

- Part I: General scheme of Subaru observing time and SSP
- Part II: SSP plan with FMOS

Part 1

Subaru Strategic Programme

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Oxford

Observing time category with FMOS

- GTO (20 nights for FMOS builders)
- General open use
 - normal program: up to 5 nights
 - Intensive Program (IP):
up to 20 nights/several semesters
(max 10 nights/semester)
- Subaru Strategic Program (SSP): 100-300 nights/3-5 years (max 59 nights/year)

TAC chooses

- normal program: up to 5 nights
- Intensive Program (IP): up to 20 nights/several semesters (max 10 nights/semester)

SAC (+alpha) chooses

- Subaru Strategic Program (SSP):
100-300 nights/3-5 years (max 59 nights/year)

SSP scheme

- 100-300 nights / 3-5 years (up to 59 nights / year)
- SSP must be all Japan scheme (can include foreign researchers)
- SAC chooses a program with consultant with TAC (and experts?)
- Midterm review will be made
- PI cannot propose other observations to Subaru
- Co-PI should be in Hawaii
- 1-2 PDF class persons should be in Hawaii to reduce/analysis data etc in addition to Co-PI (at least one person)
- Subaru employs 1 PDF
- Need to proceed under close communications with Subaru observatory (in particular director)

The 1st SSP: SEEDS

HiCIAO + AO188

- Extrasolar-planet search 16nightsx5yrs
proto-planetary disk search 8nightsx5yrs
=> totaling 120 nights
- A large consortium consisting with many sub-groups (about 100? people including foreign researchers)
- Starting under/with test observations
- Will be checked 2 yrs after start

SSP selection process

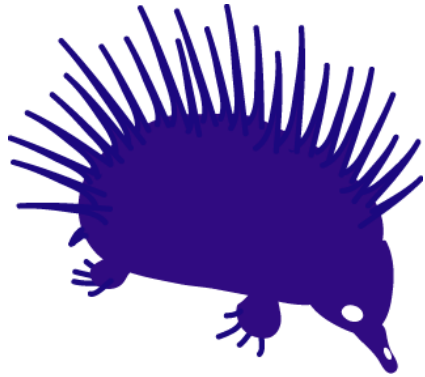
- The case for SEEDS (not necessarily exactly the same as this)
- Call for SSP, based on contact from PI to director?
- Submit Proposal (~10 pages in English) including
 - scientific cases of the program
 - why SSP
 - instrument to be used
 - required nights and seasons
 - plan for making consortium to achieve the goals
 - plan for data reduction and analysis
 - policy for public data release
- First review by SAC+ \Rightarrow interim acceptance (or rejection)
- Evaluation by TAC + external referees?
- Enlarging the consortium (call for joining) and preparations at the observatory
- Re-review/evaluation
- Final proposal
- Final decision by SAC

When FMOS is open for ...?

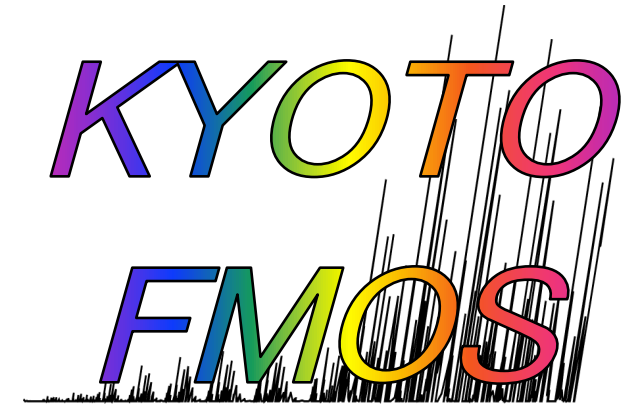
- general open use :
S10A(2010.Feb-2010.Jul)
earliest case, risk share mode
(one spectrograph and/or
with low-resolution mode ?)
- GTO cannot start before open use
- SSP/IP is expected not to start under risk share mode

Facts to be considered

- SEEDS SSP runs in S09B、S10、S11、S12、S13 =>upper limit is $59 - 24 = 35$ nights per year
- Telescope down time due to alminizing of primary mirror etc (2.5 months in S10AB; summer season?)
- Down time due to Hyper-SCam construction (5.5? months in S11AB?)
- SSP with Hyper-SCam in near future?



Part II



Subaru Strategic Program with FMOS

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2009.06.22
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Brief history of FMOS WSs

- 1997 FMOS WS1 (general use/promotion)
- 1999 FMOS WS2 (general use/promotion)
- 2004 FMOS WS with UK astronomers in Kyoto
~25 Japan + 10 UK/Australia/
(general use/promotion)
- 2006Jan FMOS Extended GTO WS1
- 2006Jul FMOS Extended GTO WS2
Extended GTO (max 50 including GTO) => SSP
- 2008Sep FMOS SSP WS1
- 2009May FMOS SSP WS2

FMOS consortium in Japan

- 30-40? Japanese
- Members

FMOS builder team

Iwamuro, Akiyama, **Tamura**, Kimura, Takato, Maihara, **Ohta** and a few grad students

+

Yamada, Arimoto, **Kodama**, Shimasaku, Motohara, Sekiguchi, Iwata, Nagao, Hanami, Ouchi, Matsuda, and their grad students and postdocs (galaxy oriented)
Totani, **Matsubara**, and **a grad student** (cosmology oriented)

Scientific interests in Japan

galaxy evolution

- revealing evolution of galaxies at $z=1-3$
 - epoch of violent galaxy evolution!
 - formation of ellipticals (red seq galaxies)
 - formation of disk galaxies
 - star formation and obscured star formation
 - metallicity evolution
 - relation to AGN/QSOs
 - emergence of Hubble sequence, etc

- current approaches

sBzK, pBzK, DRG, ERO, SMG, LBG(BM/BX), LAE, LAB,,,

=> measuring redshift, SFR, metallicity, reddening, clustering for each population

=> Relations of TLAs are not clear

Scientific interests in Japan

galaxy evolution: core unbiased survey

- next step
 - revealing whole population of galaxies at the redshifts
 - knowing relationships of various TLAs
 - with FMOS capability to the redshift desert
- need to make an unbiased survey
 - not based on color selection
 - => magnitude limit survey

Scientific interests in Japan

galaxy evolution: extension survey

- Unbiased mag limit survey cannot cover various parameter spaces in terms of galaxy evolution

e.g.,

- environment dependence
 - evolution in clusters, overdensity regions
- Relationships to higher/lower redshift galaxies
 - search for pop III galaxies (LAEs at $z \sim 6$)
HeII1640, CIV at $z \sim 6$
 - star formation history at $z = 0.5-2$
SFR(H α), metallicity,,,

=> need to extend parameter spaces (eigen vectors)

to denser regions

to lower- and higher-redshifts

to another direction of eigen vector?

Scientific interests in Japan

AGN/QSO evolution

- revealing obscured AGN population at $z=1-3$
red AGN/QSO, optically faint AGN
- cosmic mass accretion history (SMBH evolution)
- cosmic co-evolution of SMBHs and galaxies
- hosts of AGNs and non-AGN galaxies
- AGN/QSO observations are expected to be covered by galaxy evolution surveys (lower number densities of targets)
- can co-exist with galaxy evolution survey

Scientific interests in Japan

cosmology: wide survey

- probing dark energy with BAO and power spectrum of SF galaxies at $z \sim 1$
 - Constrain w and dw/dz
 - Much wider survey fields with shorter exposure time are required
- => cannot co-exist with galaxy evolution surveys

SSP plan with FMOS

FMOS wide survey

aiming at making BAO detection / power spectrum at $z \sim 1$
 $\sim 200 \text{ deg}^2$, $\sim 3\sigma$ detection of BAO, 200 nights
plan will be presented by Totani

FMOS deep survey

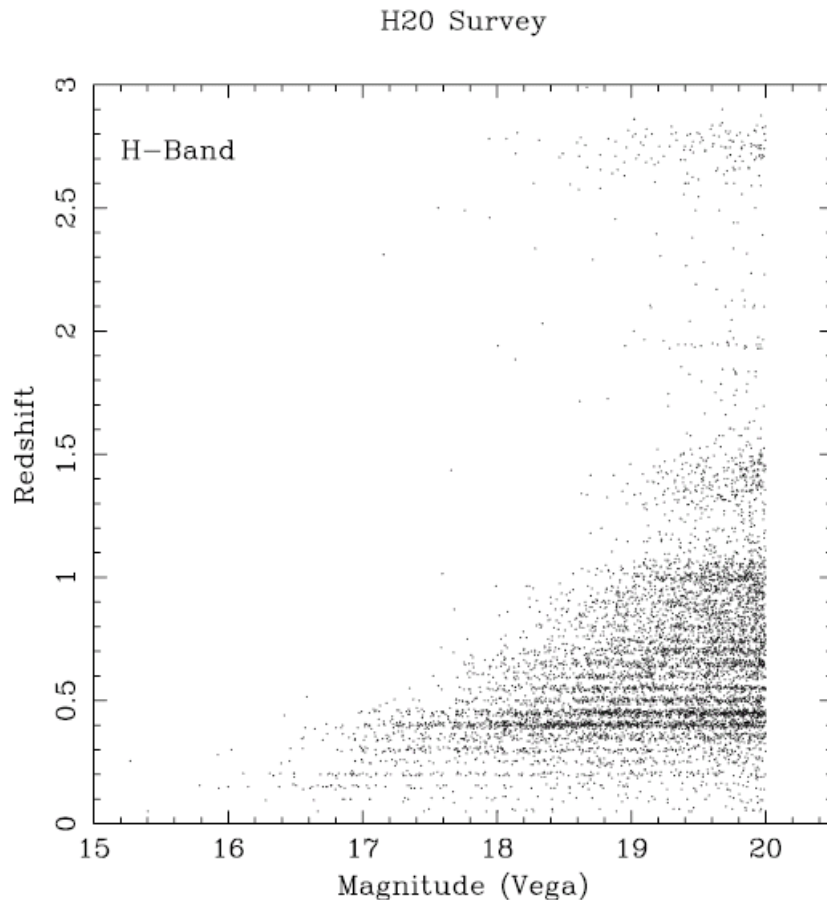
aiming at making galaxy and AGN evolution studies

- 5 FoVs magnitude limit unbiased survey, 60 nights
plan will be presented below
- extended parameter space survey (biased survey), 20-40? nights
plan will be presented by Kodama / Tamura

H20: A large magnitude limit NIR spectroscopic survey

- Why H=20 mag?
 - ⇒ Galaxies with $L > L^*$ ($L > 4L^*$) at $z \sim 2$
 - ⇒ Spectroscopy is made in zJH band and H covers the longest λ
 - K-selection may be better to cover longer wavelength, but it is not covered by FMOS and a certain fraction of red objects can not be observed...
 - ⇒ reasonable size of survey time
 - H21 survey seems to be faint for a realistic large survey

How many galaxies in one FoV within H=20?

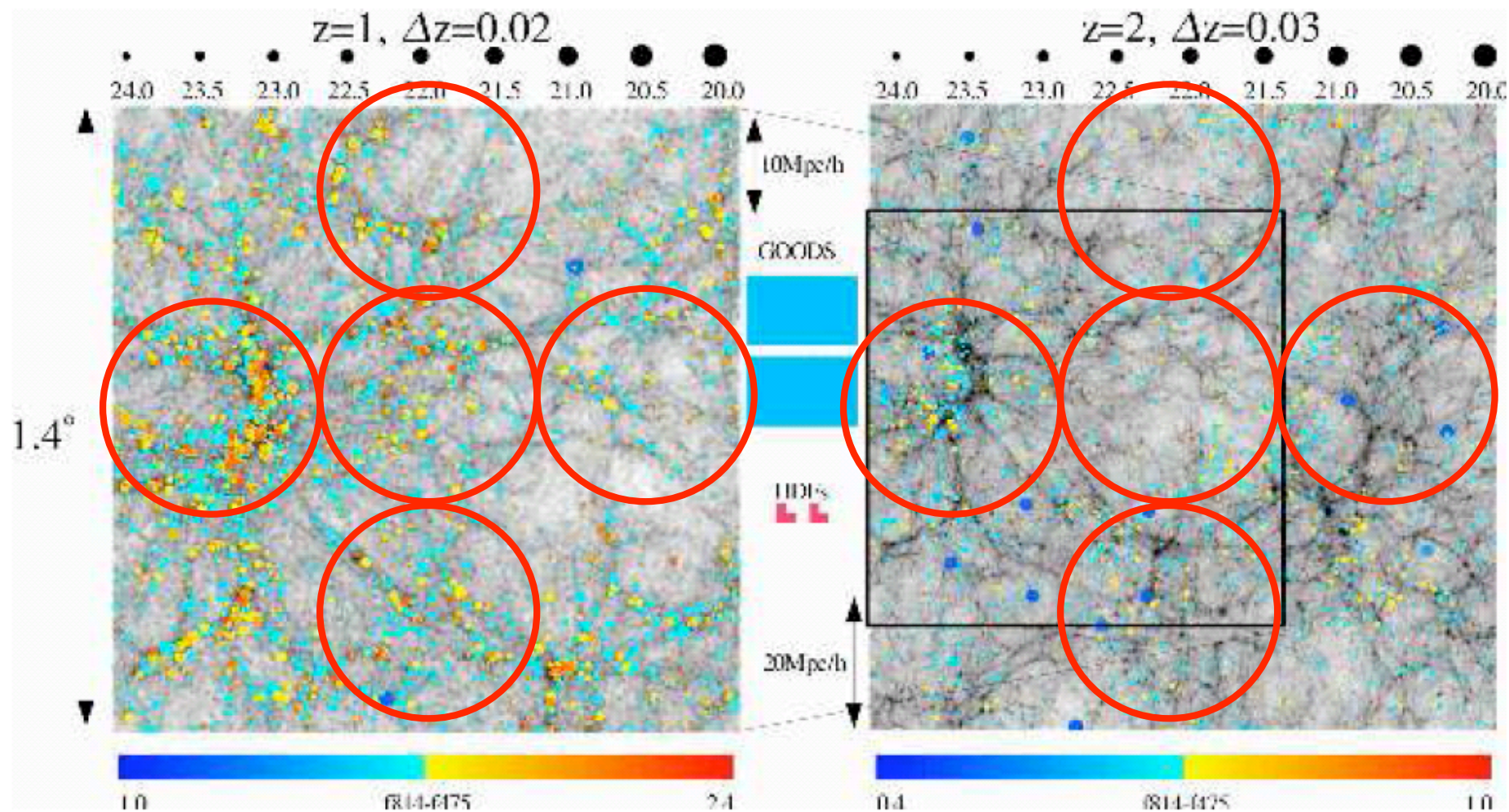


- $0.0 < z_{\text{ph}} < 0.5$ 1400-1500 / fov
 - $0.5 < z_{\text{ph}} < 1.0$ 1300-1600 / fov
 - $1.0 < z_{\text{ph}} < 1.5$ 330-710 / fov
 - $1.5 < z_{\text{ph}} < 2.0$ 75(+/-20) / fov
 - $2.0 < z_{\text{ph}} < 2.5$ 54 / fov
- (Firth et al. MN 332, 617 (2002) + Yabe (GOOS-N))

- If we take all, $\sim 3000/\text{FoV}$
- $z > 0.5$, 1500-1600/FoV
- $z > 1.0$, 450-850/FoV
- $z > 1.5$, 130/FoV

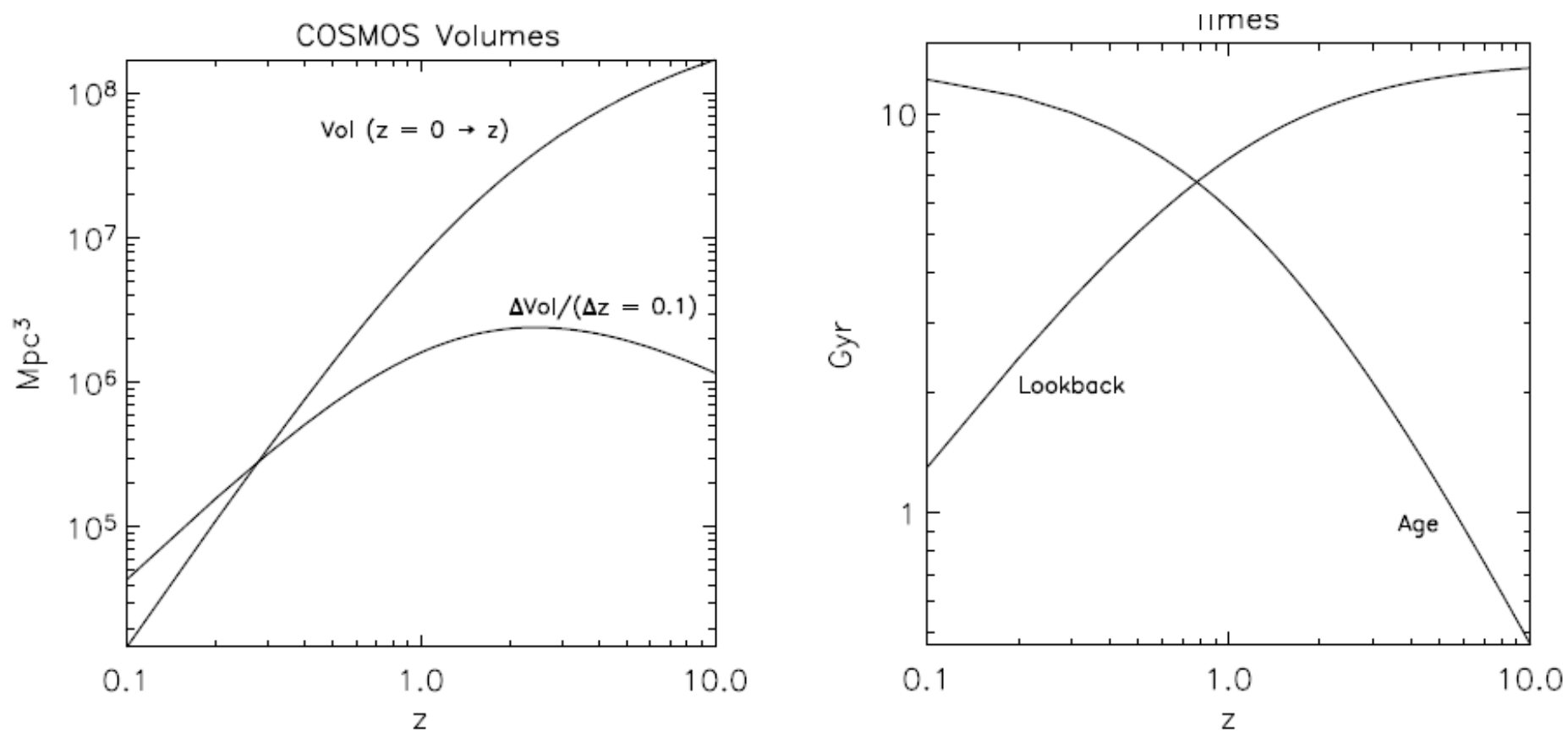
500-600 $z > 1.5$ would be necessary,
If we examine e.g., LF/SMF with
4 (e.g., red, blue; higher/lower- z) panels,
in each panel 5 data points,
20-30 gals in one point, leading S/N ~ 5
 \Rightarrow at least 5 FoVs

5FoVs of FMOS cover ...



50Mpc depth

Scoville et al. ApJS 172, 1 (2007)



1 FMOS FoV : 1/10 of COSMOS
5 FMOS FoVs: 1/2 of COSMOS

How many galaxies in 5FoVs?

- If we take all, $\sim 15,000$
 - $z > 0.5$, 7,500-8,000
 - $z > 1.0$, 2,250-4,250
 - $z > 1.5$, 650
-
- How many TLAs within $H=20$?
 - $\sim 300 \times 5 = 1,500$ sBzKs
 - $\sim 30 \times 5 = 150$ pBzKs
 - $\sim 20 \times 5 = 100$ DRGs (in GOODS-N)
 - $\sim 60 \times 5 = 300$ unID X-ray sources (SXDS) (not $H < 20$)
 - $\sim 100 \times 5 = 500$ SMGs ($> 1-3$ mJy @ 1.1mm) (not $H < 20$)
 - $\sim 75 \times 5 = 375$ VLS sources (SXDS, within $H=20$ (but K-selected))

Expected Performance

SN=5 (/sp. element) with 1 hour-integration
(point source, seeing=0."6,
fibre=1."2 Φ , sec z=1.5)

Low resolution: J~20.9 mag, H~19.8 mag (Vega)

Observing time for unbiased survey

S/N of 10 for continuum is expected to be required to determine z , if no emission lines are seen.

To achieve S/N of ~ 10 , 5h exp is expected to be necessary for $H=20$, conservatively considering with scatter of throughput, unexpected effects, etc.

Cross beam switching (200 targets/shot) + tweak

15acq + [30exp+5twk]x5 + 15acq + [30exp+5twk]x5

On source time of 300min / obs time of 380 min = 0.79 (or 1.26)

380 min = 6.3 h \sim 1 night

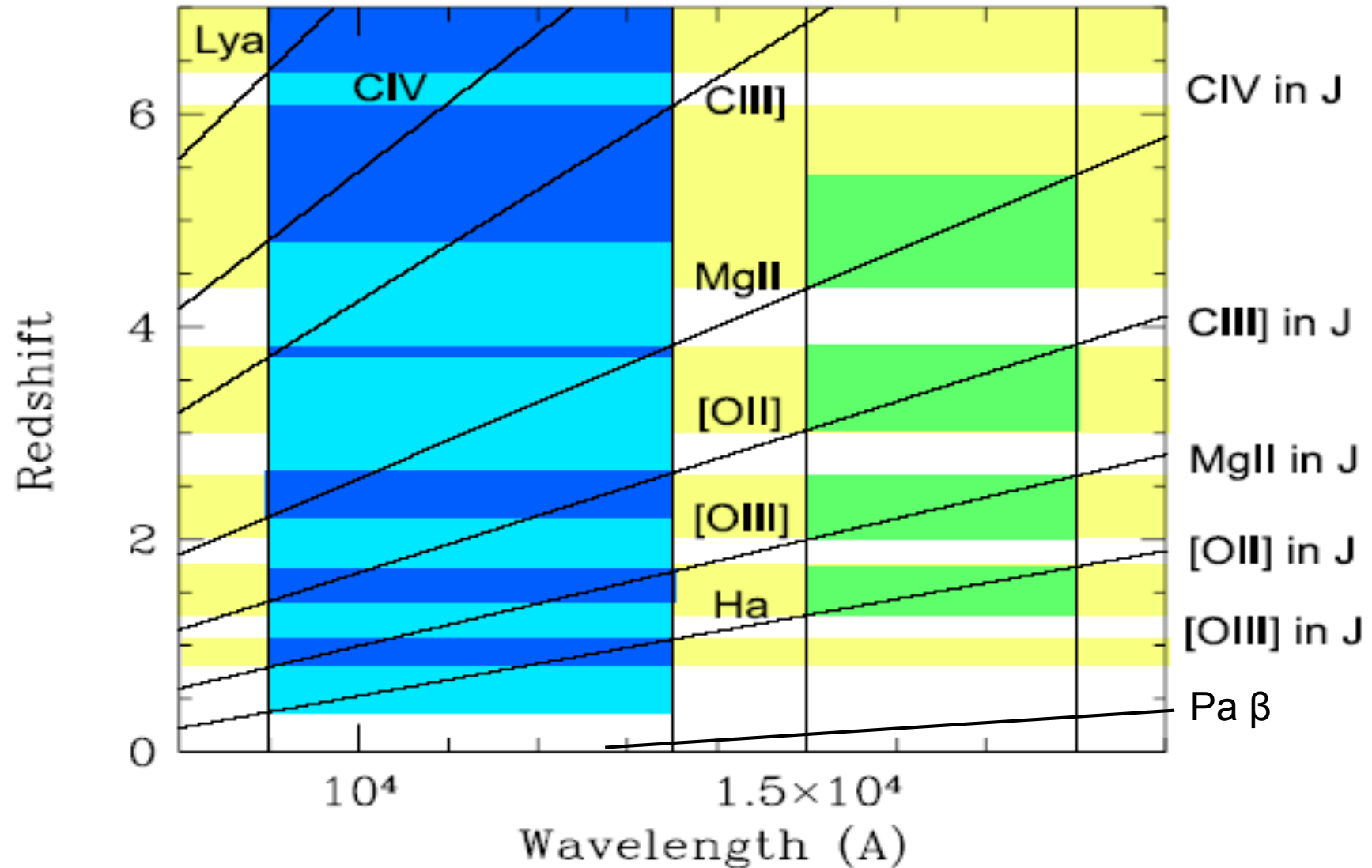
So effective on source of 5 h is expected in 1 night

3000 galaxies / FoV \Rightarrow 15 nights/FoV

75% clear nights \Rightarrow 20 nights/FoV

5 fovs \Rightarrow 100 nights!! \rightarrow too large

Major emission lines



H20 survey

- Let's take galaxies at $z_{\text{ph}} > 0.5$
 - => may cause some bias?
- Then we can study H α at $z=0.5-2$
- Number of galaxies is 1500-1600/FoV
about half size of all galaxy survey
- A plan
 - 1 FoV for all galaxies 20 nights
 - 4 FoVs for $z_{\text{ph}} > 0.5$ 40 nights
 - totaling 60 nights
- Fields
 - 3 FoVs in SXDS (including 1 all galaxies survey)
 - 1 FoV in COSMOS? (HST, but no H data)
 - 1 FoV in SDF? (GALEX, U, B data, half H data)

biased survey / extension survey

- Over density regions => Kodama's talk 10 nights
- Over density regions found in a wide area
=> Tamura's short presentation
- Higher-z LAEs / popIII galaxies
may require high-resolution mode
- How many nights? TBD

Field candidates

For *galaxy/AGN* evolution

- SXDS/UKIDSS UDS 2h -5d
- SDF (Subaru Deep Field) 13.5h 27.5d
- LH/UKIDSS DES 11h 57d => Tamura
- COSMOS 10h 2d
- ADF (Akari Deep Field aka NEP) 18h 66d
- SSA22 22h 0d => Kodama
- Clusters at $z=0.5-3$ => Kodama

For *BAO survey* => Totani

- Red Cluster Survey fields
- CFHT Legacy Survey fields

Summary:

Current plan of SSP with FMOS

FMOS wide survey

aiming at making BAO detection

~200 deg², ~3 σ detection of BAO, 200 nights

will be presented by Totani/Sumiyoshi

FMOS deep survey

core unbiased survey : H20

aiming at making galaxy and AGN evolution studies

5 FoVs magnitude limit unbiased survey, 60 nights

biased? extension survey

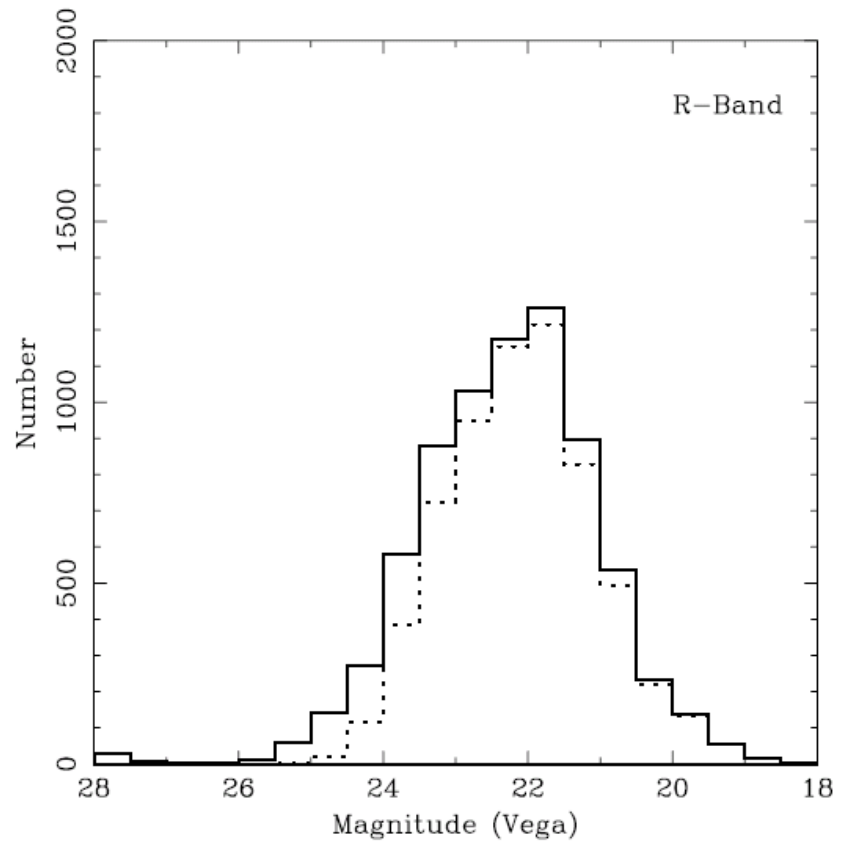
extended parameter space survey (biased survey), 20-40? nights

ideas will be presented by Kodama / Tamura

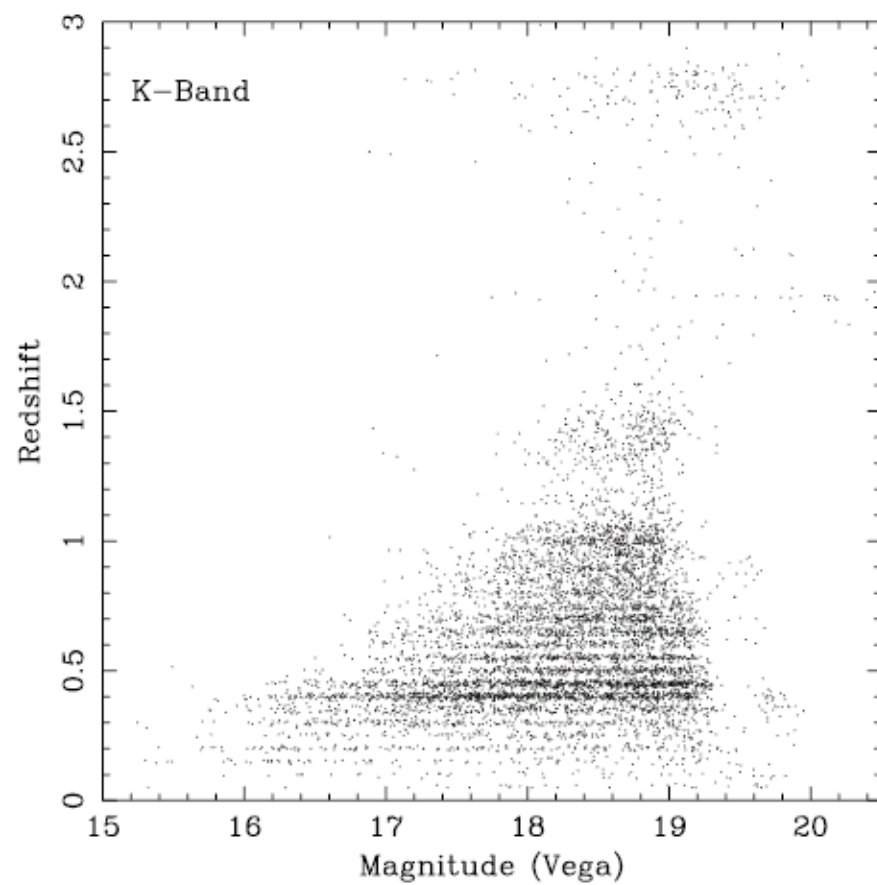
schedule

- If SSP starts in S10B (earliest case)
- Number of nights should be fixed in May
to allocate time for the semester
- Call for SSP in autumn (Oct? Nov?)
or
- Call for SSP in winter (Feb?)

H2O Survey



H2O Survey



K19 Survey

