

Astroparticle Strategy in Japan

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Astroparticle project List in Japan

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Change in Japanese Funding System for the last few years

- ***Before the change***

1. Proposals from institutions to funding agency
2. Support from the community (no roadmap)
Individual project evaluation
3. Set up a council in the government
(many negotiation before that)
4. Approval

Change in Japanese Funding System for the last few years

- ***After the change***
 1. Proposals from institutions
 2. Need Supports
 - from the community
 - from the Science Council of Japan
 - LIST BIG Projects > €100M
 3. Set up a council in the government
 4. Approval
- ***Different process for 'space'***
 - JEM-EUSO, CALET, Balloon experiments and so on.

Discussions on the Japanese Roadmap in the community (Science Council of Japan)

- Master Plan of the Science Council of Japan
 - SC of Japan: representing the communities of 840,000 Japanese scientists
 - In 2010, the Science Council of Japan discussed the long-term plan of the Japanese scientific research (not only astroparticle physics), and made a “Master Plan” for **big** research projects.
 - Listed 43 big projects in 7 fields from 285 plans from all the scientific fields.
 - Astroparticle physics related big projects (> €100M):
 - Large-scale Cryogenic Gravitational Wave Telescope (LCGT)
 - Nucleon Decay and Neutrino Oscillation Experiments with Large Advanced Detectors.
 - SuMIRE
- Sub-committees of SC have prepared ‘Road map’ of various funding level of projects including small scale projects as well as big ones

“Roadmap” by the Science and Technology Council of MEXT

- ST Council of MEXT
 - Evaluate prioritization of 43 projects in 7 fields, listed in the Master Plan of SC
 - Formulated a Roadmap in 2010 with 18 plans approved for a certain degree of priority. Although the Roadmap does not guarantee budgetary measures, it should be seriously considered when promoting the related measures
- ‘Large-scale Cryogenic Gravitational Wave Telescope (LCGT) project’ and ‘SuMIRE’ are included in these 18 projects
 - Both were funded soon after that
- Revisions to the Roadmap
 - Flexible re-assessment of the roadmap is scheduled

Discussions on the Roadmap in the astroparticle physics community

- CRC (Cosmic Ray Researchers Congress)
 - Symposium for the future projects
 - Last held on Sept. 2010
 - Summarized ‘Present and future of Japanese Astroparticle physics (in Japanese)’
 - Set up a committee to discuss the future projects in CRC
 - Held town meeting on small and meadium scale experiments (July-30, 2011)
 - Discussed 8 projects
 - 3 big projects were already selected before this procedure

Future experiments

including participation to the international projects

- **High energy cosmic ray**
 - Telescope Array 2
 - JEM-EUSO
 - CALET
- **Gamma ray**
 - CTA*
 - Tibet Air shower array - extension
- **Neutrinos/Proton Decay**
 - HyperK
 - GADZOOKS!
 - IceCUBE extension/ARA*
- **Double Beta Decay**
 - KamLAND2-Zen
 - CANDLES
 - DCBA
- **Dark Matter**
 - XMASS
 - NewAGE
- **Dark Energy**
 - SuMIRE
- **Gravitational Wave**
 - LCGT
 - (DECIGO)

* Participation to the International Project

Major (Host) Institutes Conducting Astroparticle Physics

- Institute for Cosmic Ray Research(ICRR), Univ. of Tokyo (Kamioka Observatory is a branch of ICRR)
 - Super-K, XMASS, LCGT(GW), TA, Tibet, CTA
- IPMU, University of Tokyo
 - SuMIRE, (Super-K, XMASS, KamLAND-Zen)
- Tohoku Univ.
 - KamLAND, KamLAND-Zen
- Osaka Univ.
 - CANDLES
- Chiba
 - IceCUBE
- KEK
 - QUIET, T2K, (Super-K), DCBA

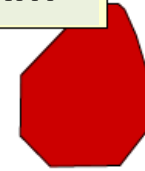
Cosmic Ray

Telescope Array 2

- **TA2**: to study extreme energy cosmic rays
 - 10,000 km² (TA x15, Auger x3)
 - SD: 507(TA) → 5,000
 - FD: 3(TA) → 5
- Obs. 1,000 events ($E > 57 \text{ EeV}$) for 10 years
 - Chemical Composition
 - Point Source?
 - Acceleration Mechanism
- €90M (Japanese contri. €35M)
 - SD: €50, FD: €30, others: €10M
- Proposal in 2015
- Construction 2016-2020

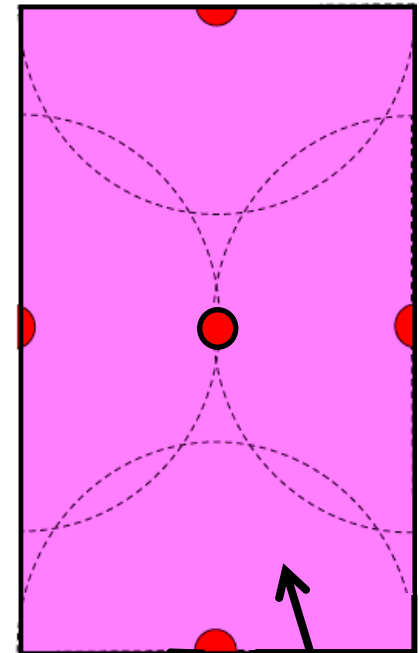
TA -I: SD

680 km²



28 km

70 km



140 km

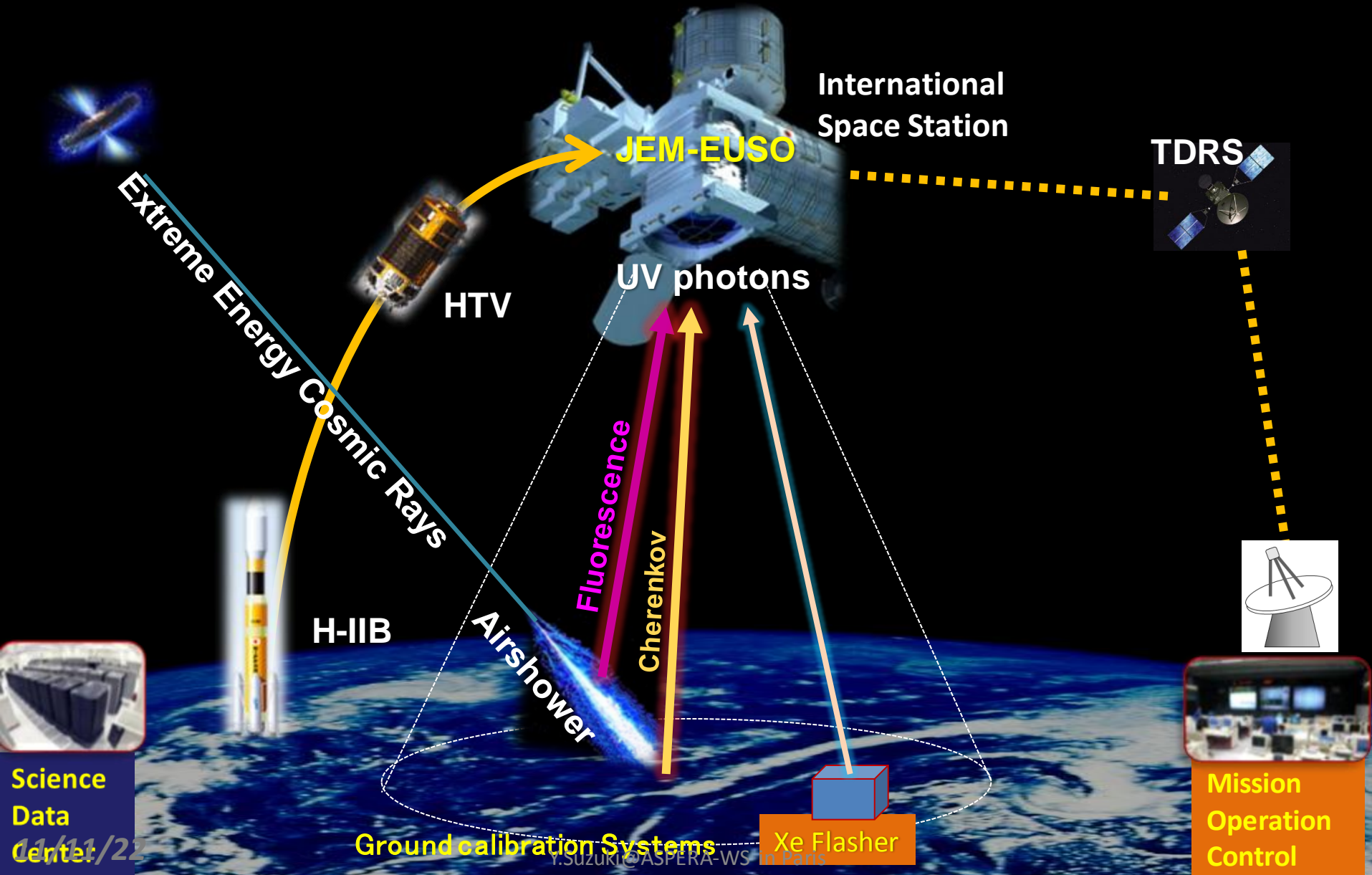
5 FD stations

5,000 SD Array



JEM-EUSO mission:

Extreme Universe Space Observatory onboard Japanese Experiment Module



Science Data Center
11/11/22

Mission Operation Control

Ground calibration Systems Xe Flasher

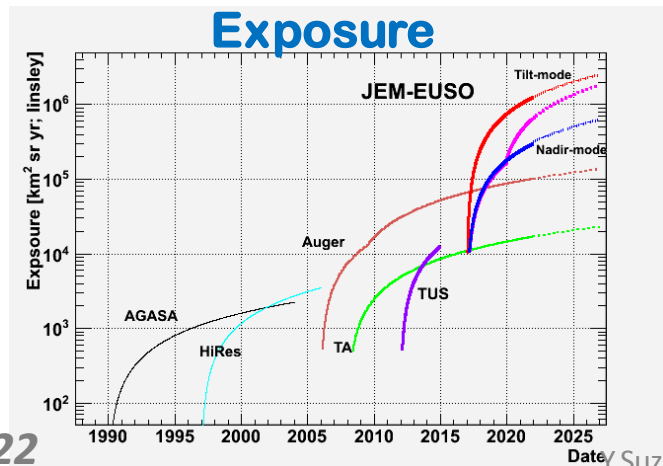
Y.Suzuki@ASPERA-WS in Paris

JEM-EUSO

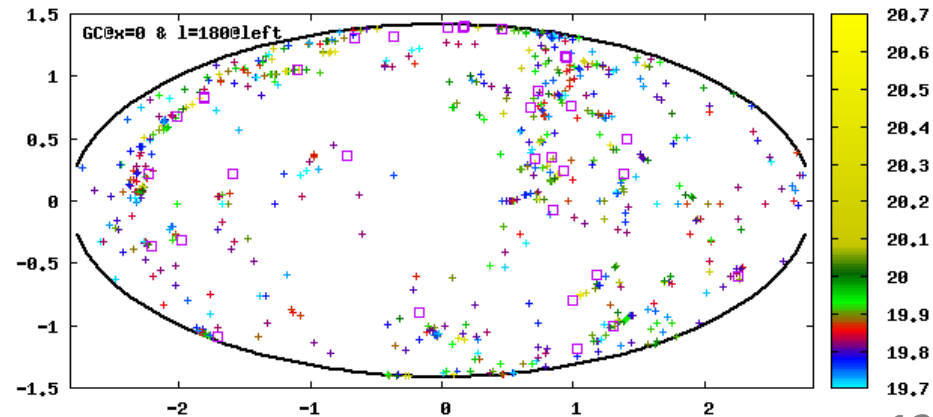
Study extreme energy cosmic rays from the space

- Detector Parameters:
 - Lenz: $d=2.5\text{m}$
 - Field of View: 60°
 - 300,000 pixels
- AUGER x10
- 13 countris, 77 institutions and 217 scientist:
- JAXA, ESA, NASA and ROSCOSMOS

- Instrument cost $\sim \$180\text{M}$ (Japanese contri. $1/3 \sim 1/2$)
- Launch in JFY 2016 ?
- Field test
 - JFY2012 test at TA site
 - JFY2013-14 Balloon experiment



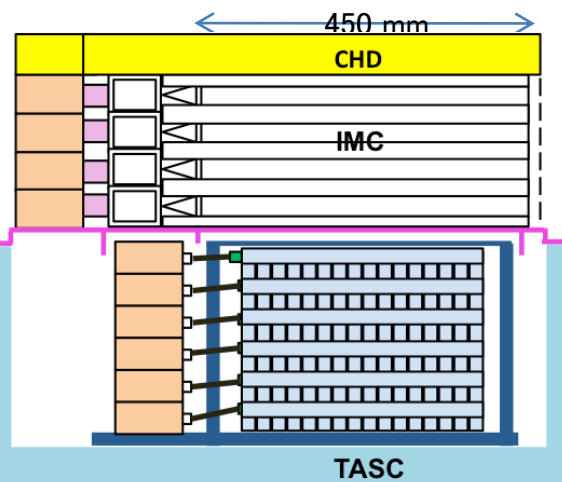
Arrival Direction Map (Five year Obs.)



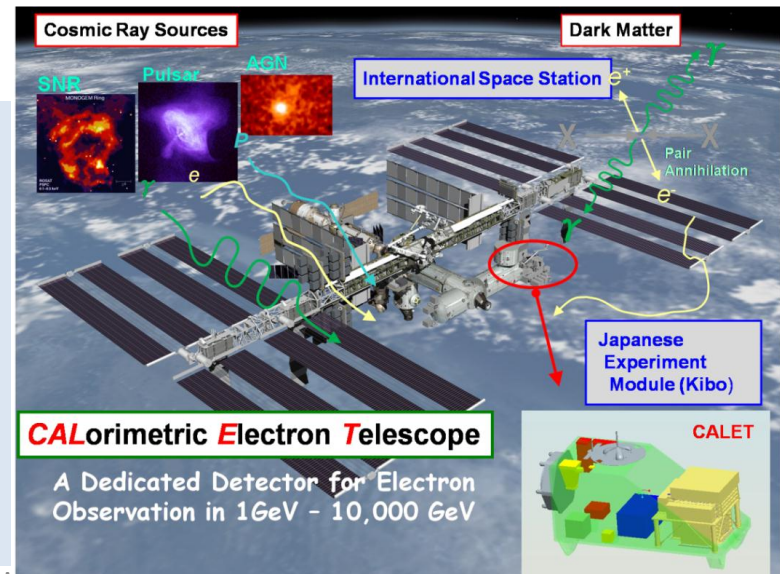
CALET

Calorimetric Electron Telescope

- A detector on ISS dedicated to electron observation in 1 GeV – 20,000 GeV
- Aims:
 - Nearby CR sources
 - Dark matter
 - Origin and Acceleration of CR
 -etc.
- 26 institutes 94 members
- Launch Carrier: HTV-5
- Mission approved for launching in 2014.
 - Phase B in current
- Mission period 2 to 5 years
- Mass 650kg



$S\Omega$:
1200 cm^2sr for e
1000 cm^2sr for γ
• $\Delta E/E$: a few %
(>10 GeV) for e, γ 's
• e/p separation :
 $\sim 10^{-5}$
• Angular res. :
0.13-0.26 deg.
over 10 GeV



Gamma Ray

We have a participation to CTA

Tibet AS extension

Tibet AS (1081 ch, $8.3 \times 10^4 \text{m}^2$)
(cooperation with China)

1) Add underground μ detector (MD)

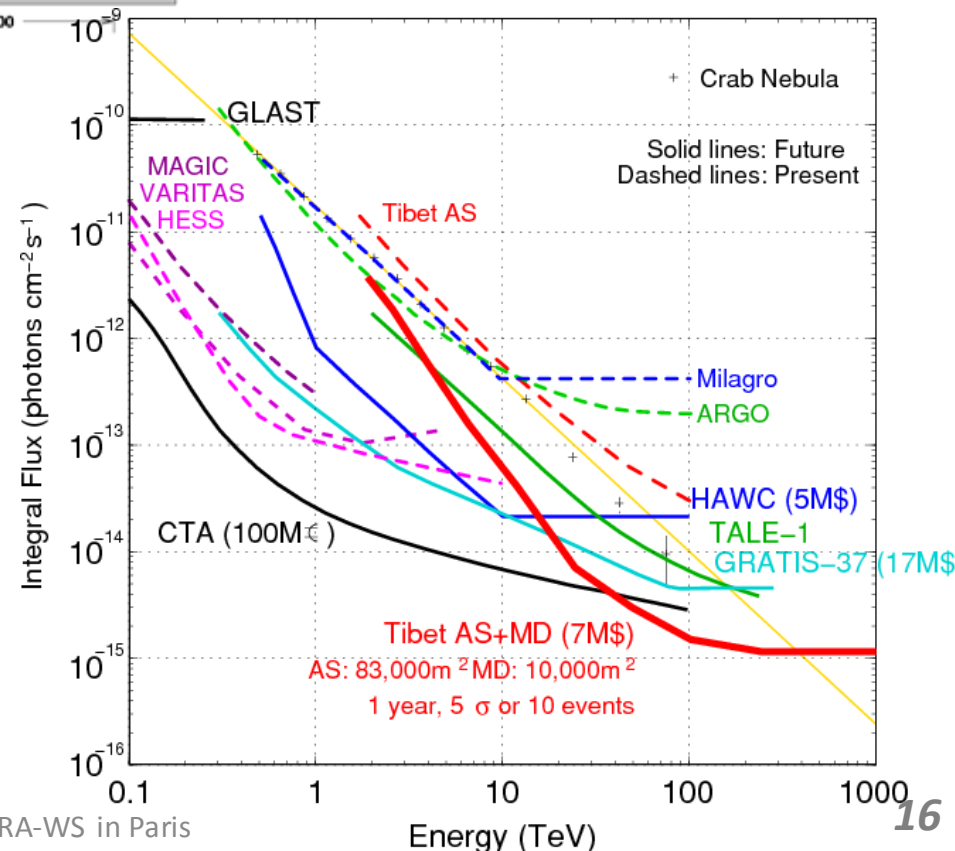
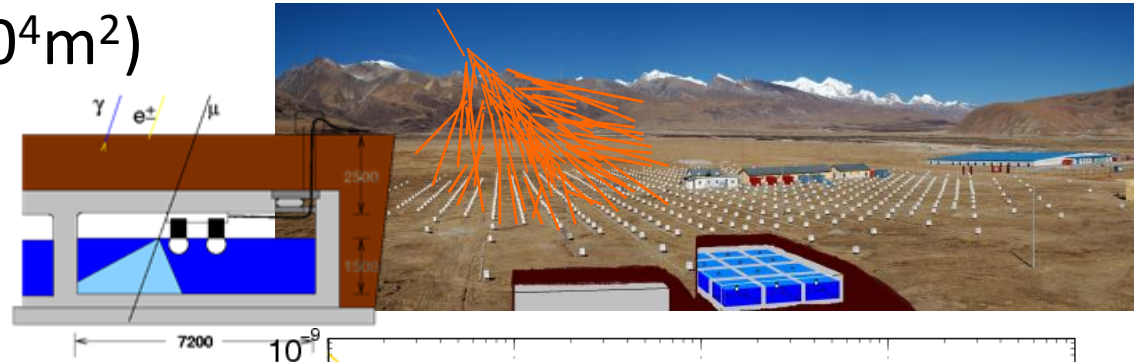
(384 ch, $\sim 10^4 \text{m}^2$)

- γ -ray observation $>100 \text{ TeV}$
- Improve one order of mag.
- Expect to obs. ~ 10 sources

2) Tibet AS + YAC (Yangbajing Airshower Core detector)
($200 \sim 5,000 \text{m}^2$)

- Precision study around Knee

- 1) €5.5M + 2) €2.5M
- Construction 2012

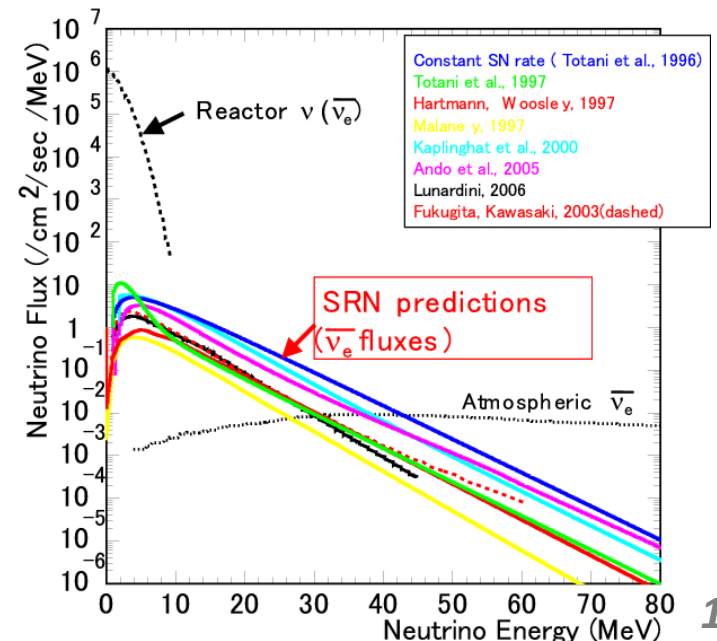
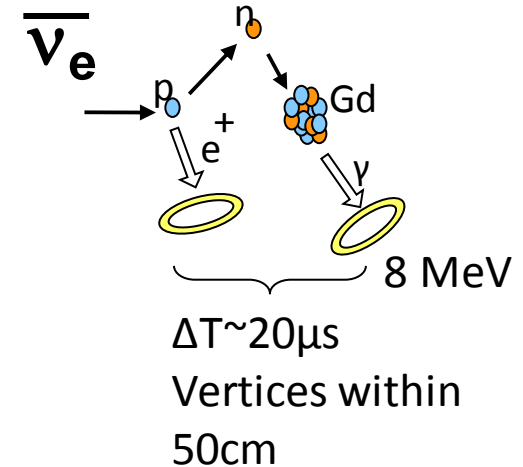


Neutrinos/Proton Decay

We have a participation to IceCUBE/ARA

Super-K upgrade Gadzooks!

- Add 0.1% Gd to Super-K (~100 tons of $Gd_2(SO_4)_3$ in 50,000 tons of water) for neutron tagging
 - Identification of anti ν_e
- Aim
 - to discover supernova relic neutrinos (SRN)
 - to detect reactor neutrinos
 - to increase sensitivity for other processes



Super-K upgrade Gadzooks!

- Construction cost
 - €10 M
 - 100tons of $Gd_2(SO_4)_3$
 - Water circulation system
 - Refurbish SK tank
 - Start construction in 2014, earliest
 - Operation in 2015

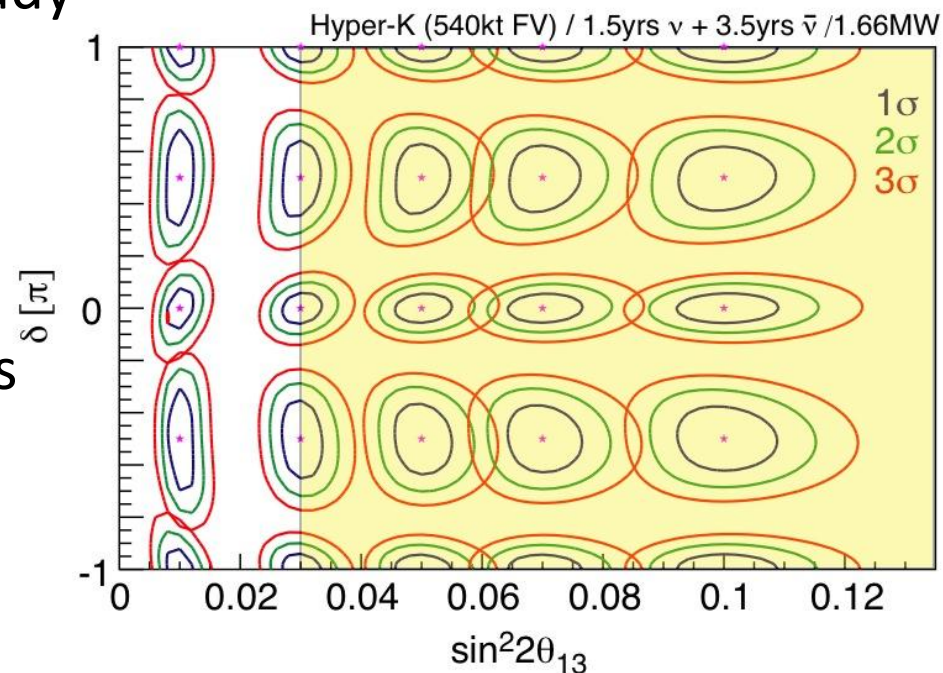
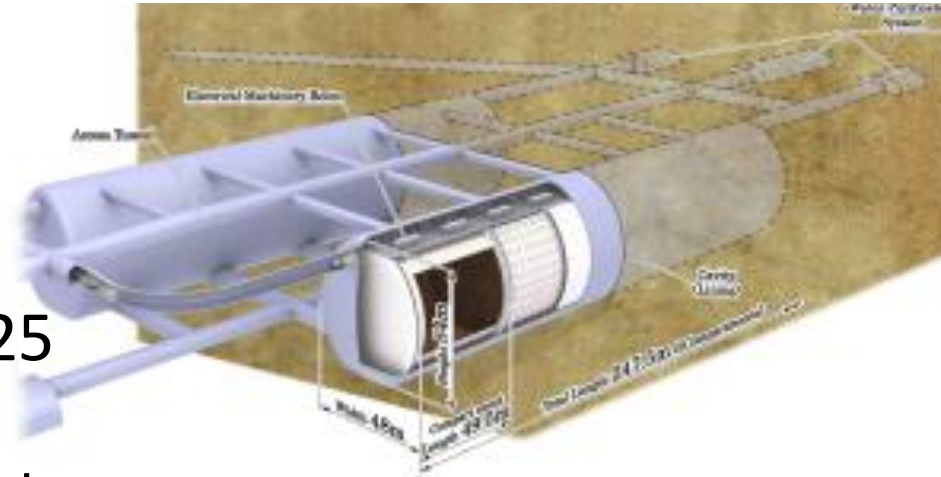


Status

- 200 ton test tank completed
- Gd pre-treatment system, Water circulation system installed (for 200tons test)
- Near future plan (2012) (R&D studies using 200 ton test tank (EDGAS))
 - Gd-water transparency
 - Water circulation test
 - Mount 240 20-inch PMTs in the tank.
 - Global circulation test.
 - Test data taking

Hyper-kamiokande

- Water Cherenkov detector
 - 1 Megaton (0.56 Mton fid.)
 - 99,000 20-inch ϕ PMTs
- Extend Super-K by a factor of 25
 - A far detector of LBNE with upgraded J-PARC; Neutrino study with atmospheric ν
 - CPV, mass hierarchy, θ_{23} octant
 - Nucleon decay search
 - $\tau_{\text{proton}} = 10^{34} \sim 10^{35}$ years
 - ν from Sun, Supernova, WIMPs
 - Solar ν ; 200 ev/ day
 - Supernova @Galactic center (Andromeda) 250,000 (50) ev.
 - SRN 830 ev/10 yrs



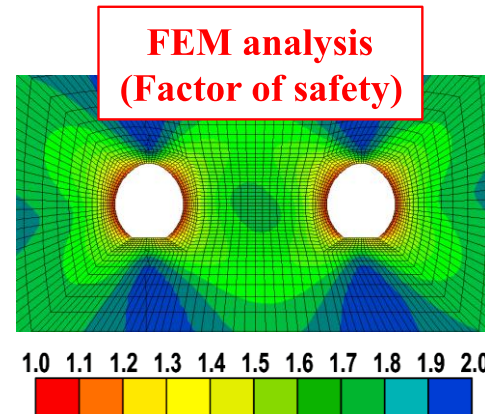
Hyper-kamiokande

- Collaboration
 - 41 working group members
 - 14 institutions (U of Tokyo, ICRR, Kyoto U. etc.)
- Construction cost
 - €726M (crude estimation)
- Time table
 - 2014 construction start
 - 2019 operation start
- **Letter of Intent (Oct-2011, arXiv:1109.3262)**

Status

- Cavity design was made based on extensive geological survey and rock property measurements
- Detailed scheduling and costing underway

Twin cavern analysis

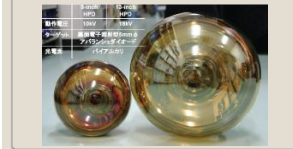


Photon sensor

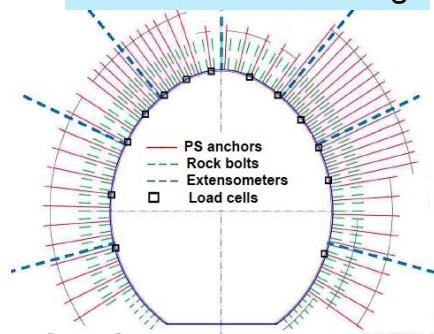


8" and 13" HPDs available in 2012

Hamamatsu will release in 2012



anchors, rock bolts design



Geological survey



Double Beta Decay

KamLAND2-zen

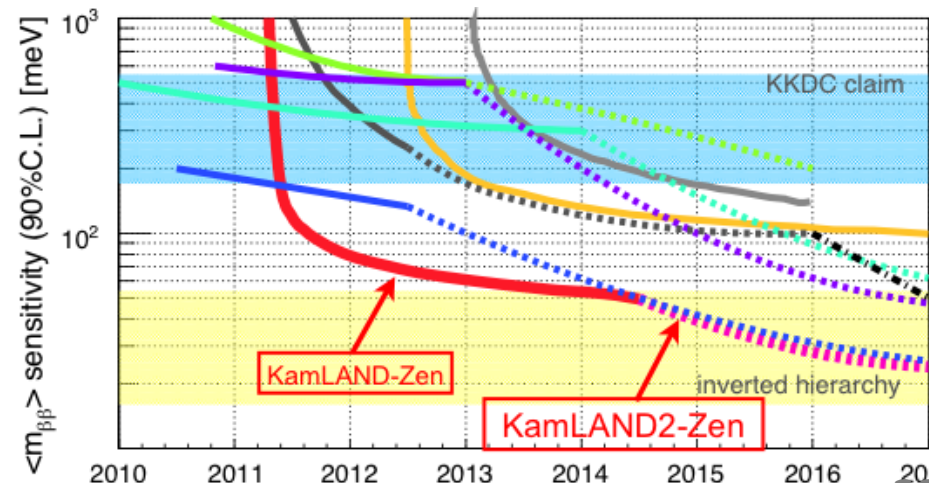
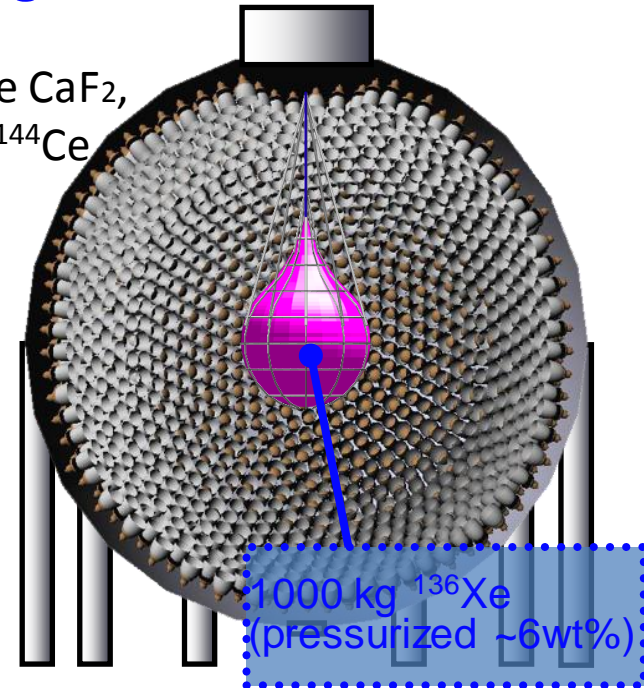
KamLAND2-zen

Double beta decay of ^{136}Xe

- Improvement
 - New scintillator x1.4
 - Light collection x1.8
 - 2.5 times light detection
- 1,000 kg of enriched Xe
- Sensitivity
 - 20 meV in 5 years
- Other possibility:
 - NaI: dark matter
 - DB: CdWO_4

chimney enlargement

capability to accommodate CaF_2 , CdWO_4 , NaI, ^{144}Ce and others

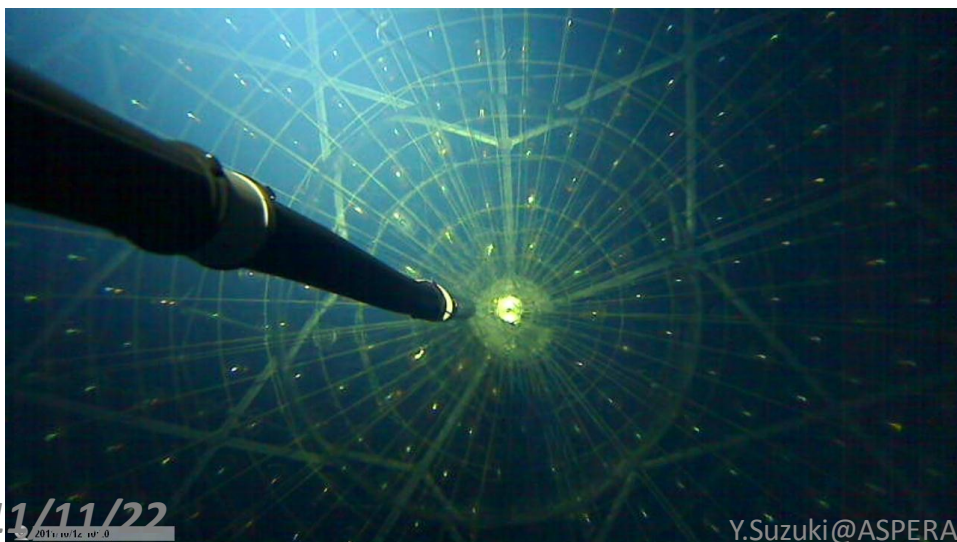


KamLAND2-zen

- KamLAND2-zen
 - €22M for the improvements
 - Start construction earliest in 2014
 - Operation in 2015
- Collaboration
 - 6 institutes, 35 members

Status

- KamLAND-zen is taking data
 - Started in 2011, September
 - 330 kg of 90% enriched ^{136}Xe in liq. Scintillator
 - Delivered: 450 kg
 - Procurement for **800kg** on going
 - 50 meV in 5 years



CANDLES IV

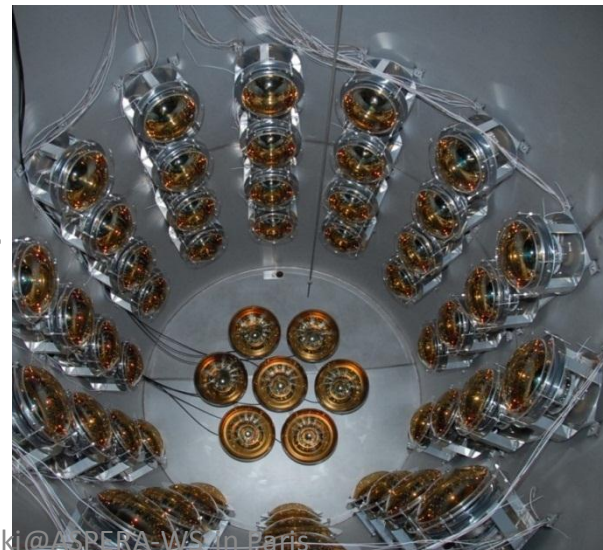
Double beta decay of ^{48}Ca ($Q_{\beta\beta}=4.3$ MeV, 0.187% abundance)

- CaF_2 detector with 4π active shield (liq. Scinti.)
- CANDLES IV
 - 2 ton CaF_2 1.8% enrich
- 50meV for 5 years
- Hope to start construction in 2014 or 2015
- >\$10M

Status

- CANDLES III
 - 305kg CaF_2
 - In commissioning
 - 500 meV

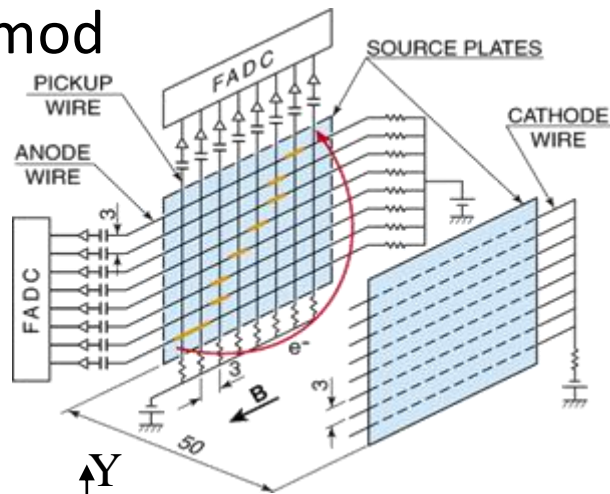
CANDLES III



DCBA/MTD(Magnetic Tracking Detector)

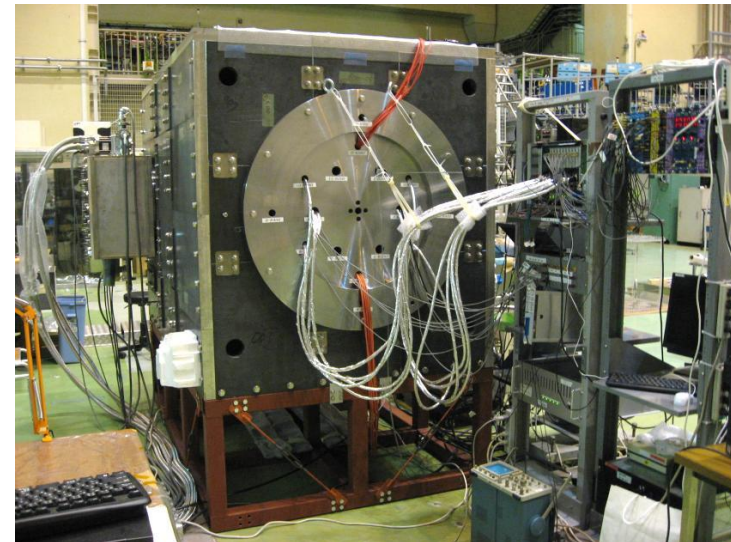
Double beta decay of ^{150}Nd

- 40kg/module x 30 ~ 1 ton
- Sensitivity: 30meV
- \$60M for 30 modules
- Collaboration:
 - 9 insitute and 25 collaborators
- 5 years construction for 10 mod



Status

- DCBA-T2 (^{100}Mo)
 - Ob. $2\nu\beta\beta$ candidates of ^{100}Mo
- DCBA-T3 (^{150}Nd)
 - Superconducting Magnet: Completed
 - Drift chamber: under constructin

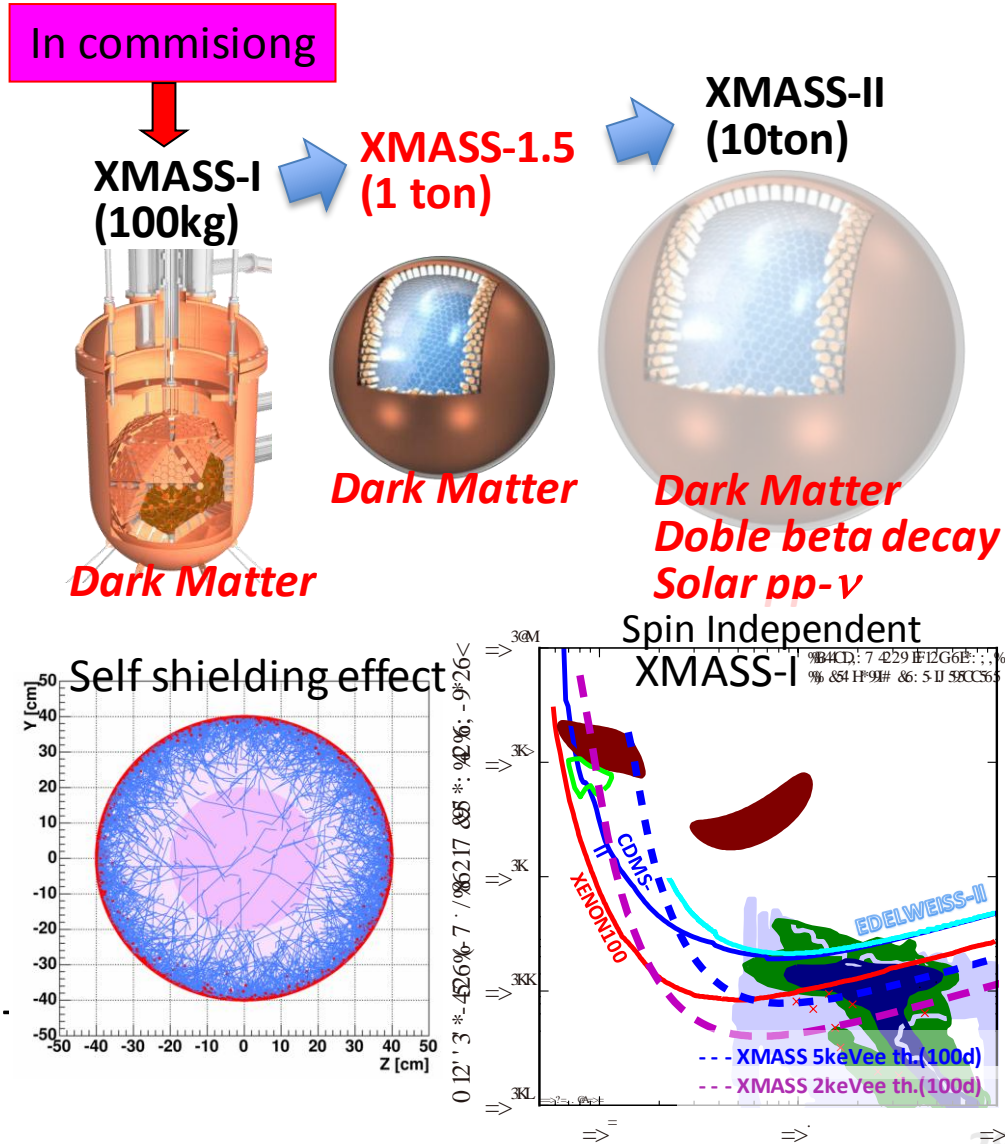


Dark Matter

XMASS

Multipurpose (single phase) liq. Xenon deceptor

- XMASS-II: 10 ton
 - Dark Matter
 - $\sigma_{SI} = 10^{-47} \text{cm}^2$
 - Double beta decay
 - 30 meV
 - Solar pp-neutrinos
 - 10 events/day
- XMASS-1.5(1 ton)
 - Dark Matter
 - Sensitivity (SI) 10^{-46}cm^2
 - A few $\times 10^{-45} \text{cm}^2$ for XMASS-II



XMASS

- XMASS 1.5
 - €15M
 - Start const in 2013
 - Take data in 2015
- XMASS-II
 - €96M
 - Start const in 2017
- Collaboration
 - 10 institutes
 - 42 collaborators

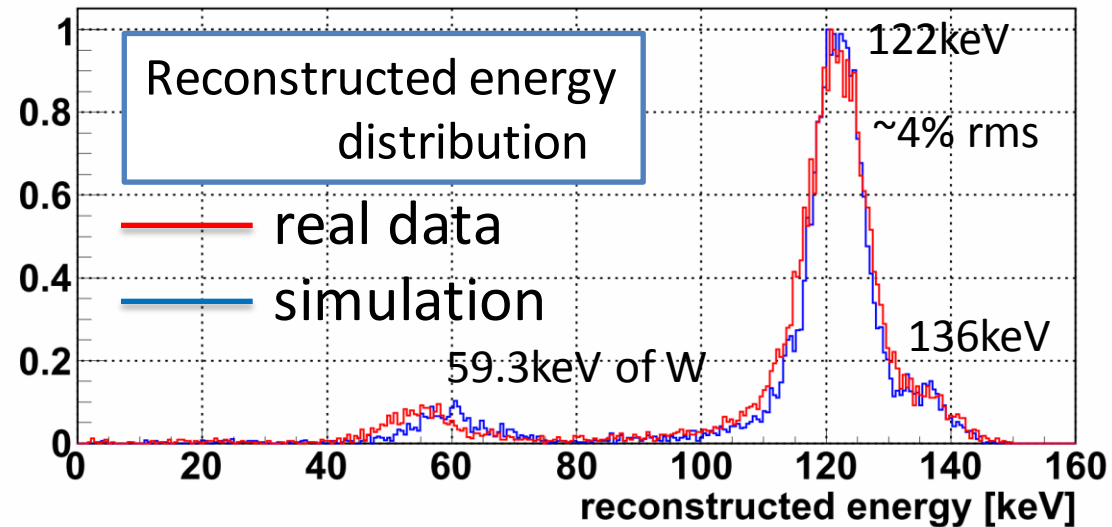
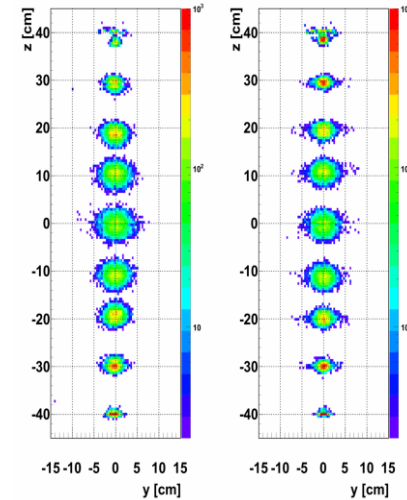


Status

- XMASS-I (100kg fid.)
in commissioning
 - Reconstruction by hit pattern and timing
 - Very high p.e. yield
 - : 15.1 ± 1.2 pe/keV

Reconstructed position

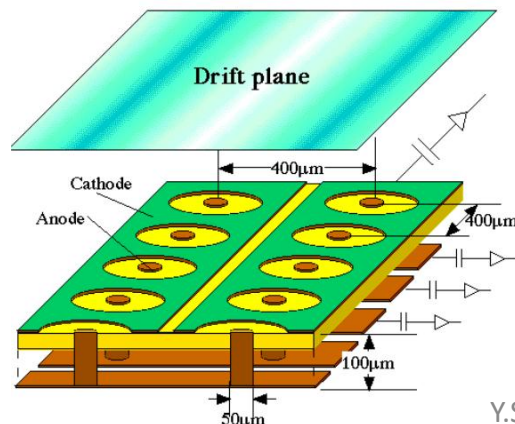
Real Data Simulation



NewAGE

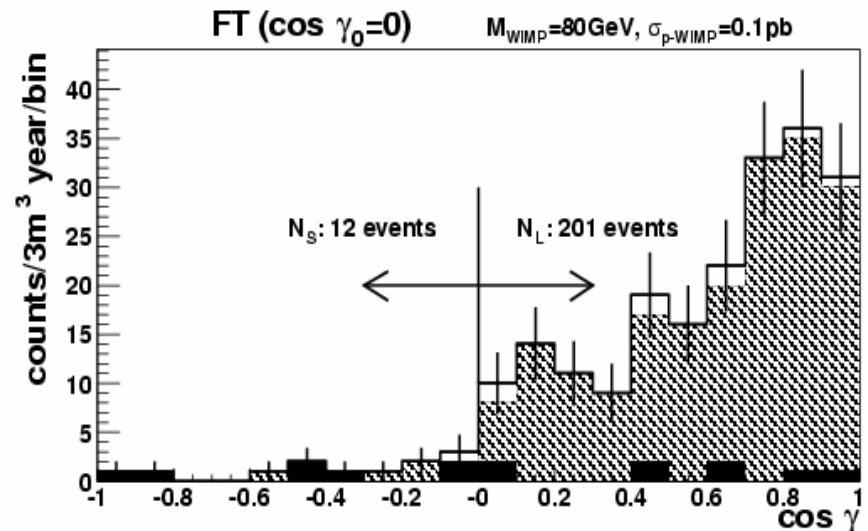
New generation WIMP search with an advanced gaseous tracker experiment

- Directional search for dark matter
 - 3D tracking
 - MPGD(Micro Pattern Gas Detector) read out
 - CF4 gas (~ 0.05 bar)
- Collaboration
 - 3 institute, 10 collaborators
- \$1M for 1 m³ detector



Status

- (30 cm)³ detector: running
- (30 cm)³ detector upgrade: funded

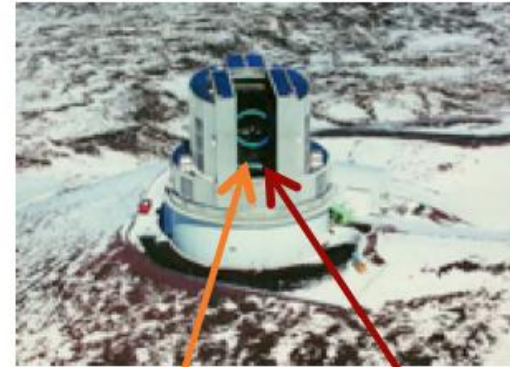


Dark Energy

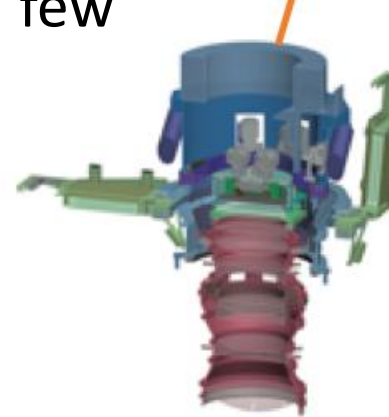
SuMIRe

Subaru Measurement of Image and Redshift

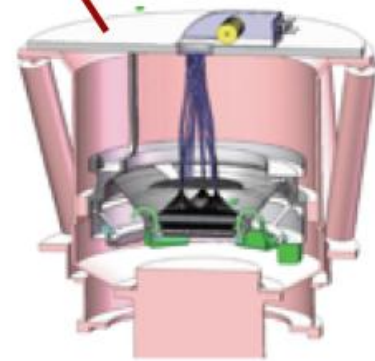
- Wide-field camera (Hyper Suprime Cam) and multi-object spectrograph (Prime Focus Spectrograph)
- Goals: the fate of the Universe
- Precision images of a few 10^9 galaxies (2013~2017)
- Measure distances (redshifts) of a few 10^6 galaxies (2018~2022)
- Precursor survey of ~\$1B class ultimate surveys in the LSST and other projects
- HSC Project (IPMU/ NAOJ/ KEK/Princeton/Taiwan)
 - First Light: Spring 2012



Subaru (NAOJ)



HSC



PFS

Gravitational Wave

LCGT

Large-scale Cryogenic Gravitational-wave Telescope

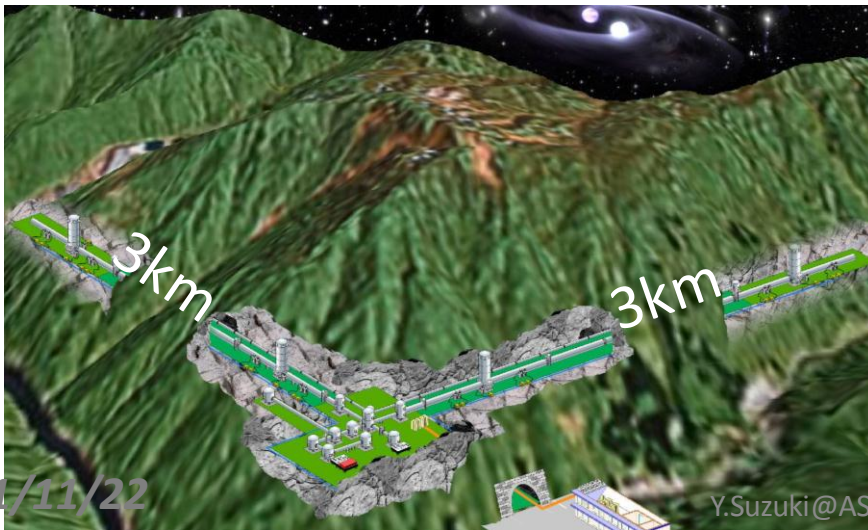
LCGT detector

- 3 km x 3km
- Underground to reduce seismic noises
- Cryogenic temperature mirrors
- Sensitivity:
 - Similar to the advanced LIGO and VERGO
- Collaboration
 - 41 institutions and 123 collaborators

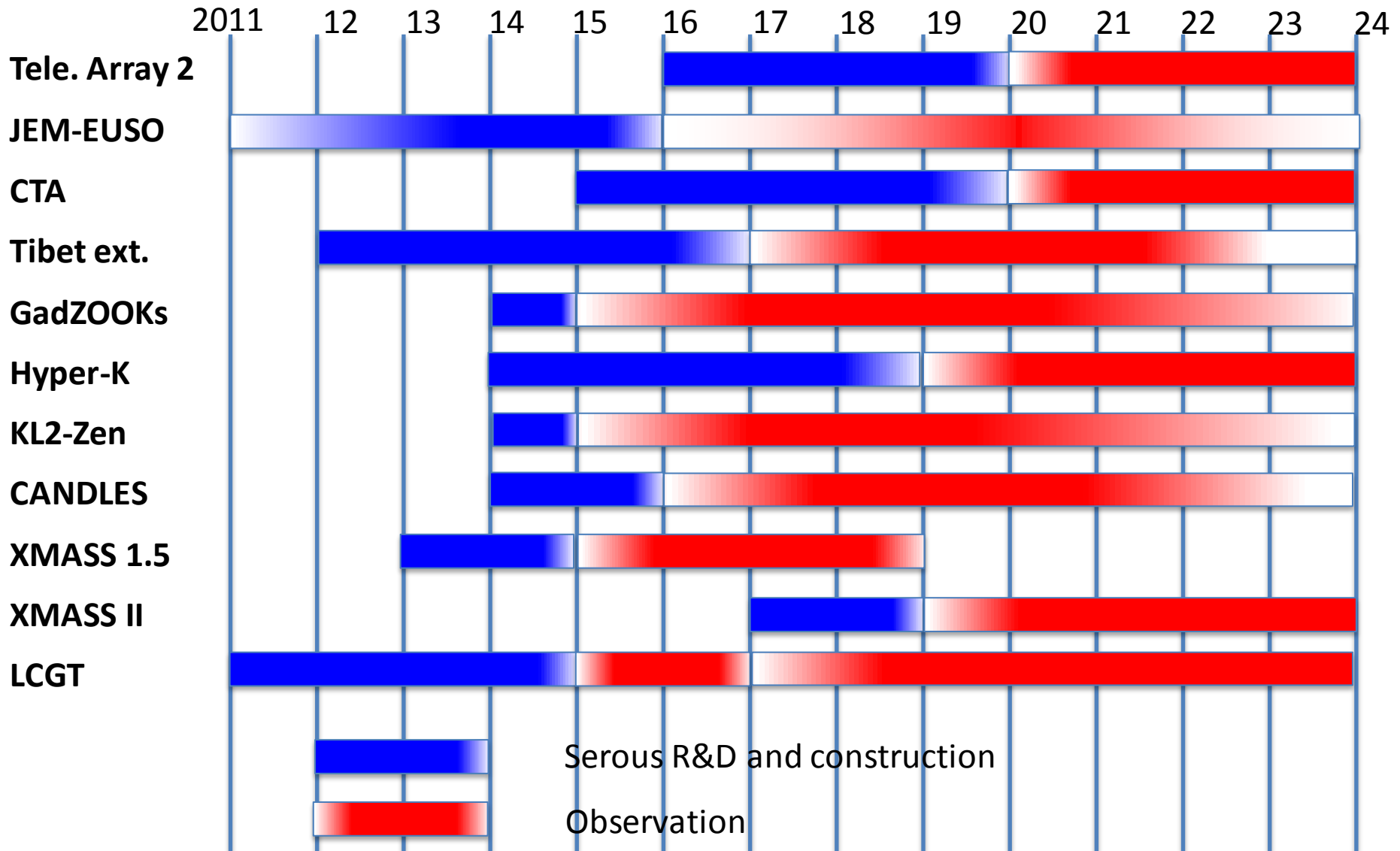
- Cost
 - \$155M (mostly funded)

Status and Time Table

- Construction started in fall 2010
1. Non-cryogenic observation in 2014.
 2. Observation with full cryogenic system in 2017.



Timeline

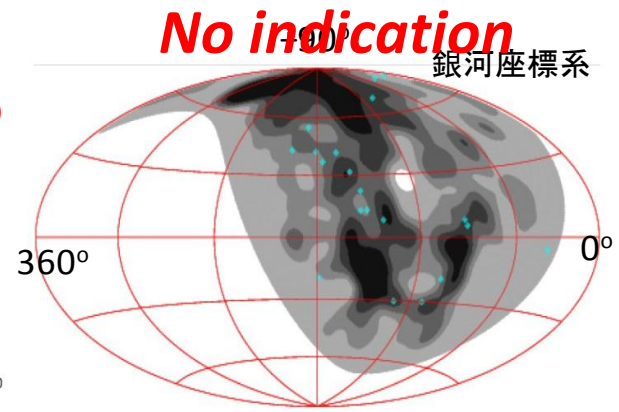
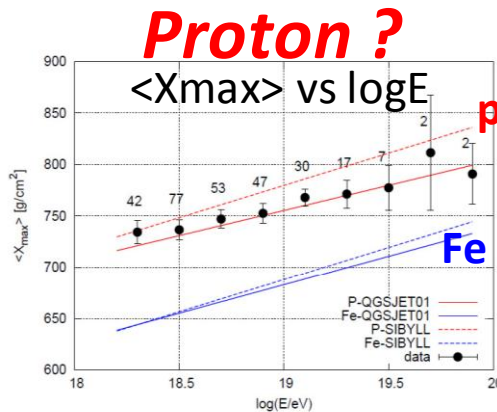
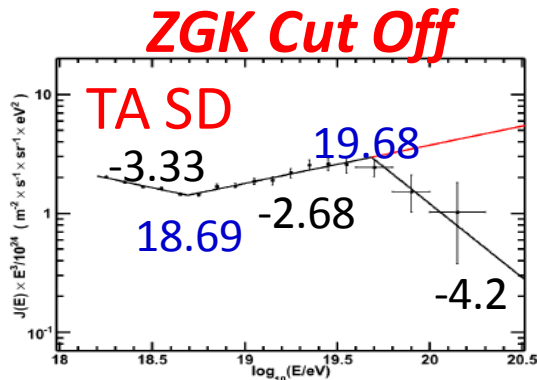


おしまい
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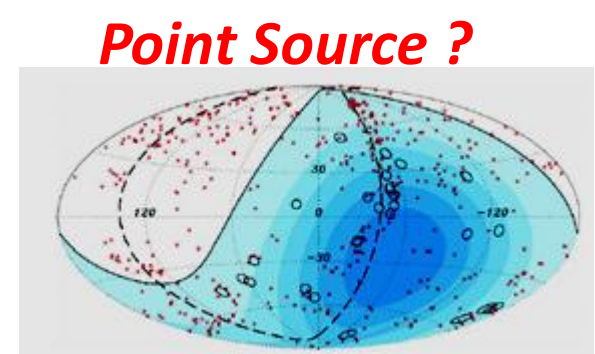
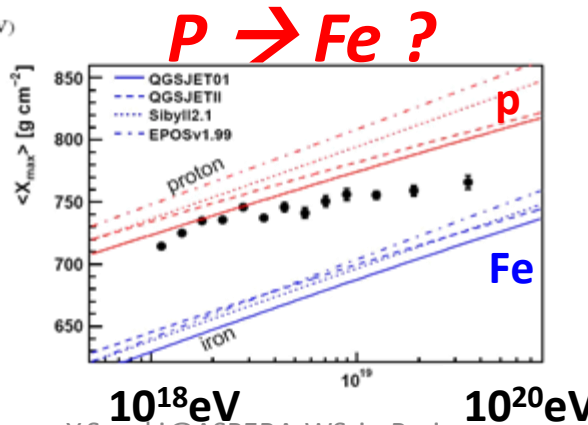
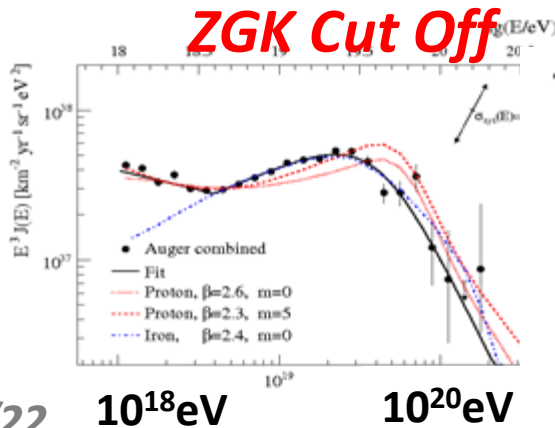
Extreme Energy Cosmic Rays

- GZK cut off
- Study of Acceleration mechanism
- Identification of Extreme Energy Cosmic Ray Sources
- Study of Galactic Magnetic Field

TA (north)



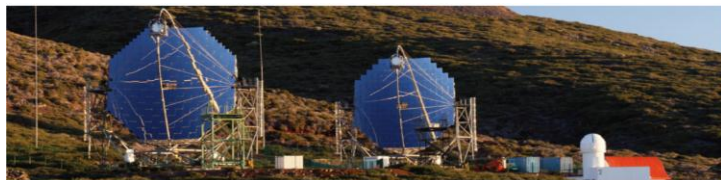
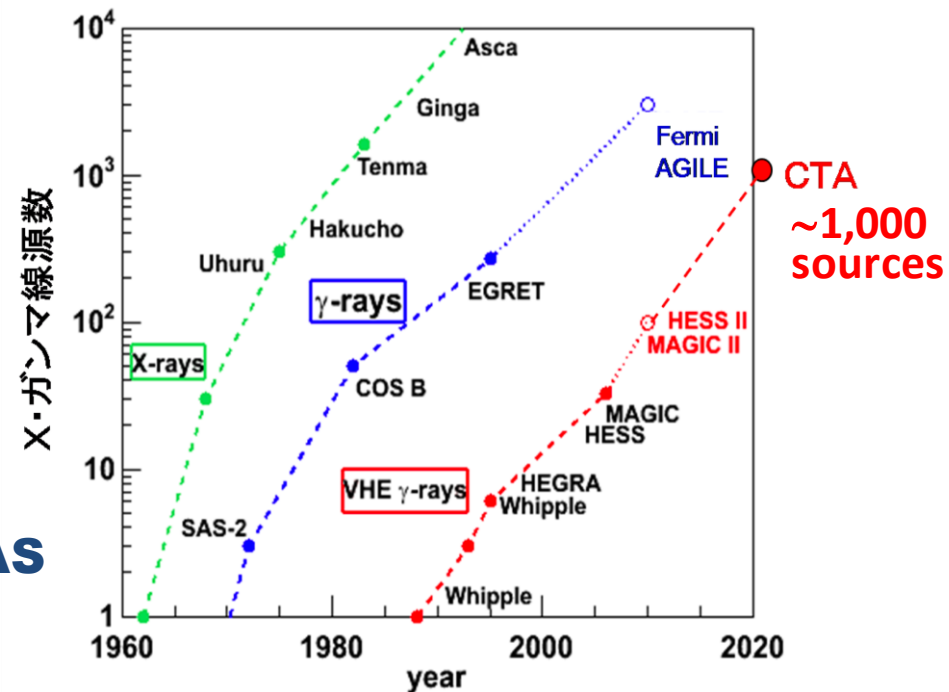
AUGER(South)



Gamma Ray Astronomy

- GeV ~ 100 TeV γ -rays
- Origin of Cosmic Ray
- High Energy Stellar Objects
- Structure of Space-time
- Dark matter

- Expect more than 1000 gamma ray sources



MAGIC

17m x2
Canaries



VERITAS

12m x 4
Arizona



HESS

12m x 4
Namibia



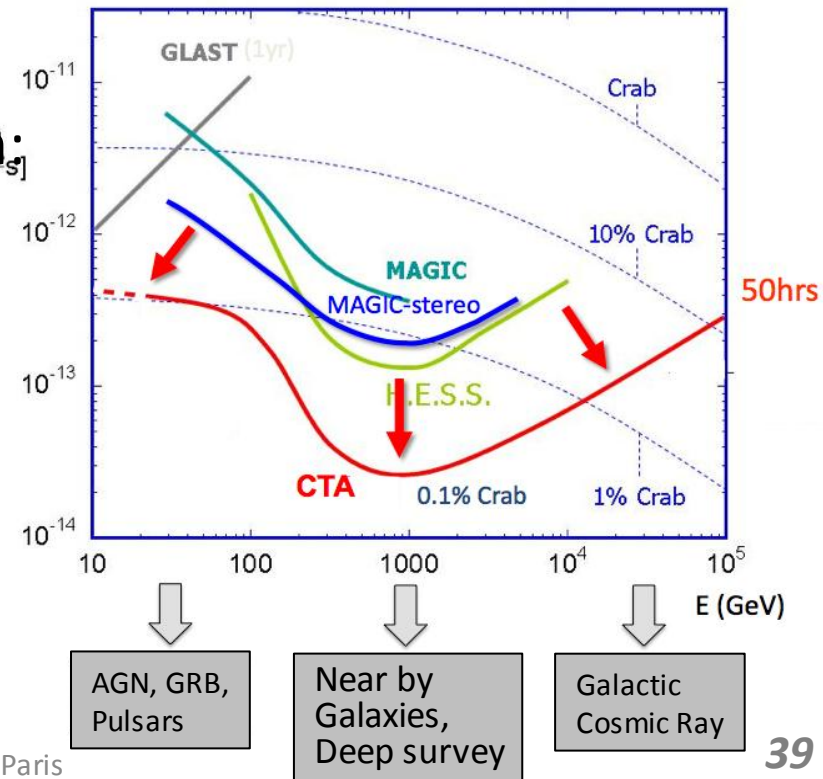
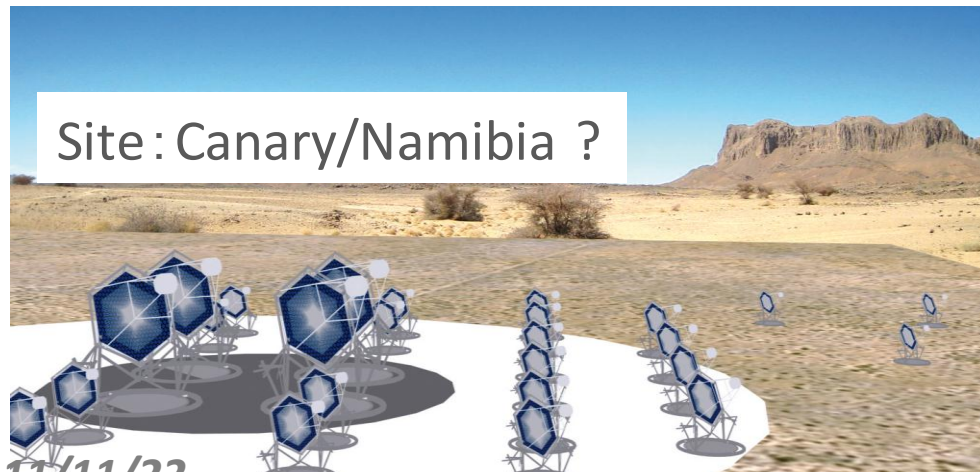
CANGAROO

10m x4
Woomera

CTA

- Telescopes
 - 23m x4: 10 GeV – 1 TeV
 - 12m x23: 100 GeV – 10 TeV
 - 6m x32: 1 TeV – 100TeV (only for south)
- All sky: North and South sites
- Construction: 2015 – 2020
 - Partial Operation
- €200M (Jpn contribution: €20-40M?)
- 800 collaborators from 25 country (Jpn: 75 scientists)

- High Sensitivity (> one order)
- Wider energy range
- High spacial resolution



SuMIRe

Subaru Measurement of Image and Redshift

Cosmological power of SuMIRe HSC/PFS

