

# Latest Results from H.E.S.S. Observations of Blazars

A. Djannati-Ataï

for the H.E.S.S. Collaboration

APC

CNRS/University of Paris 7

1<sup>st</sup> GLAST Symposium

Stanford Feb 2007

# Outline

- HESS AGN Program
- HESS BL Lacs
- EBL implications
- Three new Blazars “discovered” by H.E.S.S.
- Historical “Big” flare of PKS2155-304

# *HESS AGN Program*

## **Goals**

- Discover new sources !
- Measure their VHE  $\gamma$ -ray properties :
  - spectra, short term and long term variability
- Launch MWL campaigns: broad-band SEDs
- Model the source !
- Constrain EBL in the  $\sim[0.5-10] \mu\text{m}$

# HESS AGN Program

## Observations

~300 hrs per year for AGN program ( $\frac{1}{4}$  of total observing time)

~300 hrs in 2003

~400 hrs in 2004

~300 hrs in 2005

~400 hrs in 2006

Focus: Monitor known VHE AGN, observe candidate objects, MWL studies

Initially observe ~10 hrs on a target (~1.5% Crab flux sensitivity)

Then increase to ~50 hrs if something interesting is seen!

# VHE AGN: Where did we stand

Object	Redshift	Type	1 <sup>st</sup> Detection	H.E.S.S. Reference
<b>M 87</b>	0.004	FR I	HEGRA	Science, 314, 1424, 2006
<b>Mkn 421</b>	0.030	HBL	Whipple*	A&A, 437, 95, 2005
Mkn 501	0.034	HBL	Whipple*	---
1ES 2344+514	0.044	HBL	Whipple*	---
Mkn 180	0.046	HBL	<b>MAGIC</b>	---
1ES 1959+650	0.047	HBL	7-Tel. Array*	---
<b>PKS 2005-489</b>	0.071	HBL	<b>H.E.S.S.</b>	A&A, 436, L17, 2005
<b>PG 1553+113</b>	>0.09	HBL	<b>H.E.S.S.</b>	A&A, 448, L19, 2006
<b>PKS 2155-304</b>	0.116	HBL	Mark VI	A&A, 430, 865, 2005
H 1426+428	0.129	HBL	Whipple*	---
<b>H 2356-309</b>	0.165	HBL	<b>H.E.S.S.</b>	Nature, 440, 1018, 2006
1ES 1218+304	0.182	HBL	<b>MAGIC</b>	---
<b>1ES 1101-232</b>	0.186	HBL	<b>H.E.S.S.</b>	Nature, 440, 1018, 2006

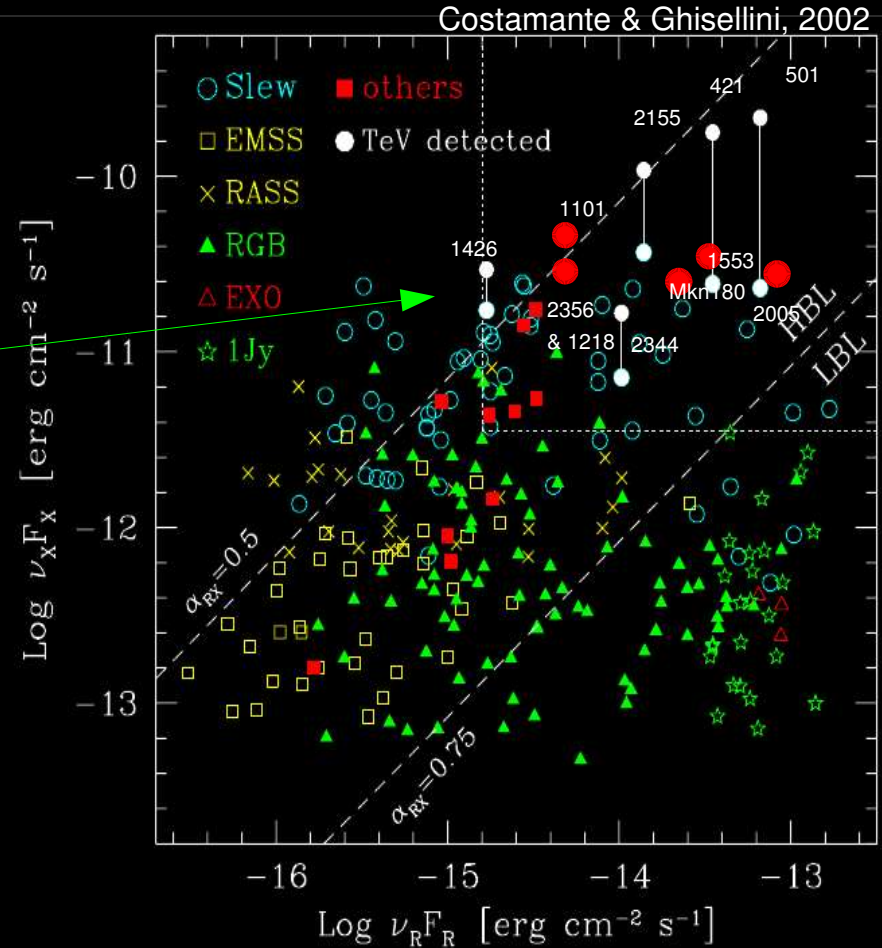
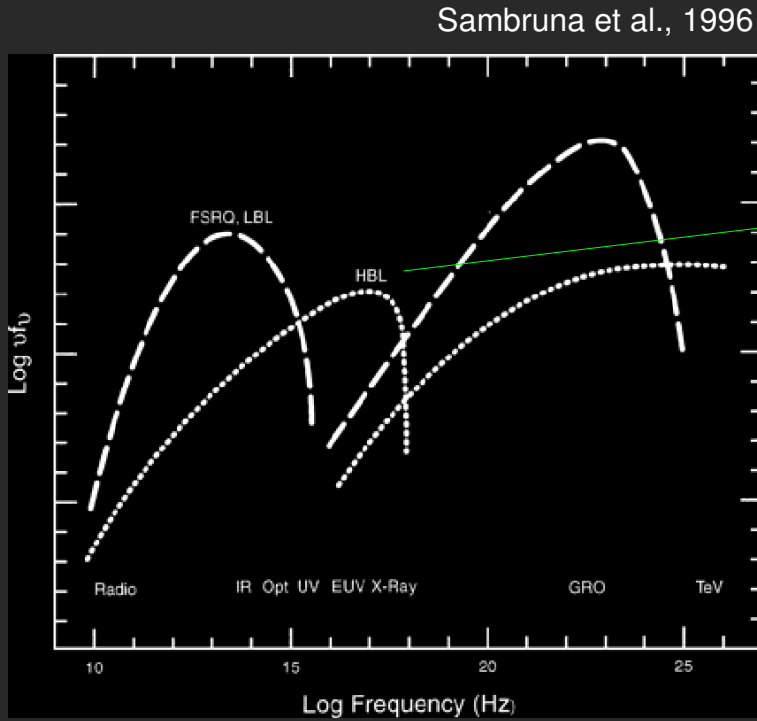
# VHE AGN: Where do we stand as of Feb 2007

Object	Redshift	Type	1 <sup>st</sup> Detection	H.E.S.S. Reference
<b>M 87</b>	0.004	FR I	HEGRA	Science, 314, 1424, 2006
<b>Mkn 421</b>	0.030	HBL	Whipple*	A&A, 437, 95, 2005
Mkn 501	0.034	HBL	Whipple*	---
1ES 2344+514	0.044	HBL	Whipple*	---
Mkn 180	0.046	HBL	<b>MAGIC</b>	---
1ES 1959+650	0.047	HBL	7-Tel. Array*	---
→ <b>PKS 0548-322</b>	0.069	HBL	<b>H.E.S.S.</b>	<b>in preparation</b>
<b>PKS 2005-489</b>	0.071	HBL	<b>H.E.S.S.</b>	A&A, 436, L17, 2005
<b>PG 1553+113</b>	>0.09	HBL	<b>H.E.S.S.</b>	A&A, 448, L19, 2006
<b>PKS 2155-304</b>	0.116	HBL	Mark VI	A&A, 430, 865, 2005
H 1426+428	0.129	HBL	Whipple*	---
→ <b>1ES 0229+200</b>	0.139	HBL	<b>H.E.S.S.</b>	<b>in preparation</b>
<b>H 2356-309</b>	0.165	HBL	<b>H.E.S.S.</b>	Nature, 440, 1018, 2006
1ES 1218+304	0.182	HBL	<b>MAGIC</b>	---
<b>1ES 1101-232</b>	0.186	HBL	<b>H.E.S.S.</b>	Nature, 440, 1018, 2006
→ <b>1ES 0347-121</b>	0.188	HBL	<b>H.E.S.S.</b>	<b>in preparation</b>

HESS has detected 10 AGN at VHE energies:

7 are “discoveries” 2 are 1<sup>st</sup> confirmation of “weak” detections

# VHE Blazars : HBLs



All VHE blazars are HBL

But there exists at least another type of VHE emitting AGN: M87

# HESS BL Lacs

2 objects with  $>100\sigma$

PKS 2155-304 & Mkn 421

3 objects with  $>10\sigma$

1ES 1101-232, H 2356-309,

PKS 2005-489

1 object with “Evidence for”

$4.0\sigma$  on PG 1553+113

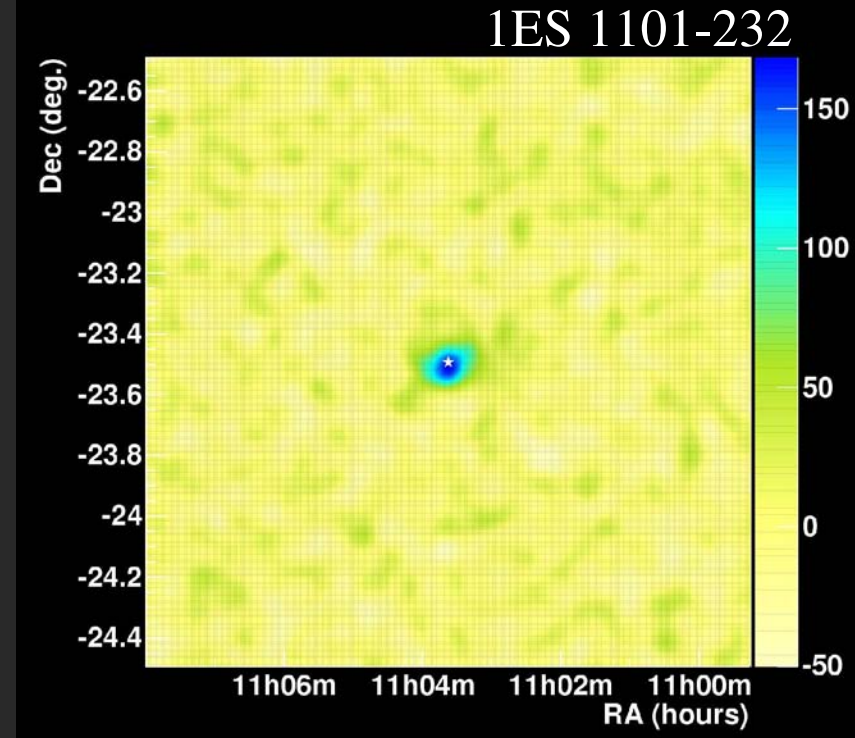
$>10\sigma$  including 2006 obs.

All seen in multiple epochs

PKS 2155-304: 2002-2006

PG 1553 in 2005 & 2006

Others: 2004-2006



HESS BL Lac fluxes are low!

**Average Observed Flux for H.E.S.S. BL Lacs:**

- PKS 2155-304: **~15% Crab** above 200 GeV
- PKS 2005-489: **~2.5% Crab** above 200 GeV
- 1ES 1101-232: **~2% Crab** above 200 GeV
- H 2356-309: **~2% Crab** above 200 GeV
- PG 1553+113: **~2% Crab** above 200 GeV
  - 1 Crab above 200 GeV =  $2.3 \times 10^{-10} \text{ cm}^{-2}$



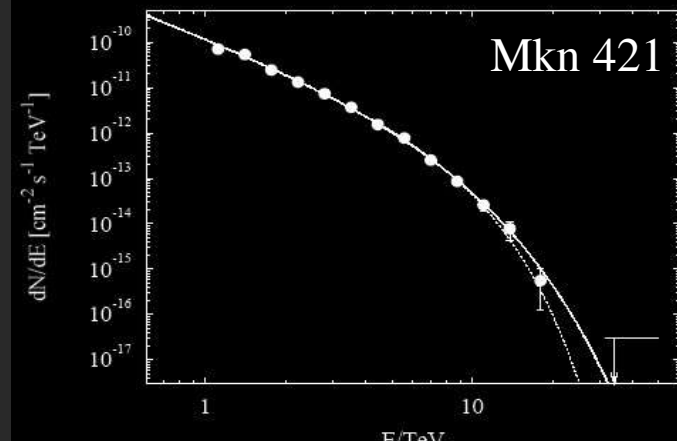
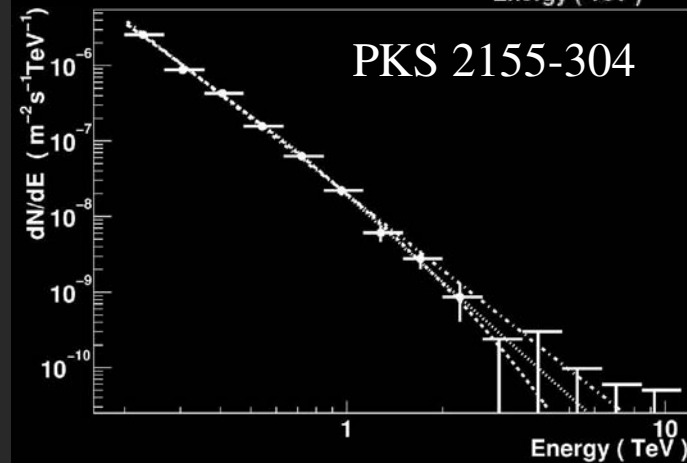
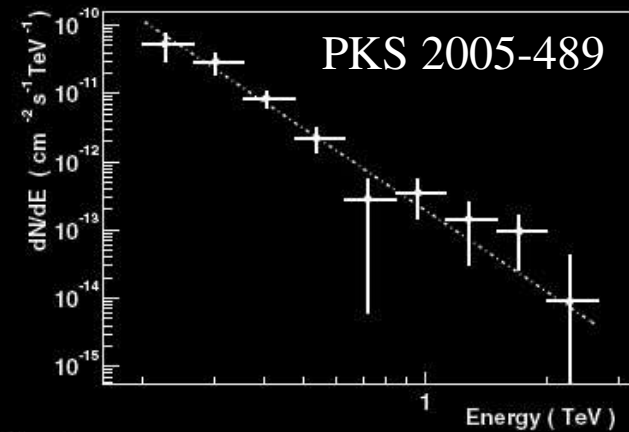
# HESS BL Lacs' Spectra

Most spectra follow a pure power-law

- with no features:  $dN/dE \sim E^{-\Gamma}$

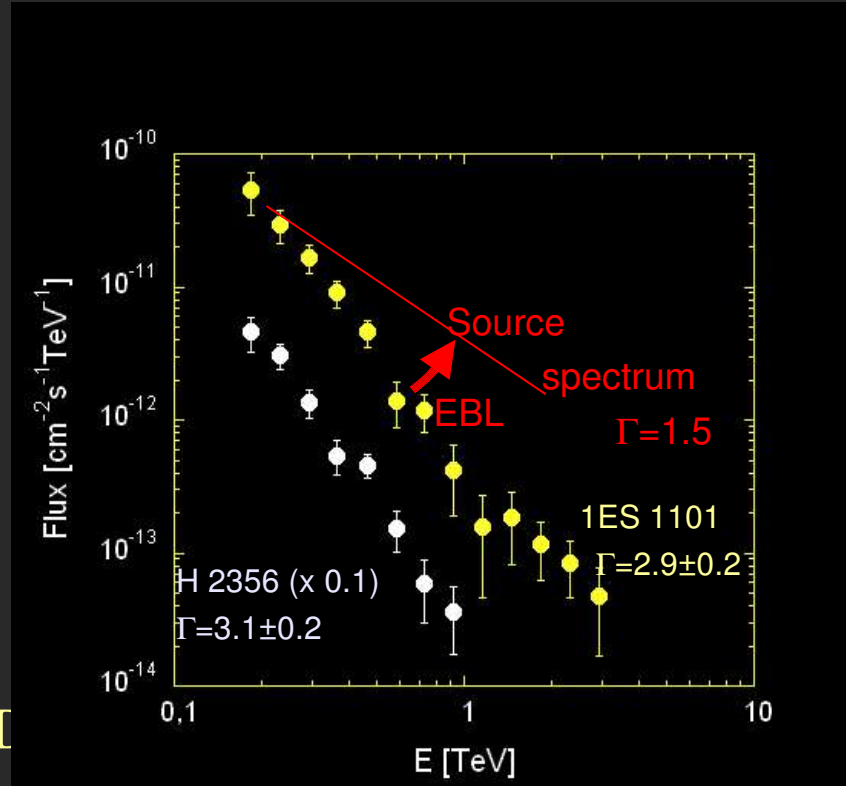
Soft spectra measured for all the H.E.S.S.  
BL Lacs:

- 1ES 1101-232:  $\Gamma = 2.88 \pm 0.17$
- H 2356-309:  $\Gamma = 3.06 \pm 0.21$
- PKS 2155-304:  $\Gamma = 3.32 \pm 0.06$
- PKS 2005-489:  $\Gamma = 4.0 \pm 0.4$
- PG 1553+113:  $\Gamma = 4.0 \pm 0.6$
- Systematic Error: 0.1
  
- Mkn 421:  $\Gamma = 2.1 \pm 0.1 \pm 0.3$ 
  - $E_{\text{cut}} = 3.1 (+0.5, -0.4) \pm 0.9 \text{ TeV}$



# HESS Implications on EBL

VHE  $\gamma$ -rays absorbed by EBL  
 Absorption increases with E & z  
 Large z => Softer observed spectra

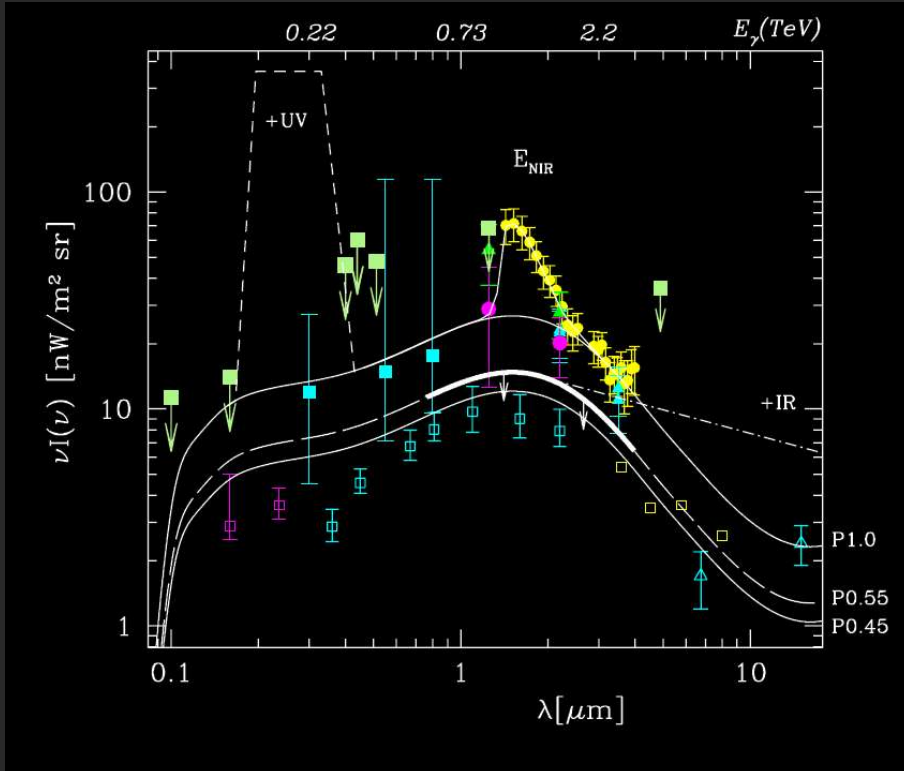


spectrum not harder than  $\Gamma = 1.5$

Within a factor 2 of lower limits

We can see much further in VHE

Nature 440, 1018, 206



# The 3 Discoveries

**PKS 0548-322 ( $z=0.069$ )**

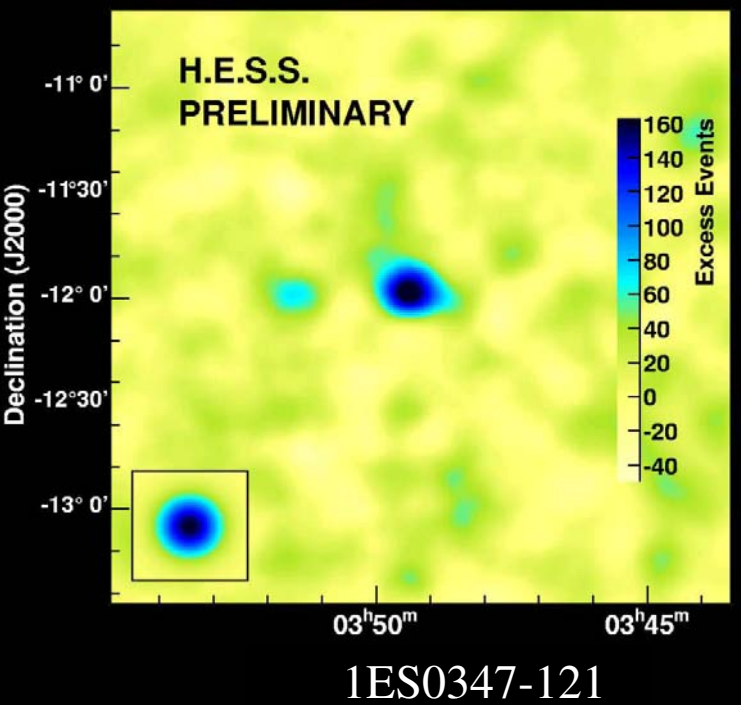
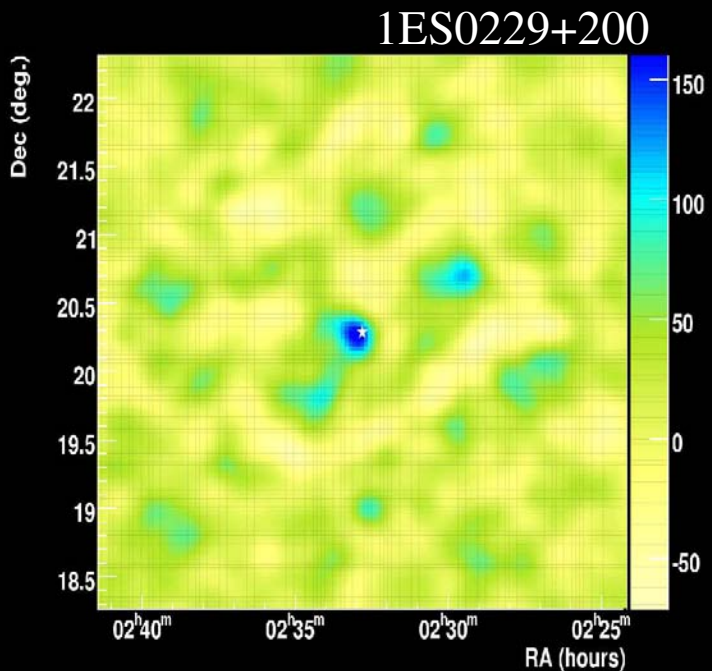
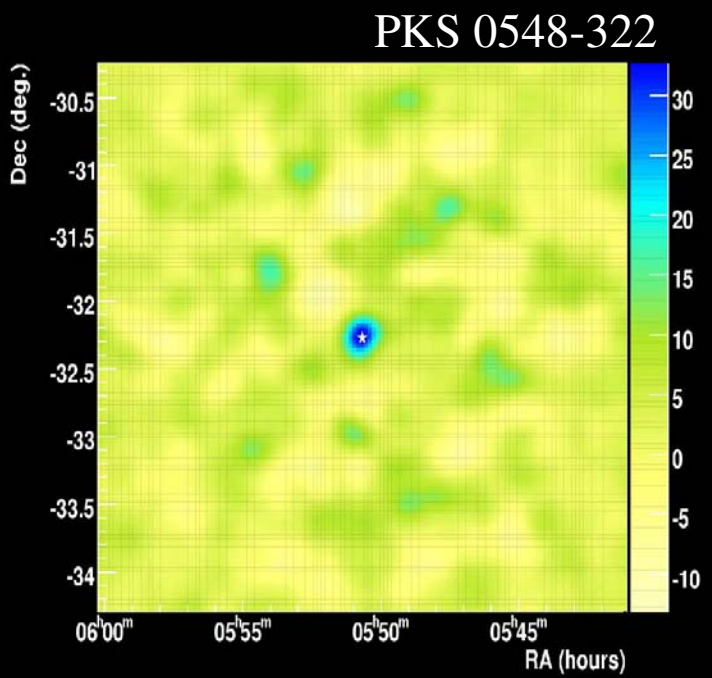
- ~1% Crab above 450 GeV

**1ES 0229+200 ( $z=0.139$ )**

- ~2% Crab above 560 GeV

**1ES 0347-121 ( $z=0.188$ )**

- ~3% Crab above 240 GeV



These  
discoveries  
confirm  
our previous  
EBL  
constraints

# ***HESS Variability Studies***

At last the Big Flare ! PKS2155-304

July-Aug 2006

1 min bins!

Variability time scale  $\geq 90$ s, but statistical assessment to come

# Conclusions

HESS has detected 10 AGN at VHE energies:

7 are “discoveries” 2 are 1<sup>st</sup> confirmation of “weak” detections

HESS BL Lacs : soft spectra, low fluxes at the level of 2% Crab

Stringent EBL limits, confirmed by new detections of  
1ES 0229+200 ( $z=0.139$ ) & 1ES0347-121 ( $z=0.188$ )

Variability at the scale of  $\sim 1$  minute with PKS 2155-304

Many more observations: upper limits