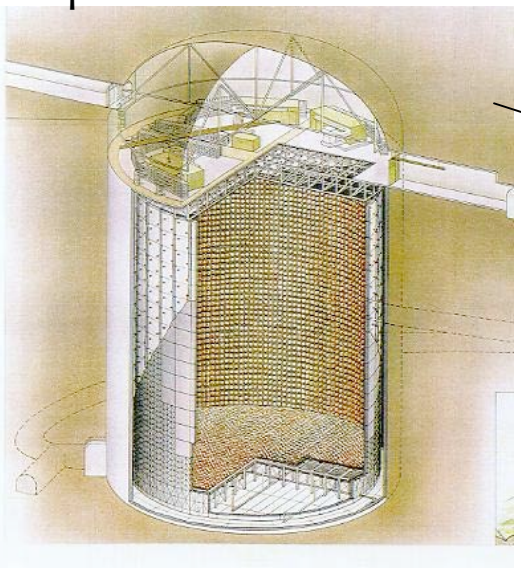
ISAS News No.1, 2004

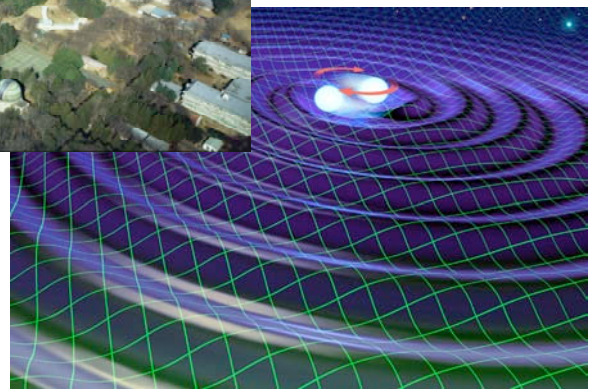
To understand the universe
- From the Big Bang to Ourselves -

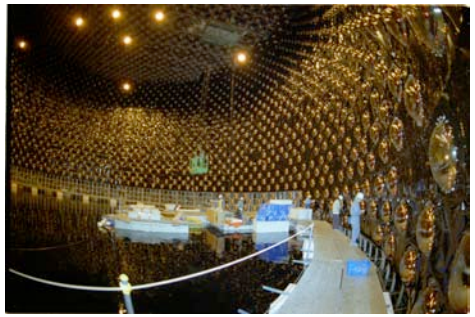
B-factory
CP Violation

Neutrino Astronomy/Neutrino Mass
Super-KAMIOKANDDE

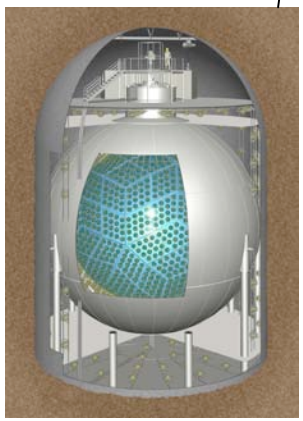


Gravitational
Wave





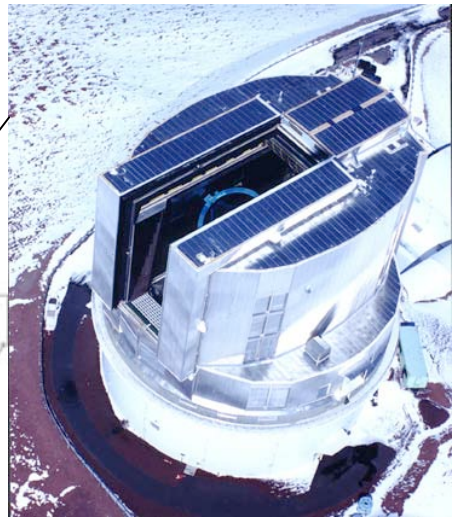
KAMLAND

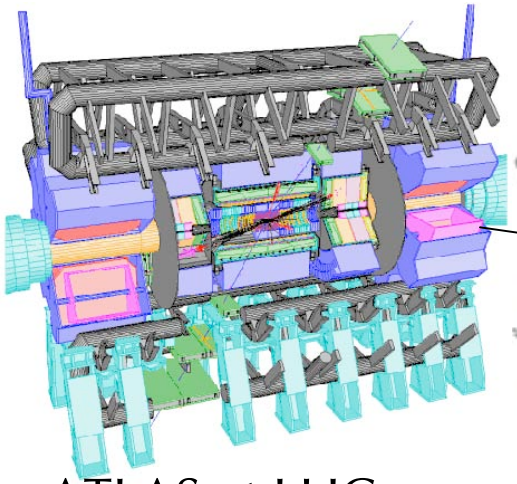


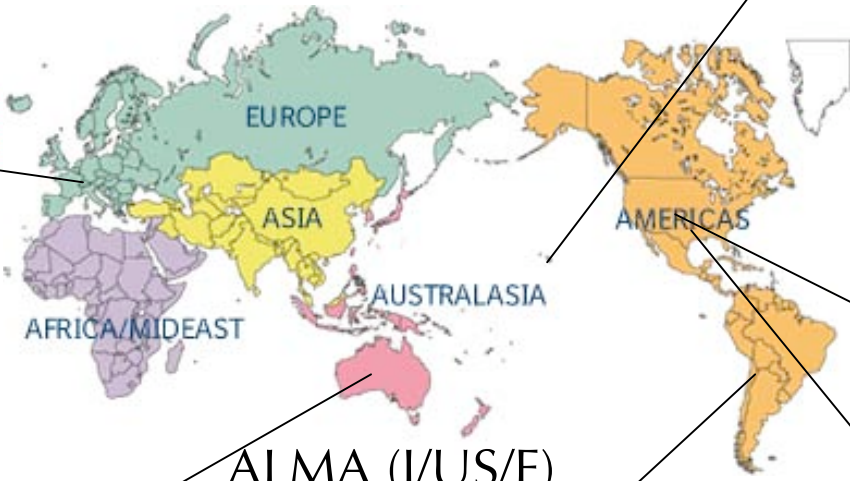
T.Takahashi, Beyond Einstein W.S , 2004

To understand the universe
- From the Big Bang to Ourselves -

Subaru



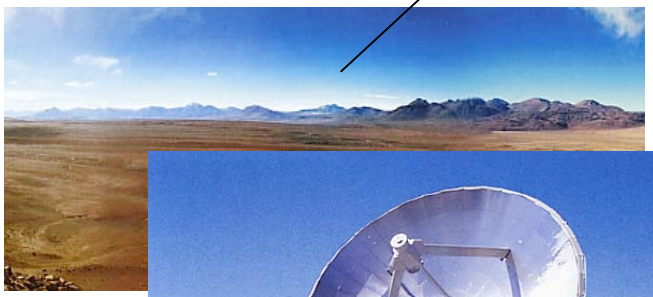




SDSS(US/J/G)

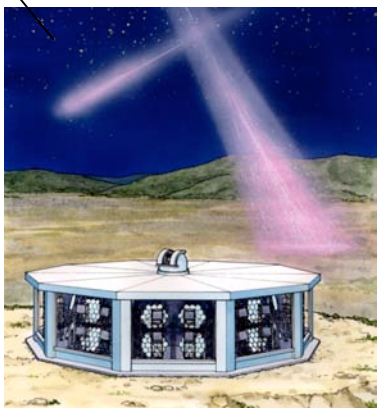
ATLAS at LHC
(E/J/US)

ALMA (J/US/E)



Cangaroo (J/Au)

Telescope Array

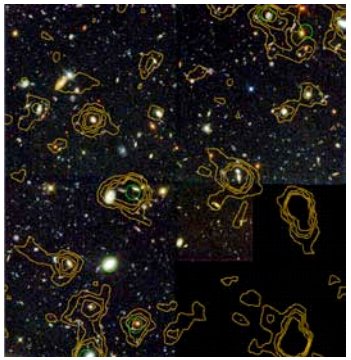


T.Takahashi, Beyond Einstein W.S , 2004

To understand the universe
- From the Big Bang to Ourselves -

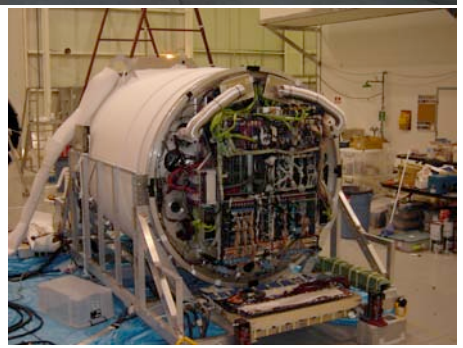
Birth & Evolution of Galaxies
(Infrared : Low Temperature
: Less Extinction
: High Redshift)

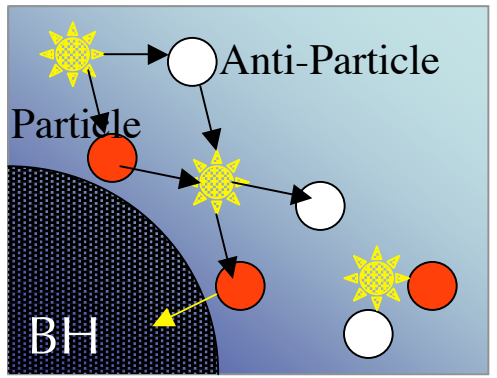
SPICA
at L2 point
(>2010)



ISO+Hubble

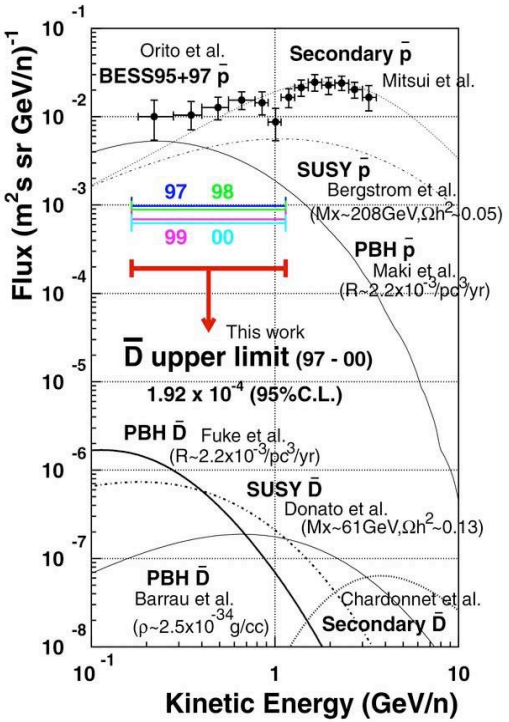
Search for
Primordial Antiparticles
in Cosmic Rays
(Particle Detectors)





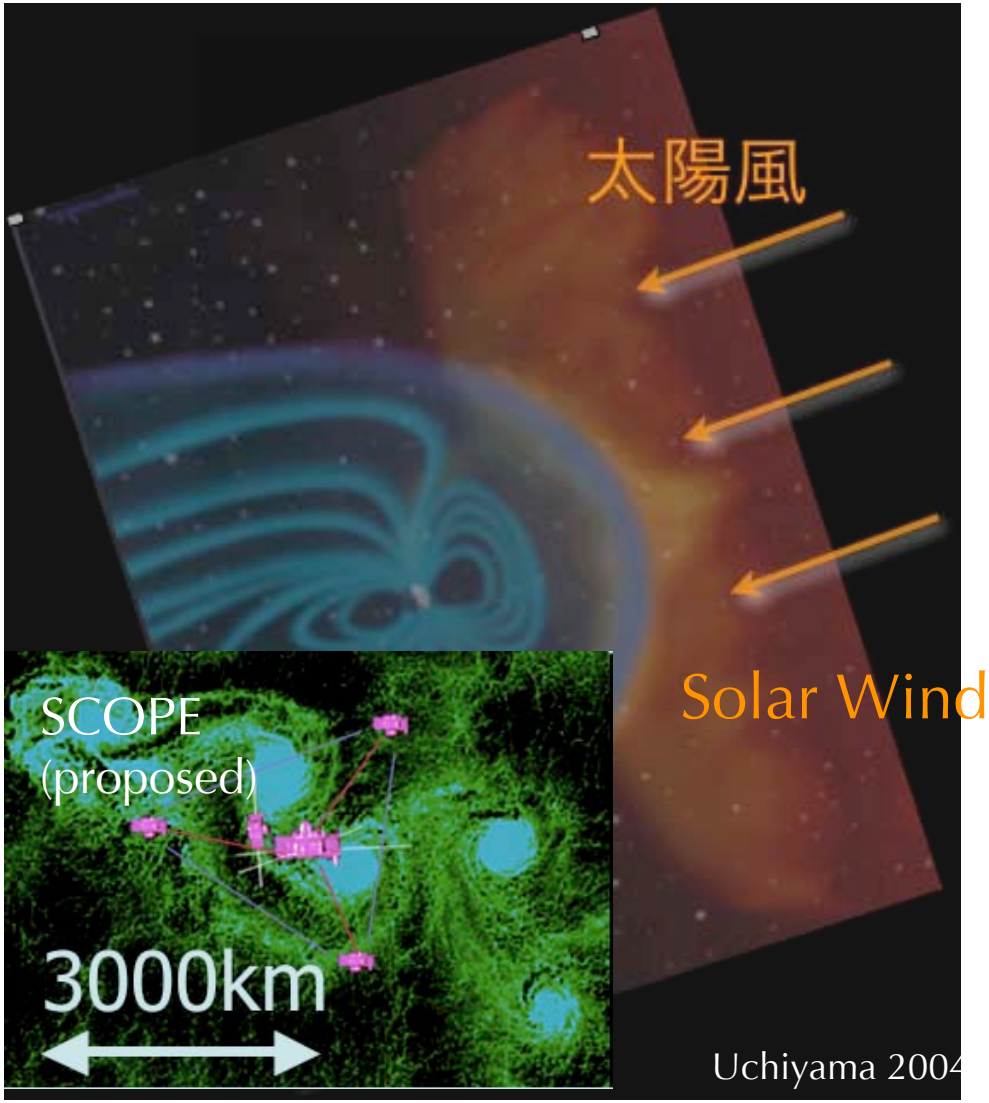
Yamamoto et al. 2004

- Evaporation of Primordial Black Holes
- Annihilation of super-symmetric particles



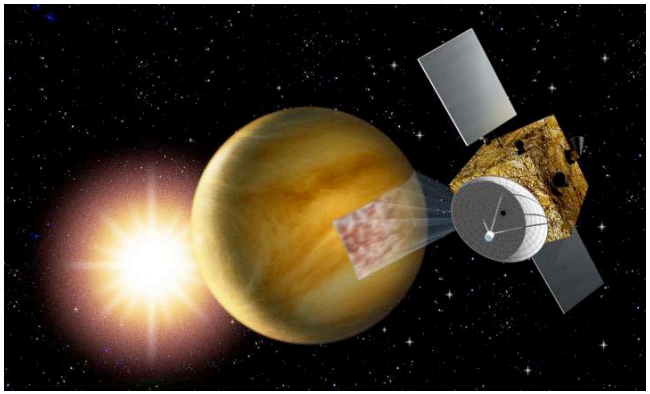
To understand the universe
- From the Big Bang to Ourselves -

From future mission planned at ISAS



The best way is to be there.

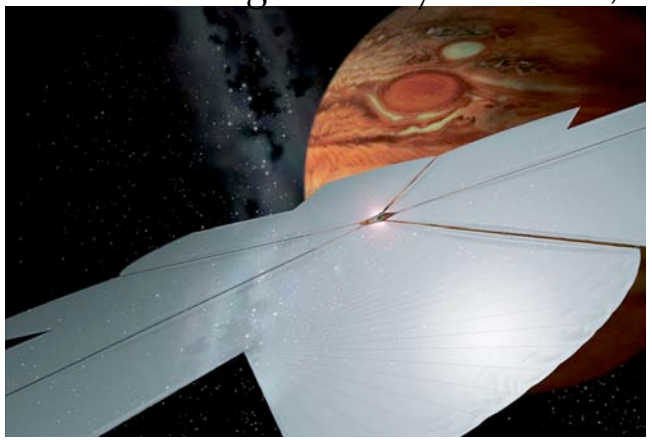
- Venus Climate Orbiter (2008)



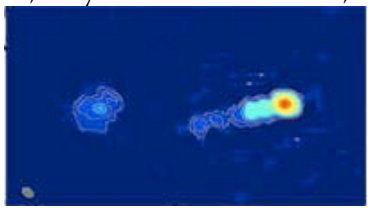
And also Bepi-Colombo(2011?)

- Solar Sail Mission to Jupiter

(approved as “High Priority Mission”)



T.Takahashi, Beyond Einstein W.S , 2004



To understand the universe
- From the Big Bang to Ourselves -

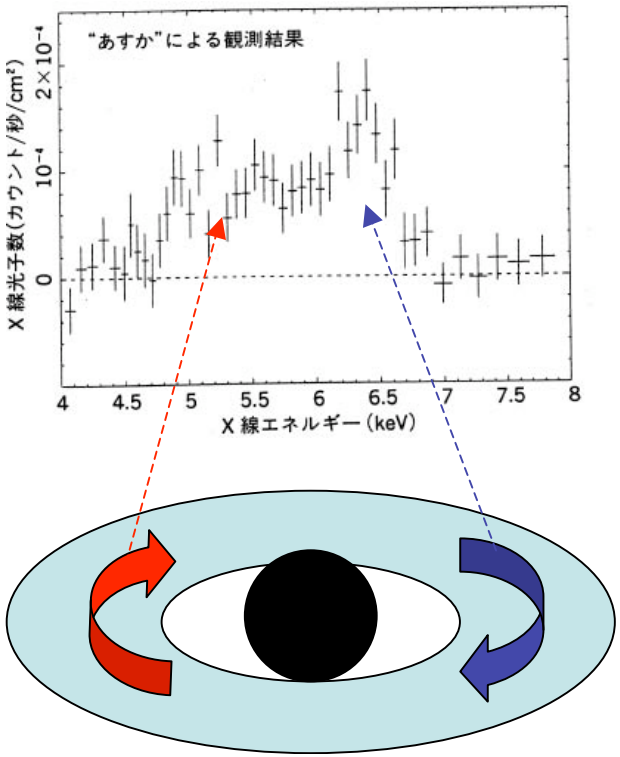
X-ray : Best probe to study Extreme Universe. Can be done only in space.

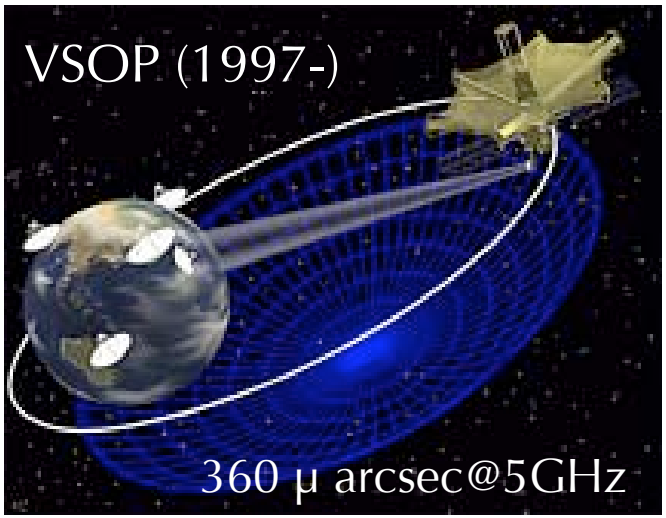
High resolution imaging by Space VLBI (relativistic jets)

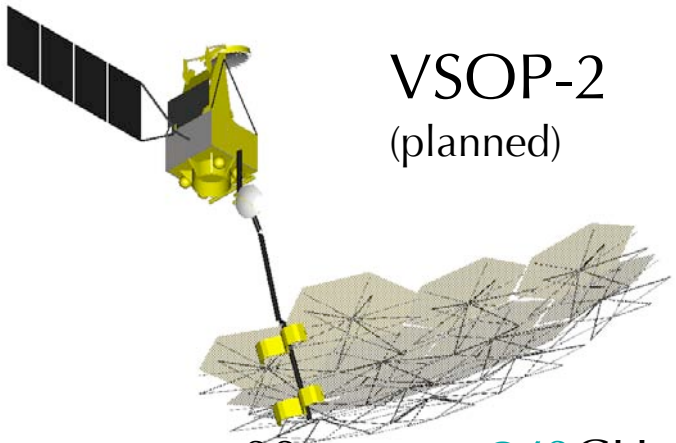
105 PhD thesis
>1400 journal papers

ASCA (1993-2001)

Signal from the edge of BH
From MCG 6-30-15(Tanaka et al.)



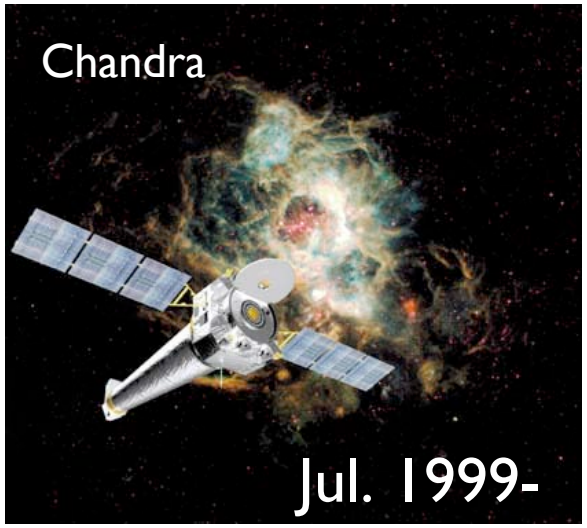




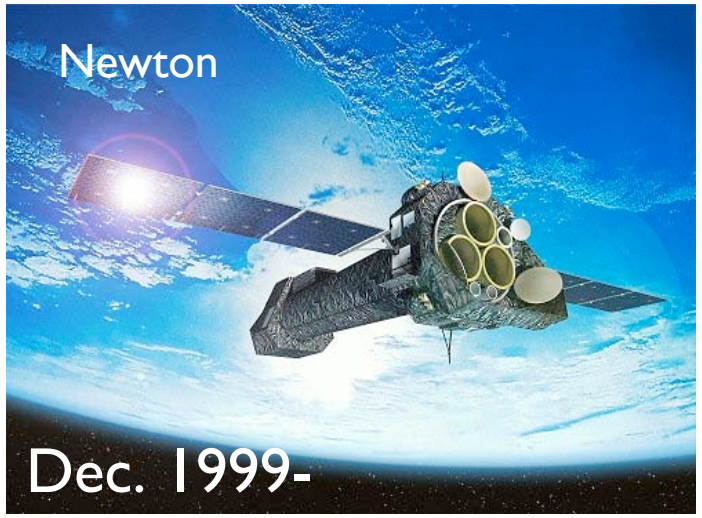
VSOP-2
(planned)

38 μ arcsec@43GHz

Overture of the X-ray Astronomy in 21st century



Energy range 0.1-10 keV
Angular resolution 1”
Collecting Area : 2 x ROSAT
1 X-ray Telescope 4-fold nested

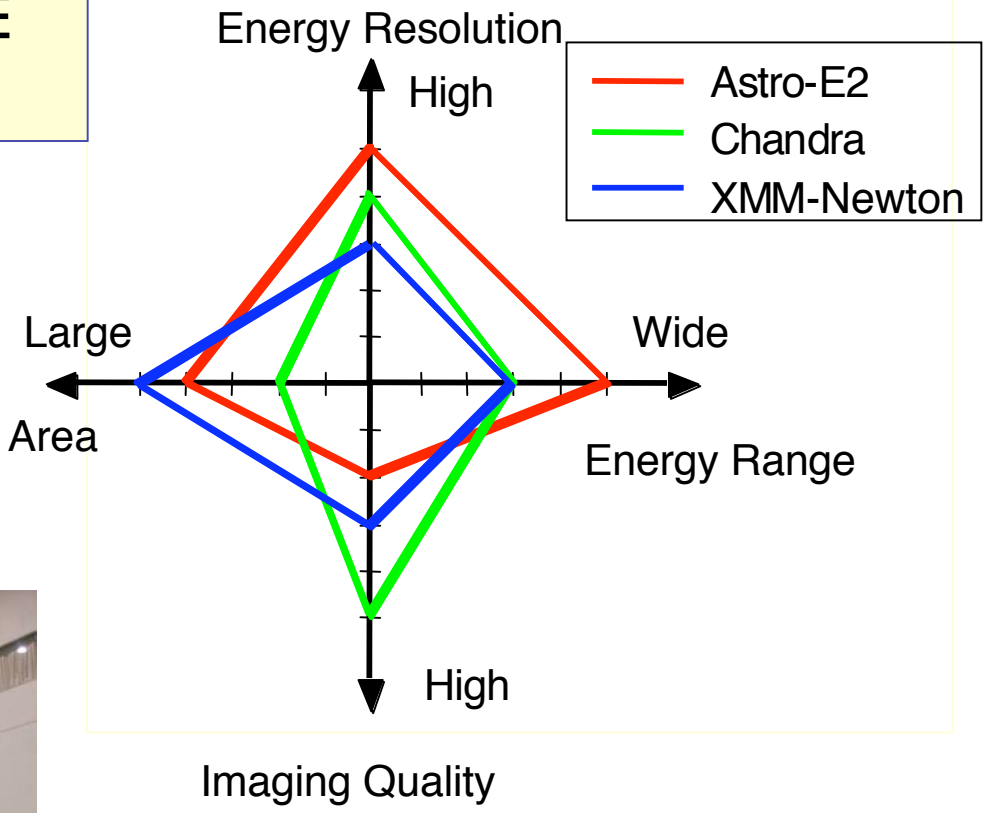


Energy range 0.1-10 keV
Angular resolution 15”
Collecting Area : 20 x ROSAT
1 X-ray Telescope 56-fold nested

Astro-E2 will come in, soon.

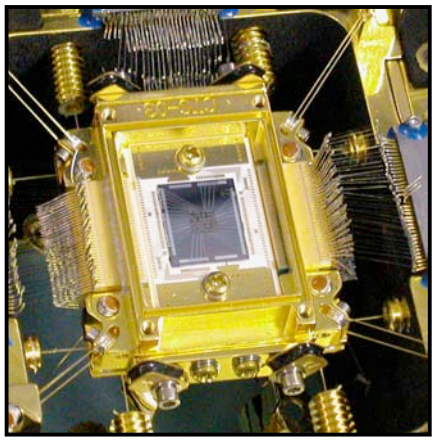
- Recovery Mission of Astro-E
- Launch in 2005

The 5th
Japanese X-ray
Mission
(Japan & US collaboration)



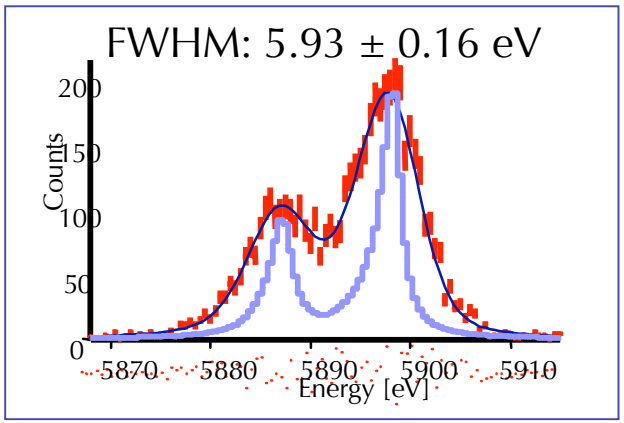
Astro-E2 will fill the missing part
of X-ray space observatories
in the New Millennium

Astro-E2 Features …

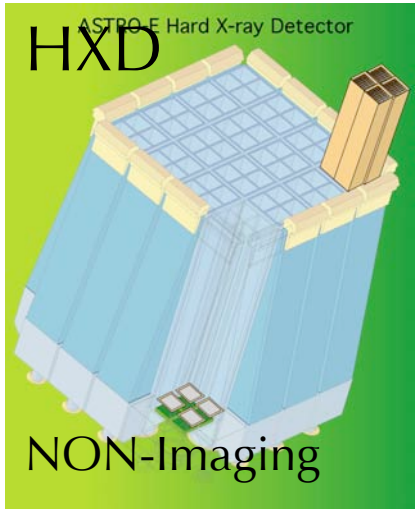


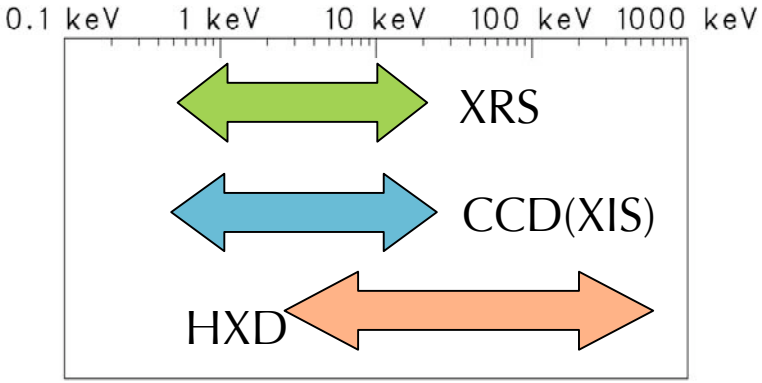
High Resolution micro calorimeter:XRS
ΔE~6 eV at 6 keV
(ΔE~40 eV Chandra HETG)
Capability for studying extended sources

Largest effective area and highest energy resolution at the energy of Fe Kα.



X-ray CCD (XIS)
and Low Background Hard X-ray Detector



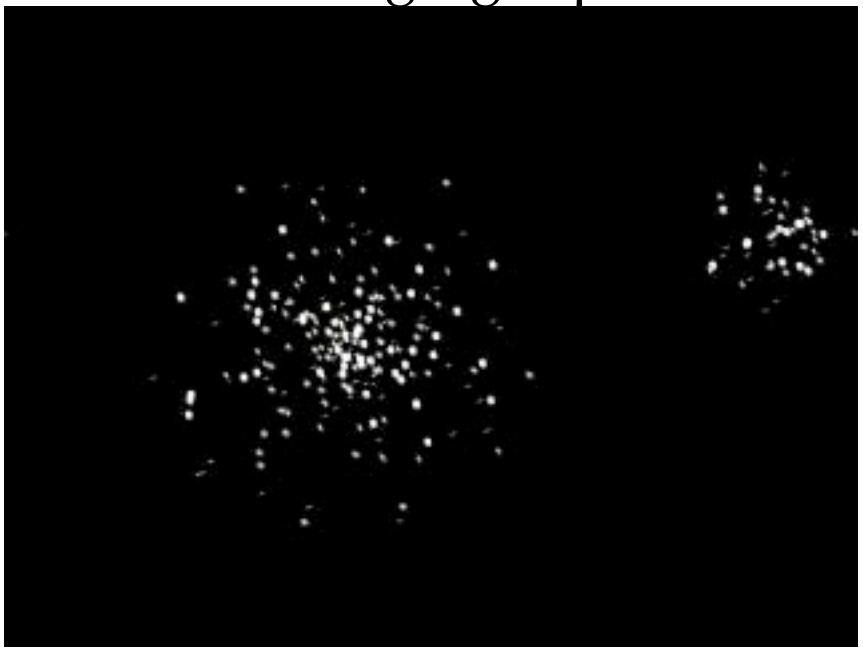


From the edge of a black hole to the collision of largest celestial objects

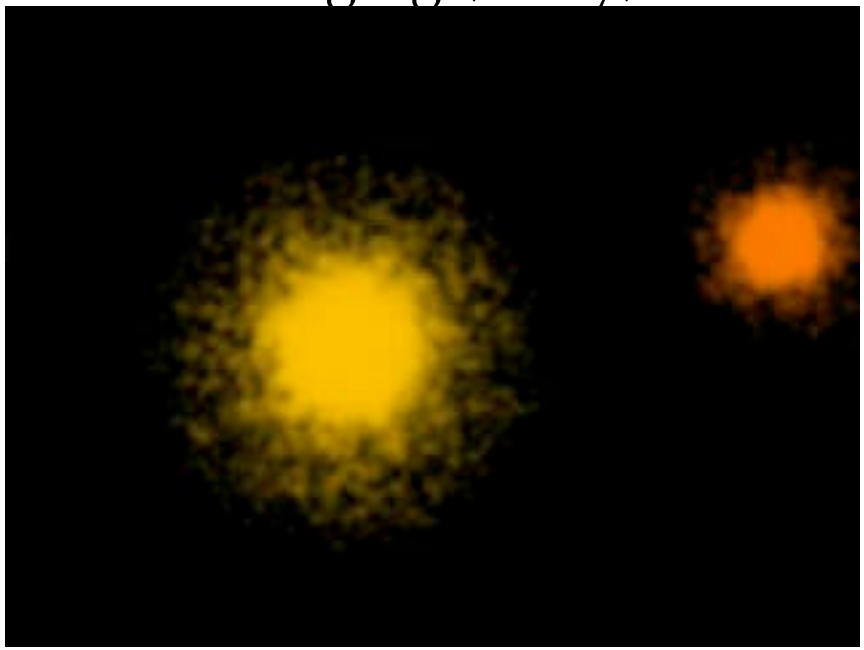
Study of the structure of the universe:

Cluster of galaxies : Largest celestial object
(self gravitating energy 10^64 erg, hundreds of galaxies)

Cluster merging (optical)

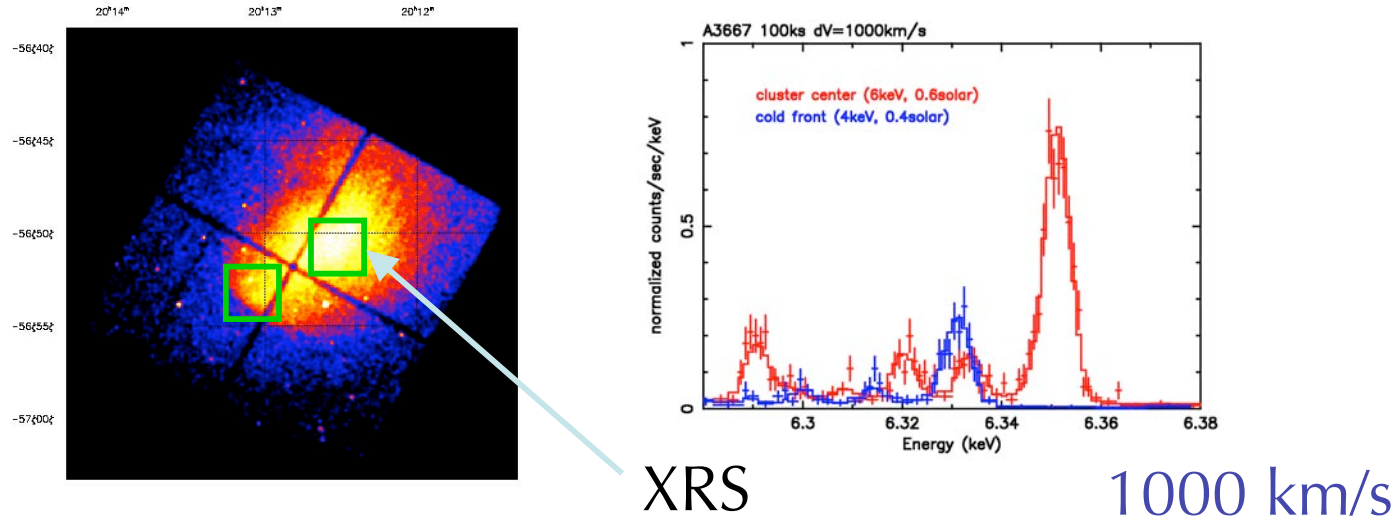


Cluster merging (X-ray)



(Takizawa, ApJ, 2000, vol. 532, 183)

Astro-E2 Study of Clusters in merger



Bulk motion of the hot gas associated with a substructure in a cluster of galaxy, if observed, will be the direct evidence of a cluster merger (Ohashi et al. 2003).

The line profile and energy shift ->

The line of sight motion of the hot gas associated with the merging sub-cluster (v>1000 km/s).

X/Gamma-ray Observatories in the Space Road Map

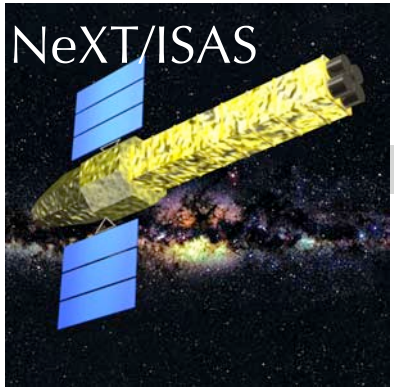
T.Takahashi, Beyond Einstein W.S , 2004

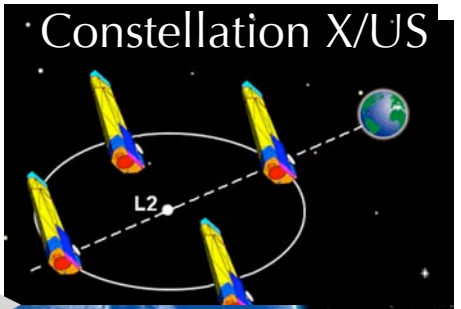
02	03	04	05	06	07	08	09	10	11	12	13	14	15

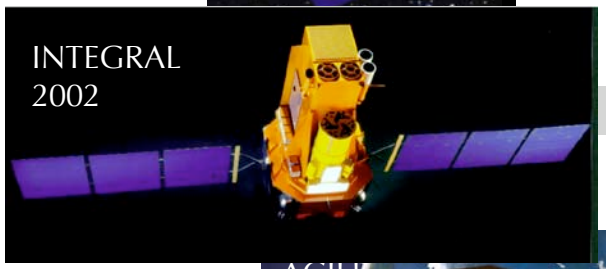
X-rays

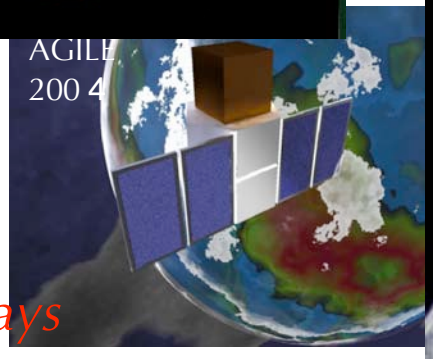
Chandra

XMM/Newton





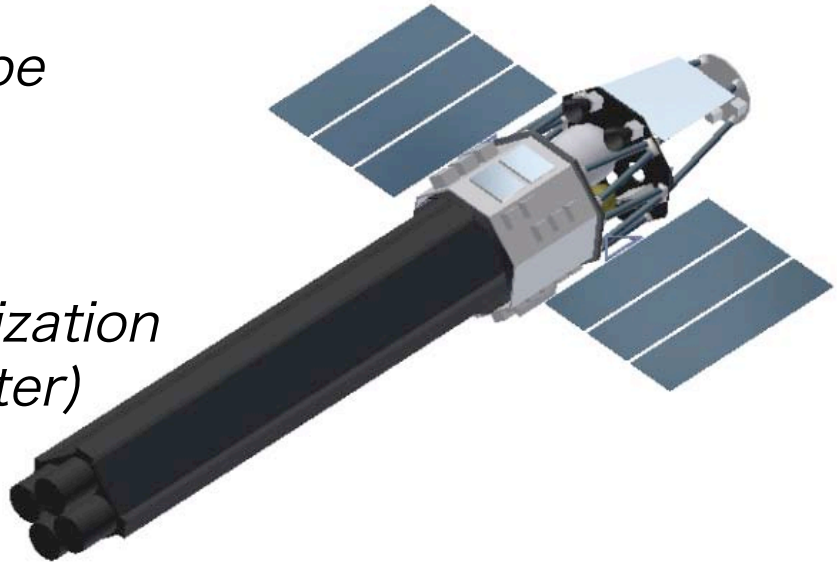


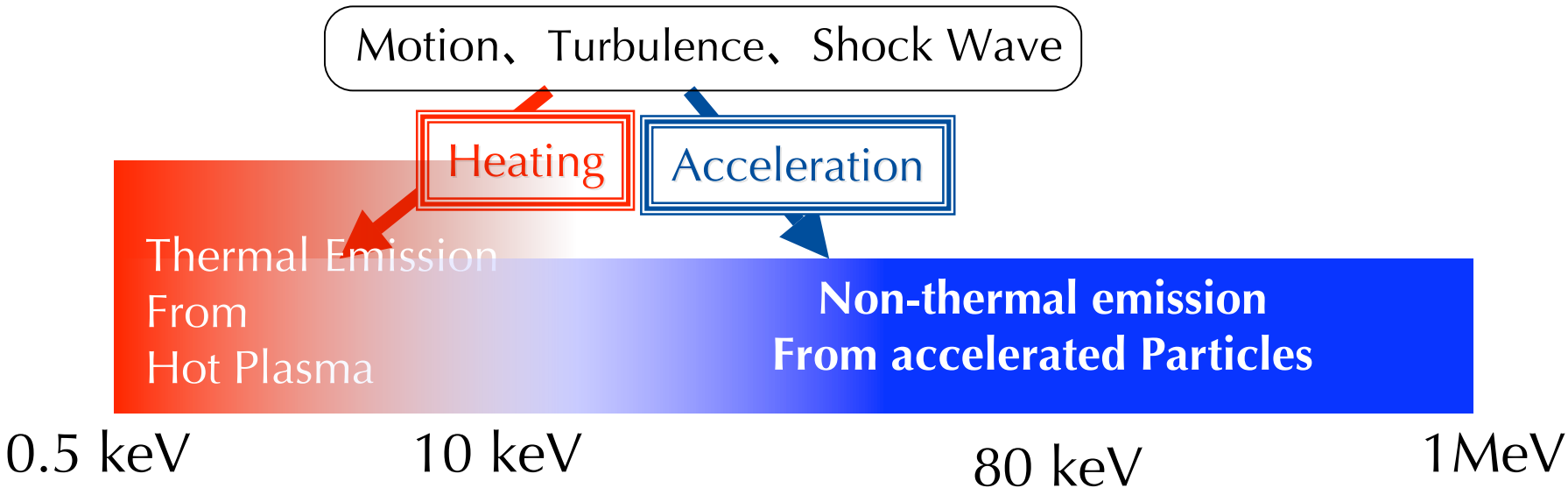


Gamma-rays

NeXT Mission

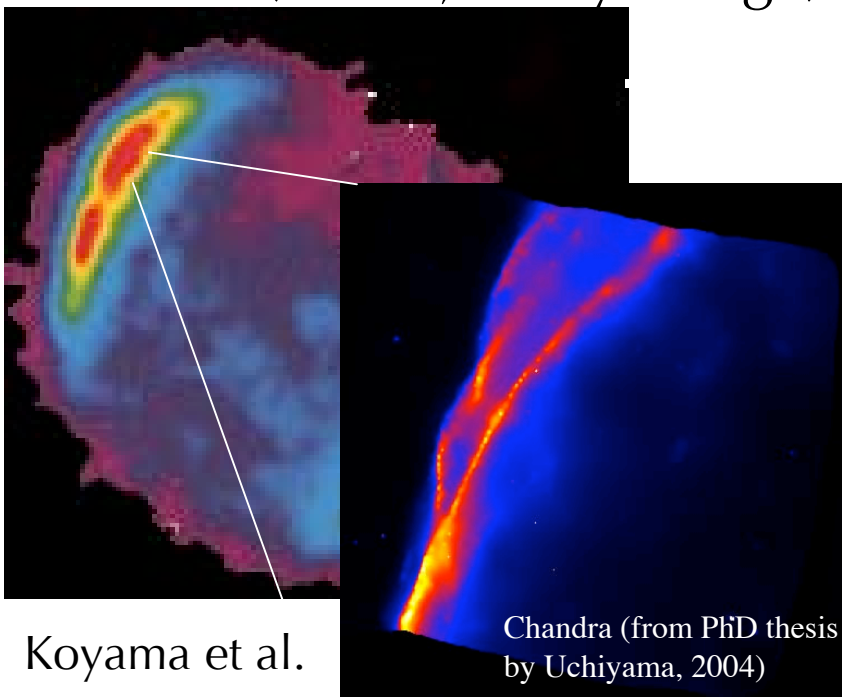
- *First Hard X-ray Focusing Telescope*
- *Highly sensitive γ-ray detector with capability to measure γ-ray polarization*
- *ΔE=3 eV resolution (TES calorimeter) for soft X-rays*





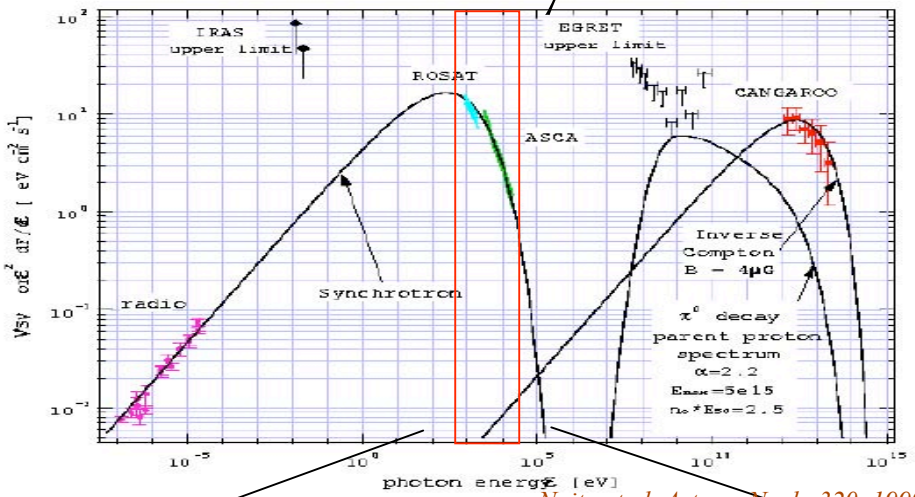
Probing High Energy Universe with X-ray Photons

SN1006 (ASCA, X-ray image)



Koyama et al.

X-rays



Naito et al. Astron. Nach. 320, 1999

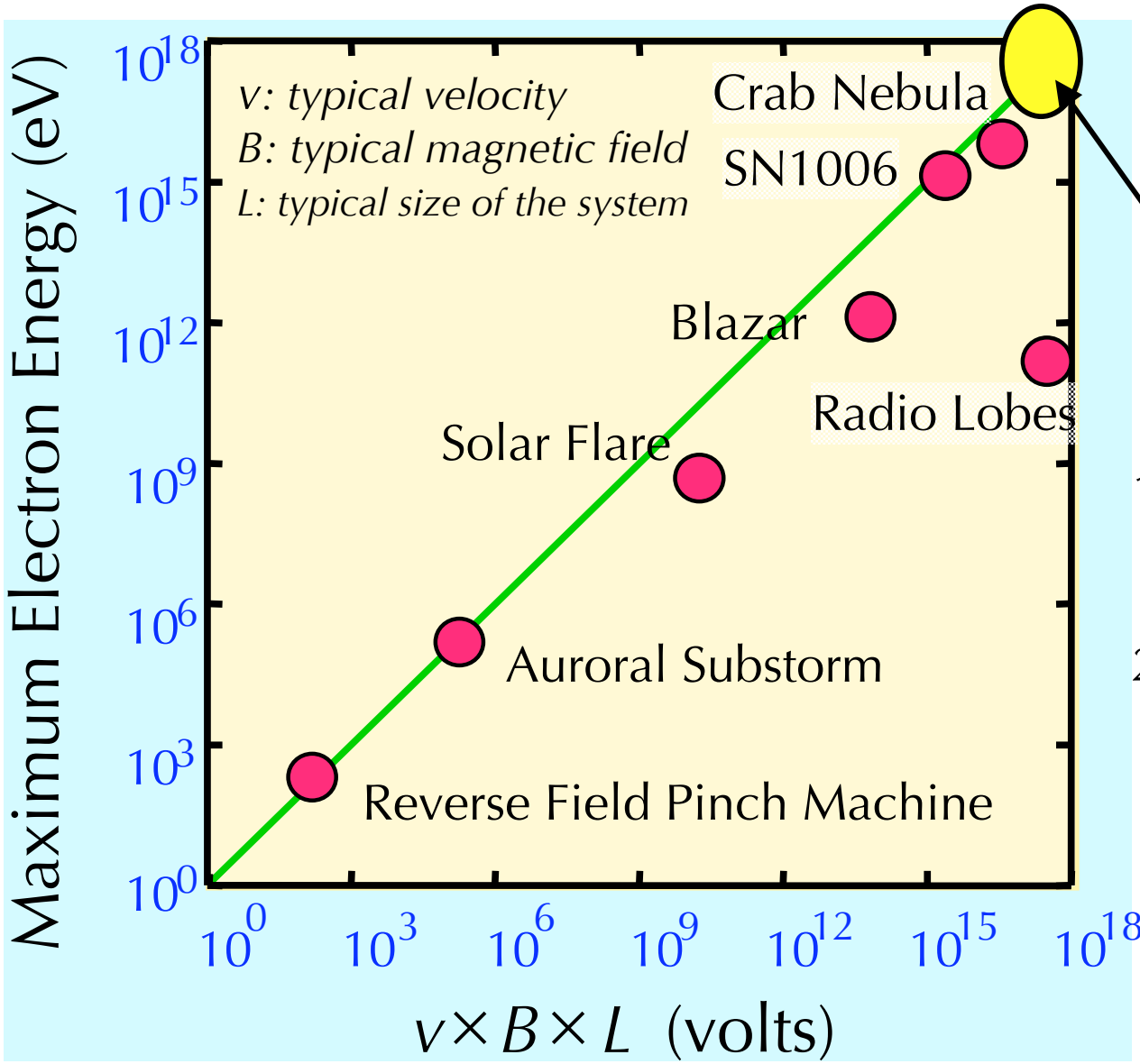
From the high energy end of the electron distribution (Energy Frontier)

$$h\nu_{\mathrm{synch}} = 5.3\, E^2_{100\mathrm{TeV}} B_{10\mu\mathrm{G}} \quad [\mathrm{keV}]$$

The site of Multi TeV particles

X-ray cools fast and should reflect particle injection
(1000 y for 160 TeV, 10μG, 1pc for 1000 km/s)

Maximum Energy Scaling of Cosmic Accelerator

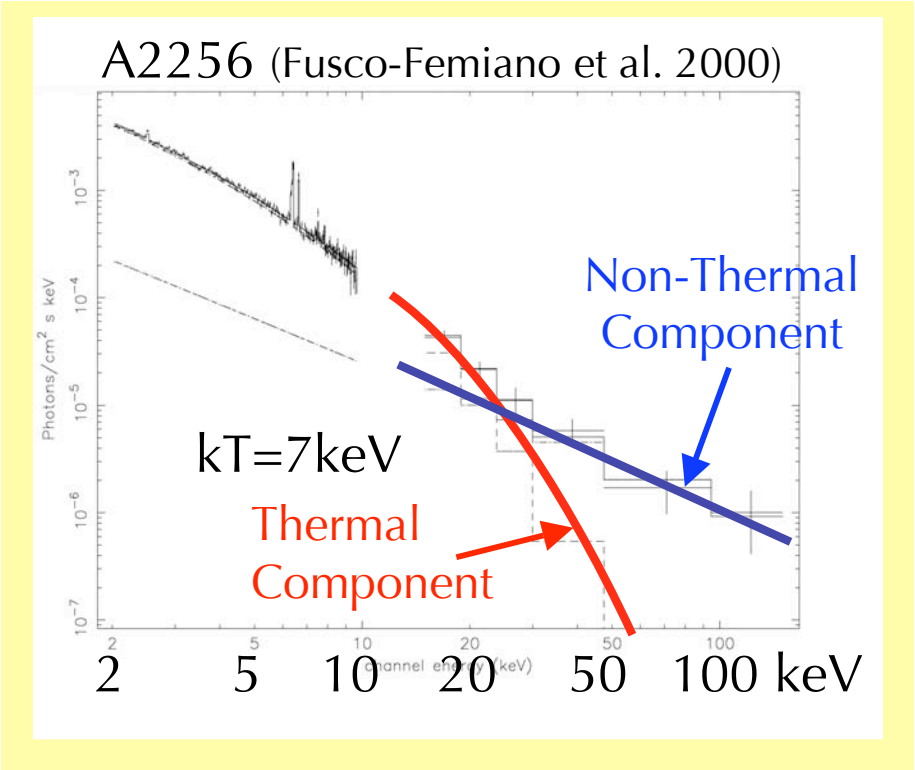


Do clusters of galaxies produce Extremely High Energy cosmic rays?

1. Shock Acceleration high v is needed and BxL for confinment
2. Direct electric acceleration via vxB field over a length L

Hillas (1984)
Makishima (1999)

What we still do not know about.

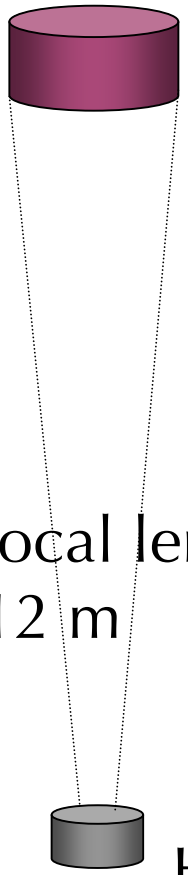


Recent Radio/X-ray observation
-> Non-thermal emission
from clusters of galaxies

Non-thermal luminosity (comparable or even larger than the thermal luminosity if p/e ~100.)

The energy we have not yet realized (Non-thermal Energy)

The NeXT Mission

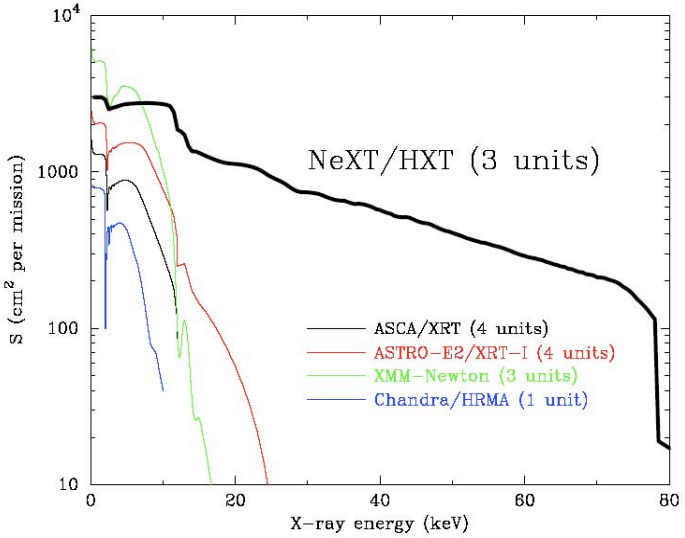


Super Mirror (0.5-80 keV)

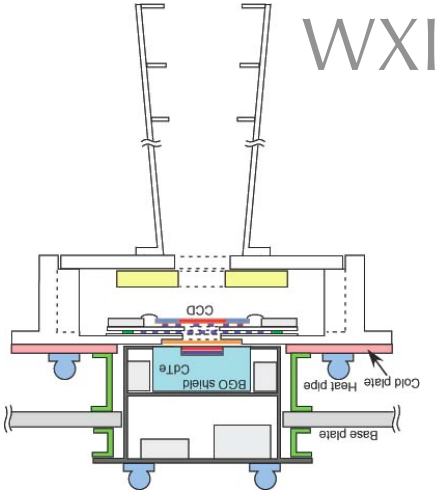
30″ HPD

focal length
12 m

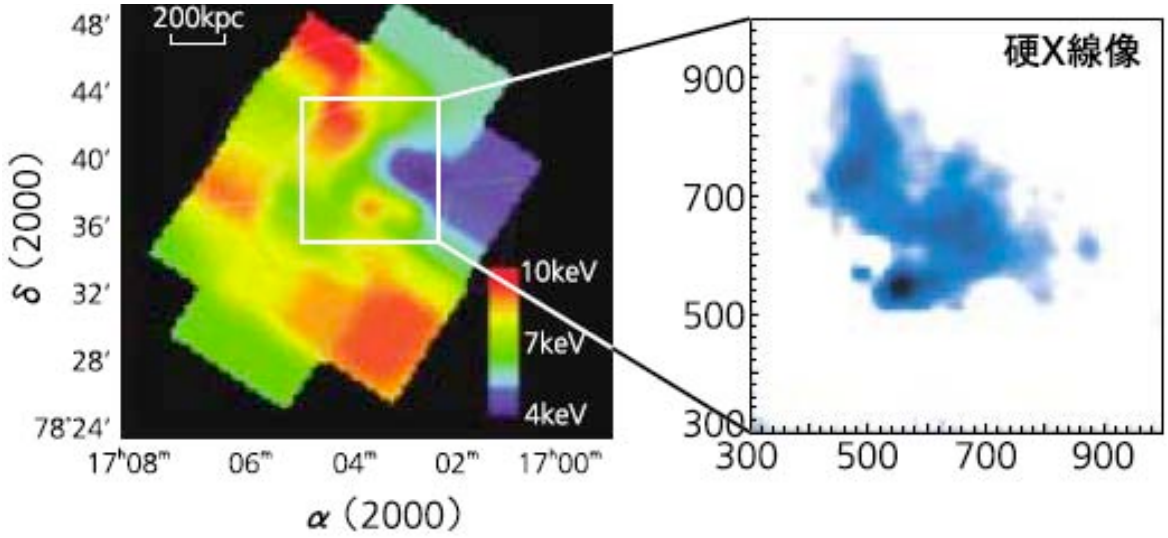
Hard X-ray
Imager



WXI



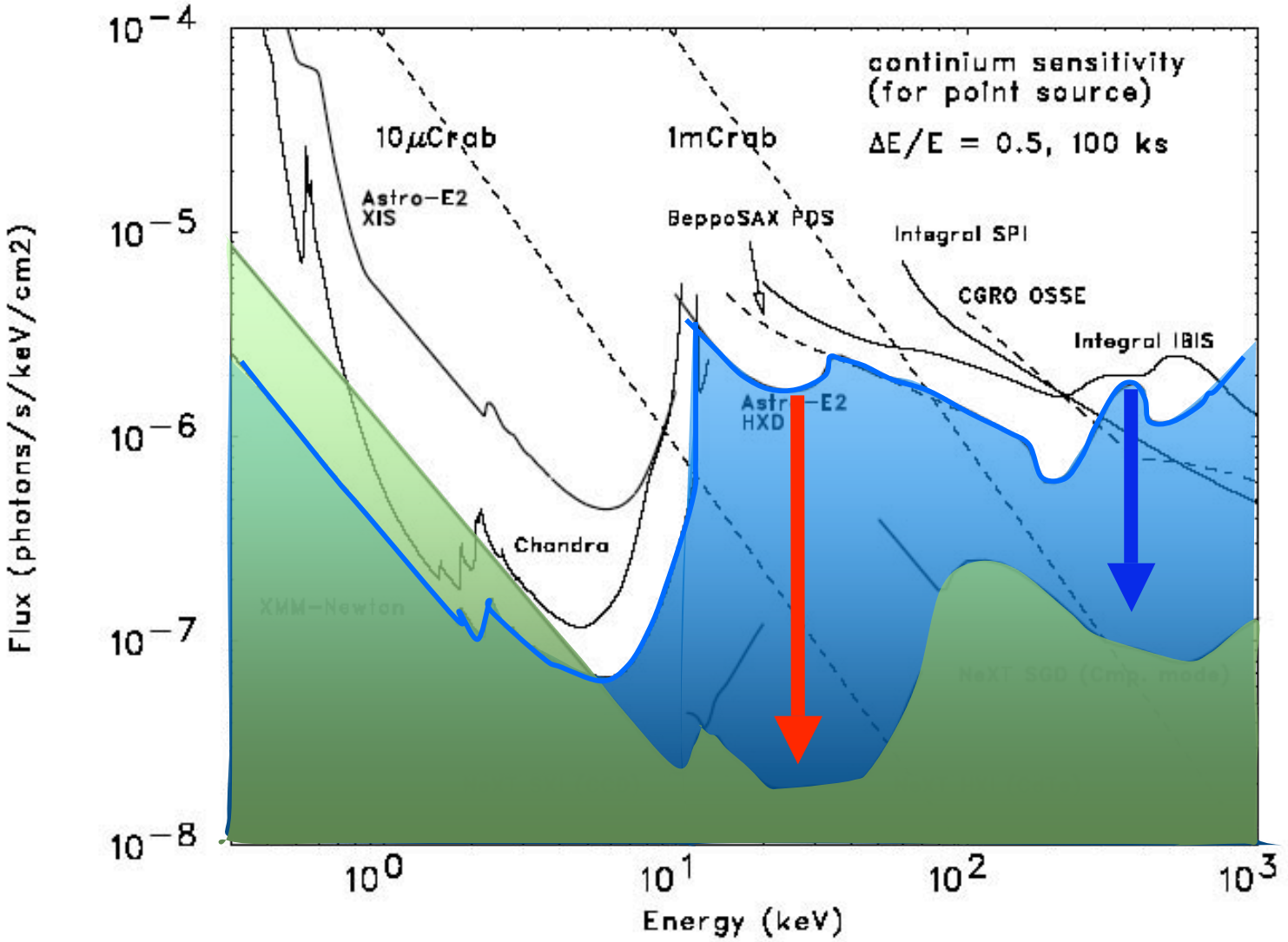
E>10 keV



NeXT Mission
Proposal, ISAS, 2004

T.Takahashi, Beyond Einstein W.S , 2004

NeXT's High Sensitivity



From NeXT proposal (2004)

Long Term Road Map ?

The big progress (or jump) in science is often provided by "Unexpected Discoveries". To increase the chance of such discoveries, we need a way to create dis-continuity, rather than just preparing Big-Missions.

- We need more players (in addition to public supporters)
- For this, it is important to make "space" more accessible (speed is most important)
  - New strategies to support small but attractive projects.
  - New technologies for "smart and quick, and cheap" missions

Hakucho (1979-85)

Tenma (1983-89)

4 years

Ginga (1987-99)

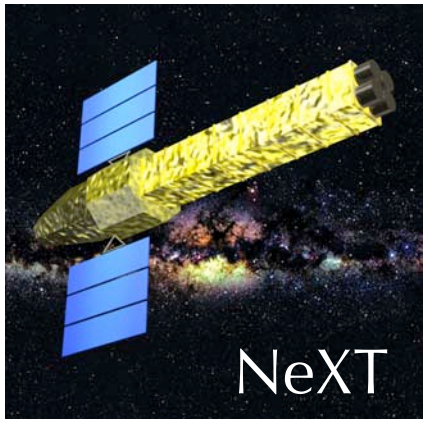
4 years

ASCA (1993-01)

6 years

7 + 5 years

Astro-E2 (2005)



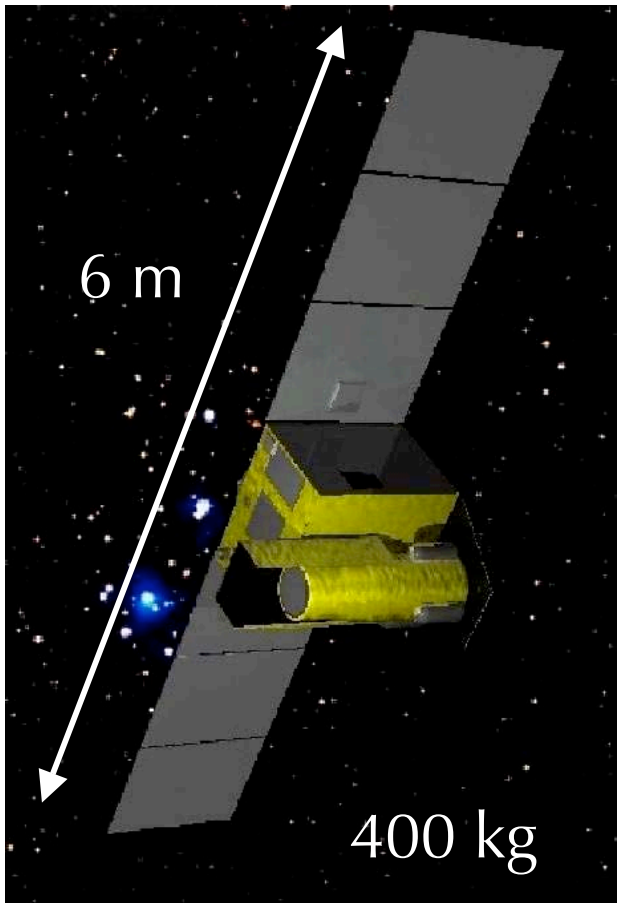
2010?

One example of small mission proposal related to B.E.

DIOS Diffuse Intergalactic Oxygen Surveyor

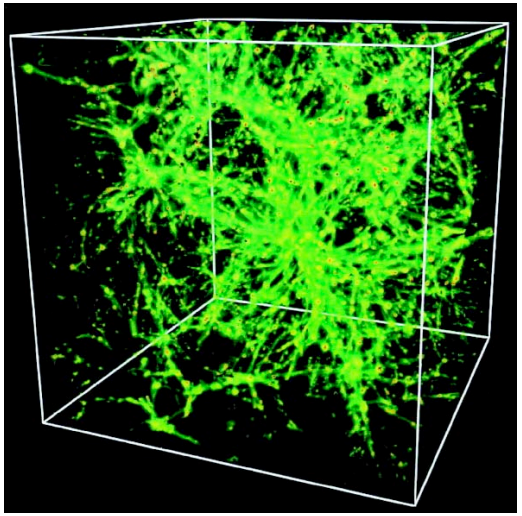
- Japanese small X-ray mission to study large-scale distribution of the warm-hot intergalactic medium
  -> ~50 % of baryon mass
- Detection of emission line (OVII, OVIII) from 10^6K gas hidden between galaxies (upto z~0.3)
- High Resolution (TES) detector
- Wide FOV mirror (0.9 deg x 0.9 deg)

Total Weight & Mass :<400kg



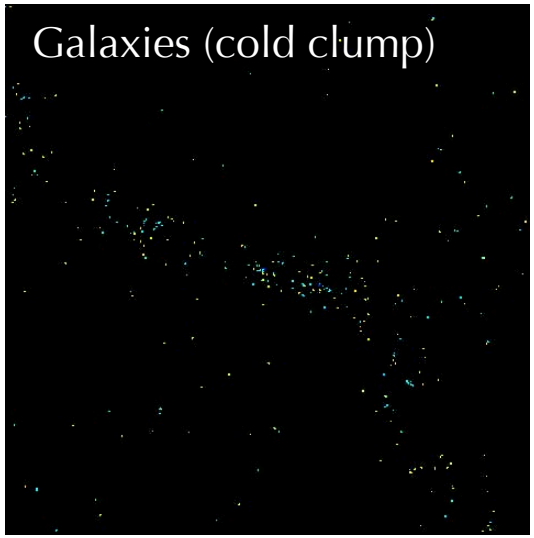
Mitsuda, Ohashi et al.

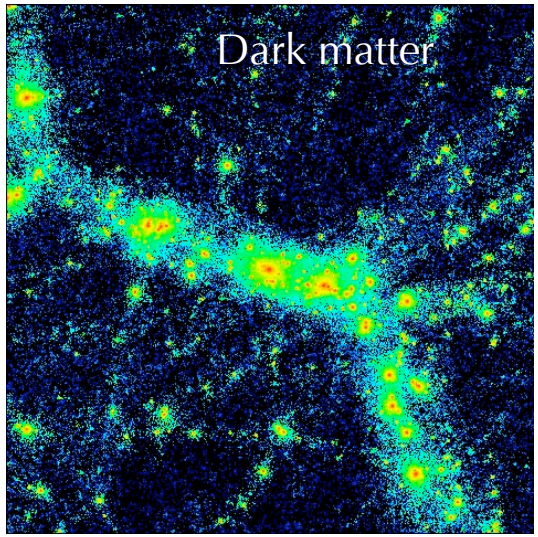
Dark Matter and Warm Gas

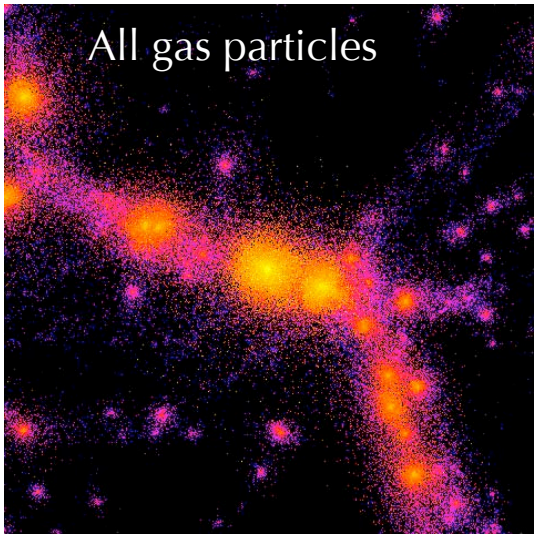


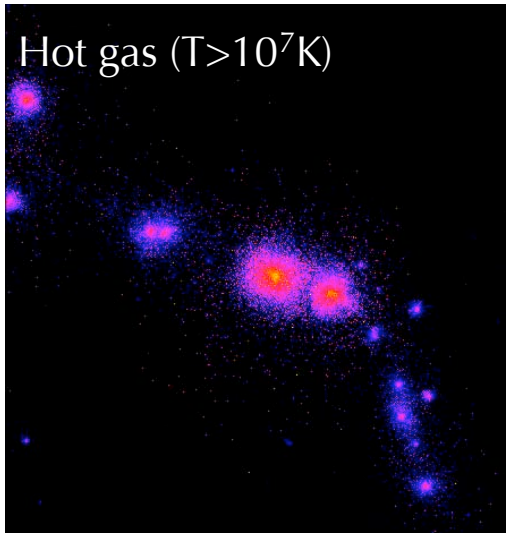
Warm gas follow dark matter very well.

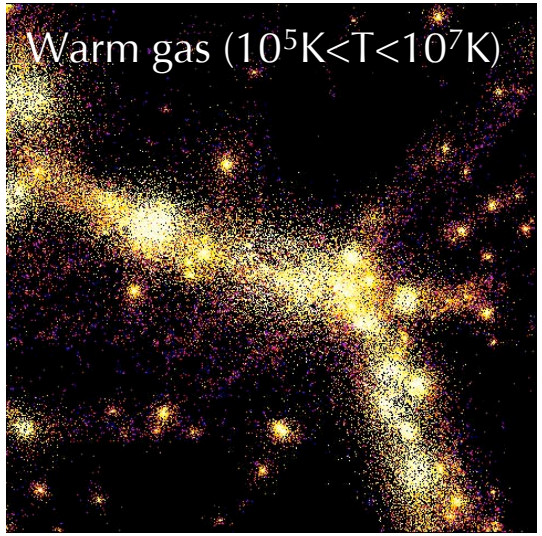
(L CDM simulation by Yoshikawa et al. 2002)









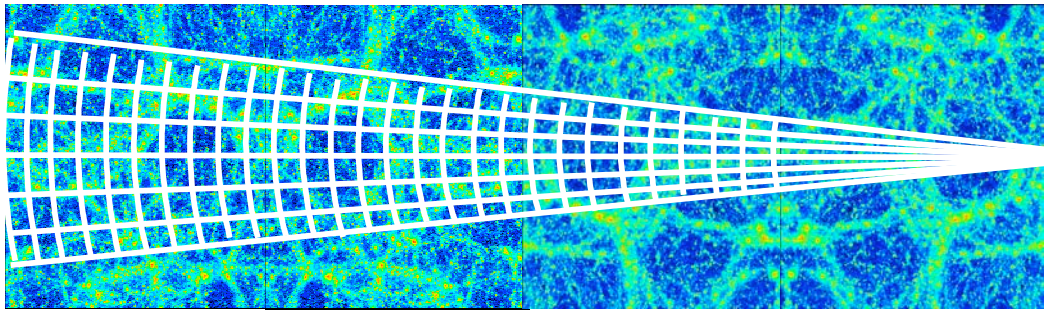


Even with small satellites…

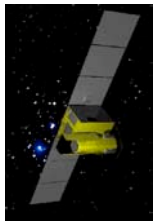
T.Takahashi, Beyond Einstein W.S , 2004

DIOS

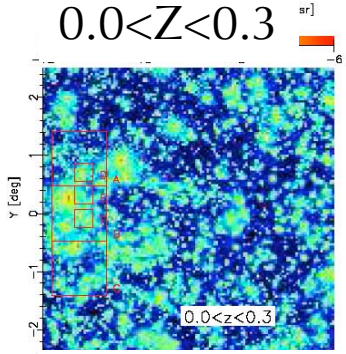
z=0.3

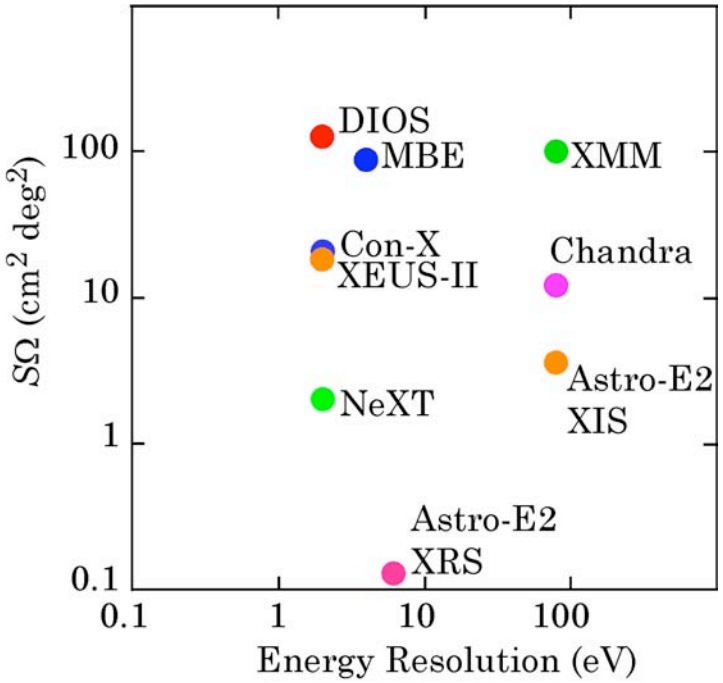


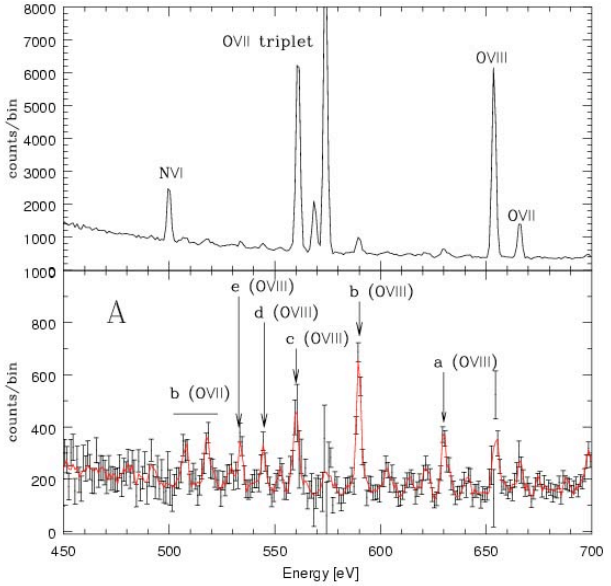
z=0



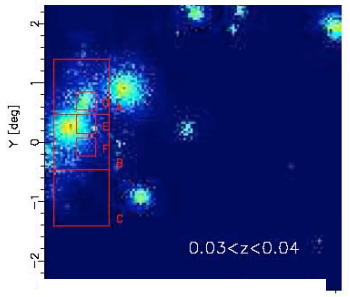
0.0<Z<0.3



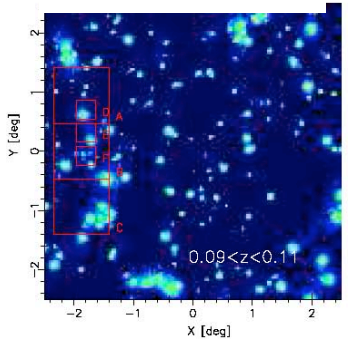




0.03<Z<0.04



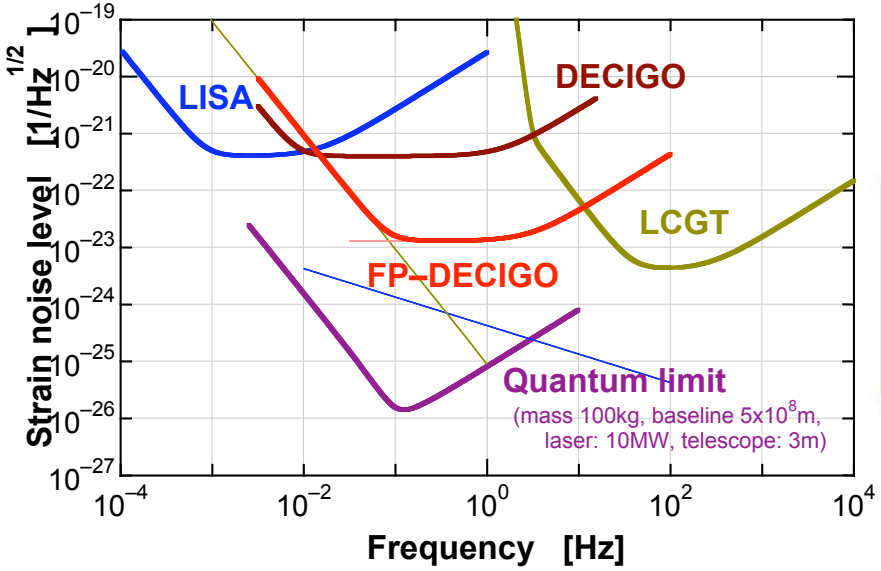
0.09<Z<0.1

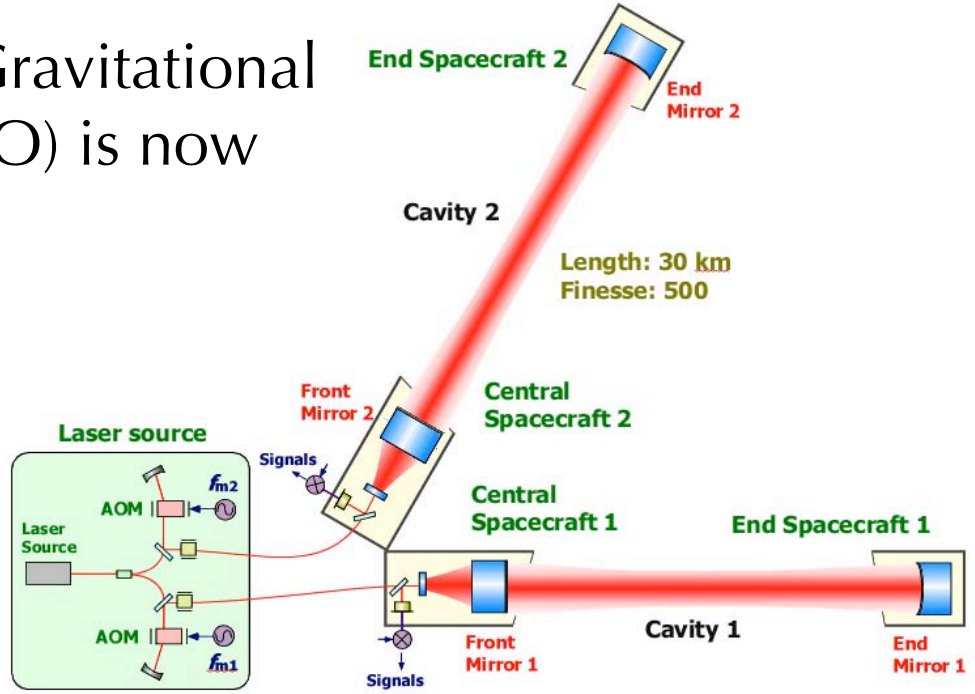


T.Takahashi, Beyond Einstein W.S , 2004

Hurdles to space is still high for new players.
But, if such hurdles are gone,
many possibilities can encourage many players to take part in.

Mission Study of
Deci-hertz Interferometer Gravitational Wave Observatory (DECIGO) is now underway.





Formation flights of 4 satellites

Gravitational Wave Group in Japan

Summary

- In Japan, various scientific program are on going, “to understand the universe”, by using accelerators, telescopes and satellites. It’s nice, but we need to have a coherent strategy for the future plan.

- Particle Acceleration and Non-thermal Universe are the important keywords for the near-future HE mission in ISAS.

- Efforts to set up small satellite (~500 kg) are on going to increase opportunities for attractive and quick mission.

- Hope that we can strengthen the activity of space science under Japan’s new space organization **(JAXA)**

Japan Aerospace Exploration Agency