WFMOS-like…

= SuMIRe's

Subaru Measurements of Images and Redshifts

PSF

(Prime Focus Spectrograph)

Hiroshi Karoji (IPMU, from April 1st, 2010)

•What is SuMIRe's PSF ?

≡

FMOS "Monster" version

~ 3000 fibers

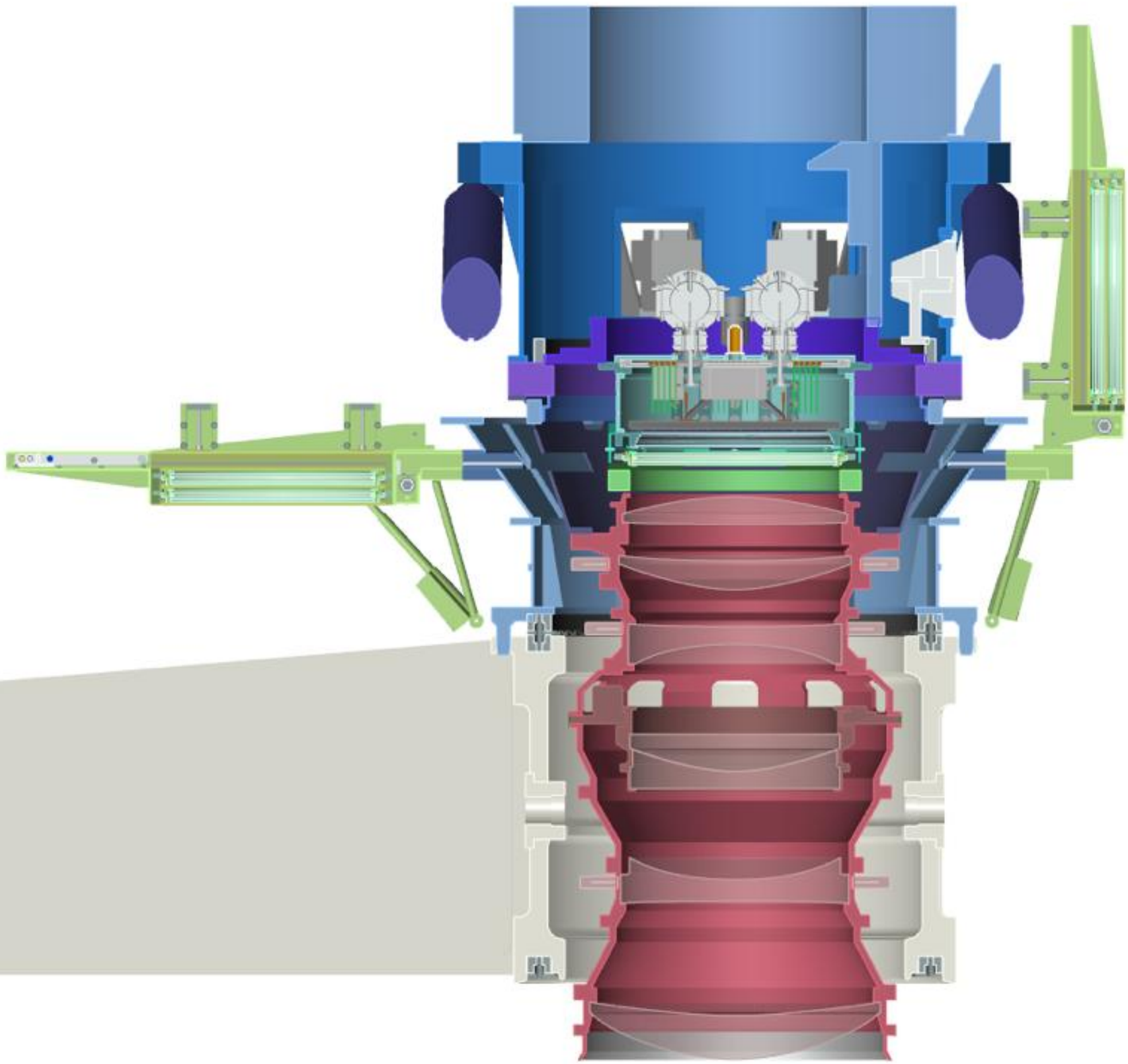
optical wavelength (400-1000nm)

firstly, z machine

(high dispersion for Galactic Archeology, later)

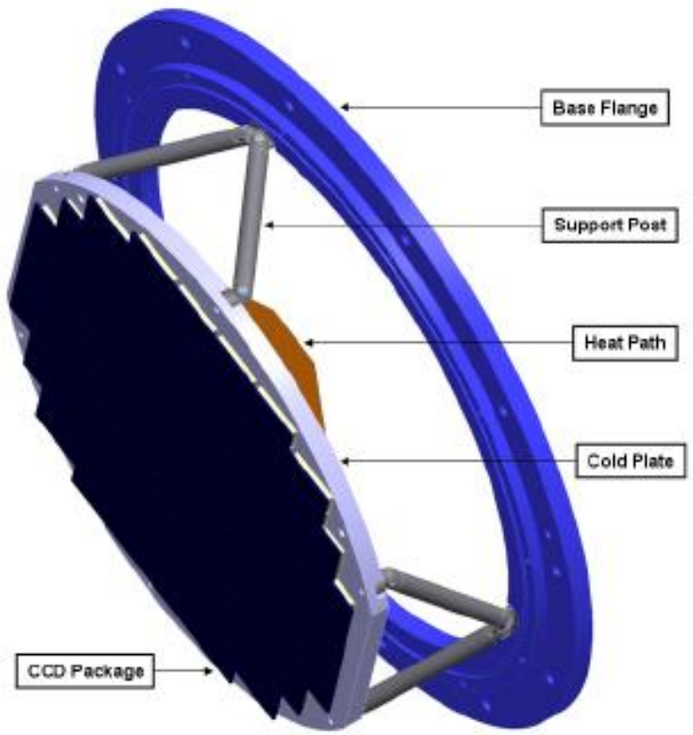
full use of HSC's PFU

What is SuMIRe's PSF ?



What is SuMIRe's PSF ?

(a)

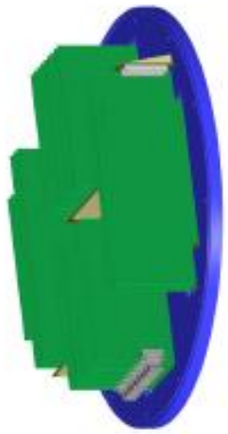


(b)

Window Assembly

Wall Assembly

Focal Plane Assembly



FEE Assembly

Back Assembly

What is SuMIRe's PSF ?

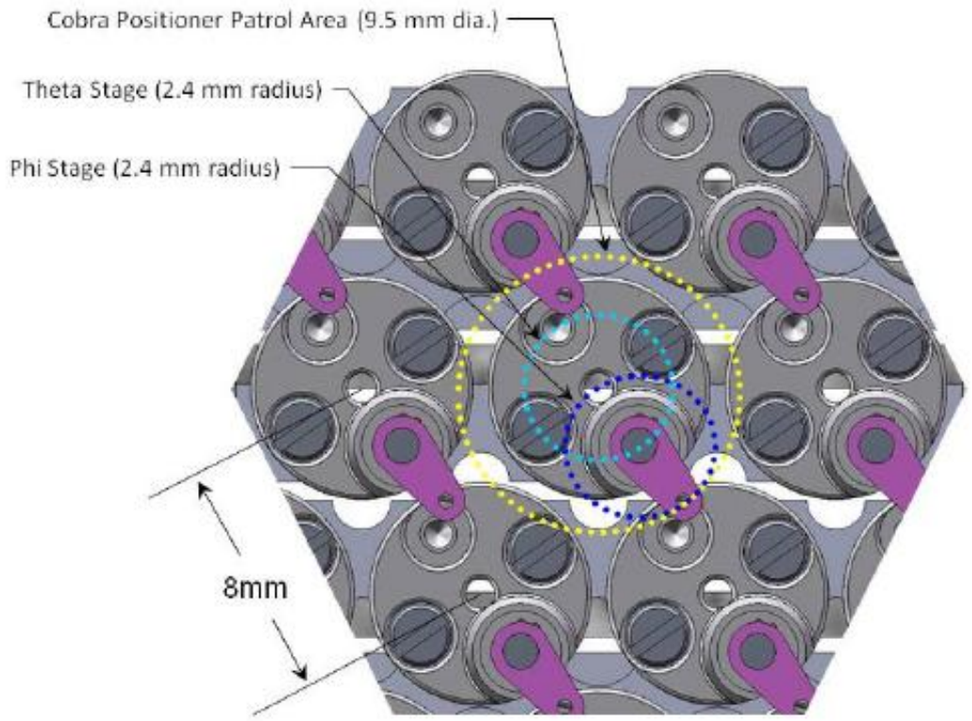
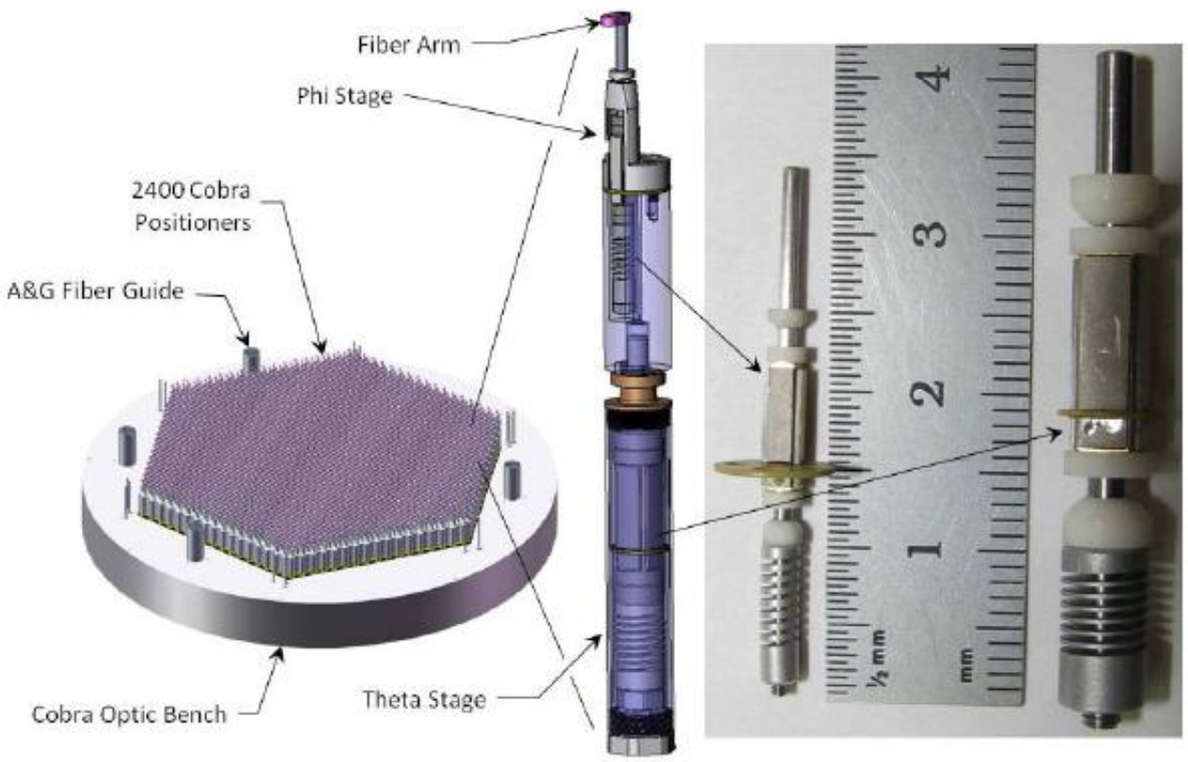
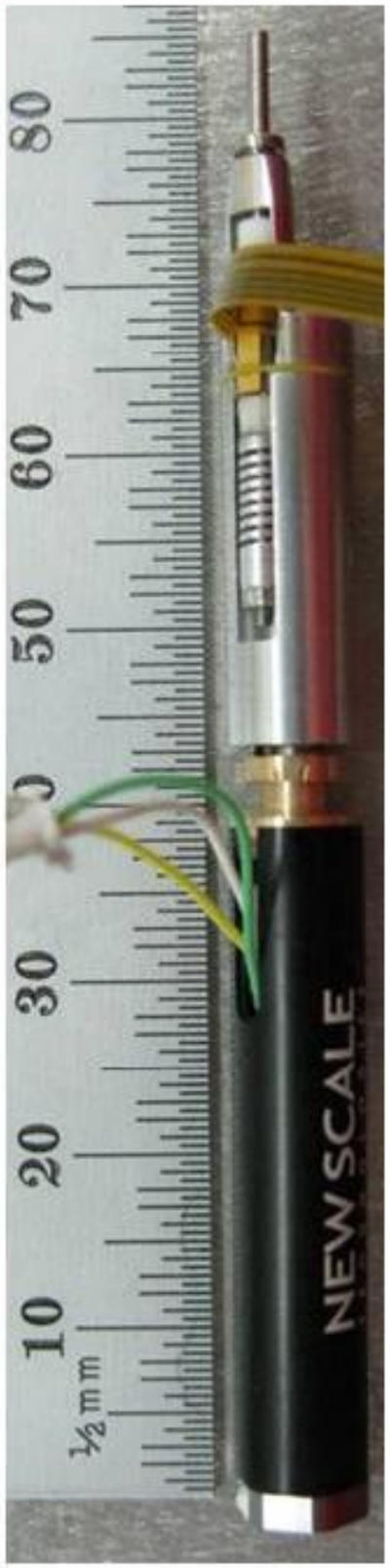
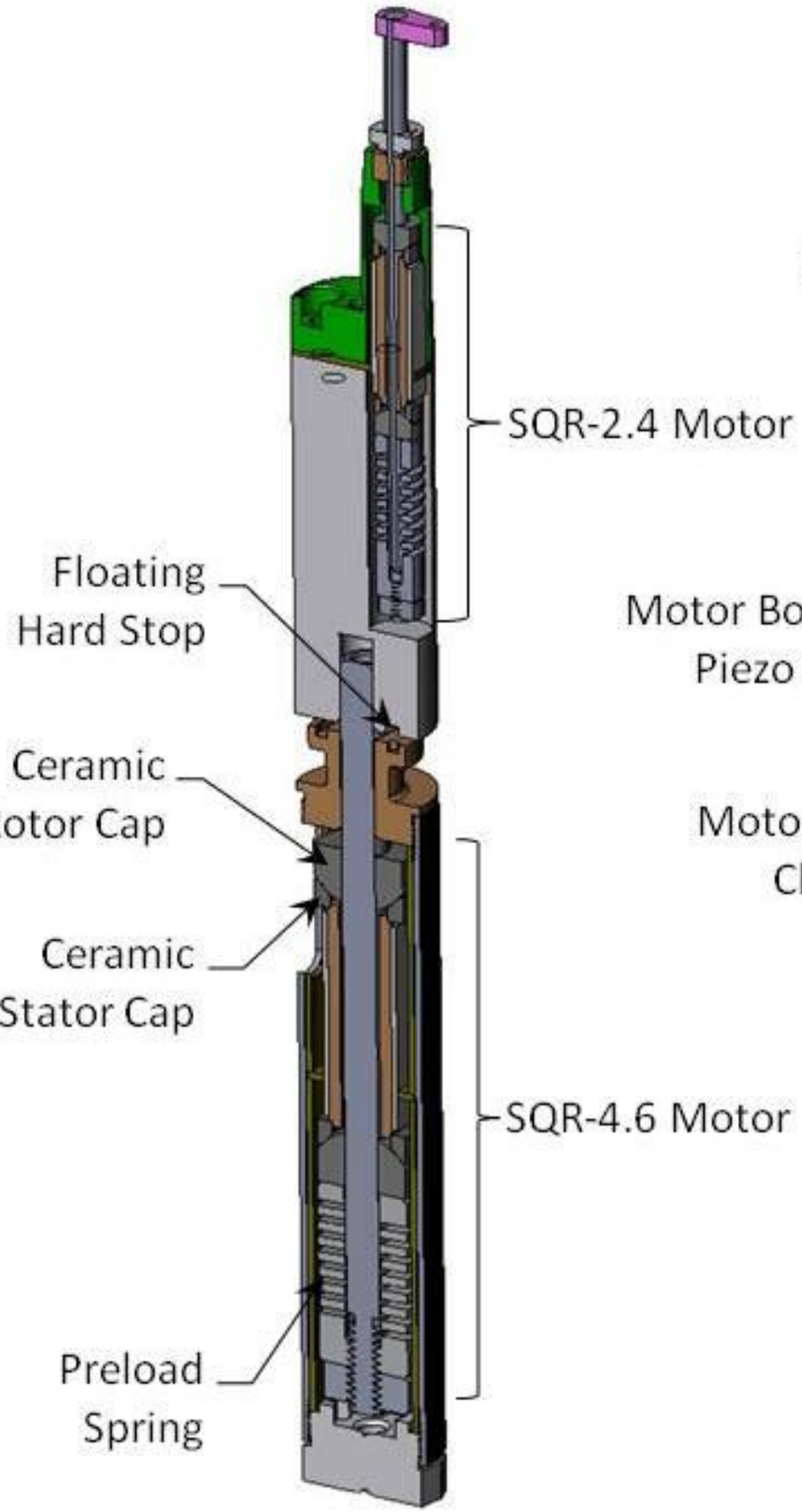


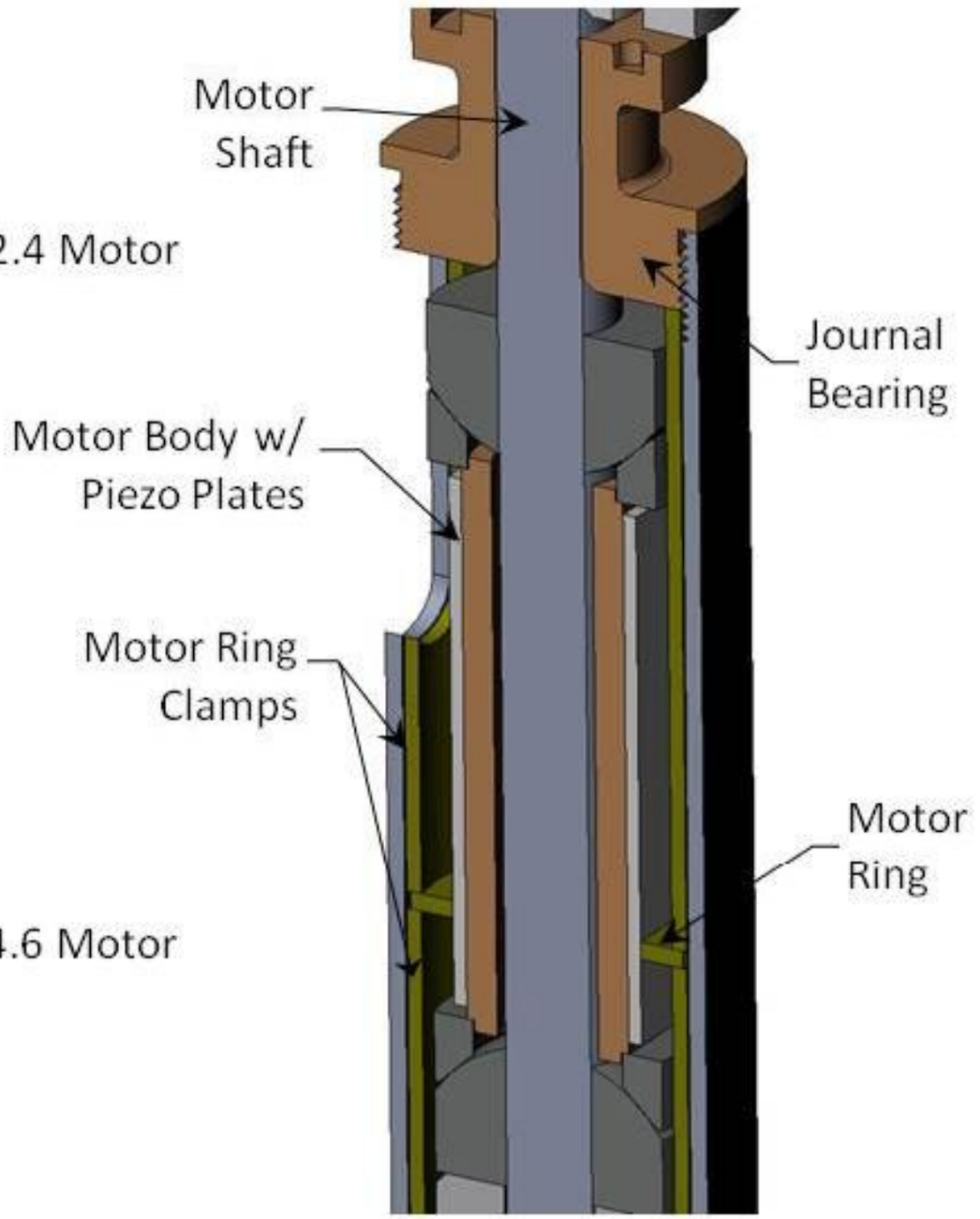
Figure 2.3-2: Cobra Positioner stage geometry, resulting fiber patrol area, and neighboring positioners in close packed hex pattern.



What is SuMIRe's PSF ?

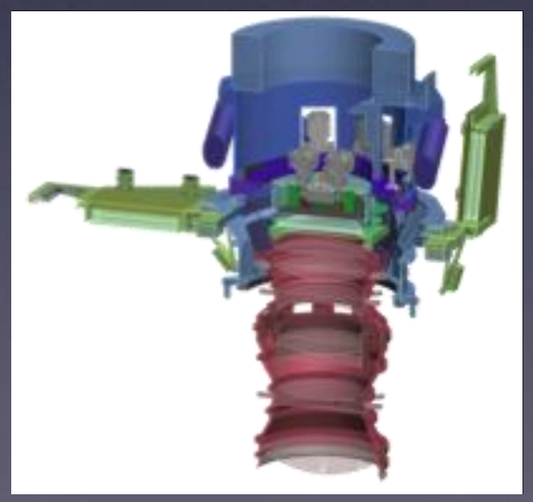




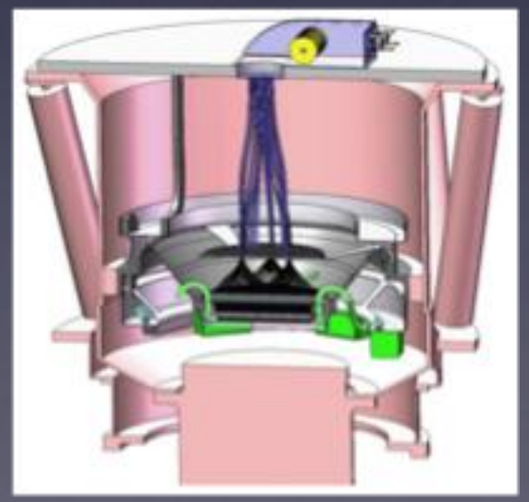


WFMOS

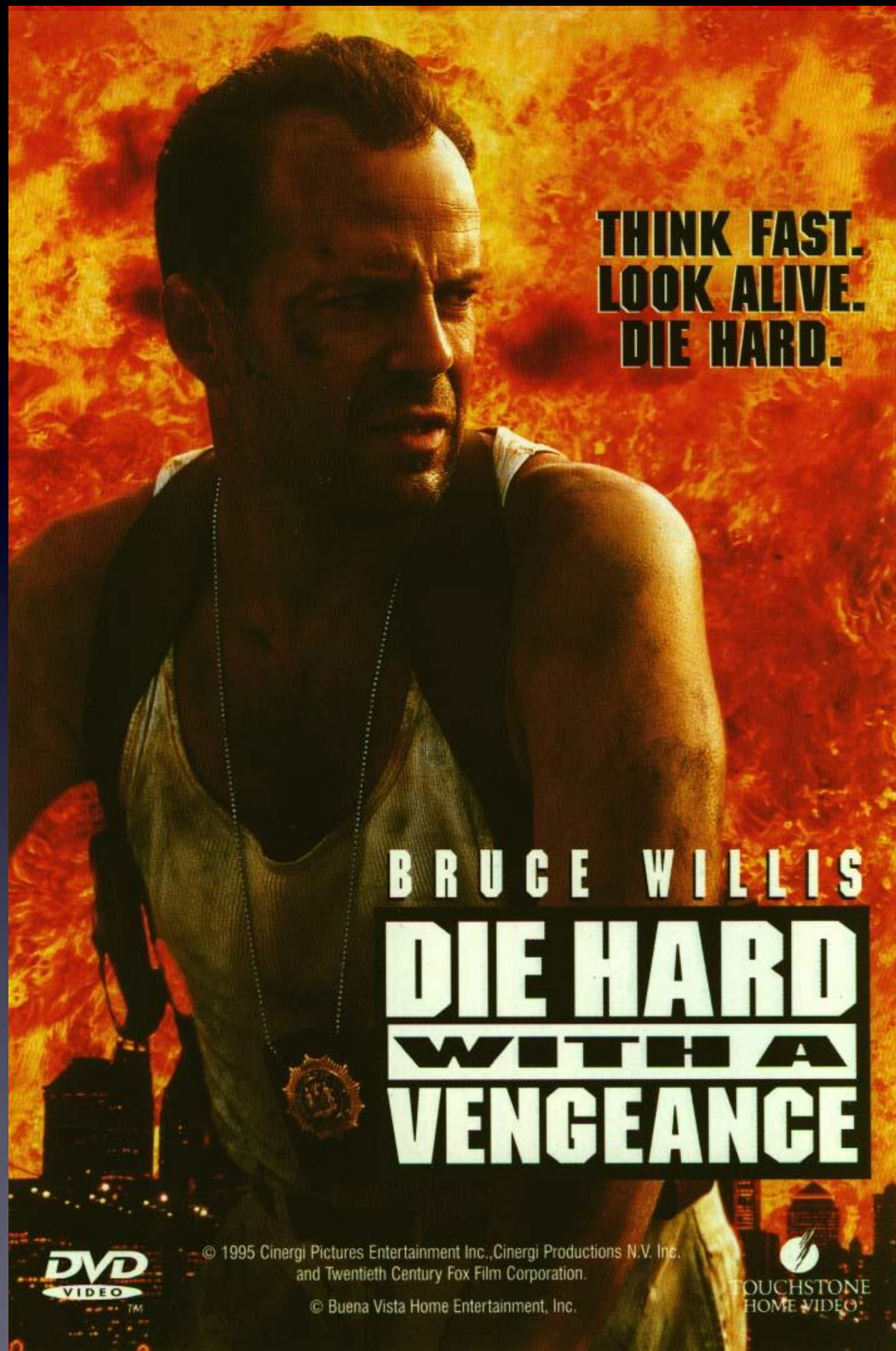
- Wide Field Multi Object Spectrograph
- designed developed by Gemini team for Subaru
- WFMOS “approved” by Subaru UM 2009
- killed in May ’09
- HSC also need ~$30M more to be completed



HSC

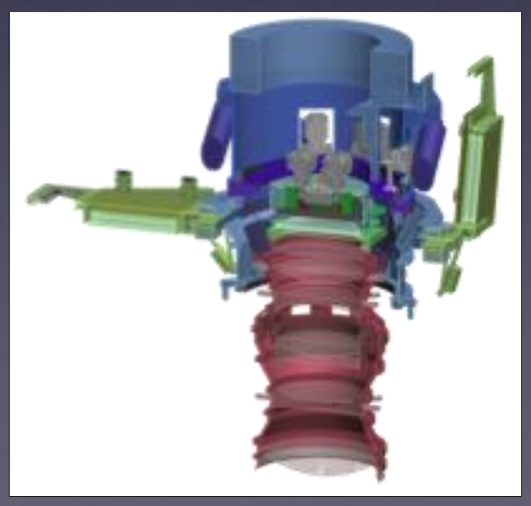


WFMOS

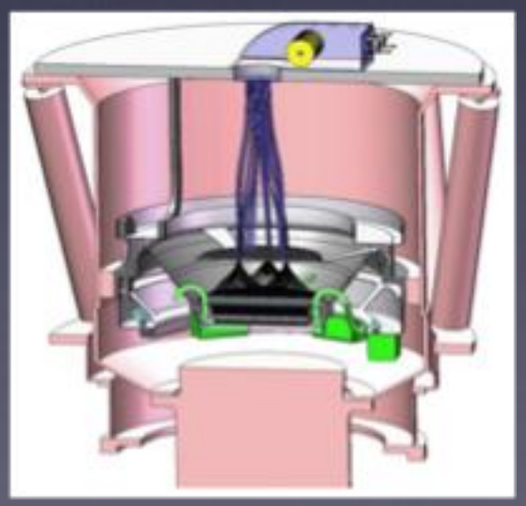


SuMIRe

- trying to revive multi-object spectrograph
- PFS = “Prime Focus Spectrograph”
- SuMIRe = combo of HSC and PFS
- trying to grab funds from the economic stimulus package



HSC

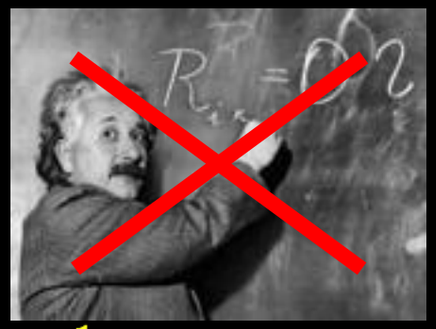


PFS

SuMIRe

- stimulus package by the previous LDP administration
- initially $3.0B for 30 scientists
- 565 proposals in July ’09
- proposed $105M for SuMIRe
- 90 chosen for presentation in Aug ’09
- initial ranking: 76th, barely within the cut of 81
- after presentation: chosen among 30 in Sep ’09
- Then the overall envelope cut to $1.1B

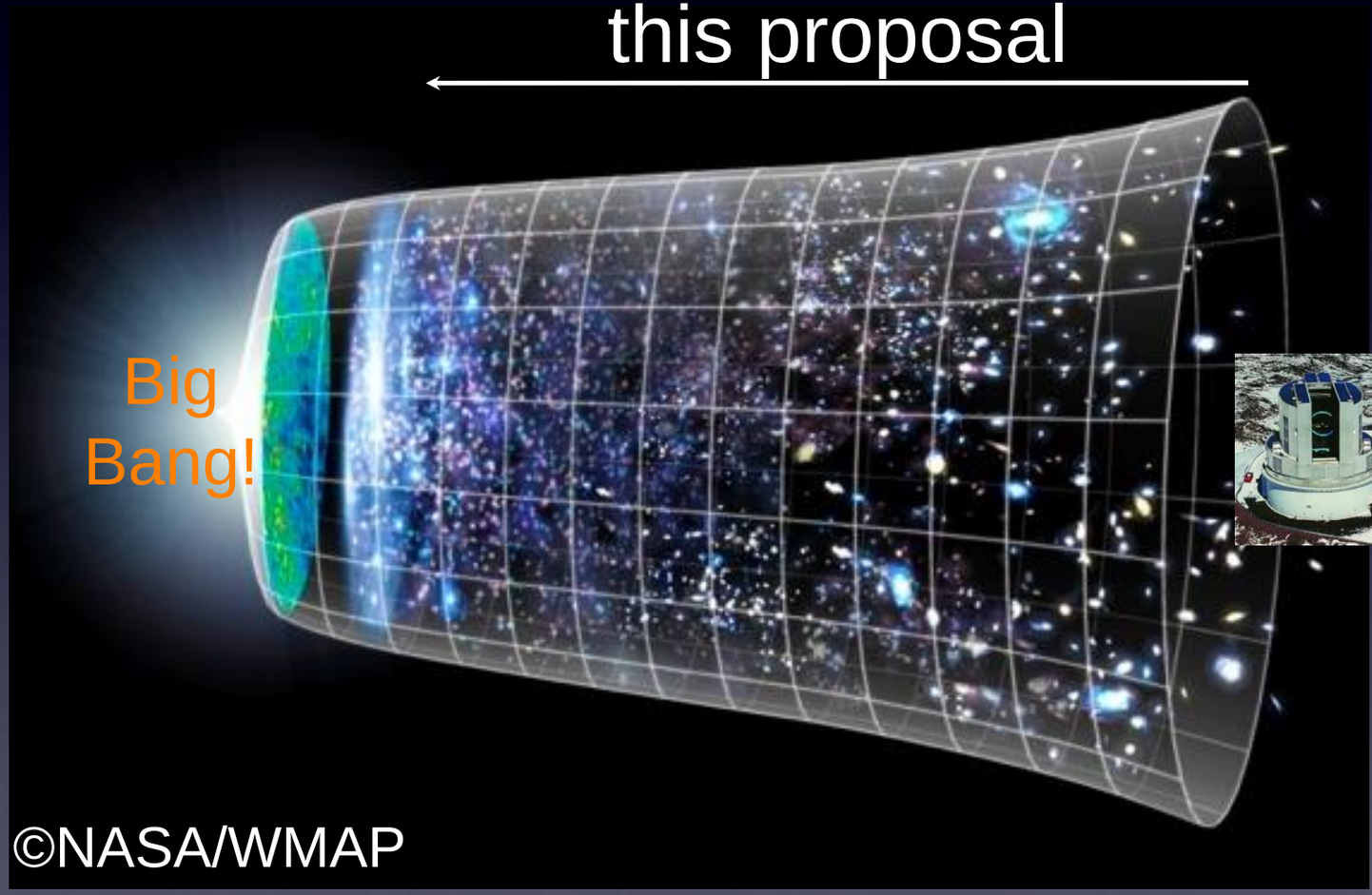
$1=¥90



Possible Results

$$R^{\mu\nu} - \frac{1}{2}g^{\mu\nu}R \neq 8\pi G_N T^{\mu\nu}$$

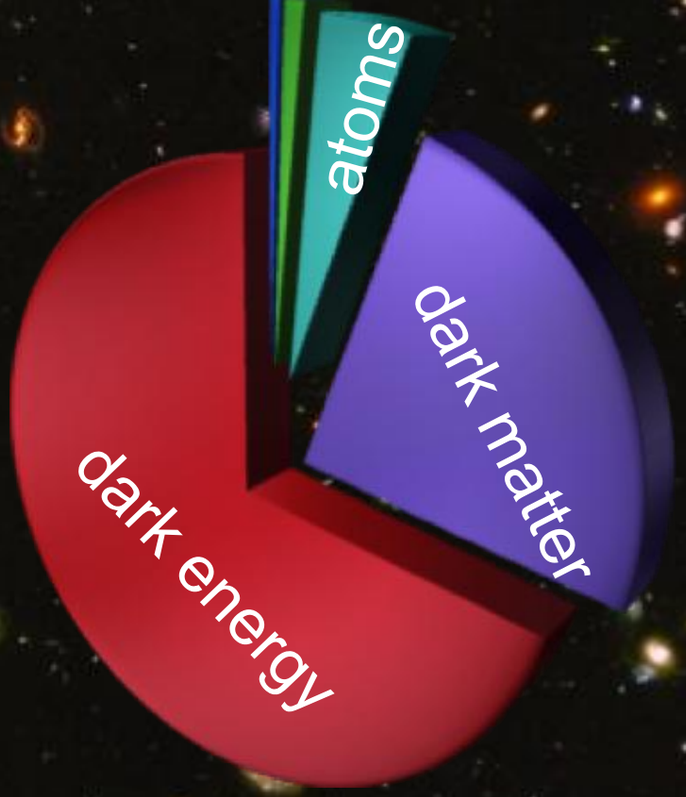
- problems with Einstein's theory of gravity?
- rate of increase in dark energy is further increasing ⇒Universe has an end!
- rate of increase in dark energy is slowing down ⇒mysterious particle and force with negative pressure
- birth of blackholes in early universe



How I pitched it

Reveal the origin and fate of the Universe

—elucidate the nature of dark matter and dark energy via imaging and spectroscopy—



How did the Universe begin?

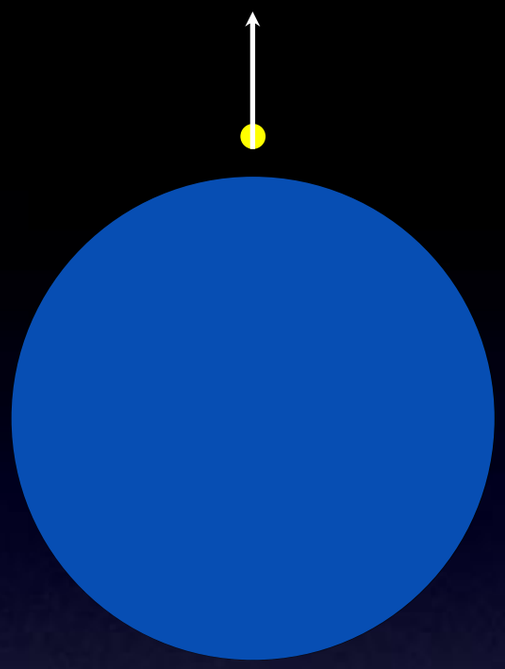
Does it have an end?

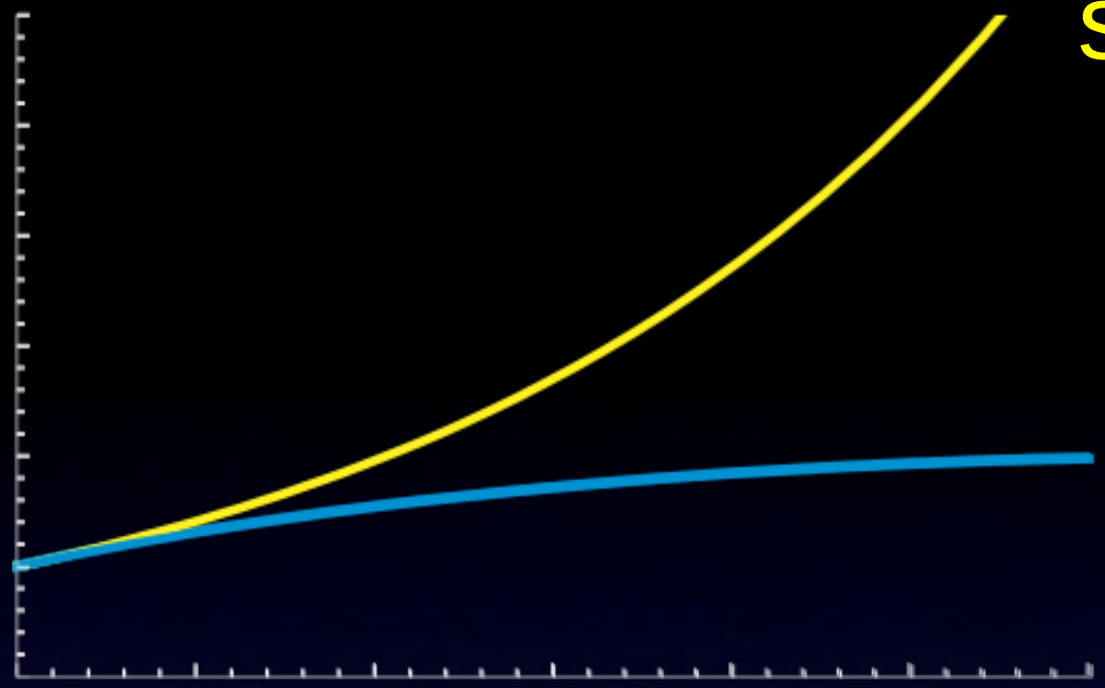
What is it made of?

Why do we exist?

Questions since the dawn of humankind now with science!

expansion

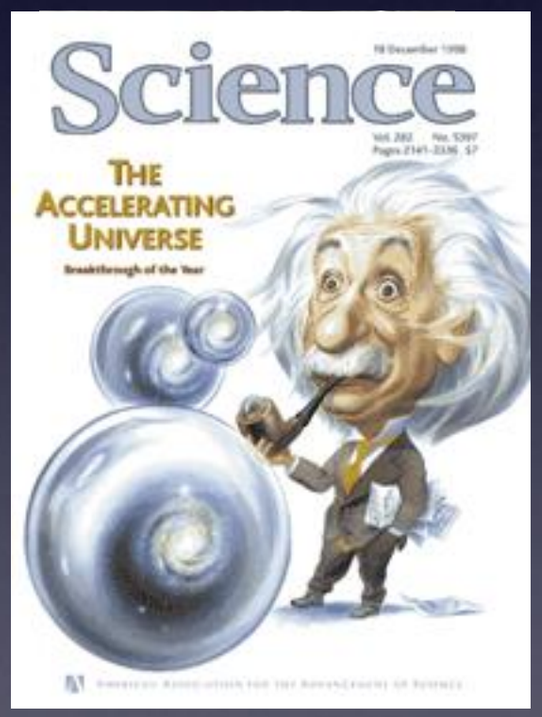




speeding up!

should slow down

- expansion started to speed up recently (~7Byr)



- energy is increasing!
- infinite source of energy?? dark energy
- Was Einstein wrong?
- new paradigm of the Universe, fundamental laws
- If the rate of energy increase very quick, eventually the expansion becomes infinitely fast
  ⇒ Will the Universe end??

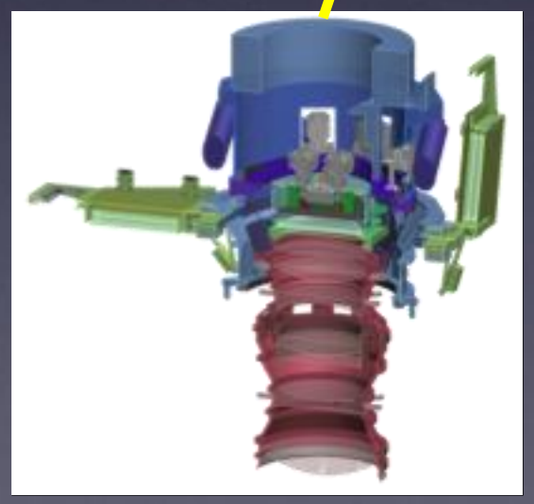
Most profound mystery in basic science (Wilczek, Nobel Prize)

Number one on my list of problems to solve (Witten, Fields Medal)

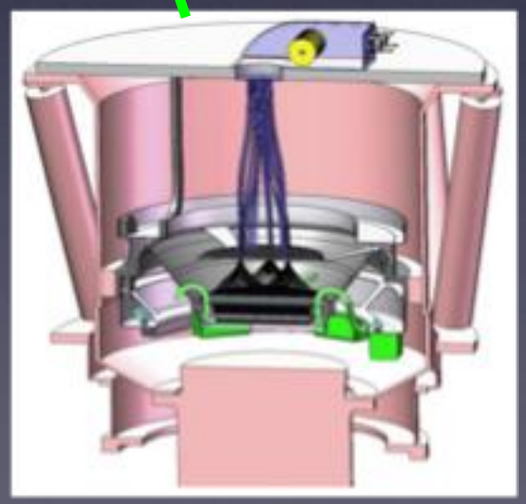
Revealing Dark Energy

- Japan is behind in this area
- measure the rate of acceleration
- ~100M galaxies
- precision imaging of galaxy shapes ⇒world class
- precision wide field spectrograph to measure distances ⇒ world leading!
- push the Japanese technology in precision control, optics, detectors, materials
- Mitsubishi Electric, Canon, Hamamatsu, Kyocera have been involved in R&D

Subaru (NAOJ)



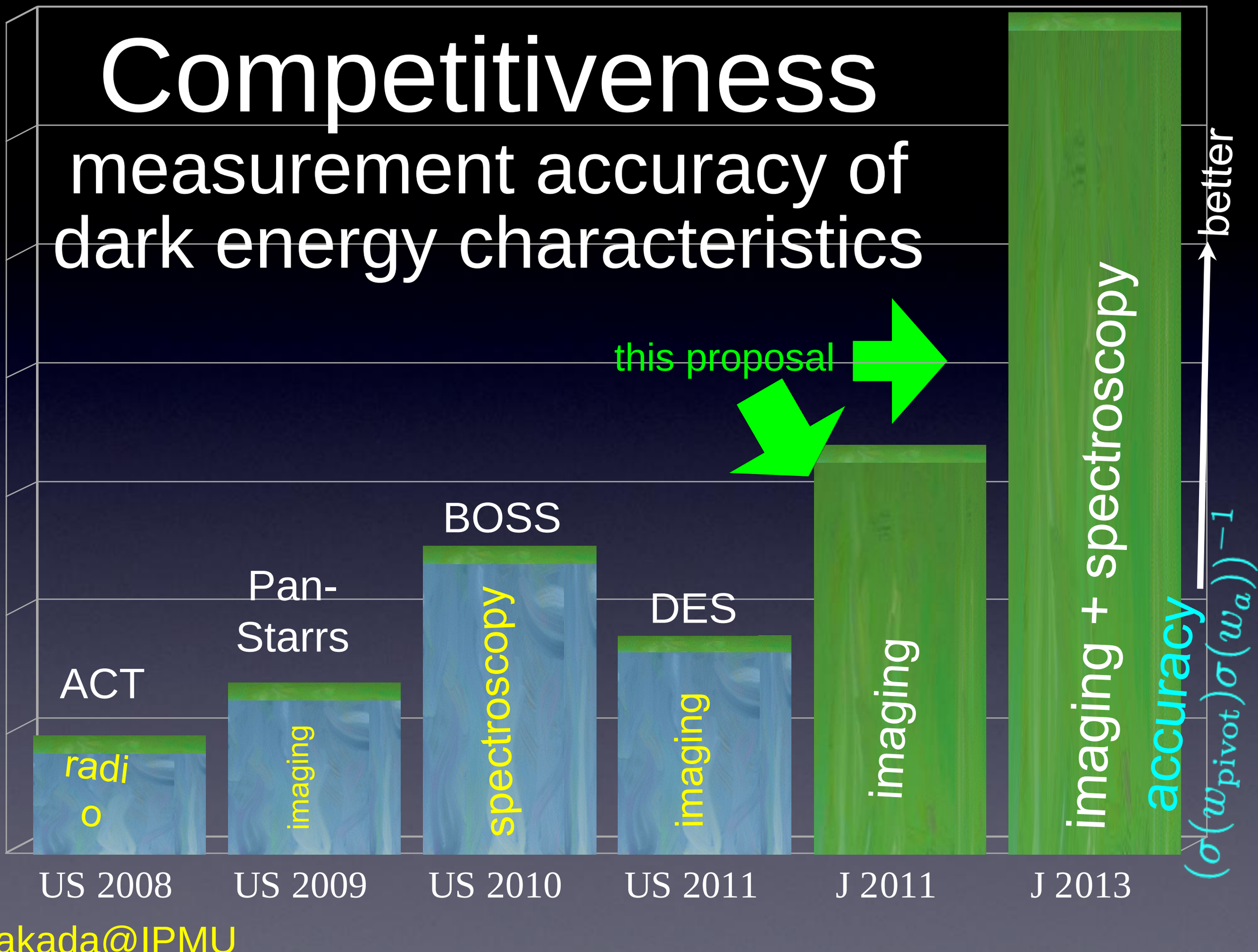
HSC



PFS

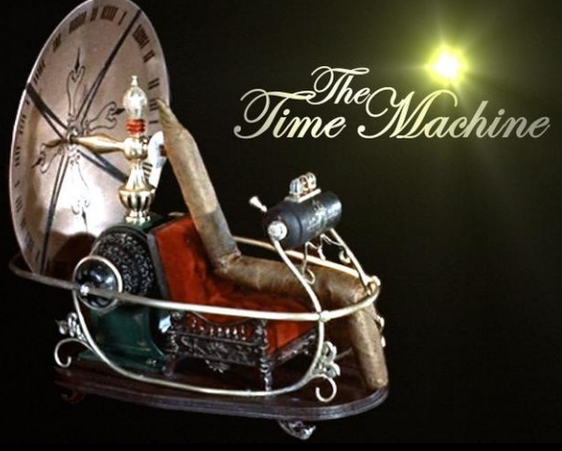
Competitiveness

measurement accuracy of dark energy characteristics



Takada@IPMU

The Origin

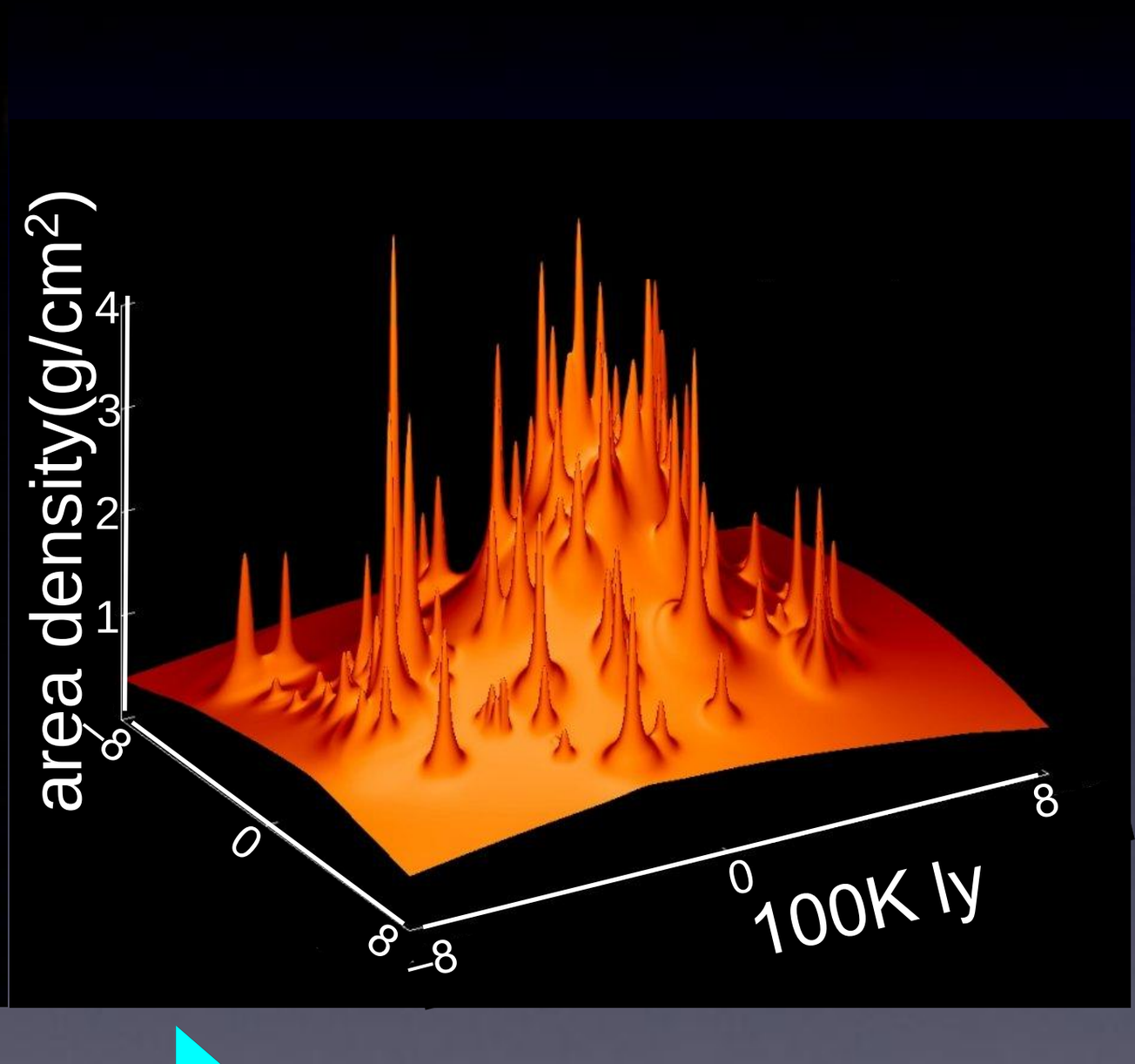


- speed of light is finite
- look far = look into past
- map at the farthest region of the Universe ⇒ origin and evolution history of the Universe
  - the skeleton is invisible dark matter, 80% of matter
  - but we can build maps of dark matter: imaging and spectroscopy

cosmic genome project

SuMIRe=Subaru Measurement of Images and Redshifts

maps of dark matter

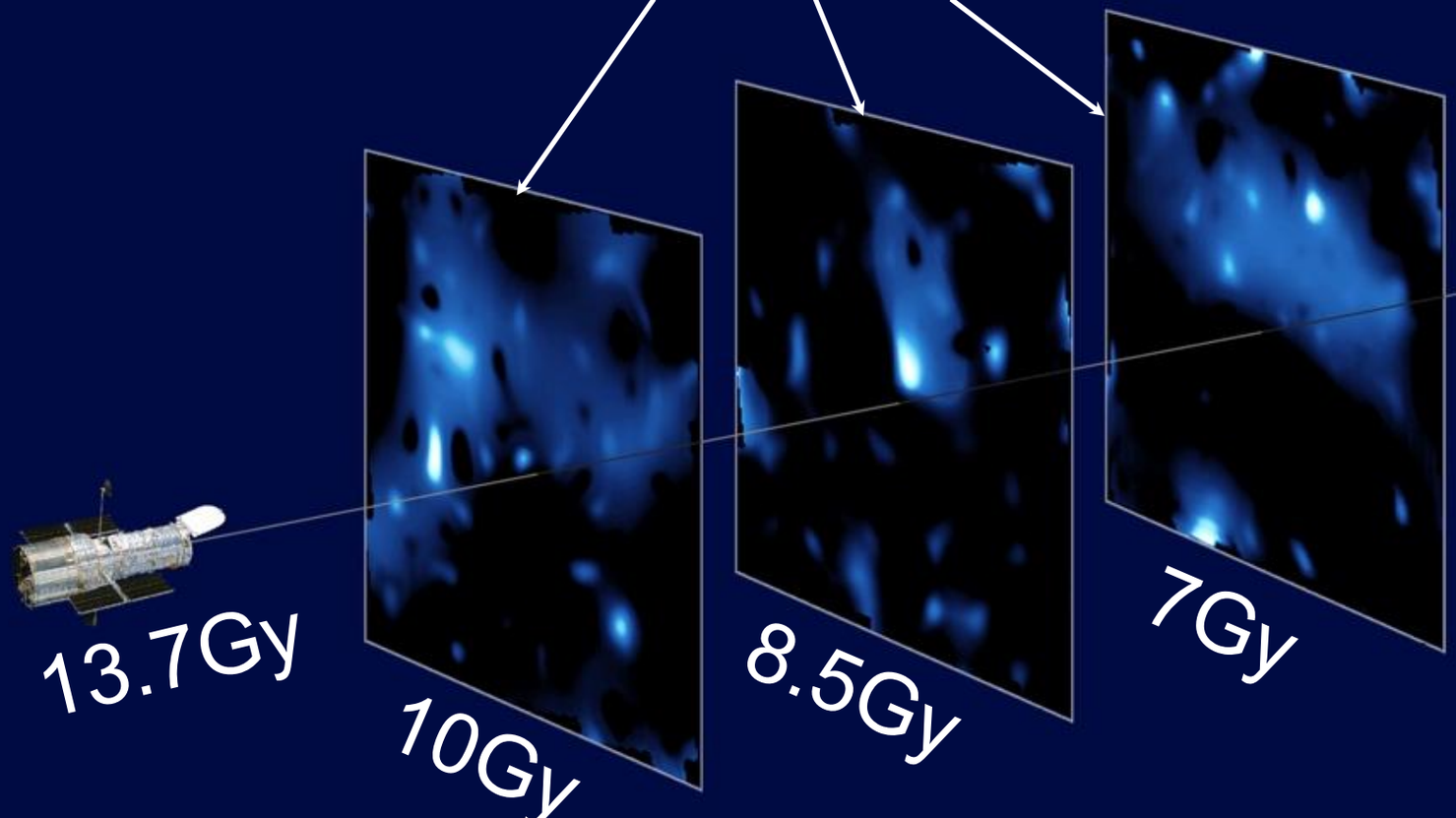


distortion in images of BG galaxies → 2D map of dark matter

3D map using depth information from spectroscopy

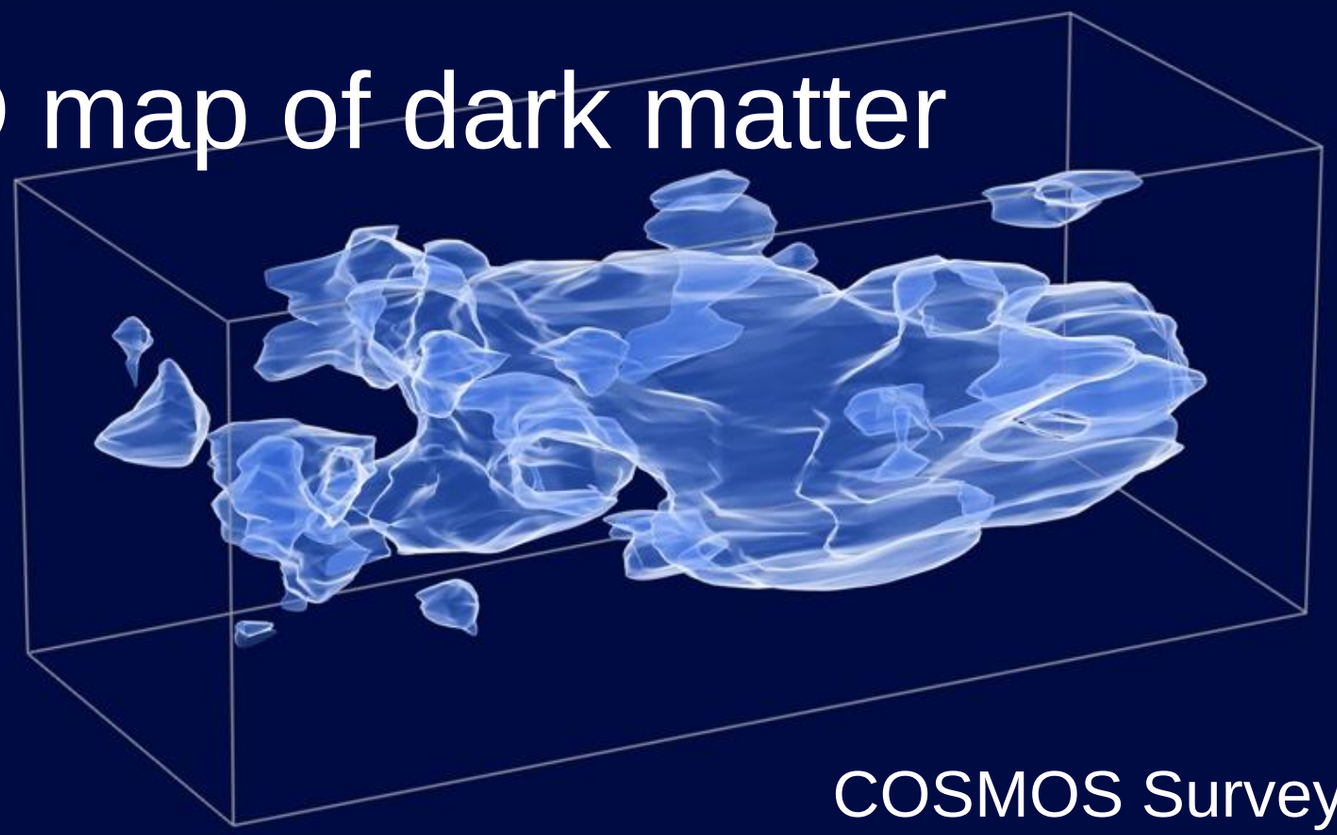
Current best
Hubble Space Telescope
too narrow, too shallow

to shallow to see the evolution effects



too narrow to see
large-scale structure
1.8 sq. dg

3D map of dark matter



COSMOS Survey

Yoshida@IPMU

can clearly see the evolution of structure

2.2Gy

3.4Gy

6Gy

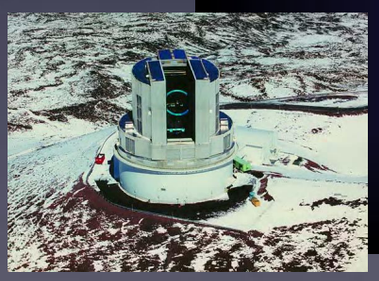
13.7Gy

Big Bang!

deep & wide
⇒world leader!

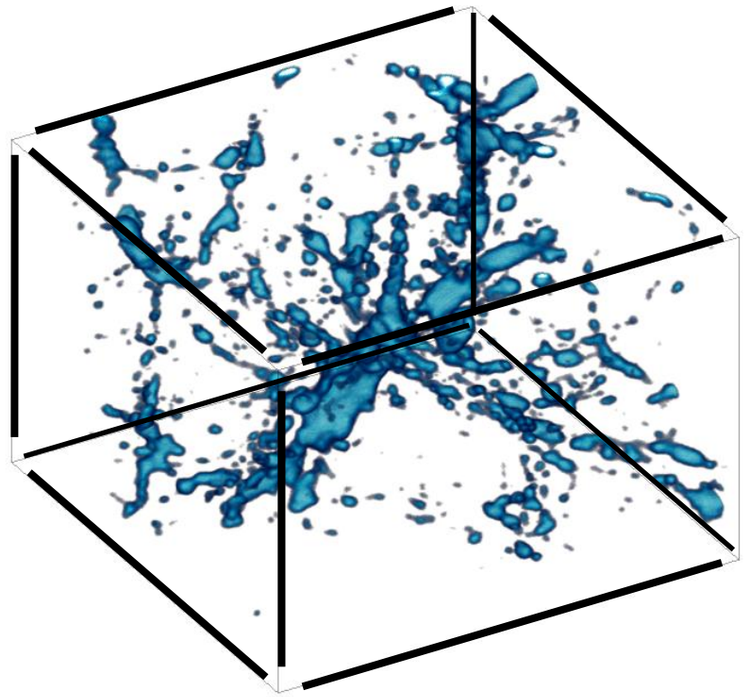
wide: 2000 sq. dg
>1000 x HST

wide enough to see
large scale structure



can prove that Universe was
very featureless early on, and
structure grew gradually
thanks to dark matter

3D map of dark matte



Only Subaru can approach the Origin this well
thanks to its 8.2m diameter and wide field

Today

- Revised proposal submitted on Dec 15, ’09
- sent to mail reviews
- funding starts Mar 1, 2010 (tentative)

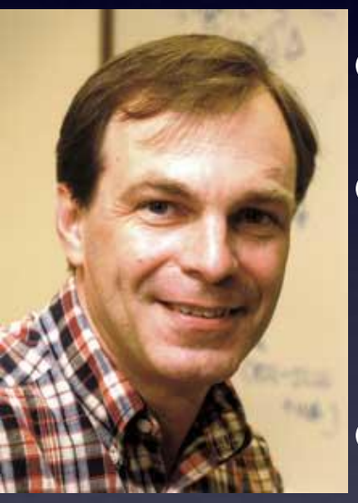
- Cap: $55M, *including* 20% overhead $1=¥90
- maximum buying power: $46M
- average for chosen 30: $31M
- To complete HSC, we need $27M more

Where are we?

pessimistic scenario

- *average* funding among 30: $37M
- Maximum buying power: $31M
- completion of HSC: –$27M
- leaving: $4M
- R&D funding for spectrograph?

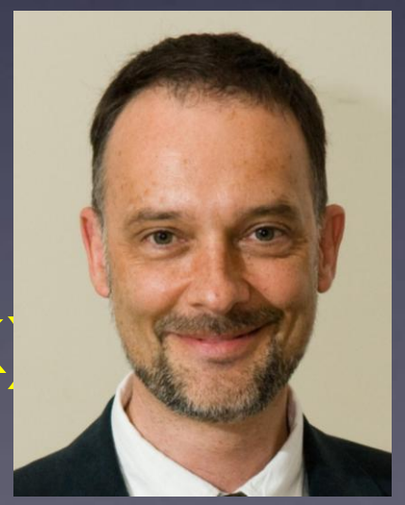
optimistic scenario



- income
- direct cost: +$46M
- final installment from Princeton: +$3M
- NAOJ: +$5M
- Caltech multi-fiber positioner: +$11M
- “boost”: +$4M
- total +$69M

- expense
- completion of HSC and
- Subaru retrofit: –$27M
- total cost for
- “WFMOS”: –$60M
- total: –$87M

- We are still short
- by –$18M
- more international
- partners? (*e.g.* UK)
- other savings?



- SC
- sible
- artners
- s

maximizing the chance

- the revised proposal states:
  - we *will* complete HSC and produce science
  - we *would love* to lead PFS in collaboration with other institutions
  - other possible (cheaper) designs?
- How can I make a credible case?

Japanese style

- Rather little engineering and manufacturing expertise at Universities, NAOJ
- work with companies
  - amazingly reliable
  - Mitsubishi Electric practically built Subaru
  - expensive? Comparable to JPL?
- so far no good candidate to lead spectrograph design & construction

summary of the status

- FIRST funding:
  - 14.5 M$ for the construction
  - ~ M$ of overhead
    - Caltech/JPL proposal for positioner
    - Marseille proposes to build spectrograph
- Community endorsed (need to be re-confirmed)