Synergy between Wide Field Transient Survey and 3.8m Telescope

- 広視野サーベイと連携した3.8m望遠鏡による突発天体観測 -

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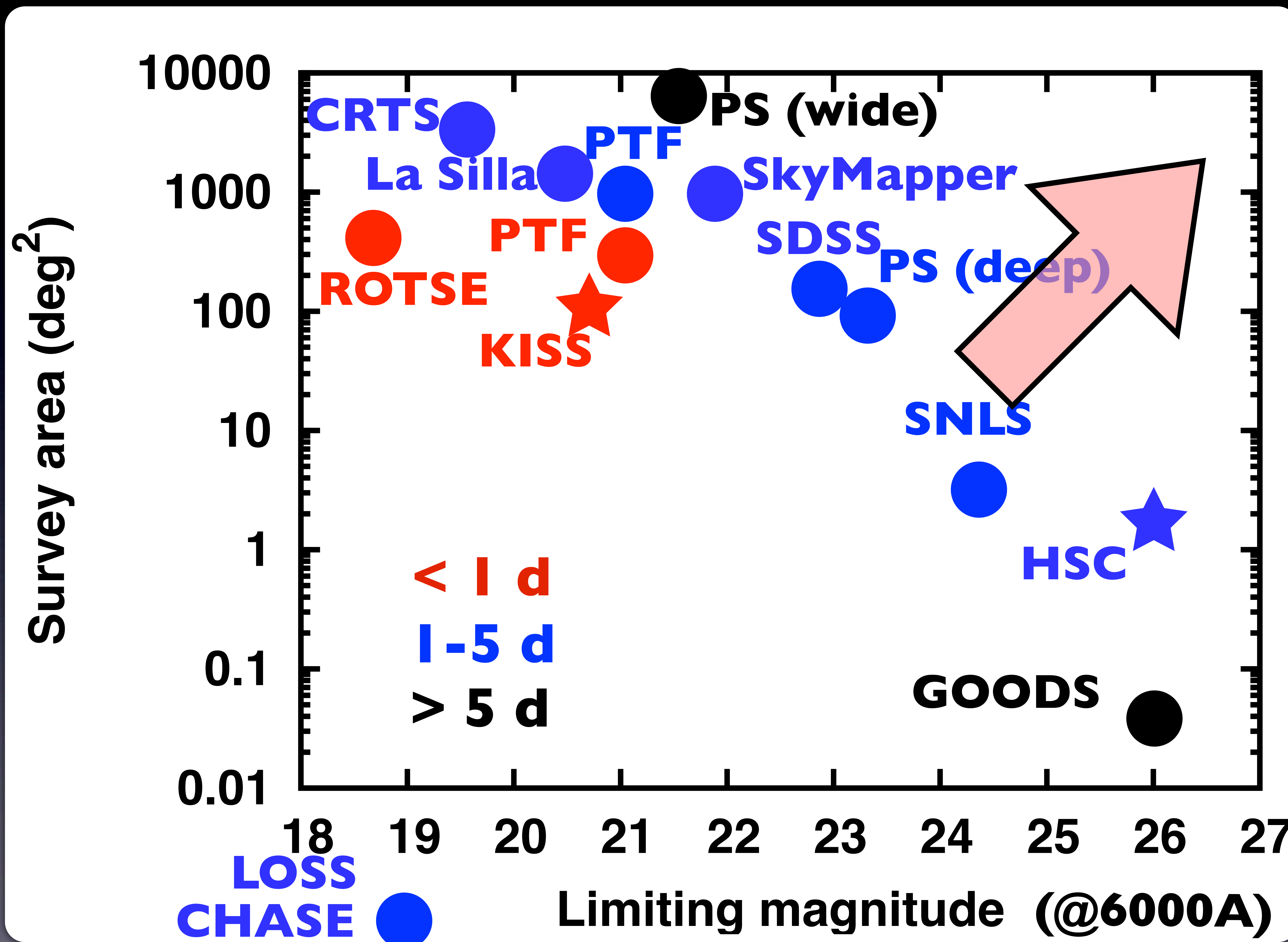
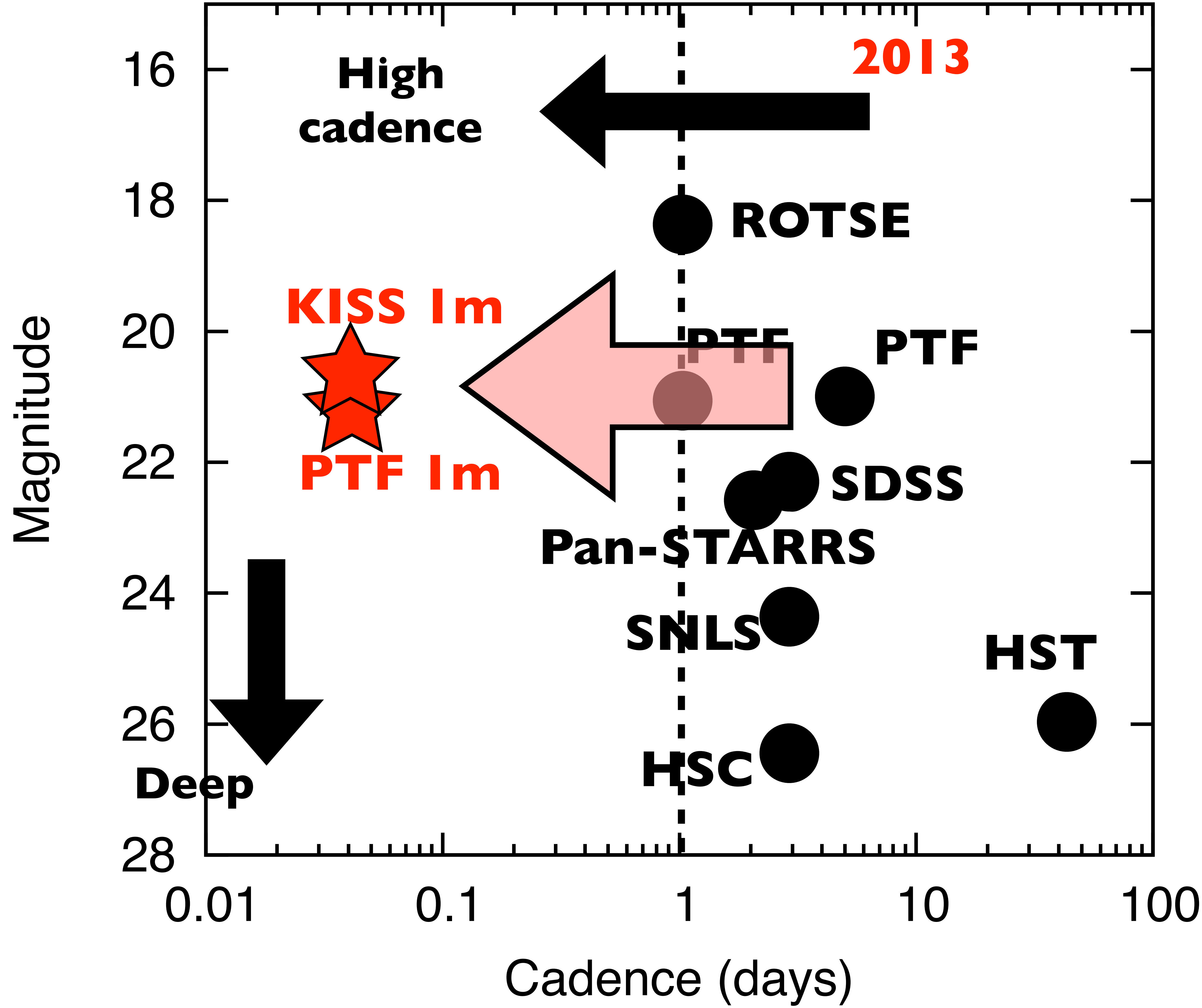
on behalf of KISS collaboration

- Synergy with High-Cadence Survey
- Synergy with Gravitational Astronomy

\- Low resolution spectrograph (ready to use anytime)
\- Flexible operation/instrument exchange


10000
1000
100
10
1
0.1
0.01
18
19
20
21
22
23
24
25
26
27
Survey area (deg^2)
Limiting magnitude (@6000A)
CRTS
La Silla
PTF
PS (wide)
SkyMapper
SDSS
PS (deep)
PTF
ROTSE
KISS
SNLS
HSC
GOODS
< 1 d
1-5 d
> 5 d
LOSS
CHASE


2013
High cadence
ROTSE
KISS 1m
PTF
PTF
PTF 1m
SDSS
Pan-STARRS
SNLS
HST
HSC
Deep
Magnitude
16
18
20
22
24
26
28
0.01
0.1
1
10
100
Cadence (days)

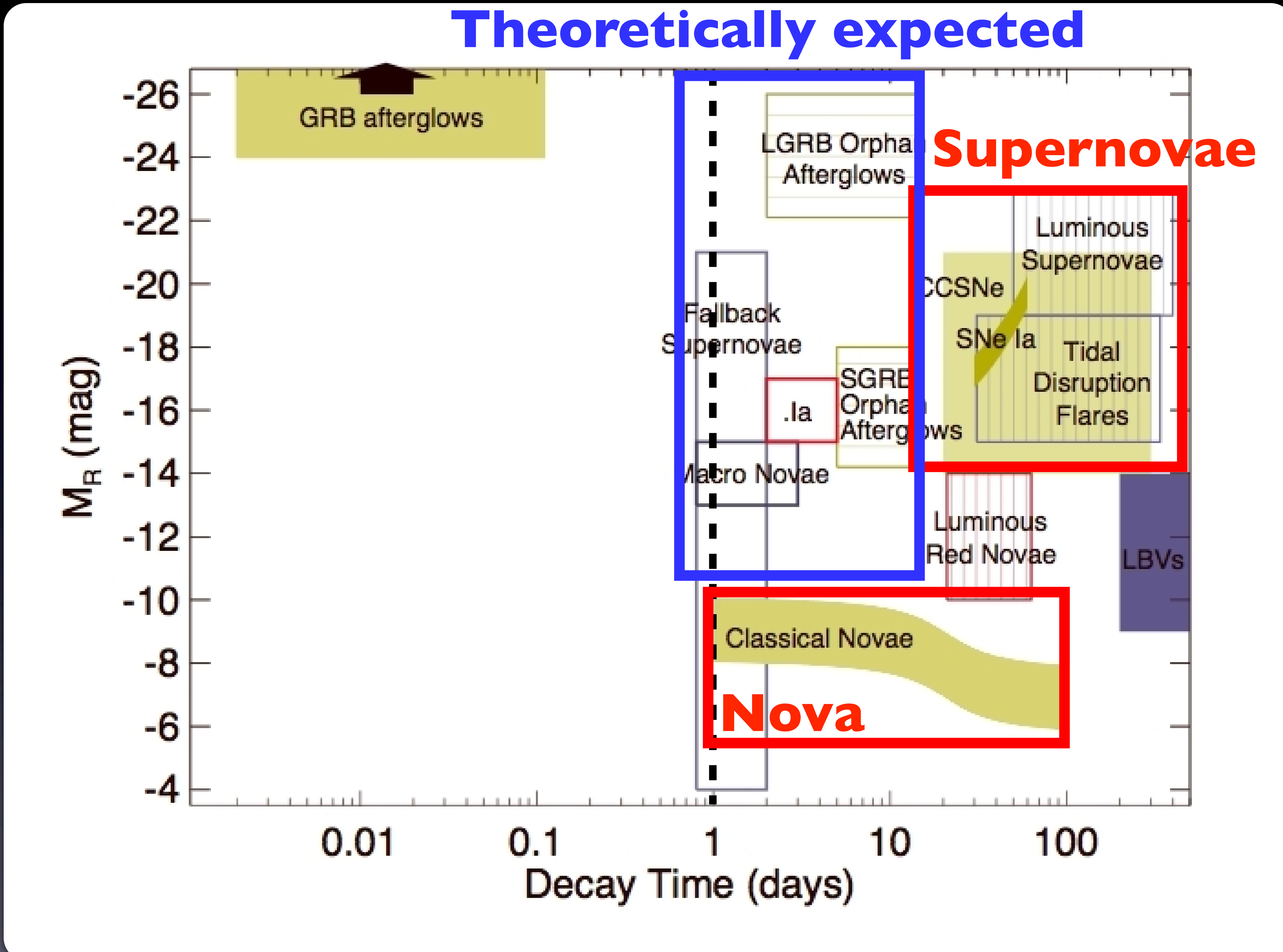


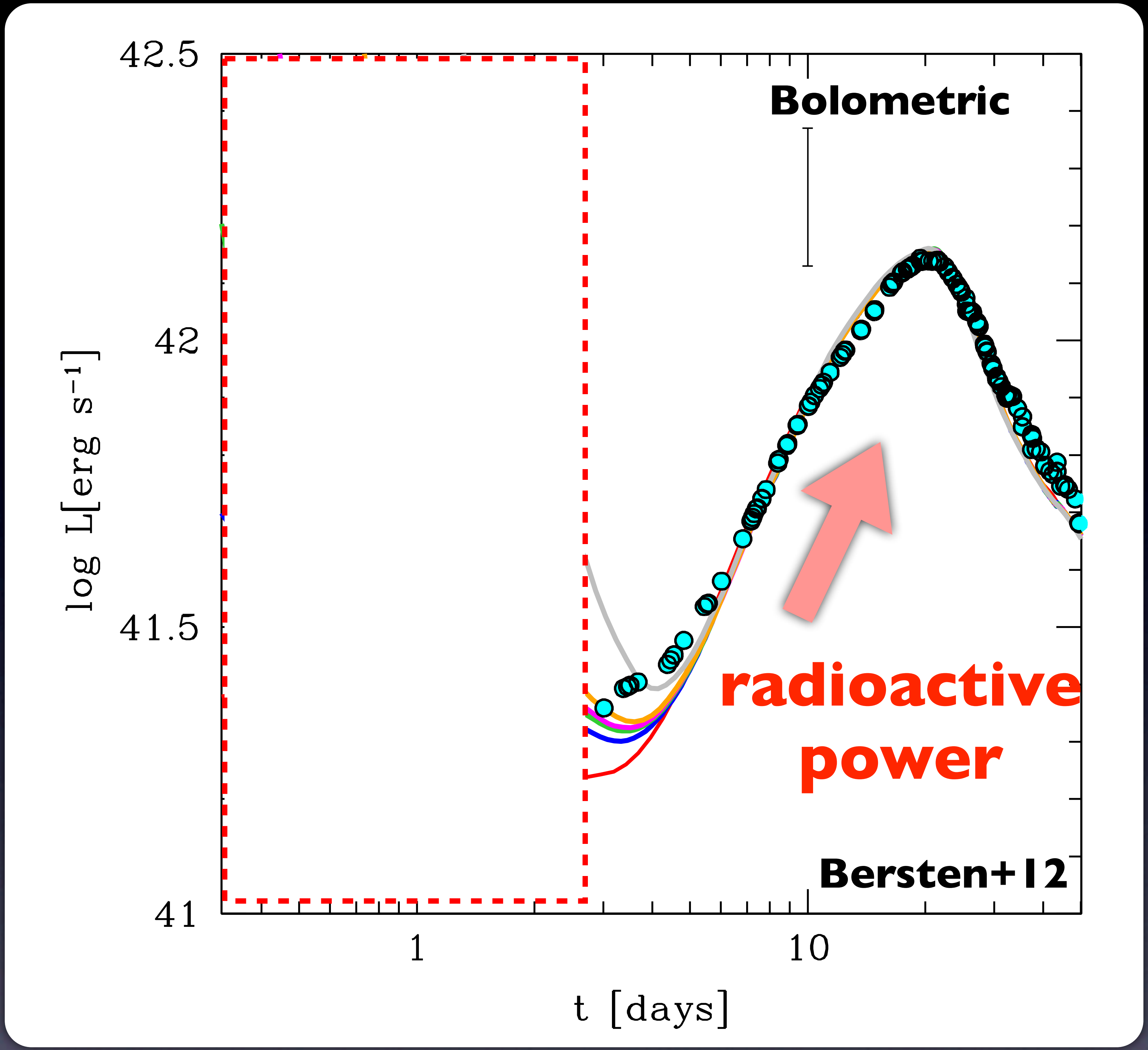
Figure from LSST Science Book
(after PTF collaboration, Rau+09, Kasliwal+,Kulkarni+)

KISS: Kiso Supernova Survey

- Extremely high cadence
  - 1-hr cadence <= 2-3 days
  - 4 deg^2 FOV (KWFC)
  - ~ 20-21 mag in g-band (3 min exposure)
  - ~50-100 deg^2 /day (SDSS fields, high SFR)
  - ~100 nights /yr
  - Automatic data reduction

Kiso 1.05m Schmidt telescope

Goal: Detection of shock breakout of supernovae

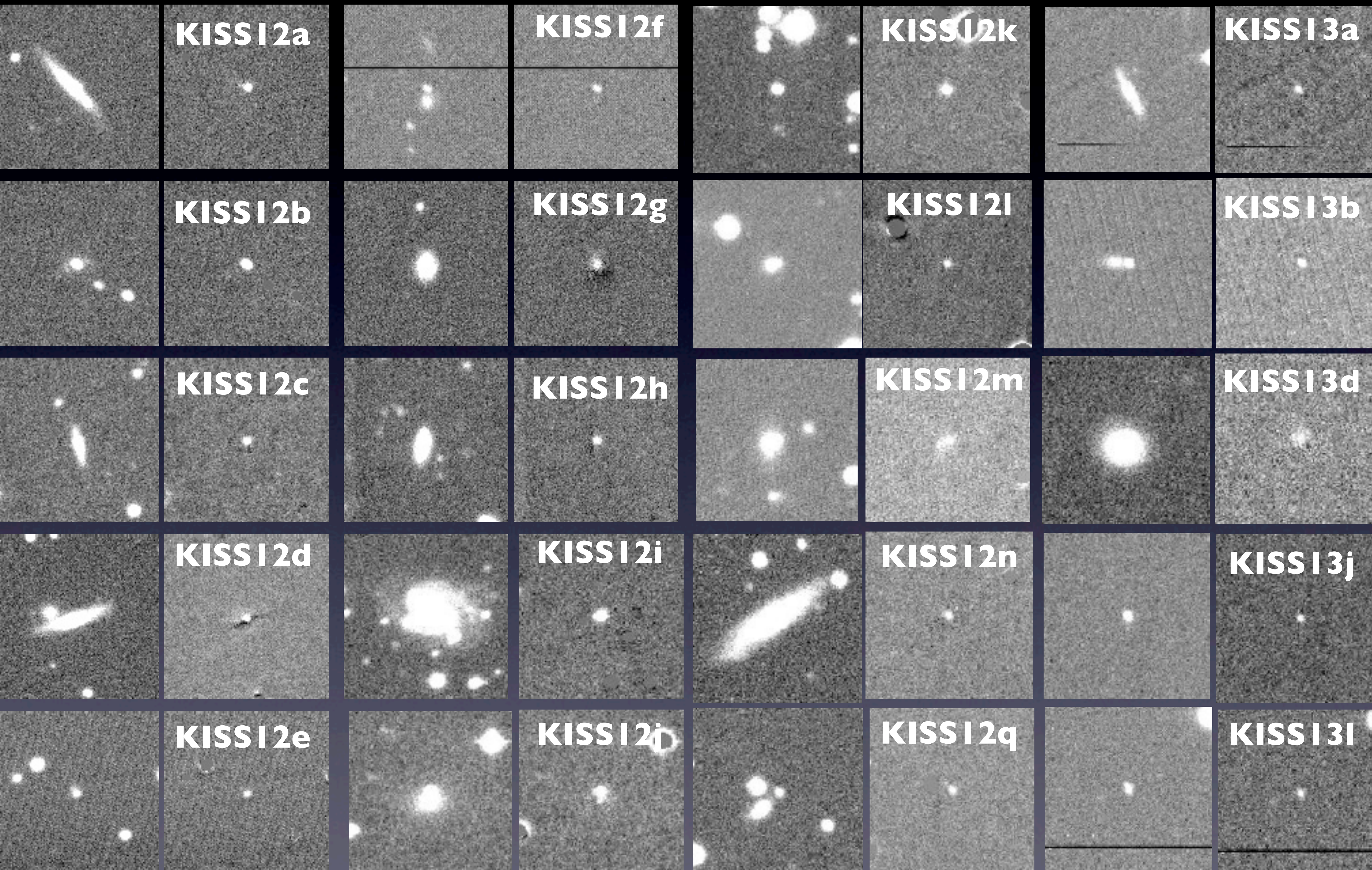


The 1st day of the SN = memory of stellar radius

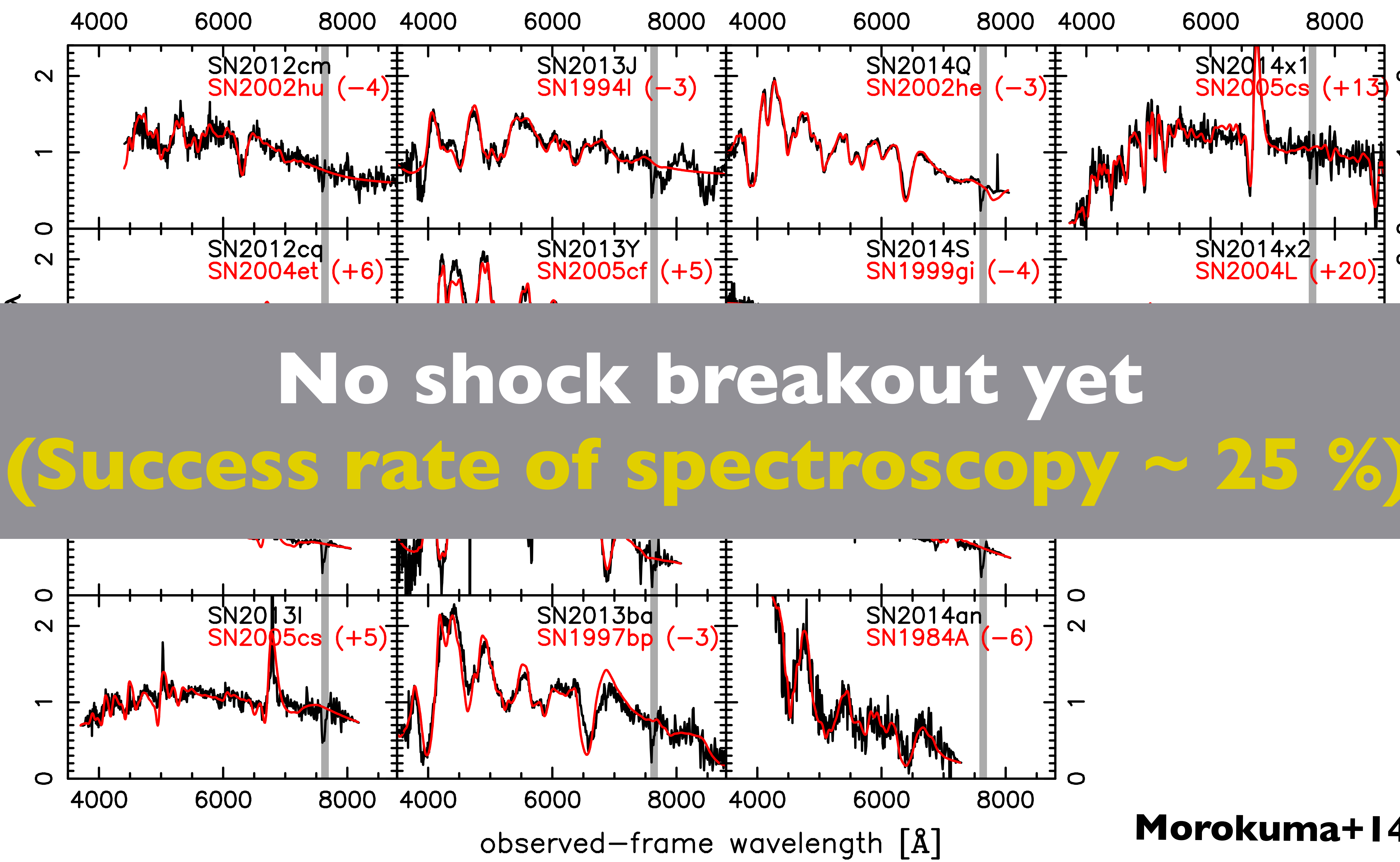
Connection between stellar evolution and SN

(Talks by Yamanaka-san and Maeda-san)

~80 SN candidates (as of 2014 May)



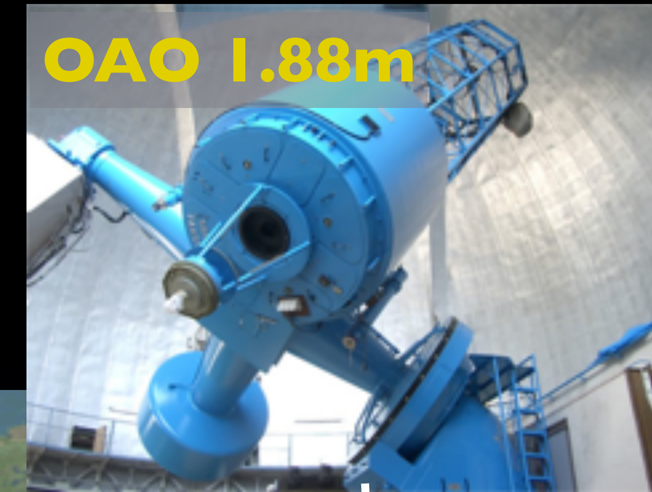
Follow up spectroscopy



No shock breakout yet

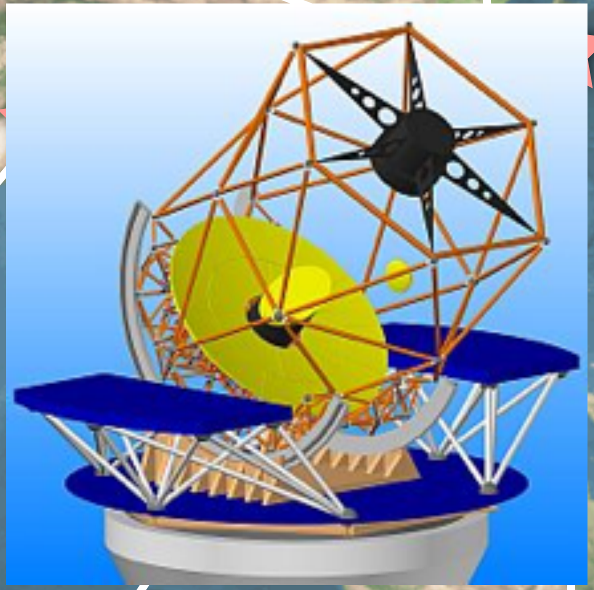
(Success rate of spectroscopy ~ 25 %)

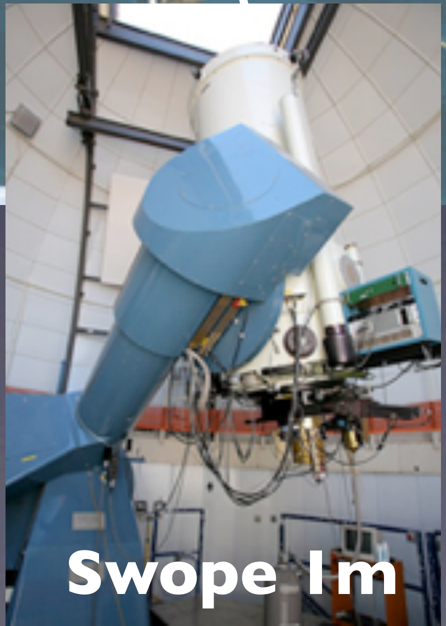
Morokuma+14

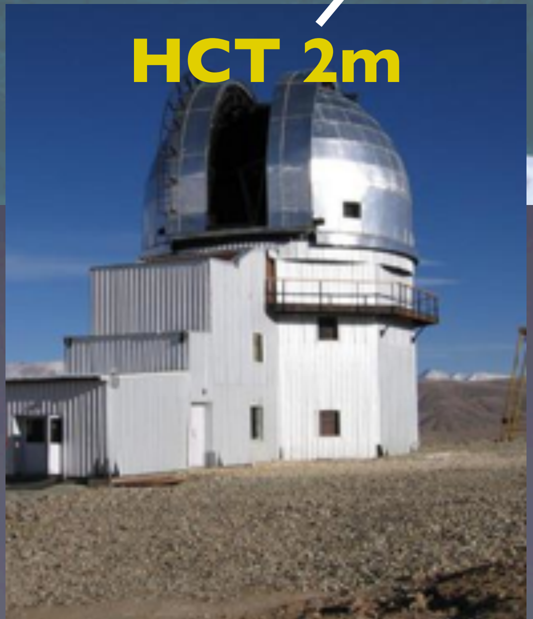


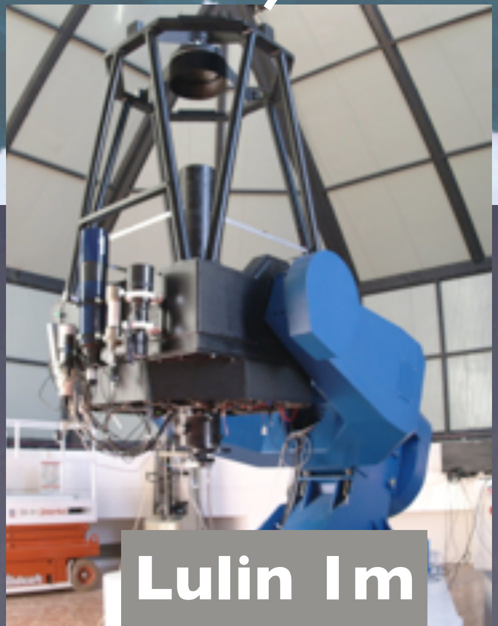
Follow up with 3.8m telescope

Spectroscopy with R ~ 500
for 20-21 mag
(rapid response is a key)









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- Synergy with Gravitational Astronomy

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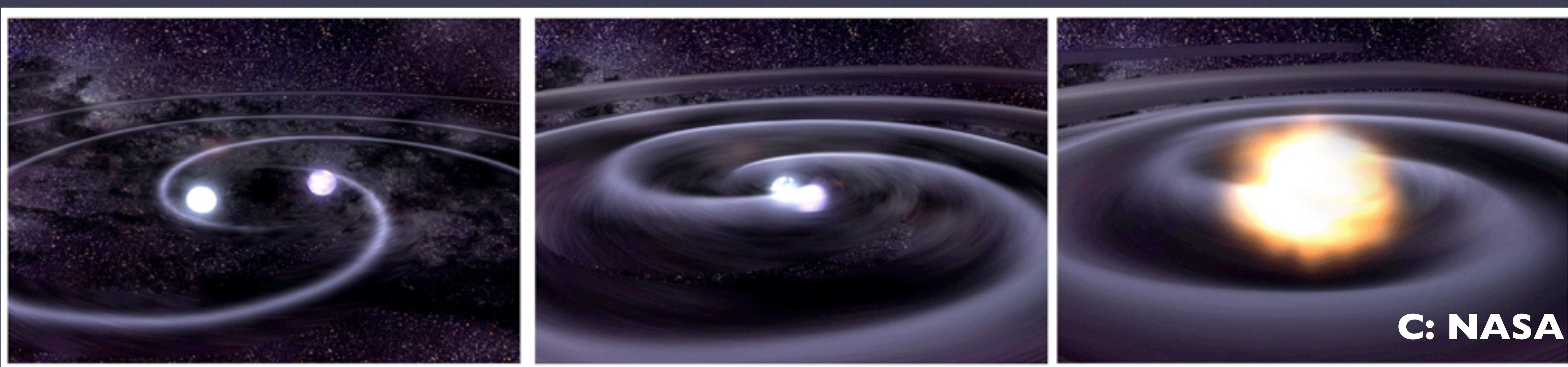
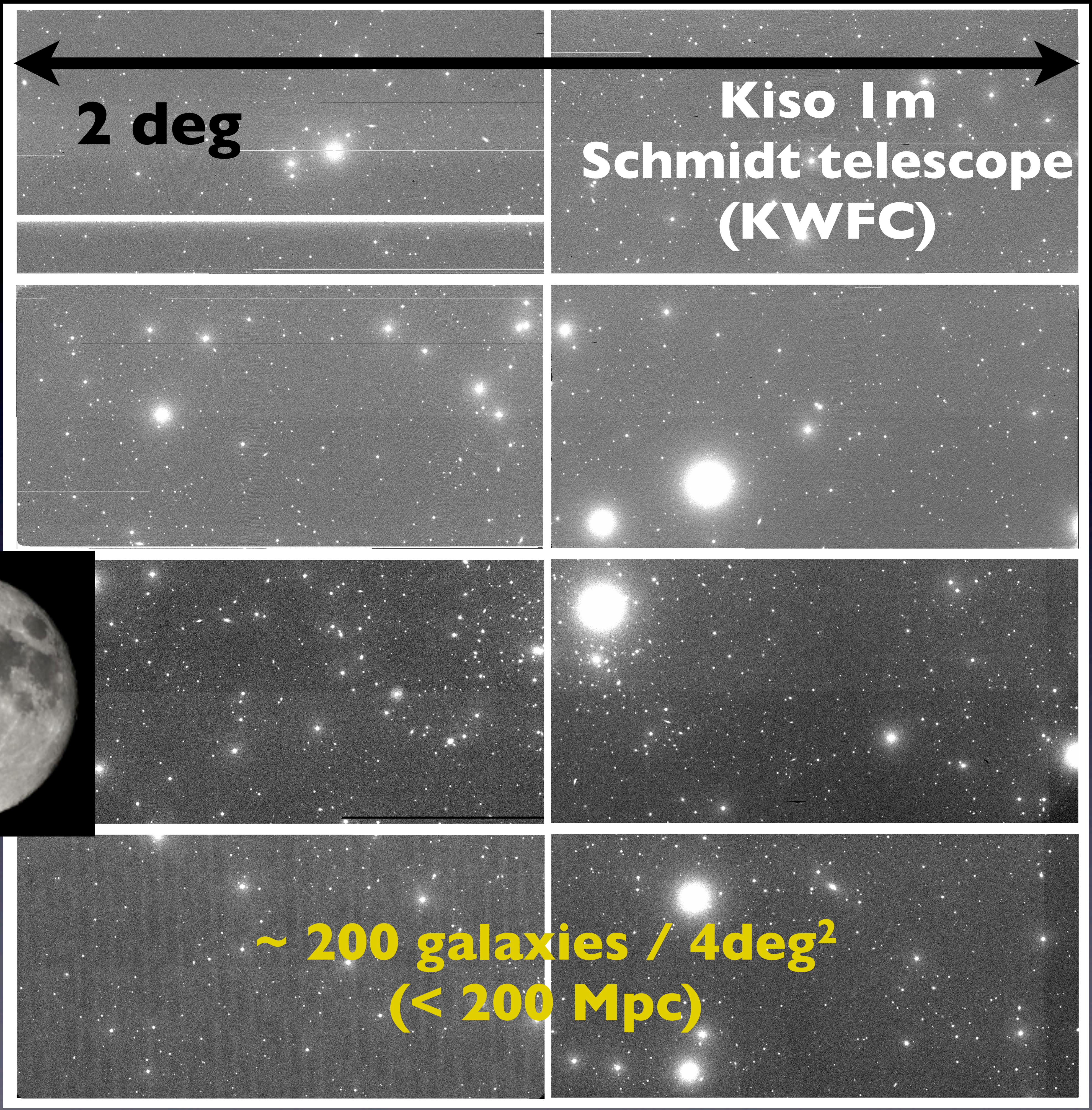
- Flexible operation/instrument exchange

New astronomy with gravitational waves

2017 -
- Advanced LIGO (US)
- Advanced Virgo (Europe)
- KAGRA (Japan)

NS-NS merger
with 200 Mpc
~ 30 events/yr
(~0.3-300)




2 deg
Kiso 1m
Schmidt telescope
(KWFC)
~ 200 galaxies / 4deg^2
(< 200 Mpc)

GW alert error box

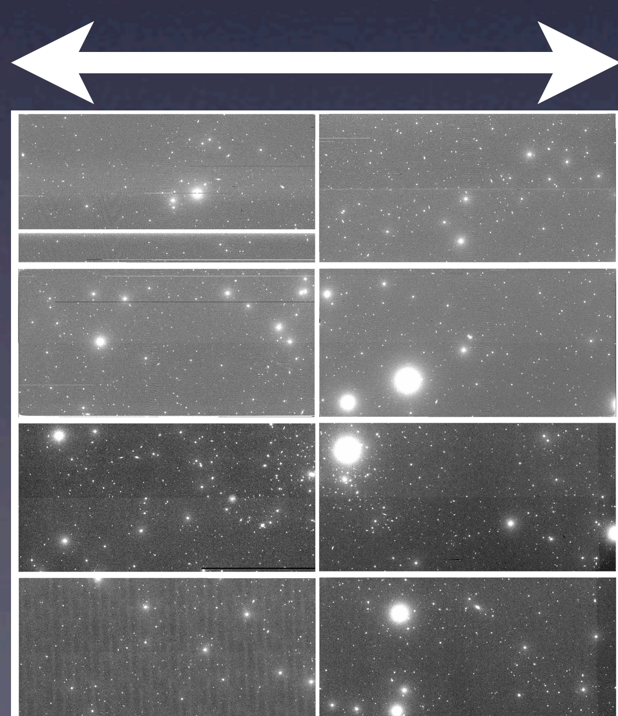
e.g. 6 deg x 6 deg

~ 2000 galaxies

(< 200 Mpc)

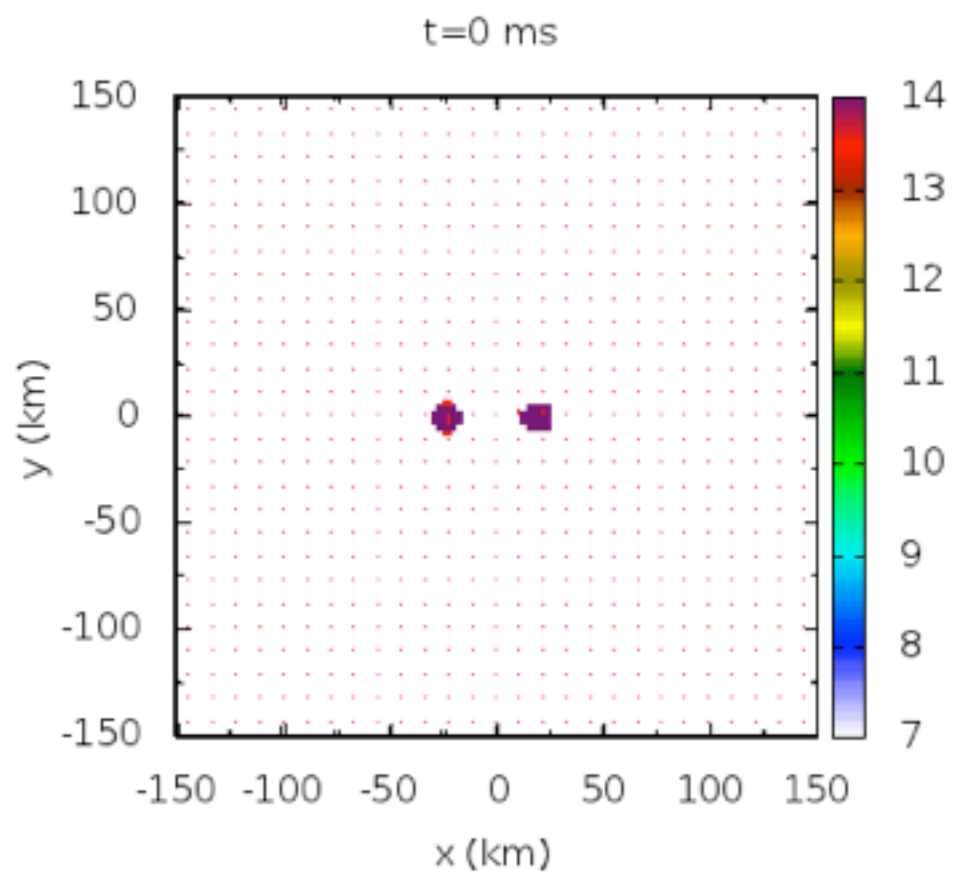
No electromagnetic counterpart
No gravitational wave astronomy

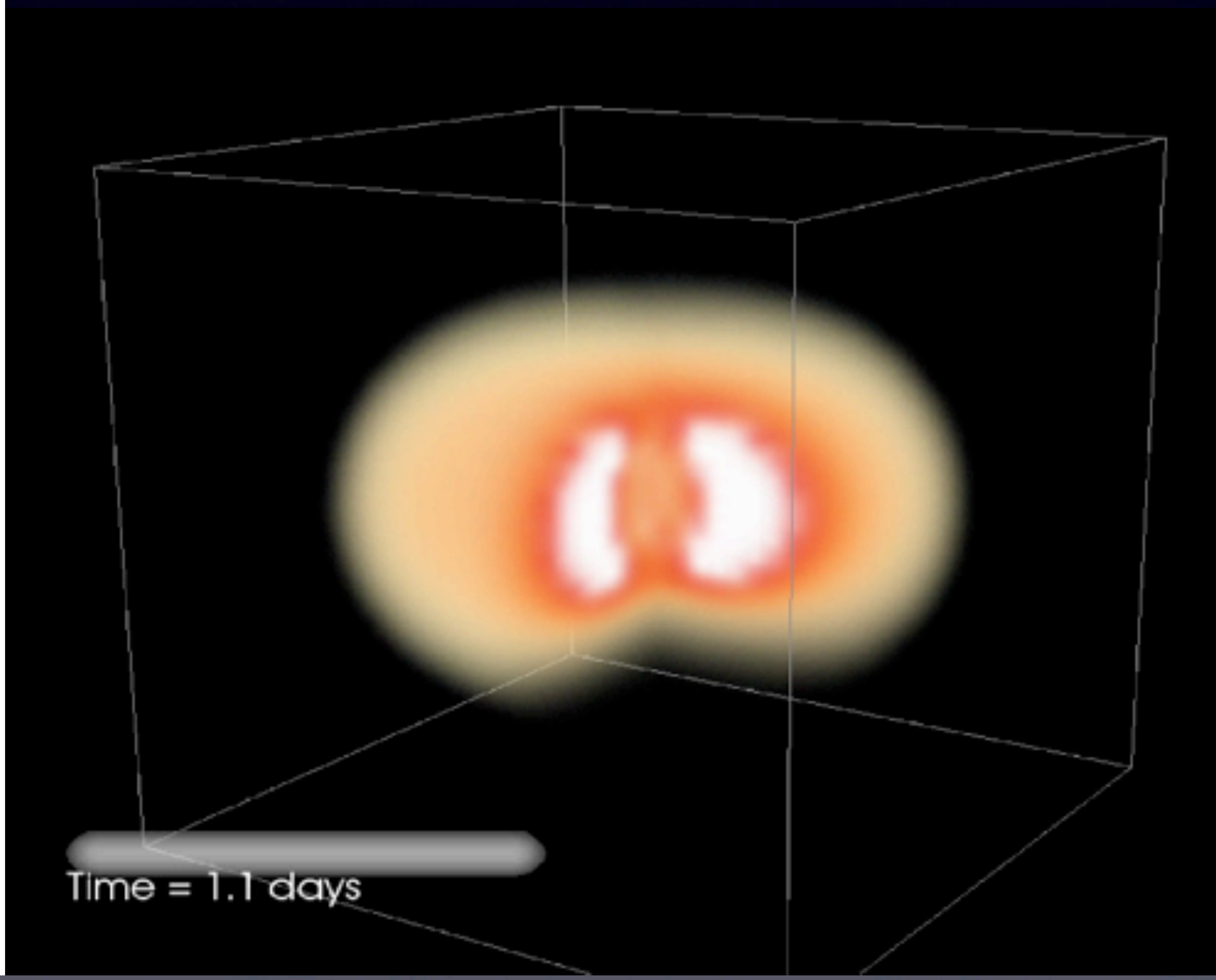
2 deg



Optical/Infrared emission from NS merger

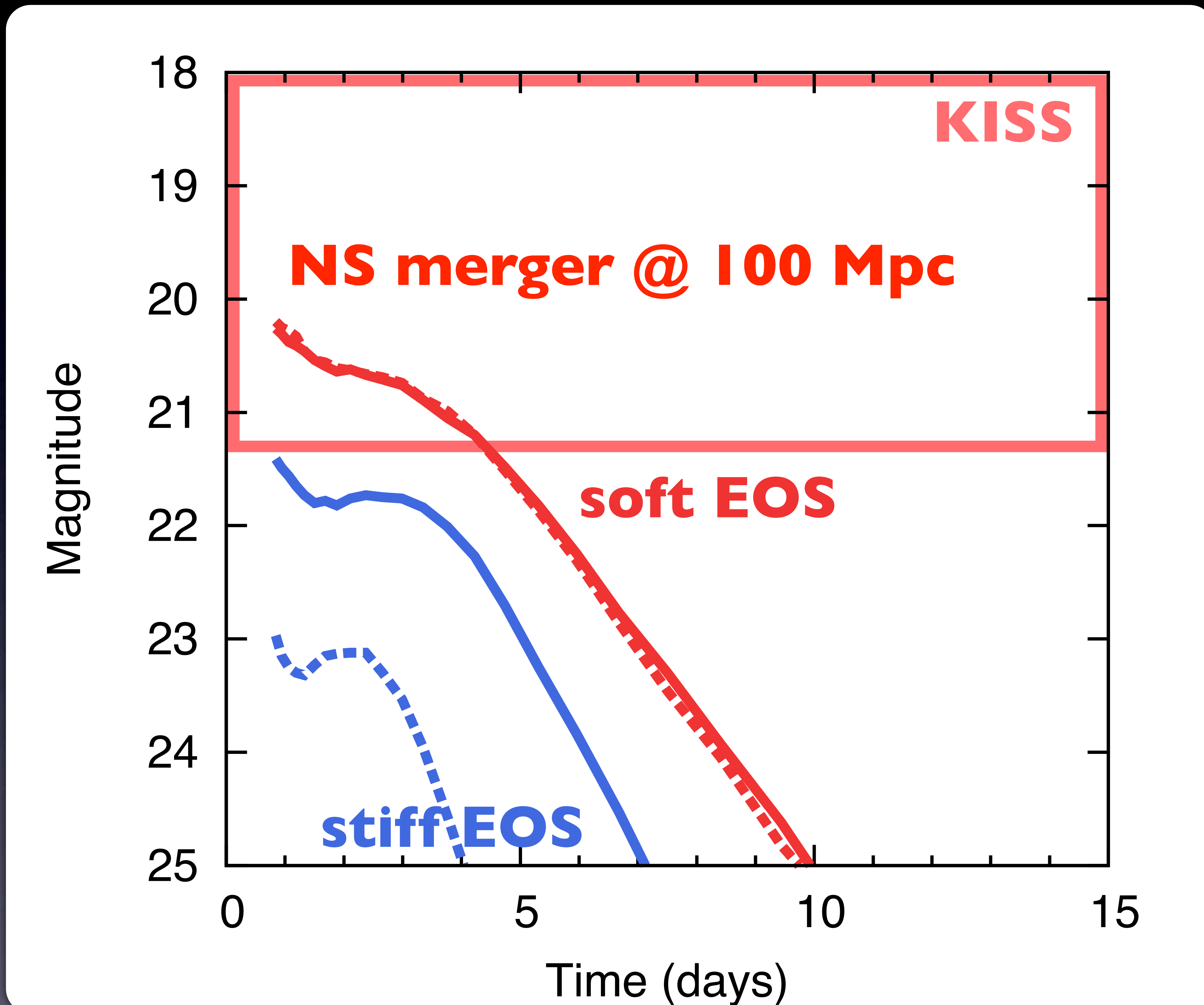
Numerical relativity → **Radiative transfer**





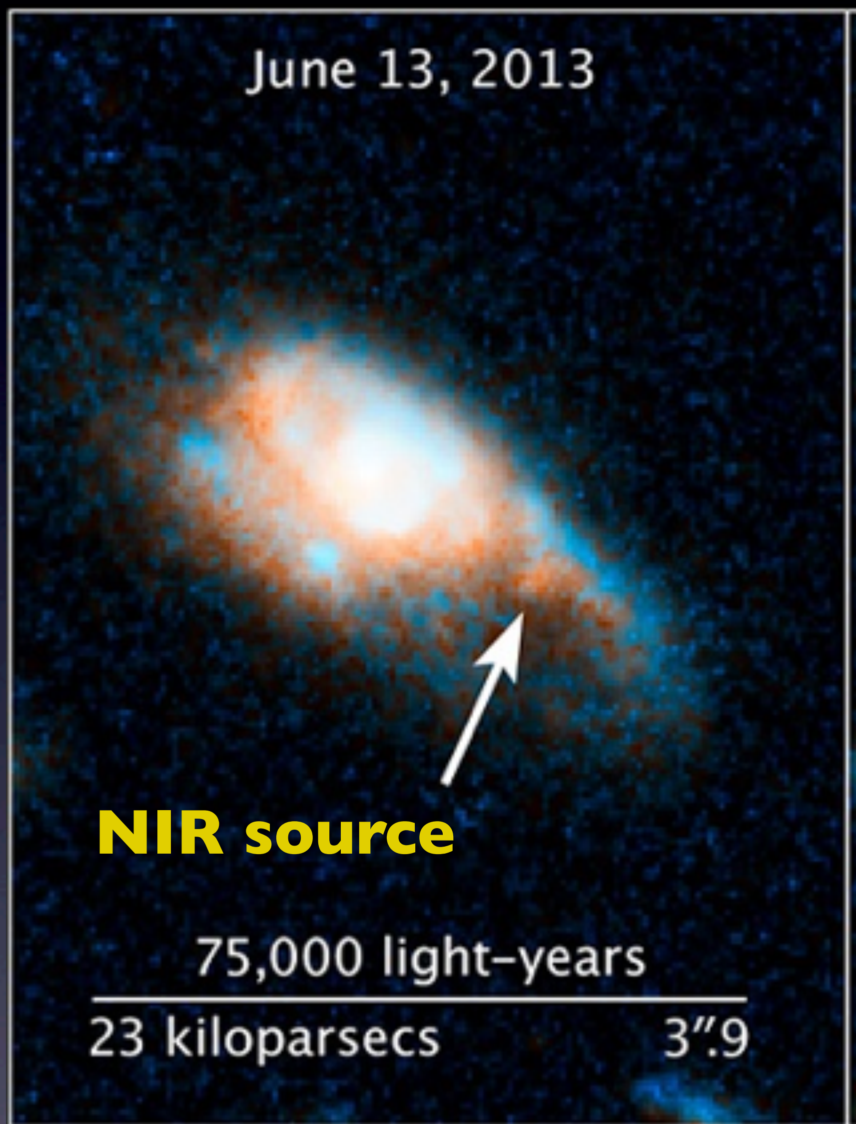
Hotokezaka et al. 2013

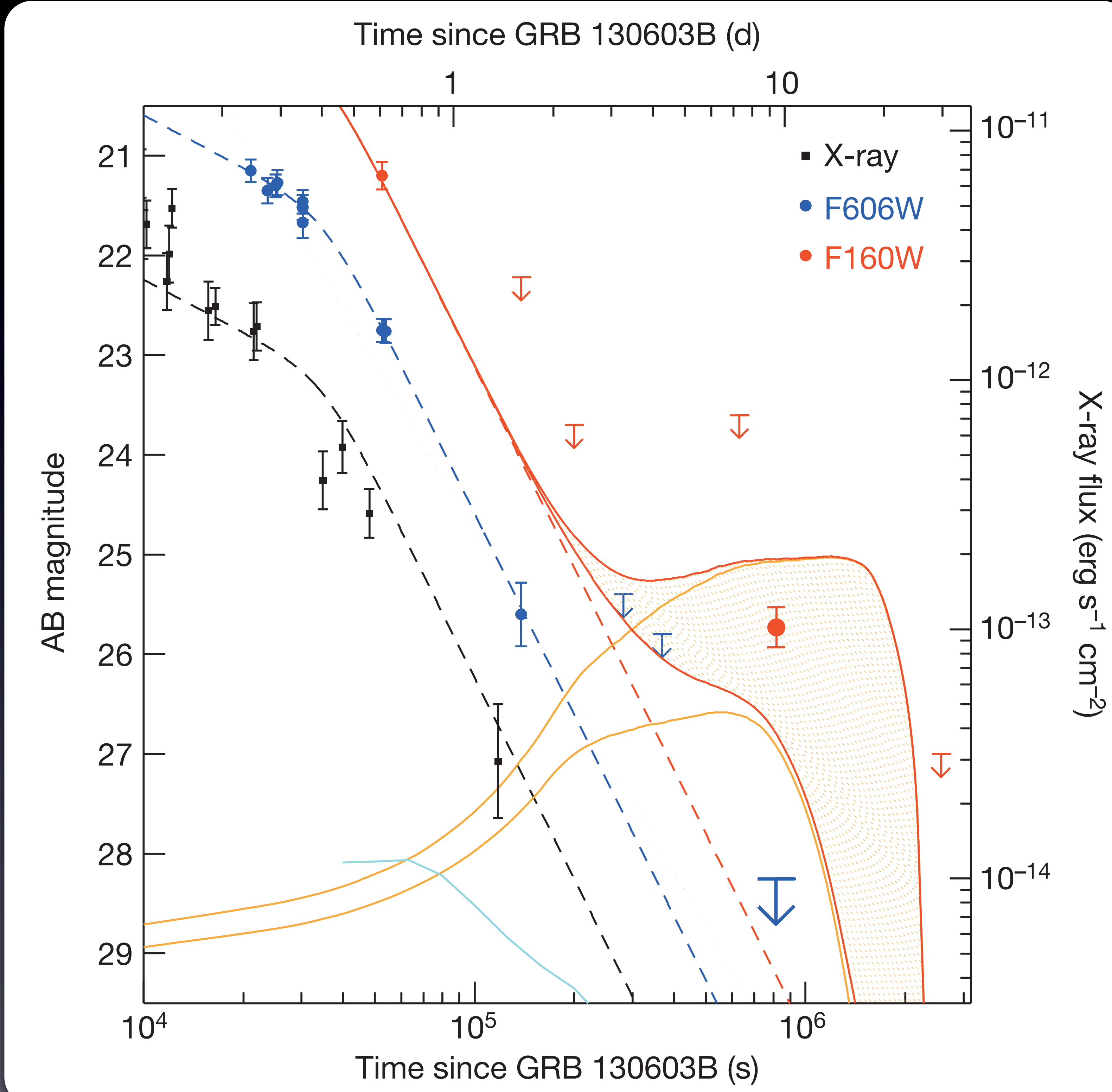
MT & Hotokezaka 2013



Best with red edge of optical (i band, 0.8um)

Bright models are consistent with GRB 130603B





Very red (R-H > 2.5 mag)

Tanvir+13
Berger+13

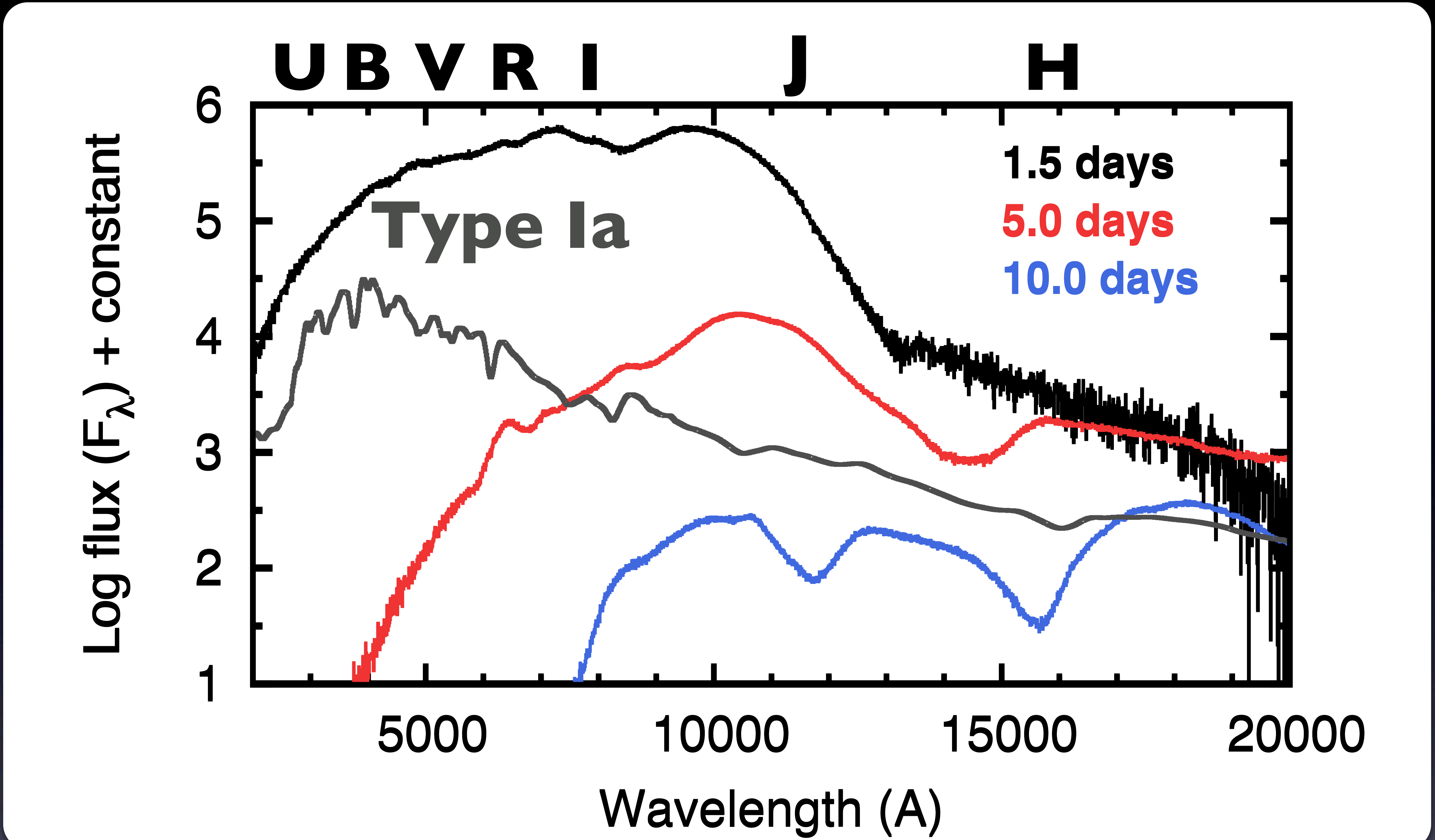
Early observing runs of GW detectors
2015-2016

Singer et al. 2014		2015		2016	
	Detectors	HL		HLV	
	BNS range	54 Mpc		108 Mpc	
	Run duration	3 months		6 months	
	No. detections	0.091		1.5	
		rapid	full PE	rapid	full PE
median area	50% CR	142 deg^2	124 deg^2	164 deg^2	43 deg^2
	90% CR	573 deg^2	529 deg^2	646 deg^2	235 deg^2
	searched	122 deg^2	88 deg^2	129 deg^2	32 deg^2

Horizon distance ~ 50-100 Mpc
Localization ~ 200 deg^2

Wide survey with 1m class telescopes
(Similar strategy with KISS)

→ **Spectroscopy with 3.8m telescope**
(R ~ 500)



- Very red SED (peak at NIR)
- Extremely broad-line (feature-less) spectra

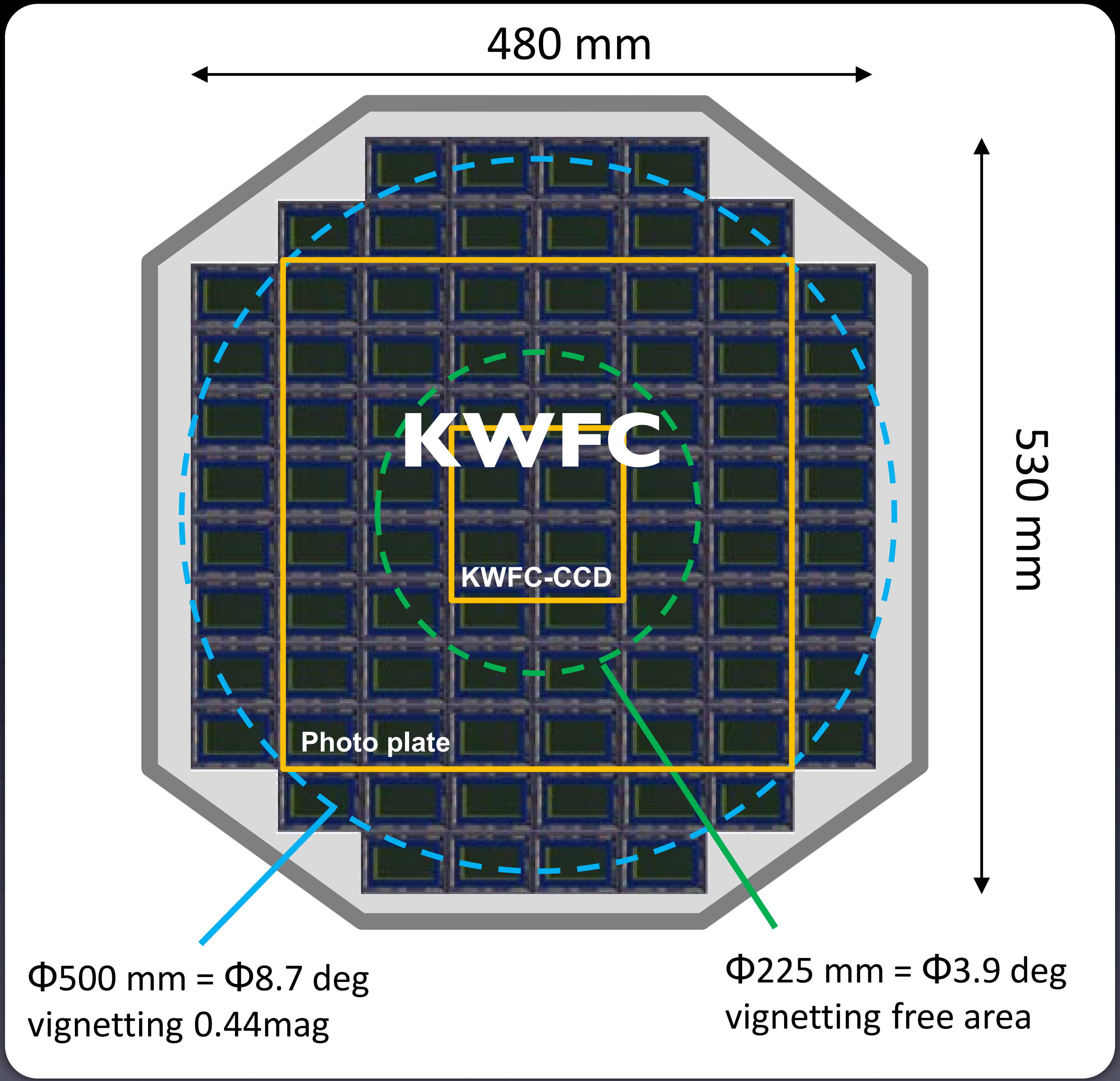
Spectroscopic identification is essential

Matsubayashi-san's talk

“Drill” with Fermi/GBM alert

by Tomoki Morokuma

- Future -
CMOS for Kiso Schmidt telescope



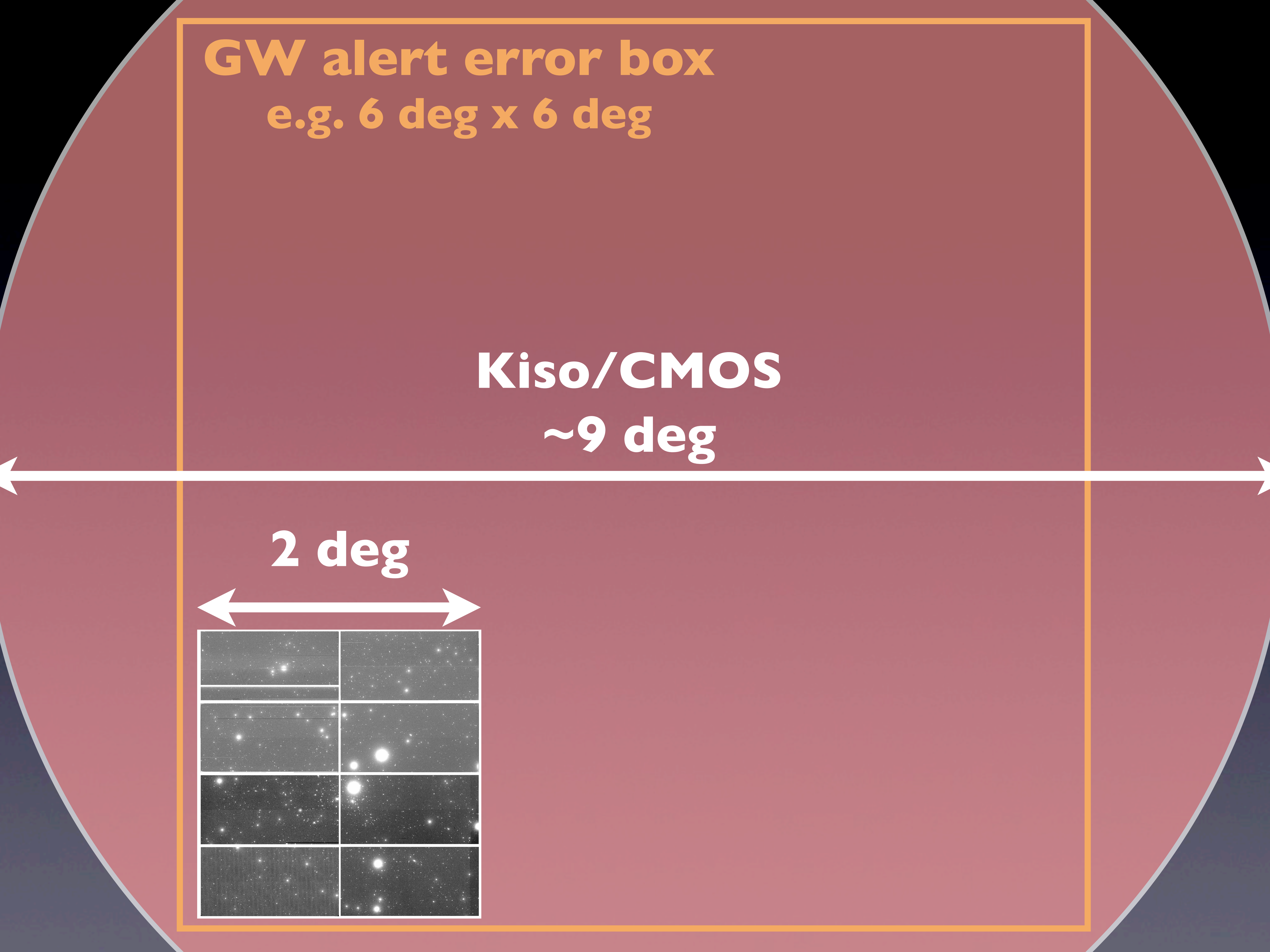
By courtesy of Shigeyuki Sako (PI), Soya Todo, Yuki Kikuchi, et al.

- No need to cool
- Fast readout (30 Hz)

- Large FOV Ω
- Efficient observation f
- High cadence

Survey power = fAΩ

c.f. Zwicky Transient Factory (large format CCD)


GW alert error box
e.g. 6 deg x 6 deg
Kiso/CMOS
~9 deg
2 deg

Summary

- High-cadence transient survey
  - Survey with 1m telescopes
    => Spectroscopy with 3.8m telescope
- Gravitational wave astronomy
  - Identification of electromagnetic counterpart
  - Early observing runs => GW events @<100 Mpc
    => Spectroscopy with 3.8m telescope
- Future
  - Wider FOV, higher cadence,
    and more efficient observations

- Low resolution spectrograph (ready to use anytime)
- Flexible operation/instrument exchange