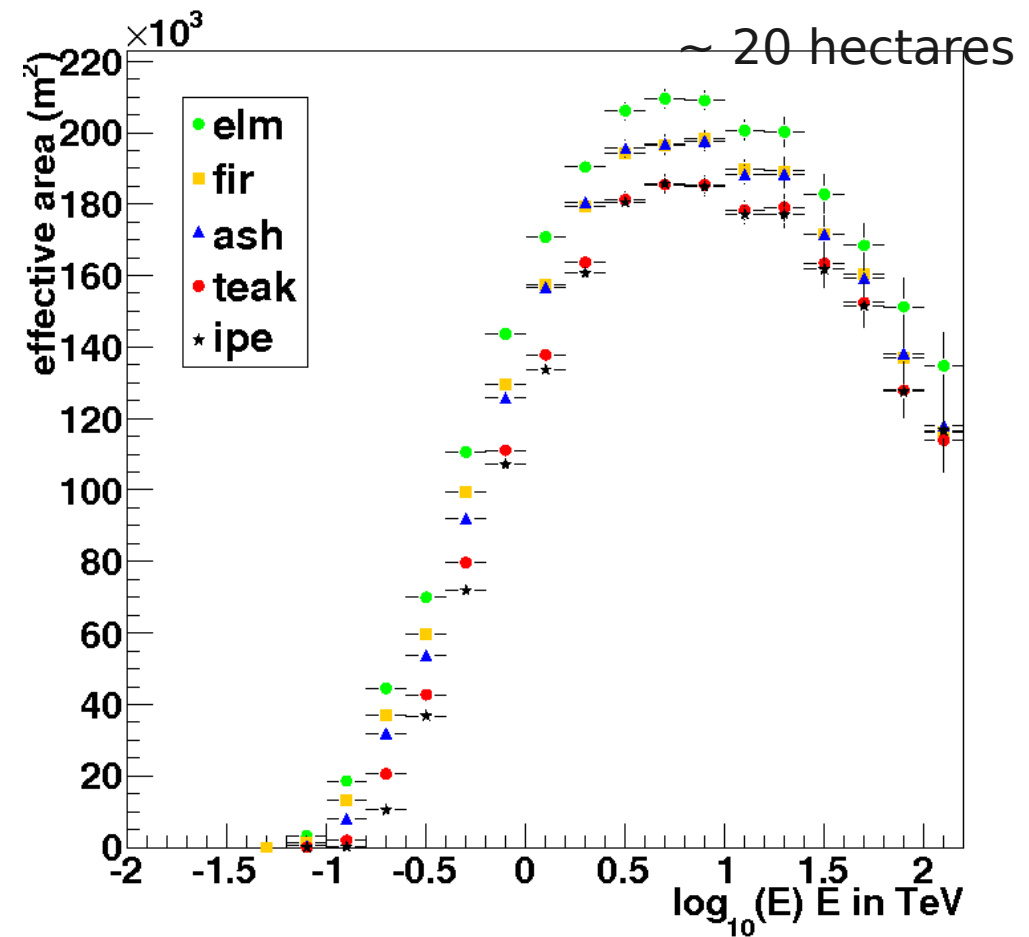
- *Elm:*
40 p.e. pour une meilleure
performance à basse énergie

Instrument response functions for point source analysis

PSF for the different configurations



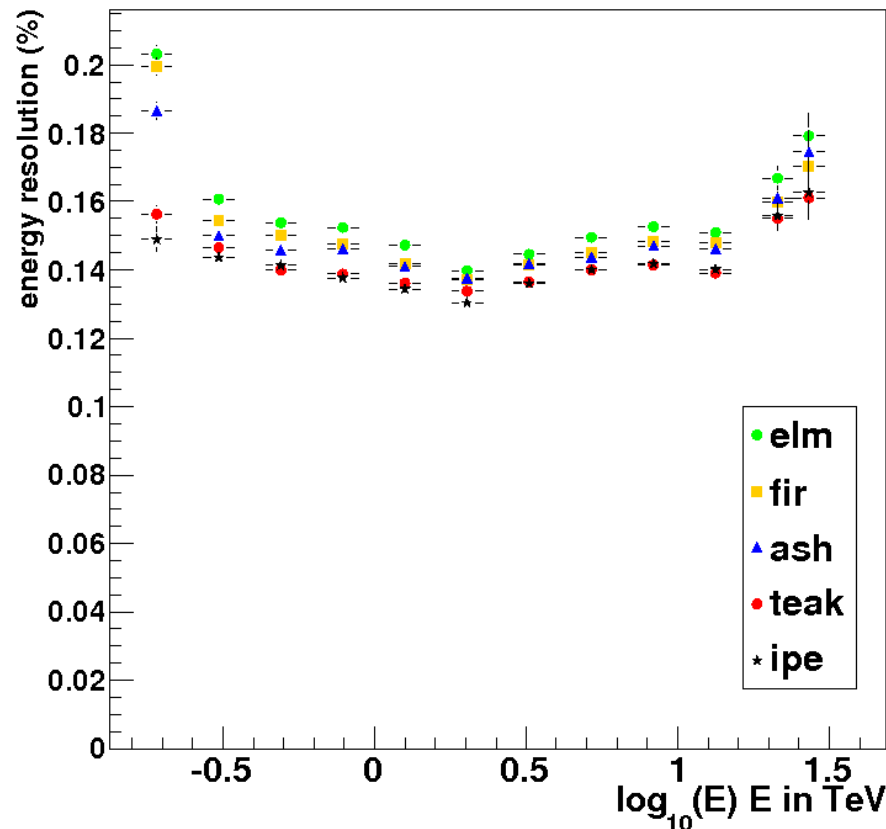
Effective areas after Theta2 cuts
(defined based on PSF)
for three configurations



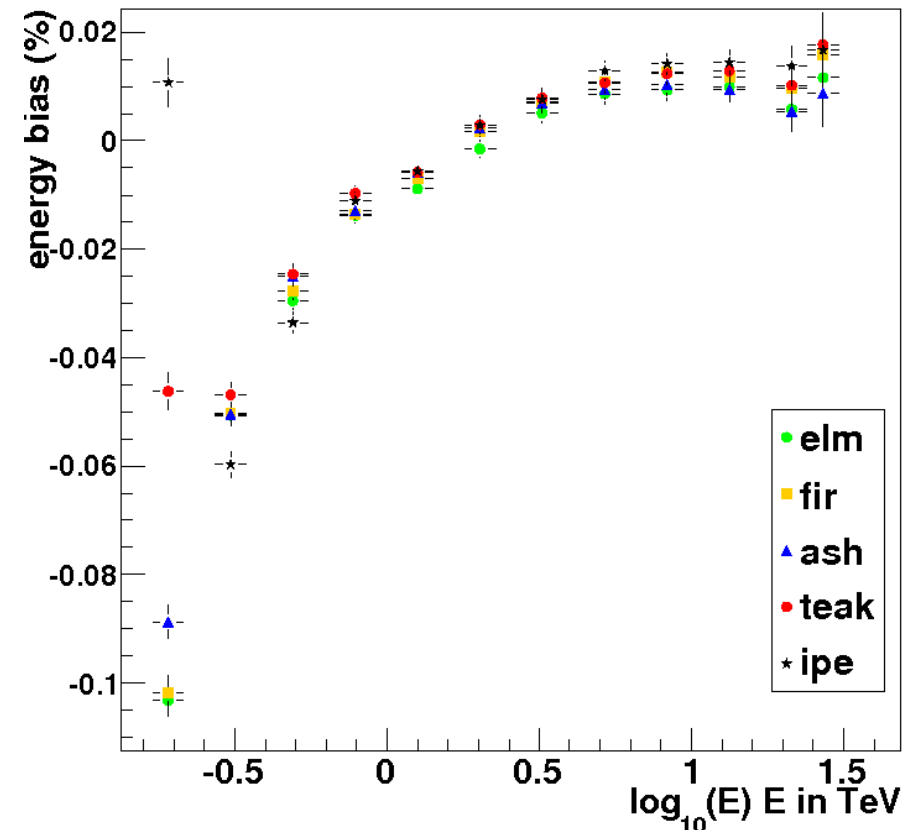
Instrument response functions for point source analysis

Energy response functions after all cuts

Energy Resolution



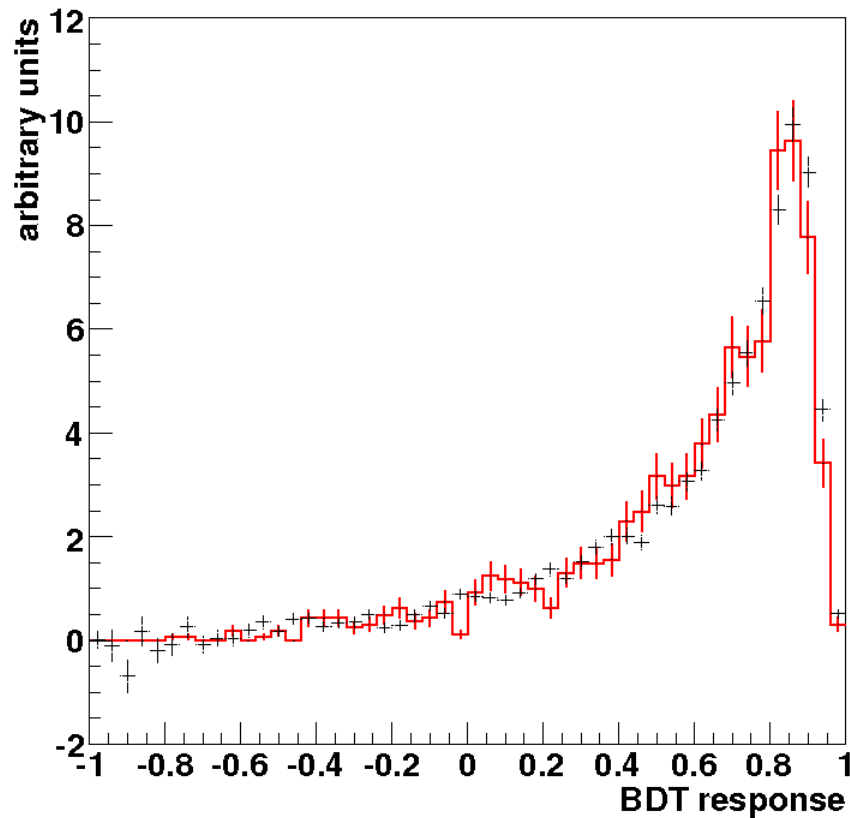
Energy Bias



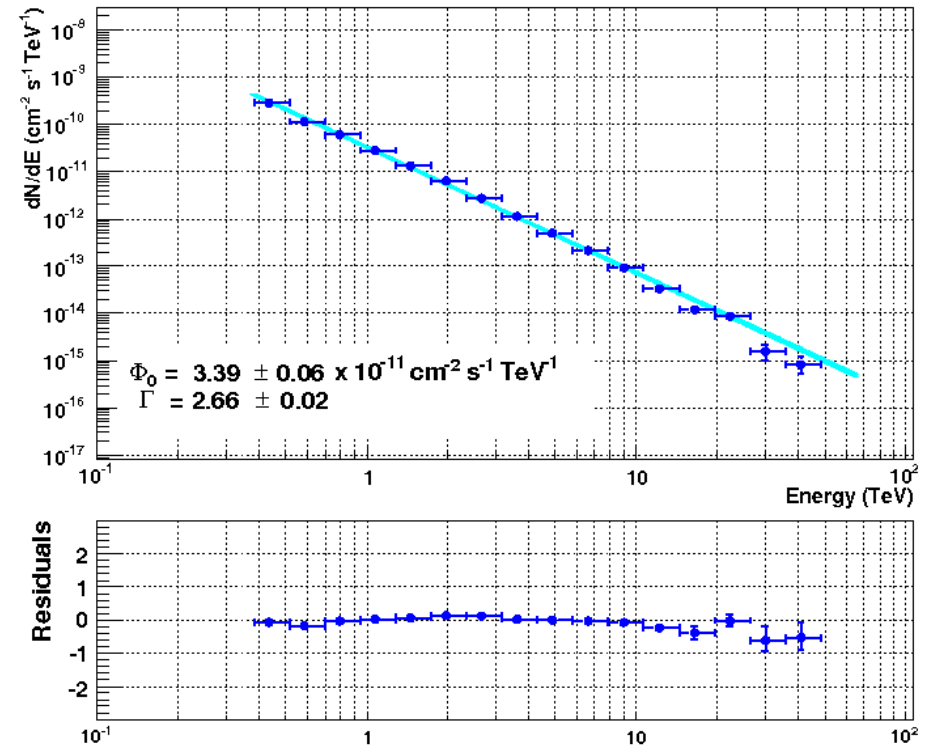
These are based on pre-defined charge profiles on standard/loose Hillas cuts
... in near future step, try with pre-defined charge profiles after new MVA cuts

Performance evaluation on the Crab

Comparison of BDT response for:
Simulation – black line
Crab excess – red crosses



Spectrum cross-checked with Monte Carlo
Crab reconstructed spectrum
power-law fit



Compatible with published results
within systematics (not same run-list)

• Performance on some H.E.S.S. sources

Source	Γ	ϕ_0 C.U.	θ_{zen}	Analysis	LT	On	Off	N_γ	N_σ	$\sigma/\sqrt{hr}$
Cen A	2.7	0.8%	24.5°	Hillas (80 p.e.)	120.0	4199	3868	330	5.0	0.46
	$\pm 0.5_{stat}$			ash (80 p.e.)	120.0	1437	1109	324	9.0	0.82
	$\pm 0.2_{sys}$			elm (40 p.e.)	120.0	3306	2967	338	5.9	0.54
H 2356	3.06	1.6%	19.0°	Hillas (80 p.e.)	116.8	8899	7718	1185	12.6	1.16
	$\pm 0.15_{stat}$			ash (80 p.e.)	116.8	2152	1319	833	20.0	1.85
	$\pm 0.10_{sys}$			elm (40 p.e.)	116.8	4477	3277	1199	18.9	1.74
1ES 0347 -121	3.10	2.0%	19.8°	Hillas (80 p.e.)	25.4	1167	840	327	10.1	2.00
	$\pm 0.23_{stat}$			ash (80 p.e.)	25.4	490	263	226	11.8	2.35
	$\pm 0.10_{sys}$			elm (40 p.e.)	25.4	1082	706	375	12.4	2.46
1ES 1553 +113	4.5	3.4%	40.0°	Hillas (80 p.e.)	24.8	7548	4962	785	10.2	2.05
	$\pm 0.3_{stat}$			ash (80 p.e.)	24.8	409	269	140	7.6	1.51
	$\pm 0.1_{sys}$			elm (40 p.e.)	24.8	1015	665	349	11.9	2.39
G0.9+0.1	2.4	2.0%	21.5°	Hillas (200 p.e.)	50.1	606	310	296	14.4	2.03
	$\pm 0.11_{stat}$			teak (110 p.e.)	50.1	731	312	419	19.3	2.73
	$\pm 0.20_{sys}$			ash (80 p.e.)	50.1	1010	553	457	16.8	2.37

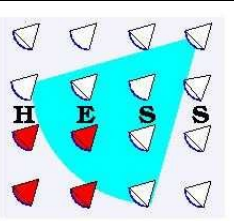
1.8

1.6

1.2

1.2

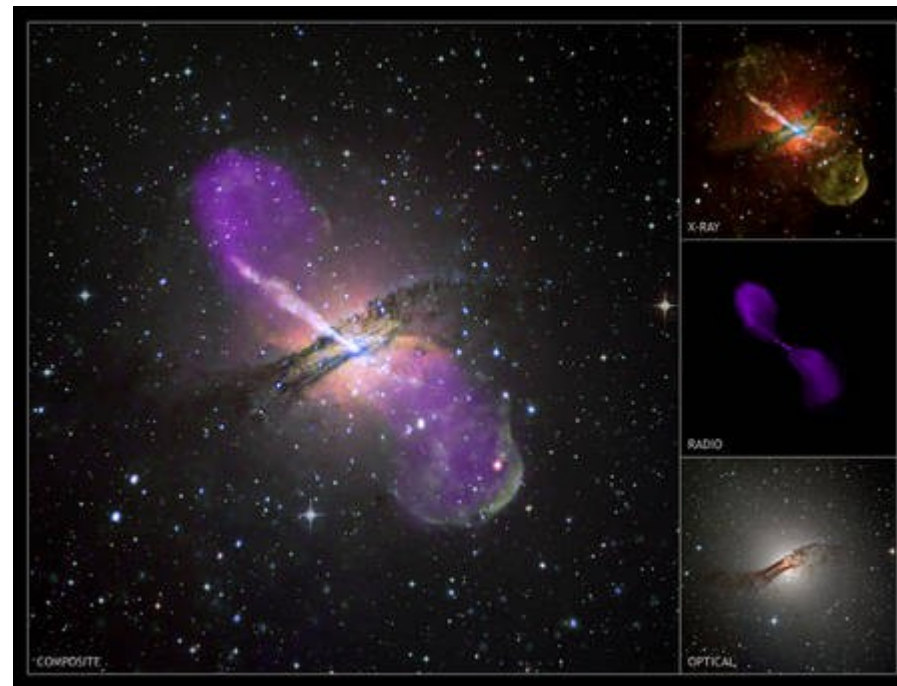
1.3

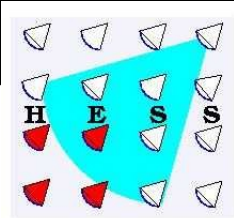


Nouveaux Noyaux Actifs de Galaxie découverts par H.E.S.S. pendant l'année passée

(grâce aux nouvelles analyses)

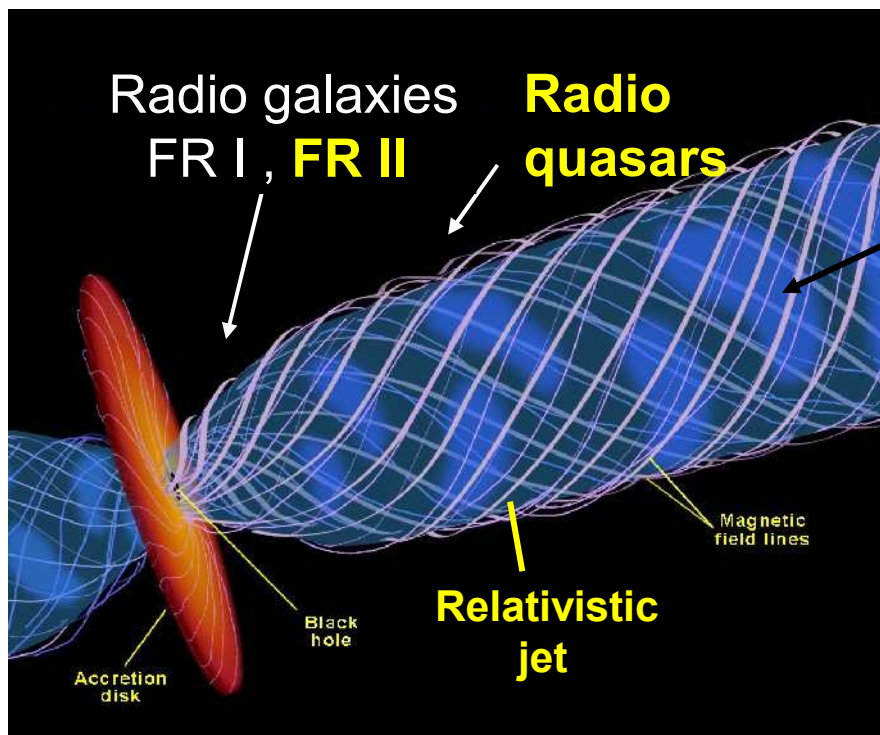
Presentation au Texas Symposium 2010



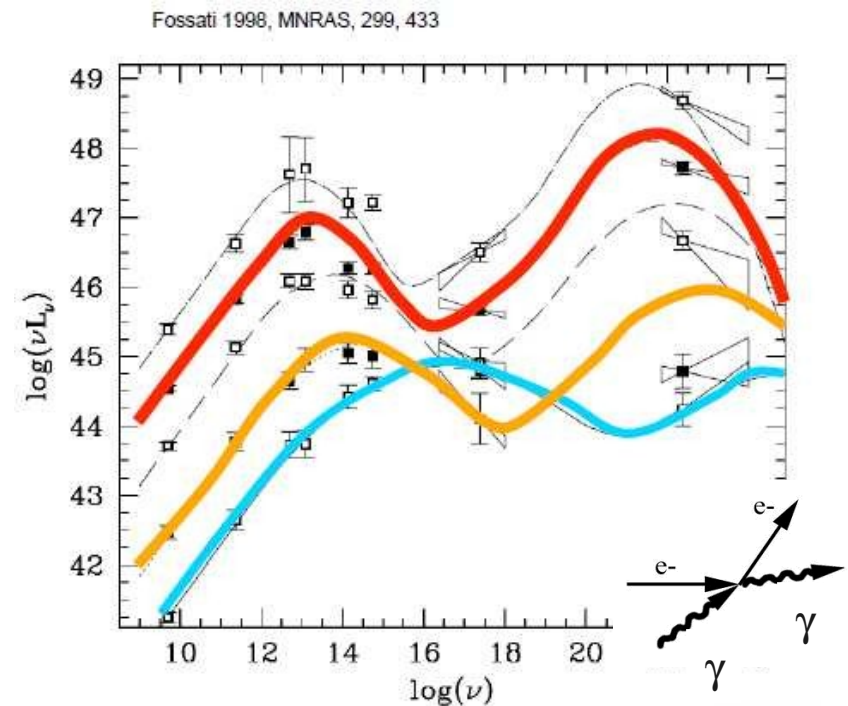


- La plupart des sources extragalactiques vues à HE/VHE sont des AGNs (Active Galactic Nuclei), visibles grâce au Doppler beaming/boosting dans le jet
- AGN : objets extrêmement variables à toutes les échelles de temps

- Récemment
 - 2ieme radio galaxies (Centaurus A, après M87)
 - galaxies starburst (NGC253, M82)



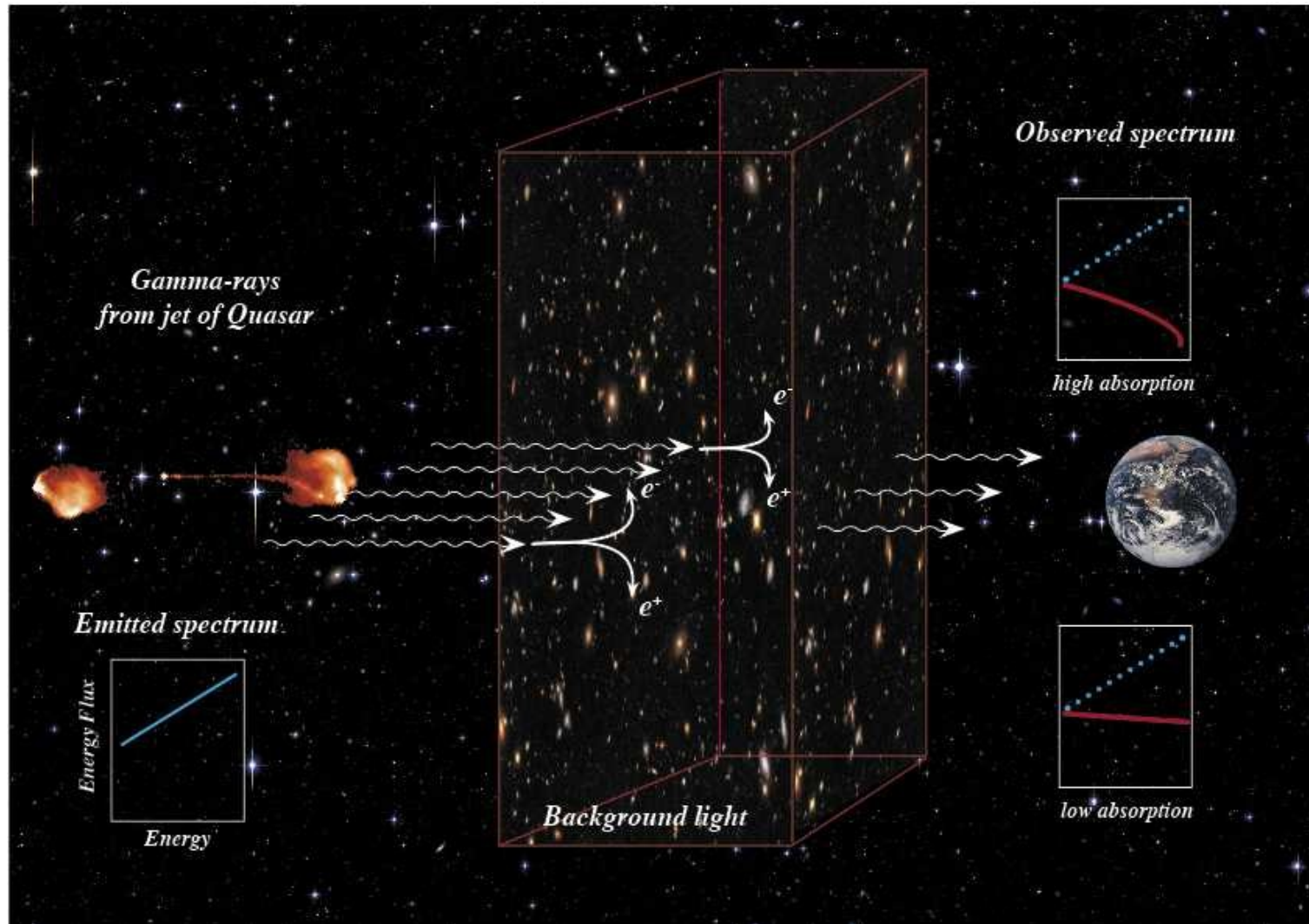
BL Lac
(HBL, LBL)
and FSRQ



Strong relativistic boosting ($\sim$ factor δ^4)
favours detection of blazars/BL Lac

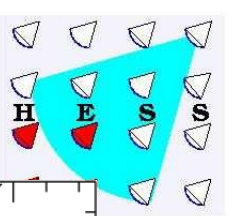
LBL: powerful, external radiation fields (EC)
HBL: low power, weak external radiation fields (SSC)

Absorption des γ sur fond extragalactique IR (EBL)

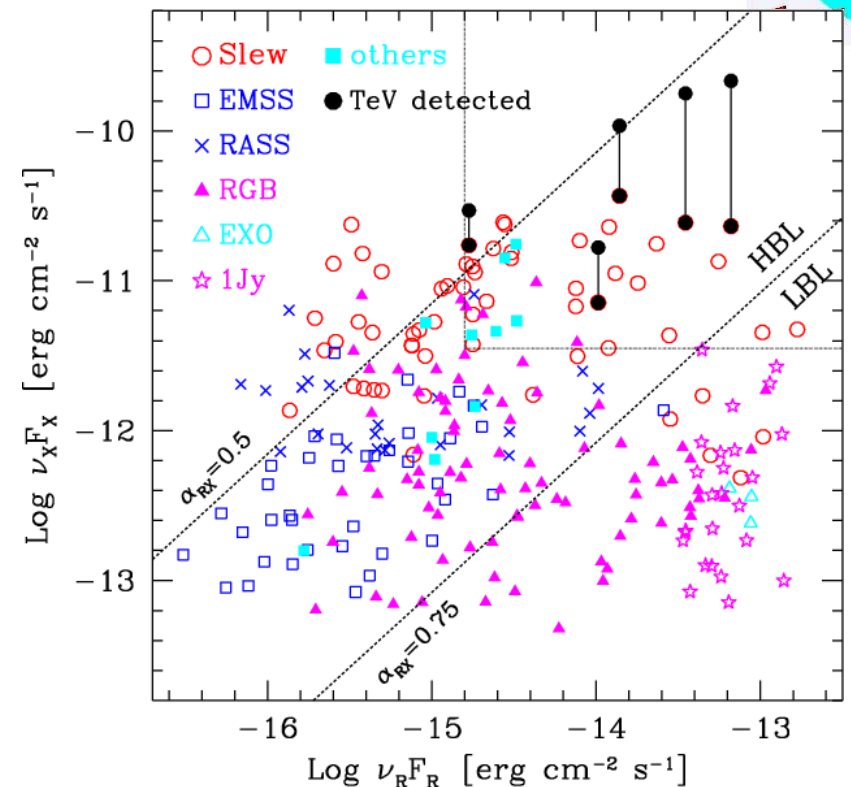


Effet de l'absorption sur le fond extragalactique IR:

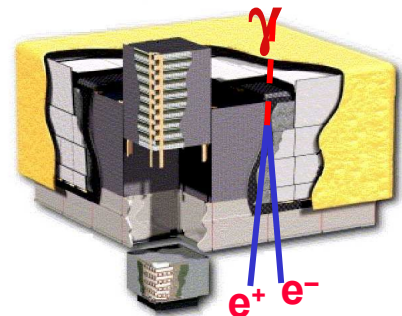
- modification de l'index spectral intrinsèque
- introduction de cut-offs or roll-overs
- rend les sources très distantes sources indétectables aux plus hautes énergies



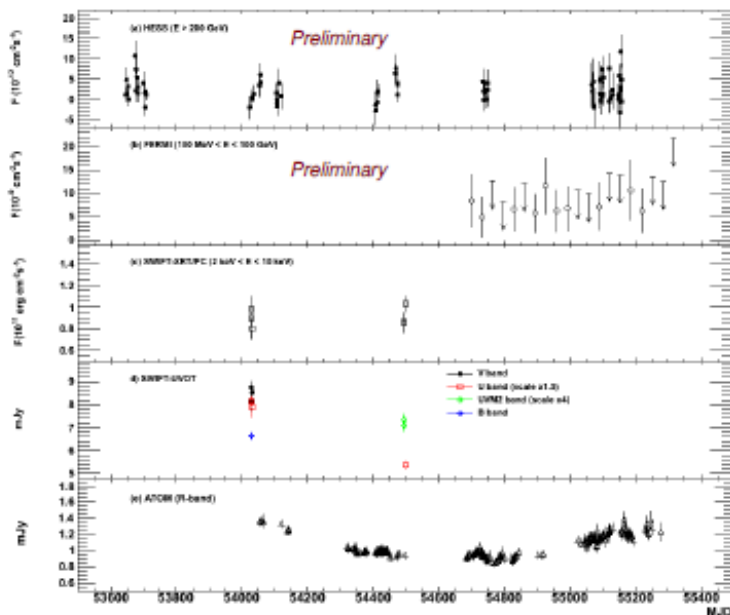
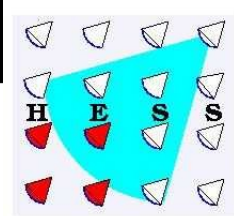
- AGN Observing Strategy
 - Most successful...
High F_x & F_r criterion...
Costamante & Ghisellini (2002) (‡)
 - Now “Fermi-bright” sources
Abdo et al., 2010 (*)
- Discovery of VHE emission from:
 - 1ES 0414+009 (‡)
 - SHBL J001355.9-185406 (‡)
 - PKS 0447-43 (*)
 - AP Librae (*)
 - **1RXS J101015.9-311909** (‡)
 - **1ES 1312-423**



Fermi 11 months AGN catalogue
 709 sources avec $|b| > 10^\circ$
 300 BL Lacertae
 296 FSRQ
 41 AGN other types
 72 AGN Unknown type



1ES 0414+009 (z=0.287)



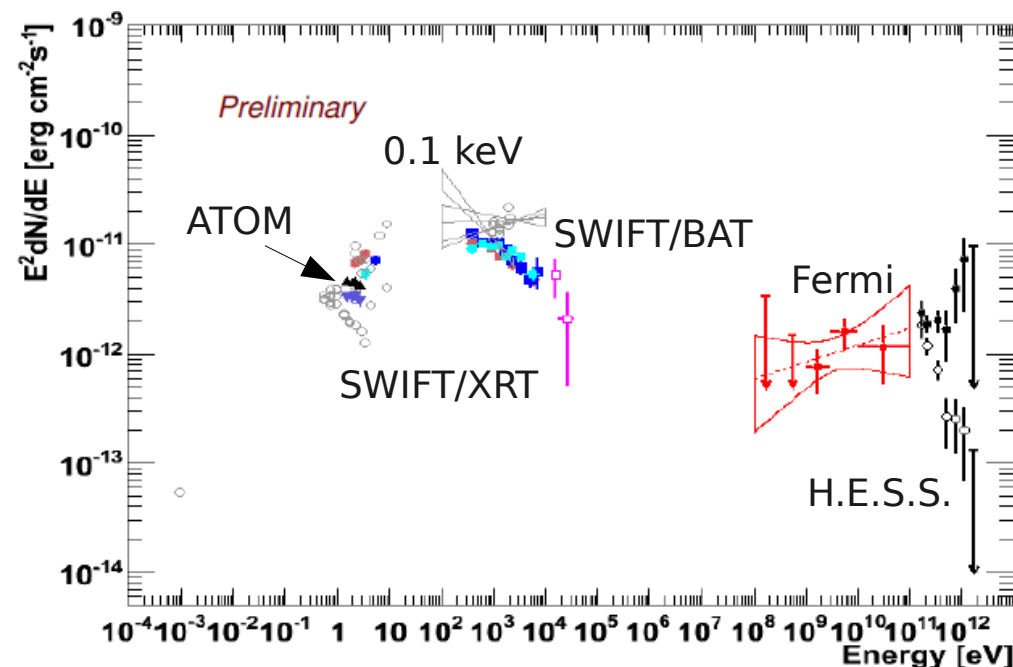
- One of the most distant blazars with a known redshift
- Observed by H.E.S.S. between 10/2005 and 9/2009
- Detected in 73.7 hours at 7.8σ (225 excess events)
- Flux $\sim 0.5\%$ Crab Nebula
- No sign of variability found
- Detected with the Fermi/LAT in 21 months of data
- Joint H.E.S.S.-Fermi ATel #2293, 12 Nov 2009

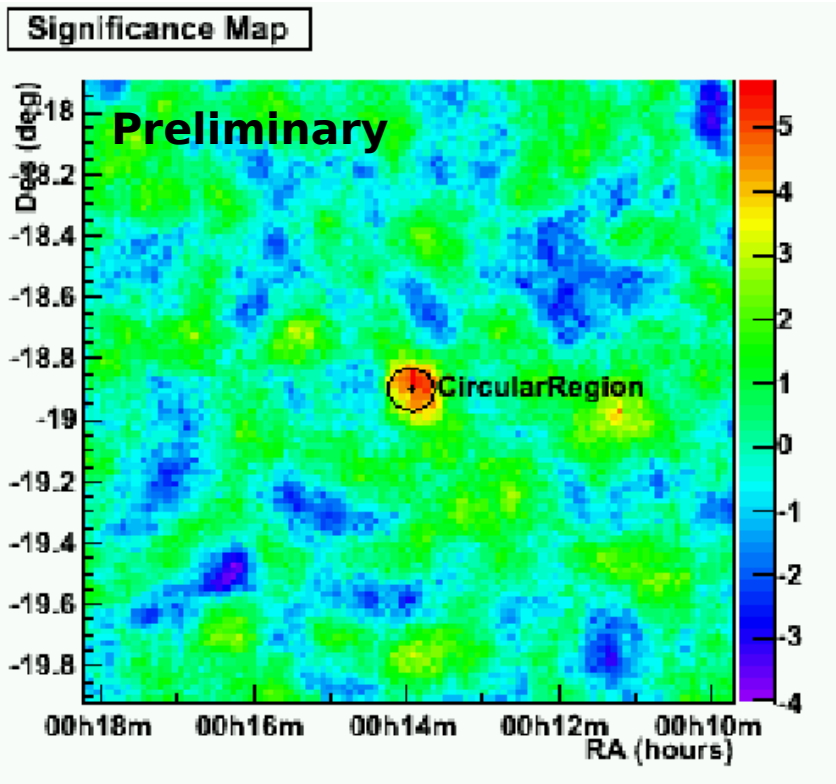
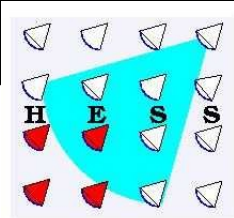
SED

Synchrotron peak ~ 0.1 keV
VHE peak above few TeV

Fermi + H.E.S.S. de-absorbed $\Gamma \sim 1.8$
 $\rightarrow$ problem with a standard one-zone SSC scenario, due to Klein-Nishina

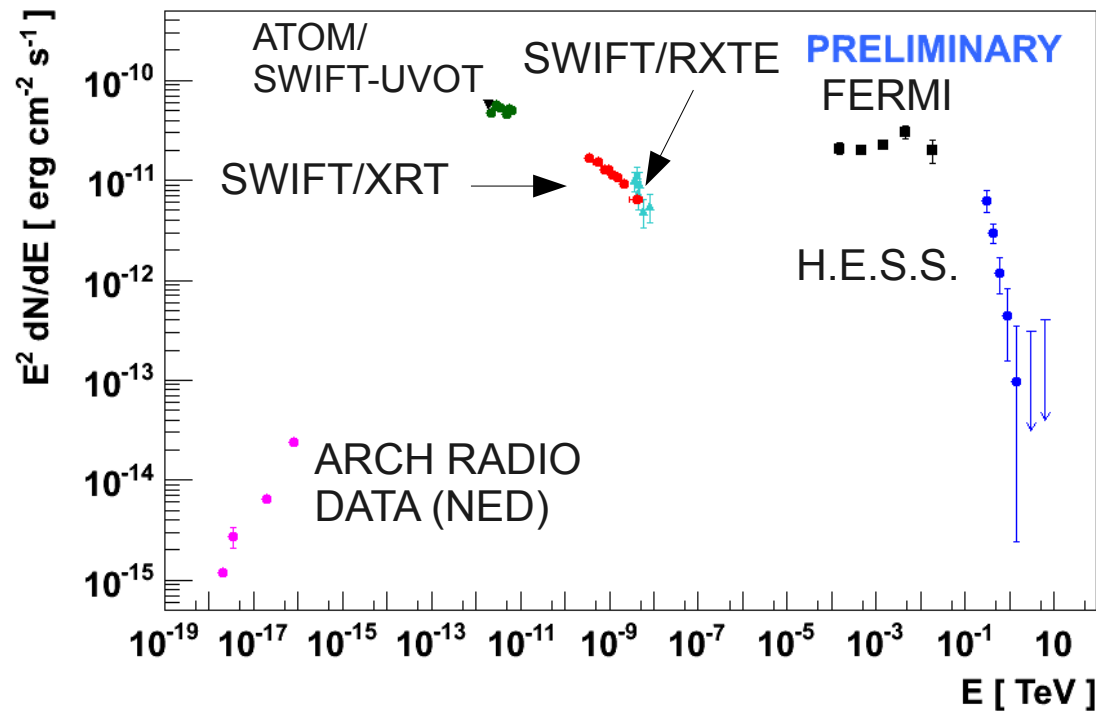
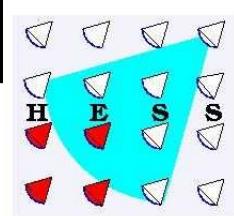
Imposing the Thomson conditions,
high values of $\delta > 200$, $B < 0.002$ G
or large emitting region
($R \sim 10^{17}$ cm, typ. size $R \sim 10^{16}$ cm)





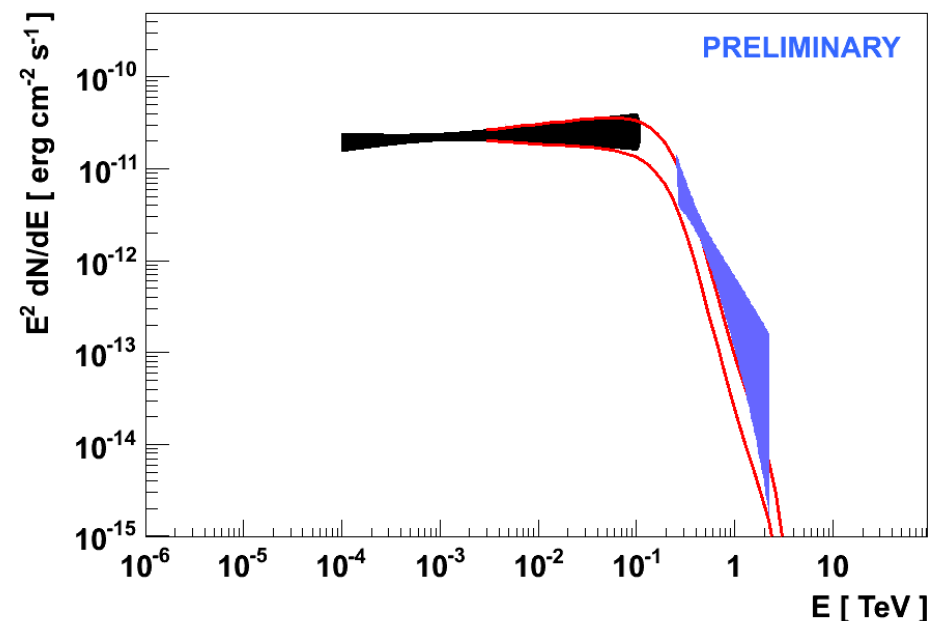
- Source present in ROSAT All Sky Surv. Catalogue (RASSBSC) of soft (0.1-2 keV) sources (Voges et al.)
- NRAO VLA Sky Survey (NVSS) catalogue of radio sources at 1.4 GHz (Condon et al. 1998)
- Selected from a list of extremely high F_x/F_r targets in the Sedentary HBL catalogue (Giommi et al., 2005)
- Discovered at VHE by H.E.S.S. $> 5 \sigma$ in 38 hours livetime (between July 2008 and August 2010) ATel #3007, 5 Nov 2010
- Flux: $\sim 1\%$ Crab Nebula
- Not present in the Fermi BSL (Abdo et al., 2010)
- No significant variability seen in optical (ATOM on H.E.S.S. site)
- GeV emission seen with a 7σ significance by Fermi subsequent to H.E.S.S. detection (ATel #3023, 8 Nov 2010)

PKS 0447-439 (z=?)

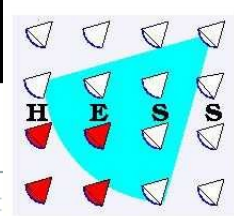


- One of the brightest sources in Fermi BSL
- H.E.S.S. discovery at 13.8σ in 13.5 hours livetime
- Announced in ATel #2350, 16 Dec 2009
- 4.5% Crab Nebula above 250 GeV
- Flares seen in SWIFT data
- No detectable variability in H.E.S.S. data

- Redshift not well-known
Perlman et al (1998) $z \sim 0.205$
Landt & Bignall (2008) lower limit $z > 0.176$
- Fermi extrapolated spectrum is absorbed (Franceschini et al, 2009) with increasing values of redshift $\rightarrow$ upper limit of $z = 0.5$ at 95% conf. level

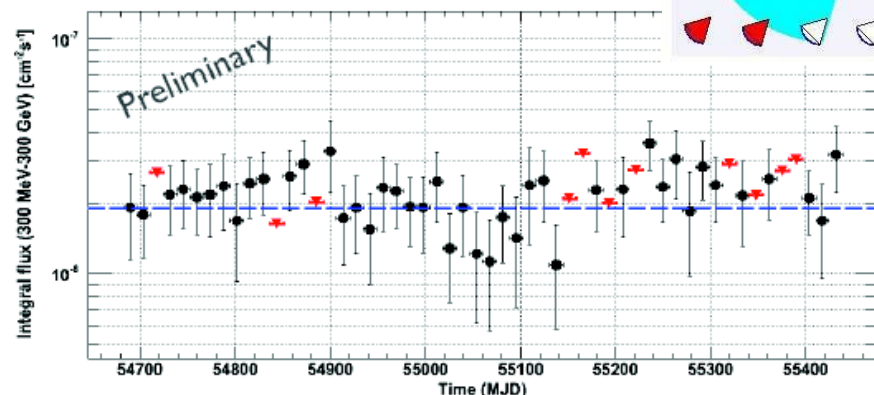


AP Lib (z=0.049)



- Source in Fermi Bright Source List (BSL) with $\Gamma \sim 2$
→ targeted for H.E.S.S. observations
- H.E.S.S. discovery at $\sim 7 \sigma$ in 11 hours livetime (ATel #2743, 17 Jul 2010)
- 2% Crab Nebula

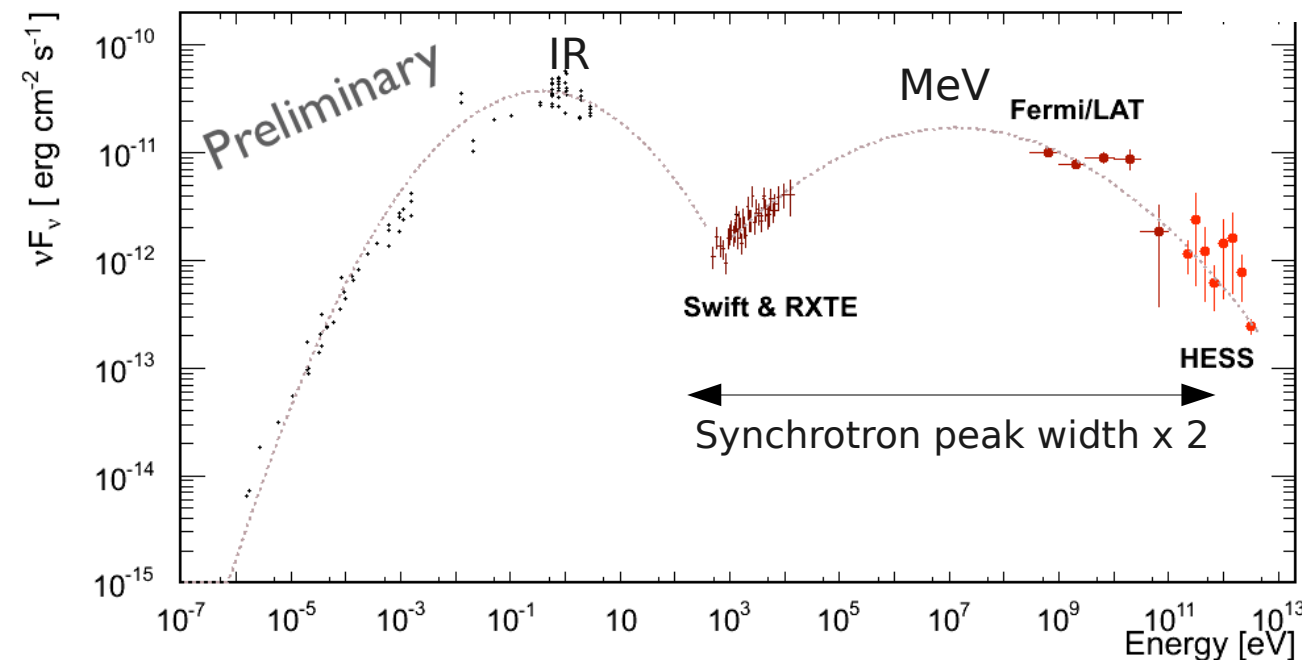
From SED → source classified as an LBL



H.E.S.S. spectrum $\Gamma \sim 2.5$ compatible with absorbed Fermi extrapolation for the source redshift

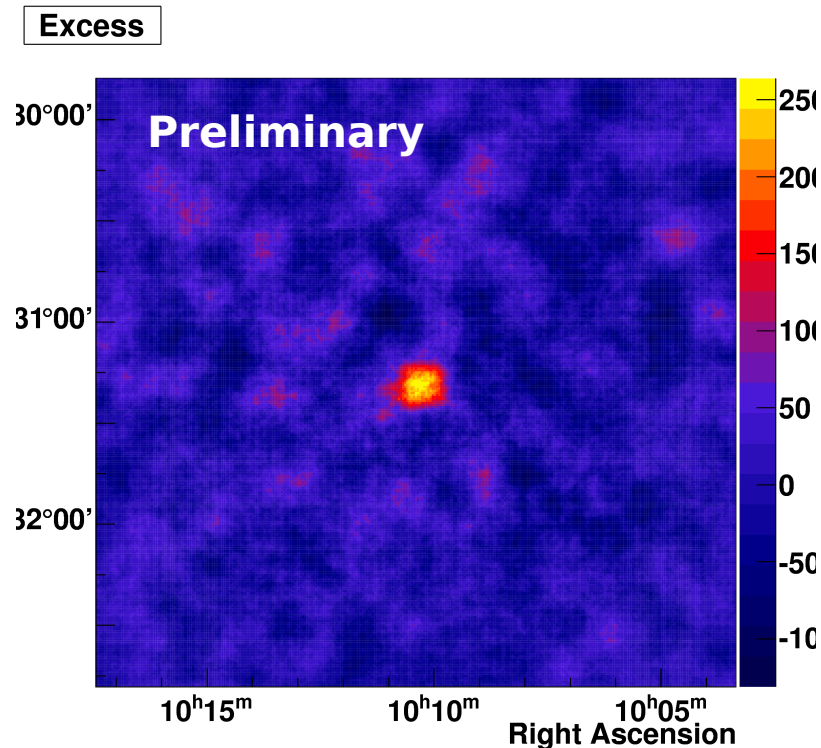
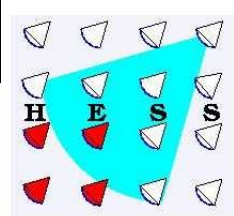
X-ray observations by Swift show a hard energy spectrum (Tavecchio et al., 2010)

Unusually broad high energy component stretching from X-rays to VHE γ -rays.

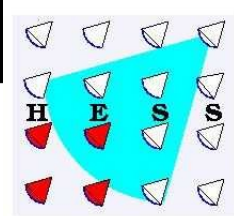


→ Synchrotron X-ray brightness is not required to produce copious amount of VHE γ -rays
External Compton component maybe responsible for VHE emission.

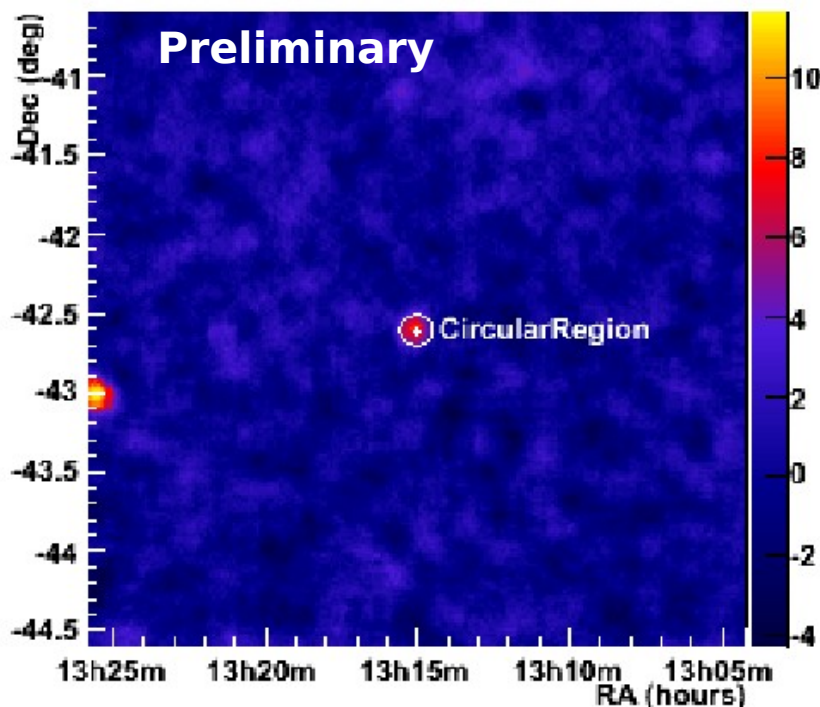
Other LBLs : BL Lacertae and S5 0716+714



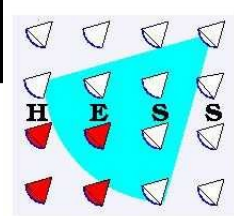
- Source present in ROSAT All Sky Survey Catalogue (RASSBSC) of soft (0.1-2 keV) sources (Voges et al.)
- NRAO VLA Sky Survey (NVSS) catalogue of radio sources at 1.4 GHz (Condon et al. 1998)
- Selected from a list of extremely high F_x/F_r targets in the Sedentary HBL catalogue and Costamante & Ghisellini (2002) criterion
- Observed by H.E.S.S. between 2007 and 2010
- Not present in the Fermi BSL (Abdo et al., 2010)
- Discovery after 33 hours good livetime → 7.2 σ , 233 γ -rays
- Flux $\sim$ 2.5% Crab Nebula



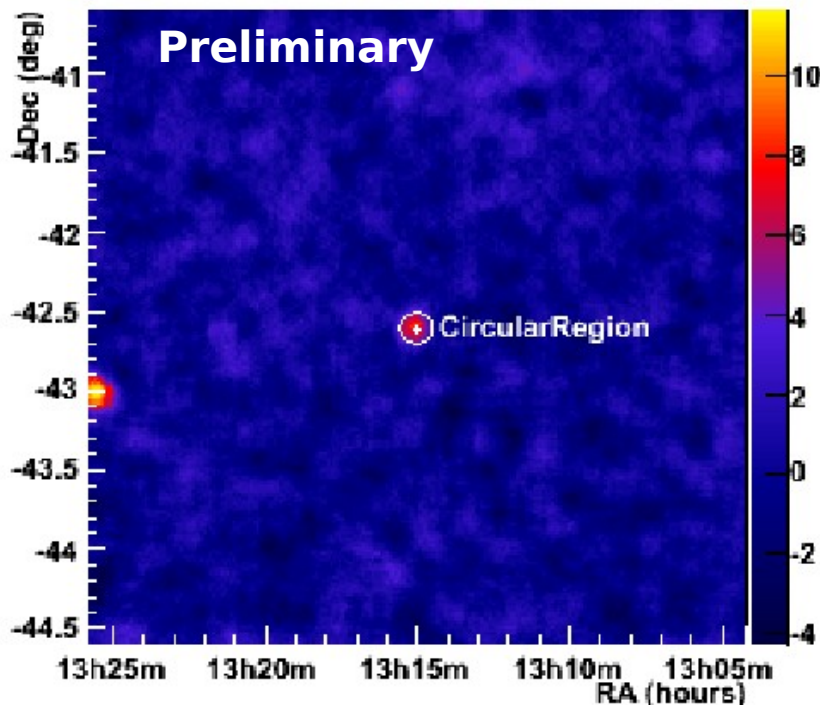
Significance Map



- Einstein Slew Survey Sample (Perlman et al. 1996)
- ROSAT Sky Survey Sample (Voges et al., 1999)
- BeppoSAX (Beckmann et al., 2002)
- No variability seen
- Stecker et al. 1996 :
 - Simple SSC model
→ Low redshift X-ray BL Lacs
should have VHE counterpart
 - Good candidate for VHE γ -ray astronomy
- Not present in the Fermi BSL (Abdo et al., 2010)

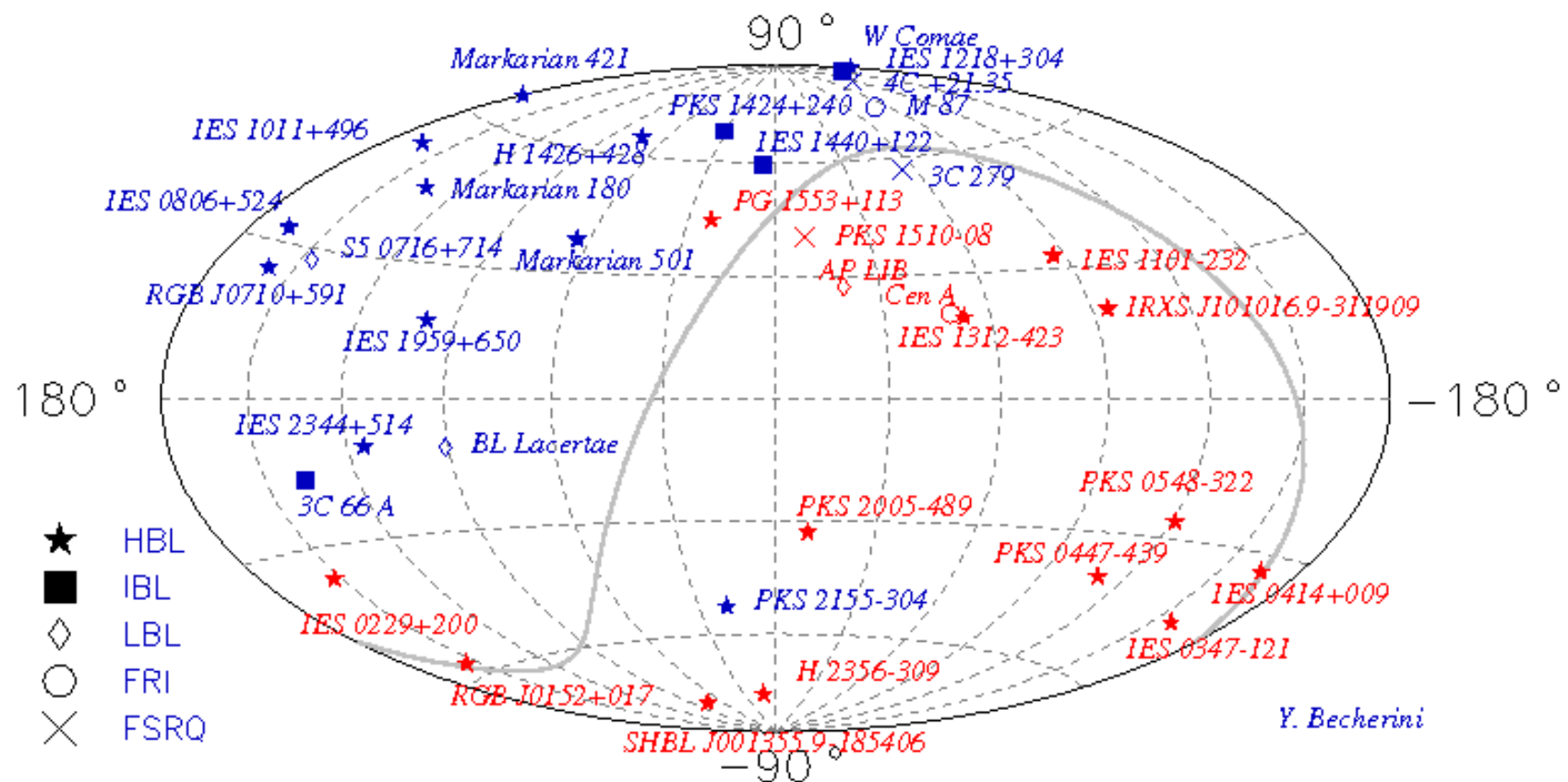


Significance Map



- In the same FoV of as Centaurus A, which was already discovered by H.E.S.S. (Aharonian et al., 2009)
- Cen A flux $\sim 0.8\%$ of the Crab Nebula, large data set available for the FoV
- Data set useful to perform a dedicated analysis on the source, which sits at $\sim 2^\circ$ from Cen A.
- H.E.S.S. discovers the VHE emission from 1ES 1312-423 with a 6.8σ significance in 168 hours of observation (~ 65.7 hours equivalent corrected by radial acceptance)
- Flux $\sim 0.4\%$ of the Crab Nebula
- H.E.S.S. enriches the catalogue of weakest-ever γ -ray sources
- Preliminary studies show no detectable variability, confirming what is seen in other wavelengths

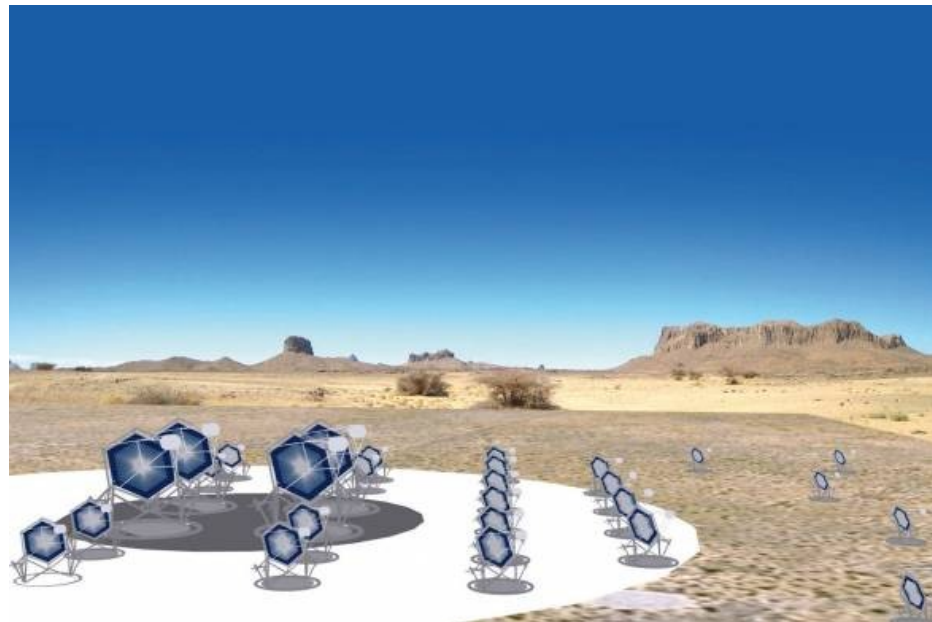
Le ciel extra-galactique au TeV



En attendant les nouveaux instruments, H.E.S.S. enrichit le catalogue des sources exclusivement par analyse.

Application de « Paris-MVA » Au Cherenkov Telescope Array : Gain en Sensibilité

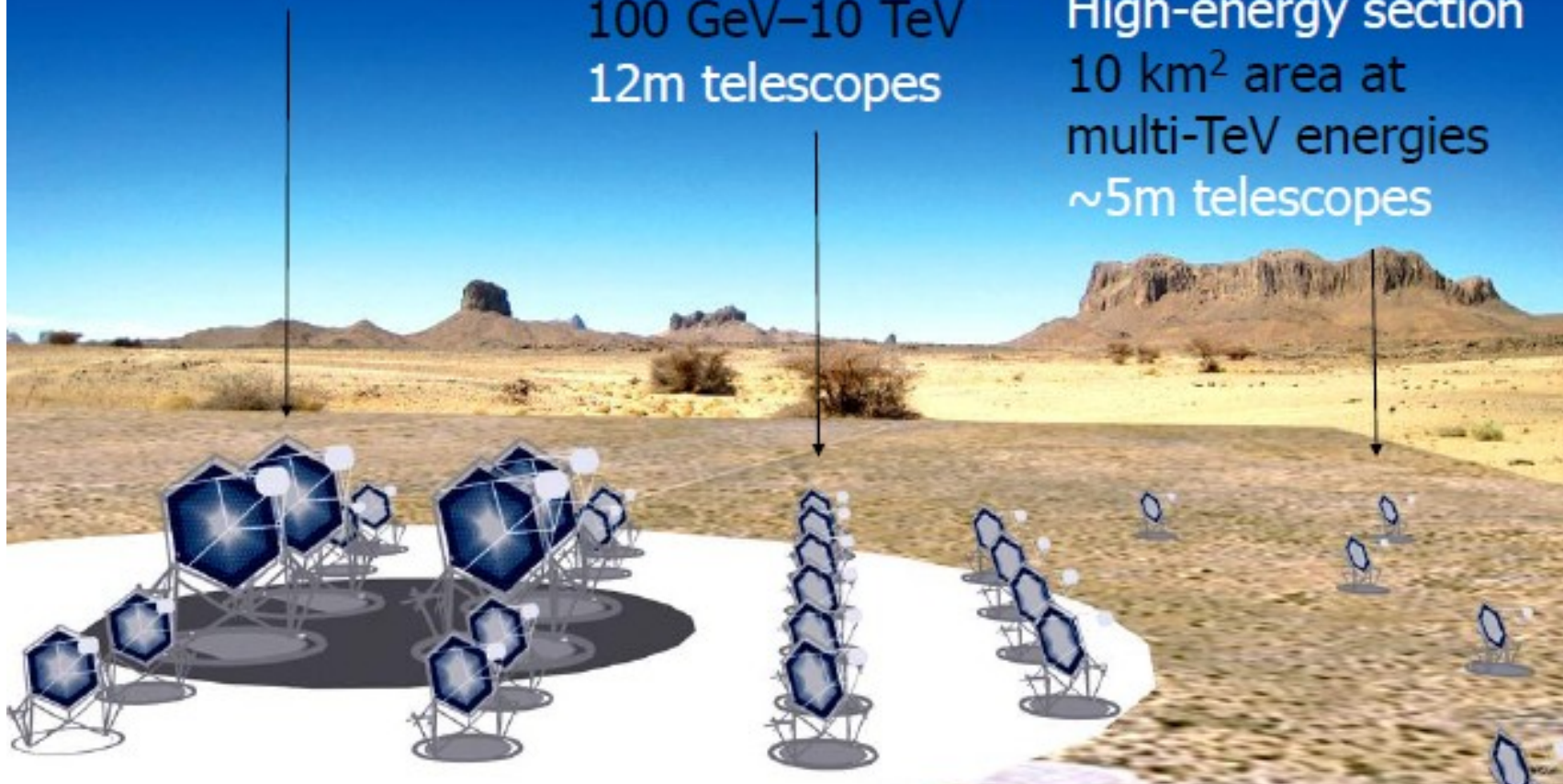
Meeting CTA Oxford,
Novembre 2010



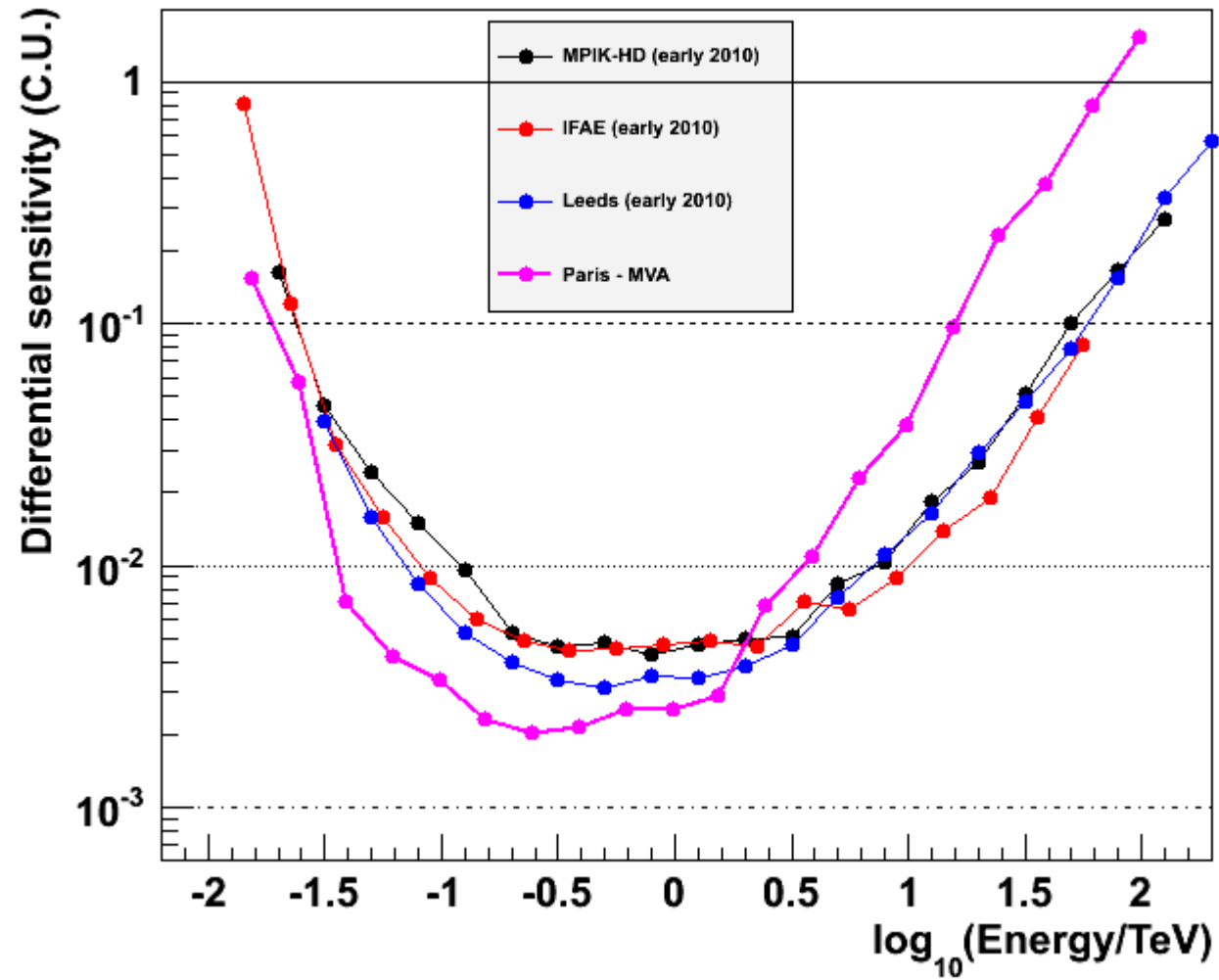
Low-energy section
energy threshold
of 20-30 GeV
~24m telescopes

Medium Energies:
mCrab sensitivity
100 GeV–10 TeV
12m telescopes

High-energy section
10 km² area at
multi-TeV energies
~5m telescopes

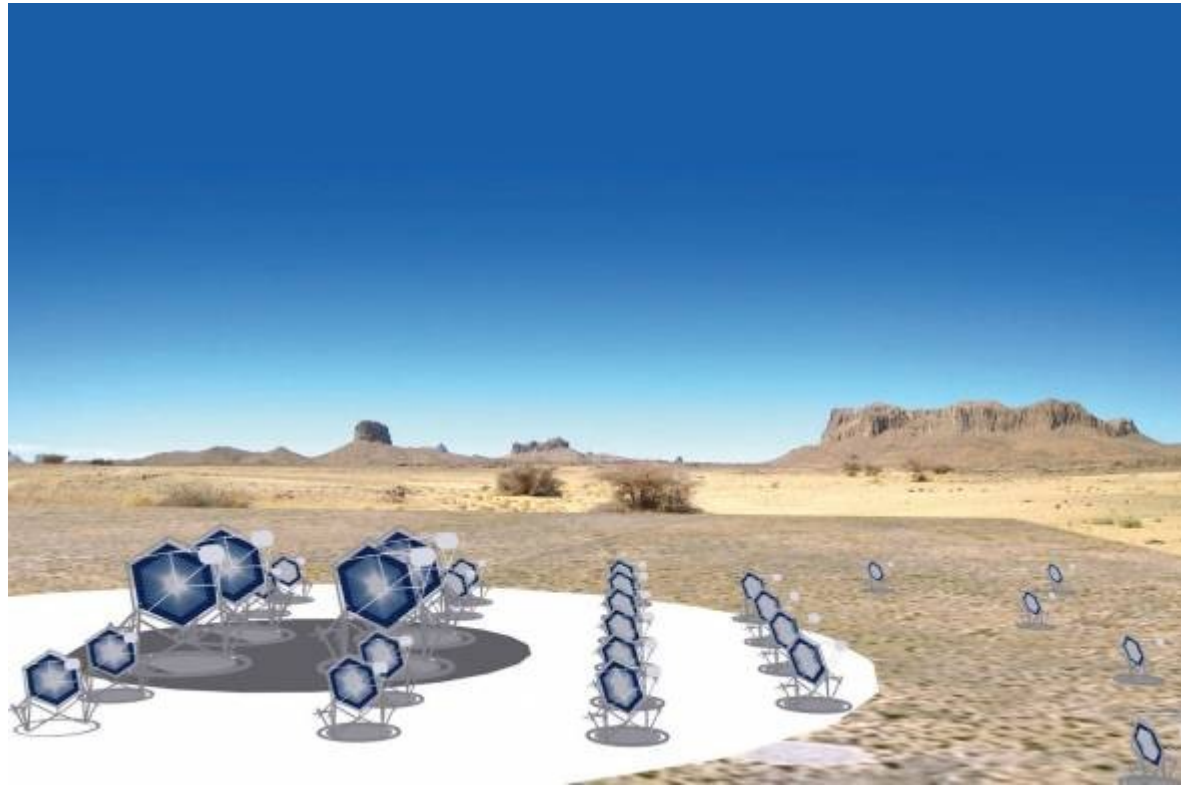


Sensitivity for array 'E'



Conclusions

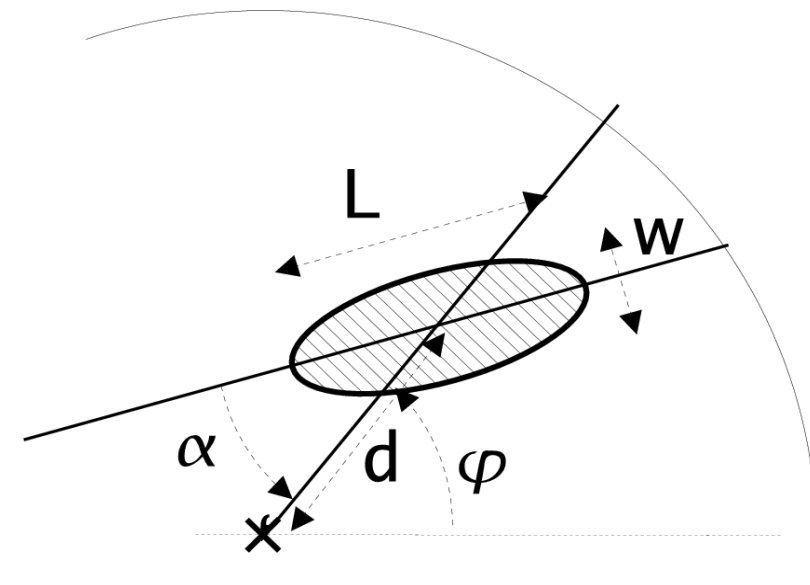
- Pourquoi une nouvelle stratégie d'analyse pour les réseaux Tcherenkov atmosphériques ?
 - L'analyse « Paris-MVA » : structure, performance
 - Analyse des sources extra-galactiques dans H.E.S.S.
 - Application de l'analyse à un réseau candidat de CTA
- Astronomie gamma VHE
 - Magnifique passé
 - Brillant présent
 - Futur plein de surprises



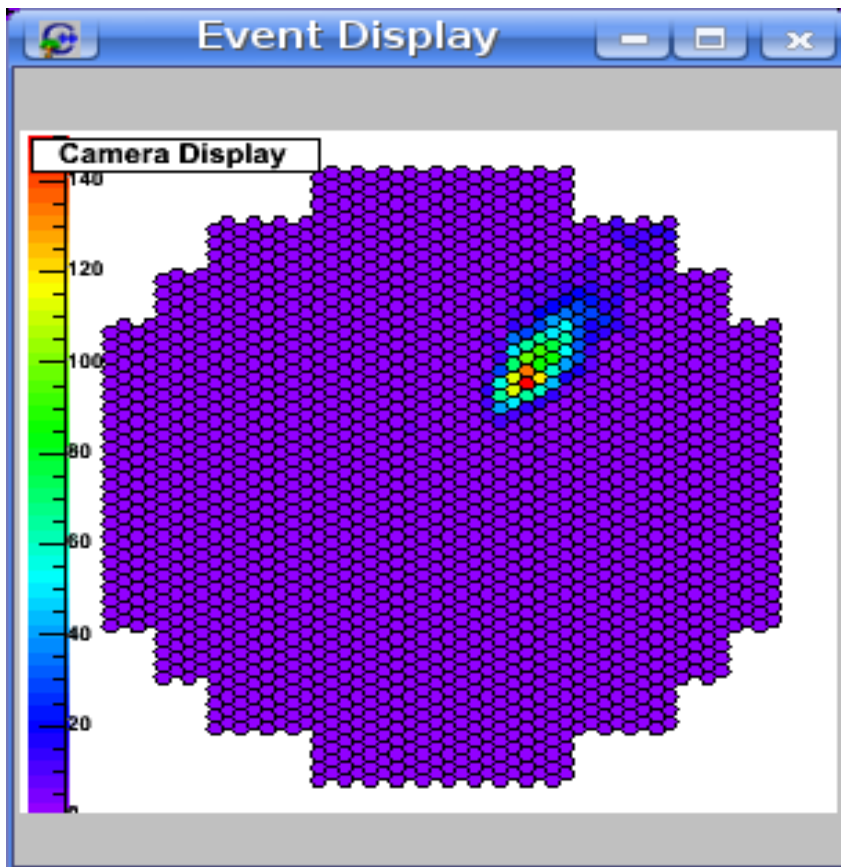
Merci pour votre attention

A preliminary estimate of the performance at low energy [30-100 GeV]

- Simulations with 100% efficiency in the H.E.S.S. telescopes
- From stereo back to MONO !!
- Low energy single telescope reconstruction:
1 electron for every 1 GeV at shower max.
- Images at 30 GeV → only few pixels available
- As soon as a even a small image is present in a second small telescope → turn on the stereo reconstruction (more efficient)

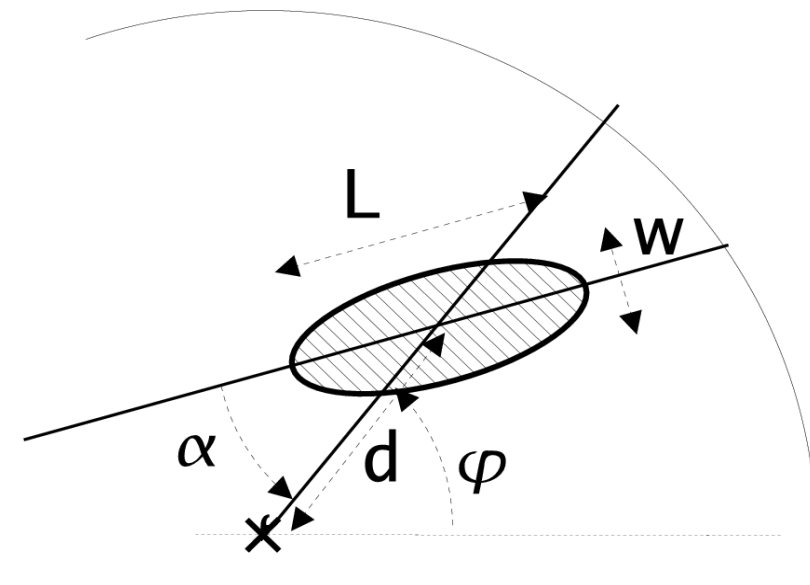


- “Hillas” based analysis on the events hitting the HESS-II telescope only
- The image given by a γ has an elliptical shape
- No stereoscopy = no direct geometrical source position estimate
 - Estimate of the source position (via parametrisation or NN) and calculation of the shower kinematic parameters
- No timing yet (in this analysis)

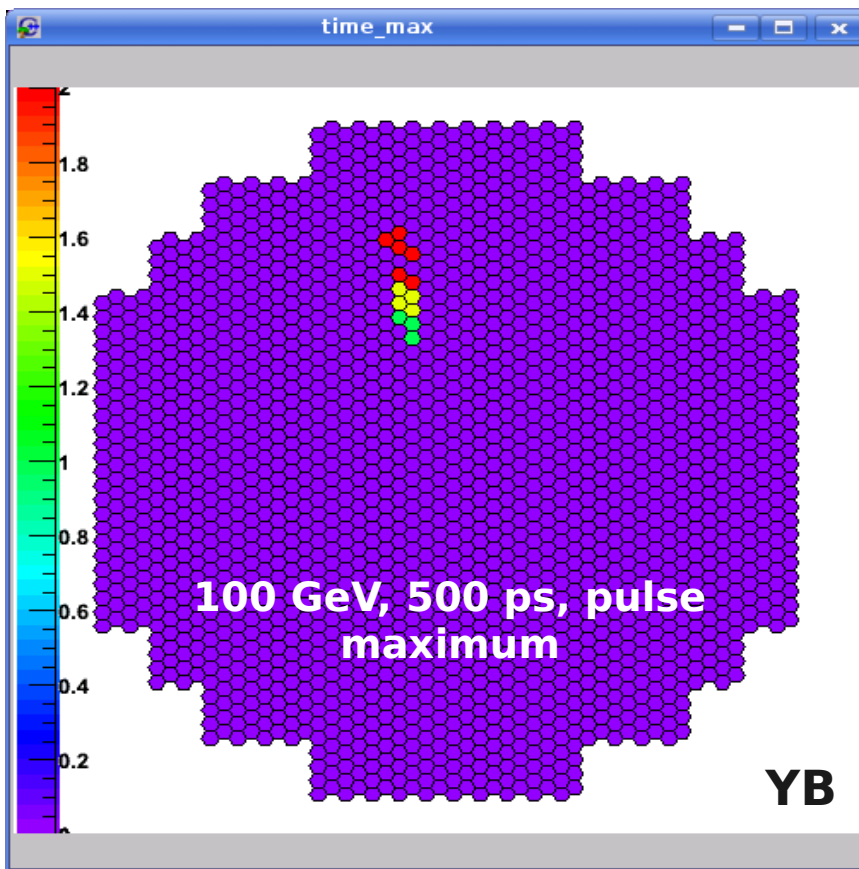


A preliminary estimate of the performance at low energy [30-100 GeV]

- Simulations with 100% efficiency in the H.E.S.S. telescopes
- From stereo back to MONO !!
- Low energy single telescope reconstruction: 1 electron for every 1 GeV at shower max.
- Images at 30 GeV → only few pixels available
- As soon as a even a small image is present in a second small telescope → turn on the stereo reconstruction (more efficient)



- “Hillas” based analysis on the events hitting the HESS-II telescope only
- The image given by a γ has an elliptical shape
- No stereoscopy = no direct geometrical source position estimate
 - Estimate of the source position (via parametrisation or NN) and calculation of the shower kinematic parameters
- No timing yet (in this analysis)



Analysis cuts for the analysis in the [30-100 GeV] range

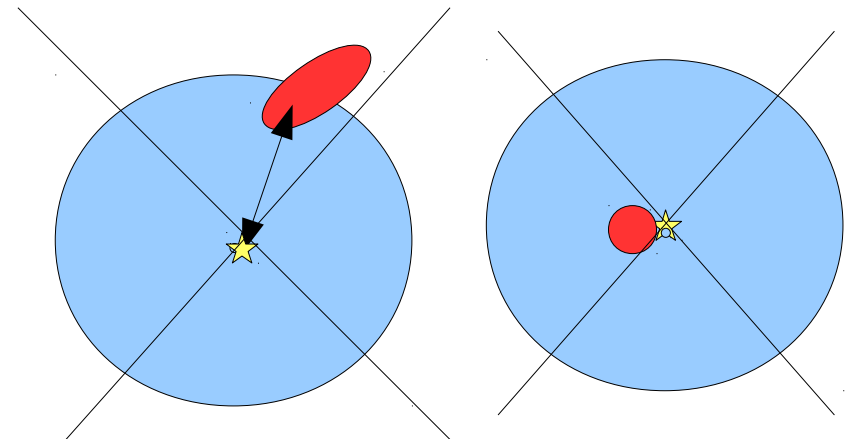
- Hadron rejection cut with Fisher algorithm in TMVA (more MVA algorithms are being tested by the analysis WG)
 - Input: nominal distance, Hillas length & width, total charge in the event



CUT : Fisher response > 0.1

Currently 70% efficiency on signal, 18% on bkg

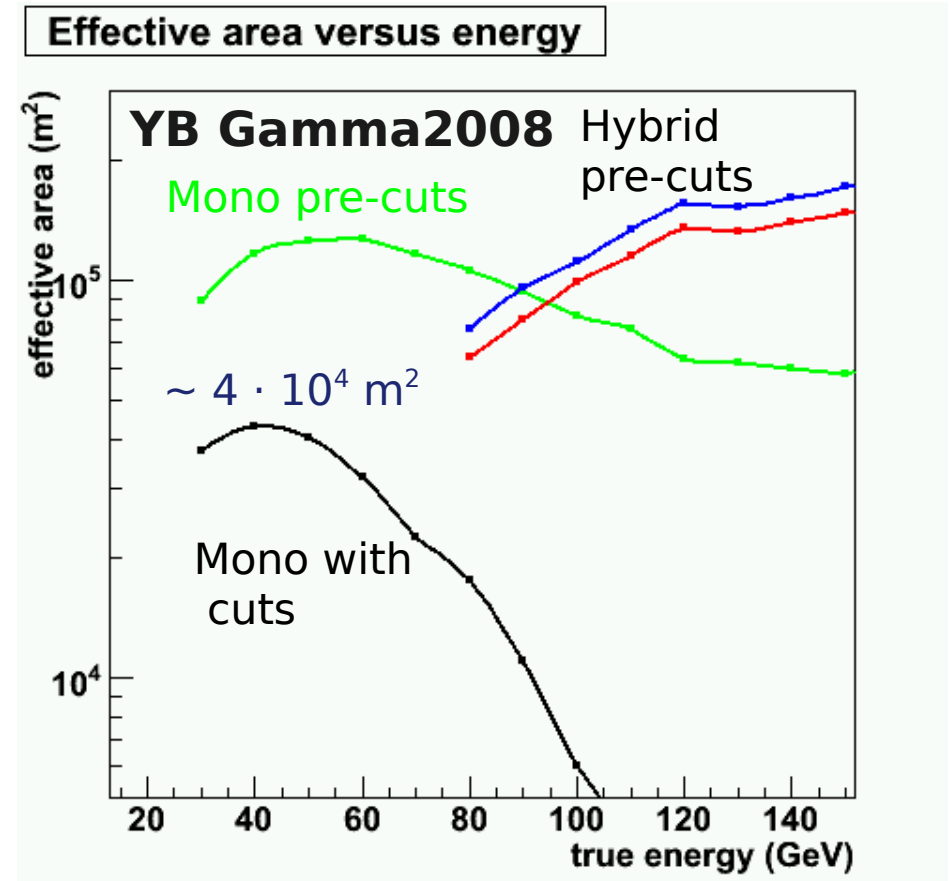
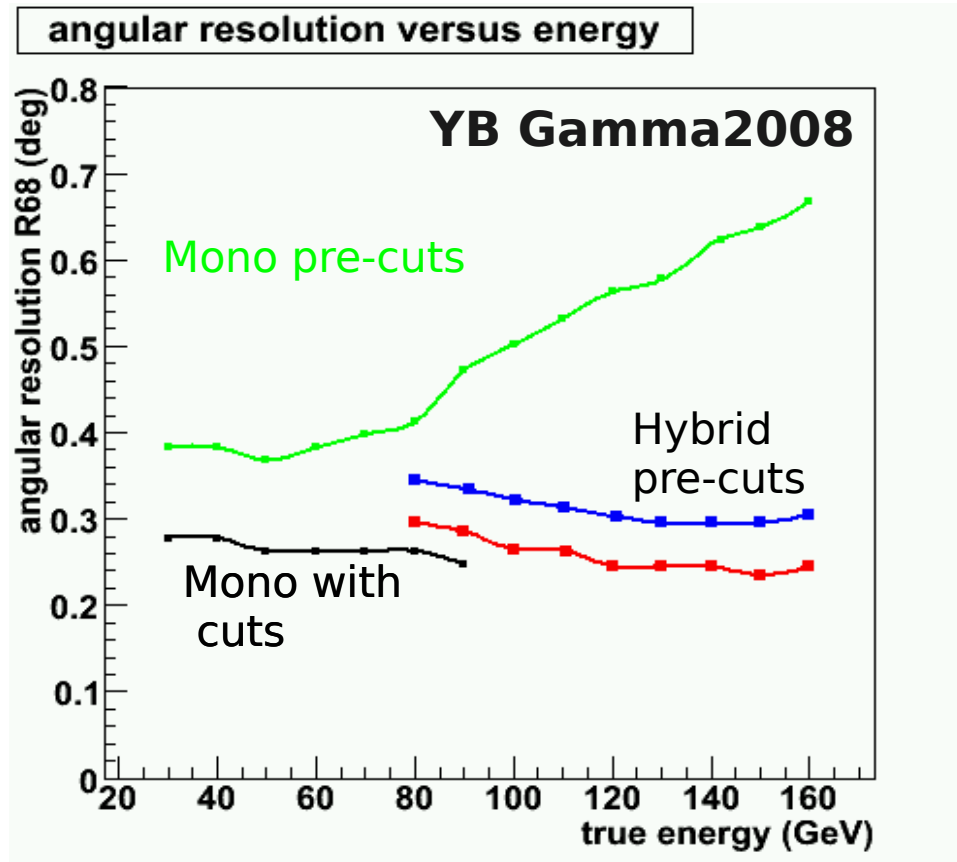
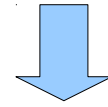
- Image shape cut
 - Reject events at the border of the camera or too close to the source direction (round images)



$0.45^\circ < \text{Nominal distance} < 1^\circ$

Expected preliminary mono-telescope performance

- **Angular resolution** between 0.28° and 0.24° as a function of the energy
- Additional cut on the angular resolution
 - $\Theta^2 < 0.13 \text{ deg}^2$



- Energy estimate through Neural Networks :
 - the **energy resolution** varies from 40% to 10% as a function of the energy,
 - the **bias** spans from +40% to -40% (further work needed!)