Future Plan of IHEP on HEP

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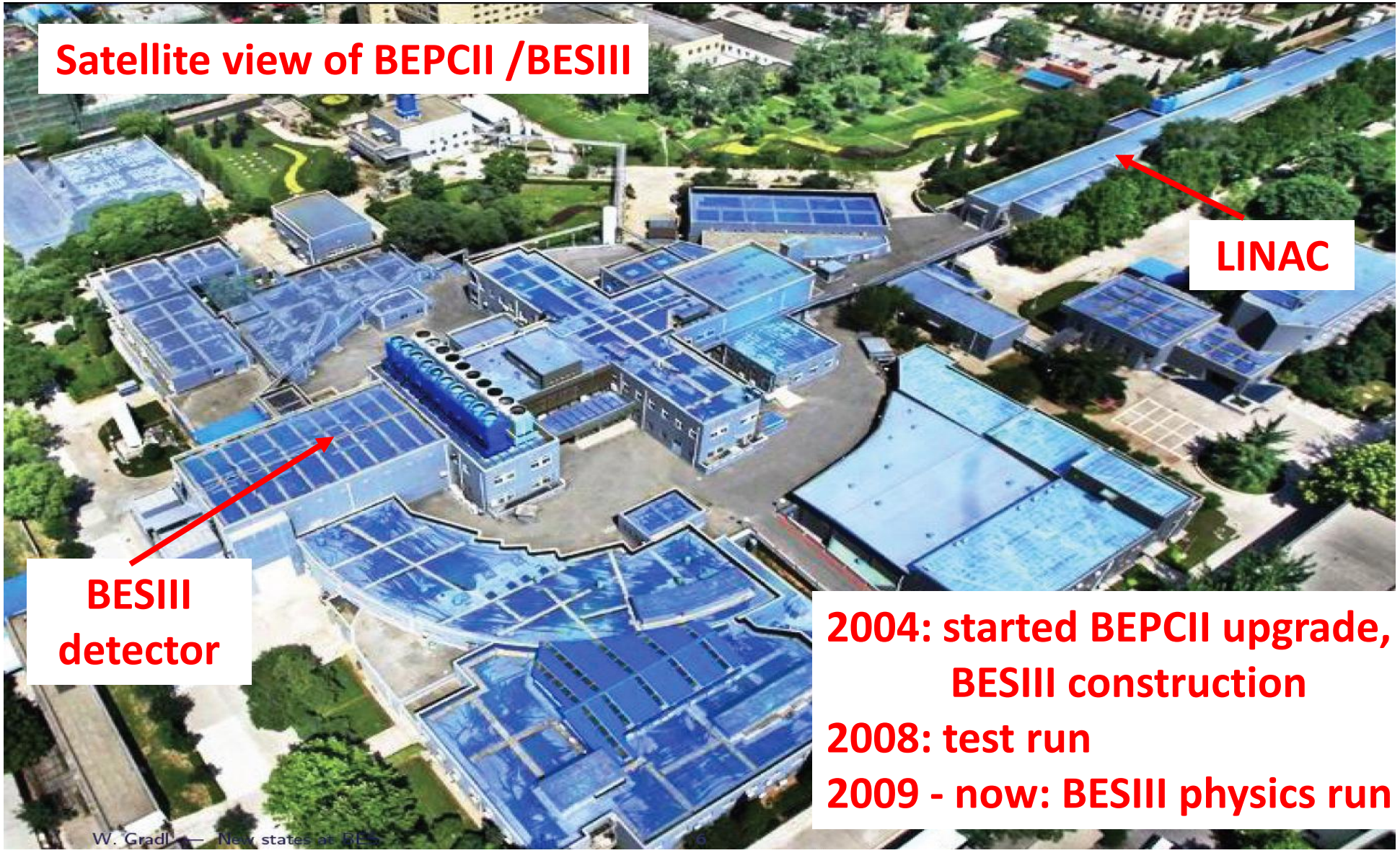
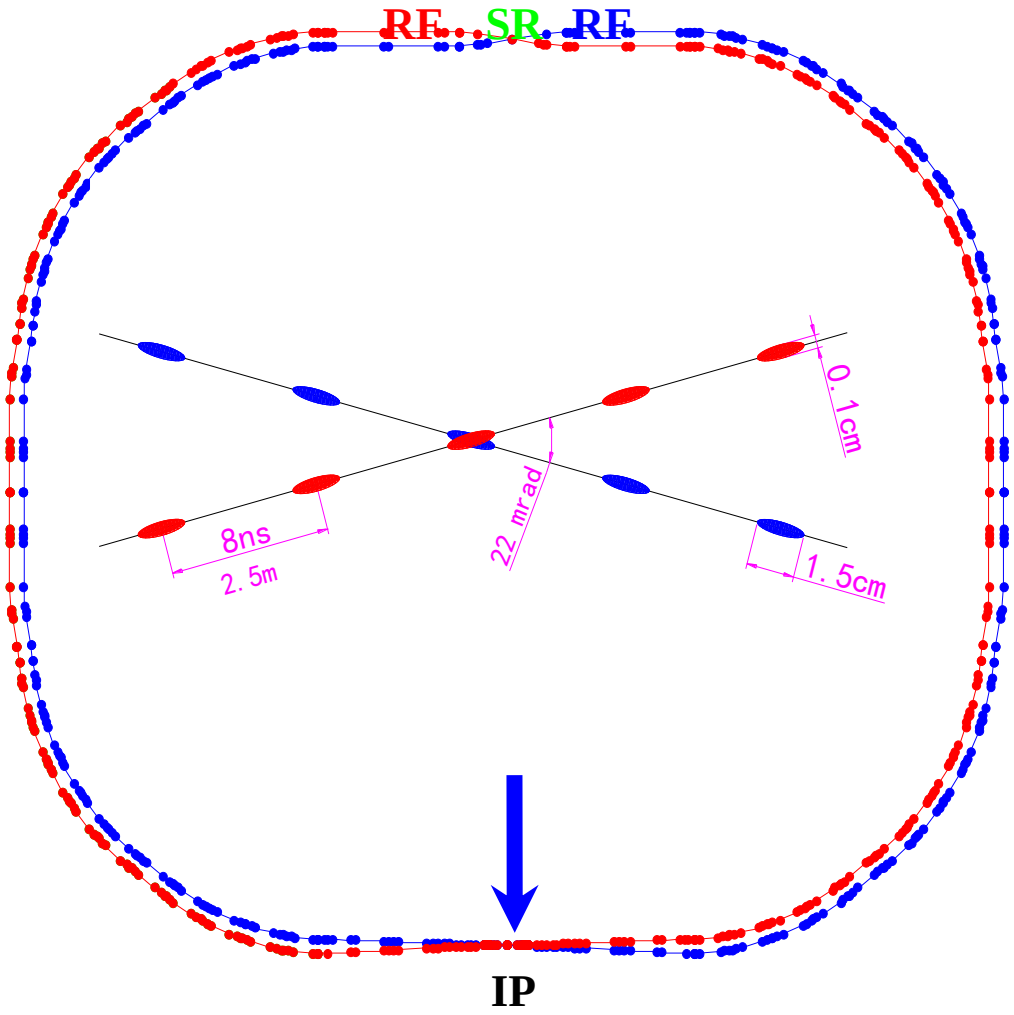
Institute of High Energy Physics, CAS

FNAL, Oct.11-13, 2012

Beijing Electron Positron Collider (BEPC)



BEPCII/BESIII: Operational since 2009



Beam energy: 1.0-2.3 GeV

Luminosity: 1×10^{33} $cm^{-2}s^{-1}$

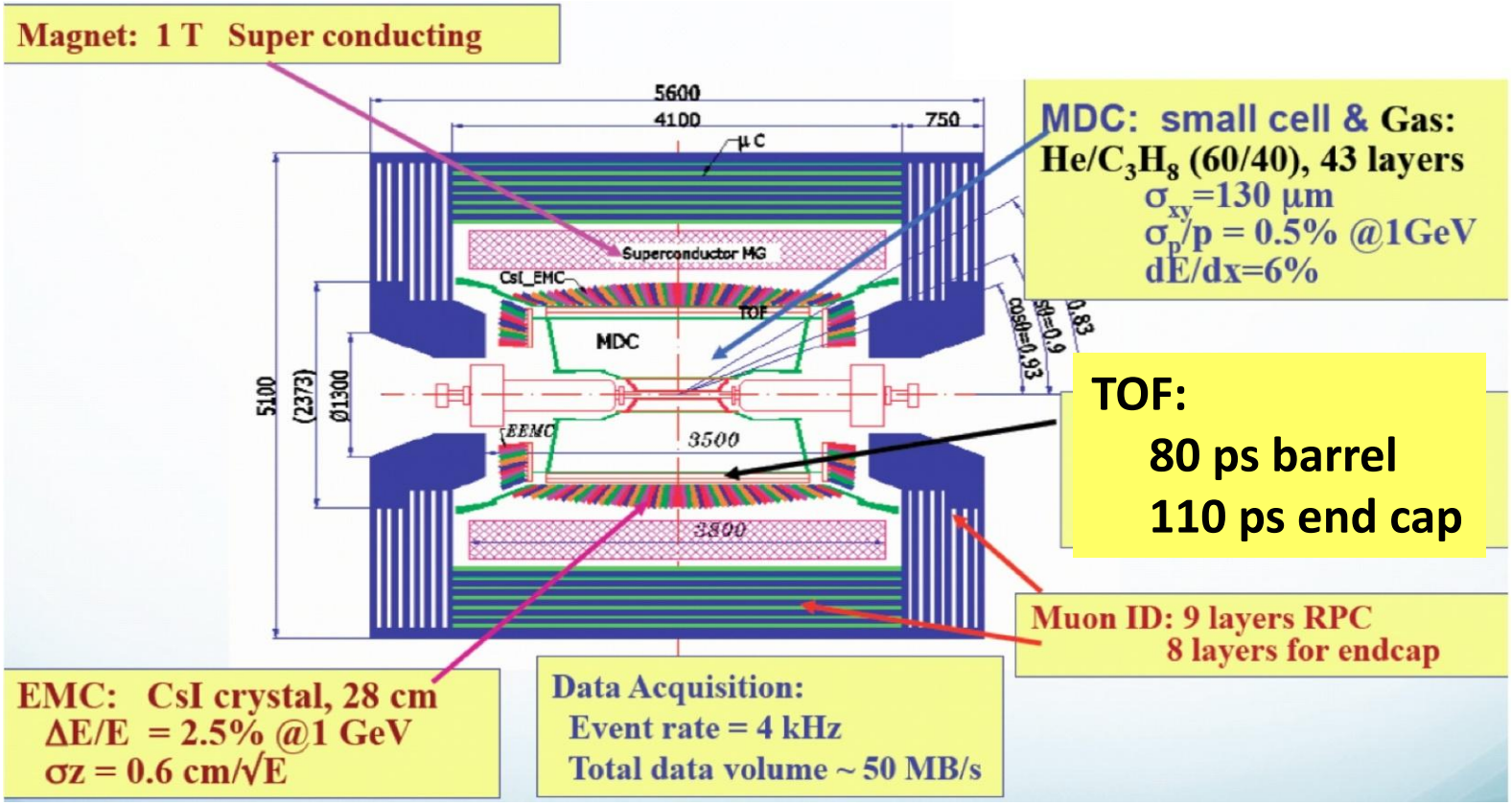
Energy spread: 5.16×10^{-4}

No. of bunches: 93

Bunch length: 1.5 cm

Total current: 0.91 A

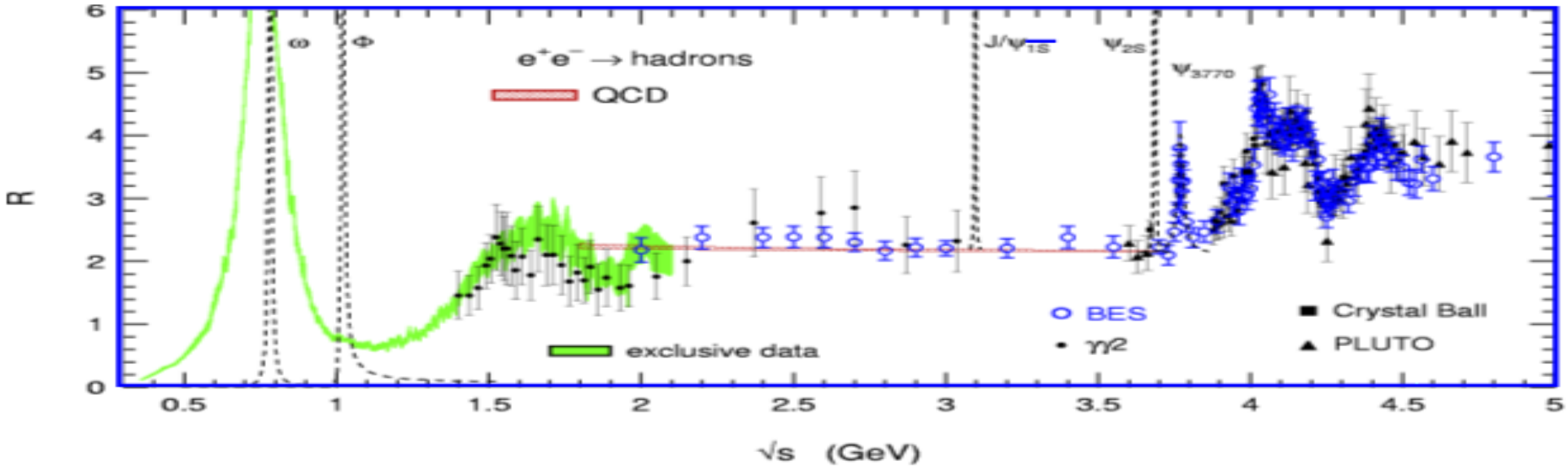
BESIII detector



- Comparable capabilities to CLEO-c, plus muon ID
- The big advantage: BEPCII is a two-ring machine designed for charm
  - Design (achieved) luminosity at $\psi(3770)$: 1 (0.65) x 10^{33}

BESIII data taking status & plan

	Previous data	BESIII present & future	Goal
J/ψ	BESII 58M	1.2 B	10 B
ψ’	CLEO： 28 M	0.5 B	3B
ψ”	CLEO： 0.8 /fb	2.9/fb	20 /fb
ψ(4040)/ψ(4160) /ψ(4260) & scan	CLEO： 0.6/fb @ ψ(4160)	2012:0.4/fb @ ψ(4040) 2013： 0.5/fb@4260, 0.5/fb@4360	5-10 /fb
R scan & Tau	BESII	2013, 2014	



BESIII will continue for the next 8-10 years

Physics Topics at BES

- **Study of Light hadron spectroscopy**
  - search for non-qq or non-qqq states
  - meson spectroscopy
  - baryon spectroscopy
- **Study of the production and decay mechanisms of charmonium states**: J/ψ, $\psi(2S)$, $\eta_C(1S)$, $\chi_{C\{0,1,2\}}$, $\eta_C(2S)$, $h_C(^1P_1)$, $\psi(3770)$, etc.

New Charmonium (like) states above open charm threshold.

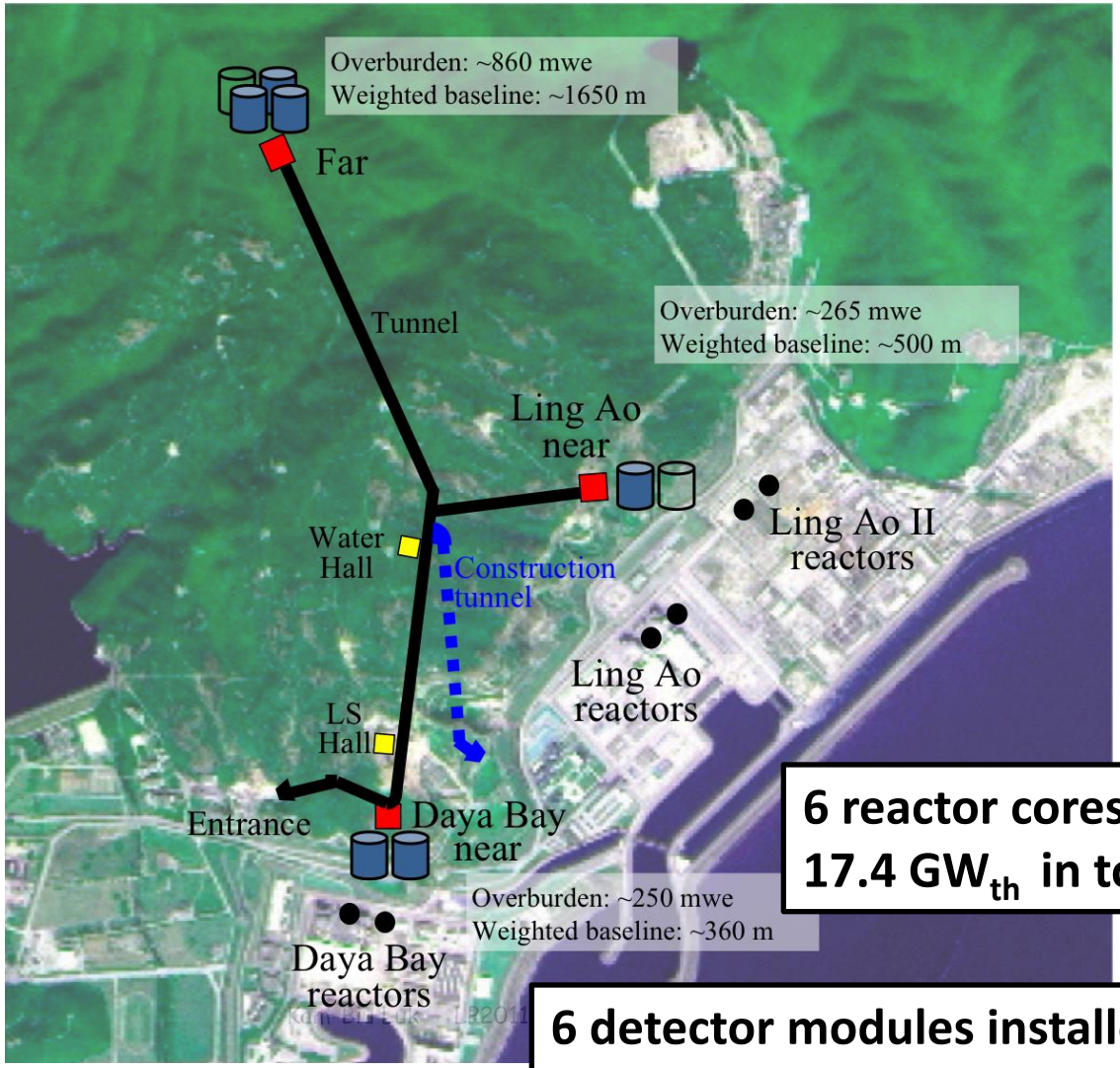
- **Precise measurement of R values, τ mass, ...**
- **Precise measurement of CKM matrix**
- **Search for DDbar mixing, CP violation, etc.**

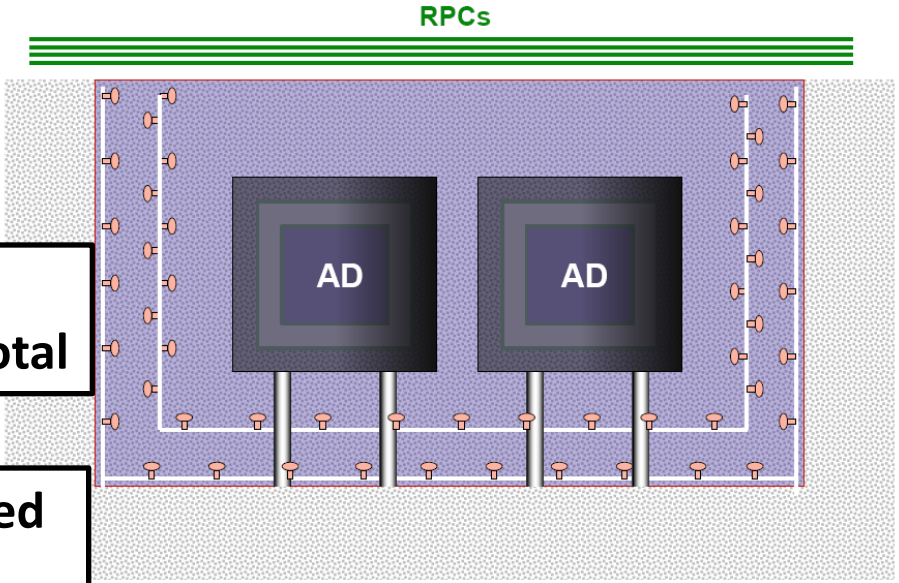
Possibilities of hosting future collider physics facilities in China

- **Super tau-charm factory?**
- **Linear Z factory?**
- **Circular e+e- Higgs factory → High-E pp collider?**

Under discussion in Chinese HEP community .

Daya Bay experiment





6 reactor cores
17.4 GW_{th} in total

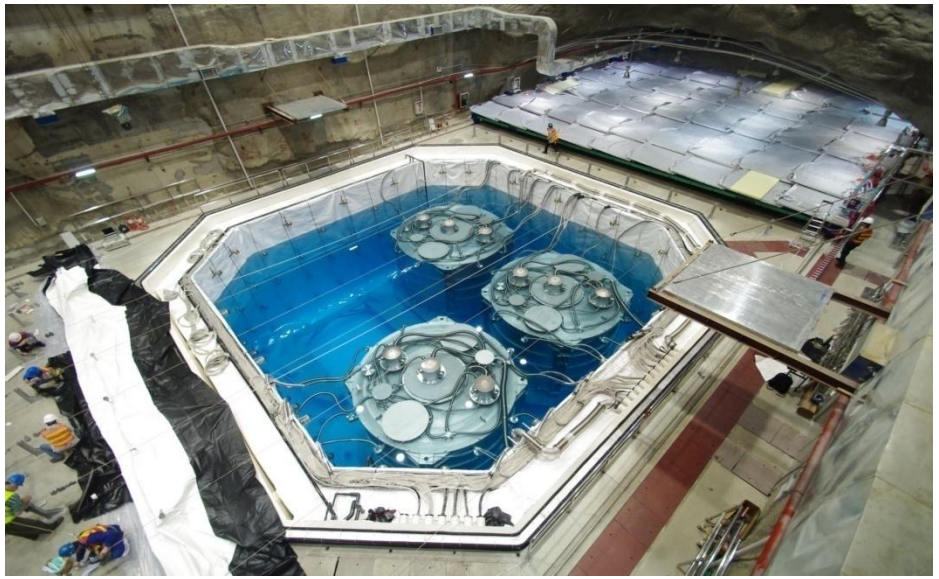
6 detector modules installed

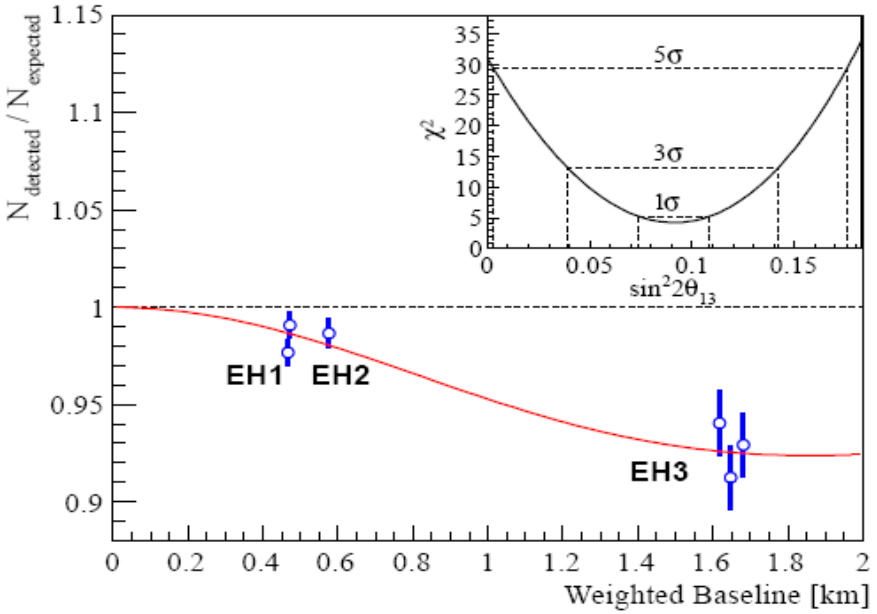
Relative measurement by 2 near sites and 1 far site

Results: observation of Electron Anti-neutrino Disappearance

- After 55 days of data taking, we observed a deficit:

$$R = 0.940 \pm 0.011\,(stat) \pm 0.004\,(syst)$$





$$\sin^2 2\theta_{13} = 0.092 \pm 0.016(stat) \pm 0.005(syst)$$

$$\chi^2/NDF = 4.26/4$$

5.2 σ for non-zero θ_{13}

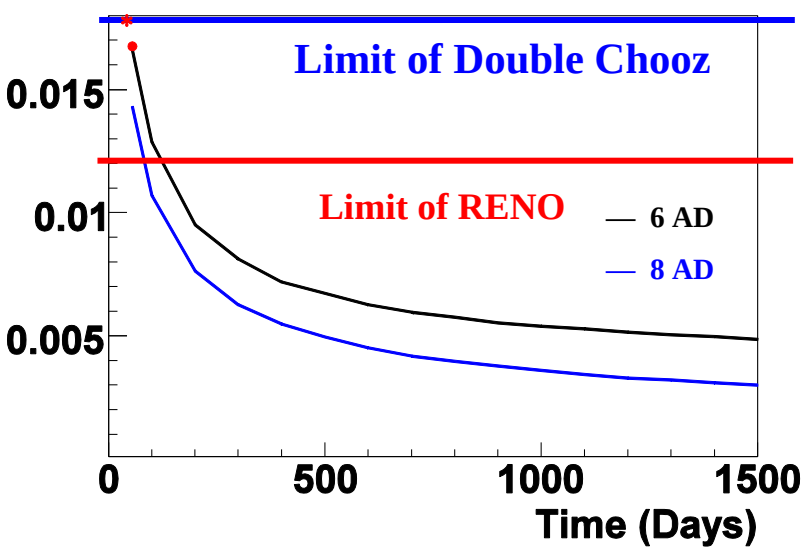
Future plan

- Updated results based on 137 days of data:

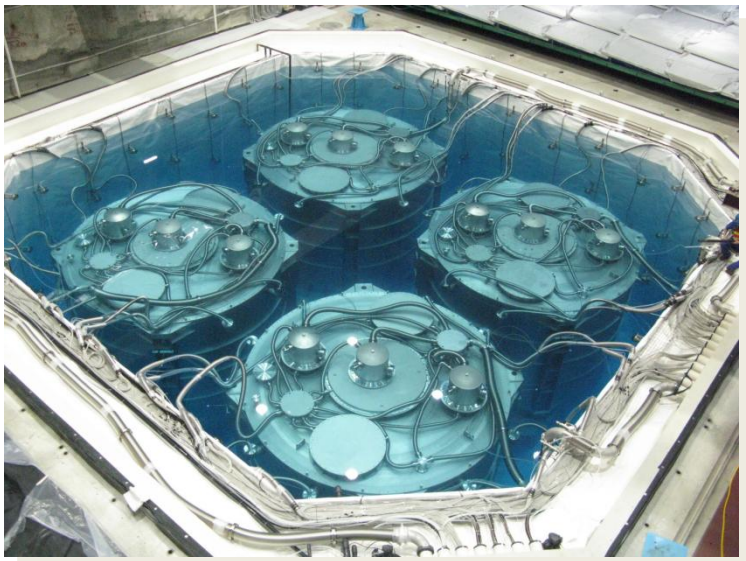
$$\sin^2 2\theta_{13} = 0.089 \pm 0.010(\text{stat}) \pm 0.005(\text{syst})$$

7.7 σ for non-zero θ_{13}

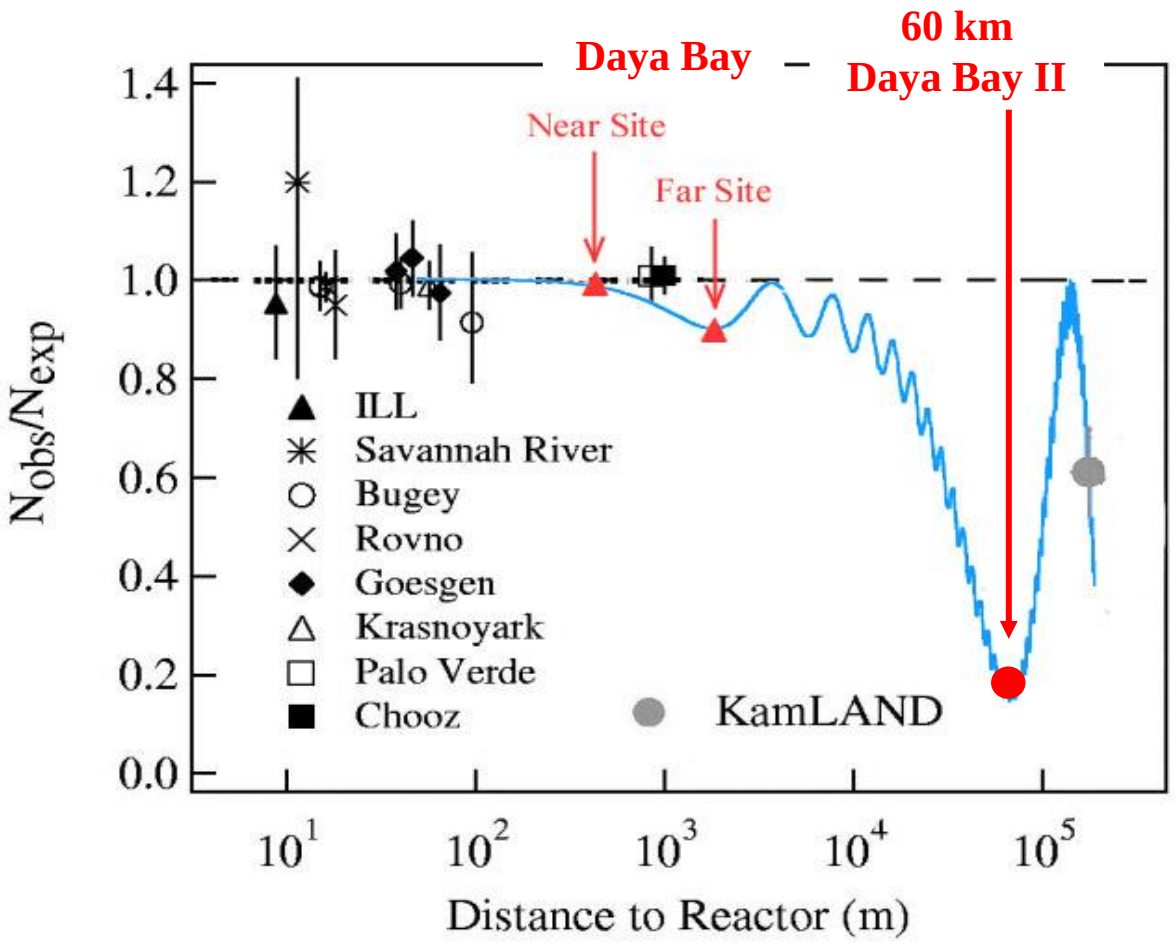
- Final goal： ~(4-5)% precision on $\sin^2 2\theta_{13}$



Expected precision of $\sin^2 2\theta_{13}$ over time



Daya Bay-II Experiment

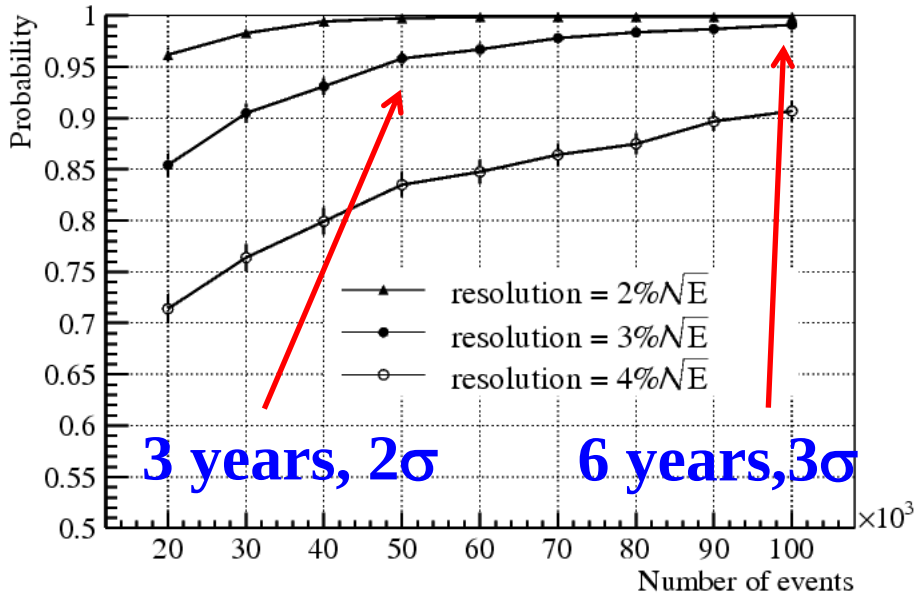


- 20 kton LS detector
- 3%/$\sqrt{E}$ resolution
- Rich physics
  - ⇨ **Mass hierarchy**
  - ⇨ **Precision measurement of 4 oscillation parameters to <1%**
  - ⇨ **Supernovae neutrino**
  - ⇨ **Geoneutrino**
  - ⇨ **Sterile neutrino**
  - ⇨ **Atmospheric neutrinos**
  - ⇨ **Exotic searches**

Talk by J. Cao at International Symposyum on neutrino and beyond, 20012

Easier now with a large θ_{13}

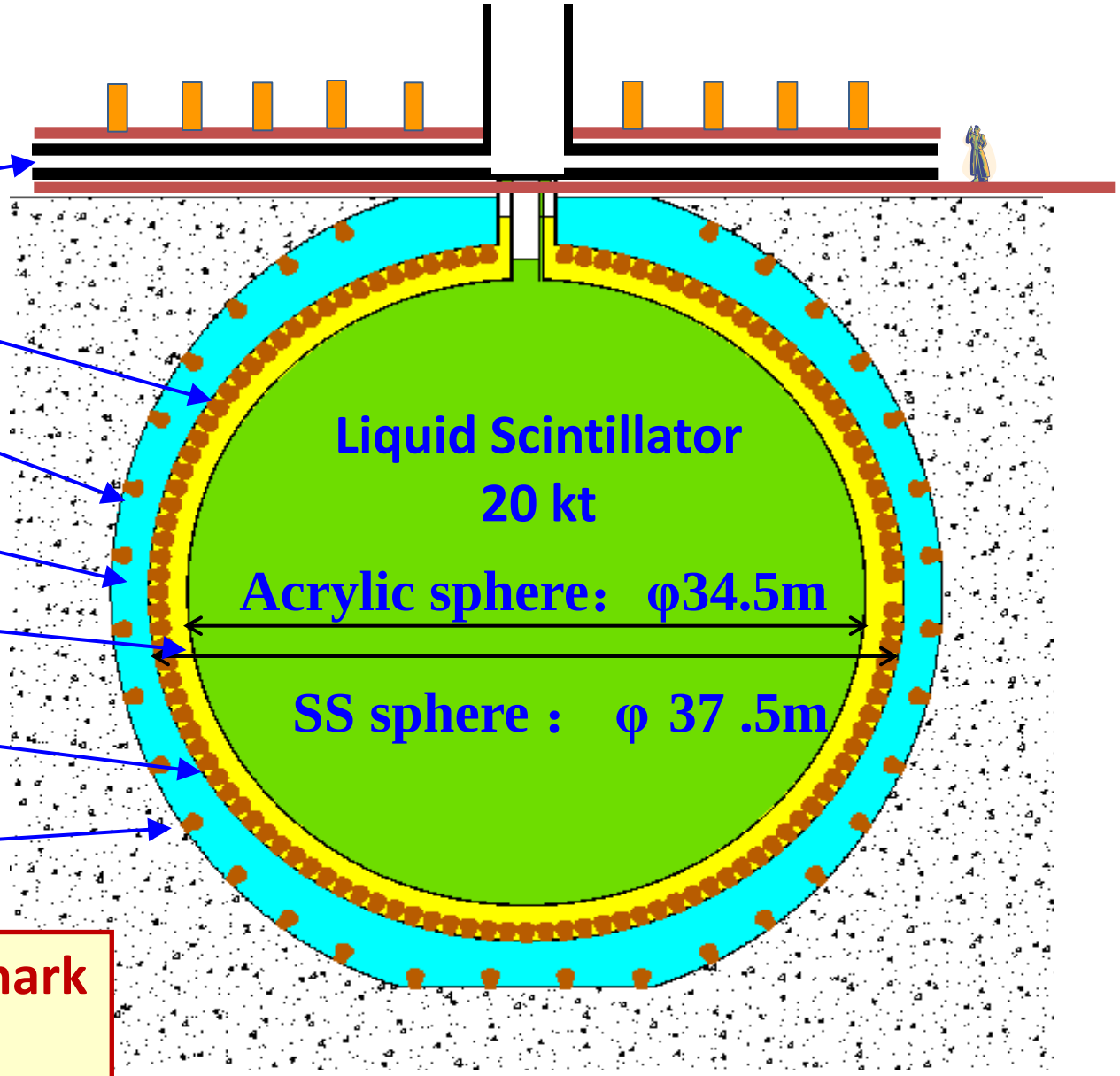
- **Smaller detector ? Relaxed resolution ?**
- **New default parameters**
  - **Detector size: 20kt**
  - **Energy resolution: 3%**
  - **Thermal power: 36 GW**
  - **Baseline 58 km**



The reactors and possible sites

	Daya Bay	Huizhou	Lufeng	Yangjiang	Taishan
Status	Operational	Planned	Planned	Under construction	Under construction
Power	17.4 GW	17.4 GW	17.4 GW	17.4 GW	18.4 GW

Detector Concept



Muon tracking

Stainless steel tank

Water Seal

Water Buffer 10kt

Oil buffer 6kt

~15000 20” PMTs
optical coverage: 70-80%

20” VETO PMTs

> X 10 over current benchmark
Details to be worked out

- **Fundamental to the Standard Model and beyond**
- **Probing the unitarity of U_{PMNS} to ~1% level !**

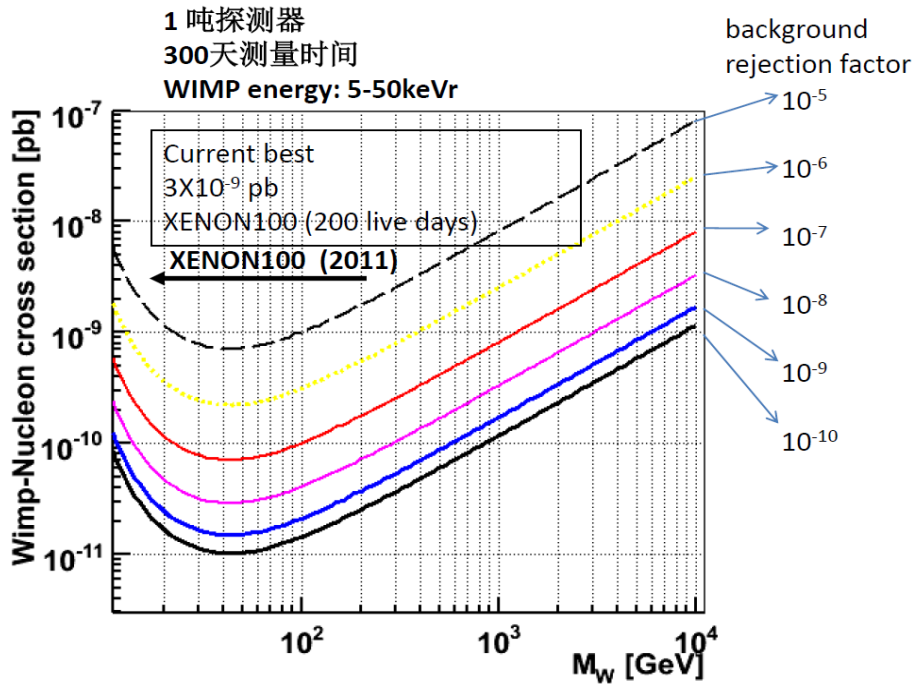
	Current	Daya Bay II
Δm^2_{12}	3%	0.26%
Δm^2_{23}	5%	0.30%
$\sin^2\theta_{12}$	6%	0.63%
$\sin^2\theta_{23}$	20%	N/A
$\sin^2\theta_{13}$	14% → 4%	~ 15%

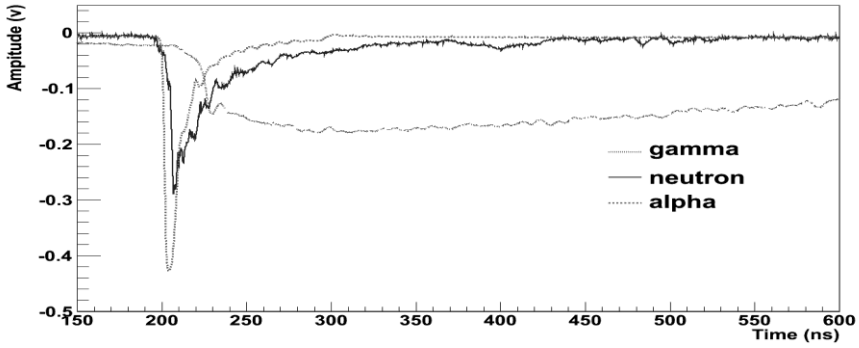
- **Daya Bay II proposed in 2008-2009, now boosted by the large θ_{13}**
  - **Science case is strong with significant technical challenges**
  - **Very rich physics.**
  - **Funding are promising.**
  - **Possible time schedule:**
    - **Proposal to government: 2015 or earlier**
    - **Construction: 2016-2020**

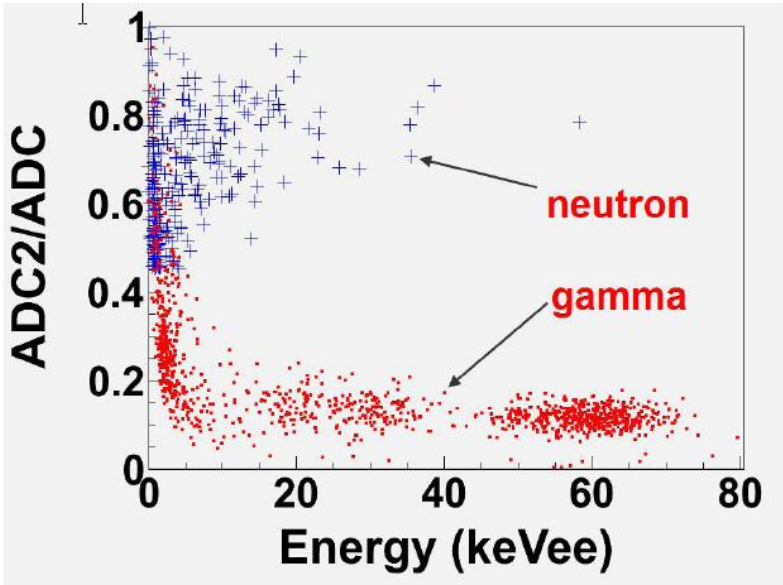
Underground Dark Matter Search

From talk by X. L. Sun, 2012

- **Main challenge for direct search:**
  - **Small scattering cross section**
  - **Low recoil nuclei energy**
  - **Large background**
- **backgrounds increase with mass (usually yes) ? How to reach ~1t ?**
- **Reject backgrounds by pulse shape discrimination**
- **CsI（Na）**
  - **Good n/γ separation**
  - **High light yield**

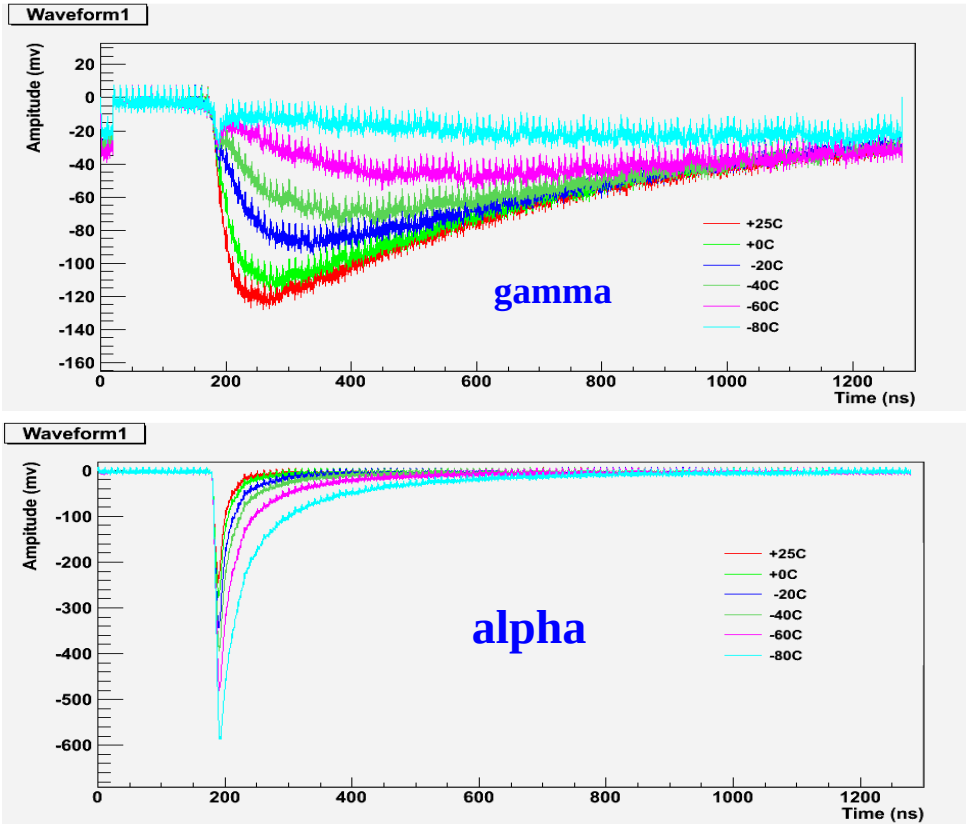


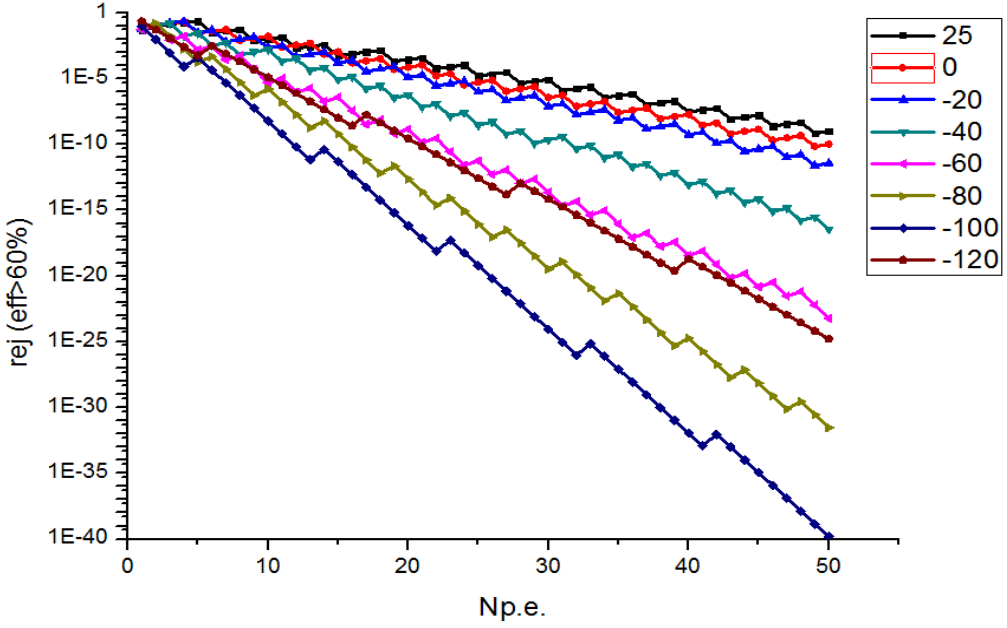




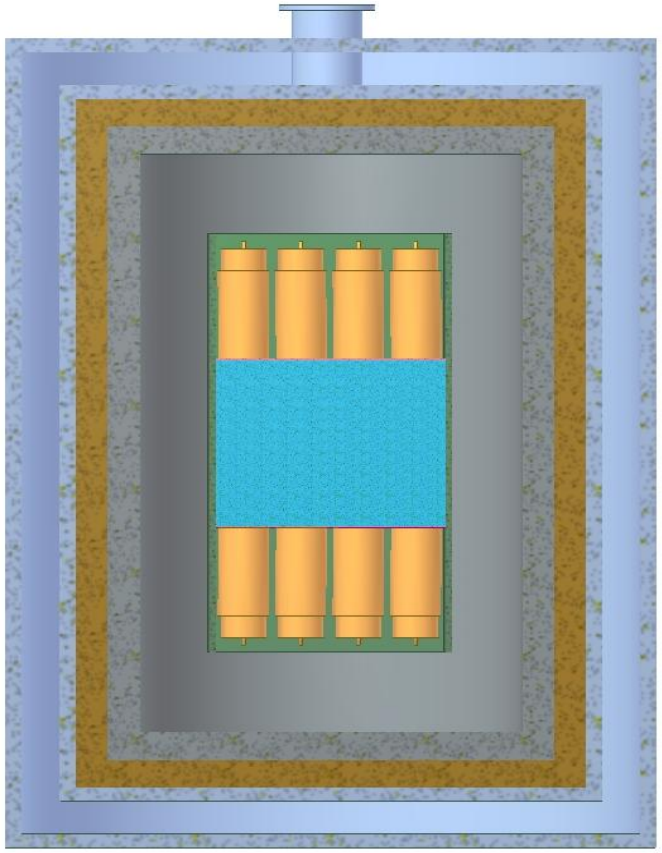
Further study

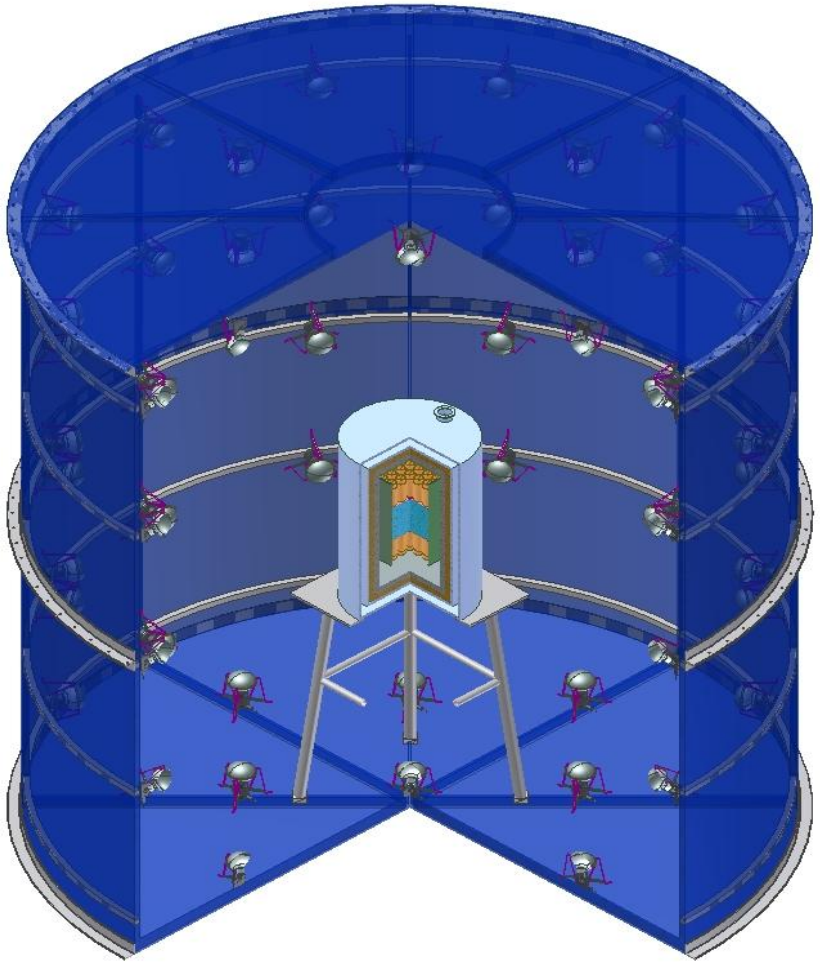
- Better to be at low temperature
- Rejection power can reach 10^8 @ 10 PE





A Prototype to be built at Daya Bay



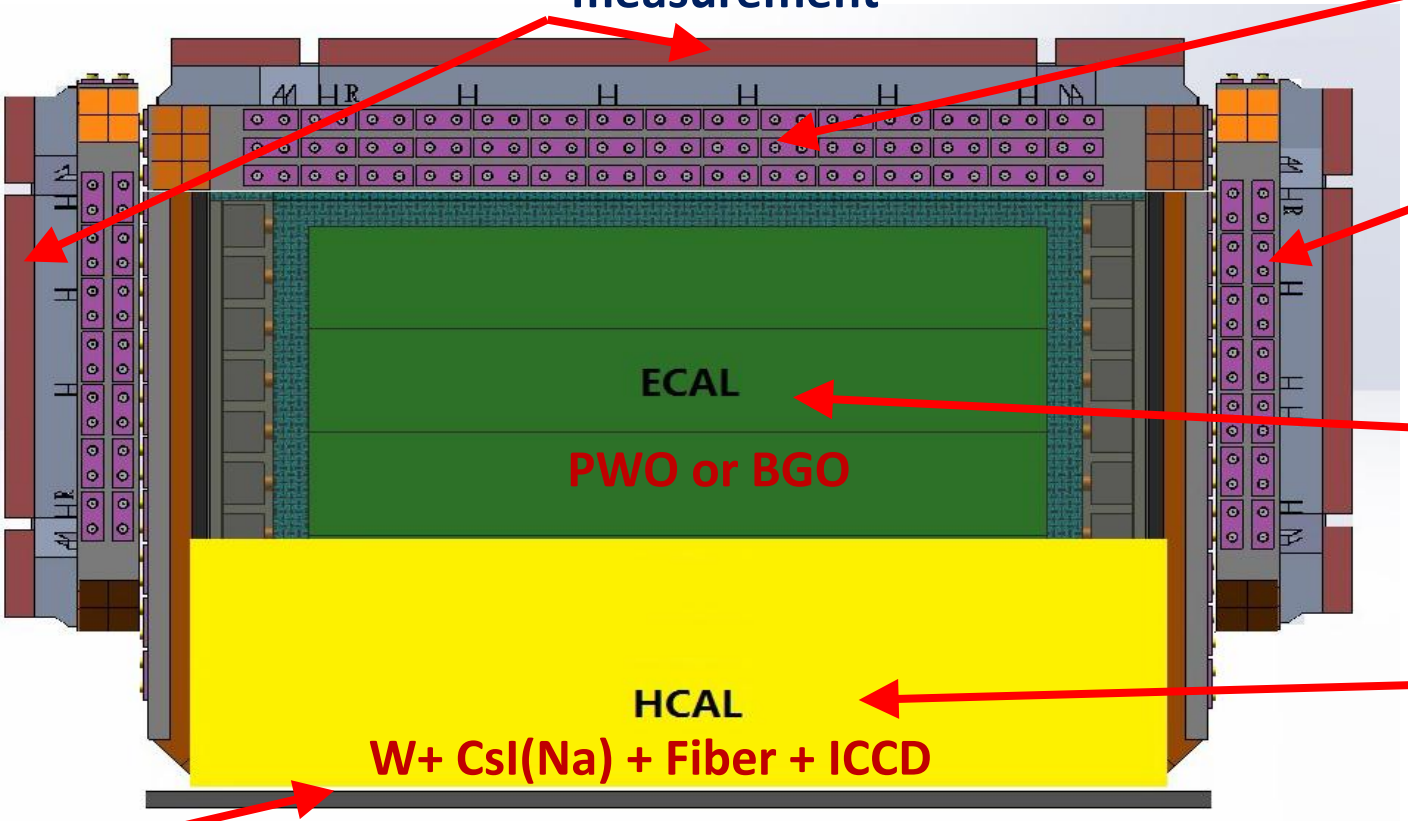


A real 1 ton experiment is still under discussion

The High Energy cosmic Radiation Detection (HERD) facility onboard China's Space Station

From talk by S. N. Zhang, 2012

Charge detector: 2-layered Si+PIN. Charge measurement



Shower Tracker:

W+scintillation fibers

Nucleon Tracker: scintillation fibers.

ECAL: lepton calorimeter. e/γ energy.

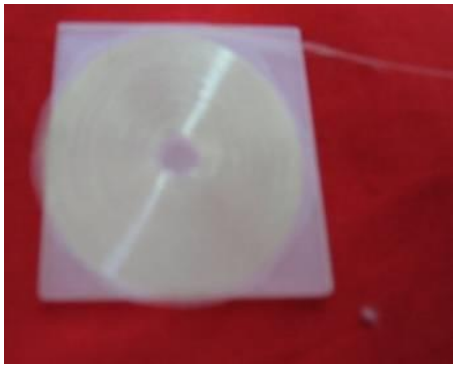
HCAL: hadron calorimeter. e/p discrimination and CR composition.

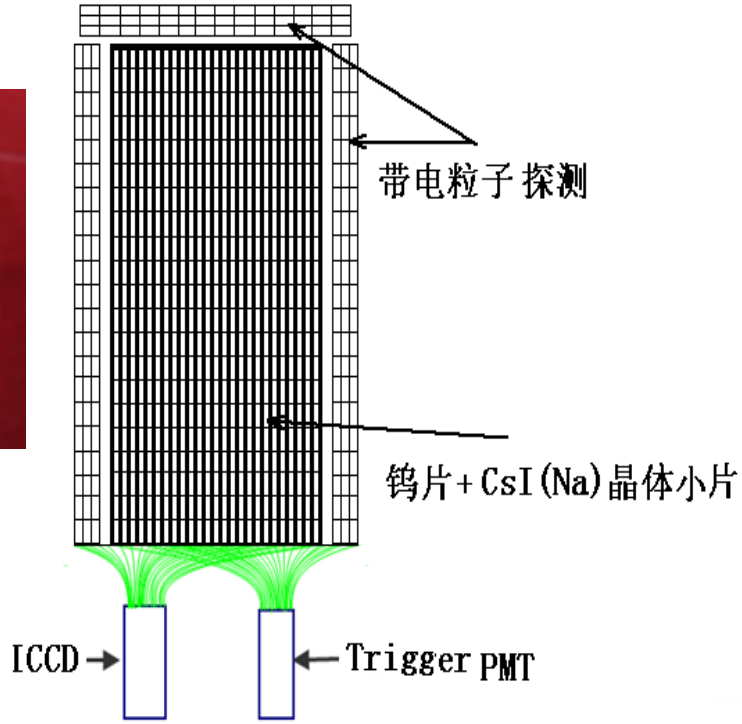
Neutron detector: B-doped plastic scintillator for delayed signals. Enhanced e/p discrimination.

3D Digital Calorimeter for Space Station

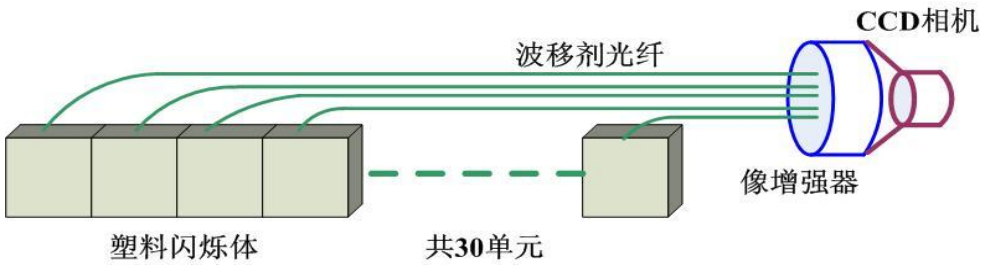
CsI(Na) crystal + Tungston plate
Readout by fiber+ICCD

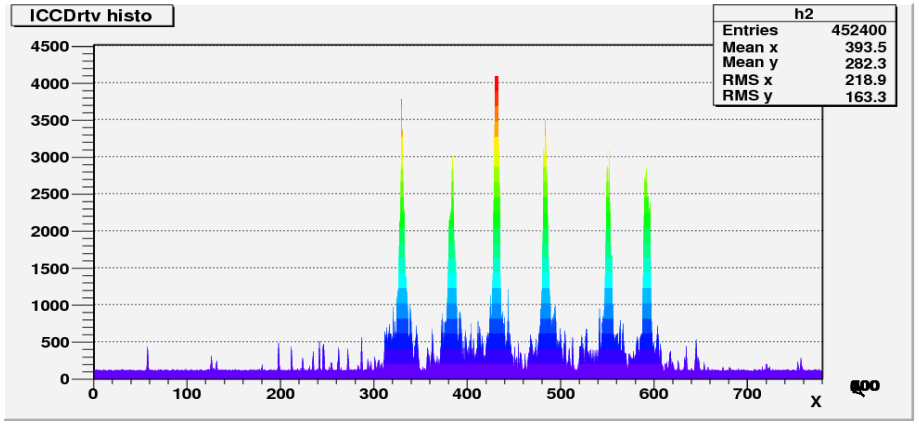
For γ,e: 30GeV—10TeV
For H,He,C,… : 30GeV—100TeV





- **Low power**
- **Mature technology**





- The mission concept (science goals with requirements) has been selected, not in competition with other missions.
- The design concept has been reviewed on Feb. 29, 2012, together with all other proposals in all fields.
  - A top ranked mission concept at this stage.
  - However simulations on the concept just started, much more needs to be done to have a real design.
- Technical review for mission selection may happen anytime.
- Launch in 2018-2020.
- 1st international workshop on HERD to be held in Beijing on Oct. 17-19, 2012: scientific objectives, mission definition and international partnership.

China's Space Station Program

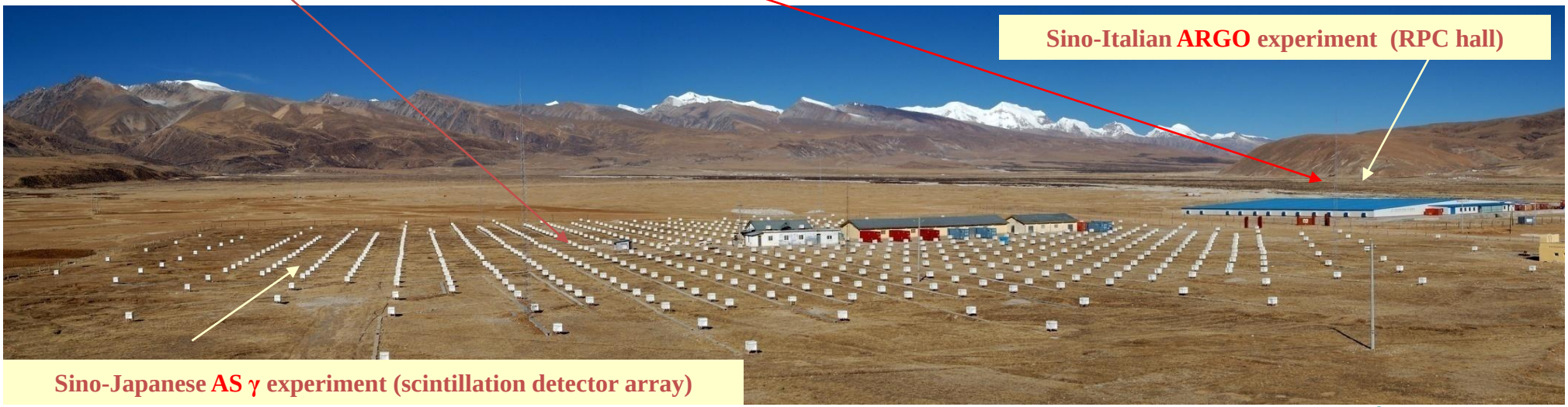
- Three phases
  - 1st phase: so far 7 Chinese astronauts have been sent out and returned back successfully; many space science research has been done. Completed successfully.
  - 2nd phase: spacelab: docking of 3 spaceships with astronauts delivering and installing scientific instruments. 1st launch on Sept. 29, 2011.
  - 3rd phase: spacestation: several large experimental cabins with astronauts working onboard constantly. 1st launch ~2018.

International collaborations on space science research have been and will continue to be an important part.

Yang-Ba-Jin Cosmic-ray observatory

~3TeV

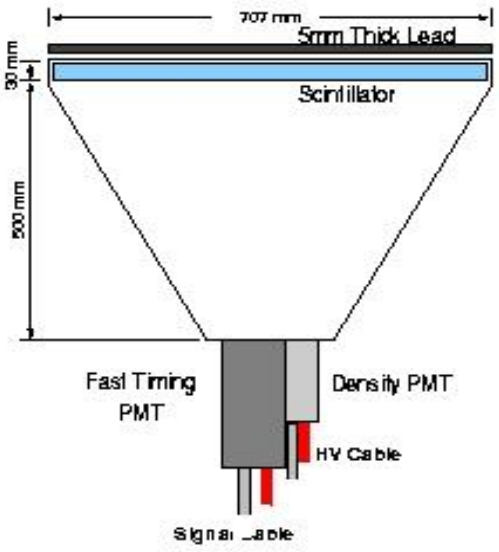
~300GeV



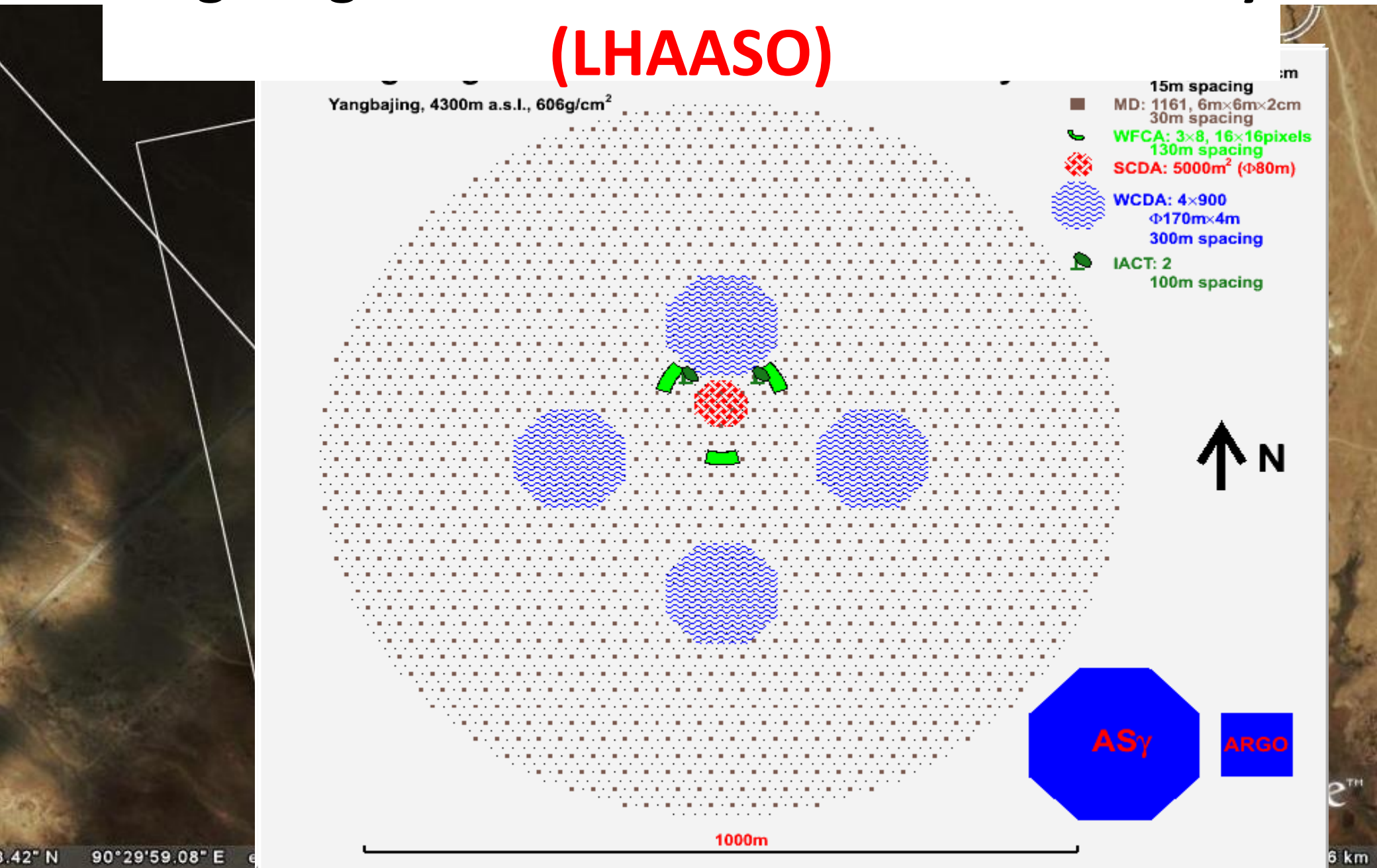
Sino-Japanese AS γ experiment (scintillation detector array)

Sino-Italian ARGO experiment (part of RPC carpet)

ASγ scintillation detector



Large High Altitude Air Shower Observatory (LHAASO)

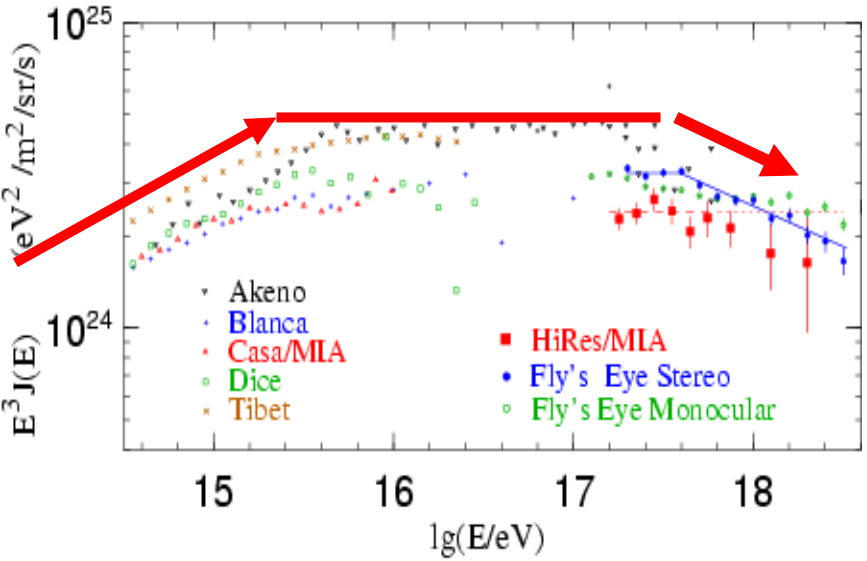


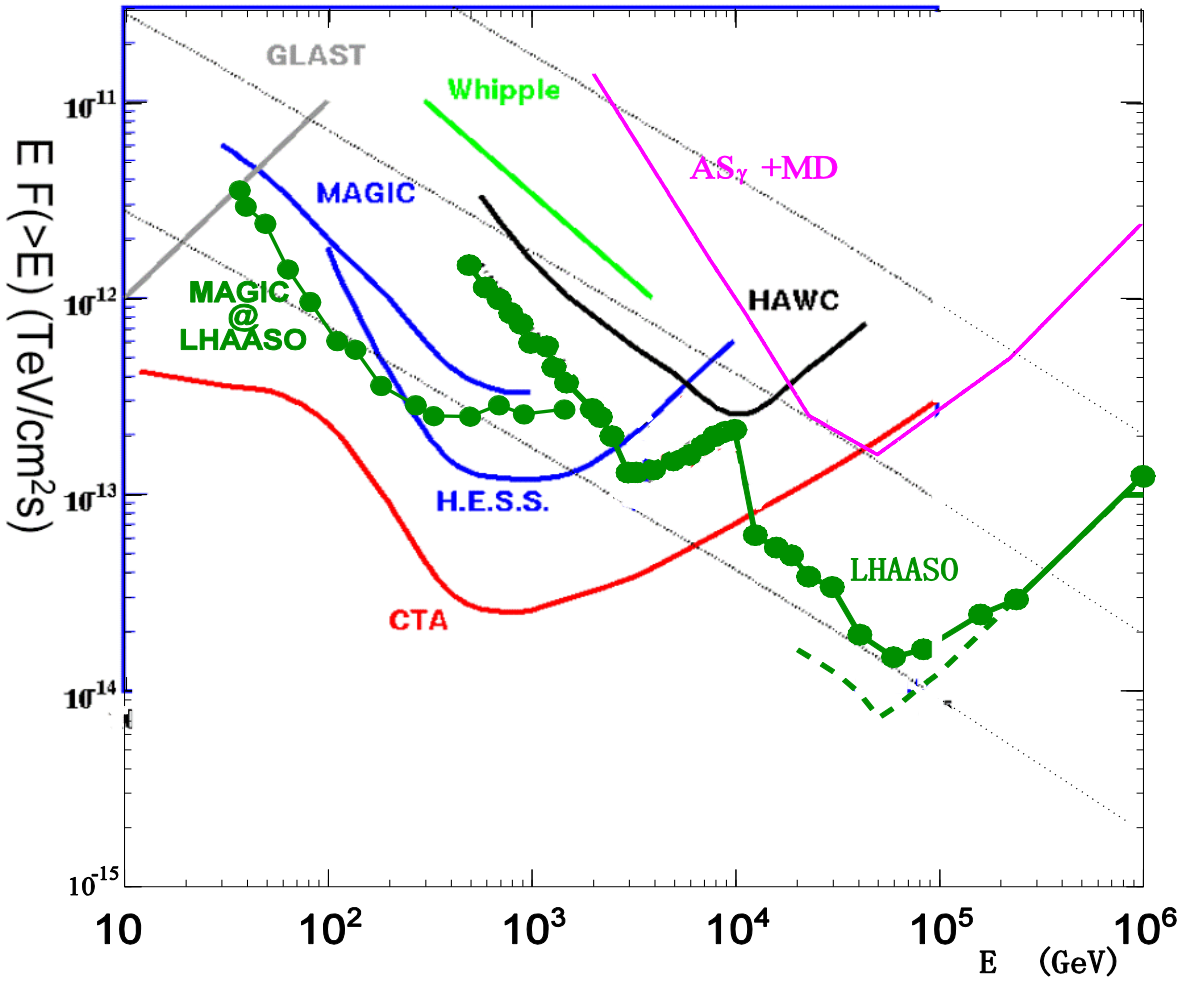
Three major scientific goals of LHAASO

- **TeV γ ray observation has an opportunity of finding CR origin: 108+ sources discovered**
  - **All-sky survey for γ source population is necessary (full duty cycle, wide FOV and sufficient sensitivity)**
  - **50+ galactic sources: γ at high energy (>30TeV) is crucial (high sensitivity and high energy resolution)**
- **PeV CR spectra of individual composition**
  - **Bridge between space/balloon borne measurements and ground based UHECR measurements**
- **Exploring for new physics frontier**

Scientific Goal: Origin of UHE Cosmic-rays & γ-ray Astronomy

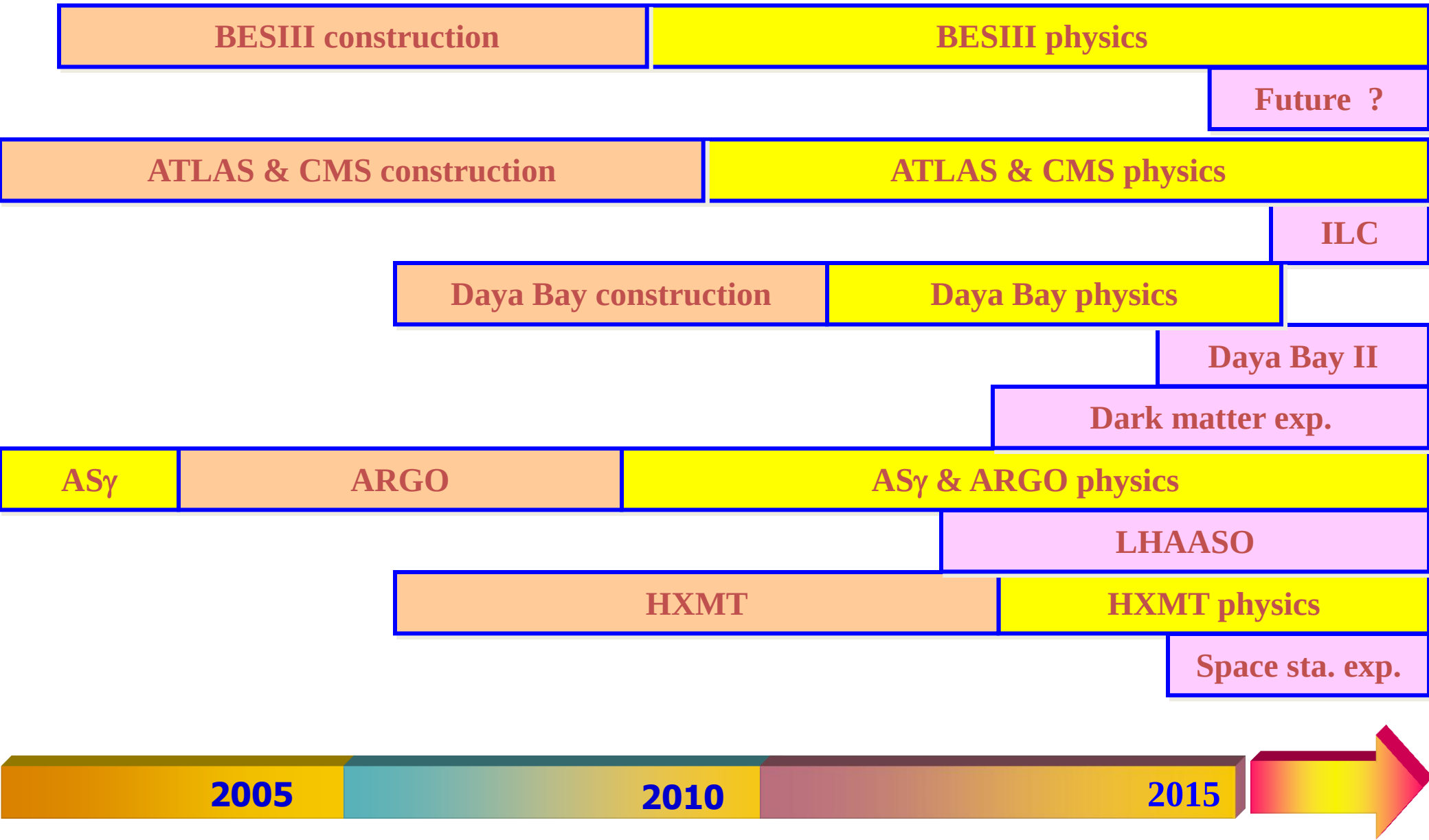
Cosmic-ray energy spectrum covering both "Knee" with absolute energy scale: understand acceleration mechanism





Sensitivity to γ-ray sources

Summary


BESIII construction
BESIII physics
Future ?
ATLAS & CMS construction
ATLAS & CMS physics
ILC
Daya Bay construction
Daya Bay physics
Daya Bay II
Dark matter exp.
ASγ
ARGO
ASγ & ARGO physics
LHAASO
HXMT
HXMT physics
Space sta. exp.
2005
2010
2015

Thank you!

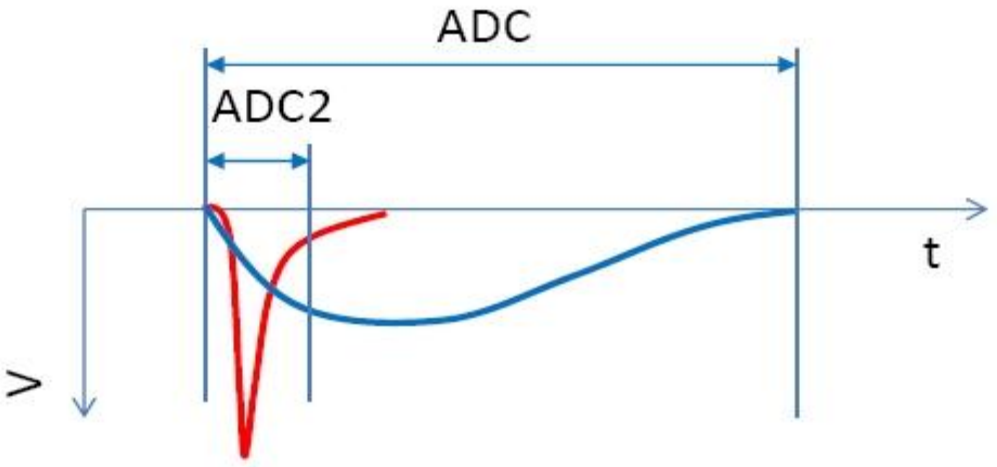
n/γ separation by PSD

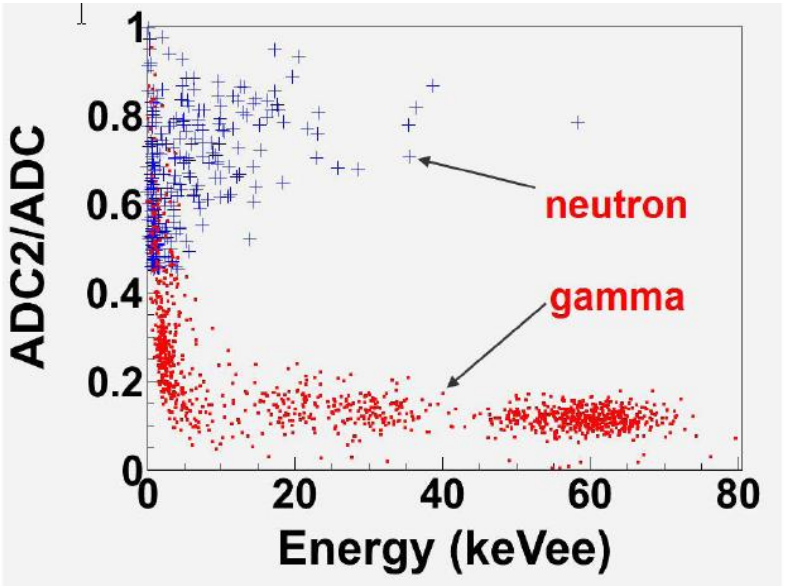
Pulse Shape Discrimination (PSD) technique could be used for n/γ separation based on different waveforms of nuclear recoils and γ-rays

Define: ADC is the integration of the slow component 2us

ADC2 is the integration of the fast component 100ns

the ratio ADC2/ADC can used for n/gamma separation





Scatter plot of ADC2/ADC versus energy for n and γ.

Dot is γ-ray from ^{241}Am and plus is neutron