

Transient Science
with Wide Field Survey
and 3.8m Telescope

- 広視野突発天体サーベイと3.8m望遠鏡によるサイエンス -

Masaomi Tanaka

田中 雅臣

(National Astronomical Observatory of Japan)

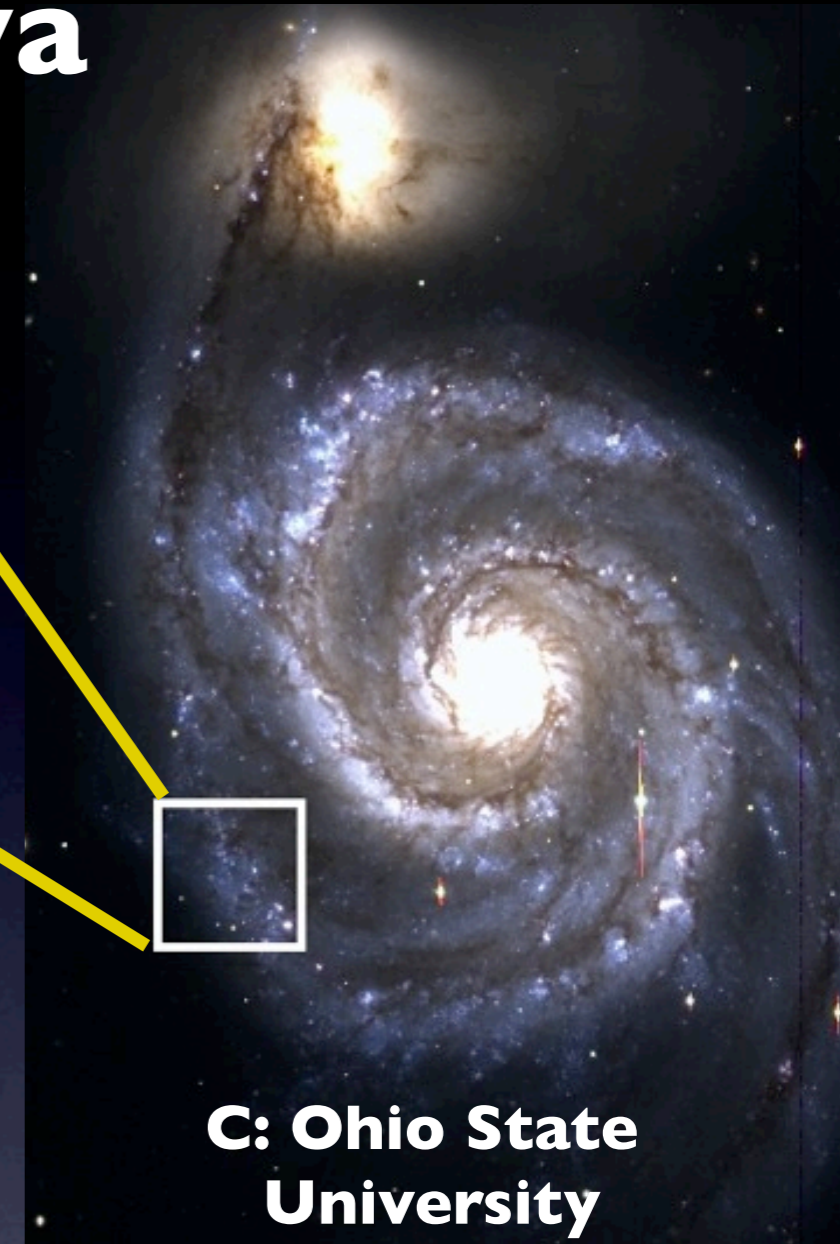
On behalf of **KISS** collaboration

Tomoki Morokuma (Univ. Tokyo)

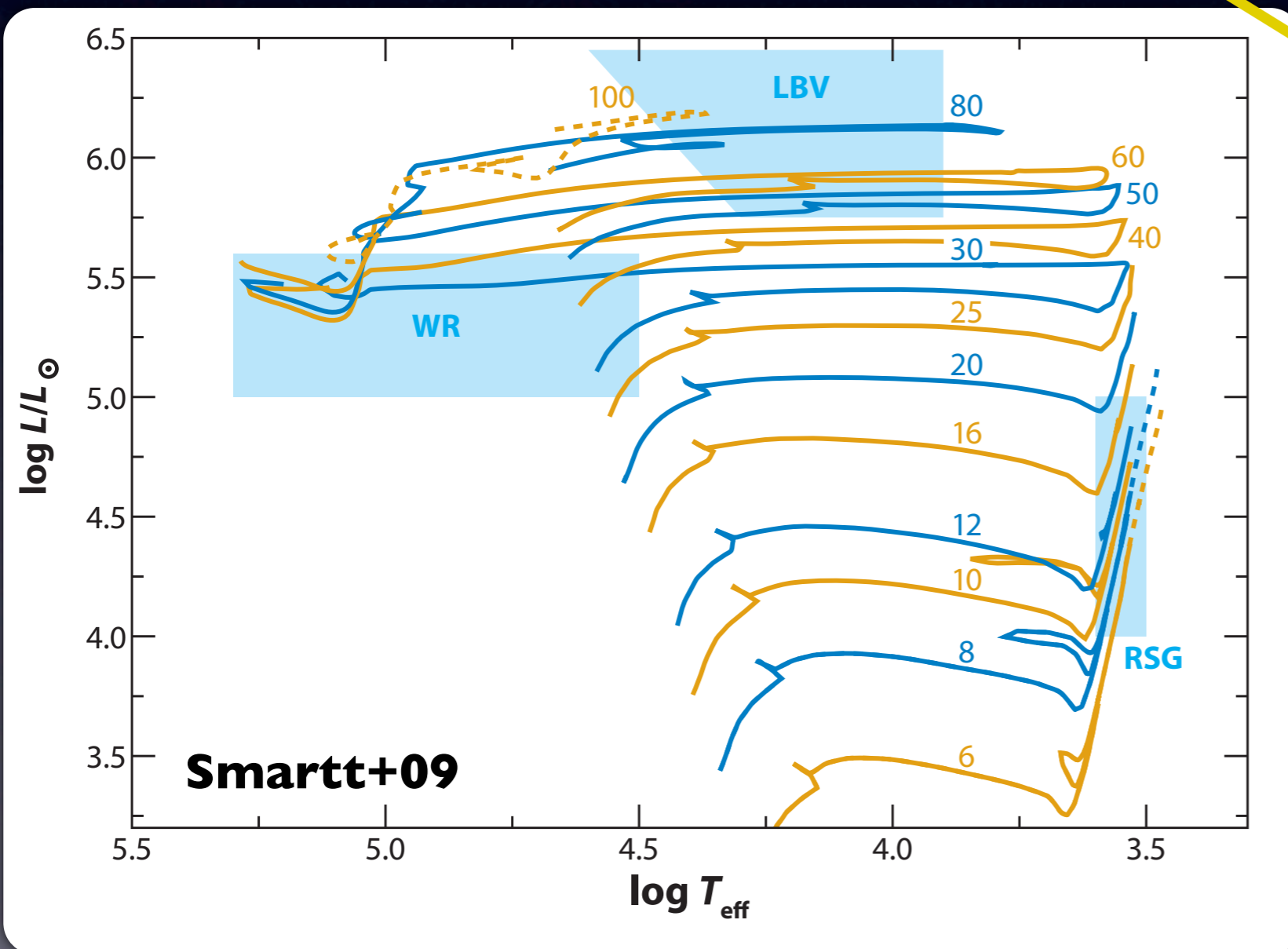
Nozomu Tominaga, Kensho Mori (Konan Univ.)

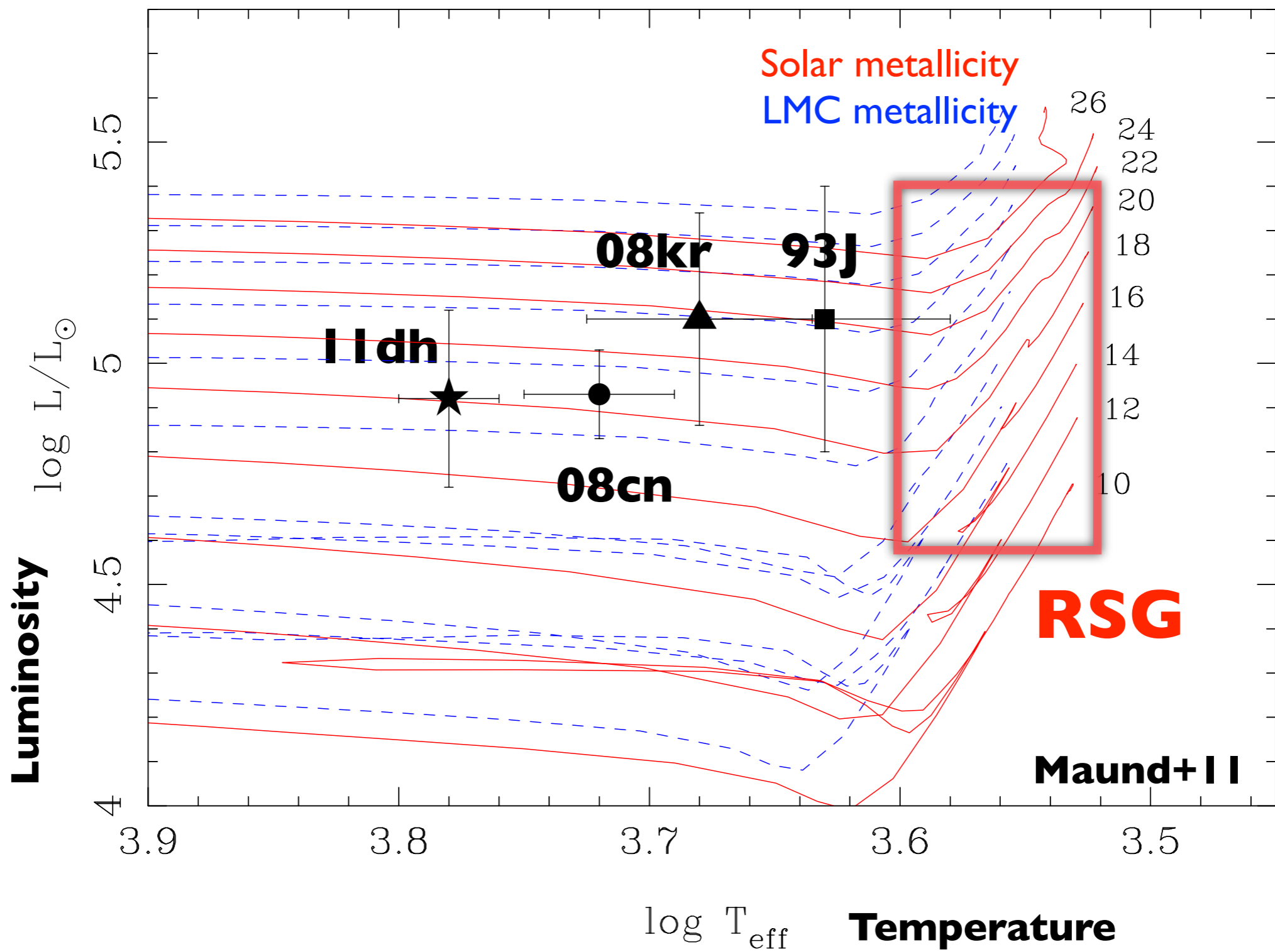
- **Frontier of Transient Survey**
- **KISS (Kiso Supernova Survey)
and Synergy with 3.8m Telescope**
- **Future Plan**

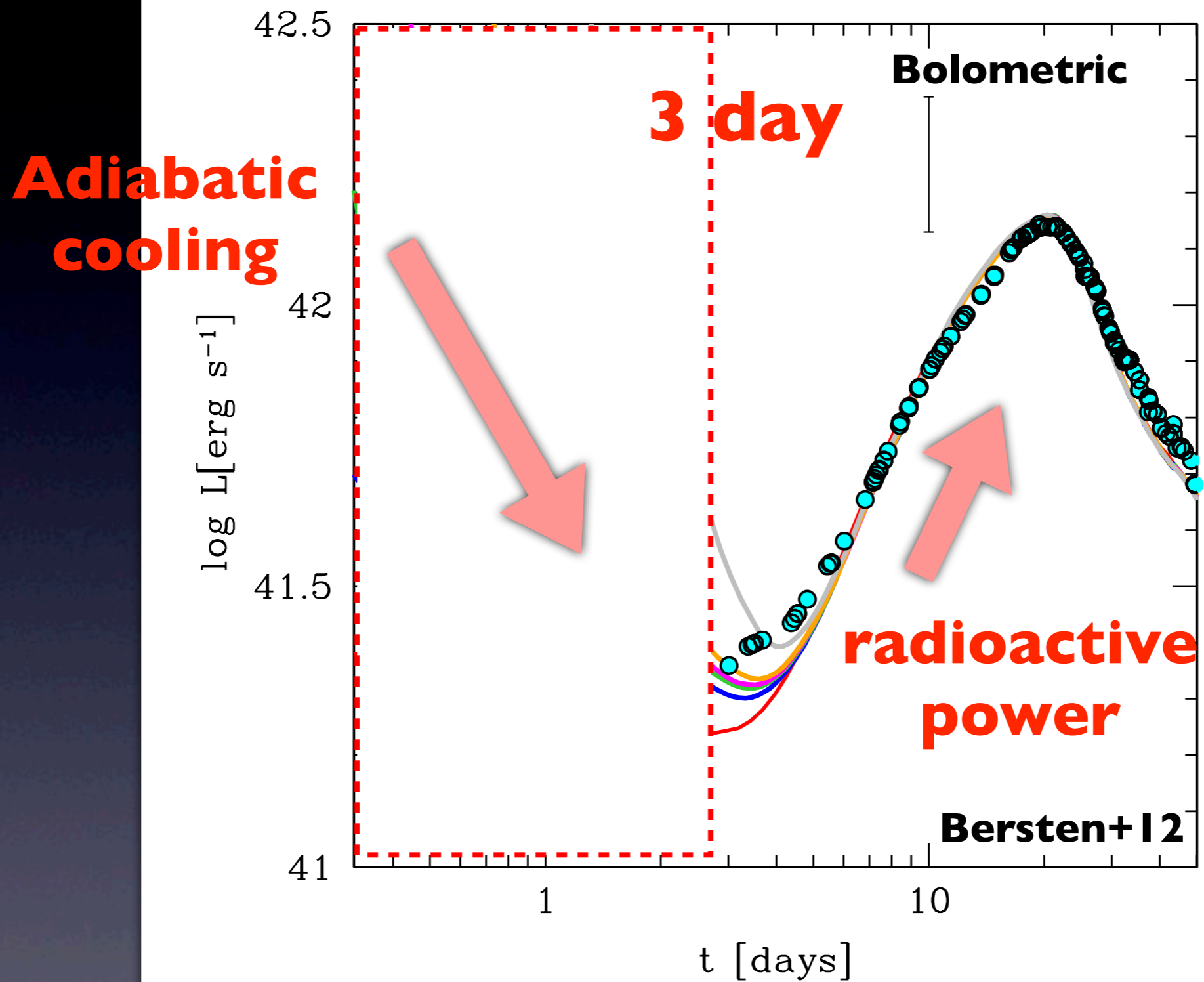
Stellar Evolution - Supernova



C: Ohio State University







Too late with typical 2-3 day cadence

SN shock breakout

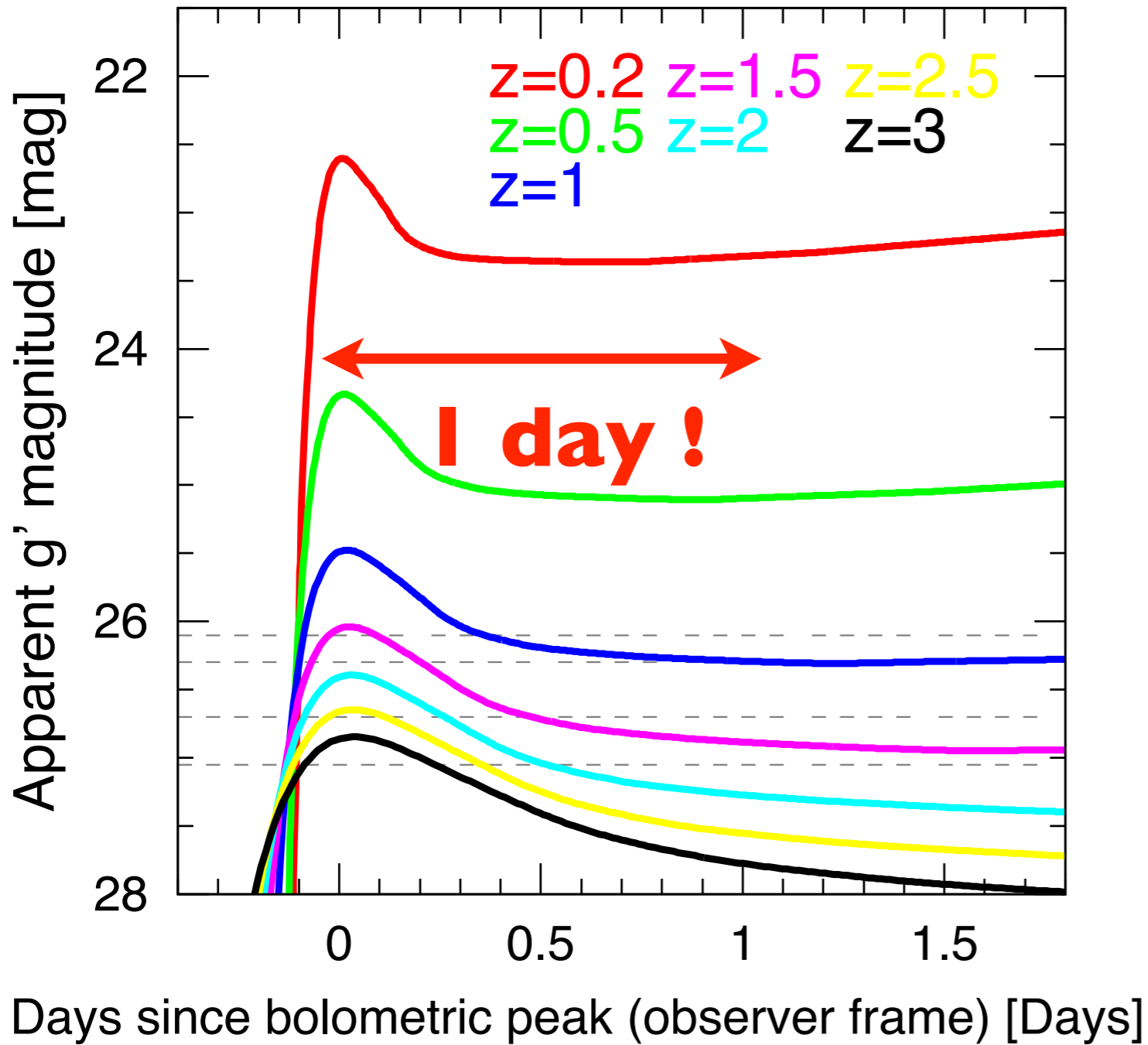


Figure from N. Tominaga

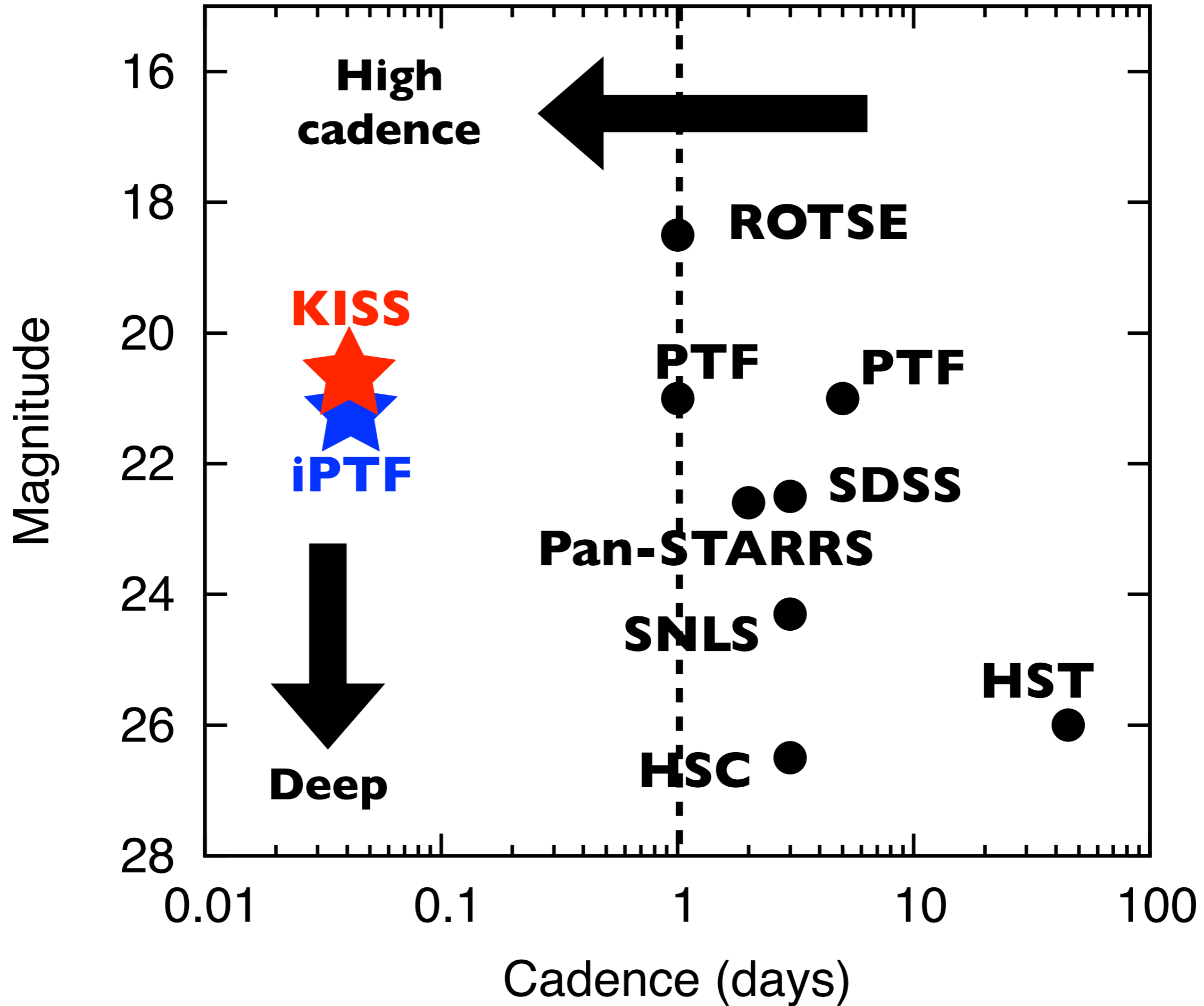
progenitor star



> a few days



➔ **Star formation tracer
at high redshift**



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KISS: KIso **S**upernova **S**urvey

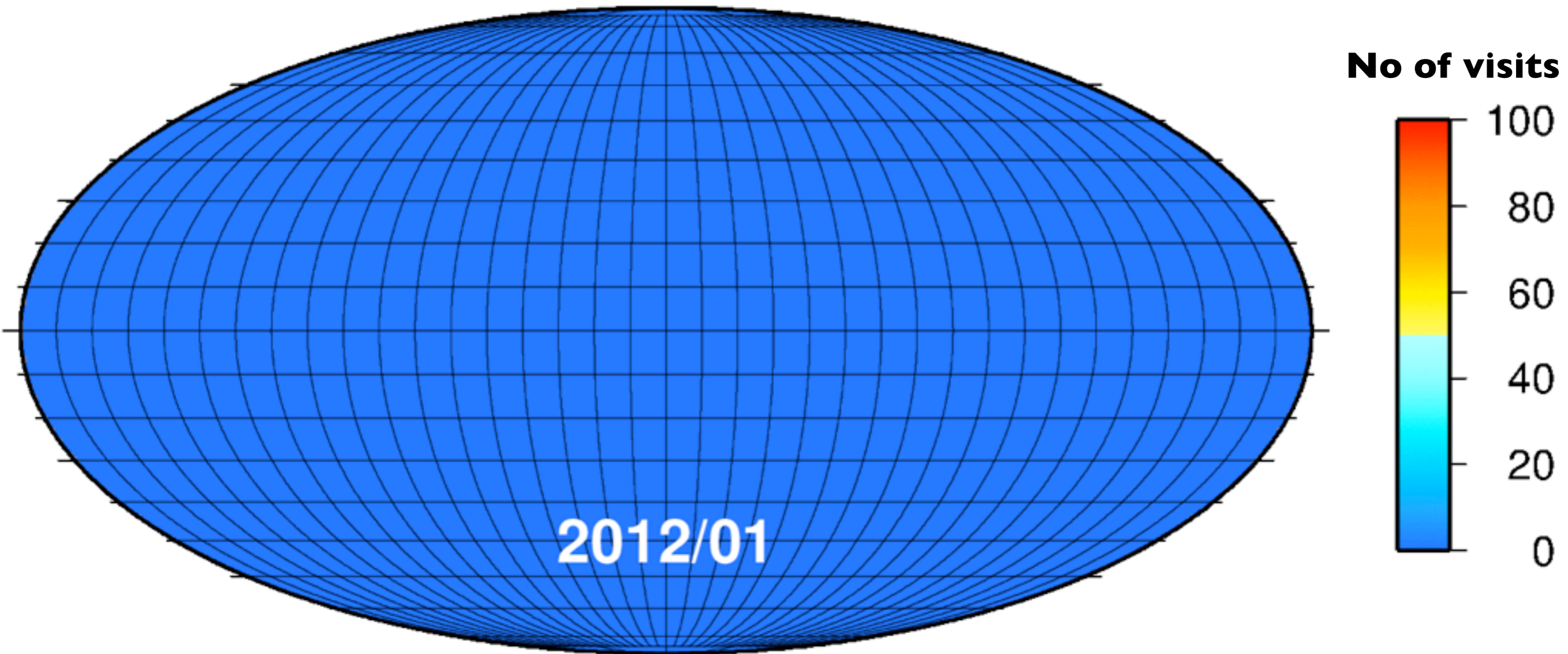
- **Extremely high cadence**
 - **1-hr cadence**
 - **4 deg² FOV**
 - **3 min exposure**
 - **~ 21 mag in g-band**
 - **~50-100 deg² /day**
 - **100 day observations/yr (around new moon)**
 - **High SFR field (< 200 Mpc, 30-100 Msun/yr)**



2012 Apr: Dry run -

2012 Sep: Main survey -

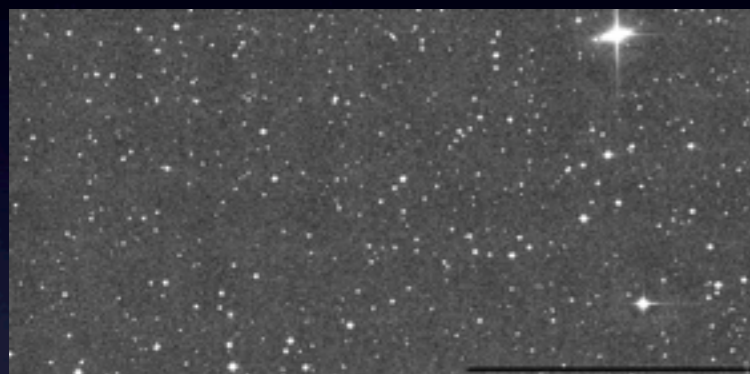
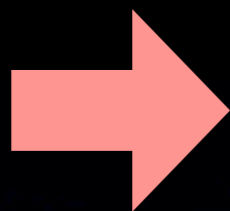
KISS 1st year



Kiso observatory



KISS pipeline



standard reduction

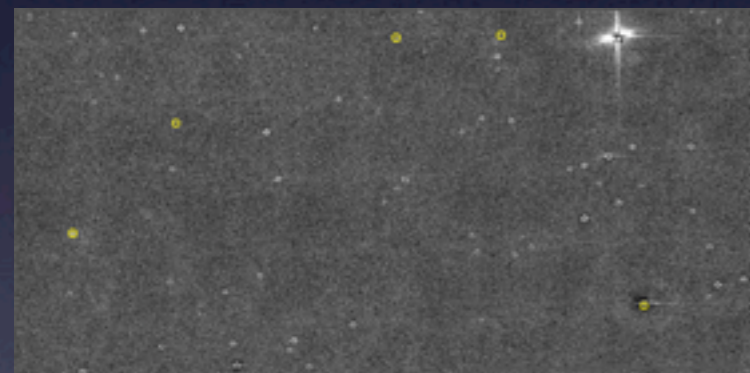


image subtraction

source detection

< 10 min

~ 50GB/day

Anywhere

cut-out images



KISS database



source
info



KISS interface



Amateur astronomers

cut-out images

KISS database

Ref

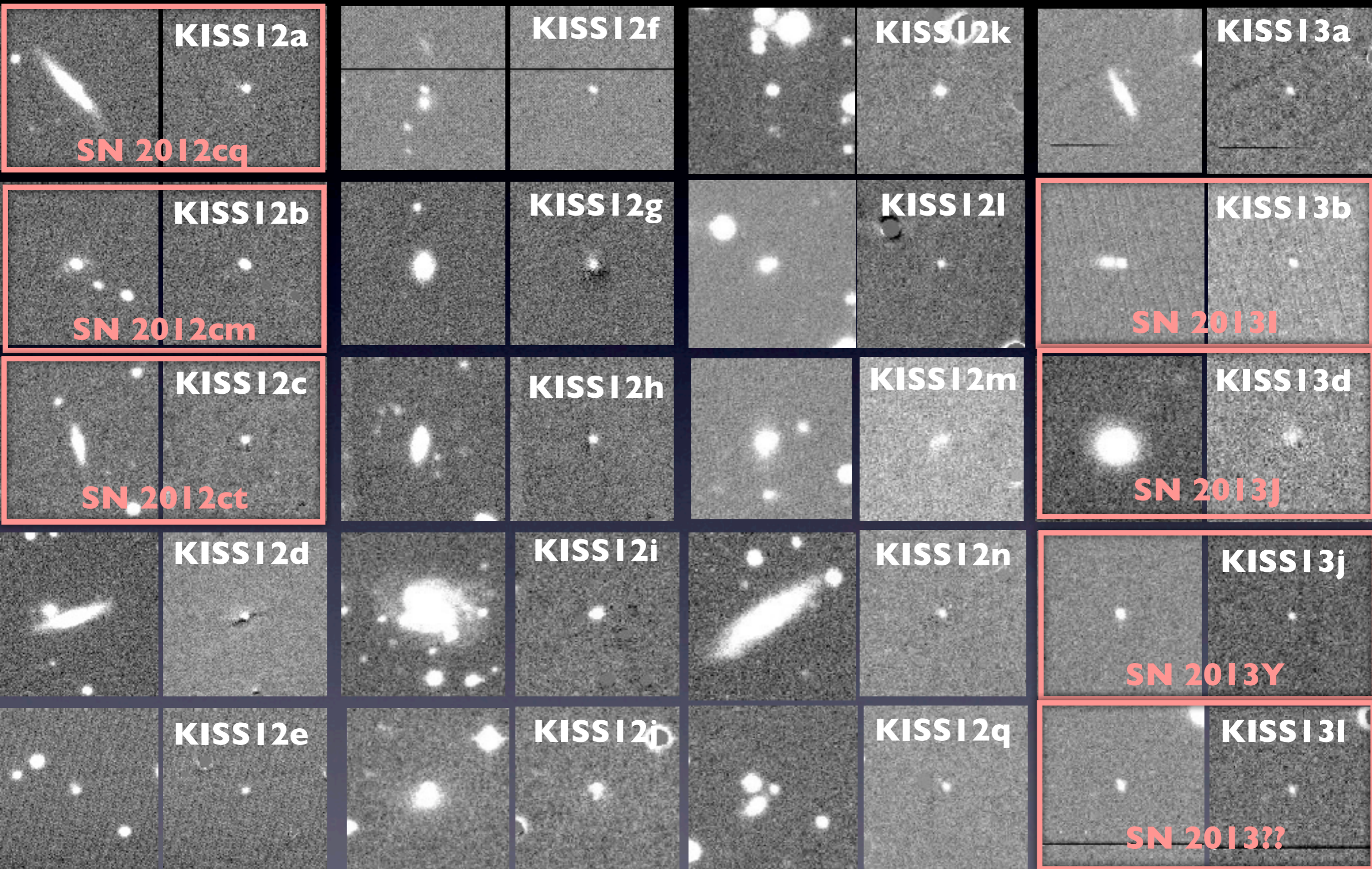
New

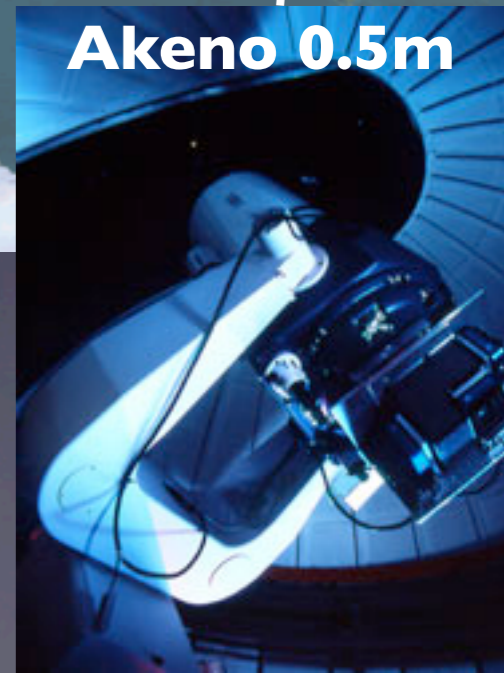
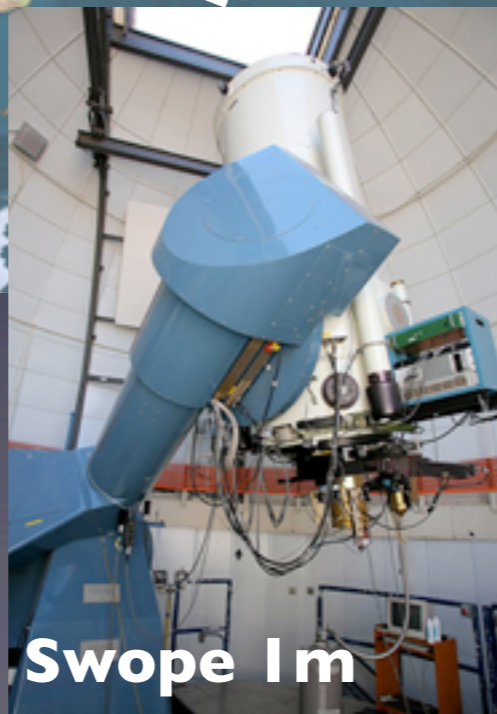
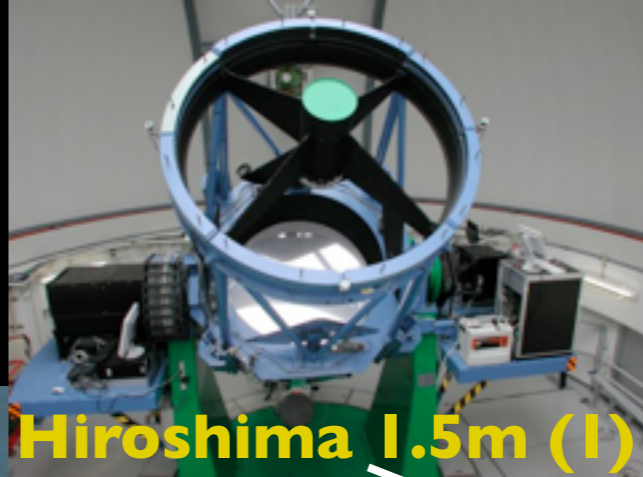
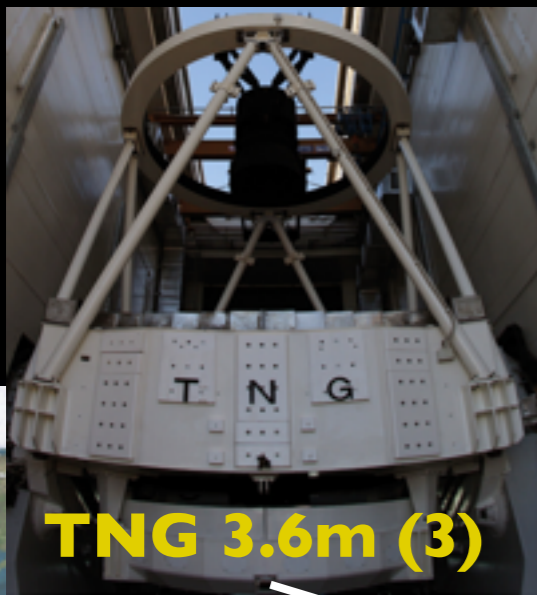
Sub

source
info



37 SN candidates





KISS collaboration

- **Survey members**

- **Tomoki Morokuma (PI), Nozomu Tominaga, Masaomi Tanaka, Kensho Mori, Koji Kawabata, Yoshihiko Saito, Nobuharu Ukita, Michael Richmond, Yuji Urata**



- **Indian Institute of Astrophysics**

- **Devendra Sahu**



- **Carnegie Supernova Project (CSP)**

- **Eric Hsiao, Maximilian Stritzinger, Mark Phillips, Nidia Morrell, Carlos Contreras, Francesco Taddia**



- **Telescopio Nazionale Galileo (TNG)**

- **Paolo Mazzali, Emma Walker, Elena Pian**



- **SNFactory**

- **Greg Aldering**



- **Russian Institutes**

- **Dmitry Tsvetkov, Nikolay Pavlyuk**

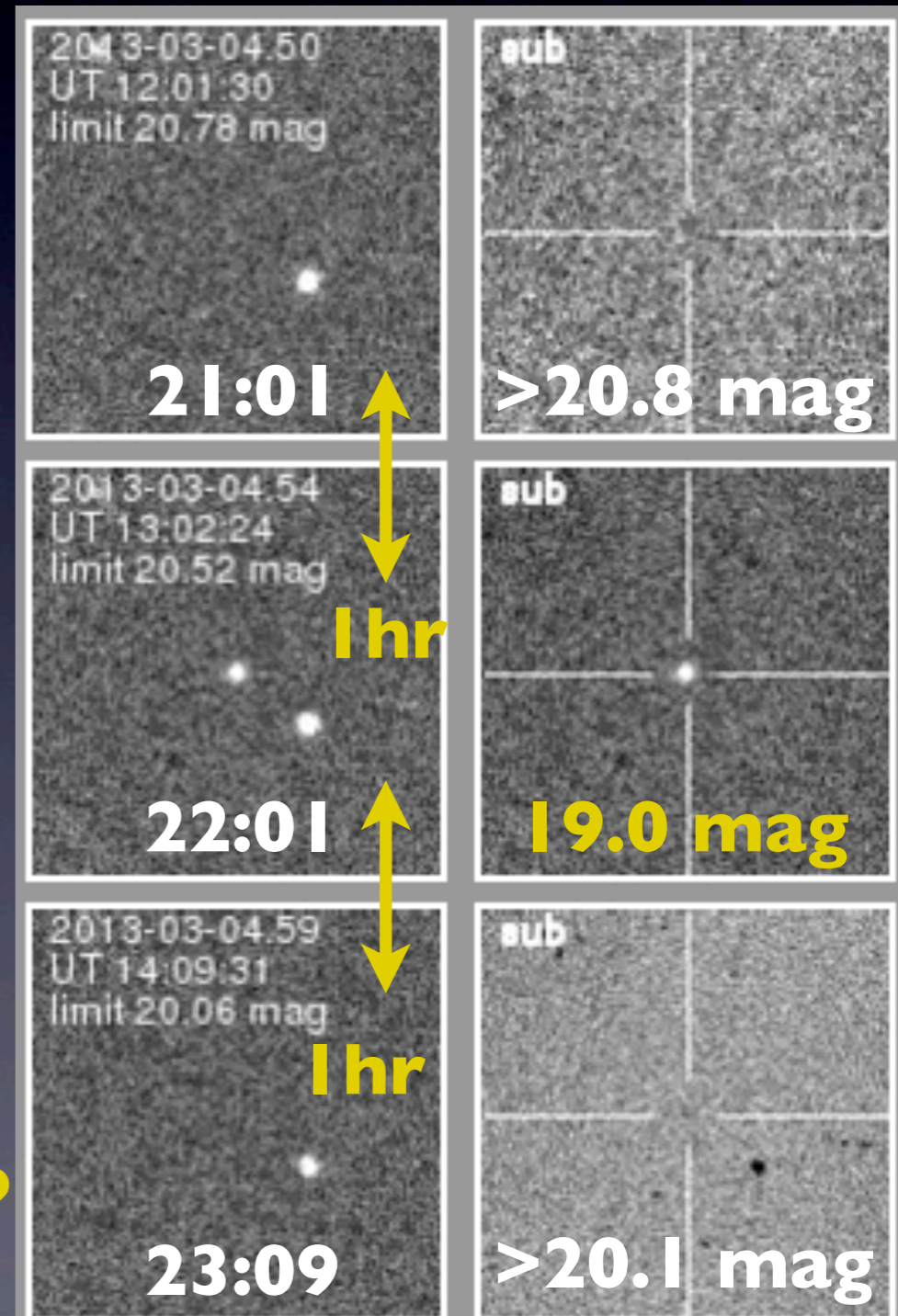
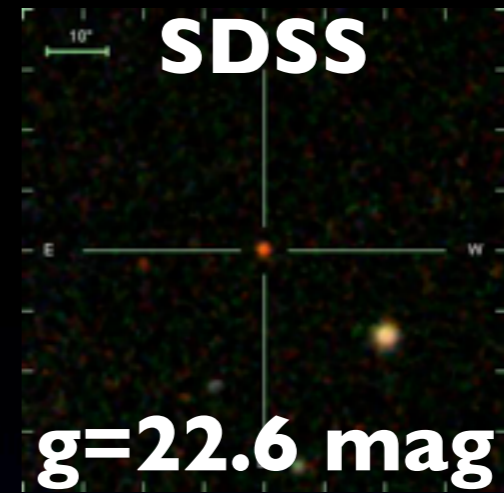


Synergy with 3.8m Telescope

- **Rapid follow up**
 - High speed pointing of 3.8m telescope is critical (1 min, Nagata-san, Kurita-san)
 - **Rapid communication (< 1 hr)**
Target feed takes ~ 10-60 min
 - Automatic response
- **Low resolution spectroscopy**
($R \sim 500$, $v \sim 500$ km/s)
- **IFU** is preferred (Ota-san, Matsubayashi-san)
confirmation image + spectroscopy
占有性・機動性が最も重要な要素
No Transient Left Behind

By-products from high-cadence survey

- **Variable QSO**
 - ~ 110
- **Variable stars**
 - ~ 80
(High Galactic latitude)
- **Rapid flare (< 1 hr)**
 - ~ 5 (after Maehara et al. ...)
(High Galactic latitude)
Nogami-san's talk



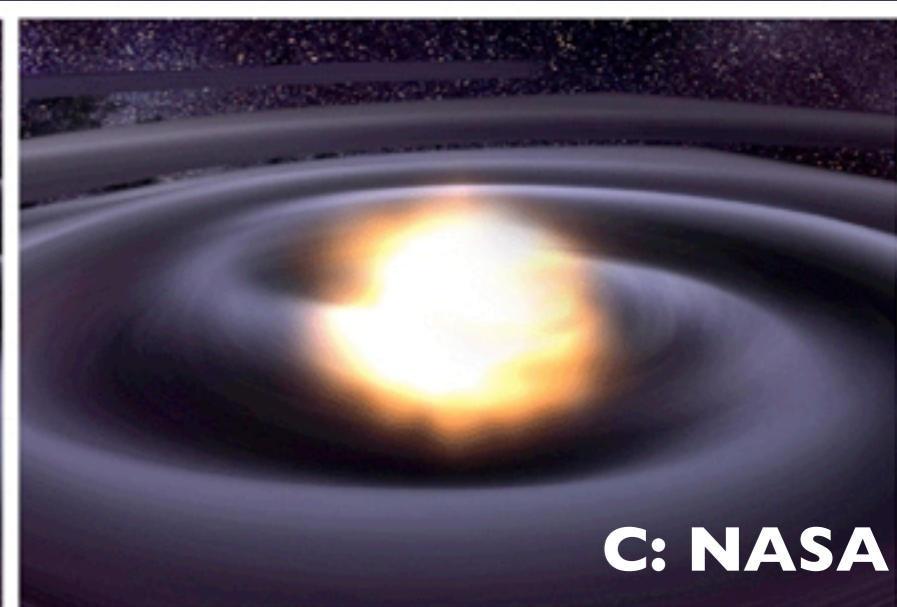
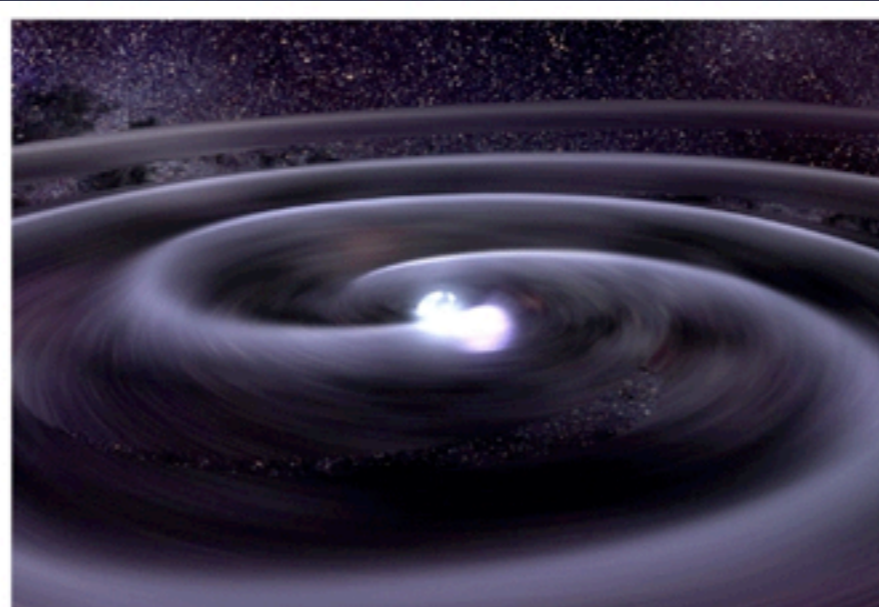
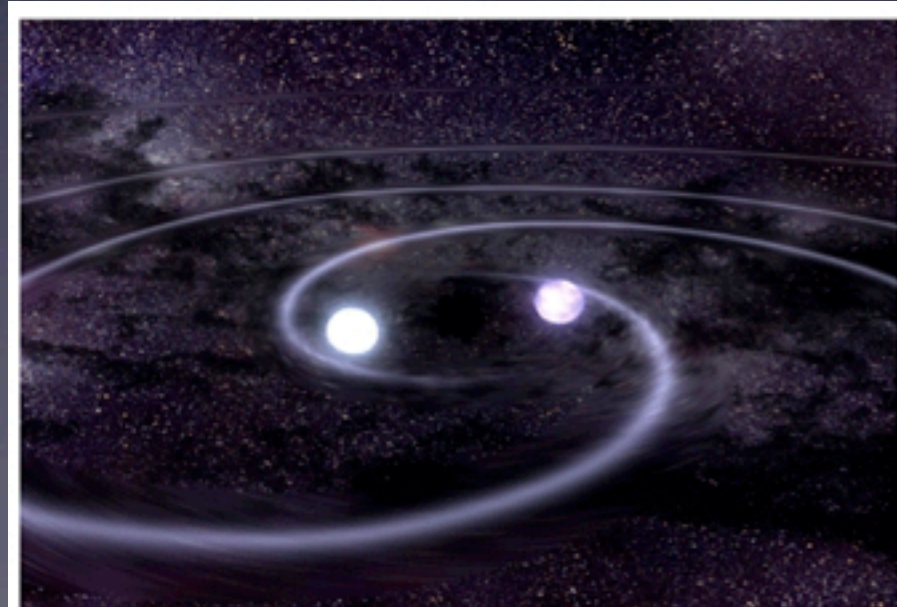
Spectroscopy during the flare!?

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Gravitational Wave - Electromagnetic Wave Astronomy

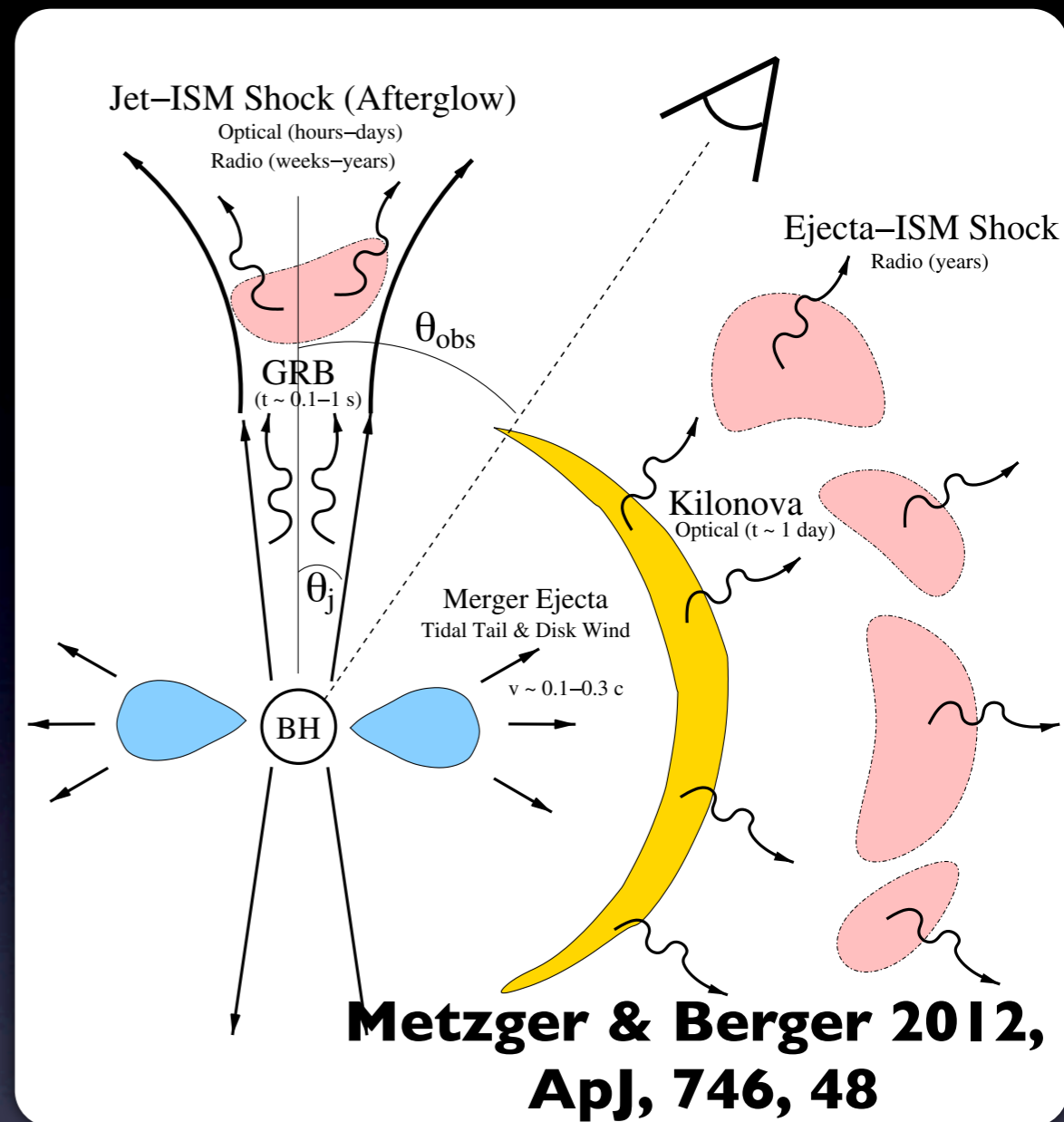
- **KAGRA 2017-**
- **Neutron star merger**
 - 1-10 events / yr
- **EM counterpart**

Ota-san's talk

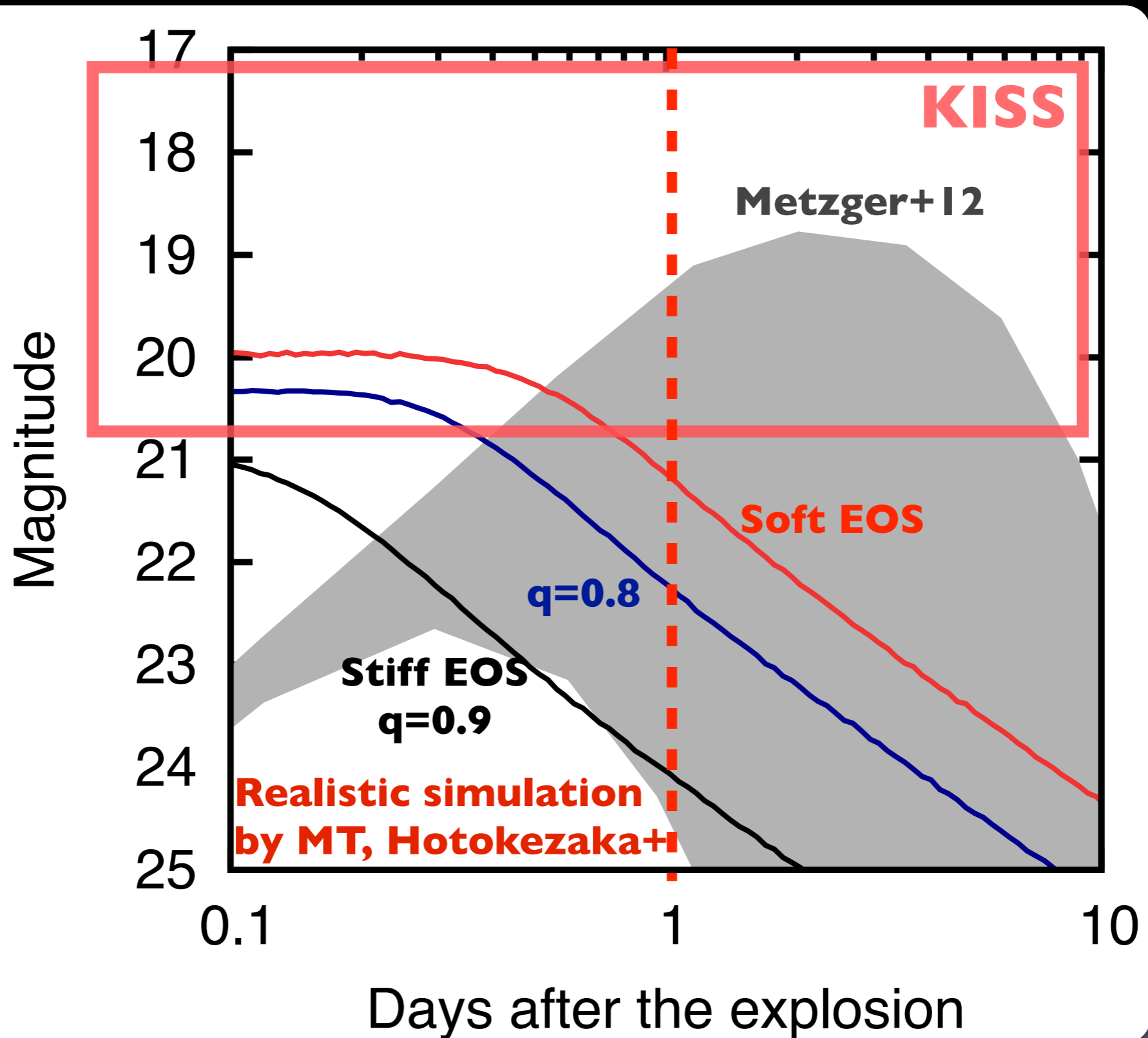


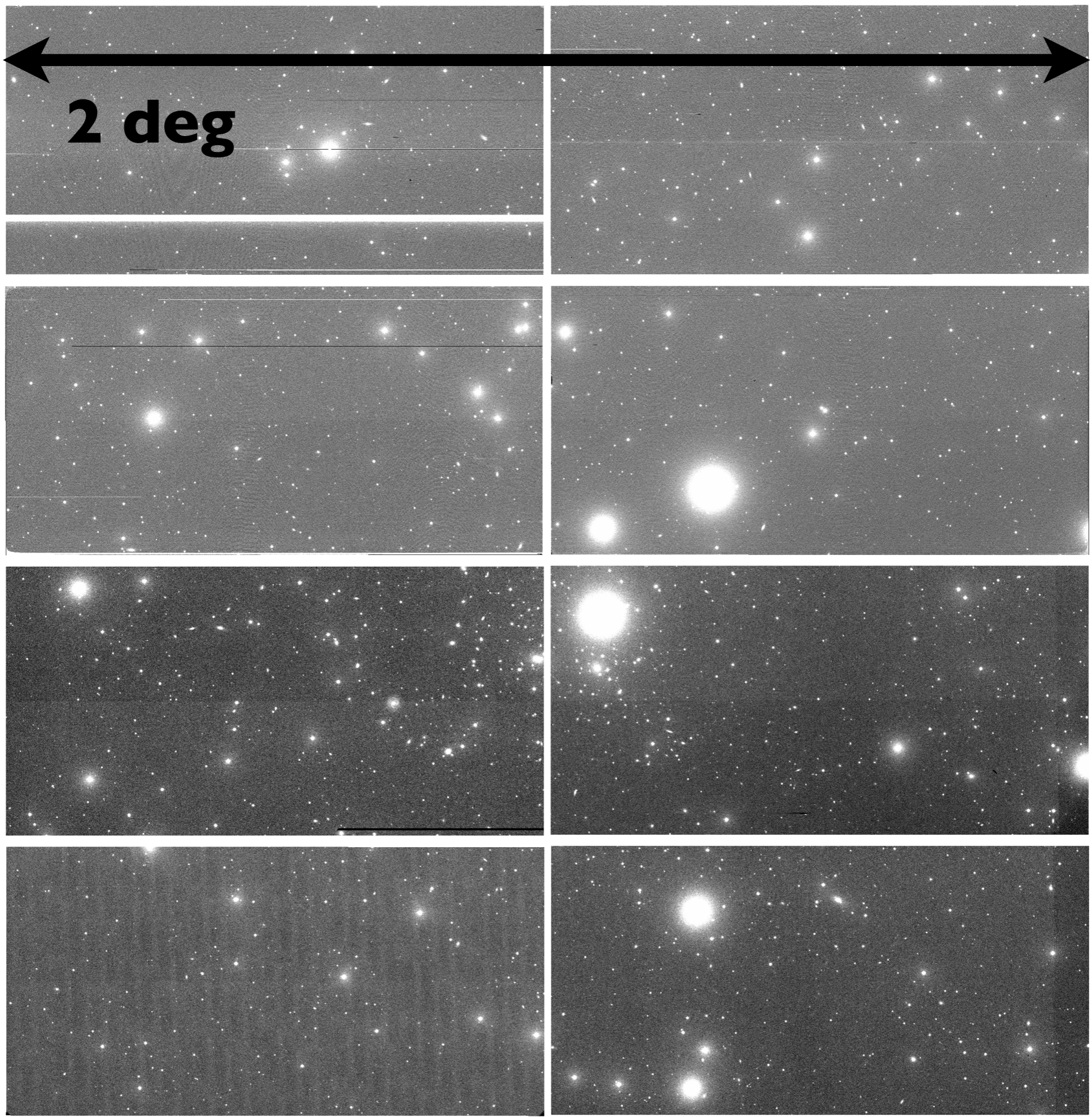
EM signature from NS-NS merger

- On-axis short GRB
 - very rare
- Off-axis radio emission
 - delayed (~ 1 yr)
 - no guarantee of association
- “kilonova” (macronova)
 - could be common if r-process occurs



Neutron star merger @ 200 Mpc





GW alert error box

10 deg x 10 deg
(for example)

6 deg

Localization with
Schmidt telescope



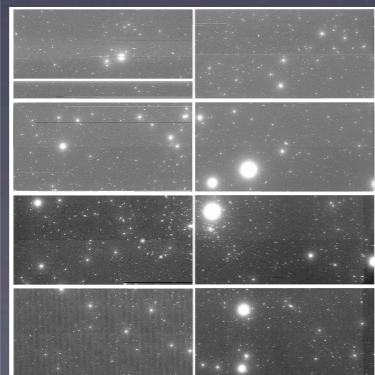
Spectroscopy with
3.8m telescope

2 deg



25 pointing

=> 2-3 hr



□ 0.3 deg

Transient Science with 3.8m Telescope

- (Need wide field survey) Kambe-san
- Rapid follow up for **high-cadence** transient survey
 - Shock breakout of supernovae
 - Rapid flare
- **Critical role in GW-EM astronomy**
 - 3.8m Telescope + 1m Schmidt (wide field)
- Hope for 3.8m Telescope
 - Low resolution spectroscopy ($R \sim 500$)
 - **IFU** (image and spec, reducing time loss)
 - Rapid communication/automatic response