Supernova Survey with KWFC

KWFCによる
超新星サーベイ

Masaomi Tanaka
田中 雅臣

(IPMU, U Tokyo)

NOAO/AURA/NSF
Bob Ferguson and Richard Desruisseau/Adam Block

Contents

- What is Supernova?
- Supernova Survey
  - Past and on-going surveys in the world
- Supernova Survey with KWFC
  - Science cases (see also Morokuma-san's talk)
- Summary

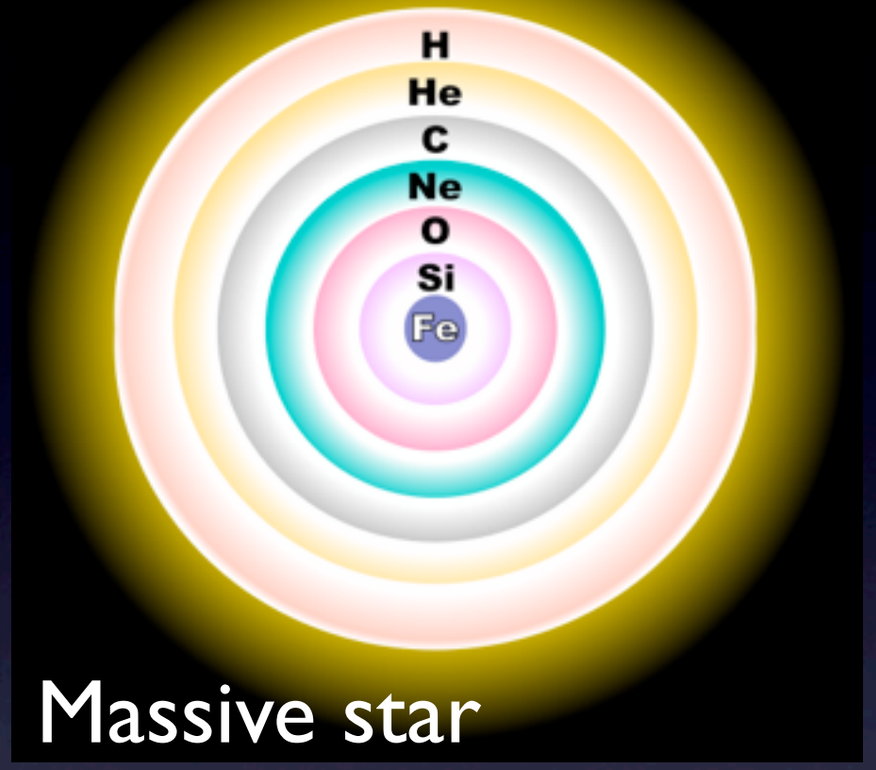
Type Ia supernova (Thermonuclear SN)

Standard candle

<u>Progenitor system</u>

Nucleosynthesis
(Fe, Si)

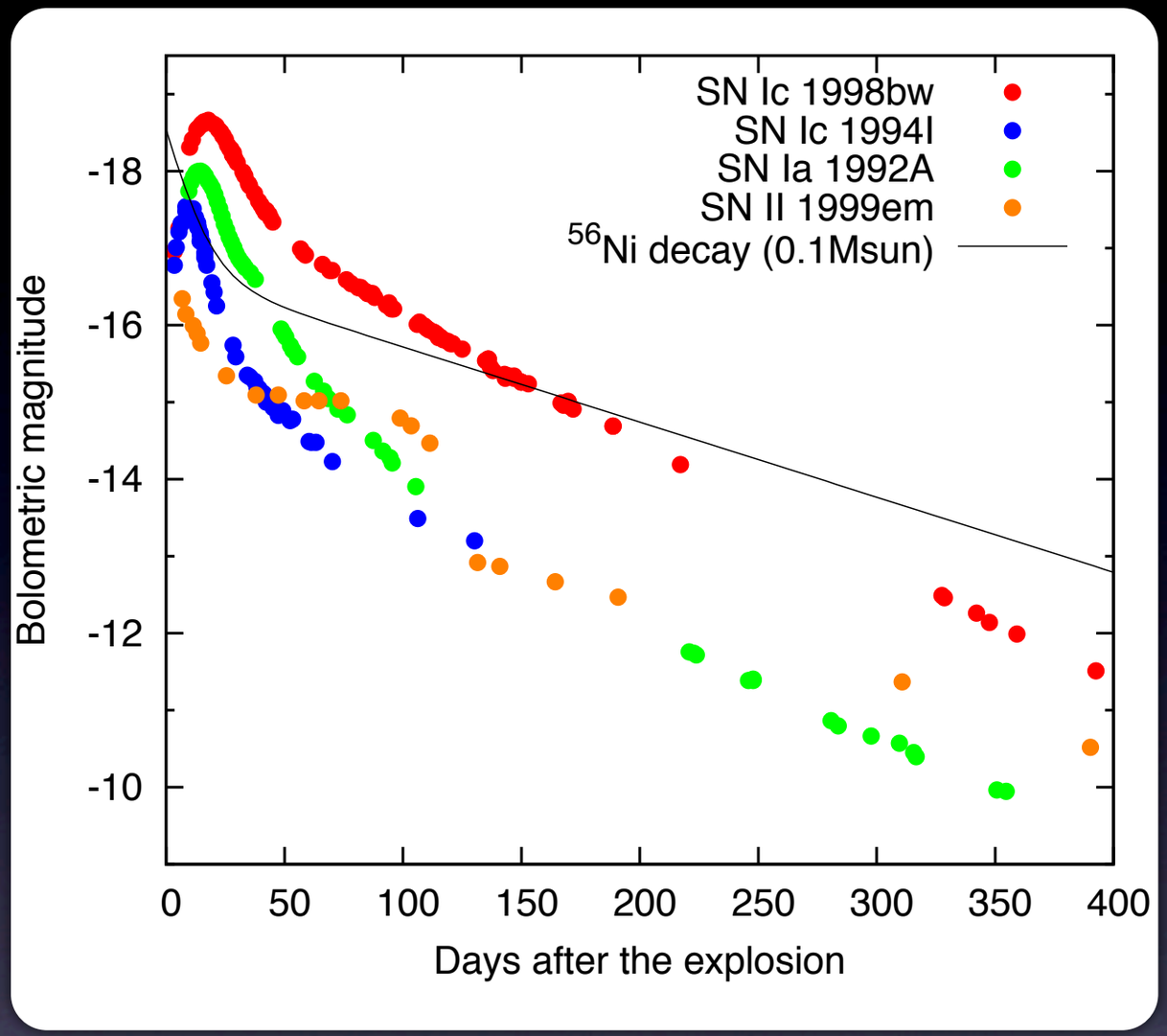
Core-collapse supernovae

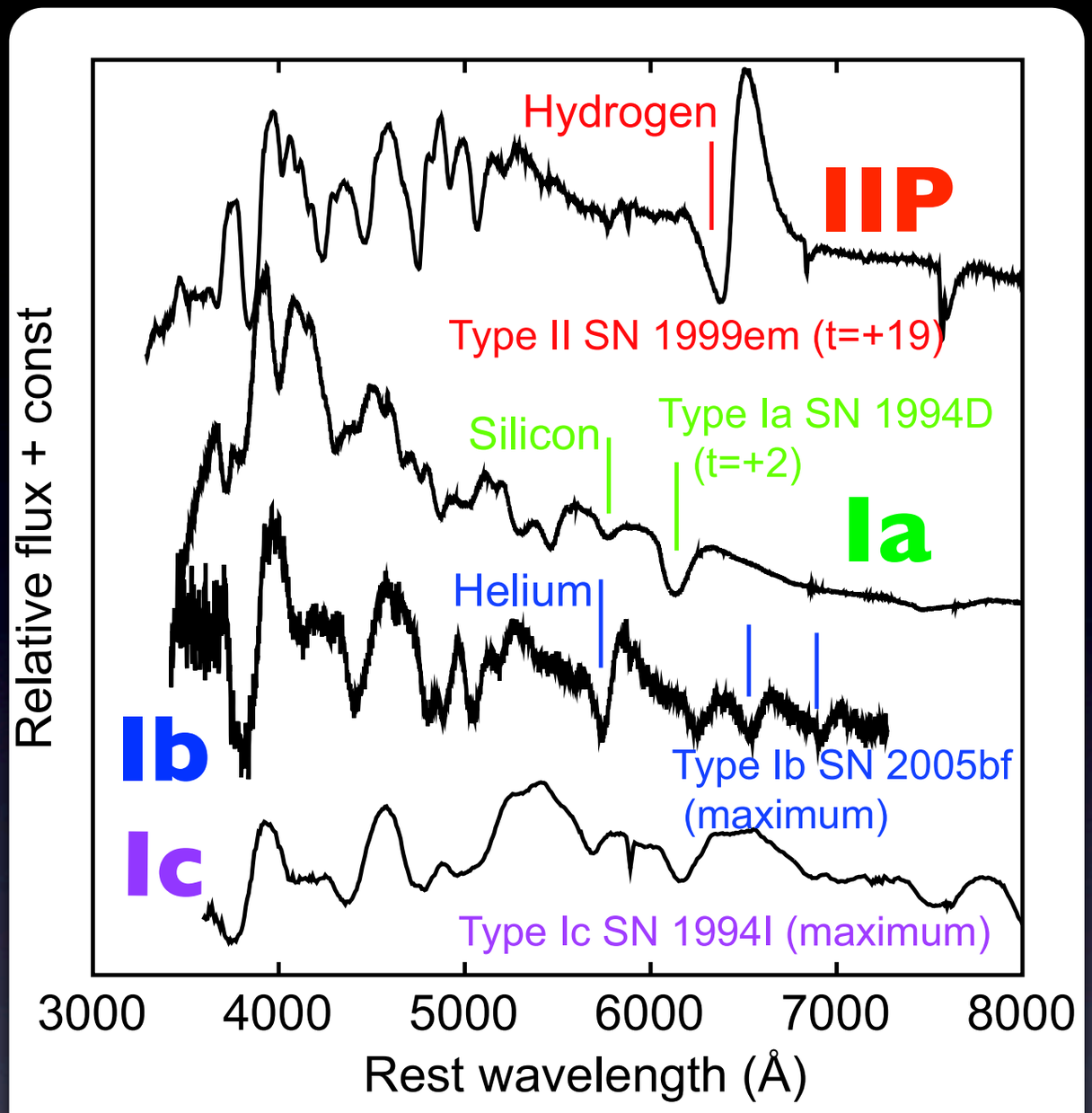


Explosion mechanism

<u>Progenitor star</u>

Nucleosynthesis
(C, O, Ne, Mg)





Survey with ~ 21 mag depth

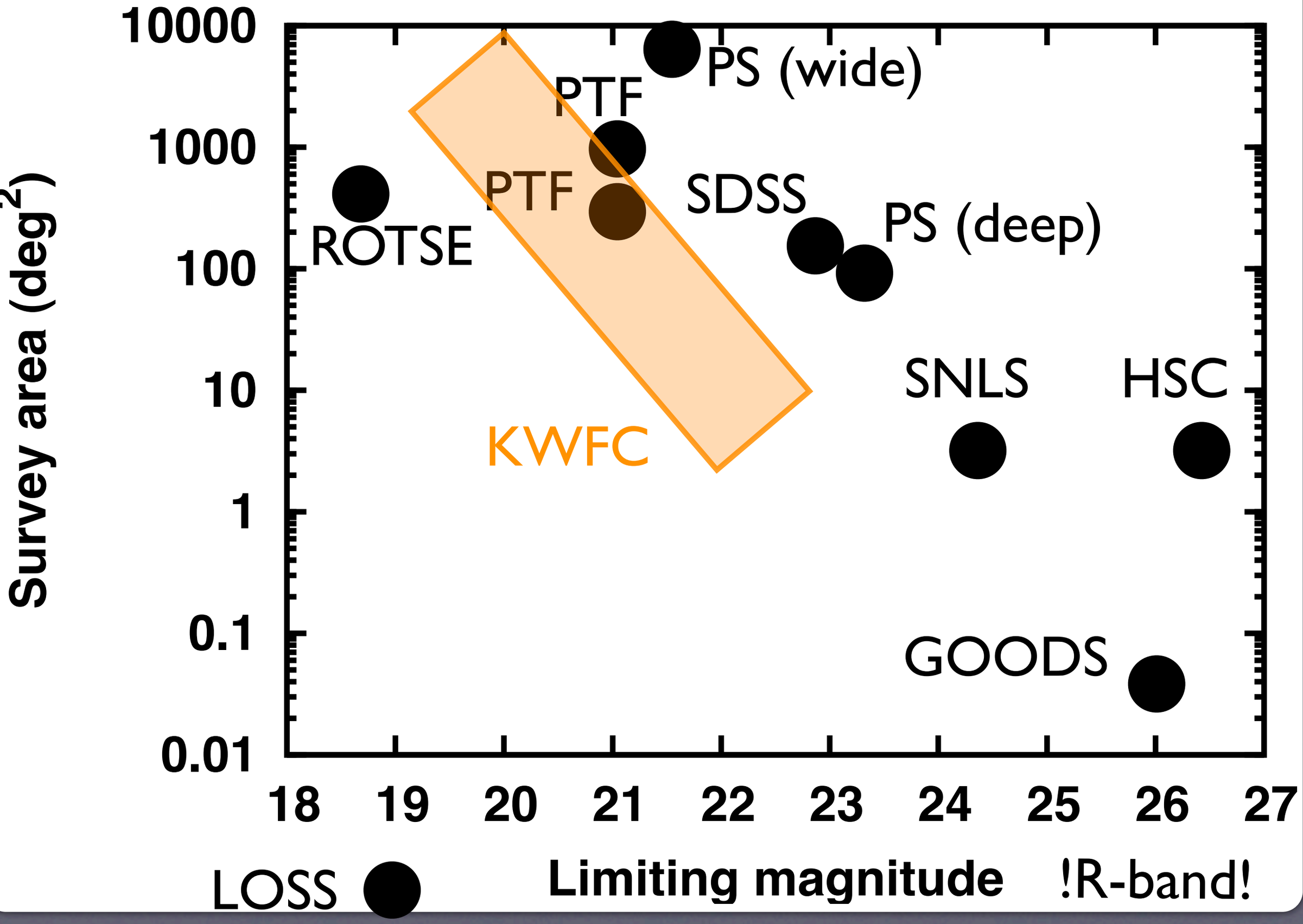
Type Ia SNe @ z~ 0.2 (μ~40, d~ 1 Gpc)

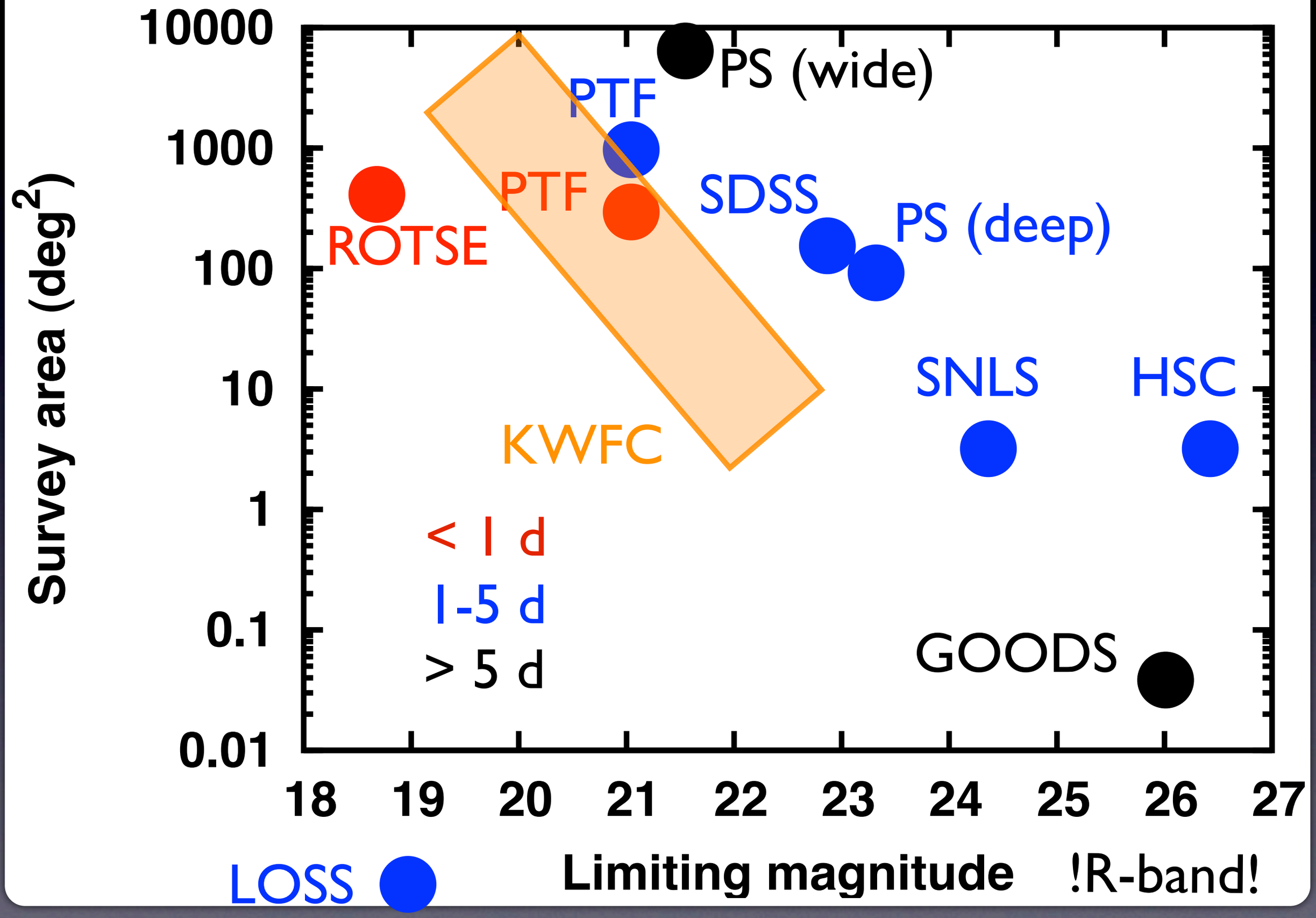
Core-collapse SNe @ z ~ 0.05 (μ~37, d~200 Mpc)

Supernova Survey

Survey	Diameter (m)	FOV (deg^2)	Depth (R mag)	Area/day (deg^2)
LOSS	0.76	0.01	19	1000 galaxy
ROTSE-III	0.45	3.42	18.5	450
PTF	1.26	7.8	21	1000
Pan-STARRS	1.8	7	21.5	6000
SDSS-II	2.5	1.5	22.6	150
SNLS	3.6	1	24.3	2
GOODS	2.5 (HST)	0.003	26	0.04
HSC	8.2	1.75	26.5	1.75
KWFC	1.08	4		

(partly taken from Rau et al. 2009, PASP, 121, 1334)

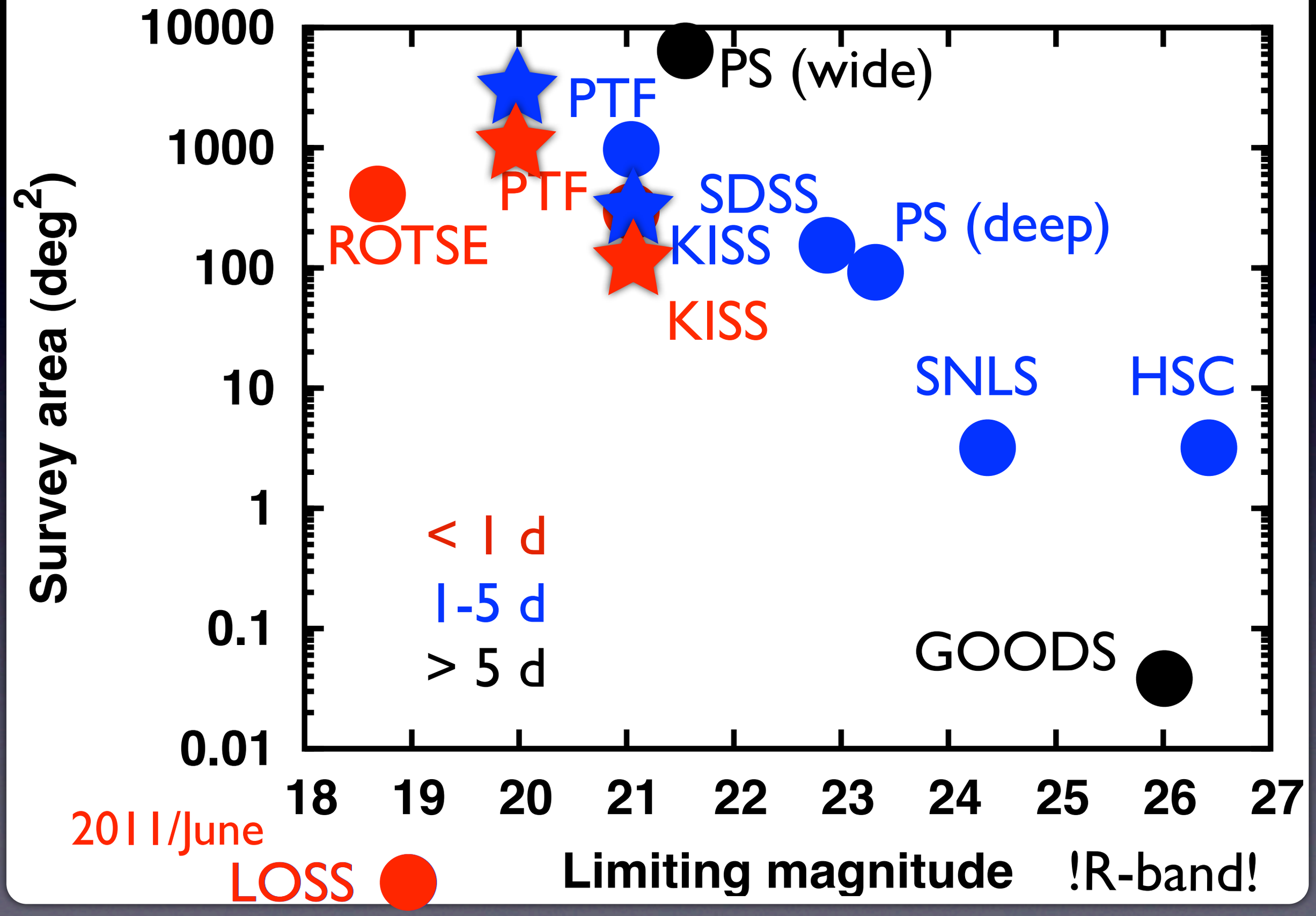

10000
1000
100
10
1
0.1
0.01
Survey area (deg^2)
PS (wide)
PTF
PTF
ROTSE
SDSS
PS (deep)
KWFC
SNLS
HSC
GOODS
18
19
20
21
22
23
24
25
26
27
LOSS
Limiting magnitude
!R-band!


10000
1000
100
10
1
0.1
0.01
Survey area (deg^2)
18
19
20
21
22
23
24
25
26
27
Limiting magnitude
!R-band!
PS (wide)
PTF
PTF
ROTSE
SDSS
PS (deep)
SNLS
HSC
KWFC
GOODS
< 1 d
1-5 d
> 5 d
LOSS

SN Survey with KWFC

KISS: KIso Supernova Survey

- Survey in blue band
  (B or g, possibly + U or u)
- 3-day cadence
  - 15 min exp. (B/g~22 mag) => ~300 deg^2
  - 1.5 min exp. (B/g~21 mag) => ~2700 deg^2
- 1-day cadence
  - 15 min exp. (B/g~22 mag) => ~100 deg^2
  - 1.5 min exp. (B/g~21 mag) => ~900 deg^2

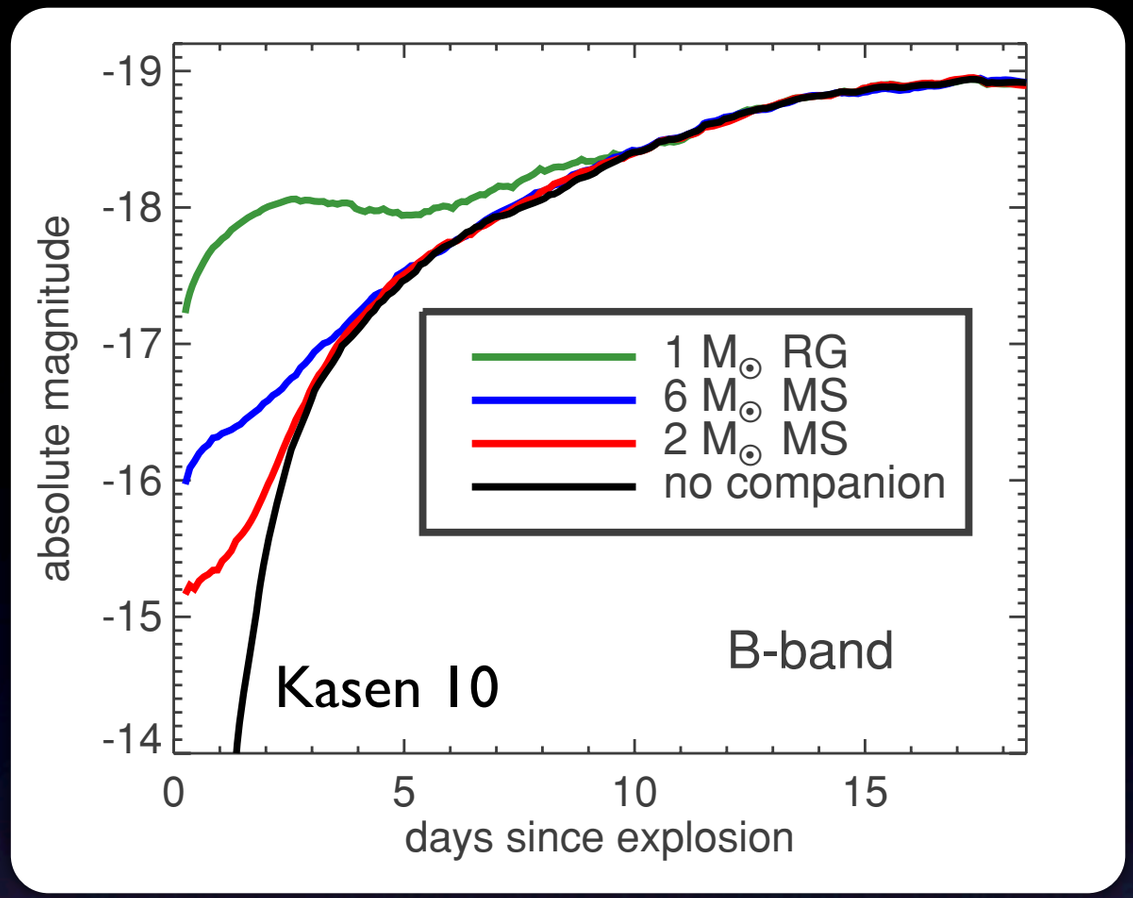

10000
1000
100
10
1
0.1
0.01
Survey area (deg^2)
PS (wide)
PTF
PTF
ROTSE
SDSS
KISS
KISS
PS (deep)
SNLS
HSC
GOODS
< 1 d
1-5 d
> 5 d
18
19
20
21
22
23
24
25
26
27
2011/June
LOSS
Limiting magnitude
!R-band!

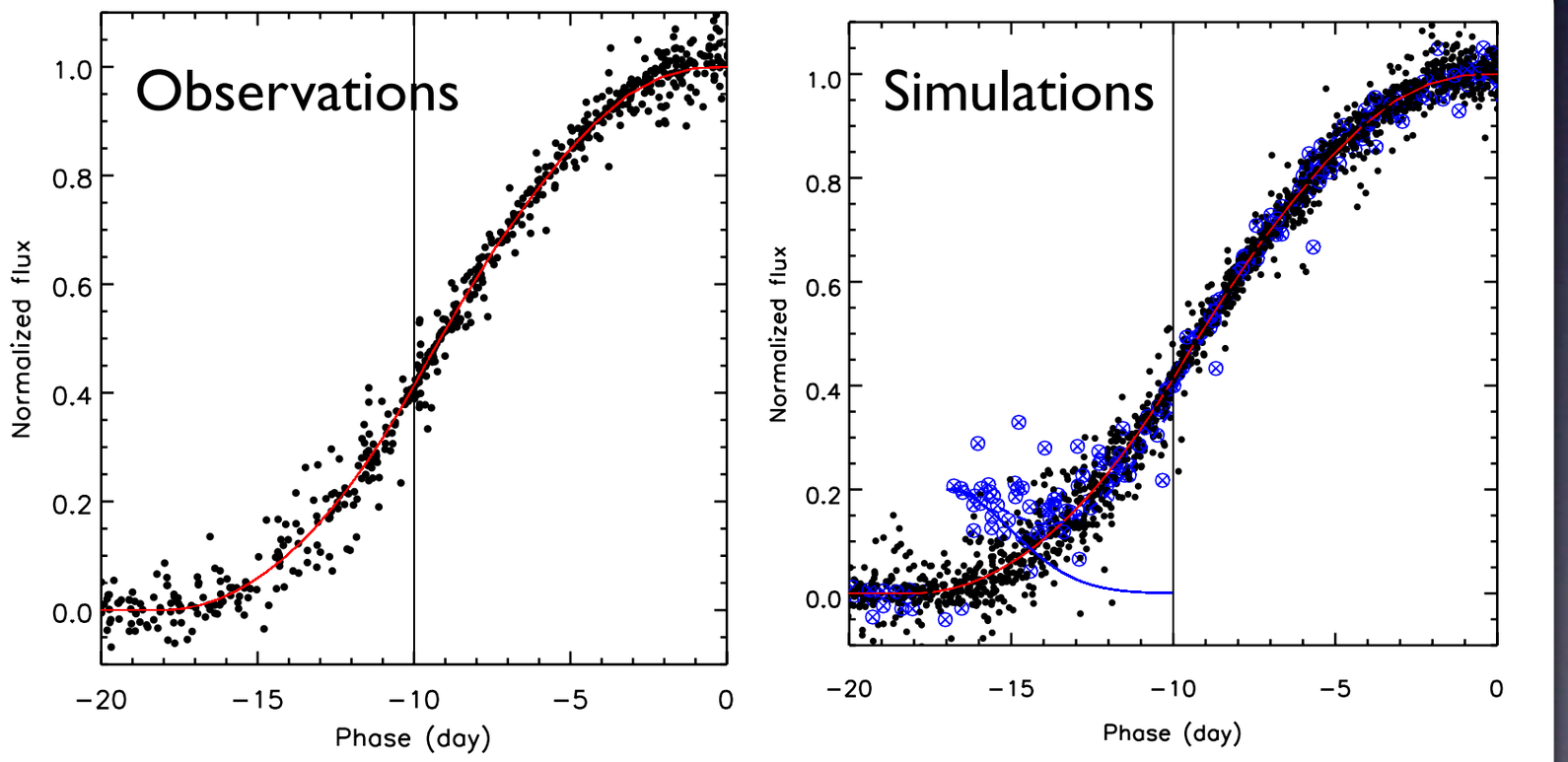
Unsolved Problem
- Type Ia SNe -

V.S.

加藤拓也さん講演

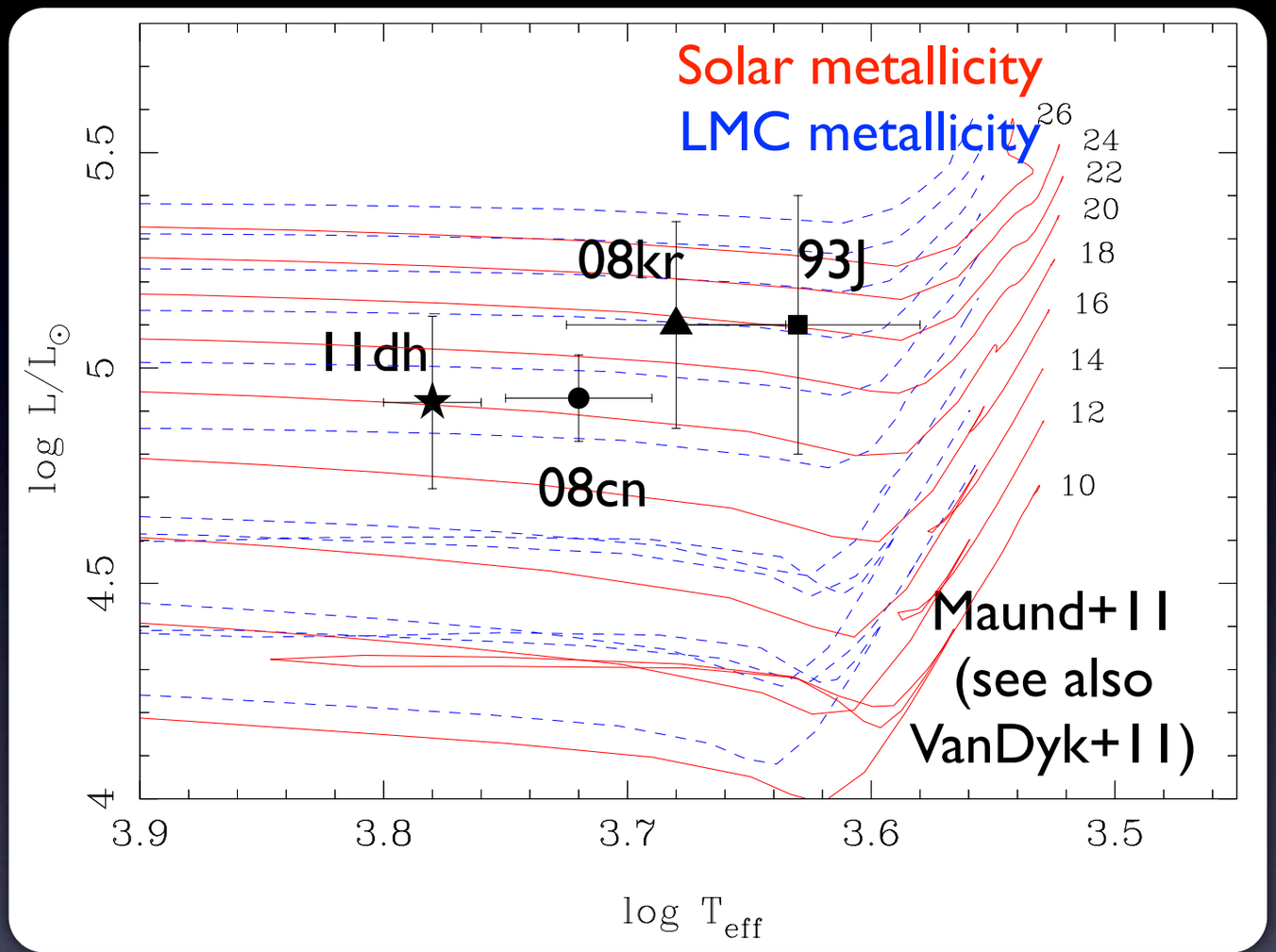
(2010年シュミットシンポ)

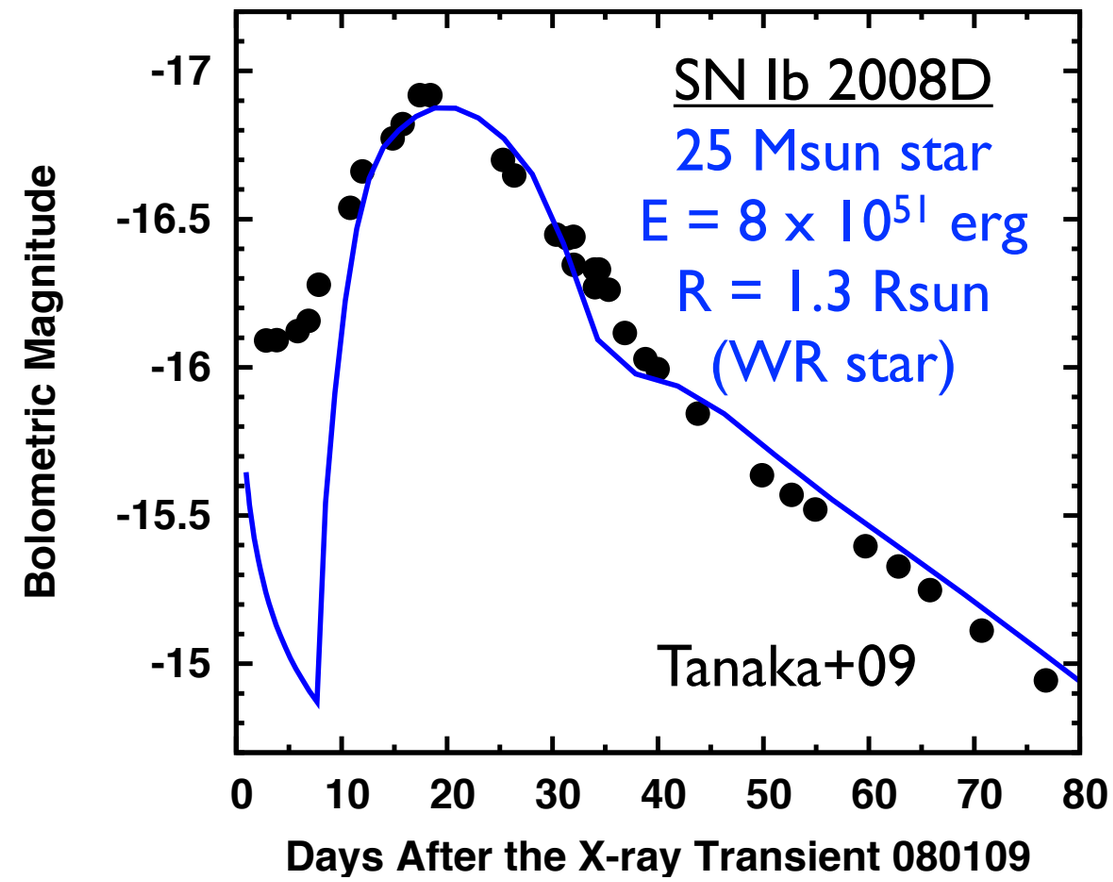




Hayden+10 (SDSS), see also Bianco+11 (SNLS)

Unsolved Problem
- Core-Collapse SNe -





Progenitor star of
extremely nearby SNe

Radius??

$$L_c = 3.3 \times 10^{42} E_{51}^{0.91} M_0^{-0.74} R_{12} (F_1/1.35)^{-0.17} t_d^{-0.34} \text{ ergs s}^{-1}$$

Chevalier & Fransson 08

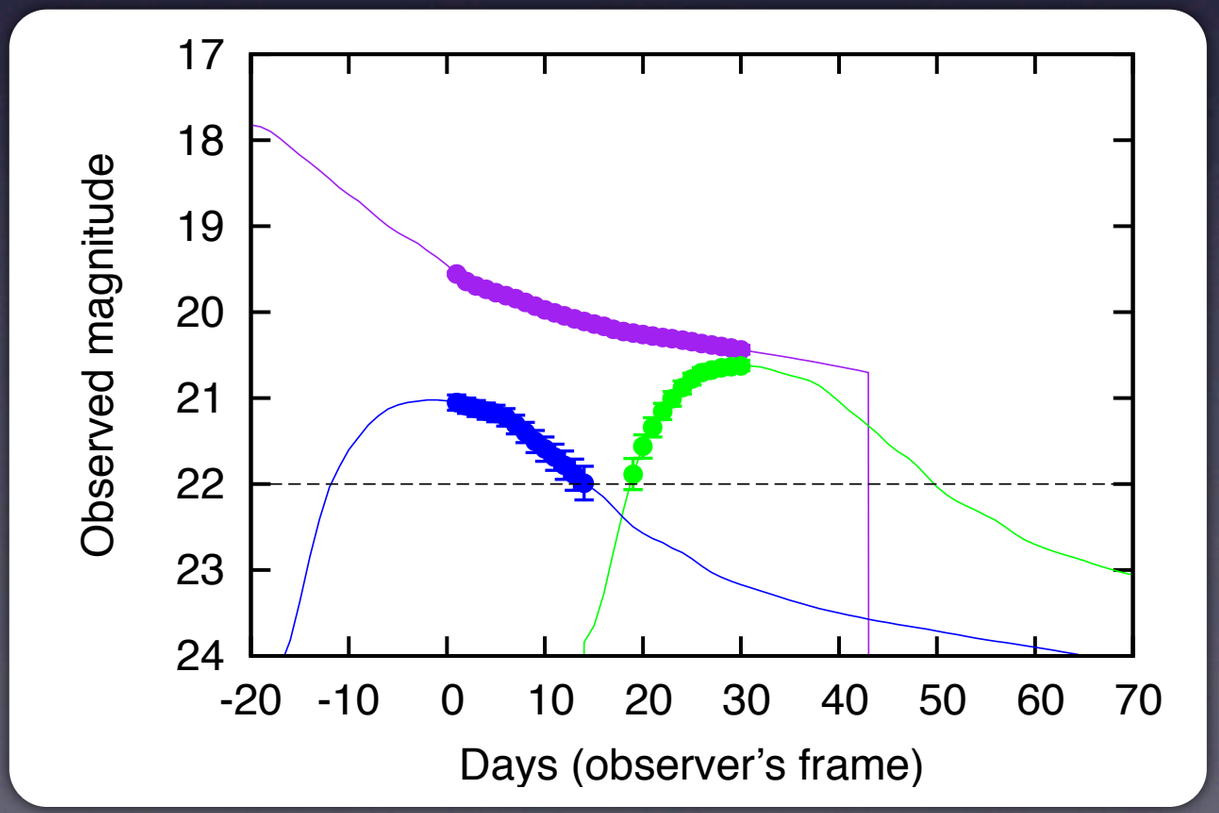
Expected Number of SN Detection

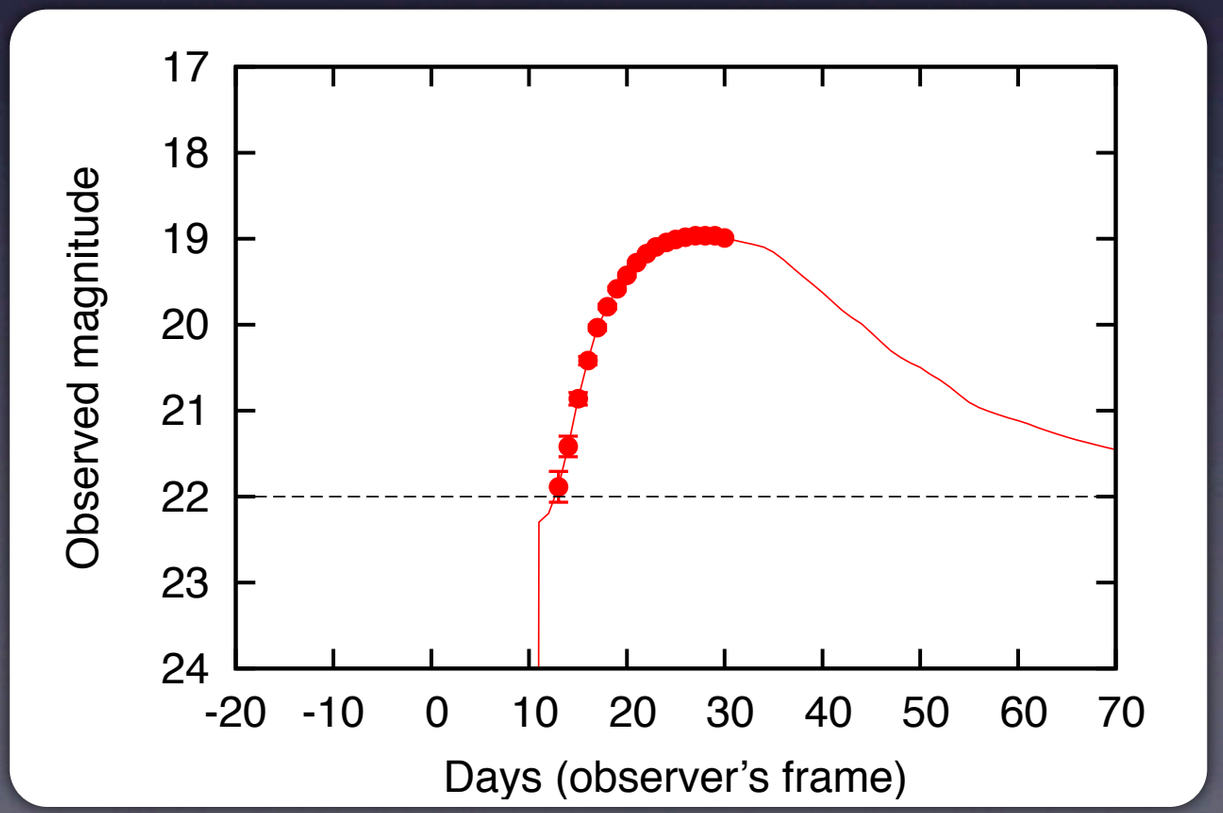
1-month survey (1-day cadence, B-band)

Number in () = Number of discovery at < 5 days after the explosion

	Exp. time (min)	Limiting mag (B/g)	Survey area (deg^2)	# of SN Ia	# of SN IIP	# of SN Ibc
Deep	15	22	100	110 (10)	6 (0.18)	2 (0.04)
Wide	1.5	21	900	300 (18)	15 (0.45)	5 (0.025)

Example of Type Ibc SNe

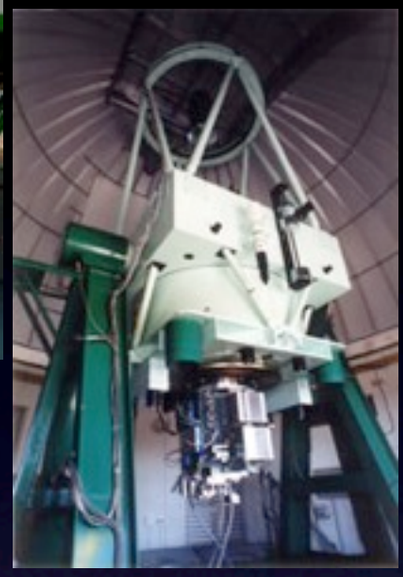




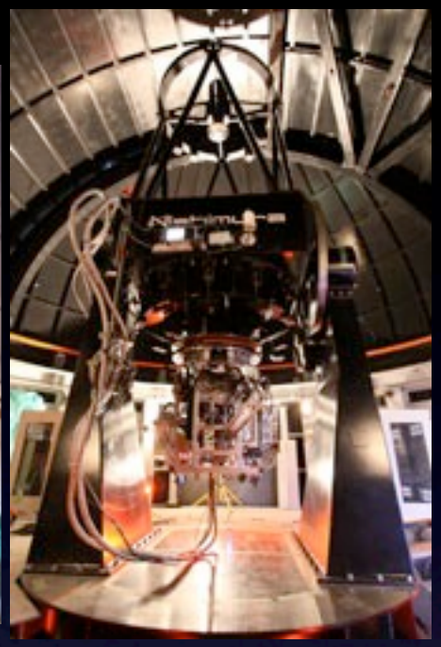
KANATA
(Opt. spec)

Pirika
(Opt. spec)

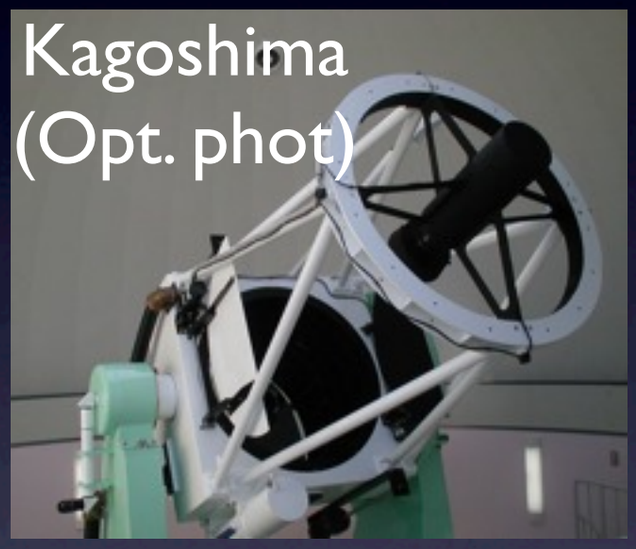
IRSF
(NIR phot)



miniTAO
(NIR phot)

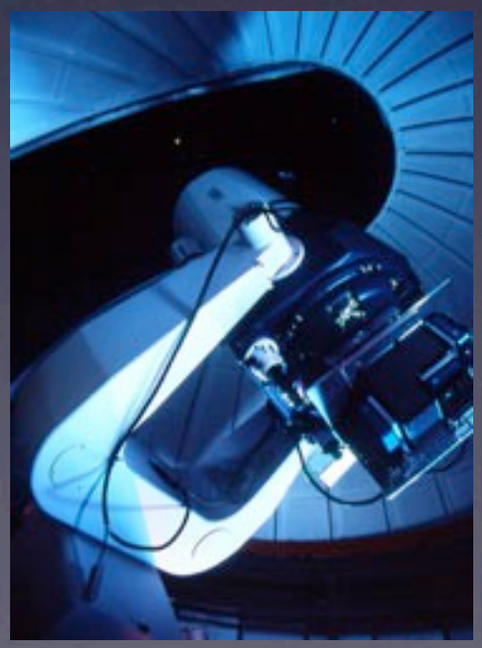


Kagoshima
(Opt. phot)

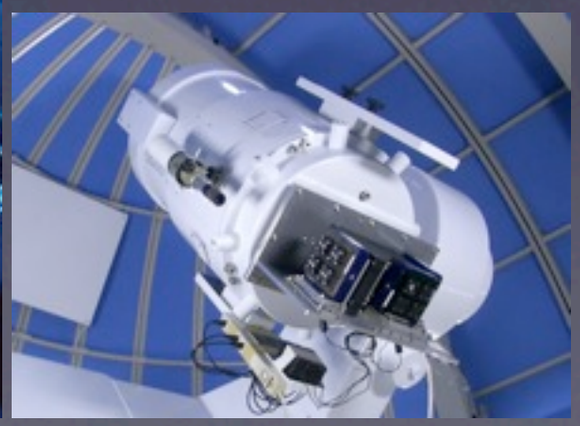


KISO/KWFC
(Opt. survey)

Subaru
(Any)



MITSuME
(Opt. phot)



OAO188
(NIR phot/spec)

KISS: KIso Supernova Survey

- **High cadence!!**
  - Competition in the "time" domain
- Catch the very moment of SN explosion
  - Radius of the massive stars
    at the very final stage of the evolution
  - Progenitor of Type Ia SNe
- Expected Results with KISS (# in 1 month)
  - Deep: (=> Morokuma-san's talk)
    * Core-collapse SNe ~ 10 (~0.2 very early detection, 0.04 SNe Ibc)
    * Type Ia SNe ~ 100 (~10 very early detection)
    (!!strongly affected by the bad weather!!)
  - Wide:
    * Core-collapse SNe ~ 20 (~0.5 very early detection, 0.025 SNe Ibc)
    * Type Ia SNe ~300 (~20 very early detection)