Introductory Remarks

- Astro-particle physics or particle astrophysics?
  - I am primarily an astrophysicist, so I call it *particle astrophysics*, in order to emphasize *astrophysical* aspects.
  - I changed the name of one laboratory in our institute from "Laboratory for *Cosmic Rays and High Energy Astrophysics*" to "Laboratory for *Particle Astrophysics*", when I was asked to become the director of the lab in 2002.
- In China, there is no particle astrophysics community, and thus no roadmap for particle astrophysics.
- I came here to tell you what we are doing in my lab and hope to attract some opportunities of collaborations.

Current and Future Research Projects on Particle Astrophysics in IHEP

Shuang-Nan Zhang

张双南

Key Laboratory for Particle Astrophysics

Institute of High Energy Physics

Chinese Academy of Sciences

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Institute of High Energy Physics

Largest basic research center in China

Major research fields:

- Particle physics: Charm physics @ BEPC, LHC exp., cosmic ray, particle astrophysics, n physics …
- Space high energy astrophysics
- Accelerator technology and applications
- Synchrotron radiation technologies and applications

1030 employees, ~ 650 physicists and engineers,
400 PhD Students and 40 postdoctors

Established at 1950, and became an independent institute at 1973 .

Bird's Eye View of BEPC

Particle Physics Experiments in China

- **BEPC & BEPCII: BESII/BESIII**
- **Non-accelerator experiments**
  - **Yangbajing cosmic-ray observatory**
  - **L3cosmic (finished)**
  - **Daya Bay reactor neutrino experiment**
  - **Cosmic Ray Tao Nuetrino Telescope (CRTNT)?**
- **International collaboration:**
  - **LHC：ATLAS, CMS, LHCb, Alice**
  - **AMS,…**
  - **KEKB: BELLE; Kamland, SuperK.**
  - **RHIC: Star, Phenix**
  - **ILC R&D**

BEPC constructed in 1984 –1988 with beam energy: 1 – 2.8 GeV

- Physics Run：Luminosity $10^{31}cm^{-2}s^{-1}$@1.89GeV，5 month/year
- Synchrotron Radiation Run：140mA @ 2.2 GeV，3 month/year

Physics Running **finished March 2004**
Synchrotron Radiation Running
finished June 2005

•The BES Collaboration

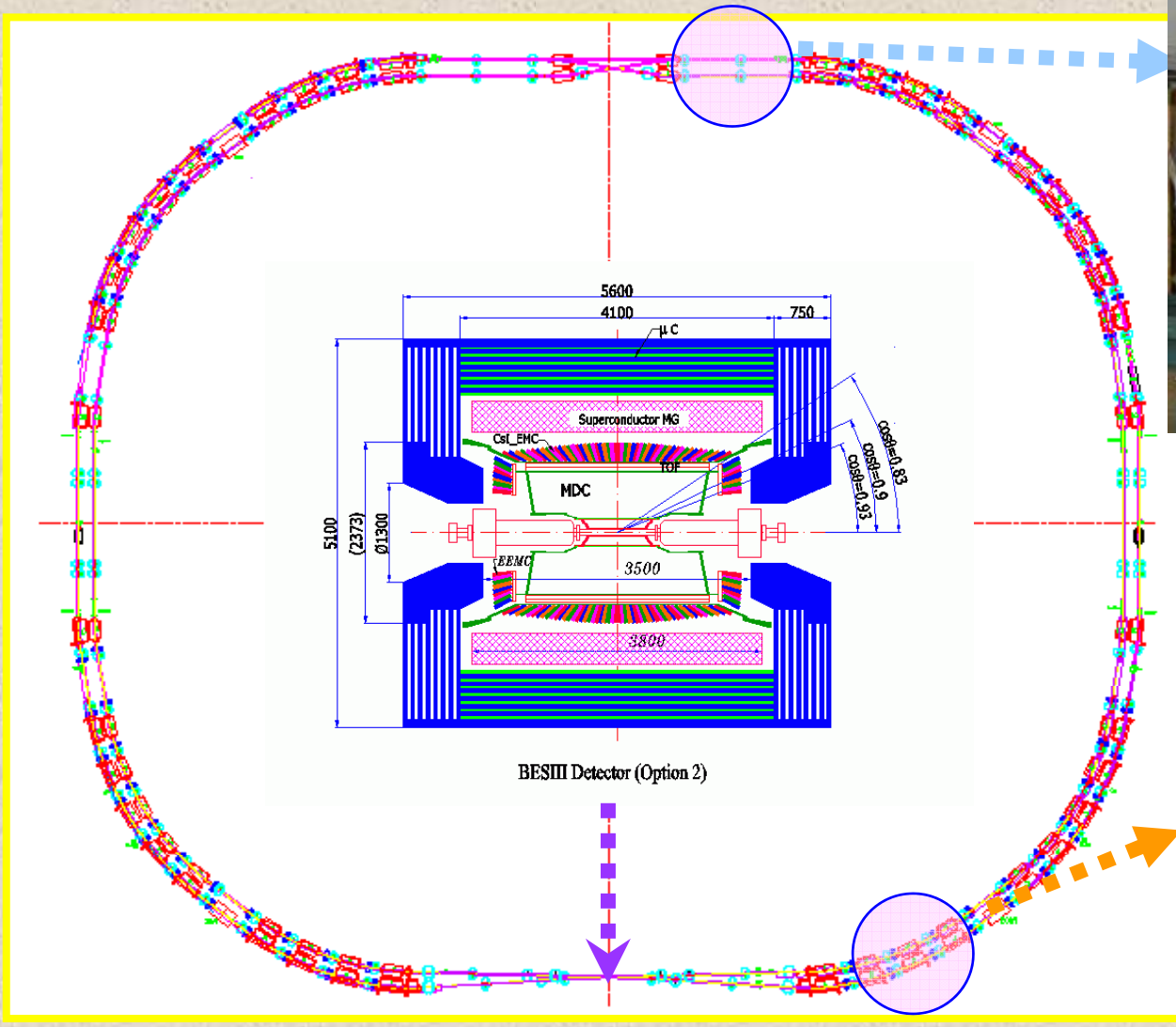
Main Physics Results from BES

- Precision measurement of τ mass: world average value changed by 3σ, accuracy improved by factor of 10, and approved τ lepton universality.
- R Measurement at 2-5GeV: $\Delta R/R$ 15-20% $\rightarrow$6.6%
  - Higgs mass prediction from SM
  - g-2 experiment
  - $\alpha(M_z^2)^{-1}$: $128.890 \pm 0.090 \rightarrow 128.936 \pm 0.046$
- Systematic study of $\psi(2S)$ and J/ψ decays.
- Resonance X(1835) in $J/\psi \rightarrow \gamma\eta'\pi^+\pi^-$ with mass and width are consistent with that of the S-wave resonance X(1860) indicated by the pp mass threshold enhancement.

LHC Experiments

1. CMS
   - 1/3 of CSC at muon end caps (IHEP)
   - HV boards for RPC (IHEP)
   - RPC of barrel muon (Beijing Univ.)
   - Physics and MC
2. Atlas
   - Drift Monitor chambers (IHEP)
   - Physics and MC
3. LCG: Tier 2
4. LHCb: Tsinghua Univ.
5. Alice: CIAE,

BEPCII



Build new ring inside existing ring . Two half new rings and two half old rings cross at two IR's, forming a double ring collider.

BEPC II Double ring Design

- In the existing BEPC tunnel, add another ring, cross over at south and north points, two equal rings for electrons and positrons. double-ring collision technology.
- 93 bunches，total current > 0.9A in each ring.
- Collision spacing：8 ns.
- In south, collision with large horizontal cross-angle（±11mr）.
- Calculated luminosity： 10^{33} cm^{-2} s^{-1} @ 3.78GeV of C.M.E
- Linac upgrade: e^+ 50mA/min. , Full energy injection up to 1.89GeV
- SR run：250mA @ 2.5 GeV.
- Major detector upgrade：BES III.

Physics at BEPCII/BESIII

- Precision measurement of CKM matrix elements
- Precision test of Standard Model
- QCD and hadron production
- Light hadron spectroscopy
- Charmonium physics
- Search for new physics/new particles

Physics Channel	Energy (GeV)	Luminosity (10^{33} $cm^{-2}s^{-1}$)	Events/year
J/ψ	3.097	0.6	1.0×10^{10}
τ	3.67	1.0	1.2×10^{7}
ψ'	3.686	1.0	3.0×10^{9}
D*	3.77	1.0	2.5×10^{7}
Ds	4.03	0.6	1.0×10^{6}
Ds	4.14	0.6	2.0×10^{6}

Progress of BEPCII

Linac Tunnel

Stage #1: Linac upgrade reached designed goal

RF Gallery

Assessment result: Linac Beam Performance

measured by the Test Group, in June-July 2006

	Design	Measured	BEPC
Energy (e+ / e-) (GeV)	1.89	1.89	1.30-1.55
Current (e+) (mA)	37	61	~ 5
Current (e-) (mA)	500	> 500	~300
Emittance（e+）(1 σ, mm-mrad）	0.40 (37 mA)	0.39~0.41 (40~46 mA)	----
Emittance (e-) (1 σ, mm-mrad）	0.10 (500 mA)	0.09~0.11 (600 mA)	----
Pulse Repe. Rate （Hz）	50	50	12.5
Energy Spread (e-) （%）**	± 0.50 (500 mA)	± 0.44 (600 mA)	± 0.80
Energy Spread (e+) （%）**	± 0.50 (37 mA)	± 0.50 (≥37 mA)	± 0.80

Stage #2: Storage Ring upgrade reached Goal

1. Production of Double ring components√

2. Remove old ring, install Double ring √

3. Tuning of storage rings:
   - beam stored at Nov. 2006
   - collision at March 2007.
   - Lum. reached 10^{31}, beam current reached 500mA.√

4. SR running: Dec. 06-Feb.07 &Jun-Aug. 07

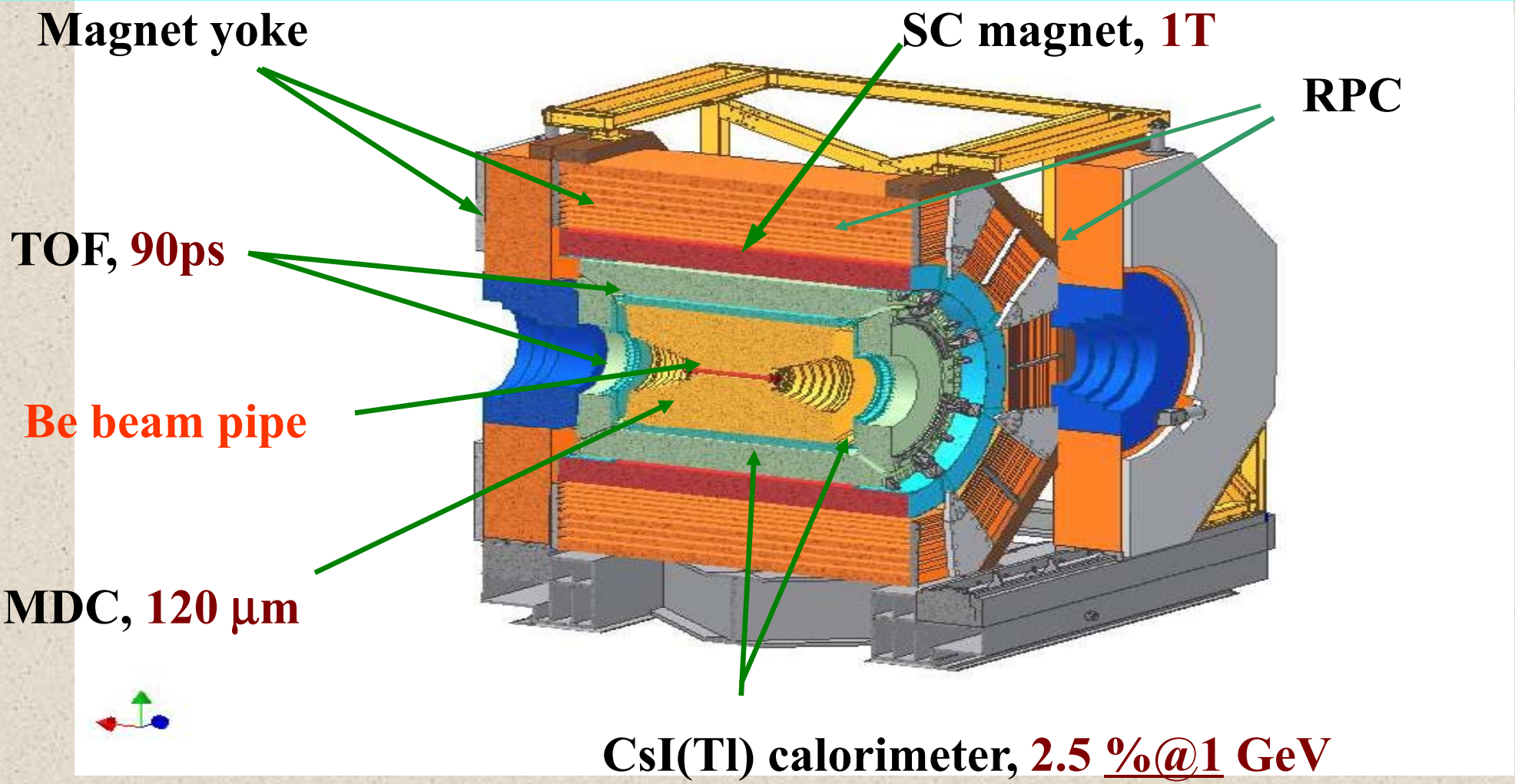
5. BESIII construction √

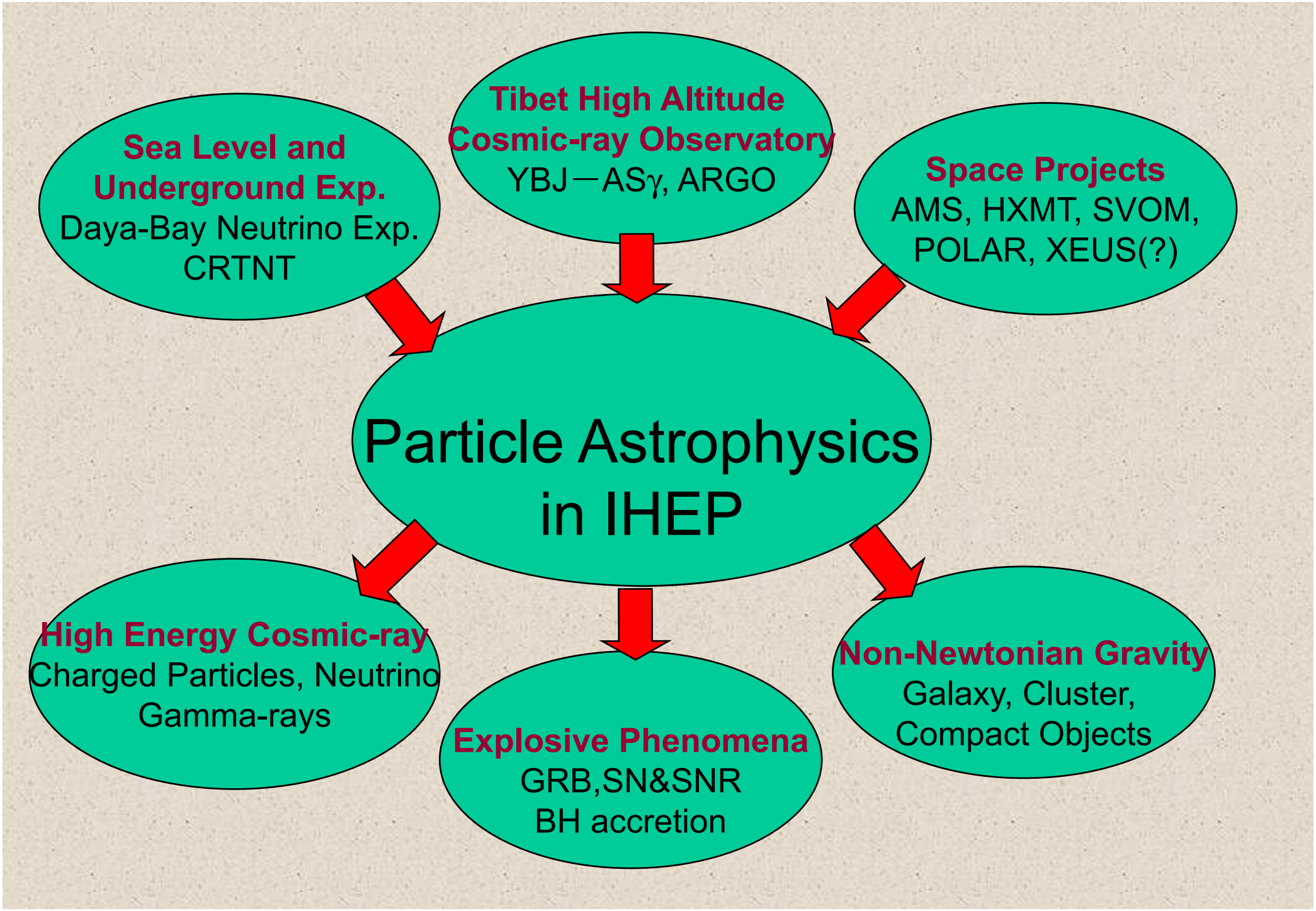
6. Field mapping of SC magnets √

Storage Ring installation finished

BESIII Detector

— construction of subdetectors finished.
— the integration started.
— to be moved into interaction region at Spring 08.




Particle Astrophysics in IHEP
Tibet High Altitude Cosmic-ray Observatory
YBJ－ASγ, ARGO
Sea Level and Underground Exp.
Daya-Bay Neutrino Exp.
CRTNT
Space Projects
AMS, HXMT, SVOM,
POLAR, XEUS(?)
High Energy Cosmic-ray
Charged Particles, Neutrino
Gamma-rays
Explosive Phenomena
GRB,SN&SNR
BH accretion
Non-Newtonian Gravity
Galaxy, Cluster,
Compact Objects

Sea Level and Underground Experiments

Neutrino mixing parameters

$$\begin{pmatrix} \nu_e \\ \nu_\mu \\ \nu_\tau \end{pmatrix} = \begin{pmatrix} U_{e1} & U_{e2} & U_{e3} \\ U_{\mu 1} & U_{\mu 2} & U_{\mu 3} \\ U_{\tau 1} & U_{\tau 2} & U_{\tau 3} \end{pmatrix} \begin{pmatrix} \nu_1 \\ \nu_2 \\ \nu_3 \end{pmatrix}$$

Parameterization of neutrino mixing

$$U = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\theta_{23} & \sin\theta_{23} \\ 0 & -\sin\theta_{23} & \cos\theta_{23} \end{pmatrix} \begin{pmatrix} \cos\theta_{13} & 0 & e^{-i\delta}\sin\theta_{13} \\ 0 & 1 & 0 \\ -e^{i\delta}\sin\theta_{13} & 0 & \cos\theta_{13} \end{pmatrix} \begin{pmatrix} \cos\theta_{12} & \sin\theta_{12} & 0 \\ -\sin\theta_{12} & \cos\theta_{12} & 0 \\ 0 & 0 & 1 \end{pmatrix}$$

6 fundamental parameters in neutrino physics:

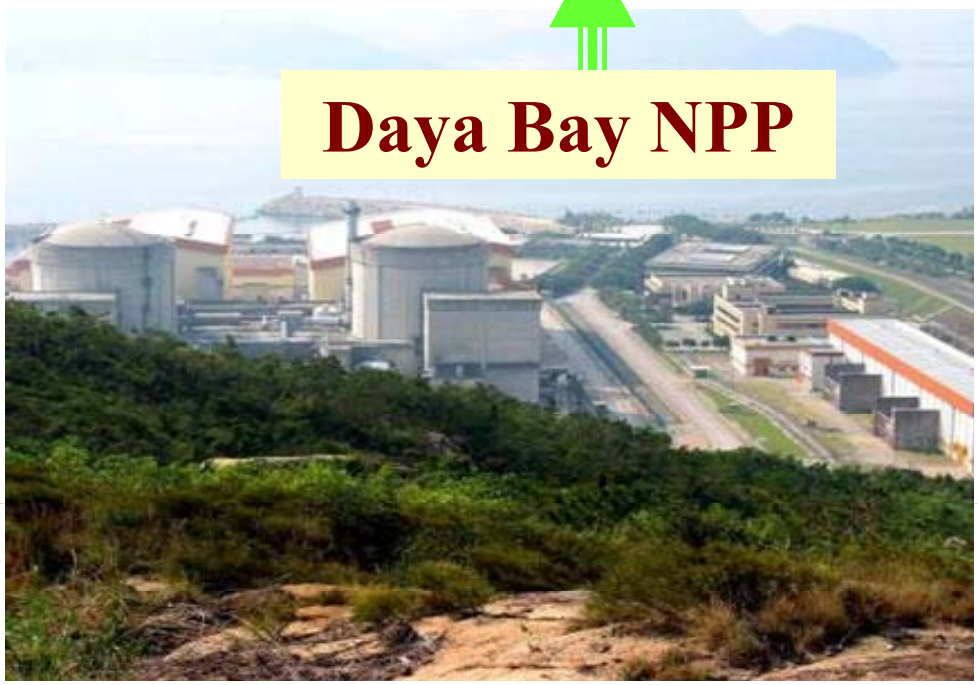
Known: $|\Delta m^2_{32}|, \sin^2 2\theta_{32}, \Delta m^2_{21}, \sin^2 2\theta_{21}$

Unknown: **$\sin^2 2\theta_{13}$,** **δ, sign of Δm^2_{32}**

Exp.: reactor ν VLBL **ν oscillation**

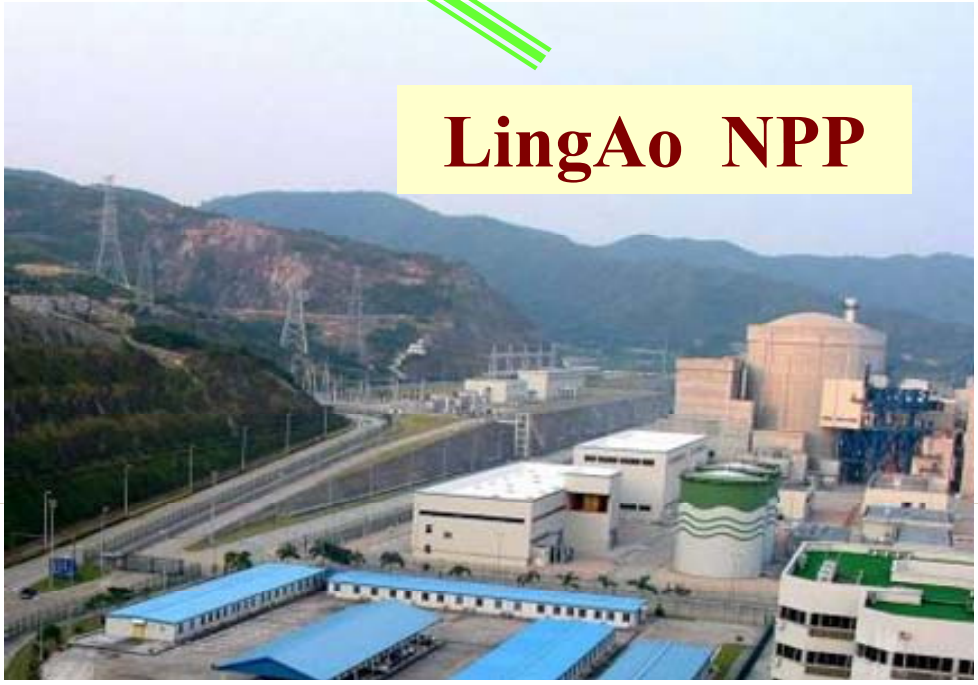
Daya Bay Reactor **J-Parc → Beijing**

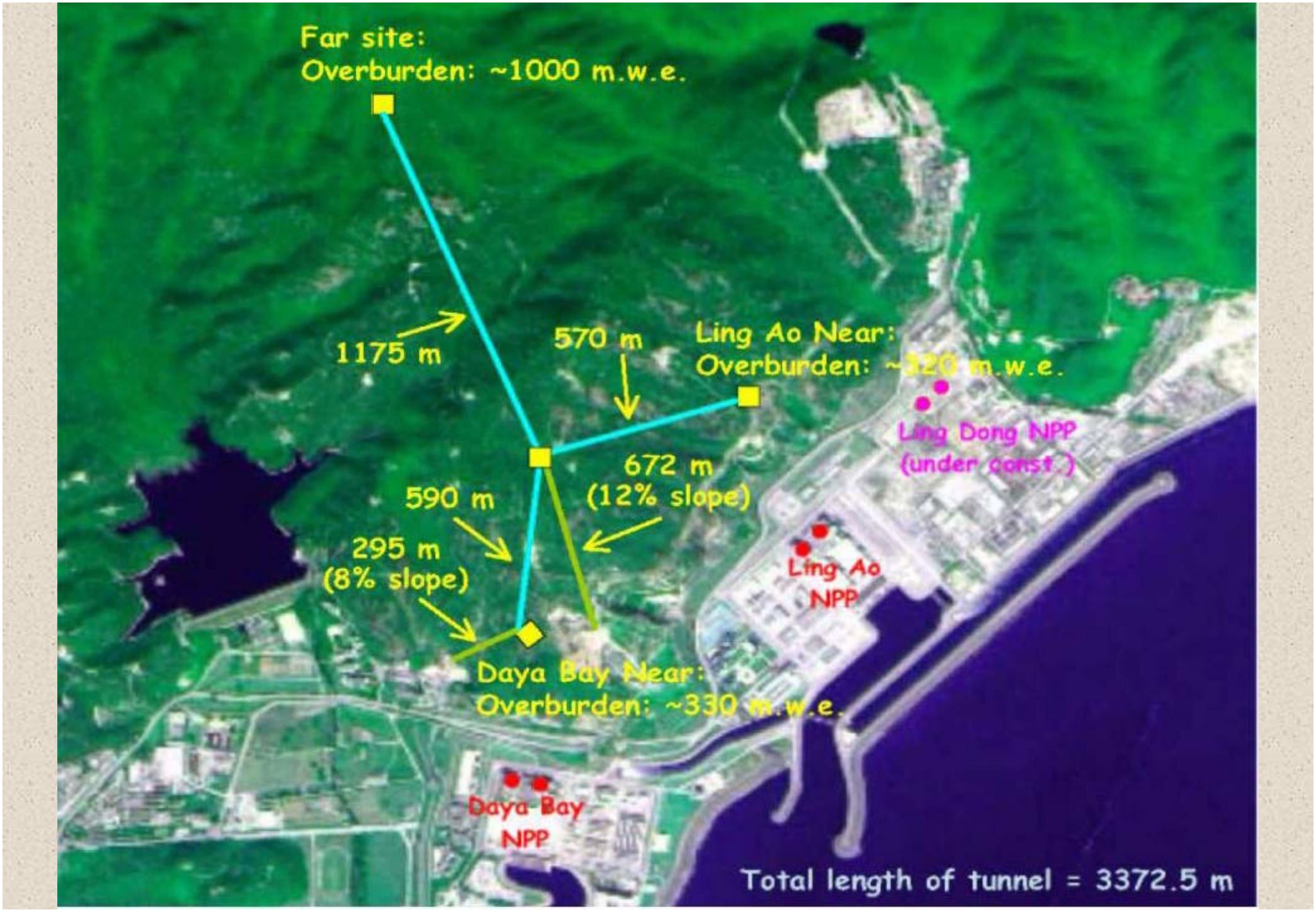
Daya bay reactor neutrino experiment with sensitivity of 0.01 to $\sin^2 2q_{13}$



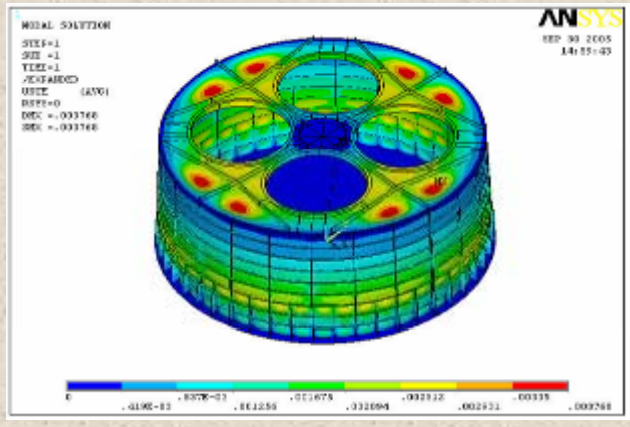
Daya Bay NPP

LingAo NPP




Far site:
Overburden: ~1000 m.w.e.
1175 m
570 m
Ling Ao Near:
Overburden: ~320 m.w.e.
Ling Dong NPP
(under const.)
672 m
(12% slope)
590 m
295 m
(8% slope)
Ling Ao
NPP
Daya Bay Near:
Overburden: ~330 m.w.e.
Daya Bay
NPP
Total length of tunnel = 3372.5 m

Detector: Multiple modules



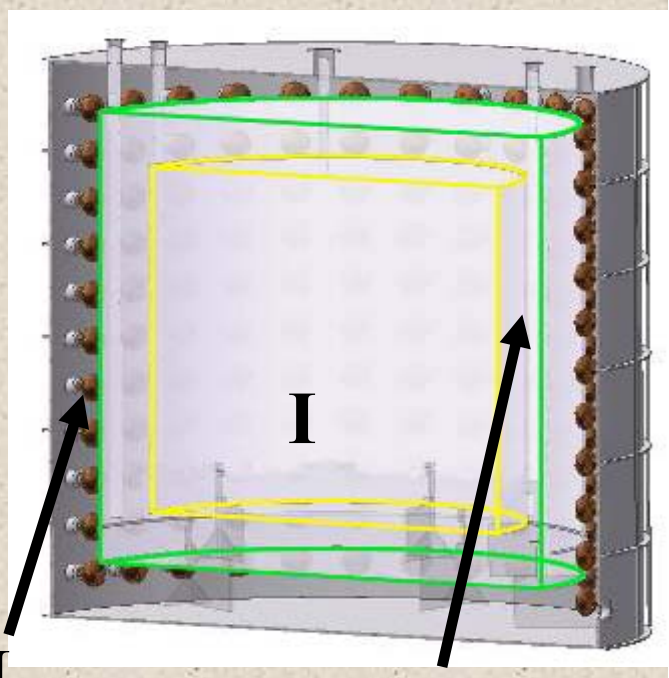
Two modules at near sites
Four modules at far site:
Side-by-side cross checks

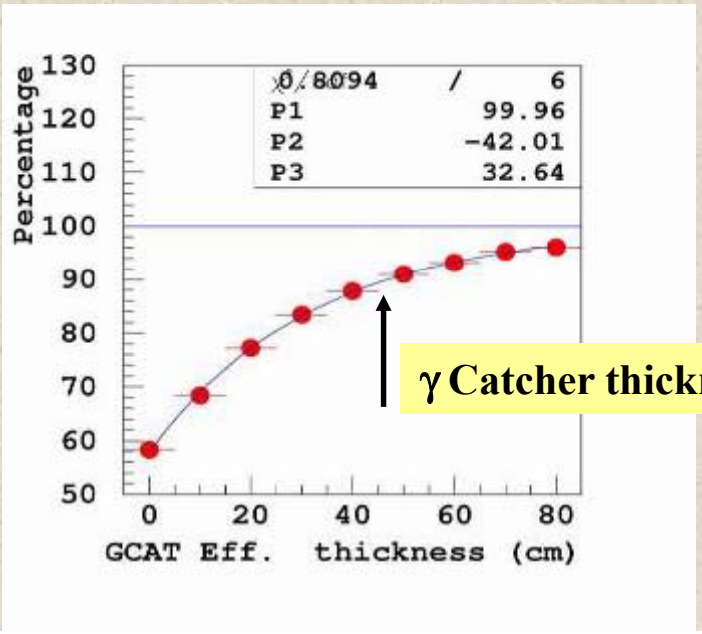
- Multiple modules for cross check, reduce uncorrelated errors
- Small modules for easy construction, moving, handing, …
- Small modules for less sensitive to scintillator aging
- Scalable

Central Detector modules

- ***Three zones modular structure:***
  - ***I. target: Gd-loaded scintillator***
  - ***II. g-ray catcher: normal scintillator***
  - ***III. Buffer shielding: oil***
- ***Reflection at two ends***
- ***20t target mass, ~200 8"PMT/module***

s_E = ***5%@8MeV,*** s_s ***~ 14 cm***





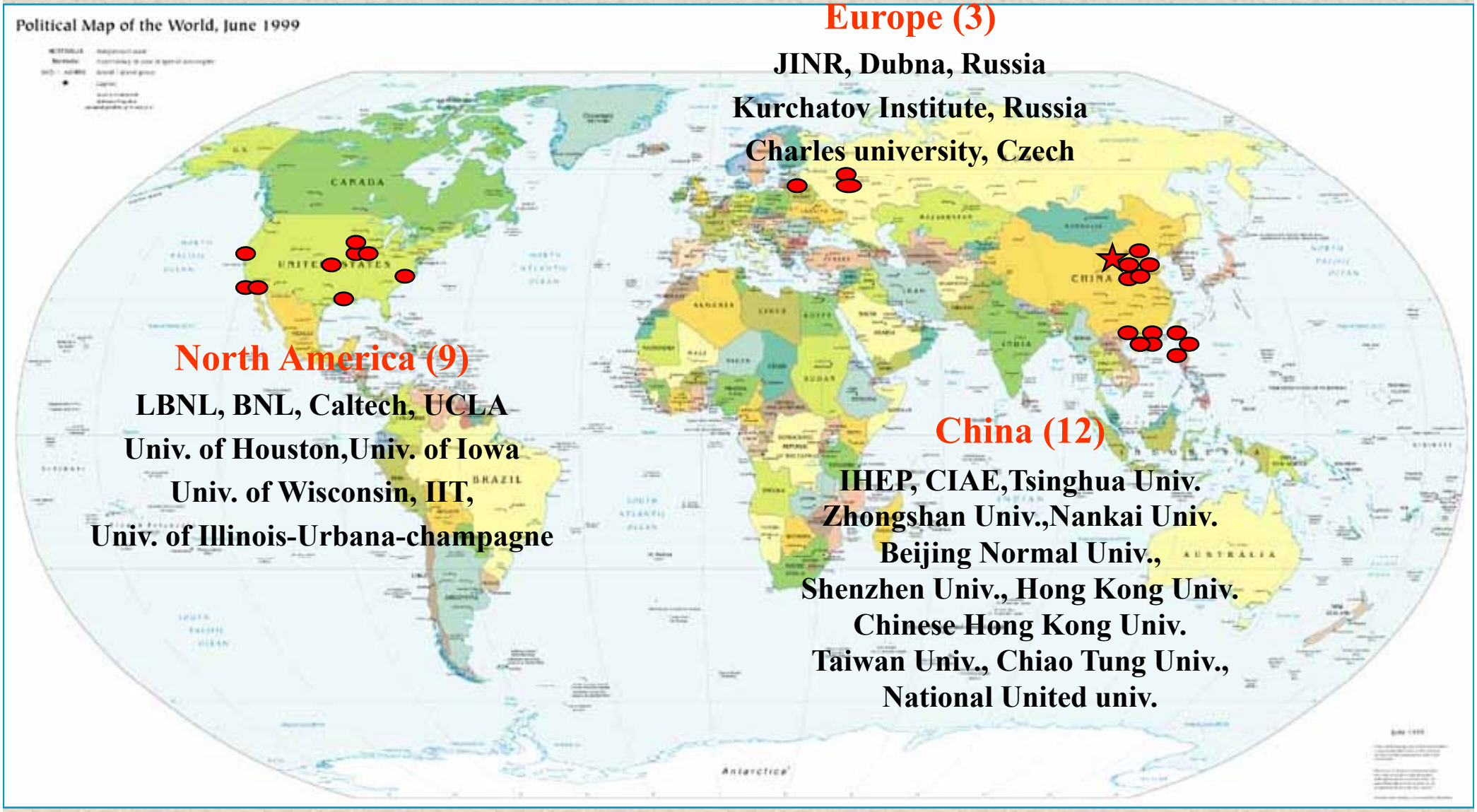
Oil buffer thickness

Isotopes	Purity (ppb)	20cm (Hz)	25cm (Hz)	30cm (Hz)	40cm (Hz)
^{238}U(>1MeV)	50	2.7	2.0	1.4	0.8
^{232}Th(>1MeV)	50	1.2	0.9	0.7	0.4
^{40}K(>1MeV)	10	1.8	1.3	0.9	0.5
Total		5.7	4.2	3.0	1.7

Systematic error comparison

		Chooz	Palo Verde	KamLAND	Daya Bay
Reactor power		0.7	0.7	2.05	<0.2%
Reactor fuel/ν spectra		2.0	2.0	2.7	
ν cross section		0.3	0.2	0.2	0
No. of protons	H/C ratio	0.8	0.8	1.7	0.2
	Mass	-	-	2.1	0.2
Efficiency	e+ E cuts	0.8	2.1	0.26	0.05
	n energy cut	0.4			0.2
	Position cuts	0.32		3.5	0
	Time cuts	0.4		0.	0.2
	P/Gd ratio	1.0		-	0.1
	n multiplicity	0.5		-	<0.1
background	correlated	0.3	3.3	1.8	<0.5
	uncorre.	0.3	1.8	0.1	<0.1
Trigger		0	2.9	0	<0.1
livetime		0	0.2	0.2	<0.1

Daya Bay collaboration



Europe (3)

JINR, Dubna, Russia

Kurchatov Institute, Russia

Charles university, Czech

North America (9)

LBNL, BNL, Caltech, UCLA

Univ. of Houston,Univ. of Iowa

Univ. of Wisconsin, IIT,

Univ. of Illinois-Urbana-champagne

China (12)

IHEP, CIAE,Tsinghua Univ.

Zhongshan Univ.,Nankai Univ.

Beijing Normal Univ.,

Shenzhen Univ., Hong Kong Univ.

Chinese Hong Kong Univ.

Taiwan Univ., Chiao Tung Univ.,

National United univ.

Status of the project

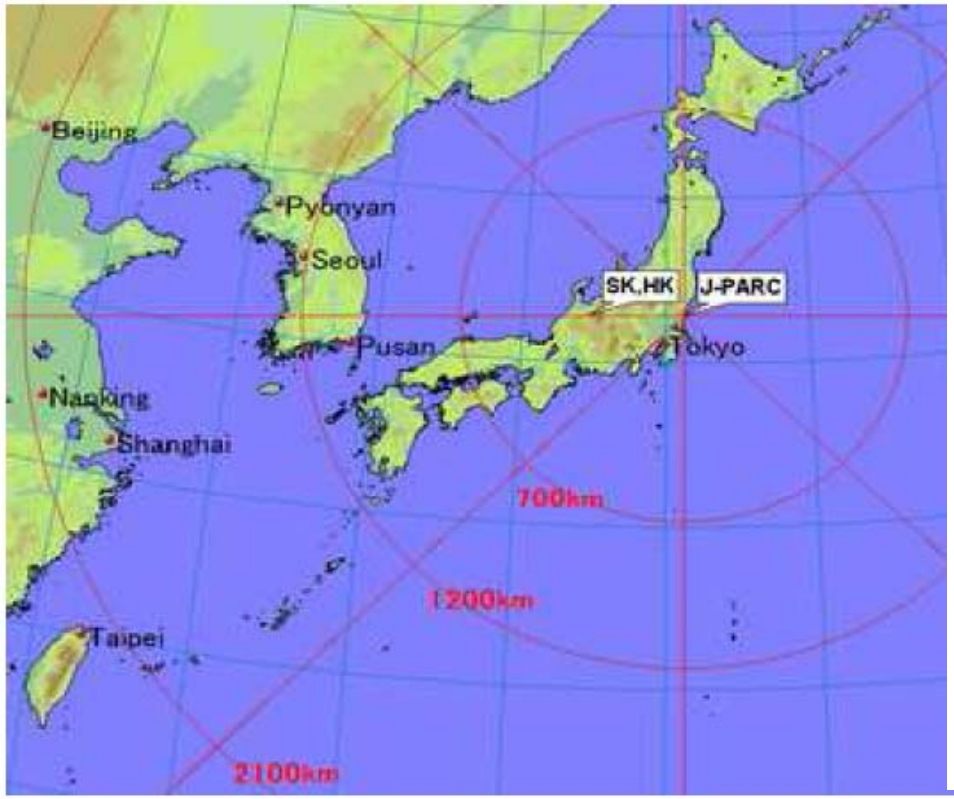
- Total Cost estimated 32 M$ in Chinese accounting.
- MoST and CAS officially approved the project.
- Chinese Atomic Energy Agency, Daya Bay nuclear power Co. and local governments support the project strongly.
- All Funds from China were approved.
- Site survey including bore holes completed.
- Design of tunnel is finished.
- Bidding of tunnel construction is done.
- Ground breaking ceremony of the tunnel construction will be held 13 Oct. 2007 at Daya Bay.
- R&D started in collaborating institutions, the prototype is operational
- DoE agreed to provide funds to construct 50% of the detector Proposals to governments under preparation

Schedule of the project

- Schedule
  - 2004-2006 R&D, engineering design, secure funding
  - 2007-2008 construction
  - 2009 installation
  - 2010 running

VLBL ν Experiment of J-Parc to Beijing

- VLBL ν exp. with 2000 - 4000 km is very interesting for many important physics, if $\sin^2 2\theta_{13}$ is not too small:
  - Sign of the difference of ν mass square
  - CP phase of ν
  - ν_τ appearance
- VLBL ν experiment from JHF to Beijing
  - Good tunnel: 20 km north of Beijing, near highway to Great Wall. 560 m long, 34 meter wide, 13 meter height , 150 m rock on top
  - Good infrastructure available
  - 2200 km to JHF with 9.5° dip angle
- Second ν beam line required.
  J-Parc phase 2? ν Factory ?
- Two reports issued and several papers published.



780 Km: CERN → Gran Sasso Opera

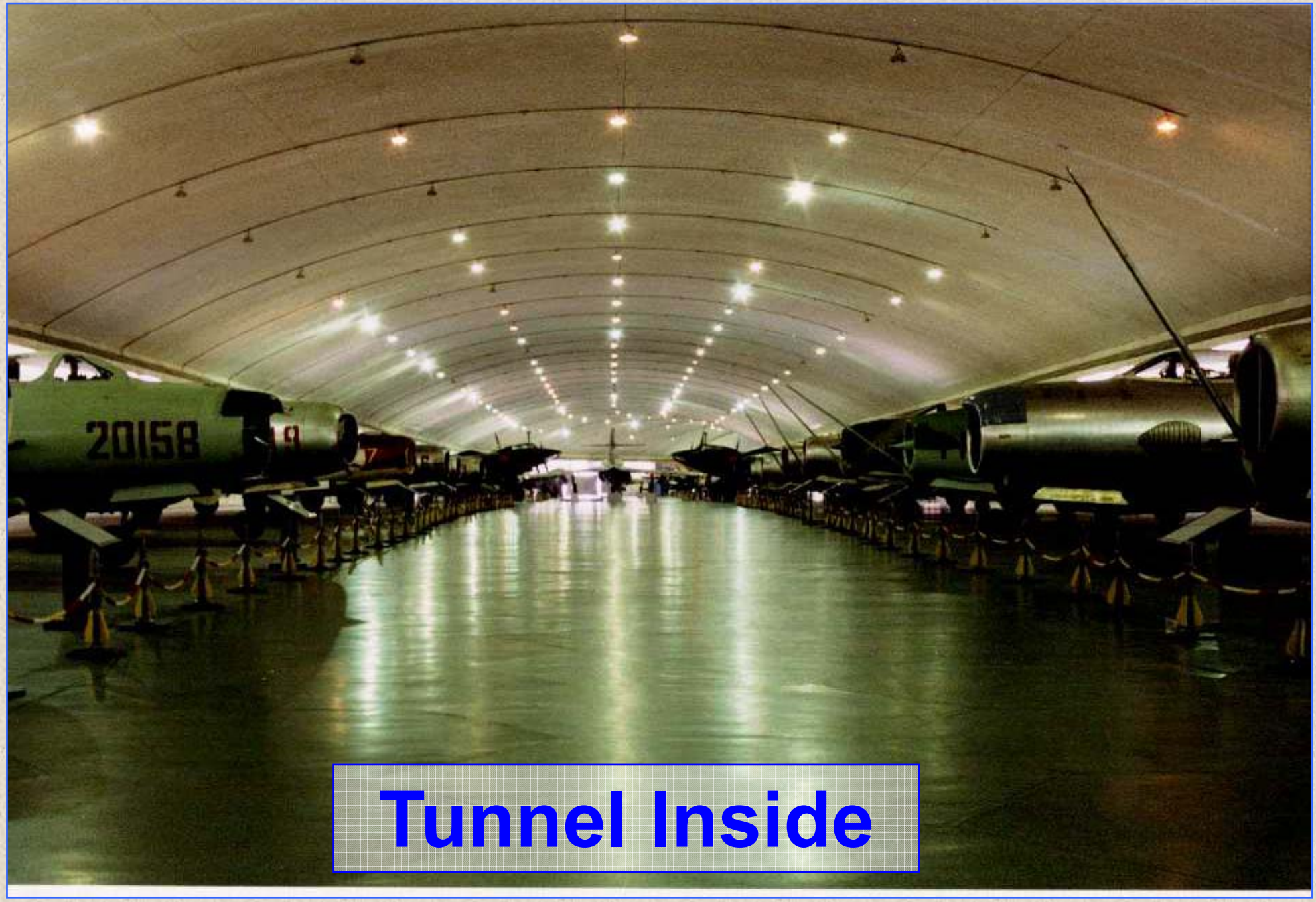
730 Km: FNAL → Soudan Minos

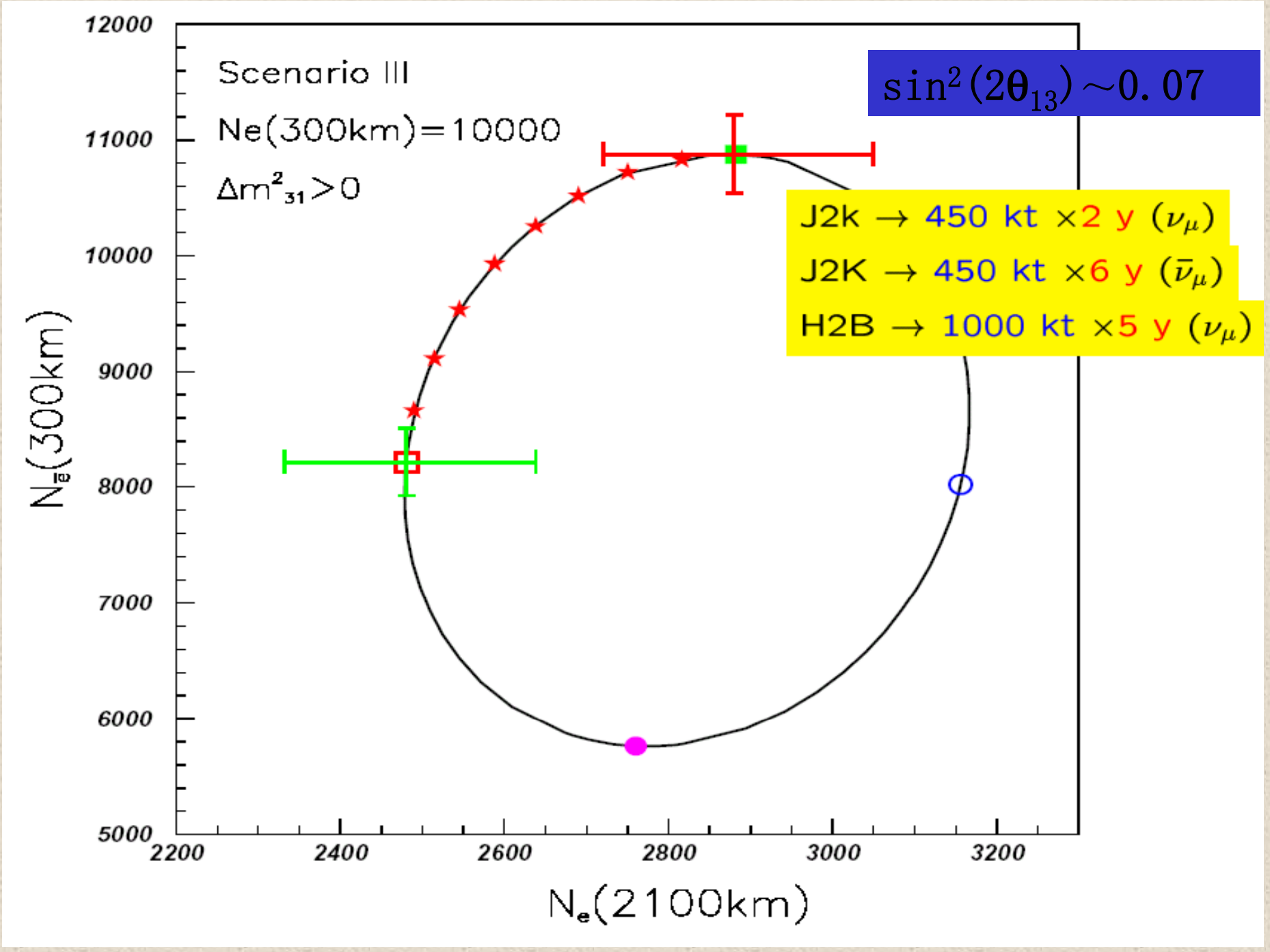
2100 Km: J-Parc → Beijing

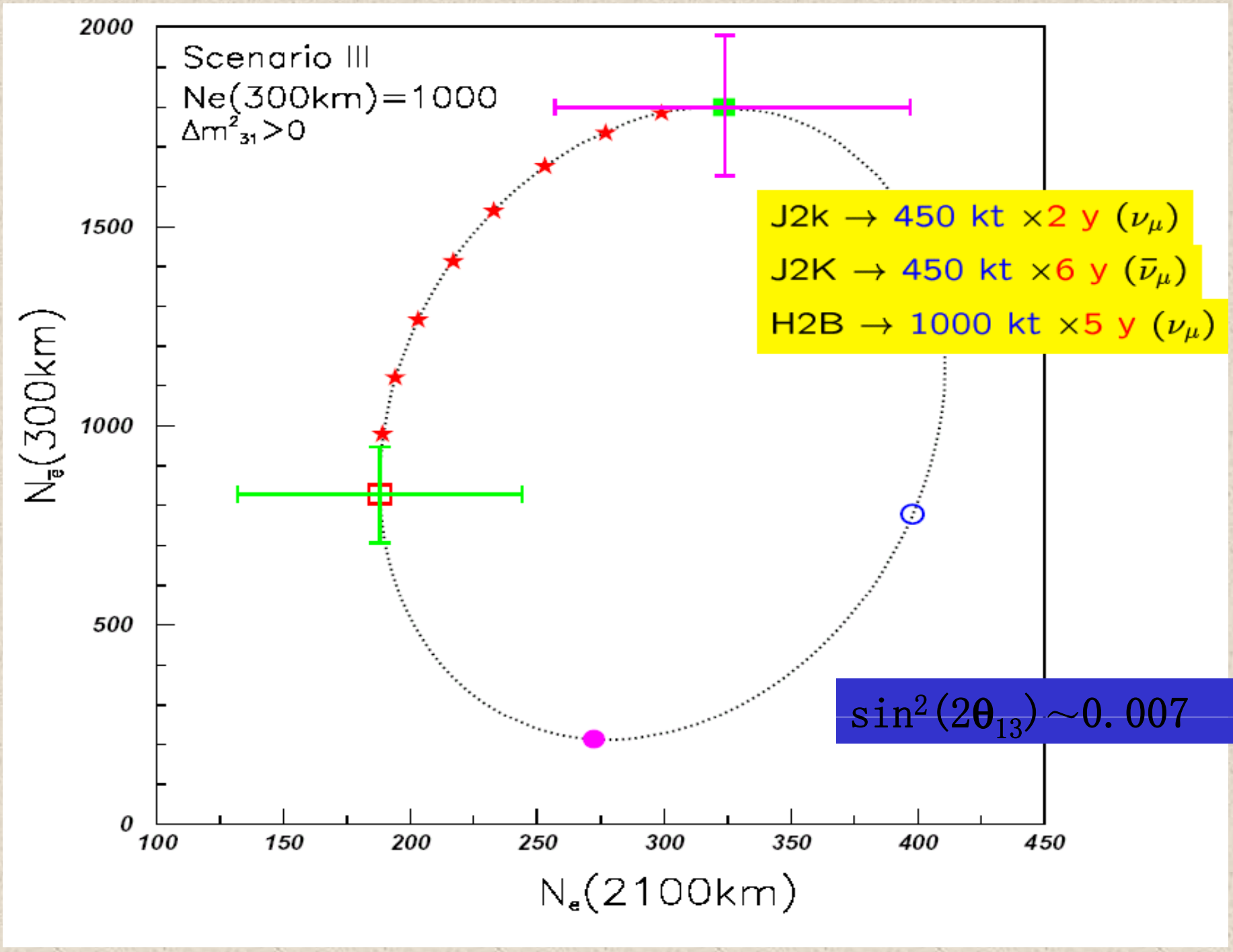
Tunnel Gate

(Aviation Museum)

20 km north of Beijing, near highway to Great Wall


20158
Tunnel Inside


Scenario III
Ne(300km)=10000
$\Delta m^2_{31} > 0$
$\sin^2(2\theta_{13}) \sim 0.07$
J2k → 450 kt ×2 y (ν_μ)
J2K → 450 kt ×6 y ($\bar{\nu}_\mu$)
H2B → 1000 kt ×5 y (ν_μ)
$N_{\bar{e}}$(300km)
N_e(2100km)
12000
11000
10000
9000
8000
7000
6000
5000
2200
2400
2600
2800
3000
3200


Scenario III
Ne(300km)=1000
$\Delta m^2_{31}>0$
J2k → 450 kt ×2 y (ν_μ)
J2K → 450 kt ×6 y ($\bar{\nu}_\mu$)
H2B → 1000 kt ×5 y (ν_μ)
$\sin^2(2\theta_{13})\sim 0.007$
N_e(300km)
N_e(2100km)
2000
1500
1000
500
0
100
150
200
250
300
350
400
450

High energy neutrino research

AGN, GRB, GZK,
Z-burst, etc

The Universe behind mountains

High E ν_e

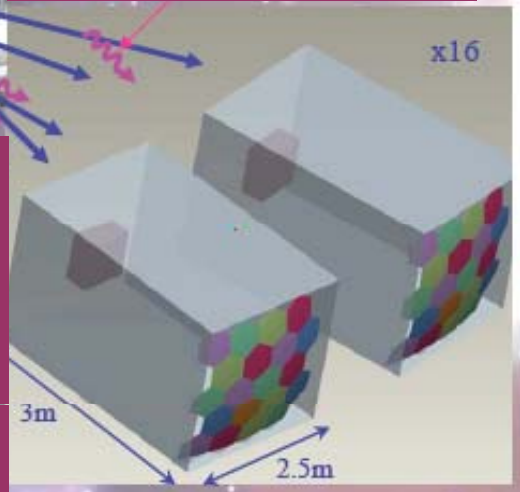
ν_μ

ν_τ

neutrino oscillation

Air-shower

Cerenkov /
Fluorescence

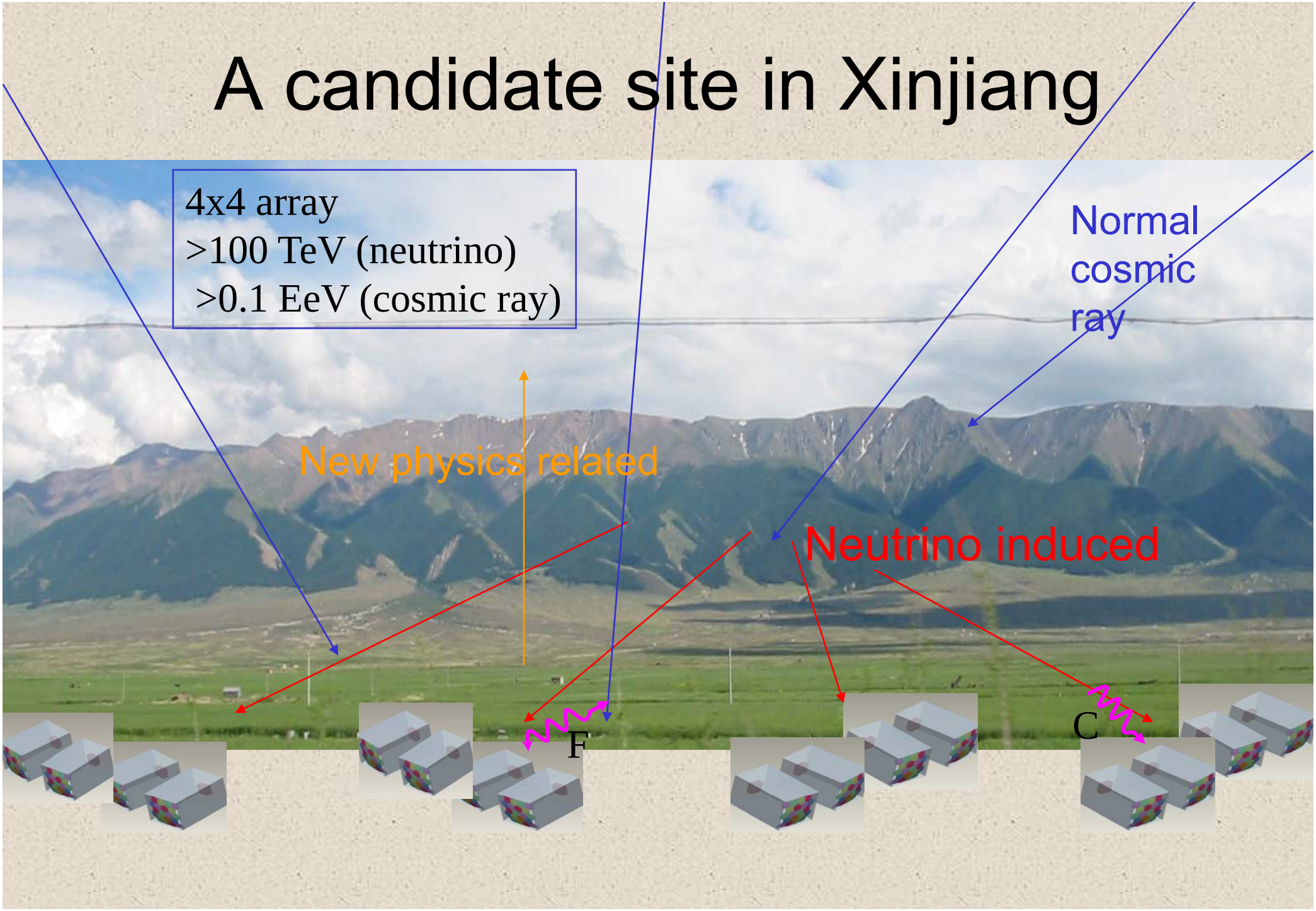


AGN event rate:
8~10 event/yr
using
16 telescopes

CRTNT

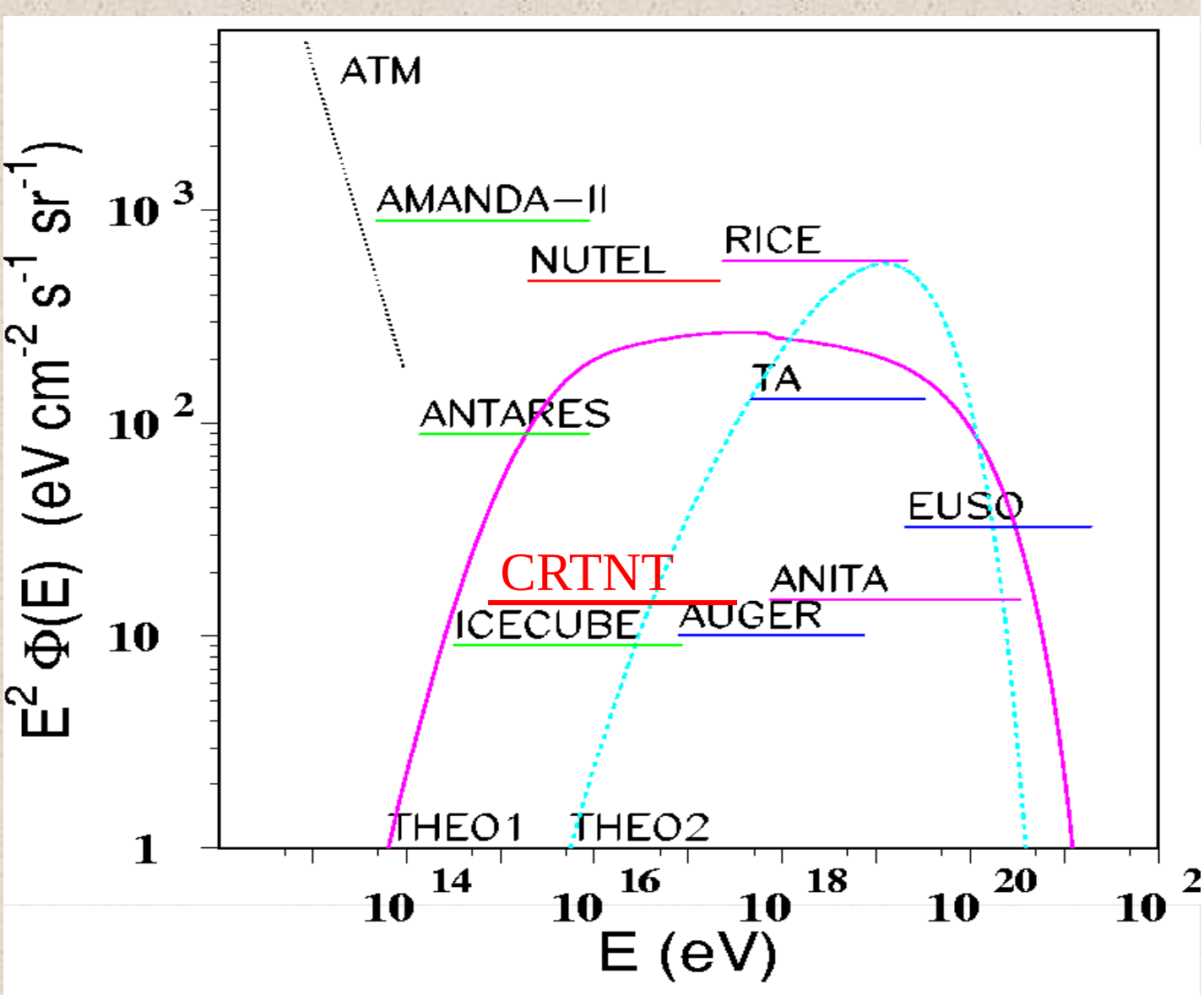
Cosmic Ray Tau
Neutrino
Telescope

A candidate site in Xinjiang

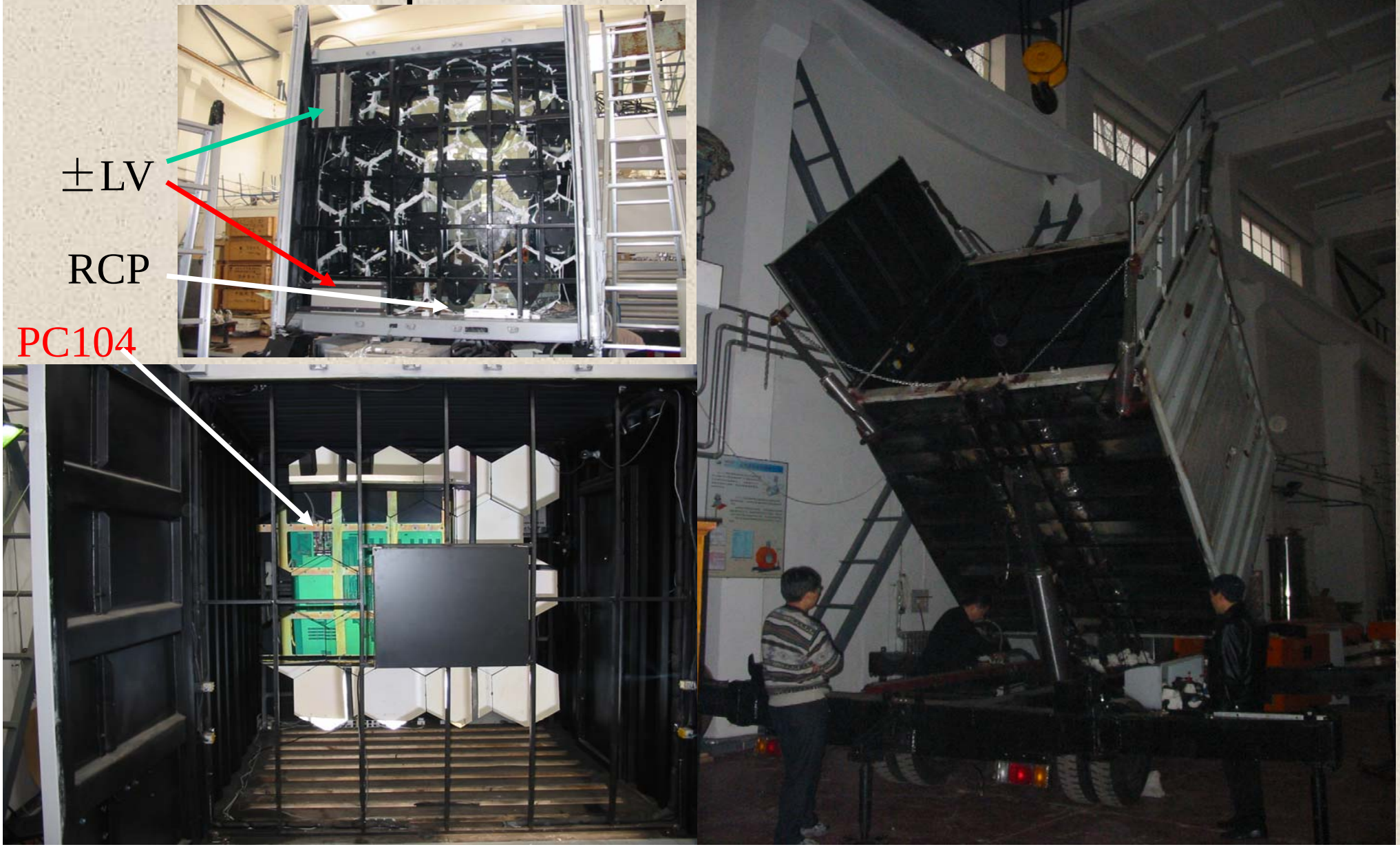


Sensitivity Summary

- Defined as reachable upper limit of flux
- Assume F(En) = F0 En^{-2}
- Assume no signal in 2 years of observation
- Feldman-Cousin method for upper limits: 2.44 signal events

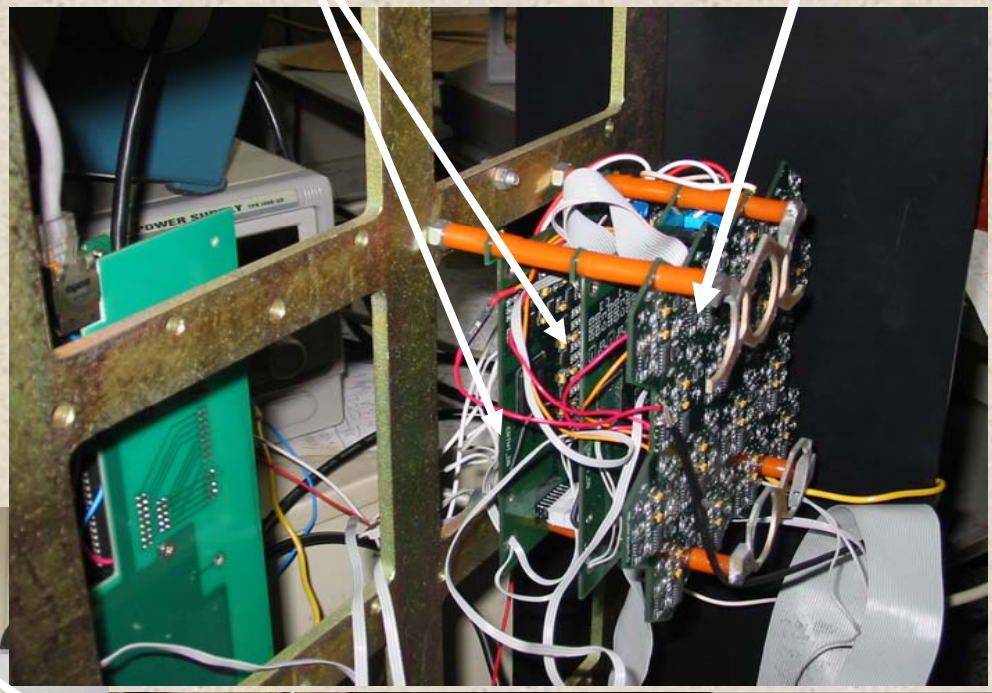


Telescope control: remote control & monitoring of door open/close, LV & HV turn on/off

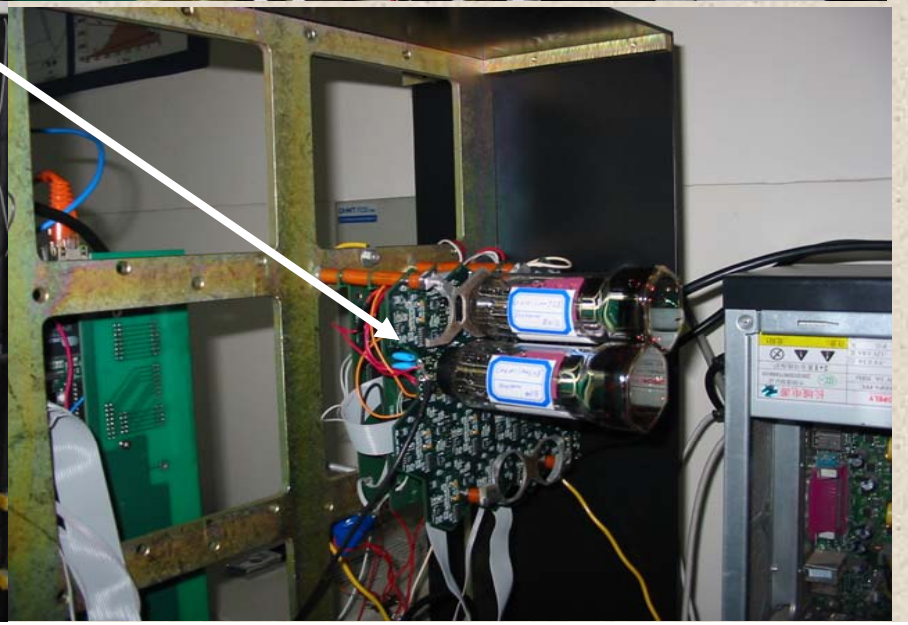


Camera

Digital boards analog board



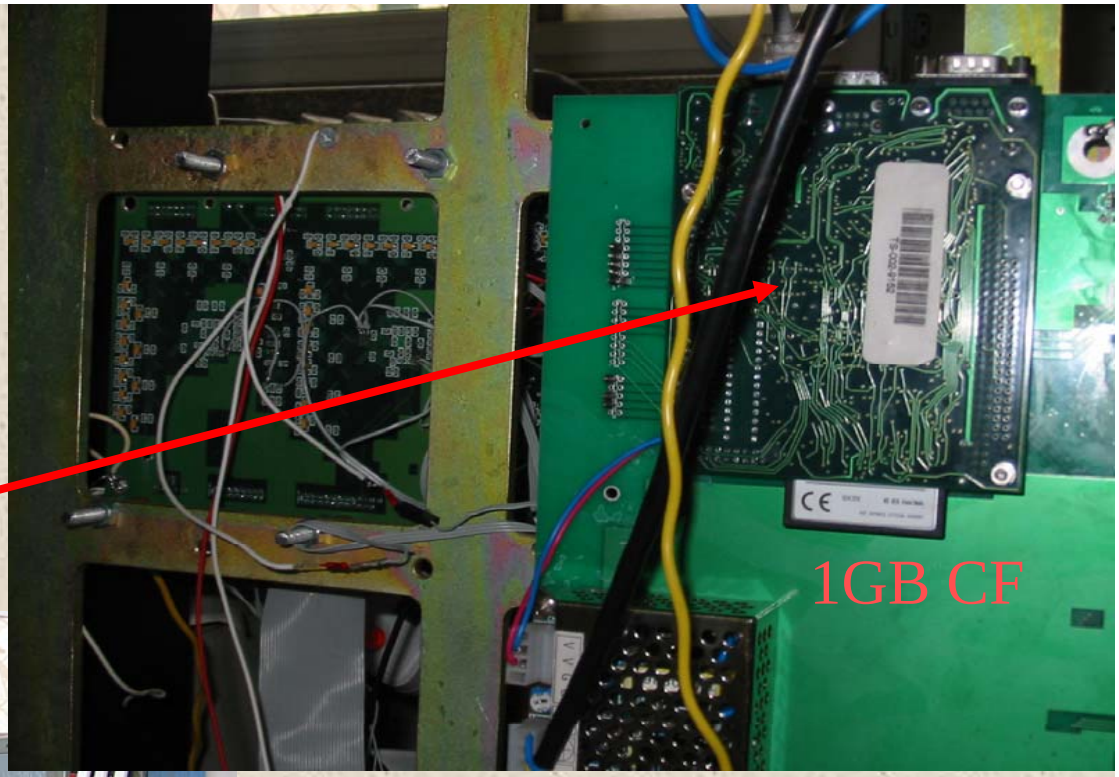
Camera holder sub-cluster

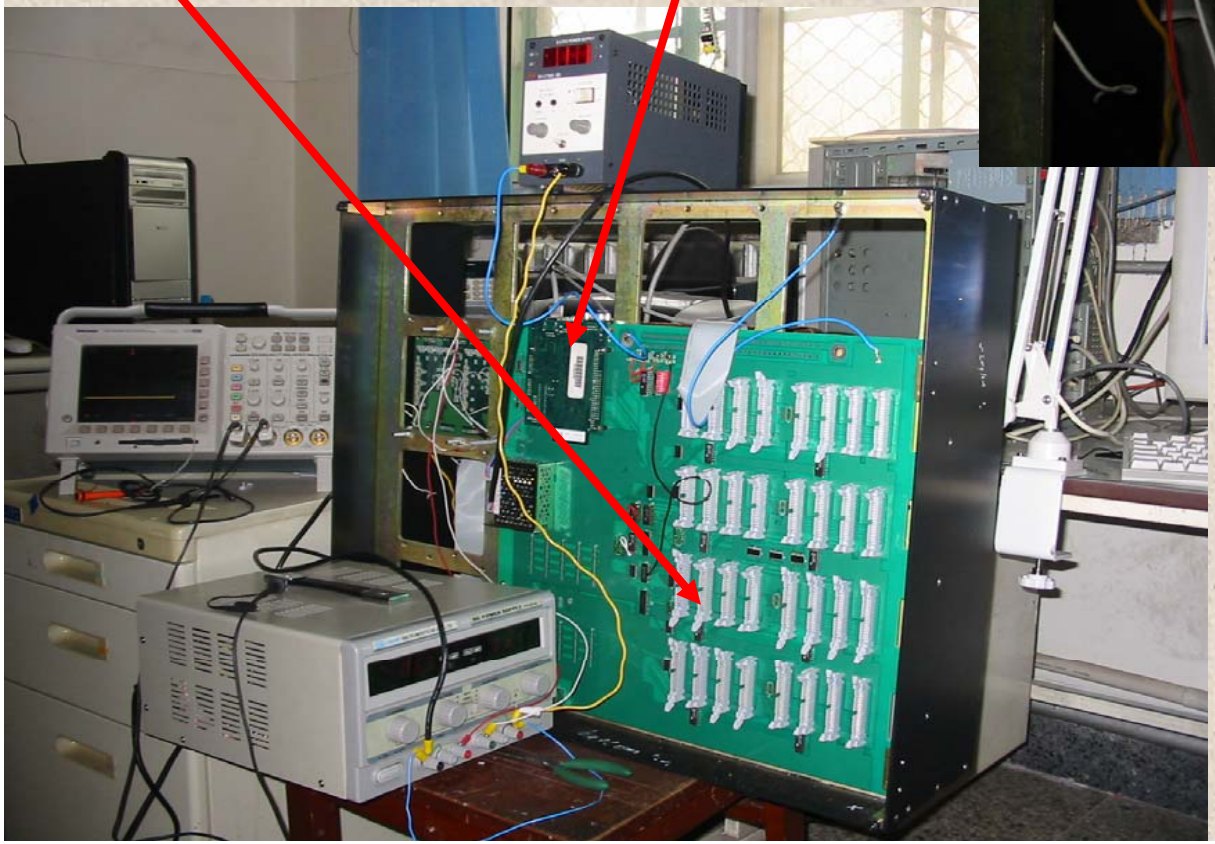


Camera: 4x4 sub-cluster & BP DAQ

data bus

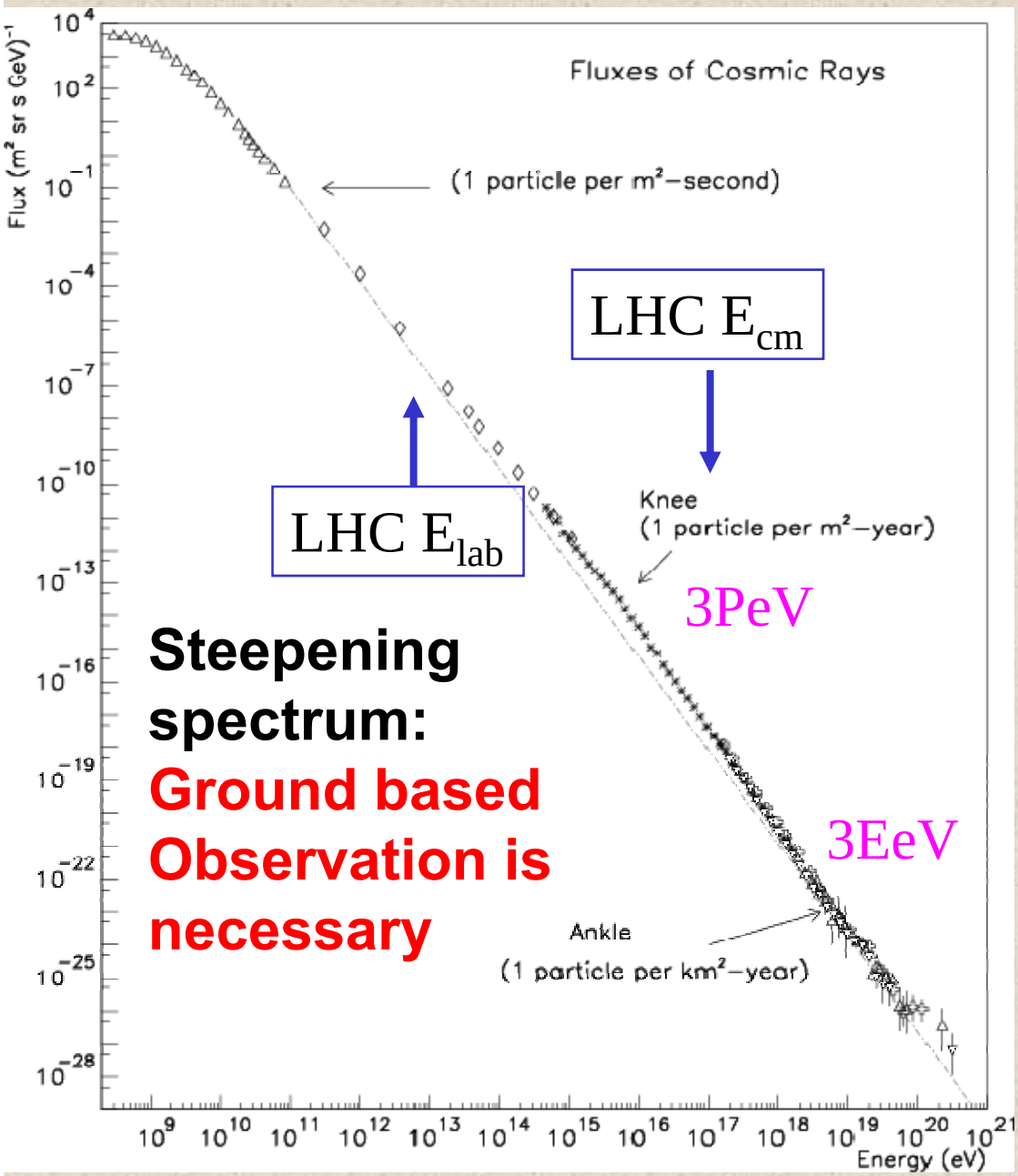
PC104(linux)

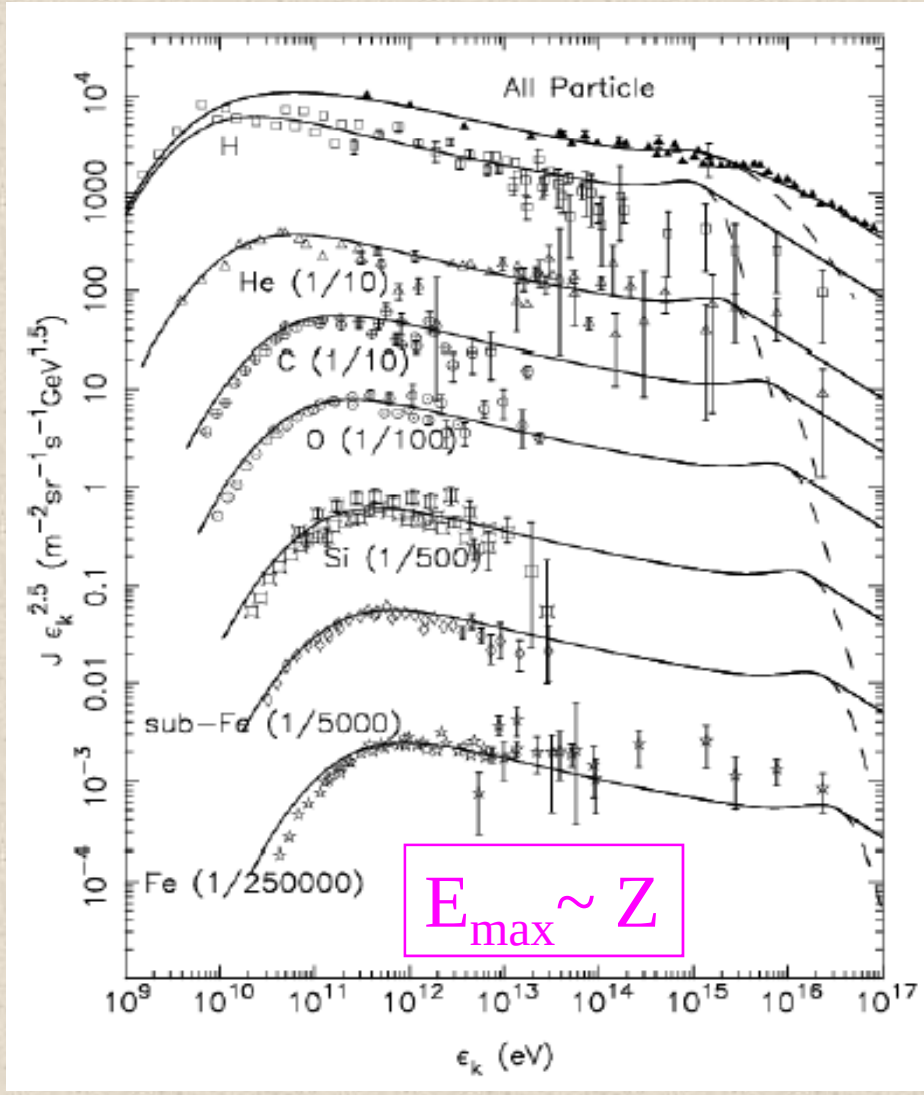




High Altitude Mountain Experiments

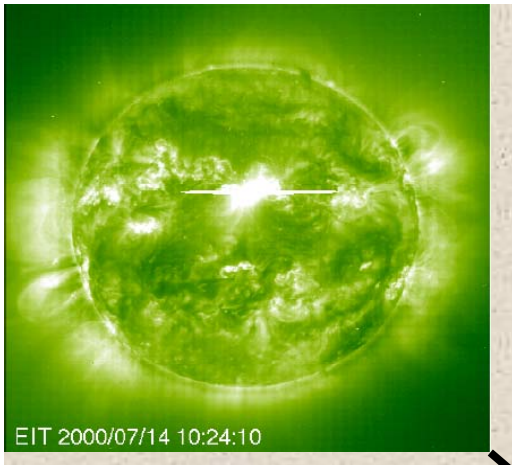
CR spectrum



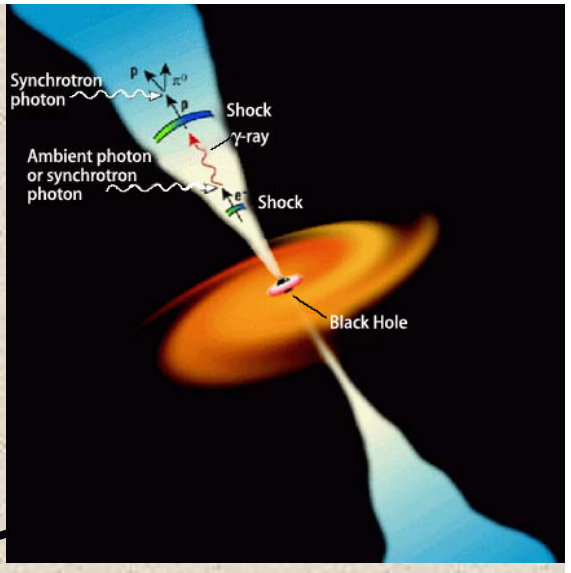


(Berezhko)

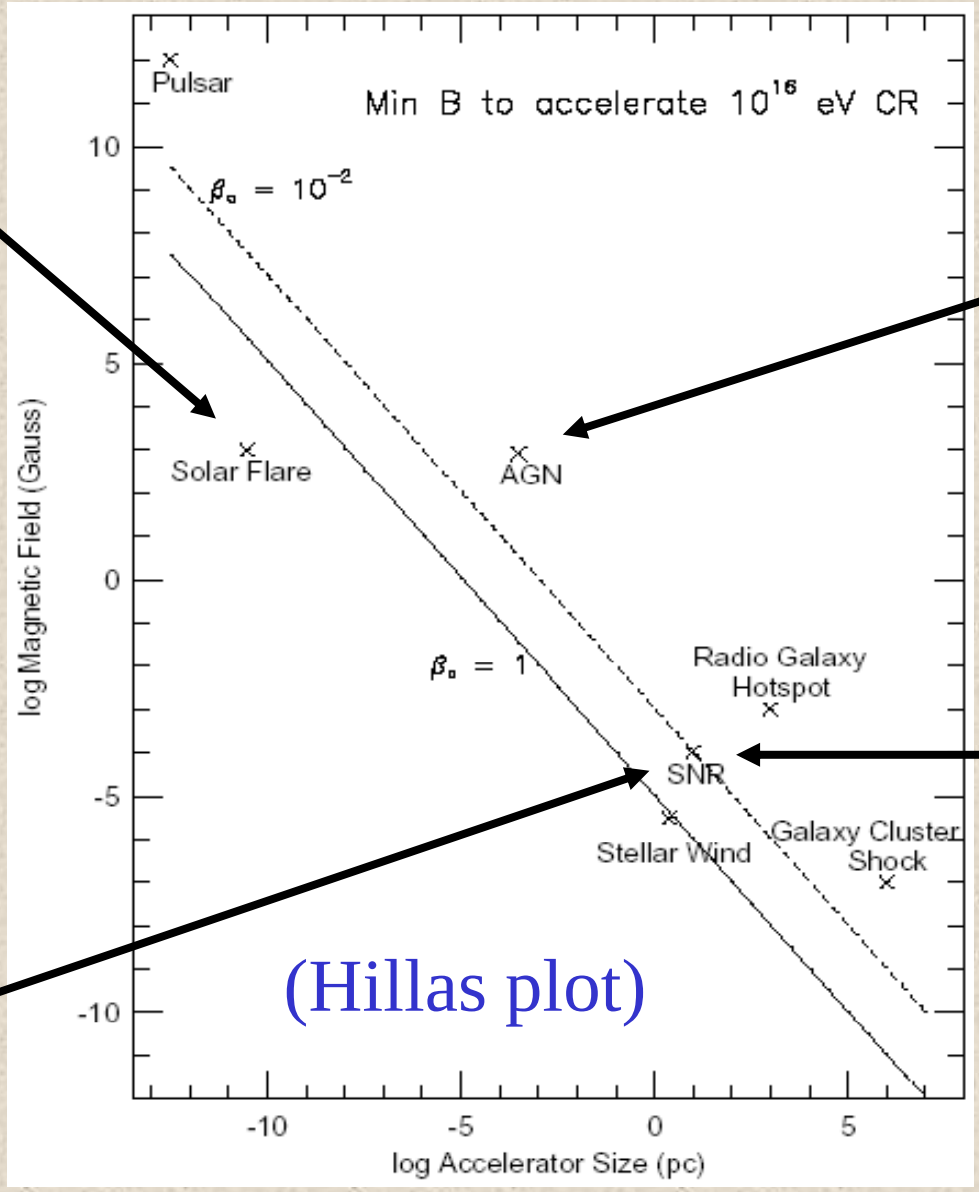
$E_{max}=\beta ZBL$



Solar flares:10^{11}eV

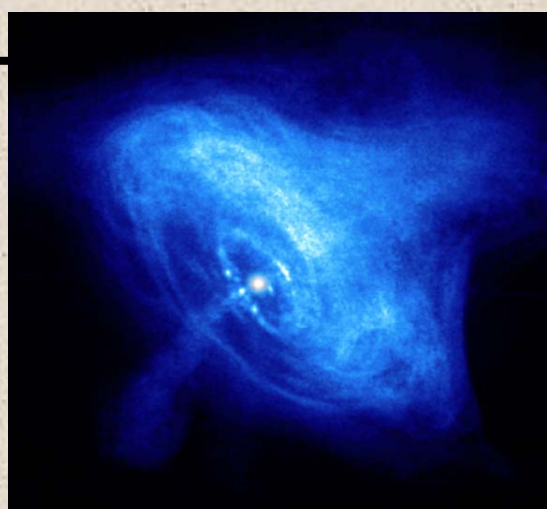


AGN: $10^{18\text{-}20}$eV

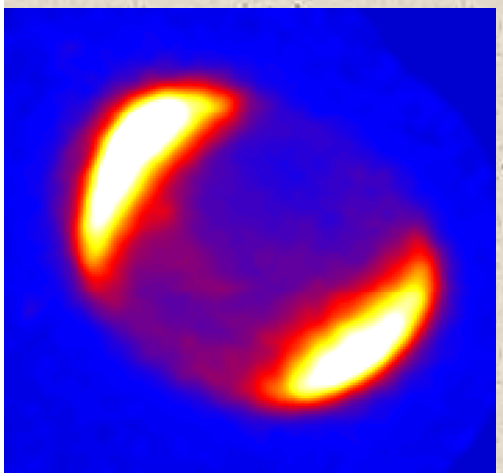


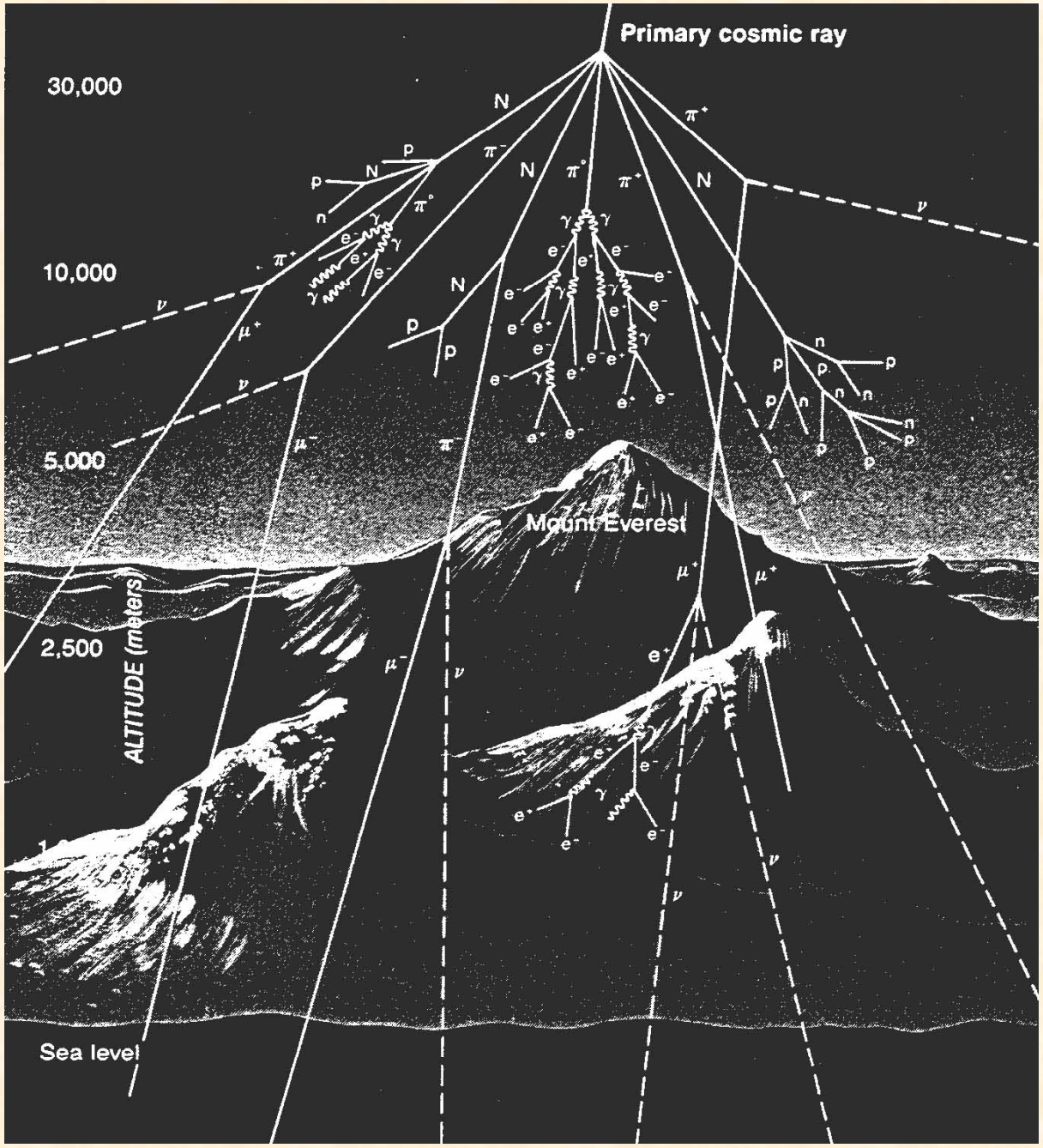
(Hillas plot)

Crab :10^{16}eV



SN1006: 10^{16}eV

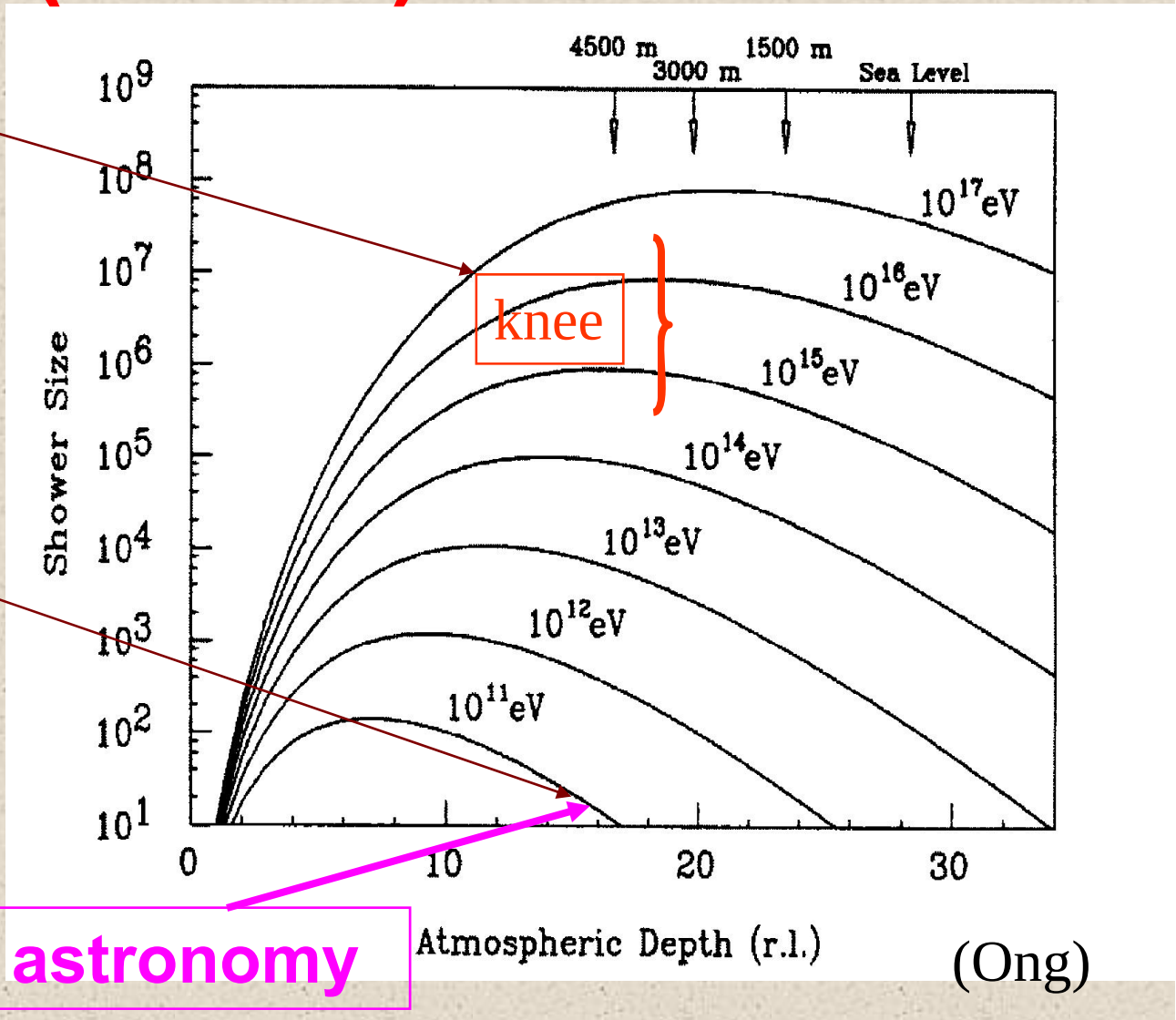




(Extensive Air Shower)

Advantage of YangBaJing altitude (4300M)

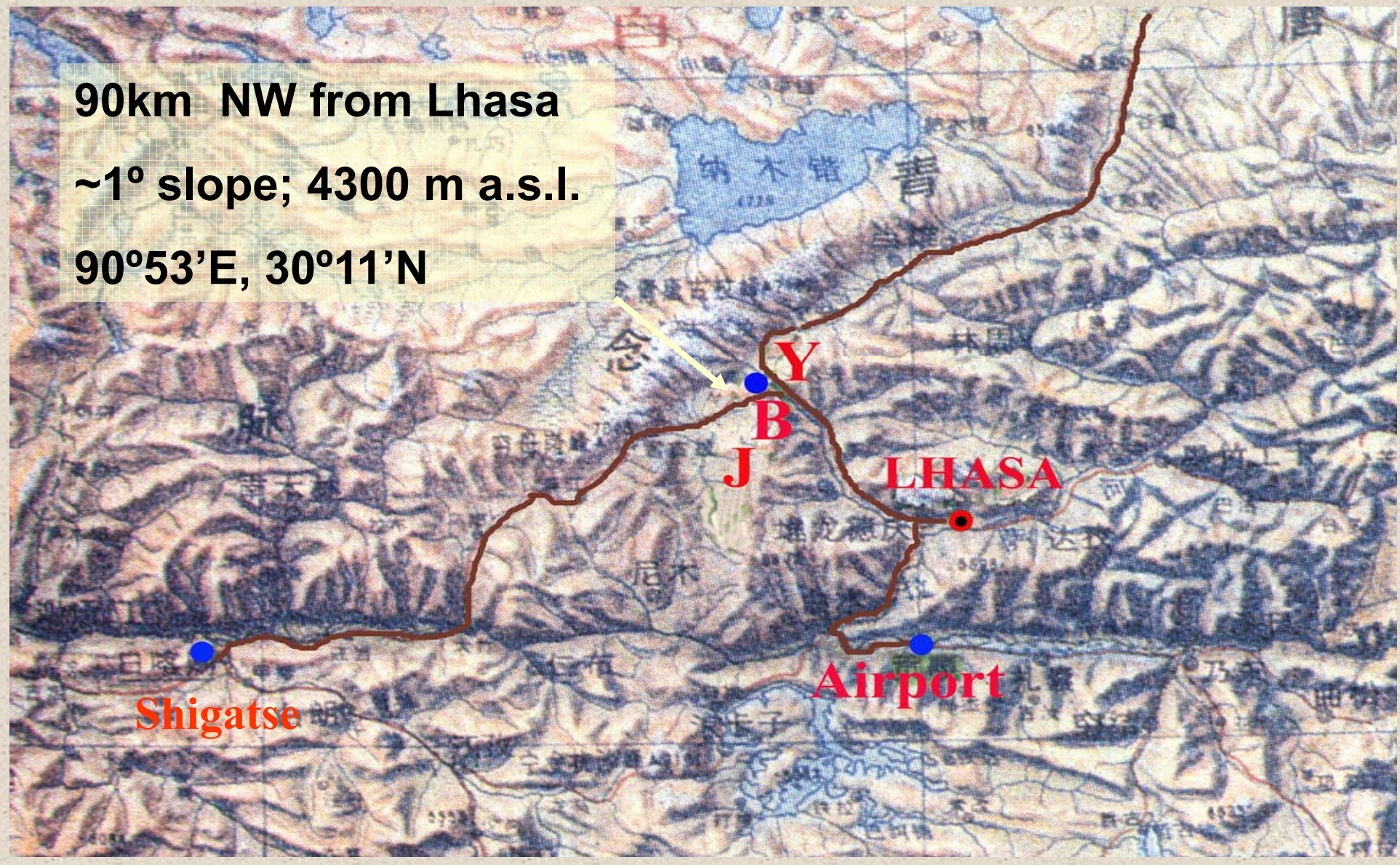
- Number of secondary reach maximum, in favor of knee physics, including composition and spectrum measurement.
- Low energy threshold, in favor of γ ray astronomy
- Better angular,energy resolution



γ ray astronomy

(Ong)

YBJ Satisfy all the requirements



Requirements on Observation Site

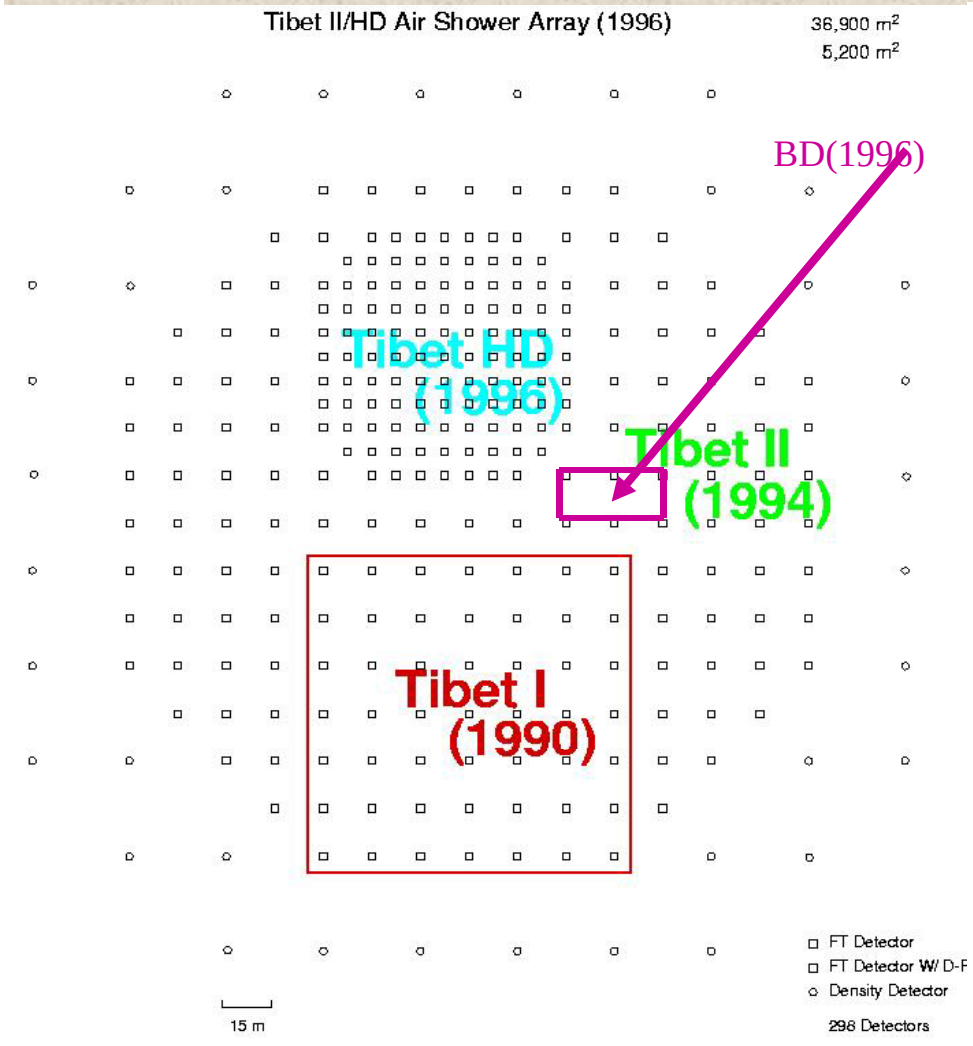
high quality operation, low cost and long life-span:

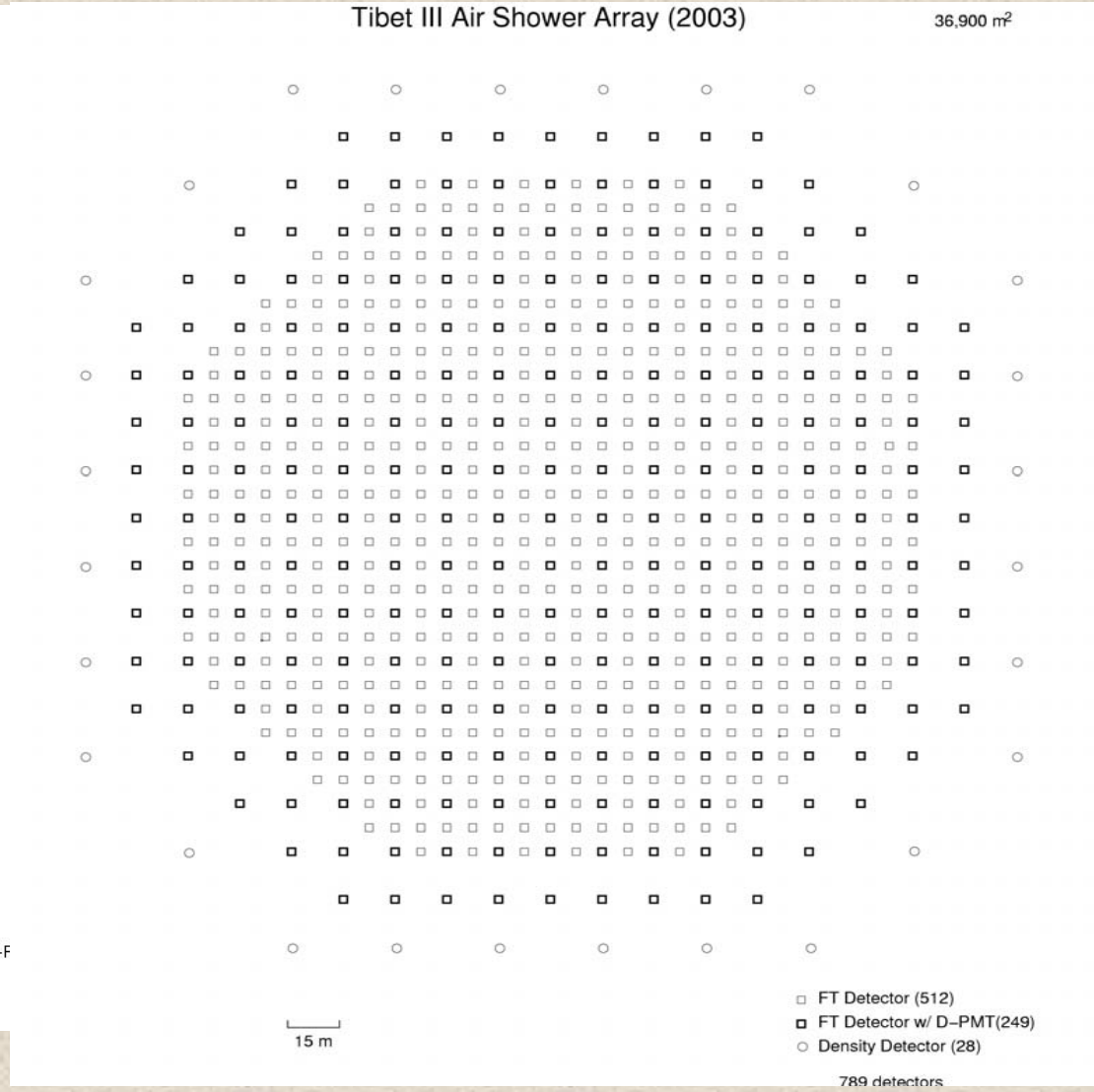
- Altitude — 4300m a.s.l.
- Topography — flat and wide, plenty of space.
- Climate — easy for construction, operation & living.
- Traffic — accessible to highway, airport or railway station.
- Power — existed electric power line network.
- Logistics — not far from local town/modern city.
- Neighborhood — 1000s of residents: clinic, post office, school …
- Communication — Telephone, mobile phone, high speed optical fiber network (155Mbps today).

History of ASγ development

3 TeV;115Hz;0.9 º;

3 TeV;1700Hz;0.87 º



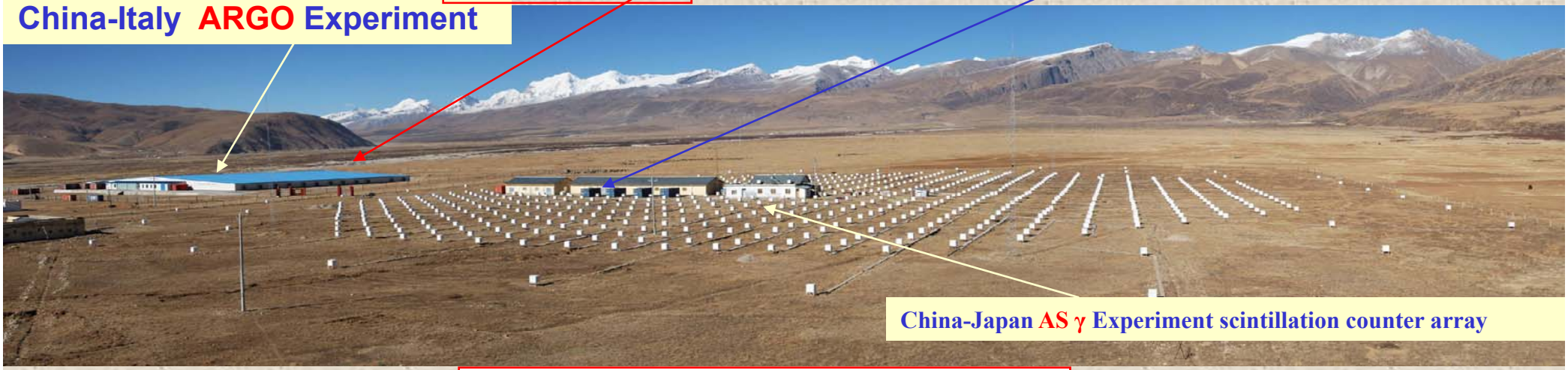


Asγ,ARGO (High Duty cycle, Large F.O.V)

~100 GeV

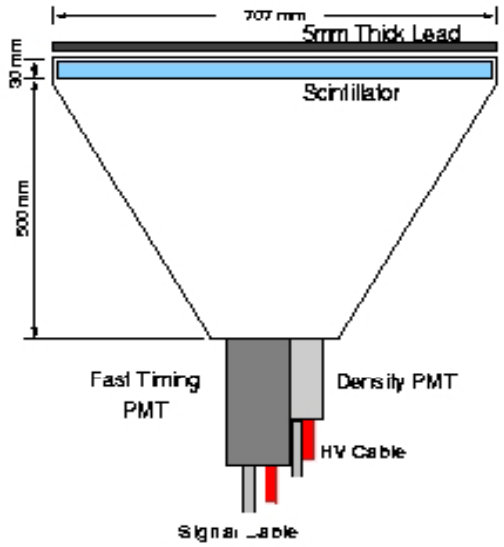
~TeV

China-Italy ARGO Experiment



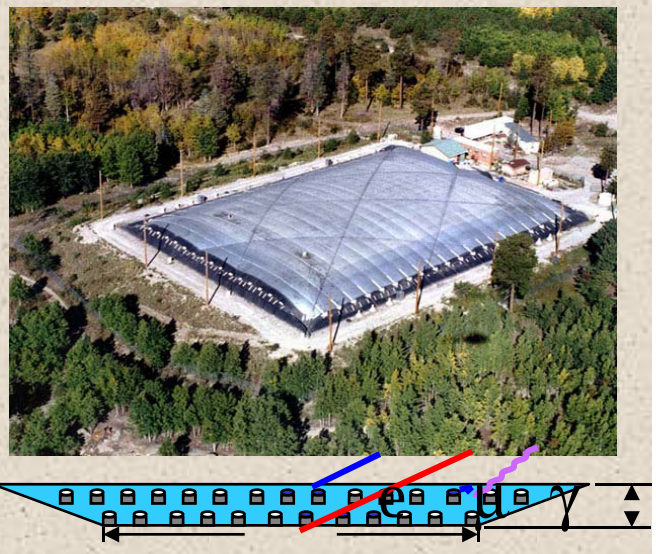
China-Japan AS γ Experiment scintillation counter array

AS γ scintillation counter

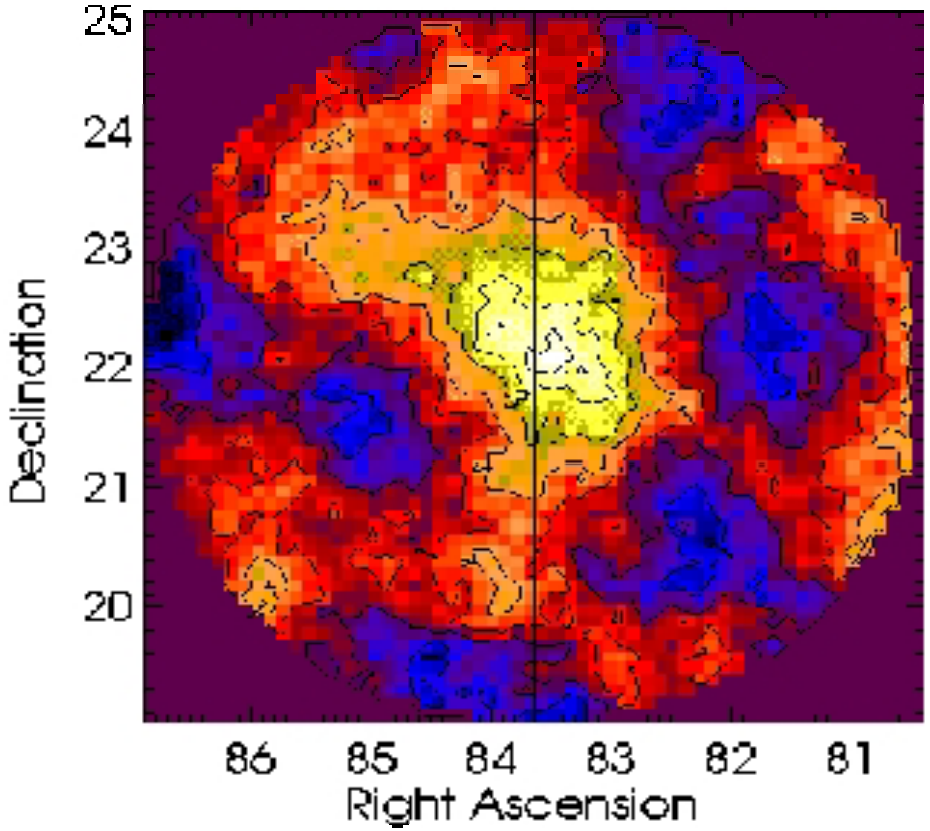


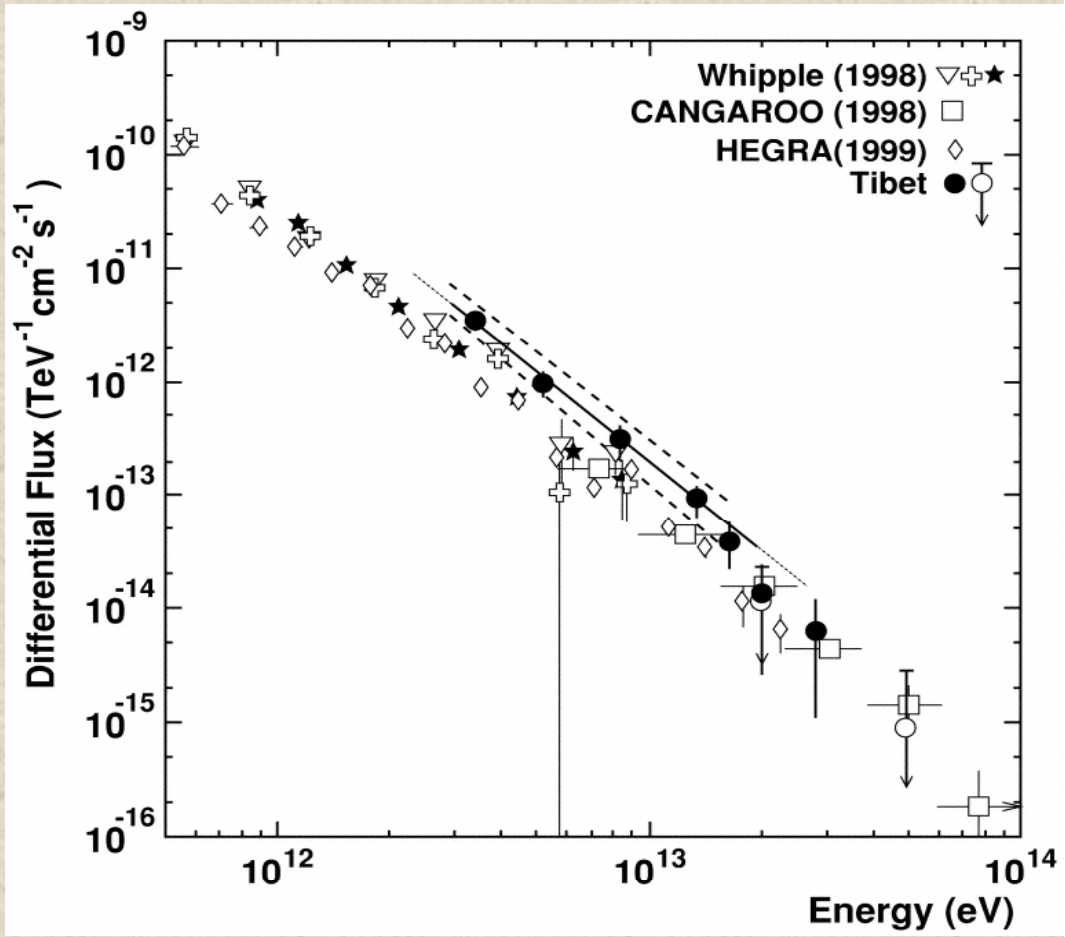
ARGO hall, floored by RPC.
Fully installed in July 2006.

MILAGRO,Jemez（2630M）



Gamma ray emission from Crab (TibetII-HD : 5.5σ,ApJ 525,L93,1999)

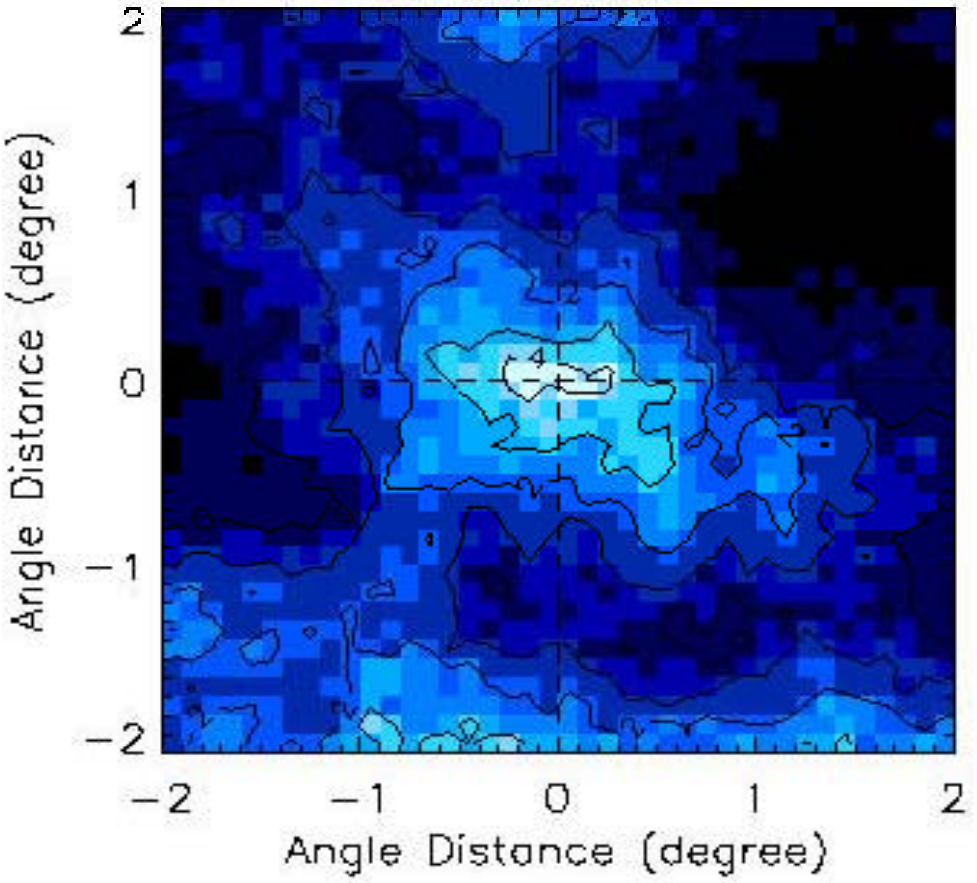


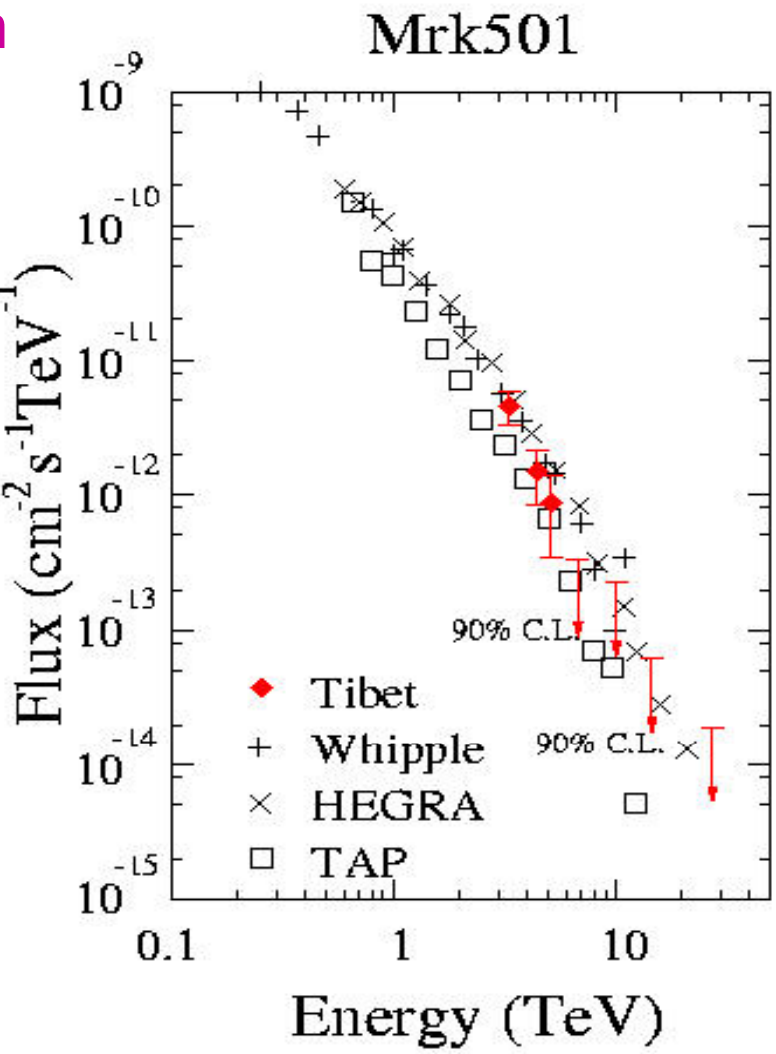


Mrk501 (TibetII HD)

ApJ 532,302(2000)

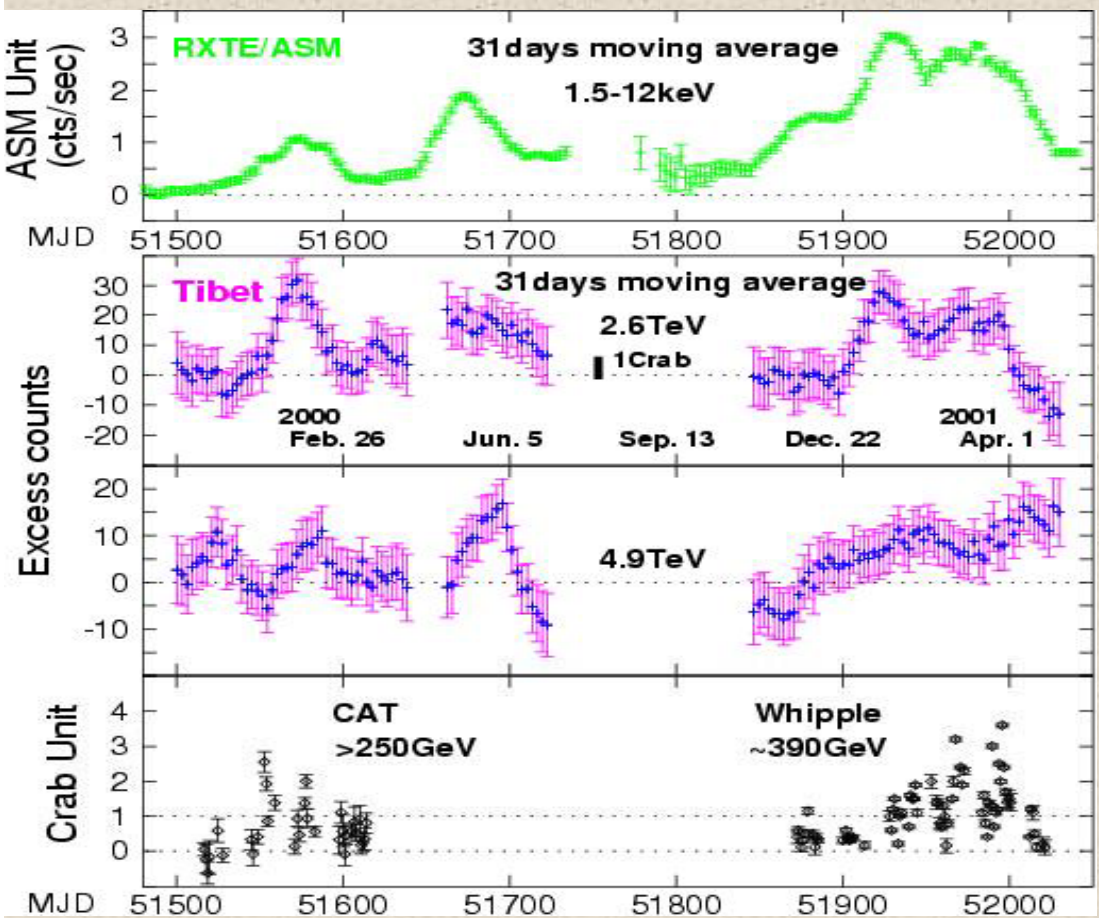
Feb.1997-Aug.1997. Only observation from conventional air shower array.

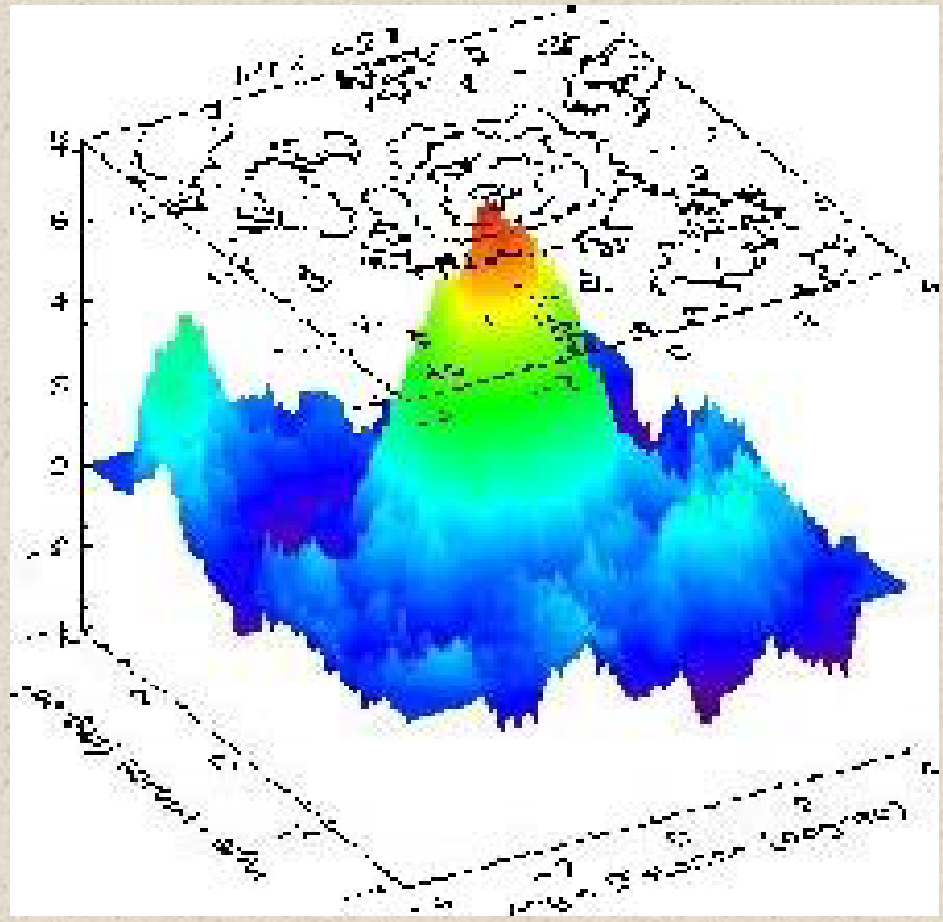




Mrk421 (6.9σ)

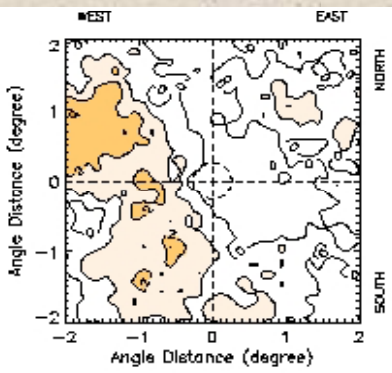
AS γobserved the flare of Mrk 421 in 2000-2001 with a much longer duration coverage than Cerenkov telescopes.



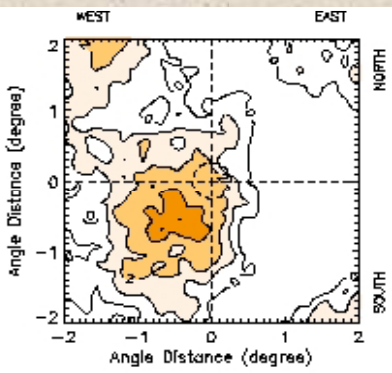


Solar Cosmic-Rays

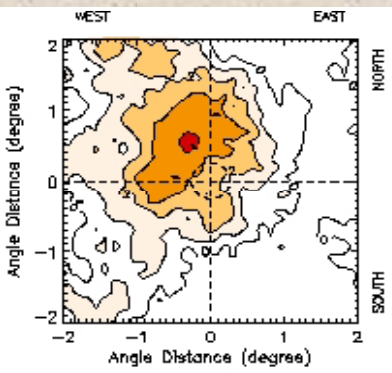
1) The first detection of solar CR shadow.



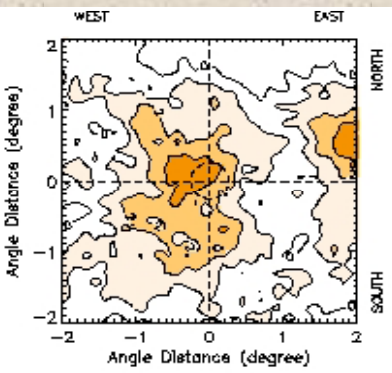
1990(Tibet-I)



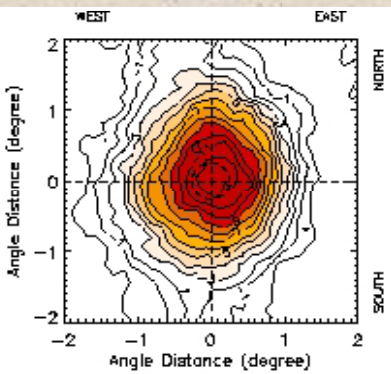
1991(Tibet-I)



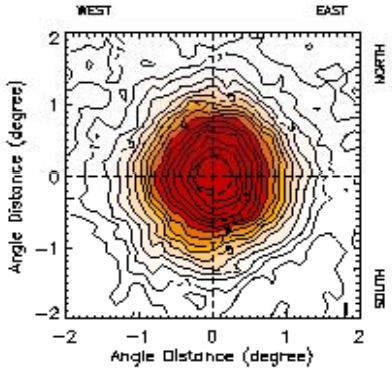
1992(Tibet-I)



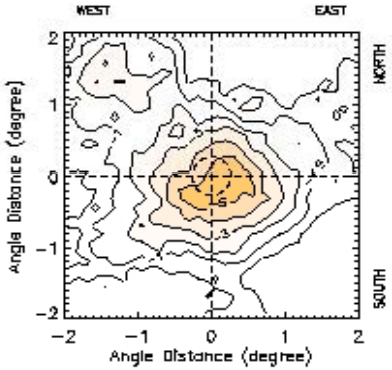
1993(Tibet-I)



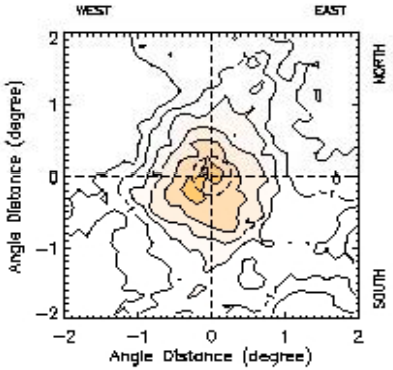
1996(Tibet-II)



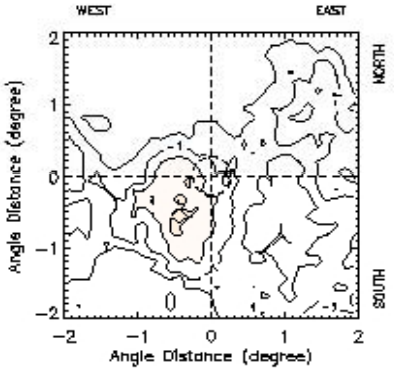
1997(Tibet-II)



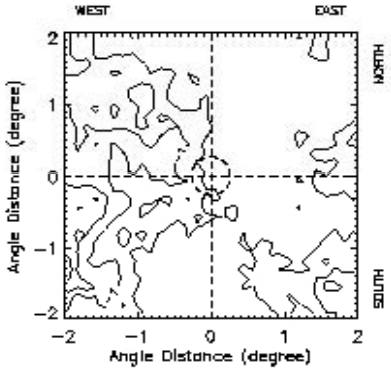
1998(Tibet-II)



1999(Tibet-II)



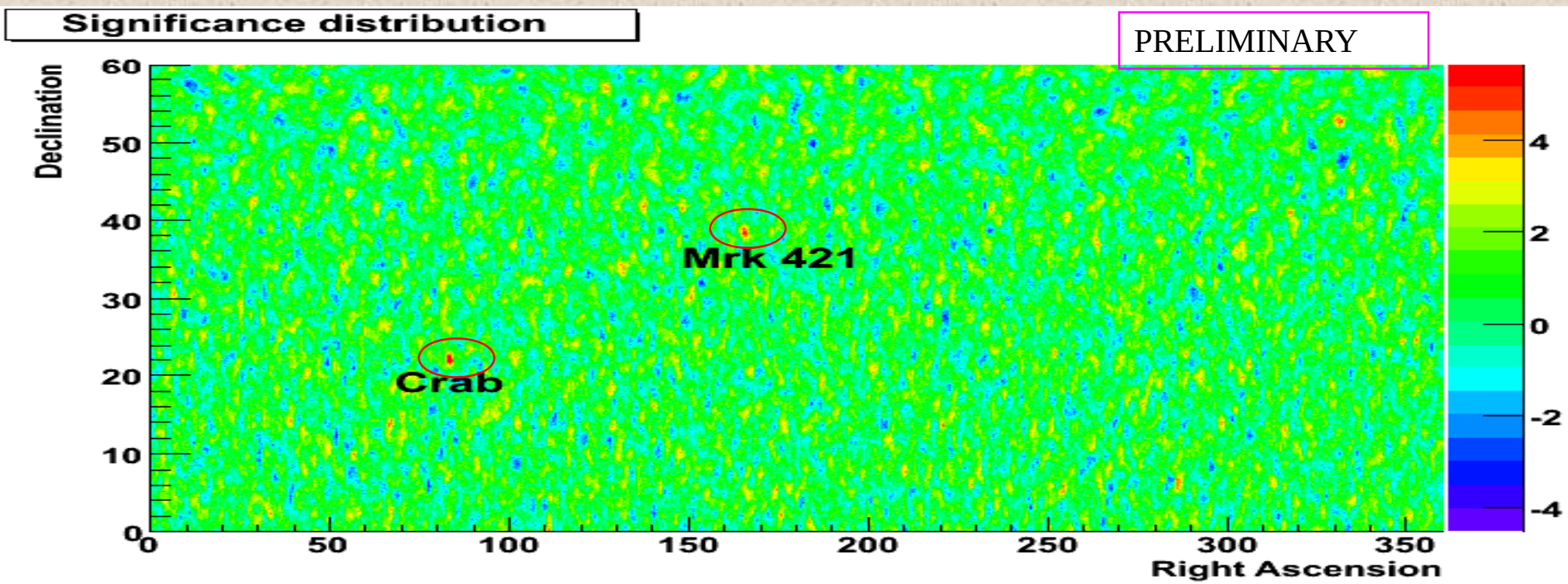
2000(Tibet-III)



2001(Tibet-III)

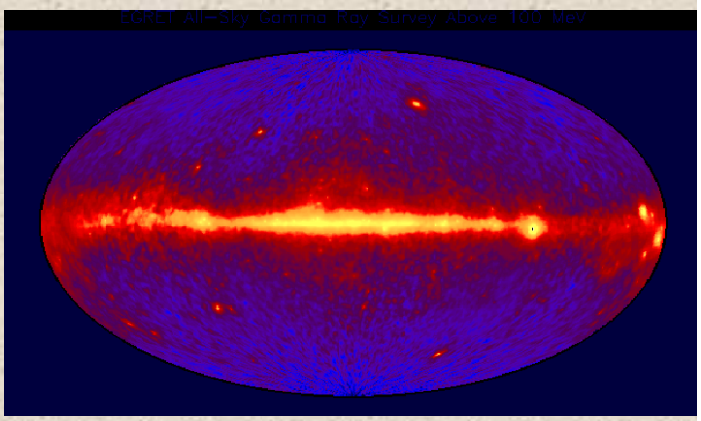
2）Search for high energy CR bursts associated with solar flares and GLE events.

All-sky Survey (1999.11-2004.10)

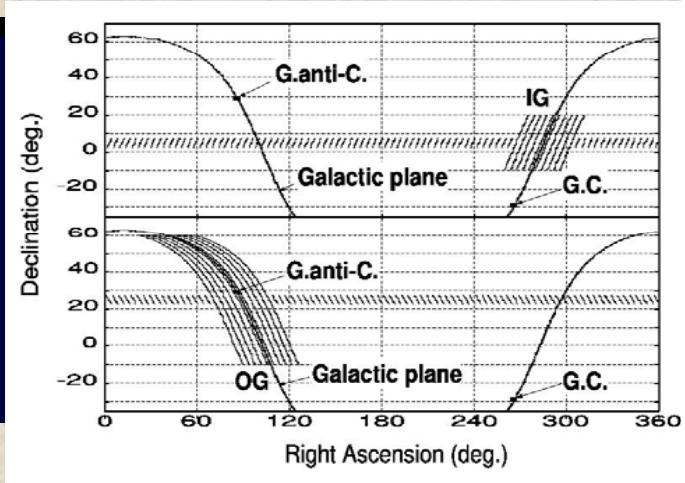


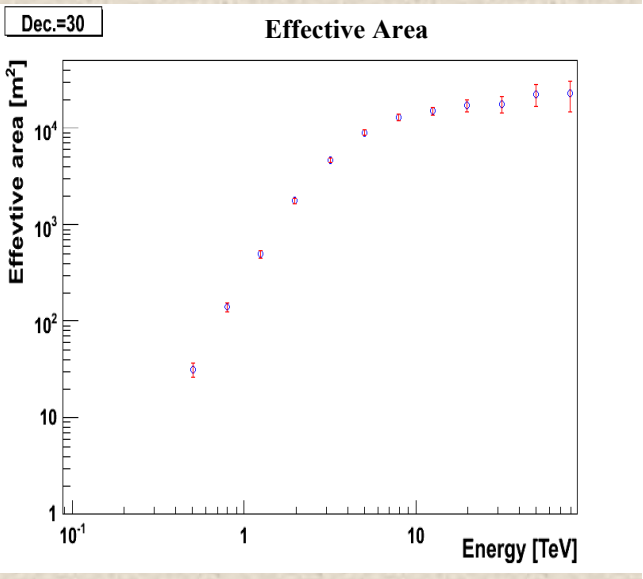
NO.	R.A.(˚)	DEC(˚)	Sig.(σ)	NO.	R.A.(˚)	DEC(˚)	Sig(σ)
1	62.7	51.1	4.2	9	254.8	5.8	4.1
2	83.7	21.8	5.6	10	263.6	21.4	4.1
3	129.3	13.5	4.1	11	286.8	6.0	4.4
4	131.8	33.9	4.3	12	316.5	13.0	4.0
5	137.5	41.8	4.1	13	318.2	40.9	4.1
6	165.7	38.3	5.4	14	331.6	52.5	4.4
7	175.8	2.1	4.4	15	353.3	24.6	4.1
8	221.3	13.6	4.6				

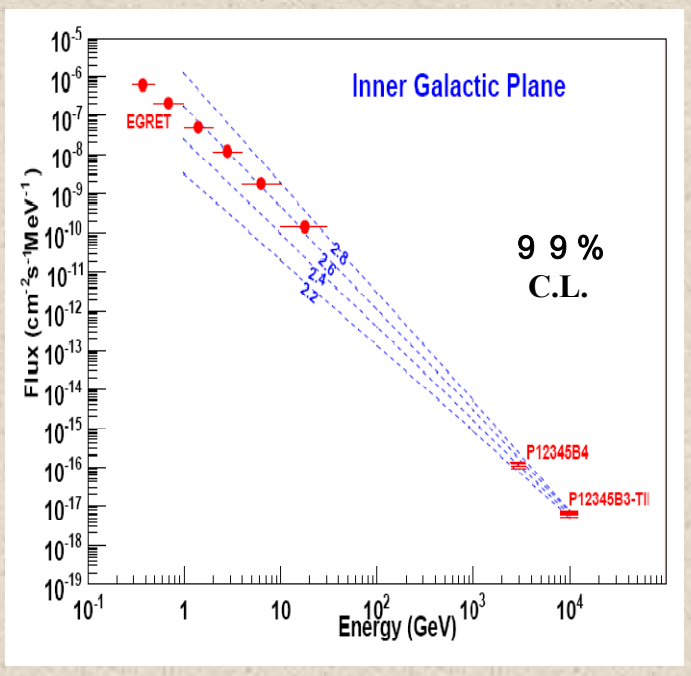
Diffuse TeV gamma ray from the Galactic Plane

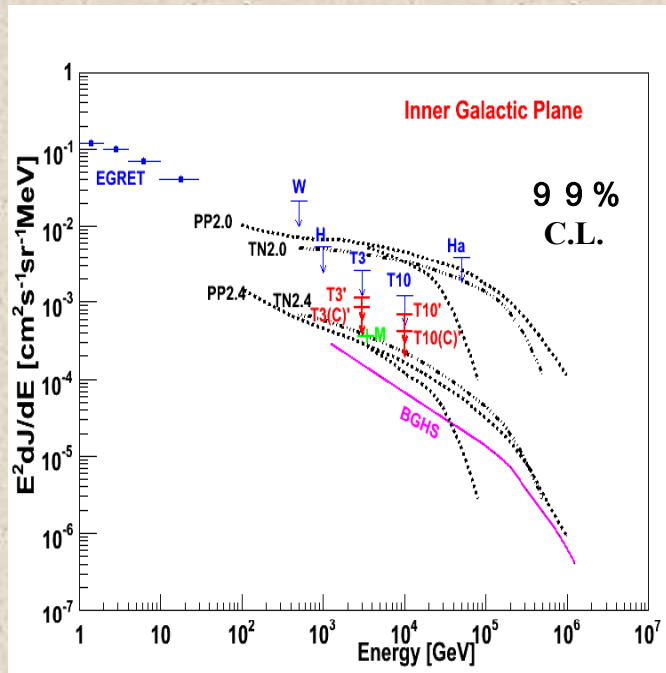


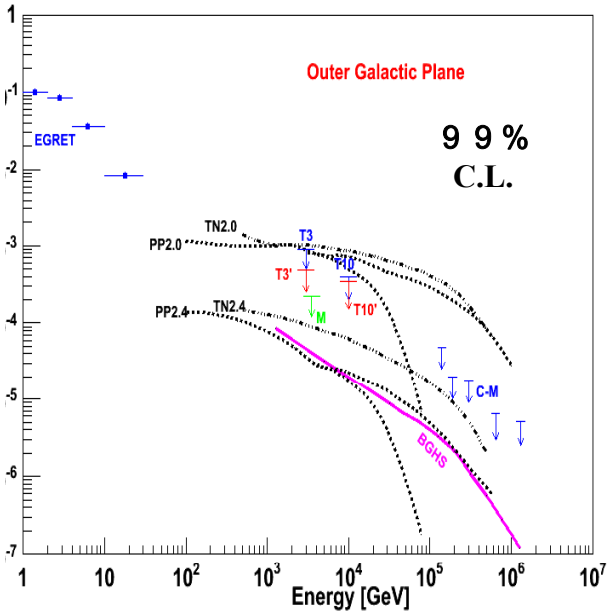
γ>100 MeV (EGRET)







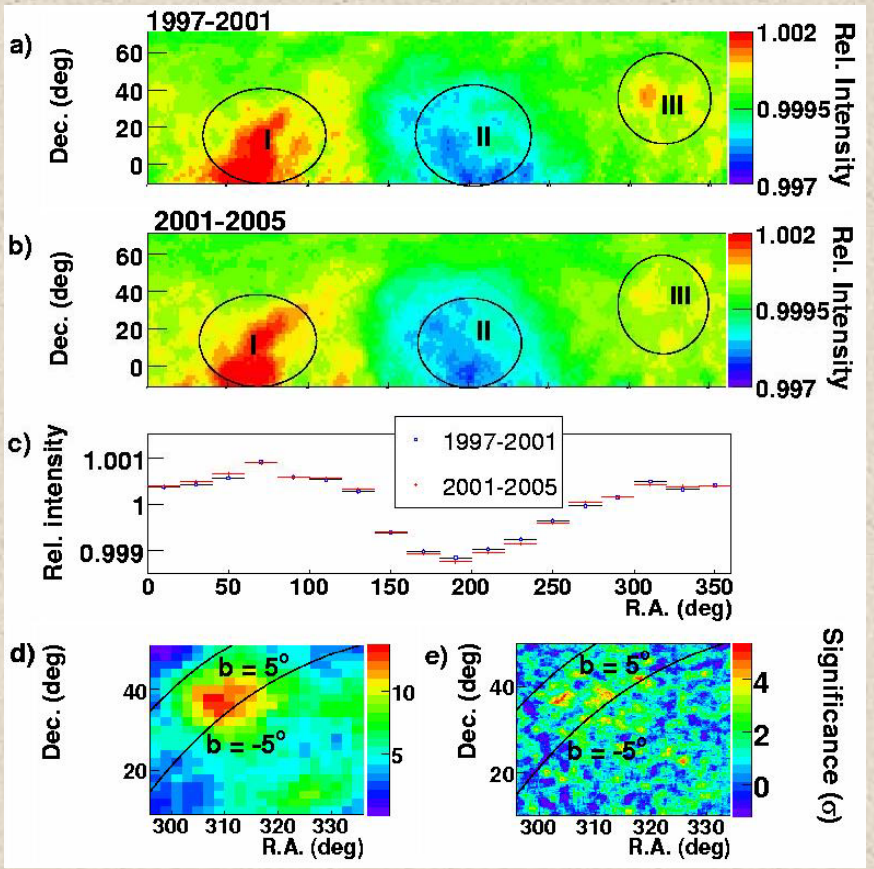


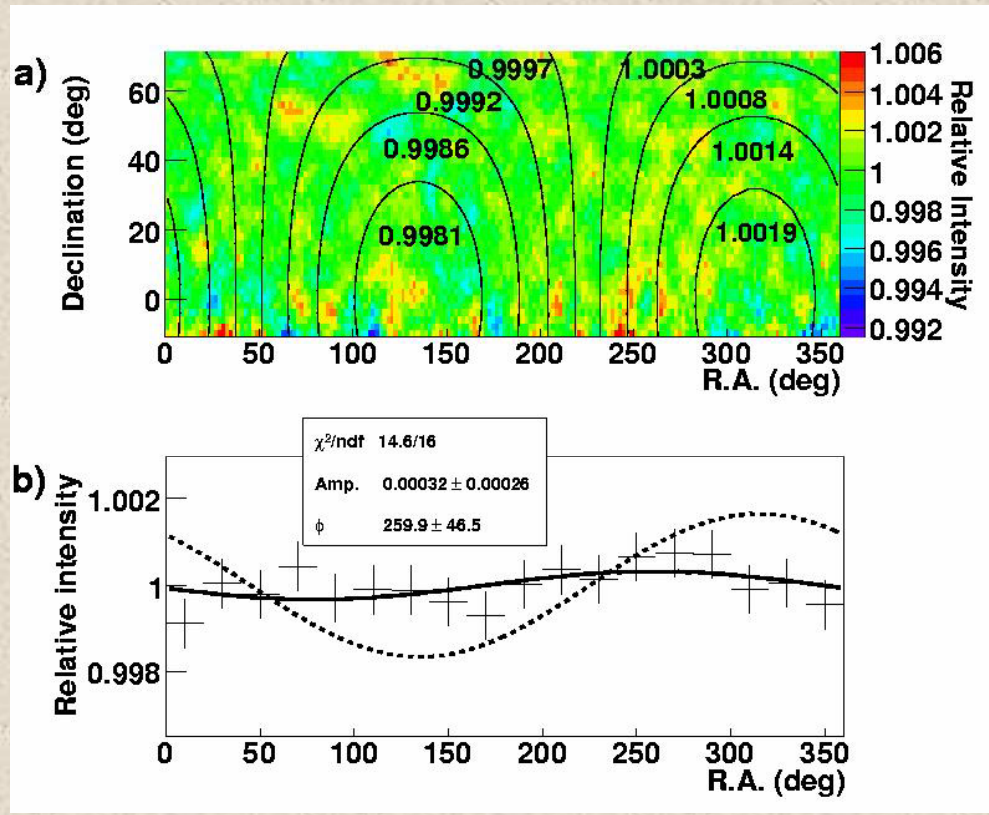


Tibet-III (22,050m^2) 1041.3 days (1999 Nov.~2004 Oct.)

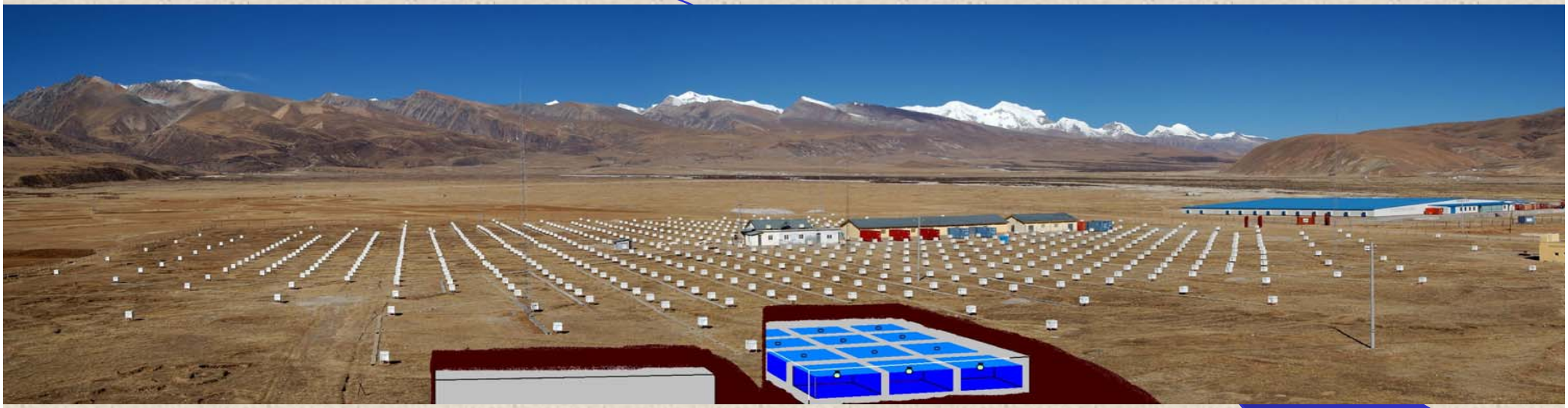
Two dimensional observation on large scale anisotropy of TeV Cosmic-ray using the Tibet Air Shower Array

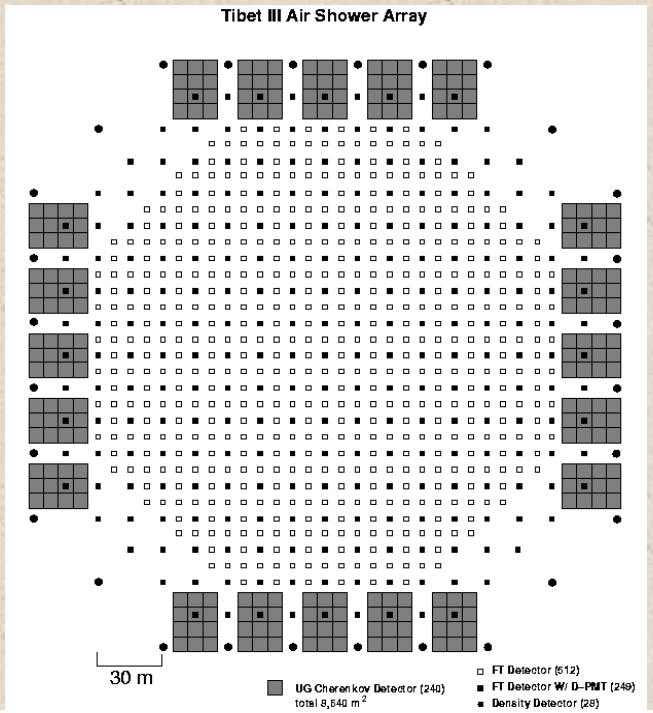
(*Science*, Oct. 20, 2006)

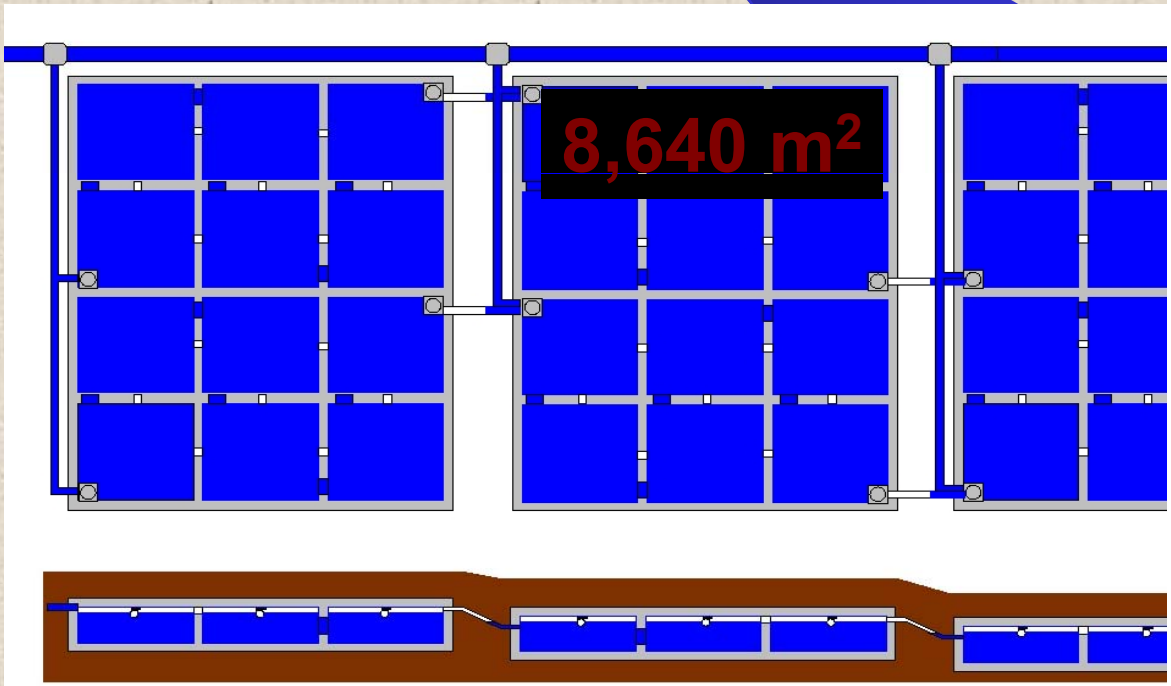




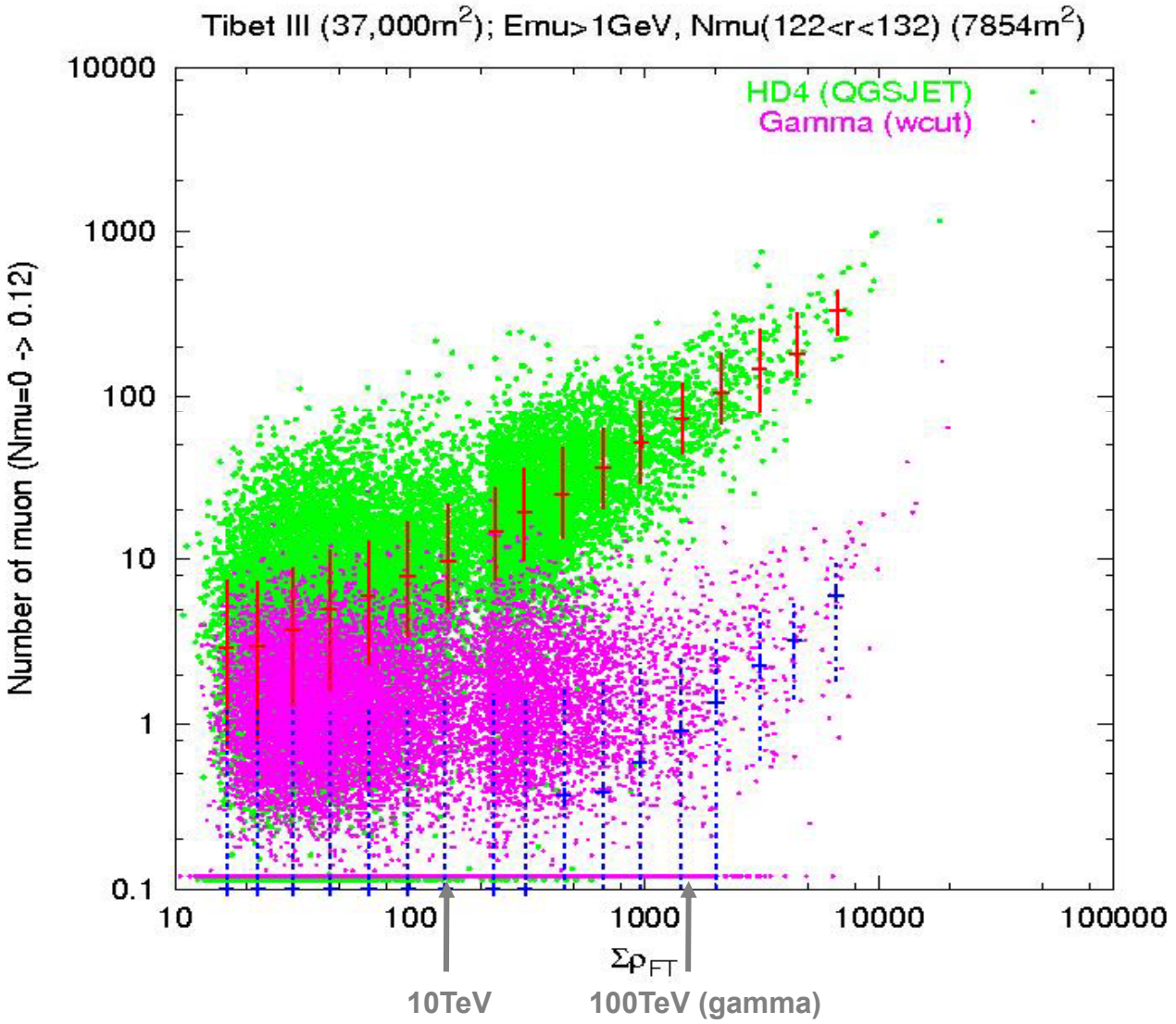
Tibet III + MUON



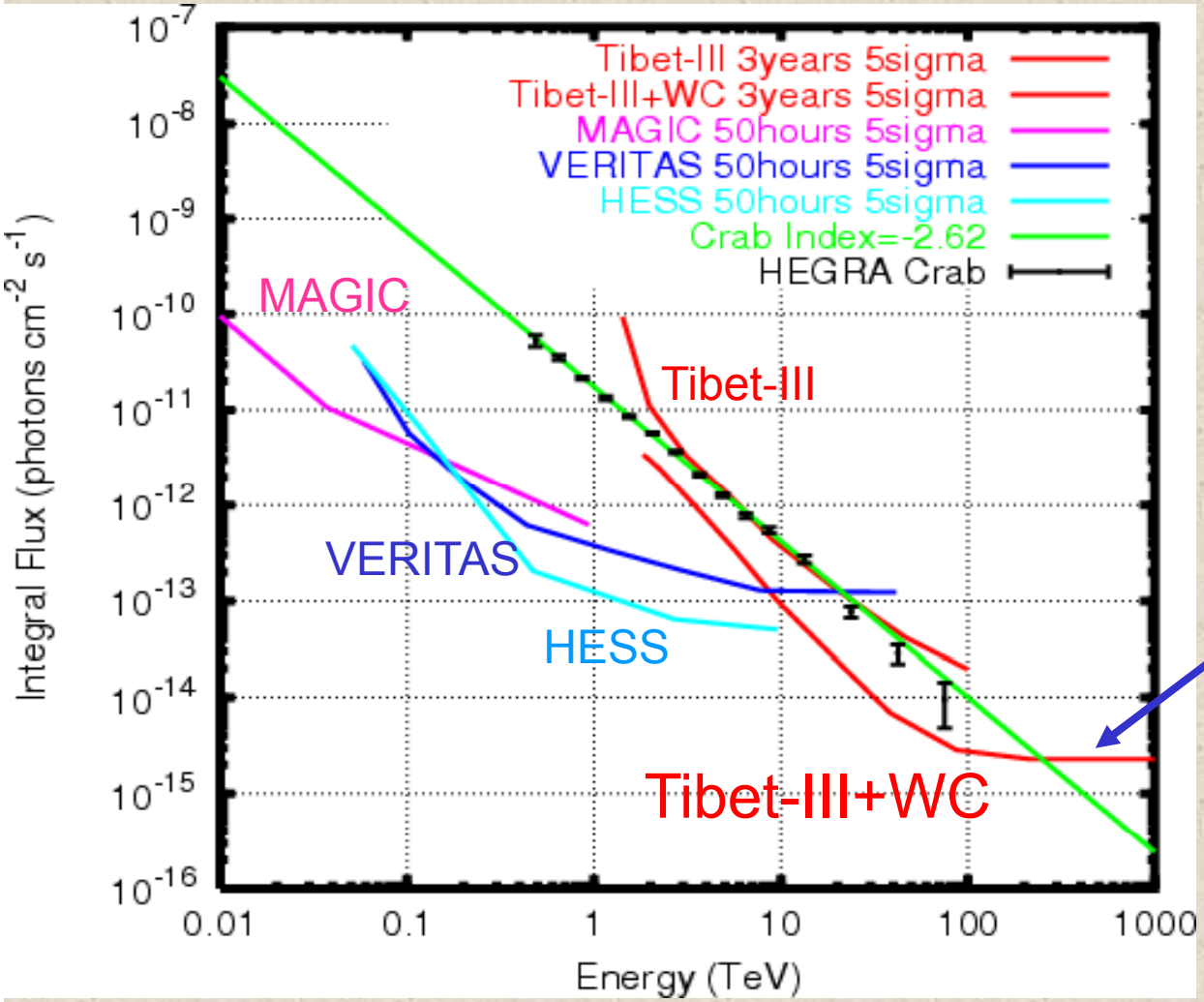




Number of μ in MUON detector



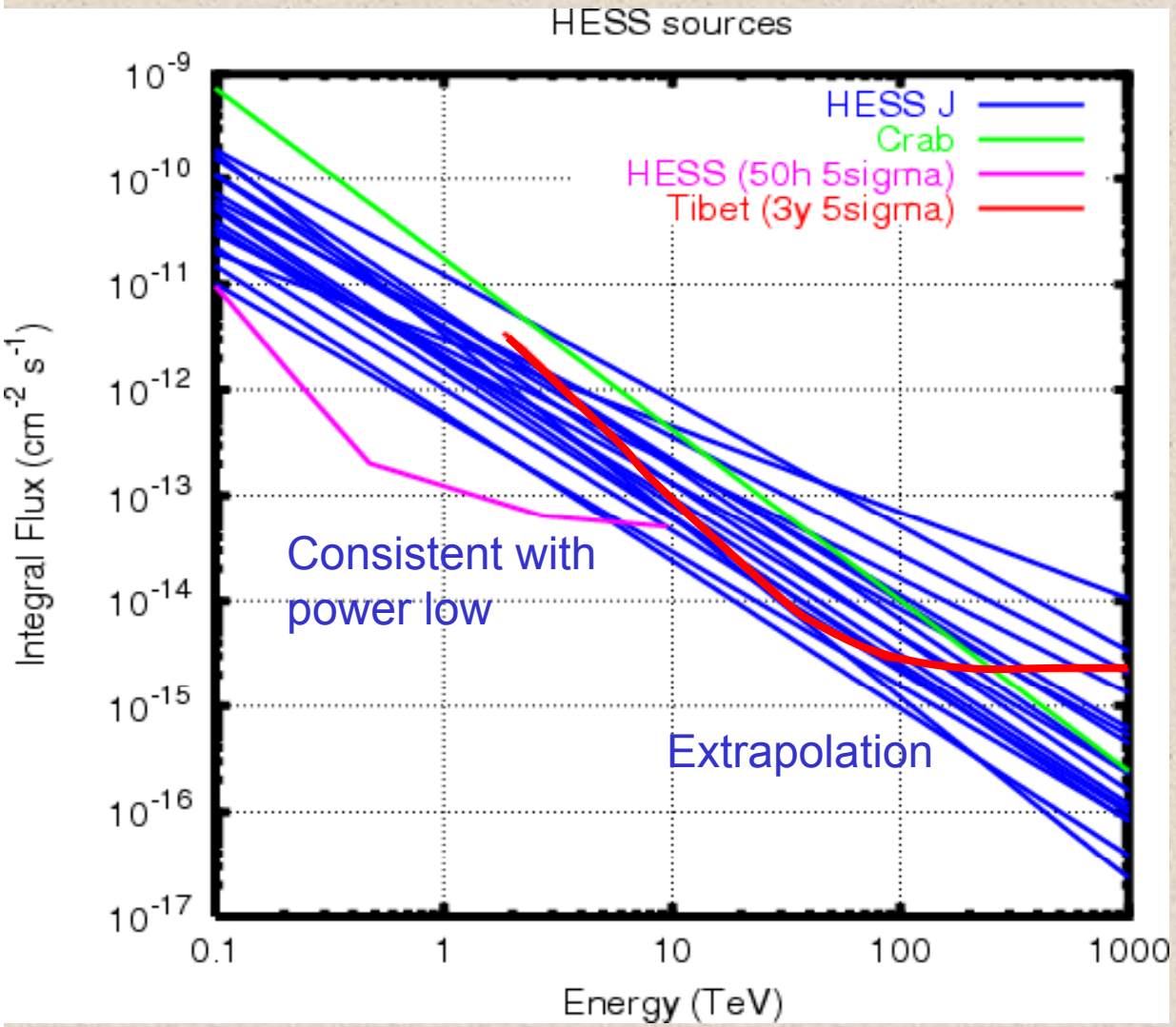
Detection Sensitivity of Tibet-III+WC (3 years 5σ)



Tibet-III Scintillation Counters
37,000m²
+
Underground
Water Cherenkov Detector
8,640m²
Crab orbit

Flat region (> 200TeV)
Background << 1 event
15 photon sensitivity
(Poisson 5σ)

Energy Spectrum of HESS sources



Aharonian et al, ApJ, 636, 777 (2006)

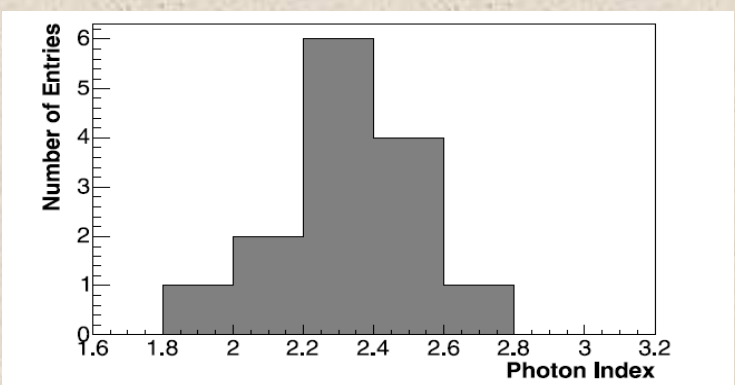


FIG. 8.—Distributions of the photon index of the new sources. The mean photon index is 2.32 with an rms of 0.2.

Indices are harder

(If it is constructed
in the southern hemisphere)

Most of HESS sources detectable by Tibet III+WC!

Status of ARGO-YBJ: an overview

ARGO-YBJ Collaboration Institutes

Spokesman: B.D'Ettorre Piazzoli

INFN and Dipartimento di Fisica dell'Universita', Lecce

INFN and Dipartimento di Fisica dell'Universita', Napoli

INFN and Dipartimento di Fisica dell'Universita' "Roma Tre", Roma

INFN and Dipartimento di Fisica dell'Univesita' "Tor Vergata", Roma

Istituto di Cosmogeofisica del CNR and INFN, Sezione di Torino

Istituto di Fisica Cosmica IFCAI/CNR, Palermo and INFN,
Sezione di Catania

50 Physicists

Spokesman: Z. Cao

IHEP,Beijing

Shandong University, Jinan

South West Jiaotong University, Chengdu

Tibet University, Lhasa

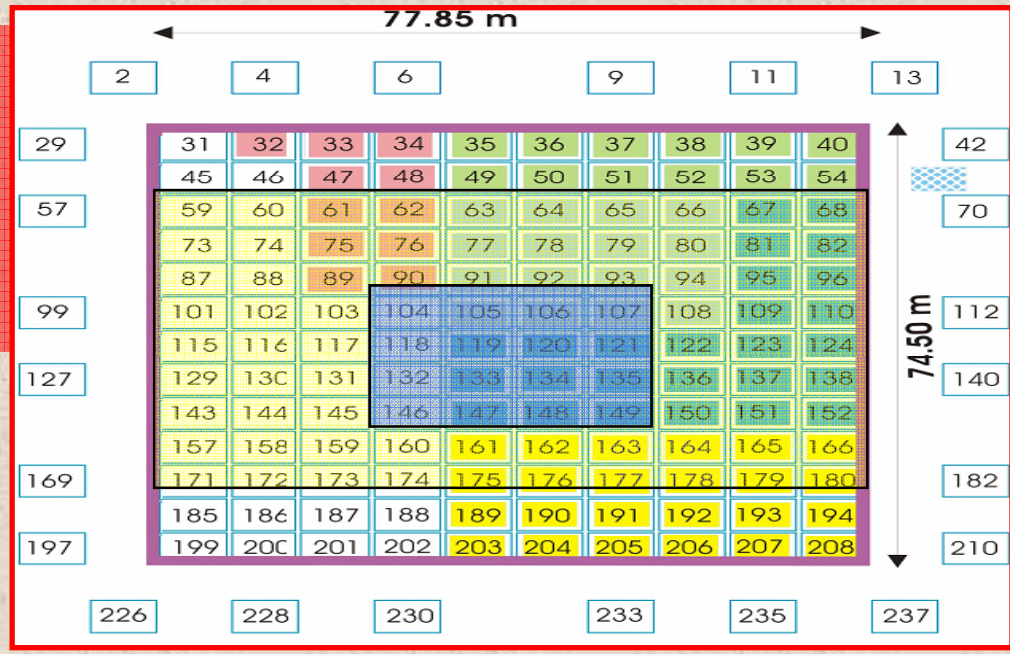
Yunnan University, Kunming

Zhenghou University, Henan

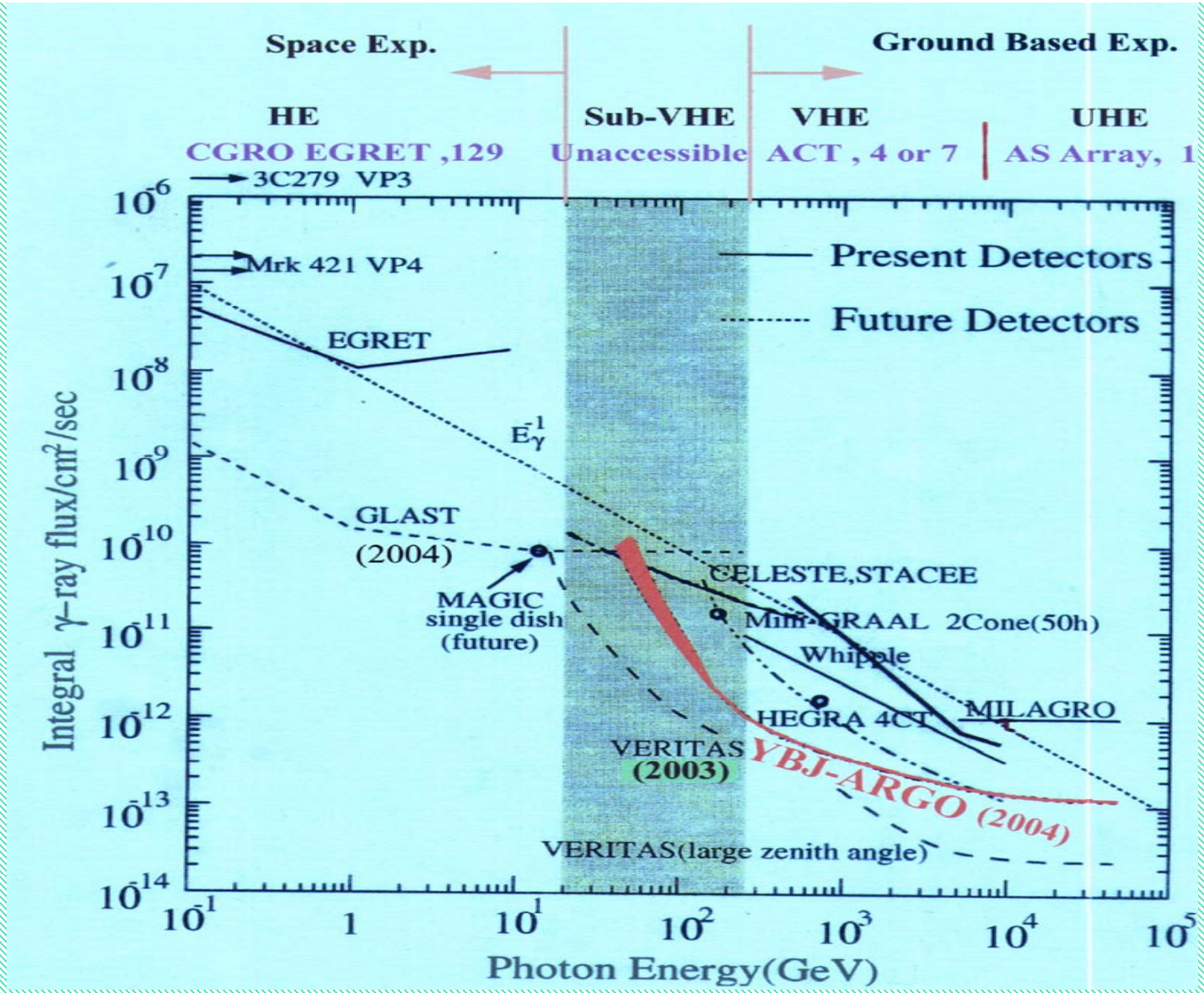
50 Physicists

The ARGO Detector

- Single layer of Resistive Plate Chambers (RPC), 78 x 74.5 m^2 full coverage, operated in streamer mode (active surface ~ 95 %).
- A guard ring partially (~ 20 %) instrumented with RPCs .
  Total area 111 x 99 m^2
  Active surface is 6700 m^2 .
- 0.5 cm of Pb on RPCs to convert g's .



Main goal: g astronomy in 300 GeV -- 10 TeV energy



Argo sensitivity

Detector Layout

Strip =SPACE PIXEL, 6 x 62 cm^2, 124800

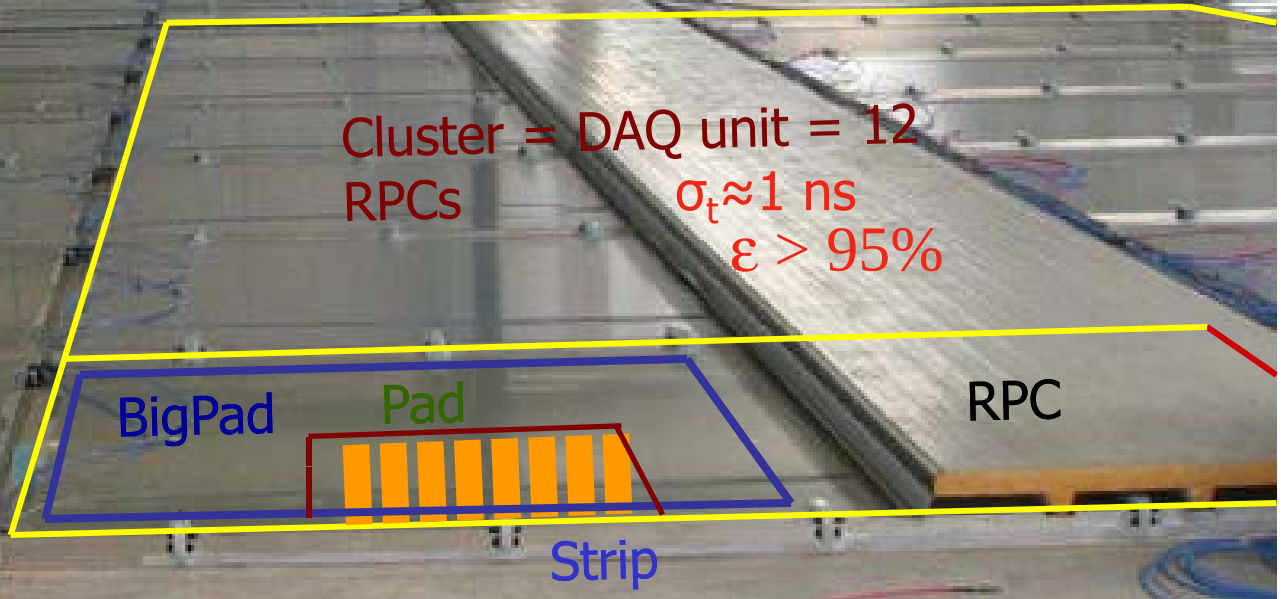
Pad =TIME PIXEL, 60 x 62 cm^2, 15600

BigPad =CHARGE readout PIXEL, 125 x 140 cm^2, 3120

Cluster = DAQ unit = 12 RPCs

$\sigma_t \approx 1$ ns

$\varepsilon > 95\%$



ARGO Operation Mode and Science

SHOWER MODE Trigger rate (≥ 20 pad): ~ 7.5 KHz @ 6MB/s

- **gamma-astronomy , 300 GeV threshold**
- **GRB (low multiplicity trigger)**
- **Cosmic Ray physics**

SCALER MODE (single counting rate for each cluster)

- **flaring activity : GRBs, Solar flares…**

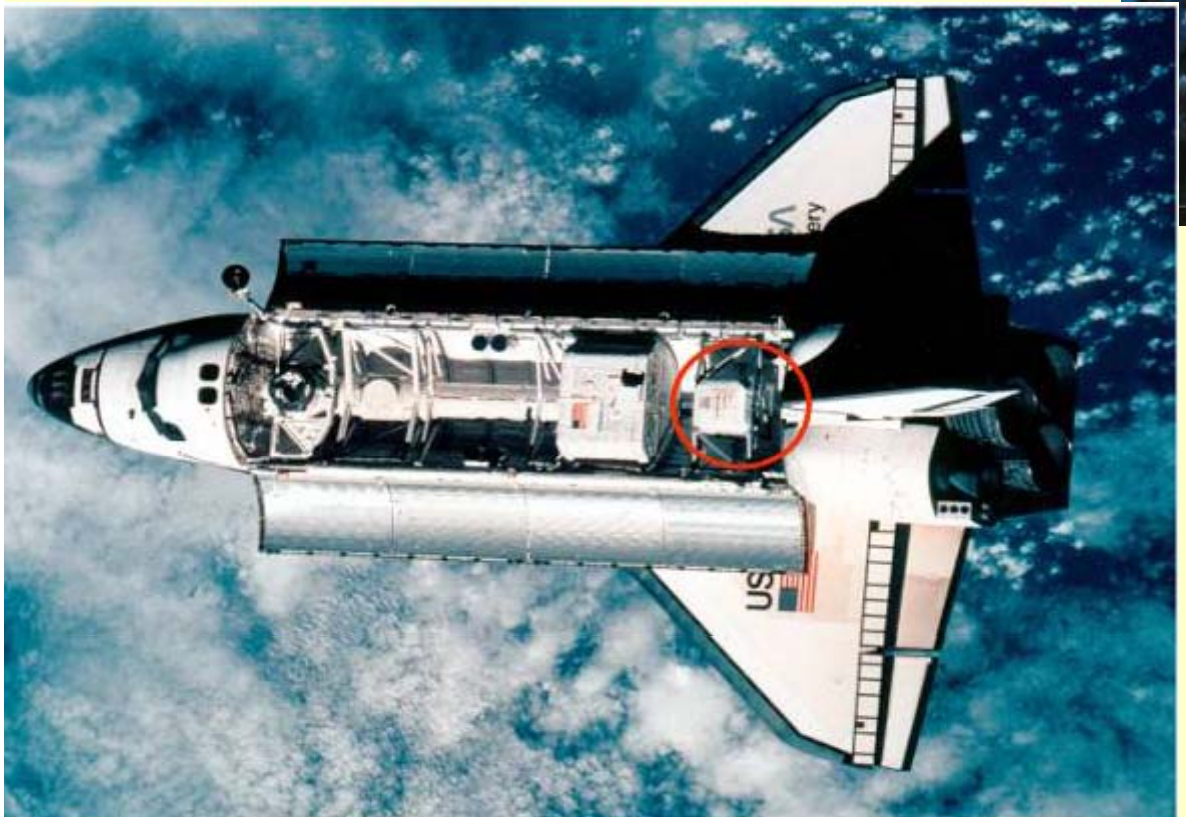
(→ environmental monitoring : temp., press. etc)

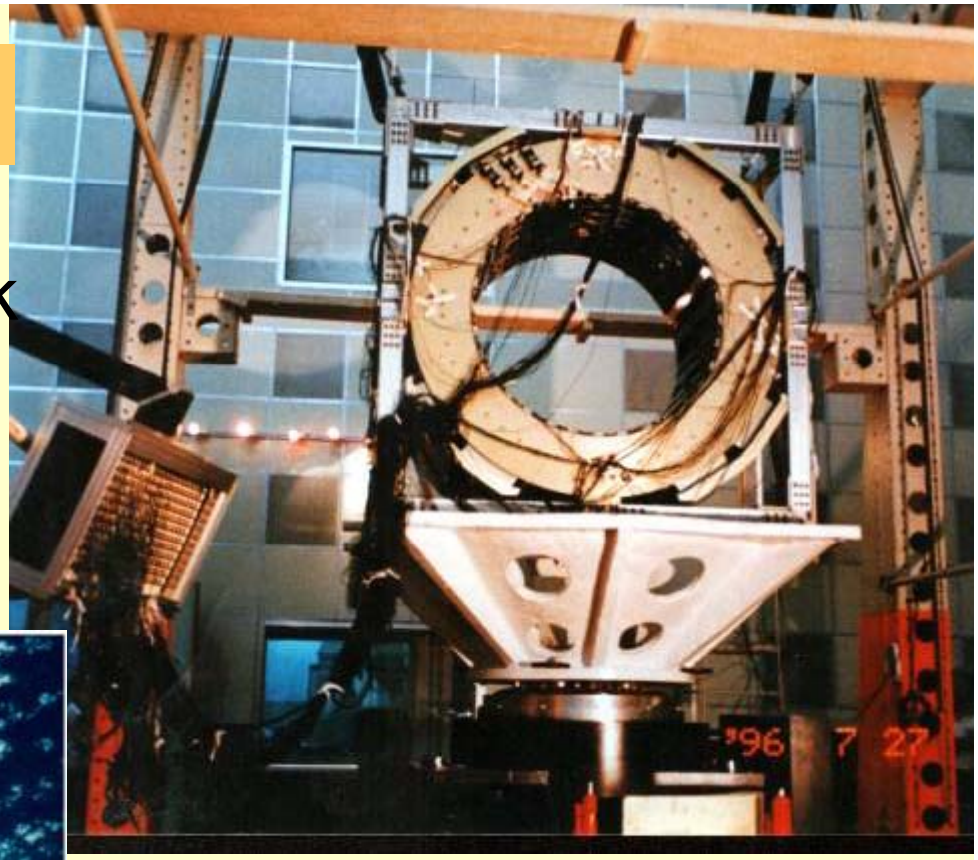
Celebration of YBJ-ARGO Experiment Carpet Detector Accomplishment and Full Scale Operation, June 26 2006

Space Experiments

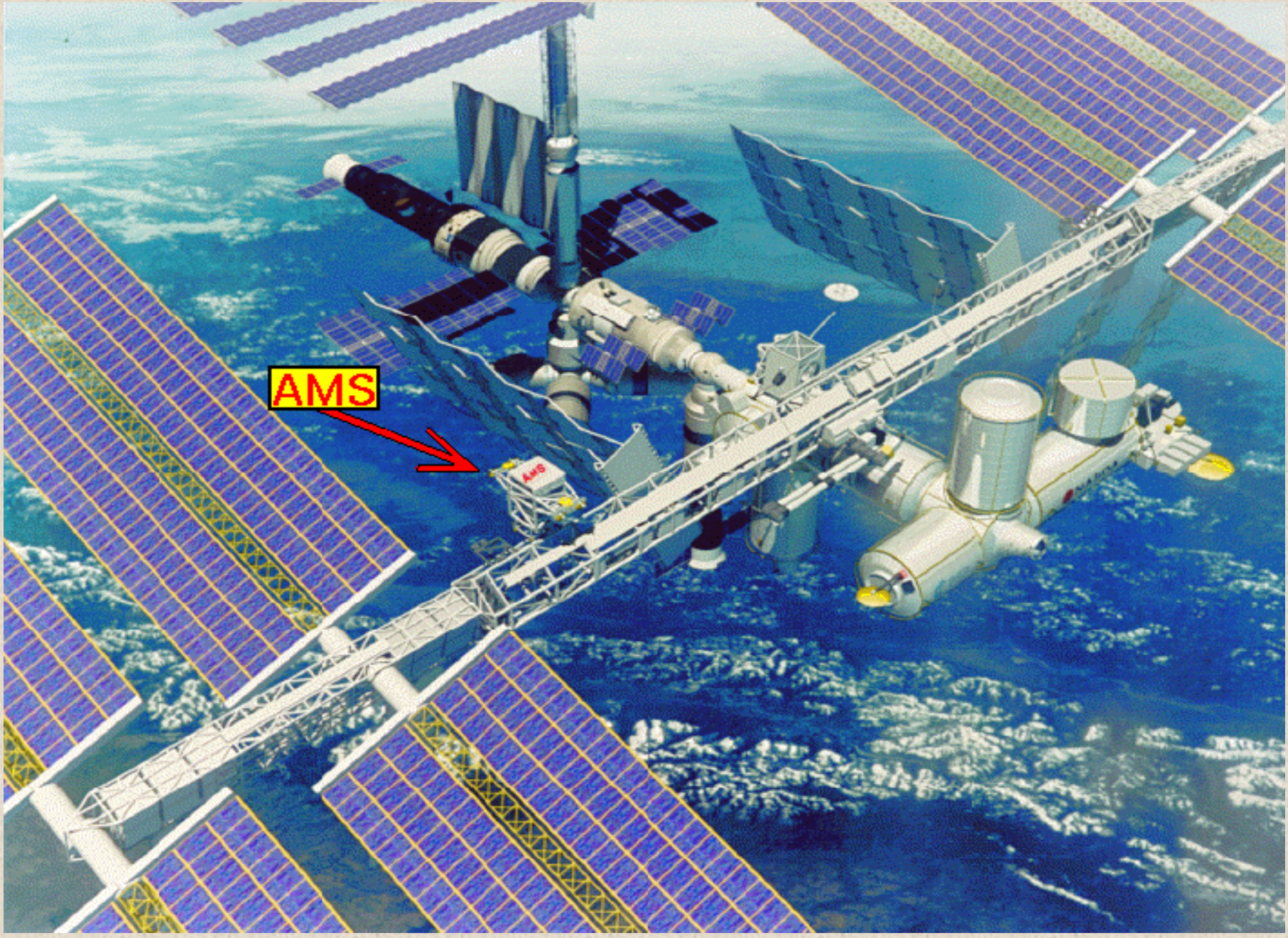
Alpha Magnetic Spectrometer

- Search for antimatter and dark matter
- precision measurement of gamma-ray and isotopes





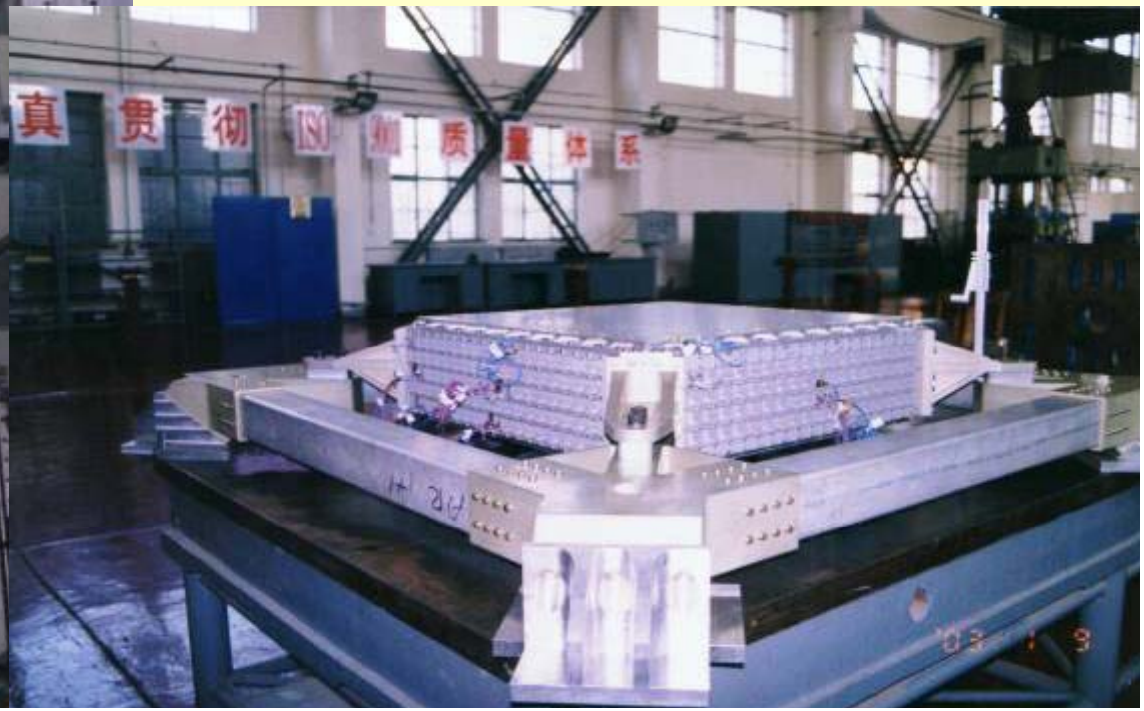
AMS01 permanent magnet and structure were built at Beijing, & became the first big magnet in space as payload of Discovery June 1998.


AMS

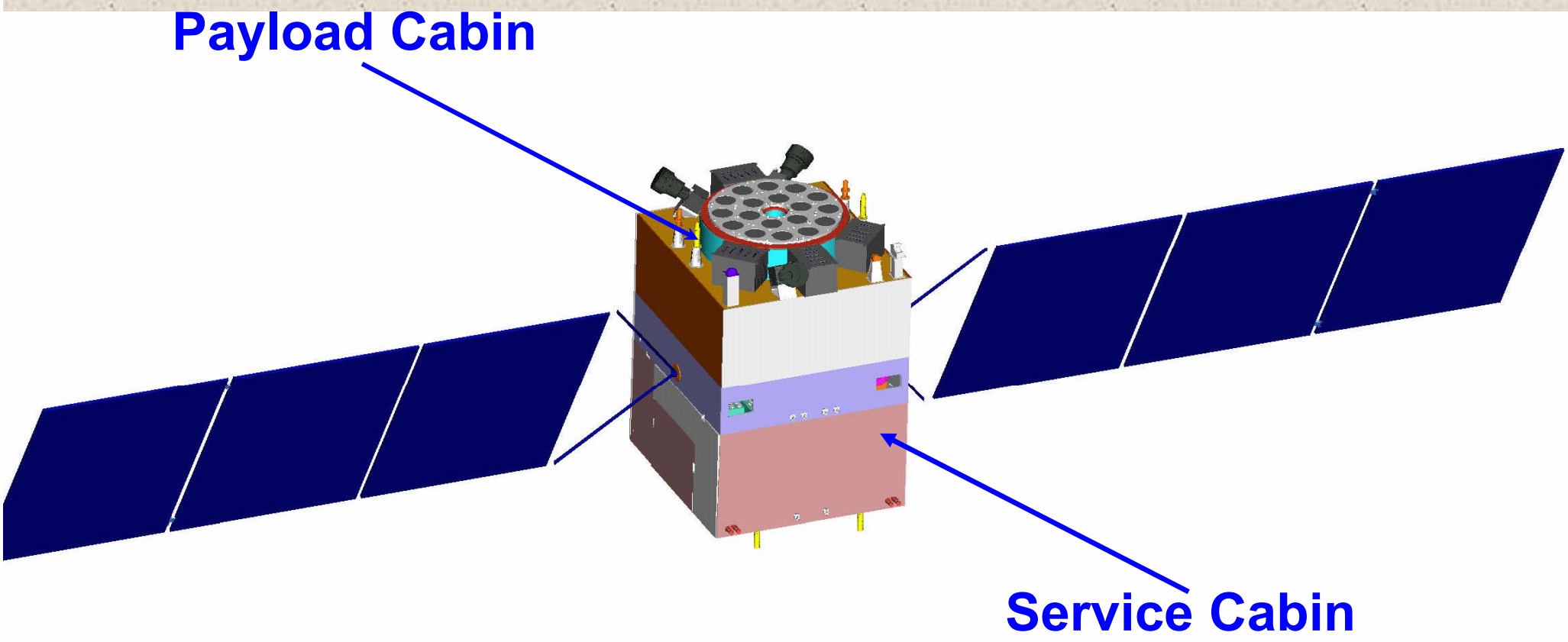
AMS02 ECAL:
IHEP, PISA and LAPP

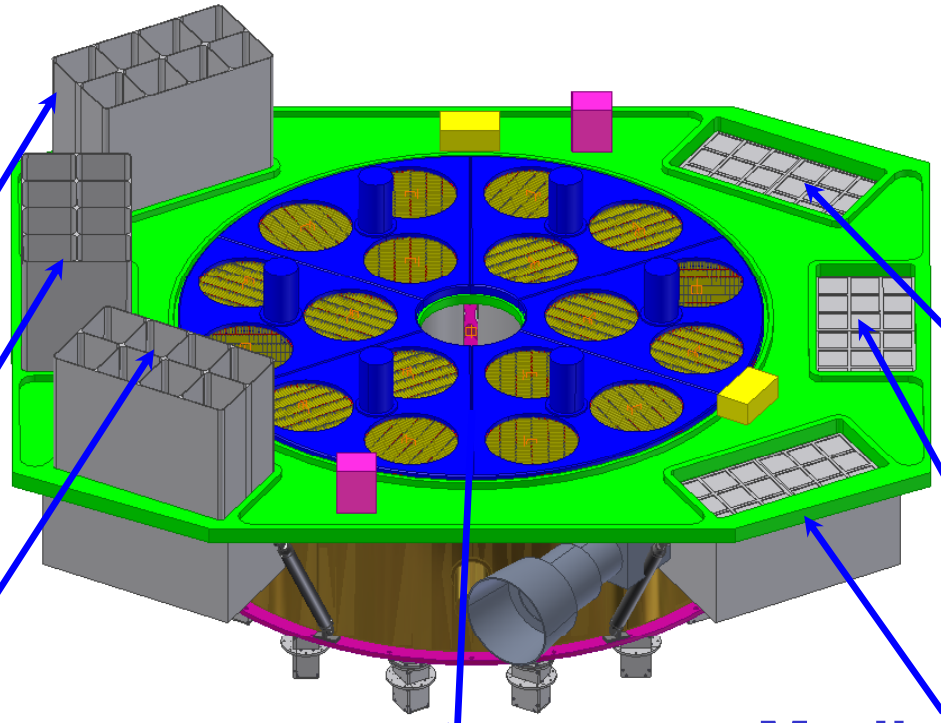
Space qualification at Beijing

ECAL assembling at IHEP



HXMT in space





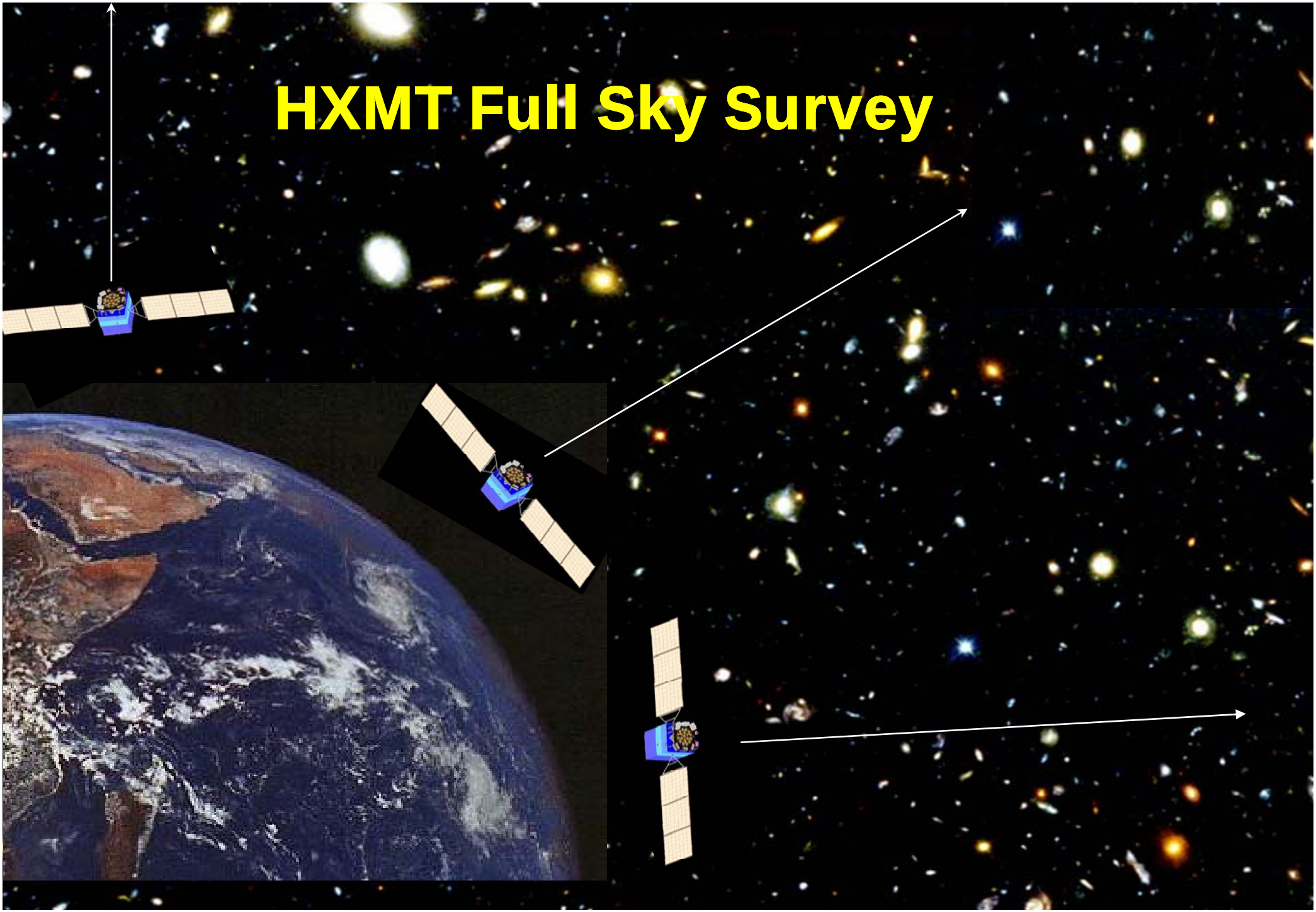
Low Energy X-ray Telescope (LE) (1-15 keV) SCD, 384 cm^2)

Medium Energy X-ray Telescope (ME) (5-30 keV) (SiPIN, 952 cm^2)

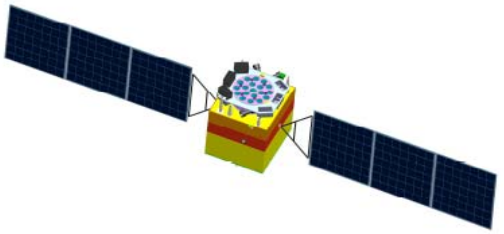
High Energy X-ray Telescope (HE) (20-250 keV, 18 modules, 5000 cm^2)

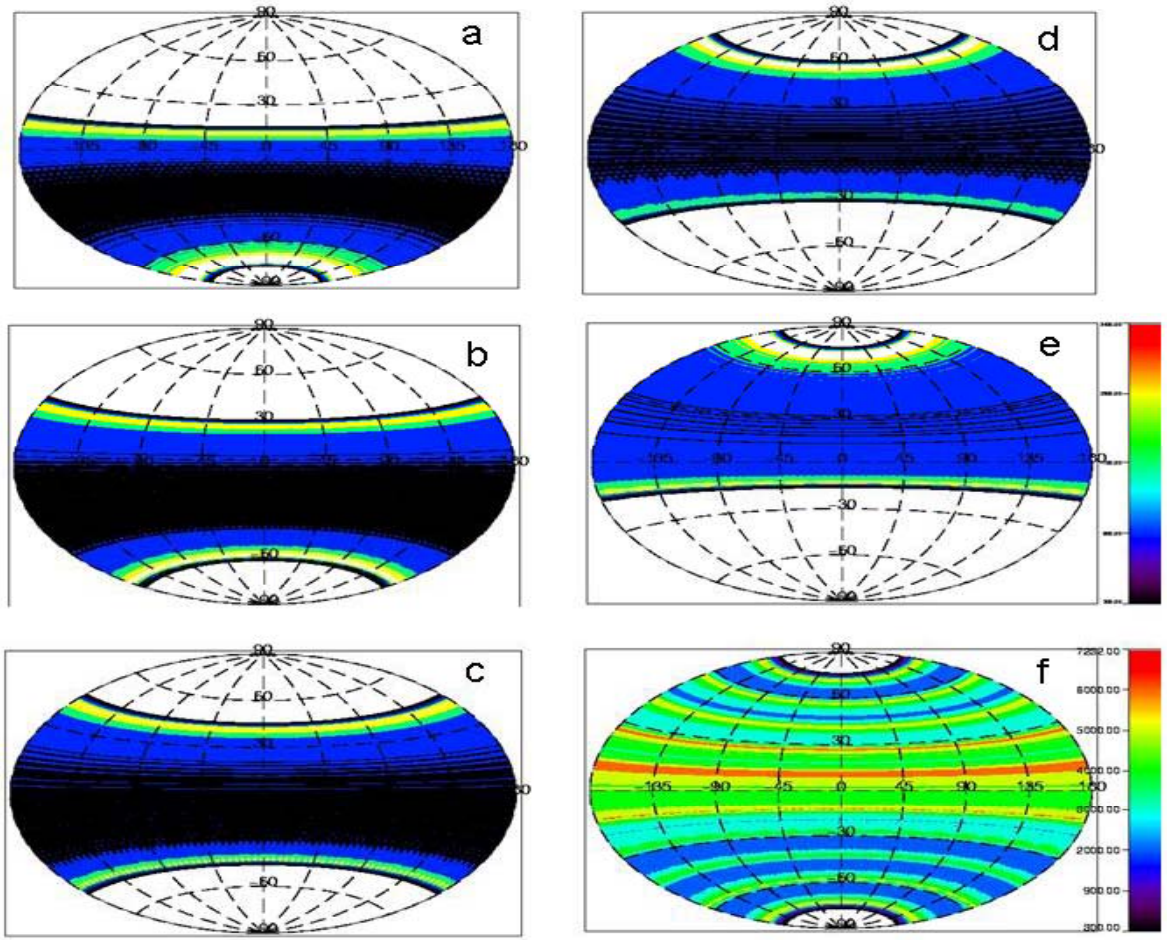
Current Status of the HXMT Mission

- Main participating institutions:
  - Chinese Academy of Sciences
  - Tsinghua University
- PI and Co-PI: Ti-Pei Li and Shuang-Nan Zhang
- Proposed in 1993
- 973 Major State Basic Research Project in China since April 2000 (Pre-Phase A study)
  - Total about $5M
- **Selected last year as the first Chinese space astronomy mission for launch around 2010**
  - Concluding Phase-A study ($2.5M)
  - Expected to enter Phase-B next year


HXMT Full Sky Survey

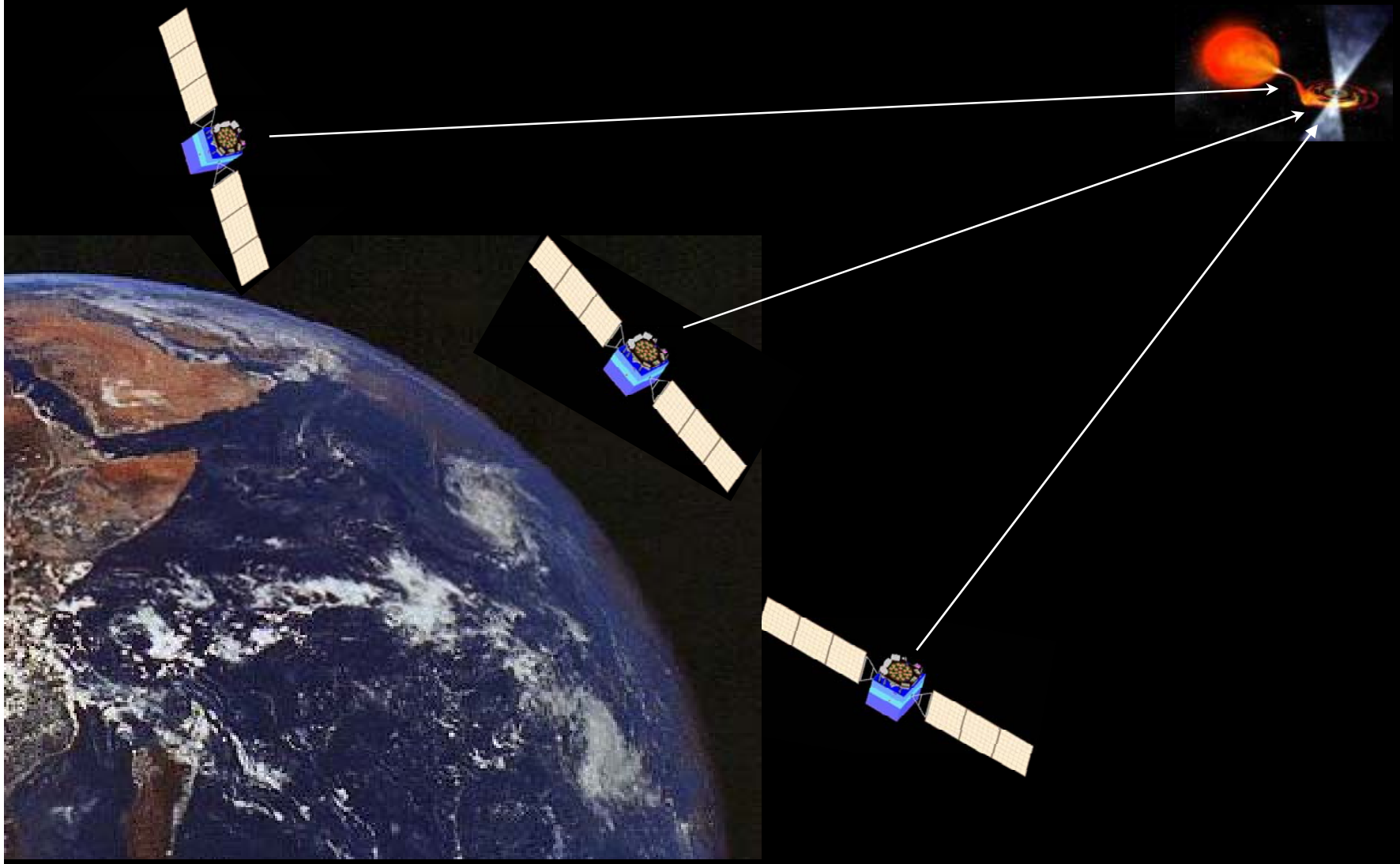
HXMT full sky survey



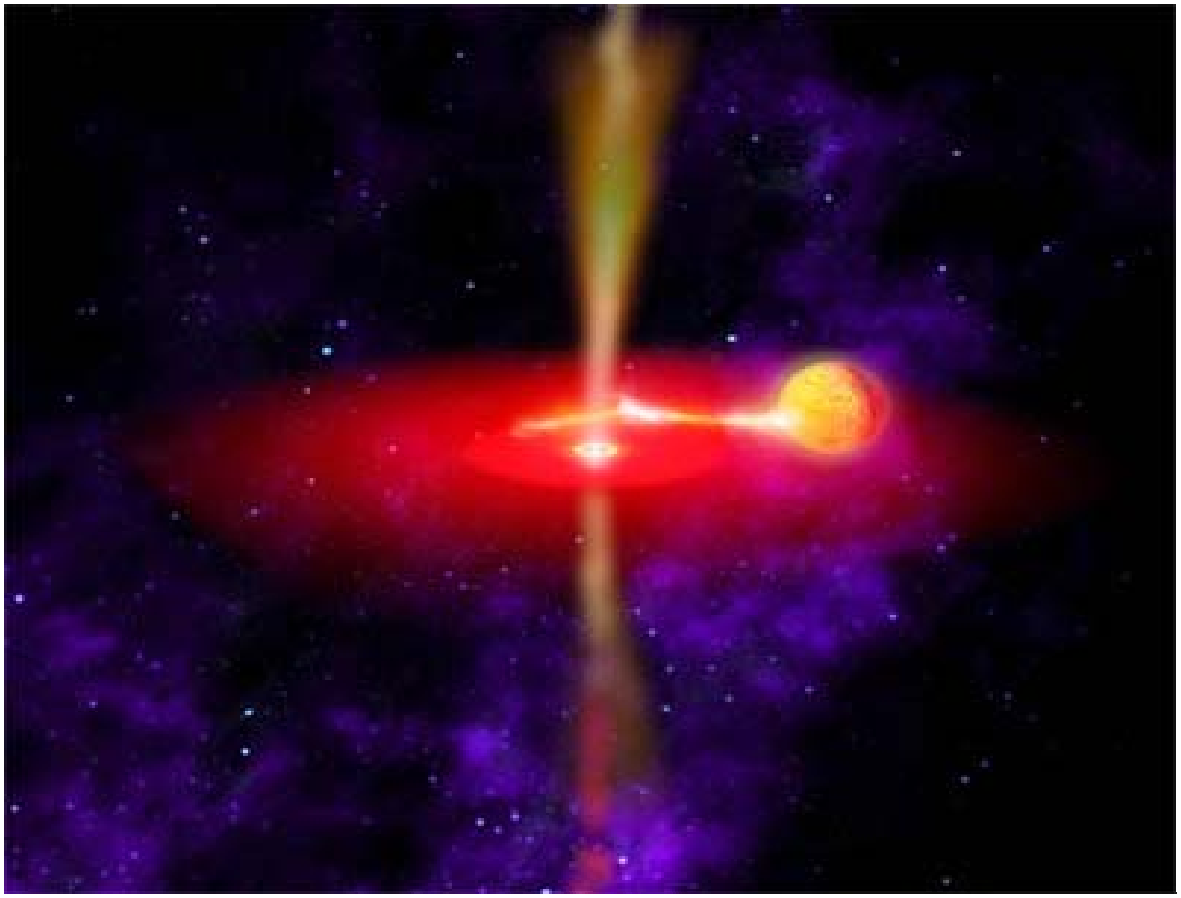


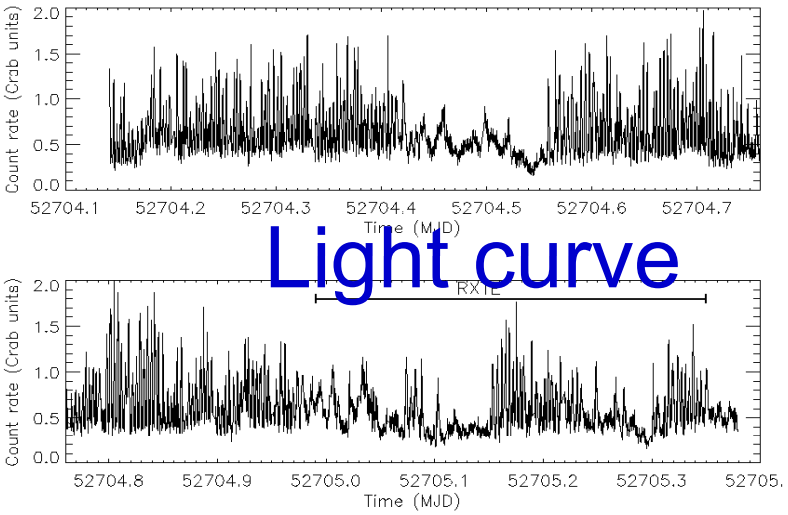
1 year exposure map

HXMT Pointed Observation

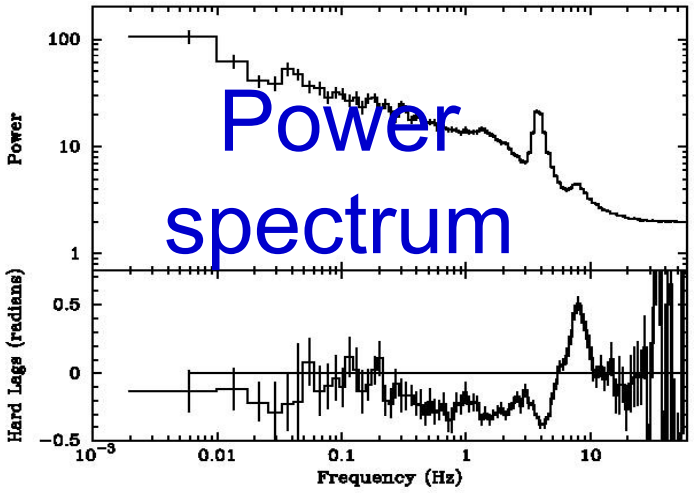


Variability of X-ray binaries



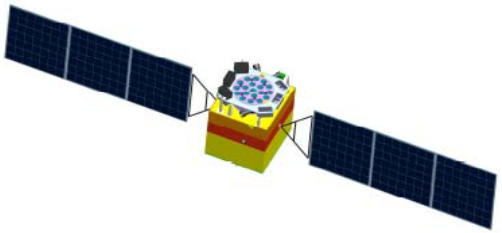


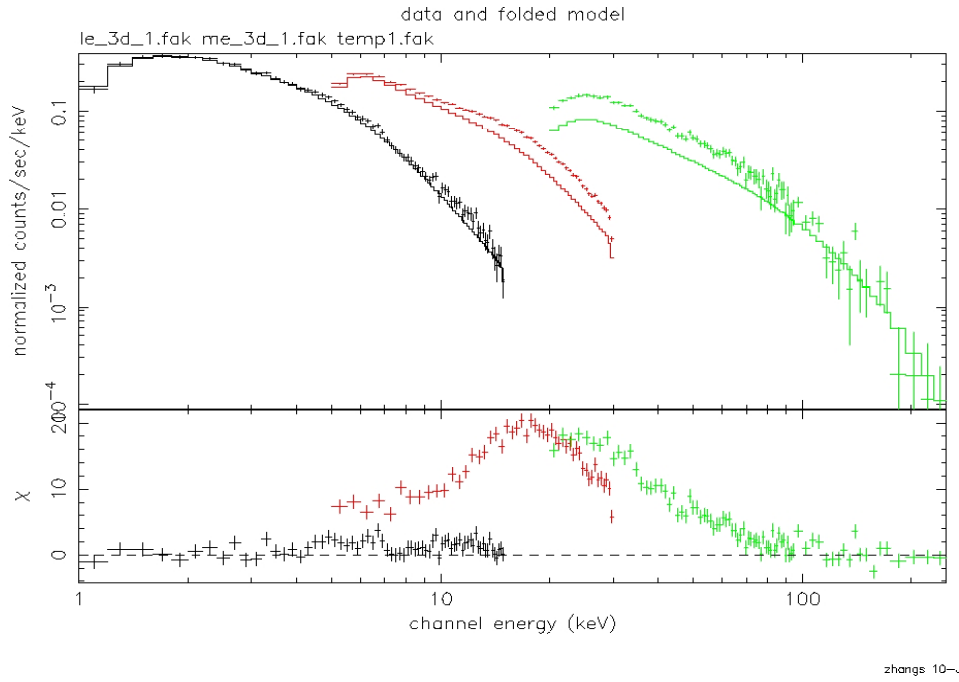
Light curve

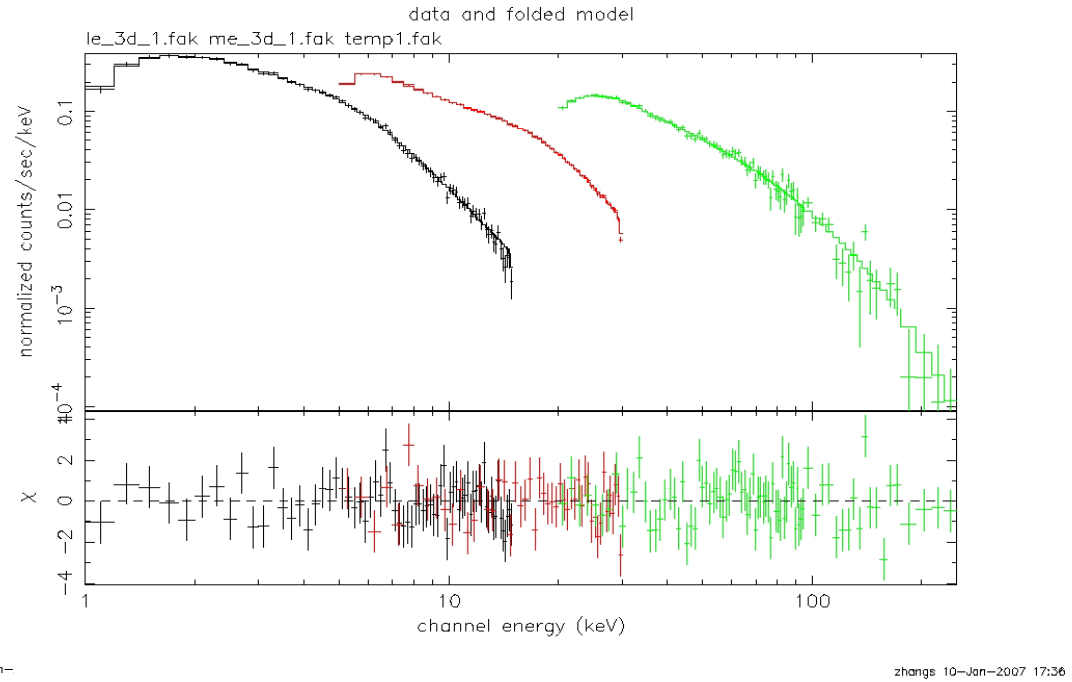


Power spectrum

AGN Broad band spectrum



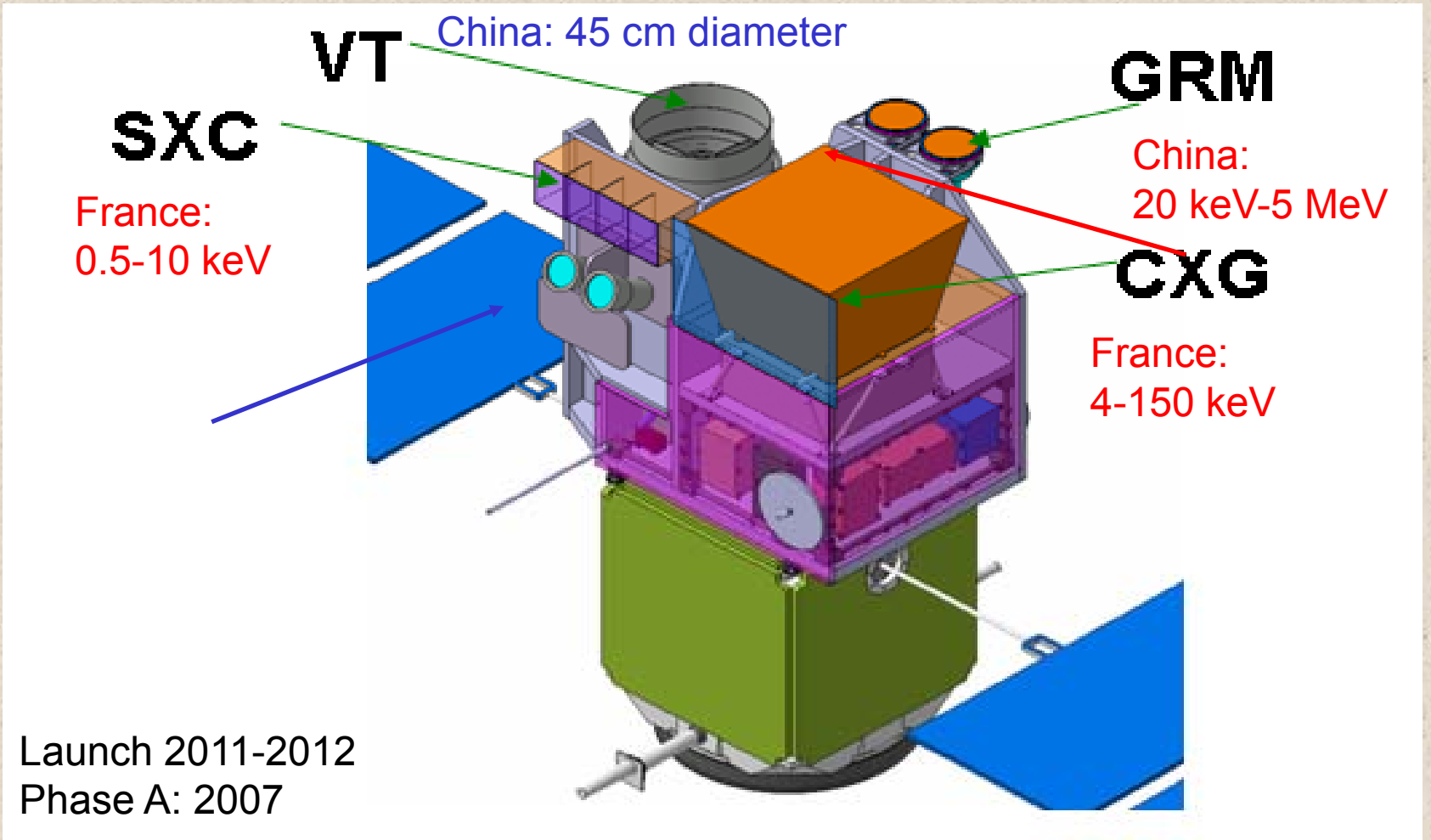




Reflection component not fitted

Reflection component not fitted

A multi-λGRB project: SVOM

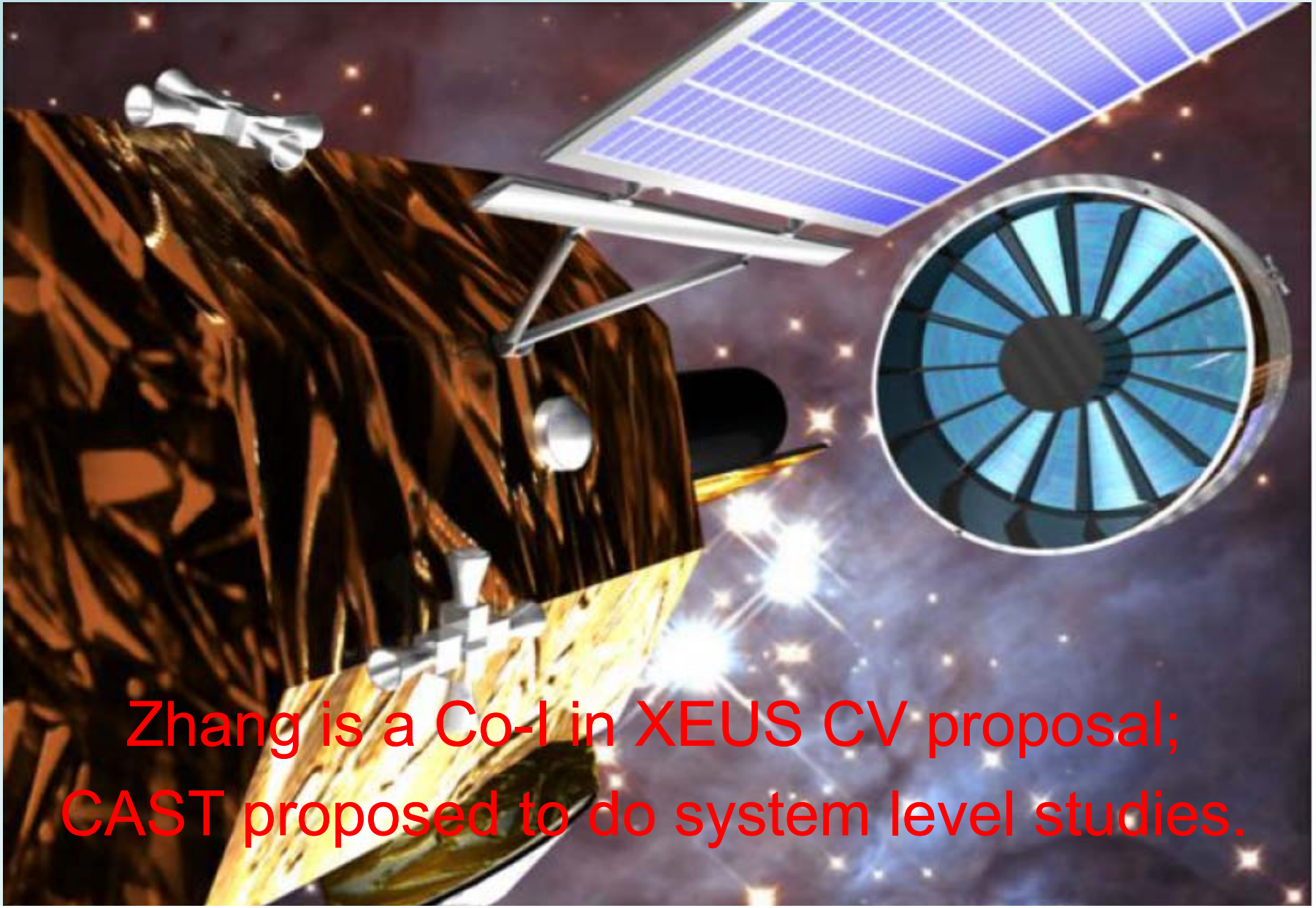


China-France collaboration

Gamma-ray burst polarization experiment onboard China's Spacelab: POLAR

- FOV of POLAR: ½ sky
- For GRB of 10-5 erg/cm2, one event per 20 days with MDP of 13~18%；
- For waiting time of 40~60 days，MDP is 10%: 6~9 GRBs per year down to 10% polarization;
- Schedule: around 2012-2013, to operate simultaneous with SVOM
- In collaboration with the POLAR team of Switzerland and French scientists.

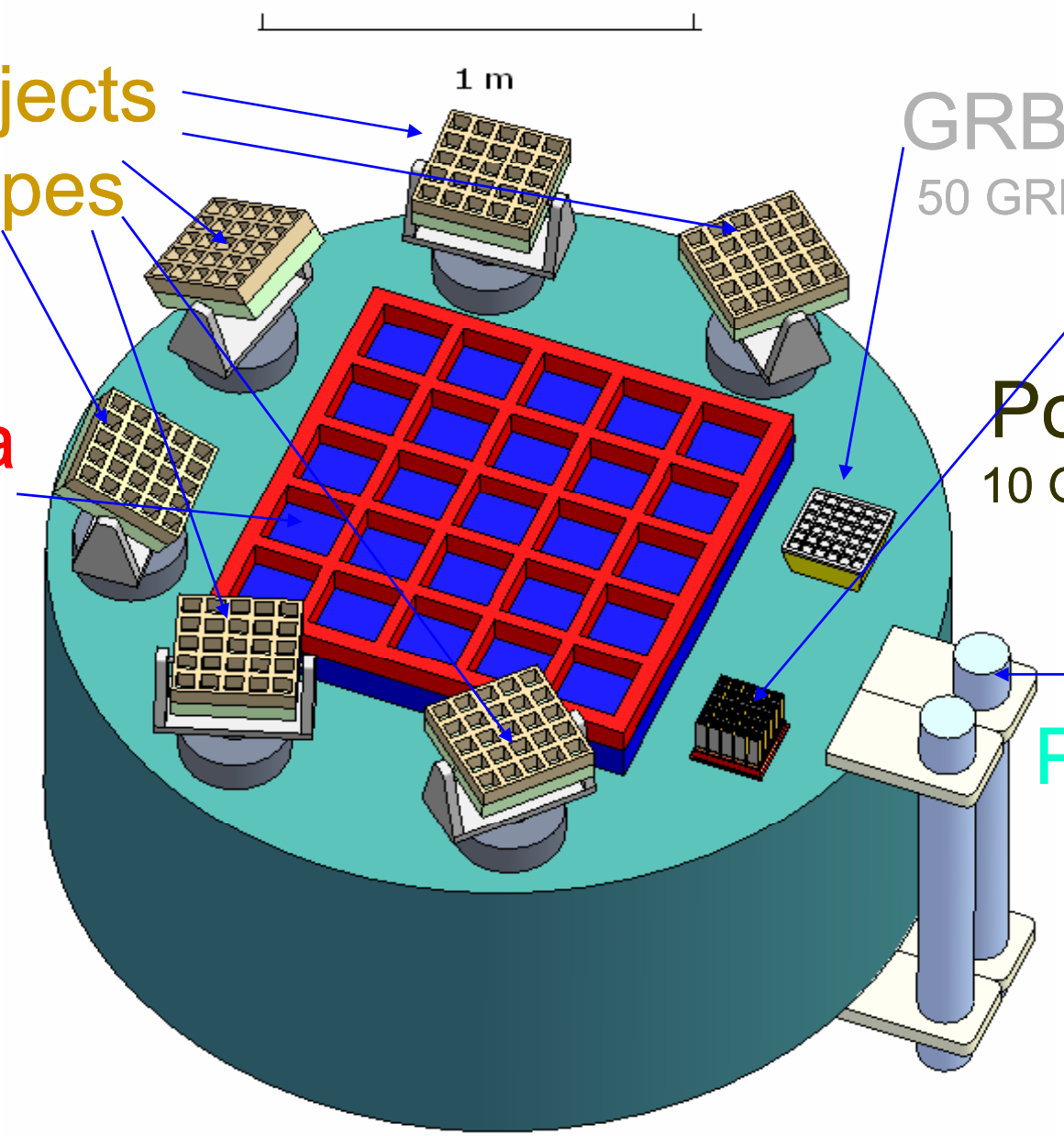
XEUS: X-ray Evolving Universe Spectrometer



XEUS key science

- How did supermassive black holes form and grow?
- How did feedback from these black holes influence galaxy growth?
- How did large scale structure evolve?
- How did the baryonic component of this structure become chemically enriched?
- How does gravity behave in the strong field limit?

X-ray Timing and Polarization mission: XTP



Multi-Objects Telescopes
2.4 m^2

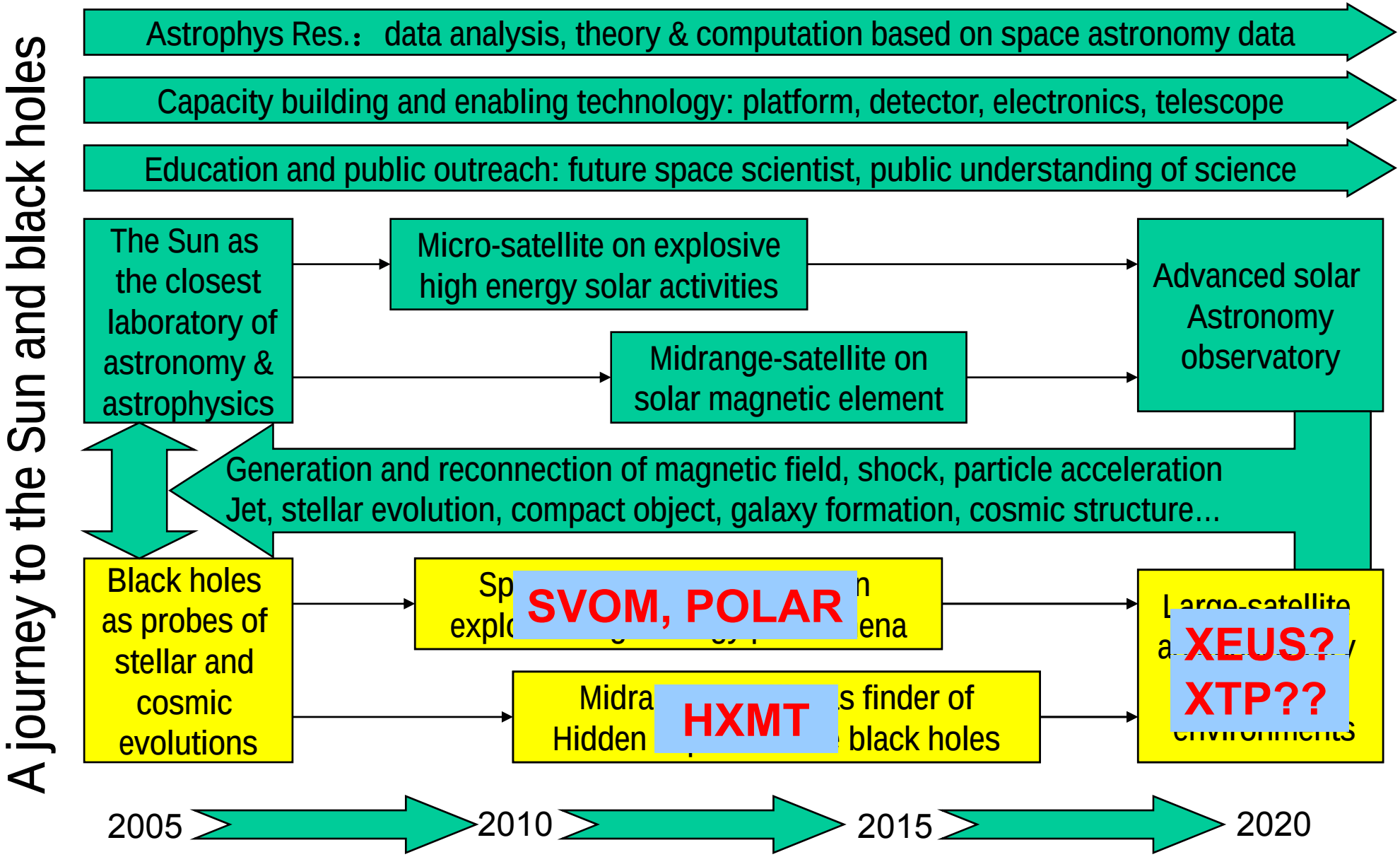
Large Area Telescope
4 m^2

GRB Imager
50 GRBs in 1-year

GRB Polarimeter
10 GRBs <3%MDP in 1-year

X-ray Polarimeter
0.1%MDP for 1-Crab in 1-day

Road Map for China's Space Astronomy and Solar Physics



Particle Physics in 21st Century

- Particle Physics & particle astrophysics: great challenges
  - Symmetry breaking mechanism: Higgs? SUSY?
  - Neutrino physics
  - CP violation:
  - Dark matter?
  - Dark energy?

Particle Physics in 21st Century

- Particle Physics & particle astrophysics:
  Great opportunities
- Major frontiers: most are big facilities
  - Accelerator Experiments:
    - High energy frontier: LHC, ILC…
    - High precision frontier
  - Non-Accelerator experiments
  - Particle astrophysics
  - Neutrino experiments
- Difficulties in big sciences: more international cooperation and more investments are the key issues

Chinese Particle Physics in 21st Century

- Chinese economy grows quickly and steadily
- Chinese government increases the supports to sciences and technology significantly and constantly.
- With construction of BEPCII/BESIII, Shanghai light source and CSNS, the new generation of Chinese accelerator and detector teams are shaping: young and growing fast. They could grasp the future opportunity in particle physics.
- Strong demands on
  - large scientific facilities based on accelerators.
  - application of accelerator and detector technology

Chinese Particle Physics
Medium and Long Term Plan

- Charm physics @ BEPCII
- Intl. collaborations: LHC exp., ILC,…
- Yangbajing Cosmic ray Observatory
- Neutrino experiments:
  - Daya Bay Reactor neutrino to measure $\sin^2 2\theta_{13}$
  - National underground Lab. (*under discussion*)
  - Very LBL oscillation: J-Prac→ Beijing (under discussion)
  - CRTNT (Cosmic Ray Tau Nuetrino Telescope)?

Current and Future Research Projects on Particle Astrophysics in IHEP

Shuang-Nan Zhang

张双南

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