



# Cangaroo VHE Gamma-ray Astronomy

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# World VHE $\gamma$ telescope

## VHE Experimental World

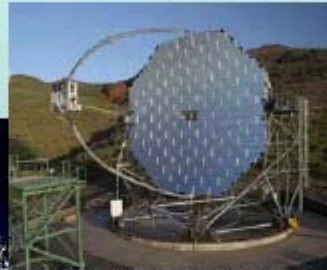
MILAGRO



STACEE



MAGIC



TIBET



MILAGRO

STACEE

MAGIC

TIBET  
ARGO-YBJ

TACTIC

PACT

GRAPES

VERITAS

VERITAS



HESS

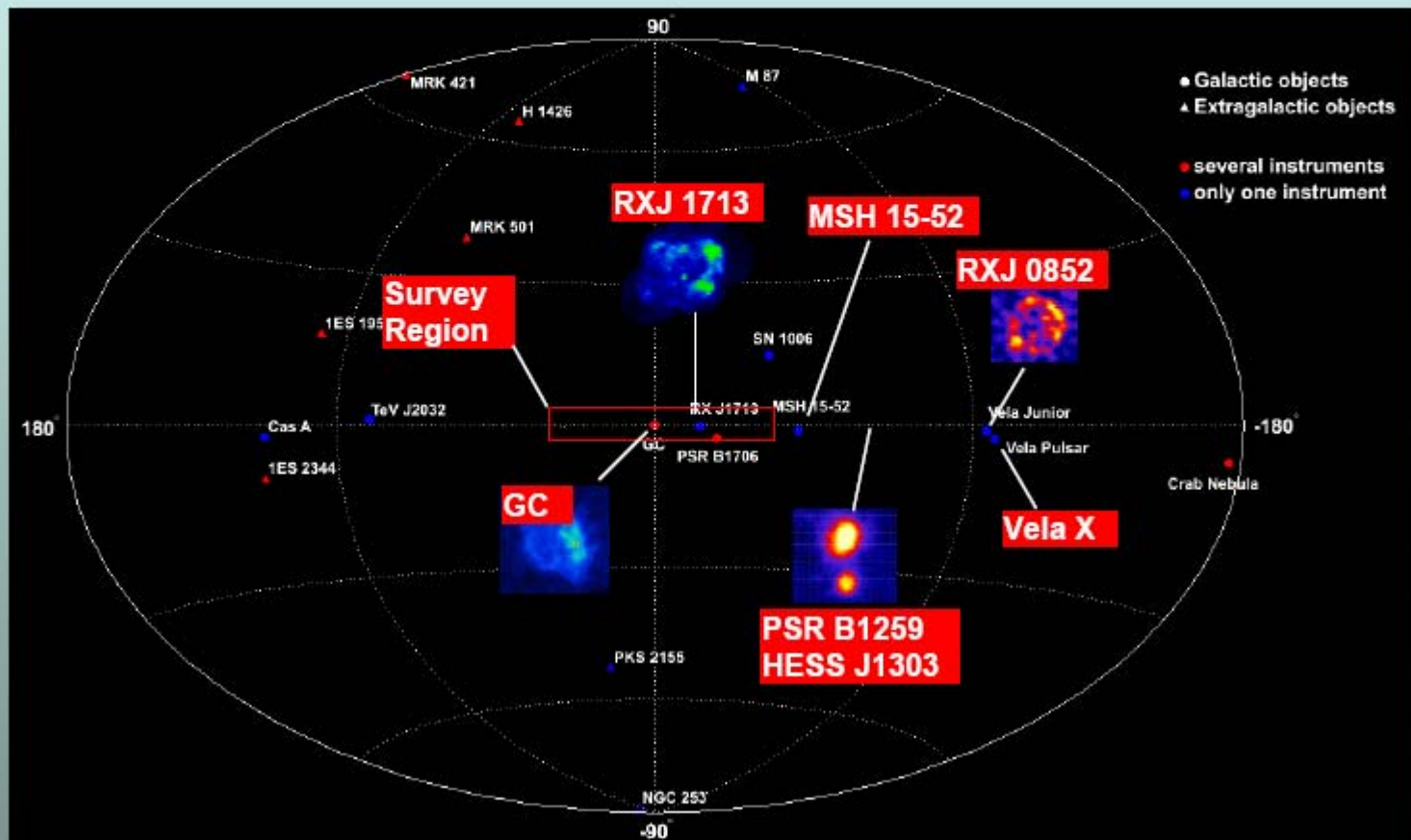
CANGAROO III



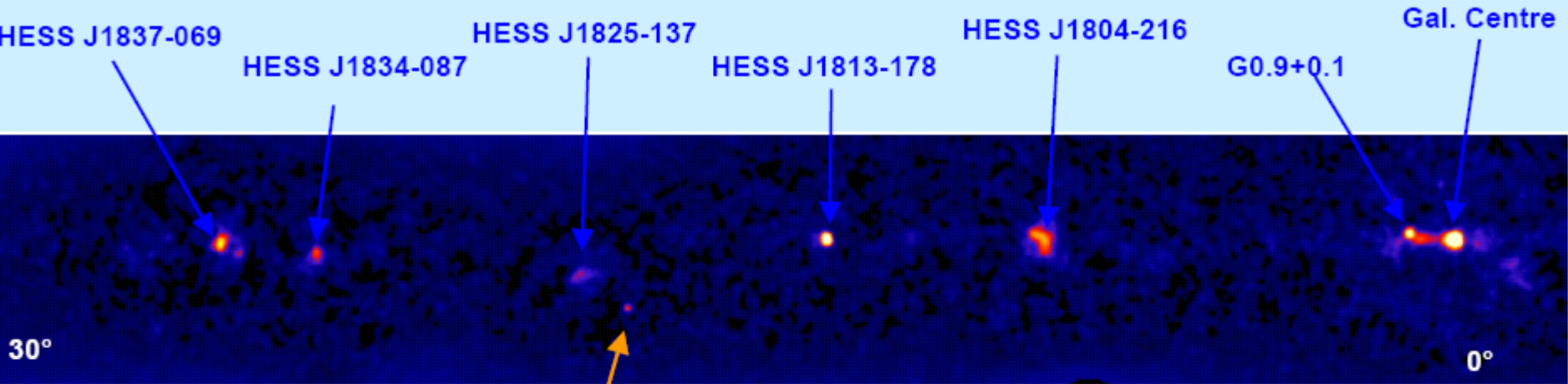
# It's a HESS time!

## HESS Galactic Plane Survey

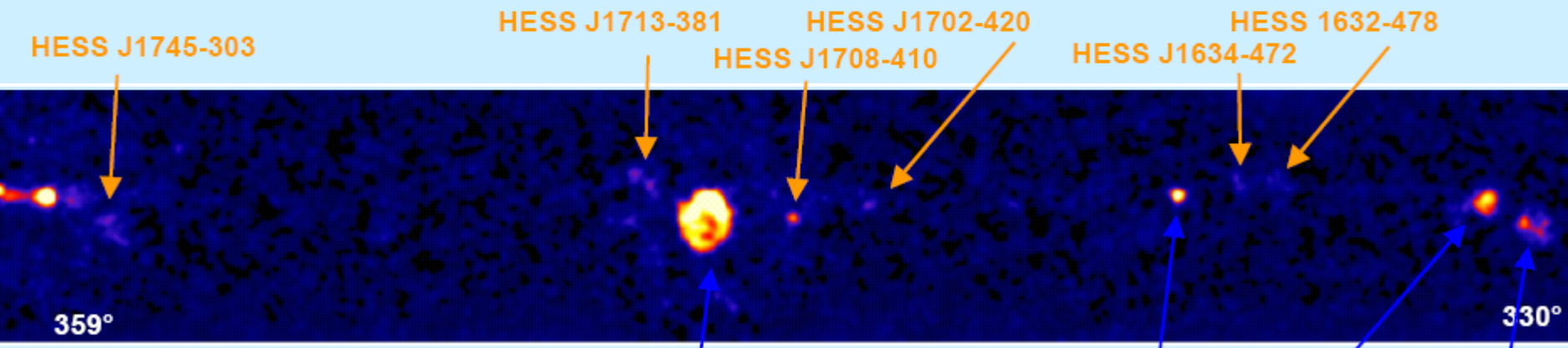
[Funk, Lemiére]



# A plenty of New Sources



LS 5039



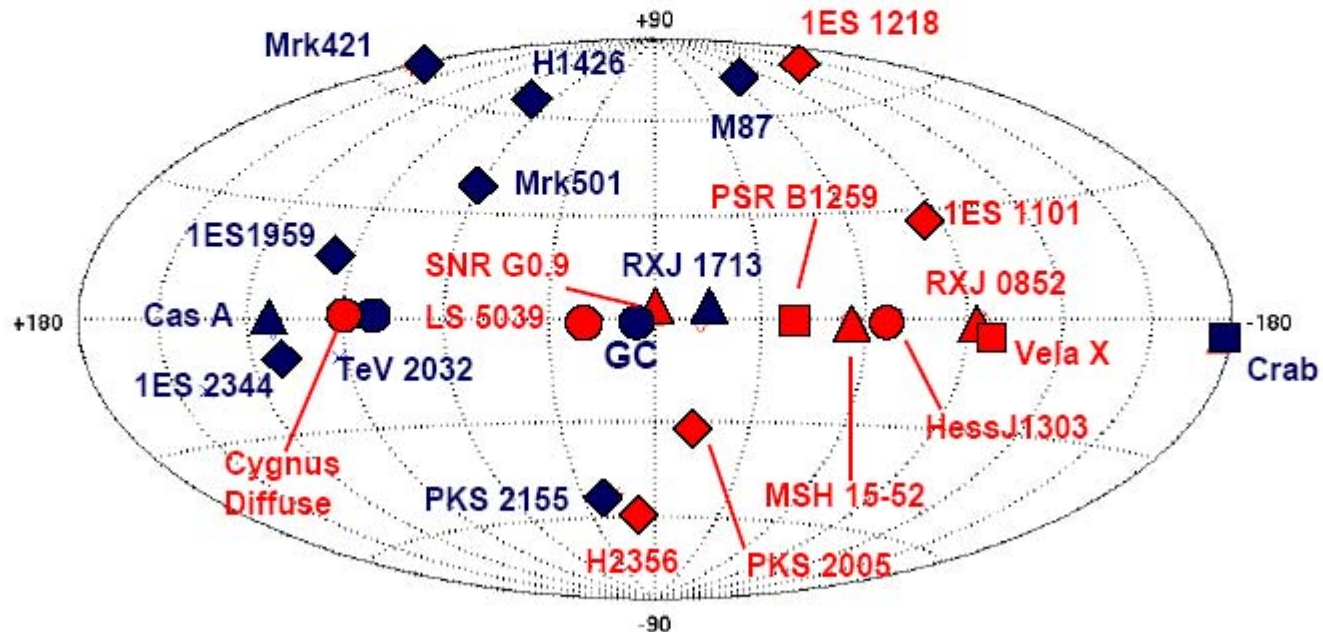
Sources > 6 sigma (9 new, 11 total)  
 Sources > 4 sigma (7 new)



# Sky Map : Call me a "Catalog"

## The VHE Sky - 2005

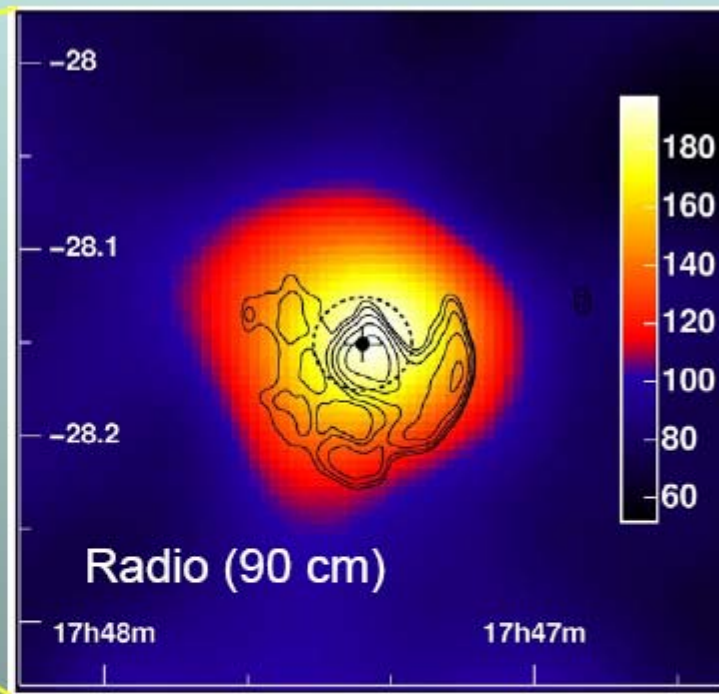
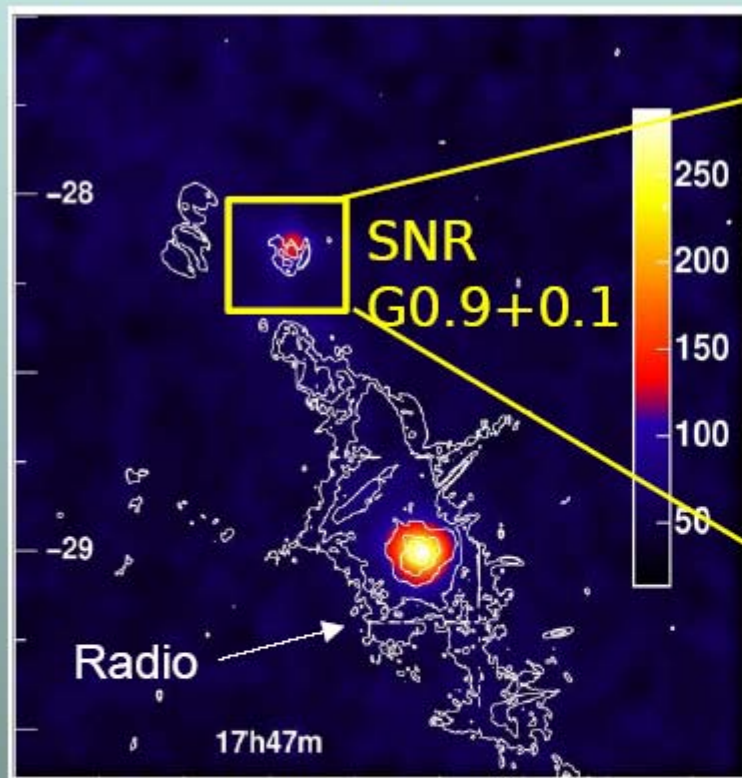
+ 8-15 add. sources  
in galactic plane.



■ Pulsar Nebula      ◆ AGN



# Emission from SNR

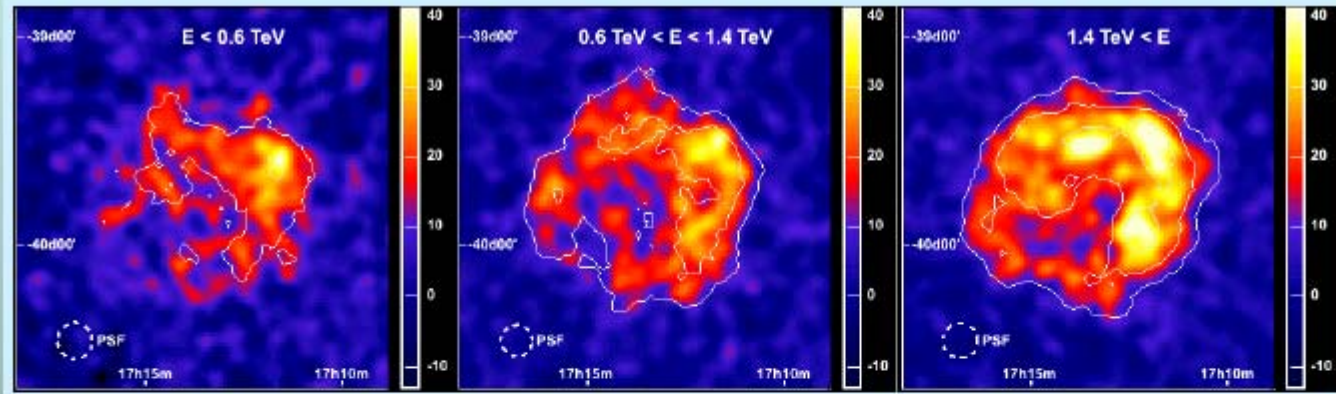


HESS [Khelifi]:  
2004: 50 hrs, 4 Telescopes  
13  $\sigma$

Consistent with pt. source  
at position of pulsar wind.  
(but not SN shell).  
2% Crab flux (50% luminosity).

# VHE Gamma emission site: universal?

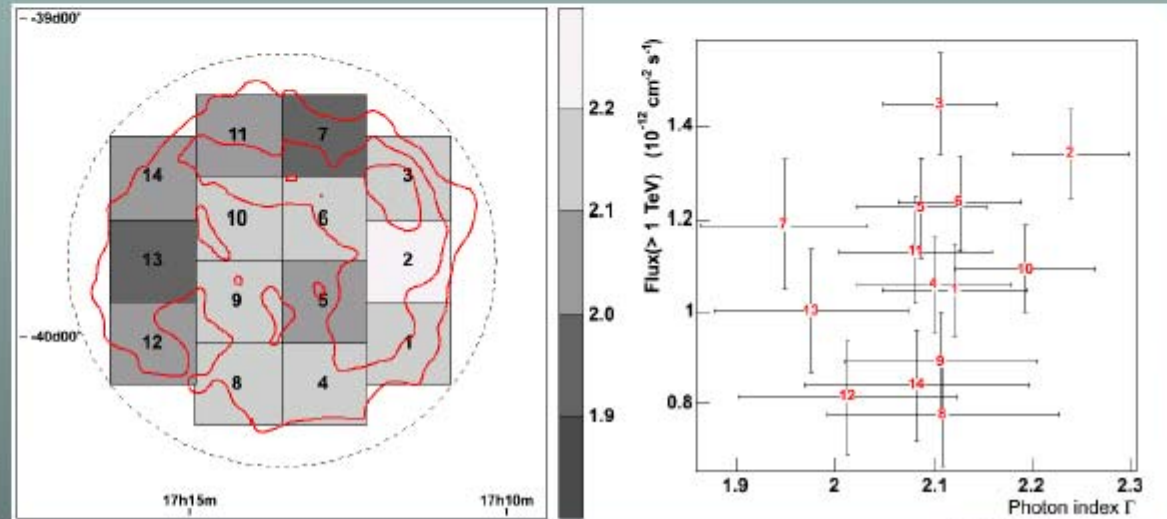
## RXJ1713-394



HESS: Morphology does not change with energy.

Spatially resolved spectra:

Spectra do not appreciably change over remnant !



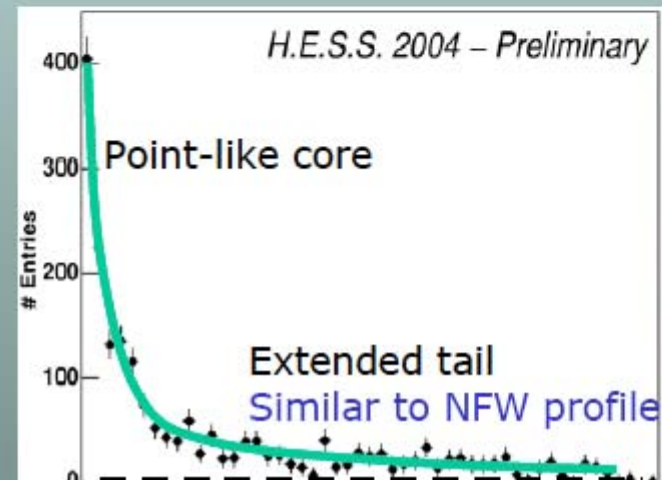
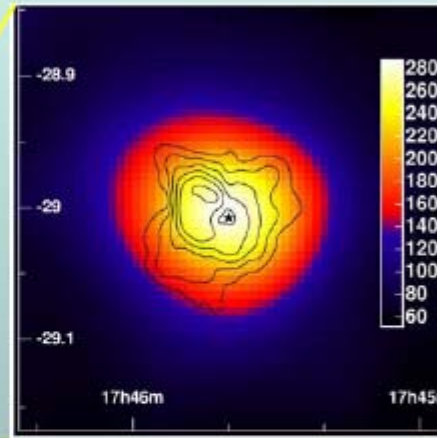
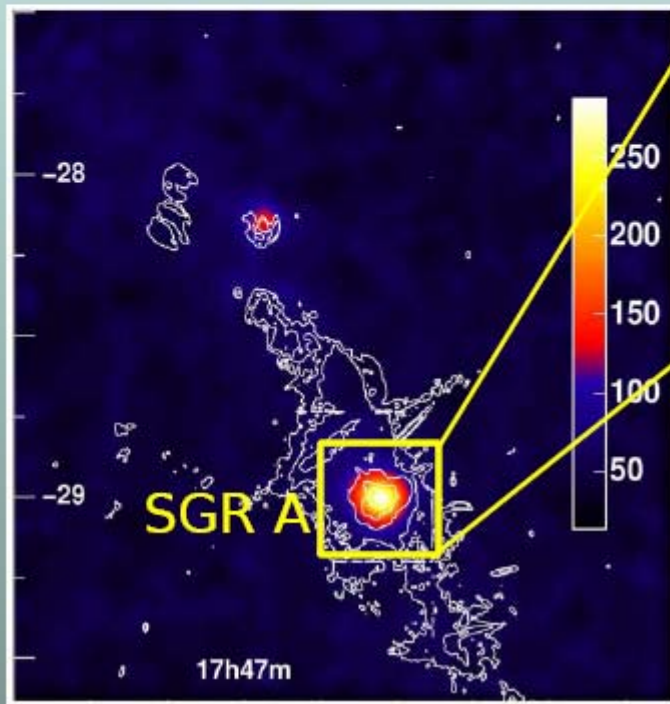
OG 1





# Emission From Galactic Center!!

## Galactic Center



H.E.S.S.

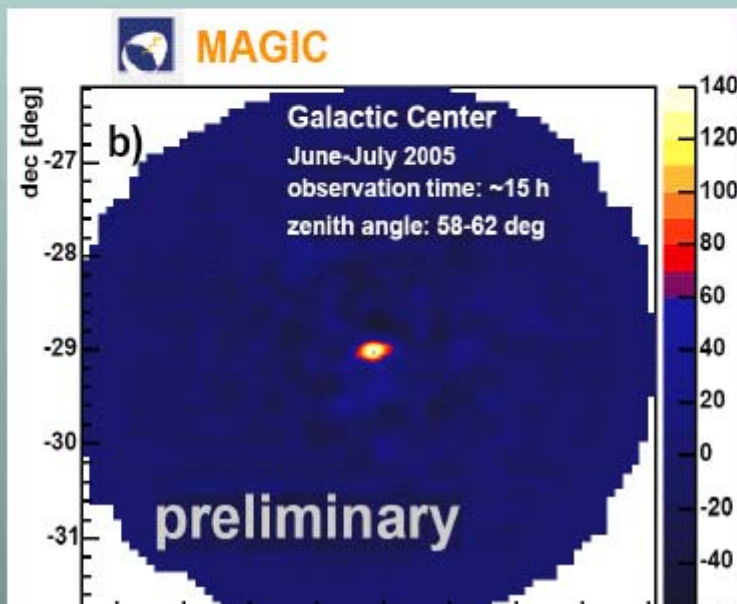




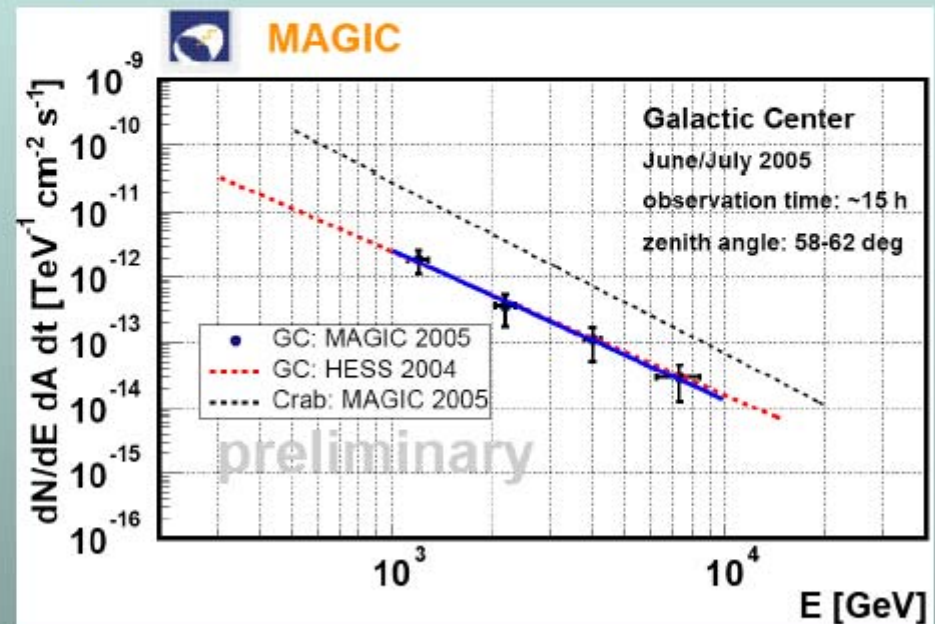
# Also by MAGIC: Spectrum

## Galactic Center

Also seen clearly by MAGIC.



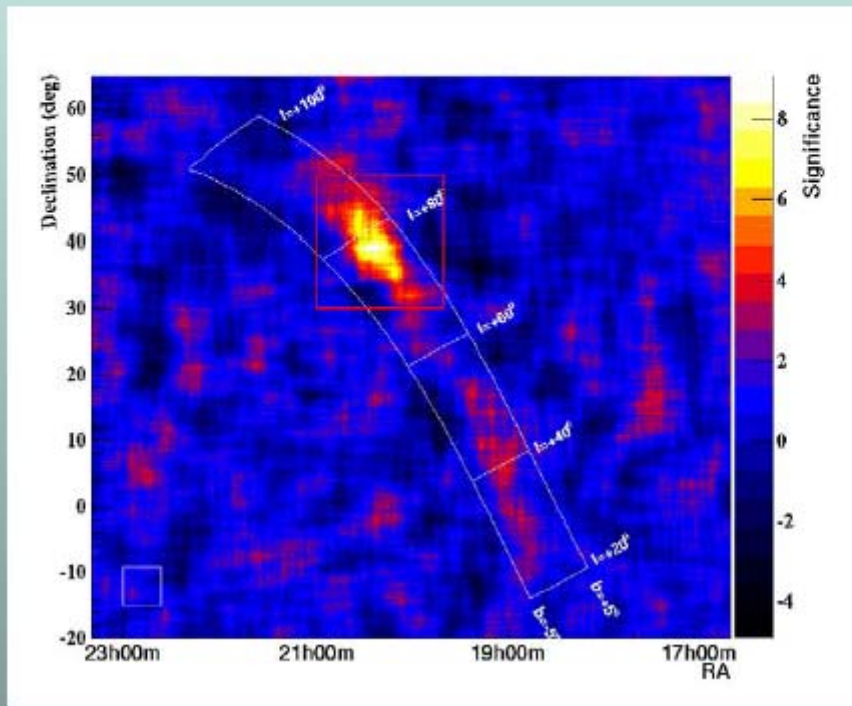
## Spectrum



Good agreement between HESS and MAGIC.

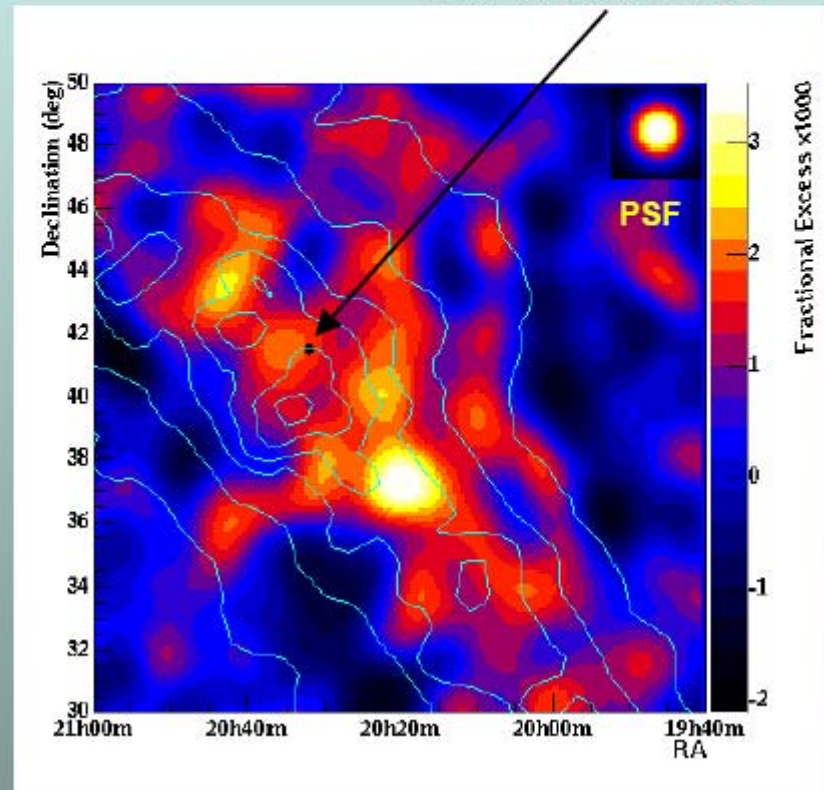
# Diffuse Emission?

## 2. Cygnus Region



Milagro [Smith]

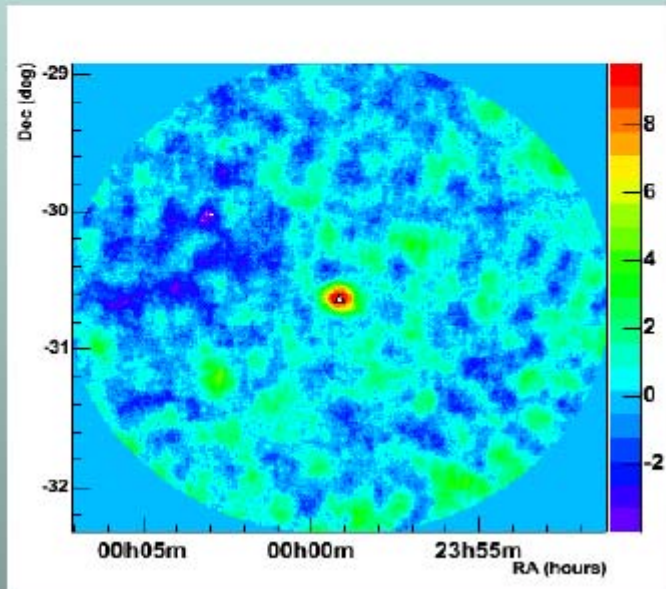
HEGRA  
TeV 2032+4130



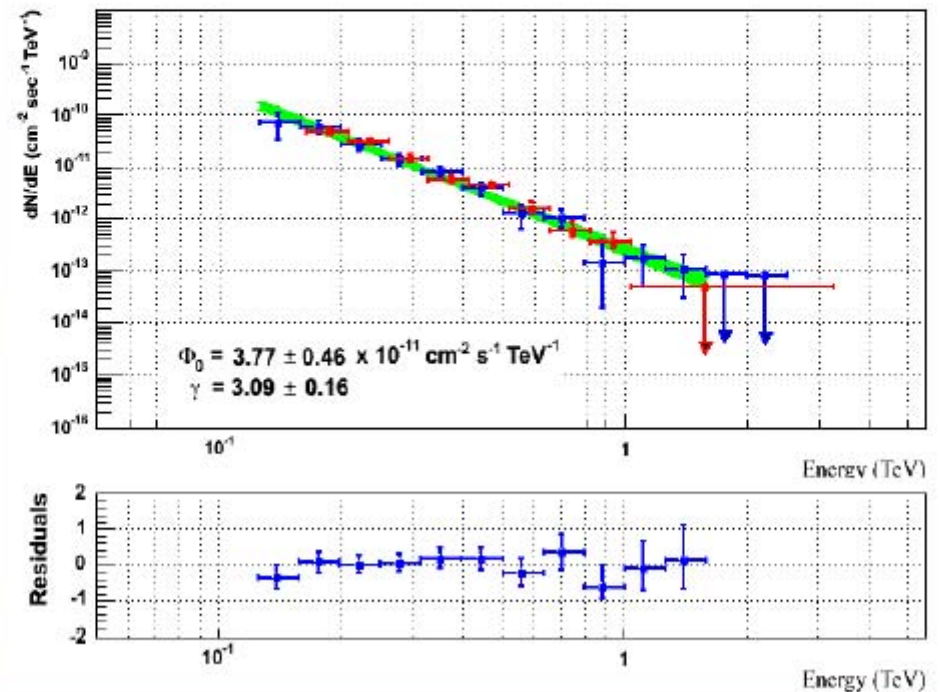


# Extragalactic Emission (HESS)

**H2356-309**  
( $z=0.165$ )



HESS [Pita]:  
2004 data:



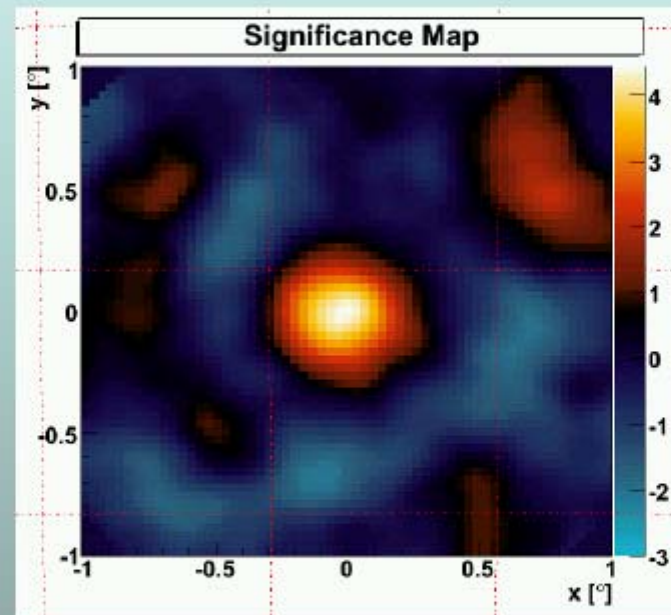
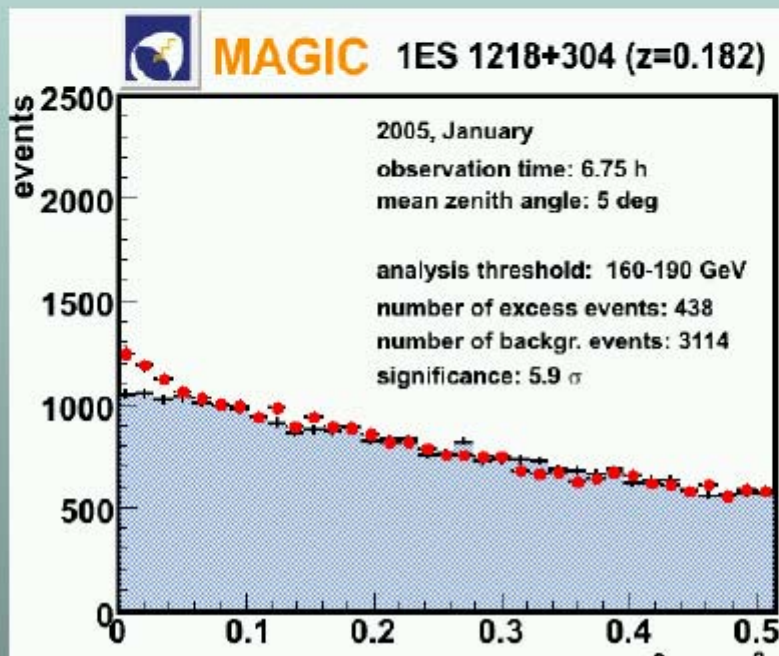
Spectrum:



# Extragalactic Emission (MAGIC)

## 1ES1218+304

( $z=0.182$ )



MAGIC [Meyer]:

2005 data:

~7 hrs,  $6\sigma$

no spectrum yet





S

## BL Lac, BL Lac, and BL Lac

M87	0.004	FR I	HEGRA	HESS
Mkn 421	0.031	BL Lac	Whipple	Many
Mkn 501	0.034	BL Lac	Whipple	Many
1ES 2344+514	0.044	BL Lac	Whipple	HEGRA
1ES 1959+650	0.047	BL Lac	Tel. Array	Many
PKS 2005-489	0.071	BL Lac	HESS	
PKS 2155-304	0.116	BL Lac	Mark VI	HESS
H1426+428	0.129	BL Lac	Whipple	Many
H2356-309	0.165	BL Lac	HESS	
1ES 1218+304	0.182	BL Lac	MAGIC	
1ES 1101-232	0.186	BL Lac	HESS	

→ Reaching further out in redshift.



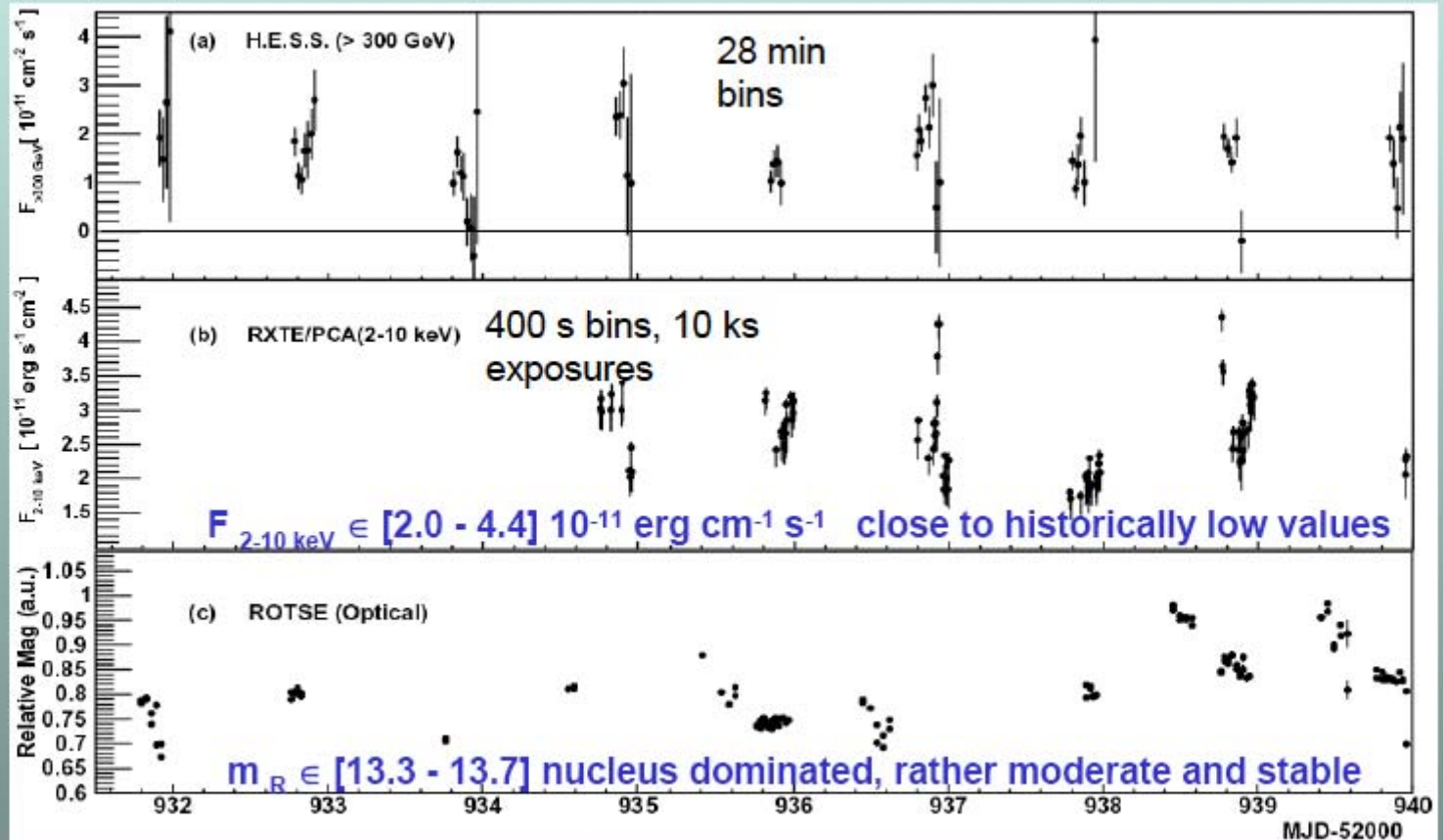
# Multi wavelengths : Electron driven

## PKS 2155-304

VHE  $\gamma$ -rays  
(HESS)

X-rays

Optical



→ Low state detected in  $\gamma$ -rays ?





# What about our CANGAROO??



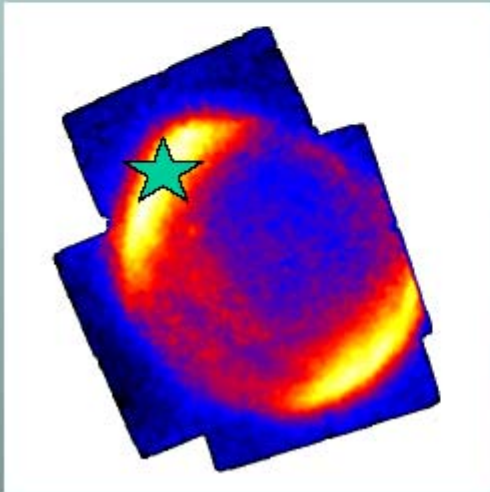
- ICRC Summary talks : 個別の結果がプレゼンされた計 23 枚のスライドのうち Cangaroo の結果が曲がりなりにも feature されたものは **2枚**のみ

# The Contradictory Story

## SN1006 : Evidence of CR origin?

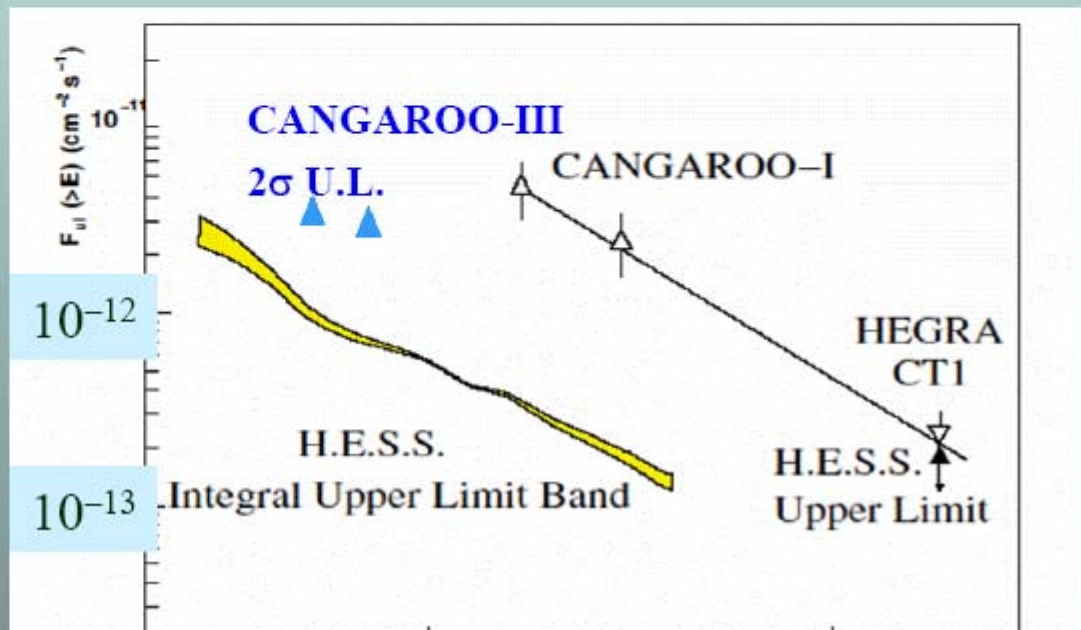
### SN 1006

Earlier detection by CANGAROO-I from NE rim. Also HEGRA CT1.



2004: HESS Upper limit.

New data from CANGAROO-III [Tanimori].  
~ 25 hrs, 3 telescopes



# What about our CANGAROO??



- CANGAROO II-III は10m クラスでは先行していた。今から振り返っても先駆的実験だった。
- しかし Mono の解析は厳しい。まだ天文のレベルではなく「宇宙線物理」のレベルの実験データ。慎重な解析・較正が望まれたのにピークを立てる方向、そして結果の解釈を考える方向にバイアスしすぎた！！



# Recent Published Papers



- **Detection of .. Galactic Center .. ApJ 606 L115 (2004)**
- **Detection of .. RXJ0852.0-4622 .. ApJ 616 L163 (2004)**  
データカットの妥当性、どこまでMCとあっているのかといった基本的記述なし。 $\alpha$ プロットだけ見せられても判断ができない。「典型的」天文スタイル。時期尚早
- **A Search for.. Vela Pulsar ... ApJ (2005 to appear)**  
解析の手法詳細の記述は評価できる。もっと早くこの手の論文を出して信用回復を図るべきだった。

# Still I would be missing...

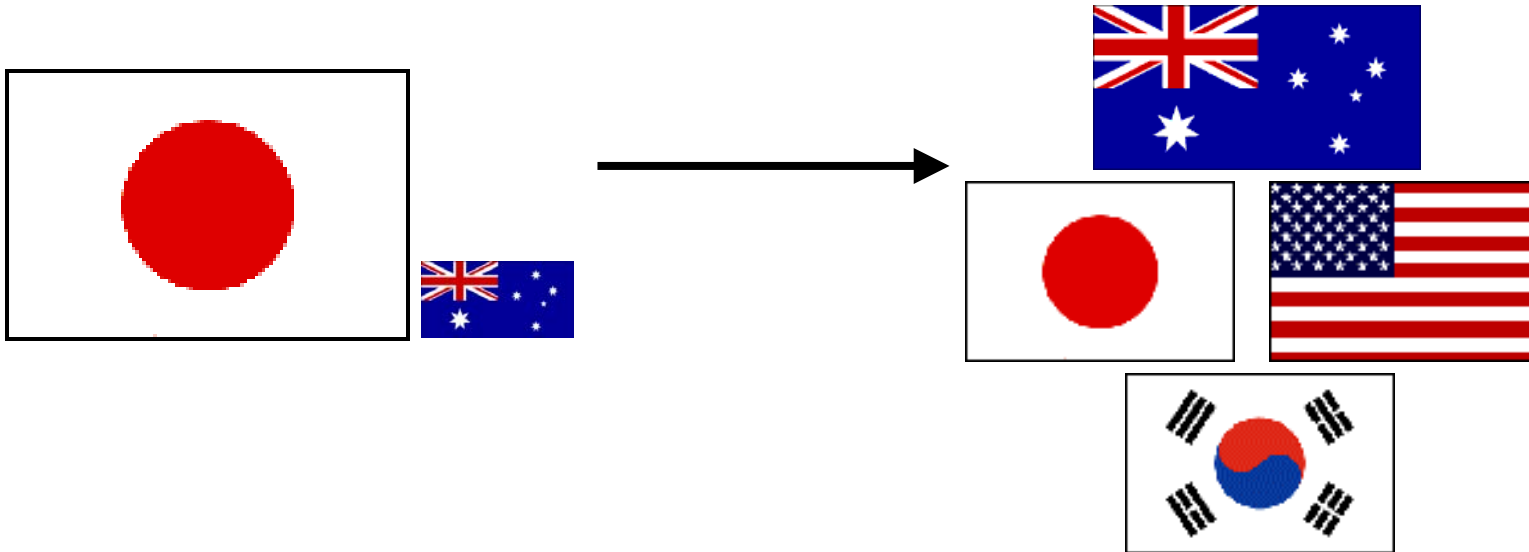


Criteria		# of events (obs)	# of events (MC)
Level 1	Hit>3 PE>4 Tclean	5.0E6	1.2E7+-0.6E7(Syst.)
Level 2	Log Likelihood<4 Distance >0.4	2.0E4	3.5E4+-1.3E4(Syst.)
Level 3	CoreD<100 Zenith<50	4.2E3	4.5E3+-0.3E3(Syst.)
Level 4	Bright Star Reduction	6.1E2	6.0E2+-0.1E2(Syst.)

Source Dependence

# Future Direction

- 国際協力！
- 日本だけが突出する時代ではない



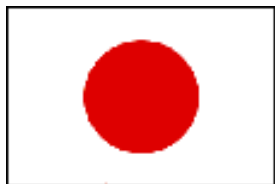


# International Collaboration



- エレキもPMTもトリガーもミラーもDAQもシミュレーションも全て噛むのは不可能
- 得意な分野に日本の資源を集中すべし。
- ソフトウェア(MC/Reco)も忘れるな(日本は遅れぎみ。しかし解析で存在感を示すためには必要！！)

例えば...



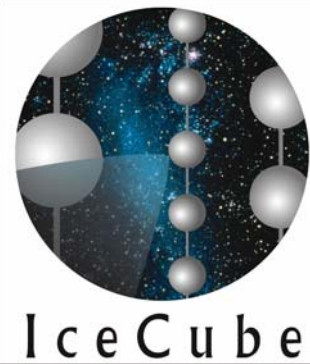
PMTカメラ  
Detector MC  
DAQ



望遠鏡躯体  
エレキ  
DAQ



ソフトウェア  
フレーム  
Host PC



# An example: Ice3 collaboration

## WBS: Working Breakdown Structure

Work Breakdown Structure (WBS)

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### 1.3

#### Instrumentation

##### 1.3.1 In-Ice Devices

###### 1.3.1.1 Optical Modules

- 1.3.1.1.1 Optical Module Layout & Design
- 1.3.1.1.10 Quality Assurance, Calibration & Testing
- 1.3.1.1.2 Flasher Board Design & Production
- 1.3.1.1.3 PMT Baseboard Design & Production
- 1.3.1.1.4 Photo-Multiplier Tube
- 1.3.1.1.5 Pressure Vessel
- 1.3.1.1.6 Connector
- 1.3.1.1.7 Magnetic Shield
- 1.3.1.1.8 Mechanical Harness
- 1.3.1.1.9 Optical Module Production

###### 1.3.1.2 Cables

- 1.3.1.2.1 Main Cables
- 1.3.1.2.2 String Hardware
- 1.3.1.2.3 Special Devices
- 1.3.1.2.4 Quality Assurance

###### 1.3.1.3 In-Ice Management

##### 1.3.2 Ice Top

###### 1.3.2.1 Tanks

###### 1.3.2.2 Cables

###### 1.3.2.3 Optical modules

###### 1.3.2.4 IceTop specific engineering

- 1.3.2.4.1 IceTop system design (tank layout and calibration)
- 1.3.2.4.2 IceTop detector simulations (tank simulations)
- 1.3.2.4.3 Data acquisition (h/w and s/w mods for air shower triggers, including feature recognition)

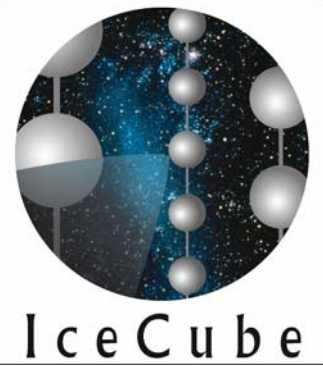
###### 1.3.2.5 Integration of SPASE

###### 1.3.2.6 IceTop management

##### 1.3.3 Data Acquisition

###### 1.3.3.1 Design

- 1.3.3.1.1 System Architecture



# An example: Ice3 collaboration

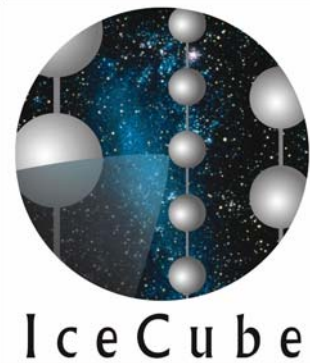
## WBS: Working Breakdown Structure

### Work Breakdown Structure (WBS)

---

- 1.4.2.5 Software Management
  - 1.4.2.5.1 Architecture & Design
  - 1.4.2.5.2 Validation
    - 1.4.2.5.2.1 Unit Testing
    - 1.4.2.5.2.2 Builds & Releases
    - 1.4.2.5.2.3 Bug Tracking
- 1.4.3 Simulation
  - 1.4.3.1 Event Generation
    - 1.4.3.1.1 Air Shower Generators
    - 1.4.3.1.2 Neutrino Generators
    - 1.4.3.1.3 Special Generators
  - 1.4.3.2 Lepton Propagation
    - 1.4.3.2.1 Muon and Tau Propagation
    - 1.4.3.2.2 Electron Showers
    - 1.4.3.2.3 Hadron Showers
    - 1.4.3.2.4 Tau Propagation
  - 1.4.3.3 Photon Field and Detector Simulation
    - 1.4.3.3.1 Photon Propagation
    - 1.4.3.3.2 OM Simulation (In-Ice, Ice Top)
    - 1.4.3.3.3 Trigger Simulation
    - 1.4.3.3.4 Event Building
  - 1.4.3.4 Simulation Production
    - 1.4.3.4.1 Simulation Setup
    - 1.4.3.4.2 Simulation Planning and Resources
  - 1.4.3.5 Special Simulations
    - 1.4.3.5.1 Shower light output simulation (Geant)
    - 1.4.3.5.2 Unspecified special simulations
  - 1.4.3.6 Documentation
    - 1.4.3.6.1 Monte Carlo Documentation
    - 1.4.3.6.2 Version Control & Distribution
- 1.4.4 Project/Technical Management





# An example: Ice3 collaboration

## Inst. Planning → Collaboration内での存在感

### INSTITUTIONAL SUPPORT PROPOSAL

### Chiba University (CHIBA)

### STAFFING PLAN

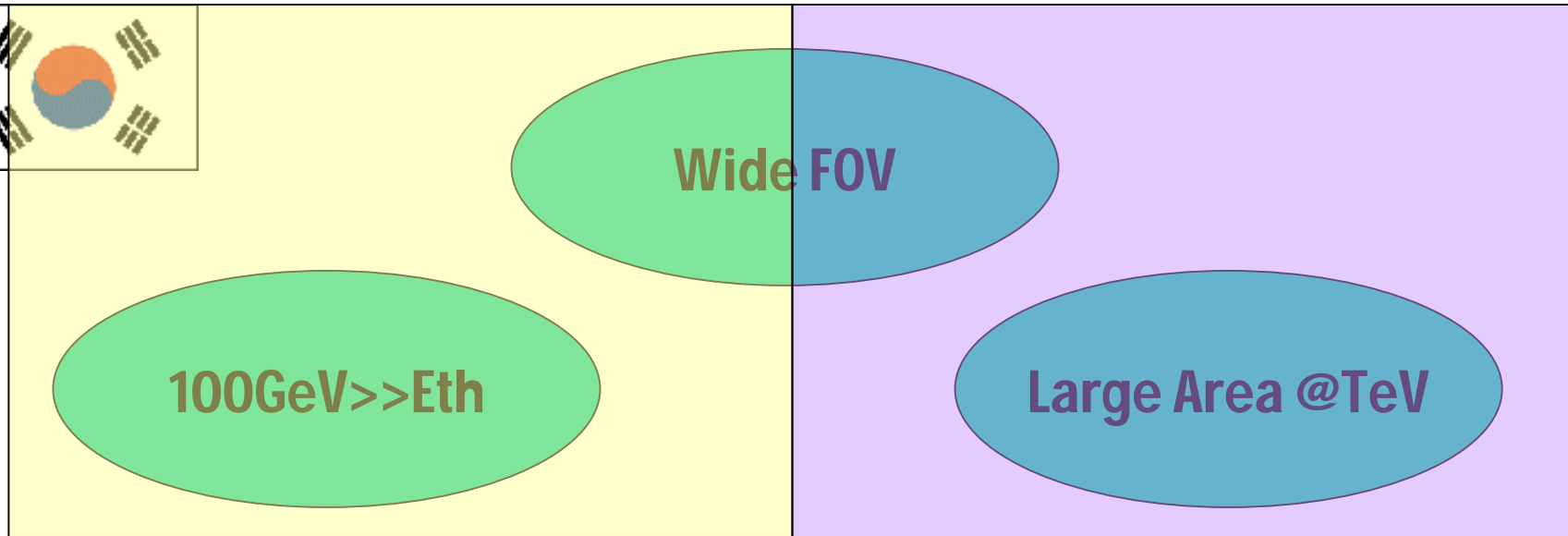
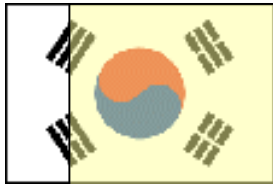
Identify individuals or planned new hires that will be assigned to do the work. **Assign work at the lowest known WBS level. One (1) WBS per line. One (1) name per line. Group by WBS first, then by Labor Category.**

WBS	Task Description	Labor Cat.	FTE	Name (Select "NOT IN THE LIST" to enter a new name)	Fill in new name (If name isn't in the list)
1.3.1.1.4 Photo-Multiplier Tube	DOM/PMT calibration	GR	0.1	NOT IN THE LIST	MIYAMOTO, HIROKO
1.3.1.1.4 Photo-Multiplier Tube	DOM/PMT calibration	KE	0.2	YOSHIDA, SHIGERU	
1.3.1.1.4 Photo-Multiplier Tube	DOM/PMT calibration	KE	0.3	MASE, KEIICHI	
1.3.1.1.4 Photo-Multiplier Tube	DOM/PMT calibration	KE	0.1	NOT IN THE LIST	KAWAI, HIDEYUKI
1.3.1.1.4 Photo-Multiplier Tube	DOM/PMT calibration	GR	0.4	NOT IN THE LIST	MINA, INABA
1.4.3.2 Lepton Propagation	ROMEO/JULIeT upgrade/maintenance	KE	0.1	YOSHIDA, SHIGERU	
1.4.3.3 Photon Field and Detector Simulation	hit constructor upgrade/maintenance	KE	0.1	YOSHIDA, SHIGERU	
1.5.2.4 Offline Reconstruction	EHE energy muon reconstruction	KE	0.2	MASE, KEIICHI	
1.5.1.2 Benchmarking and Data Verification	(E)HE verification	GR	0.3	NOT IN THE LIST	MIYAMOTO, HIROKO
1.5.1.2 Benchmarking and Data Verification	(E)HE verification	KE	0.2	YOSHIDA, SHIGERU	
1.5.1.2 Benchmarking and Data Verification	(E)HE verification	KE	0.3	MASE, KEIICHI	
1.5.1.2 Benchmarking and Data Verification	Verification using the golden DOMs	GR	0.3	NOT IN THE LIST	MINA, INABA

# Science Direction



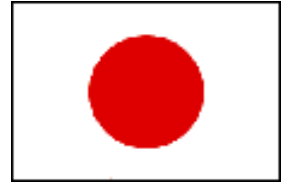
各国間で目指すサイエンスの合意が必要。



← Astronomy

Cosmic Ray Physics →

# Demanded Infrastructure



## ◆ PostDoc の雇用予算の充実

最後は人力。国際分担で負担が減る分、人に回せ。

## ◆ 宇宙線研にエレキショップは作れないか？ (国際的常識。KEK を頼るしかないのか？)



# Recommendation

- ◆ CANGAROO の教訓を生かして、将来計画は **真の**国際協力実験にする。内部チェックが働く。
  - ◆ 得意なハードに資源を集中せよ。カメラ？
  - ◆ ソフトにも必ず関与すべき。
  - ◆ **天文的ベクトルを目指すのか物理を主とするのかハッキリ意思表示すべき。**
- 究極の質問. ソースで論文を書きたいのか物理現象で論文を書きたいのか？
- ◆ 人の予算サポートを厚くする。