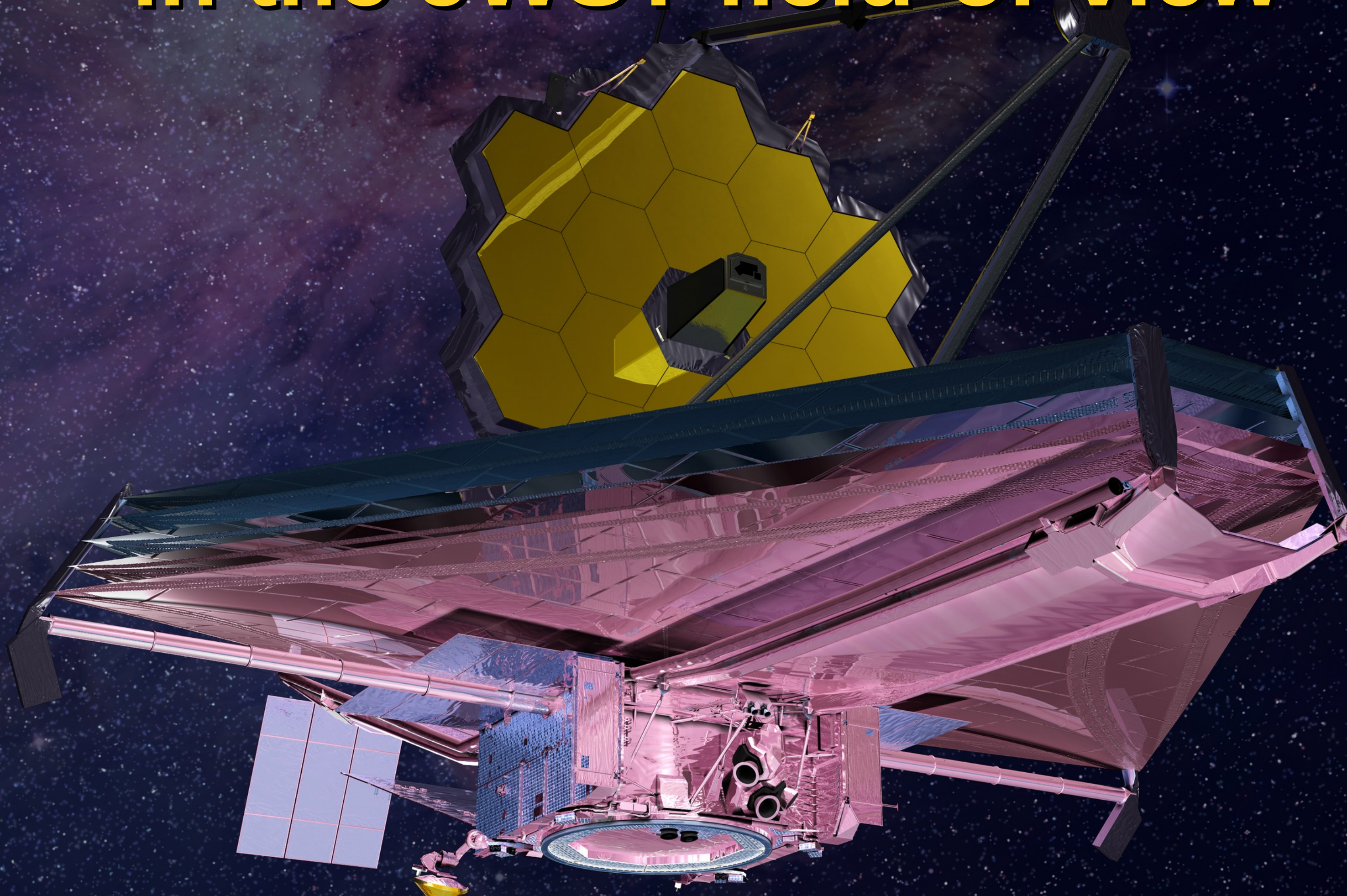
Low-redshift Supernovae
in the JWST field-of-view



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Survey strategy

Field area: ~400 arcmin^2 (~ 50 pointings)

Field position: Continuous Viewing Zone
(+/- 5 deg from ecliptic pole)

Detector: NIRcam

Filters: F200W (Short Wavelength Channel)
F444W (Long Wavelength Channel)

Cadence: 2 epochs, separated by 3 months

Low-z Supernovae

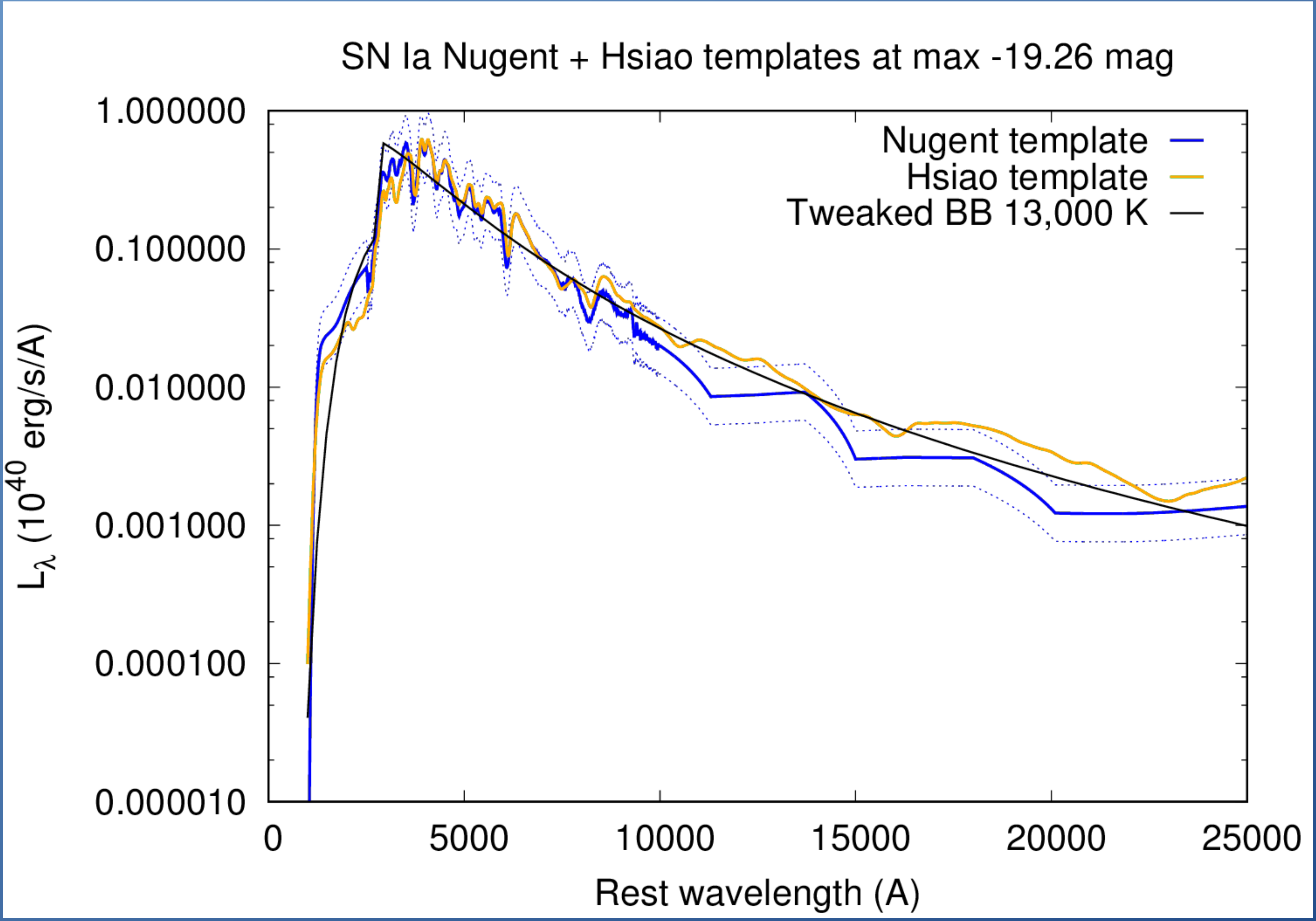
Low-z means $z < 6$ in this project

Low-z SNe are contaminating the high-z sample ==> they must be filtered out

But: the $2 < z < 5$ range is also interesting to test the presence of the prompt population of SNe Ia

CC SNe at $z > 1$ can probe the redshift dependence of the cosmic SFH

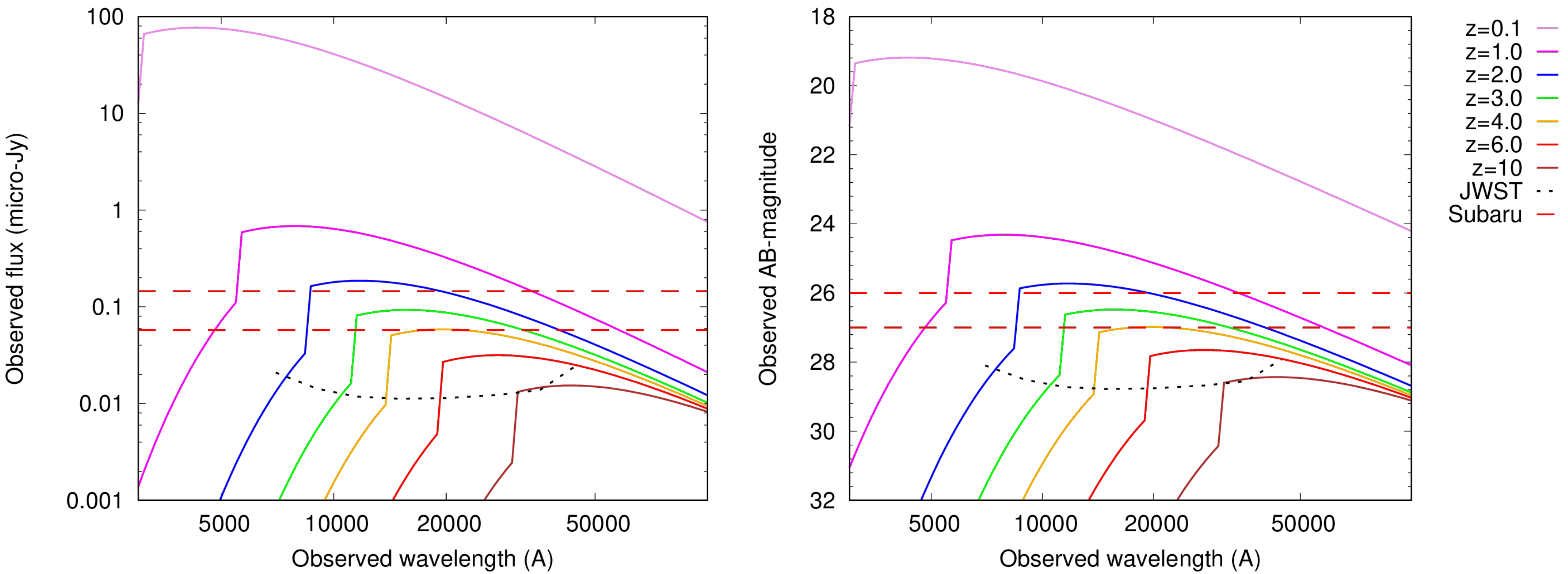
Supernova templates at maximum light



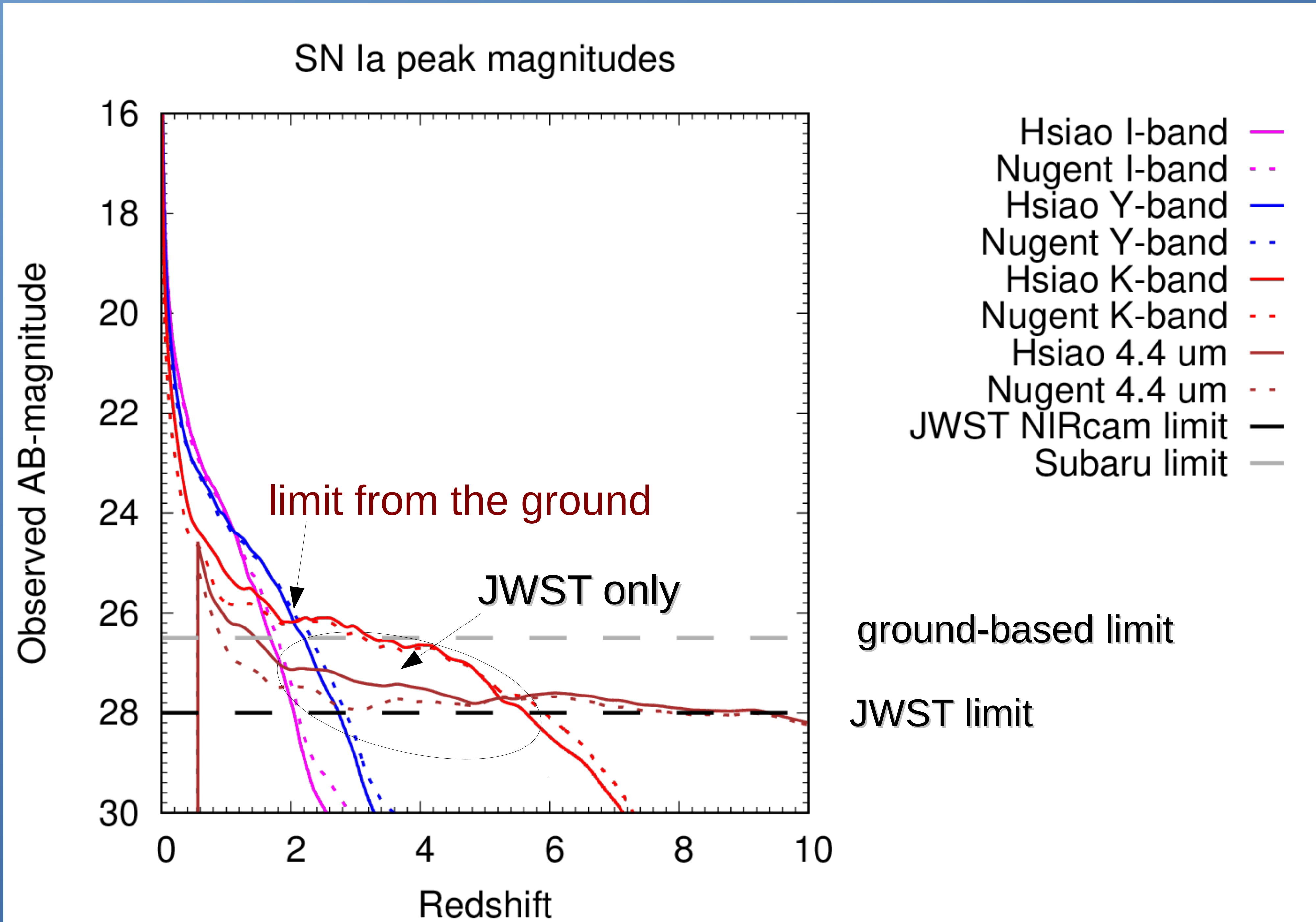
Supernova templates at maximum light

Planck13 cosmology has been adopted:
$H_0 = 67.77 \quad \Omega_m = 0.307 \quad \Omega_\Lambda = 0.693$

SN Ia templates redshifted to 0.1 < z < 10



SN Ia peak AB-magnitudes in different bands



SN Ia peak AB-magnitudes in different bands

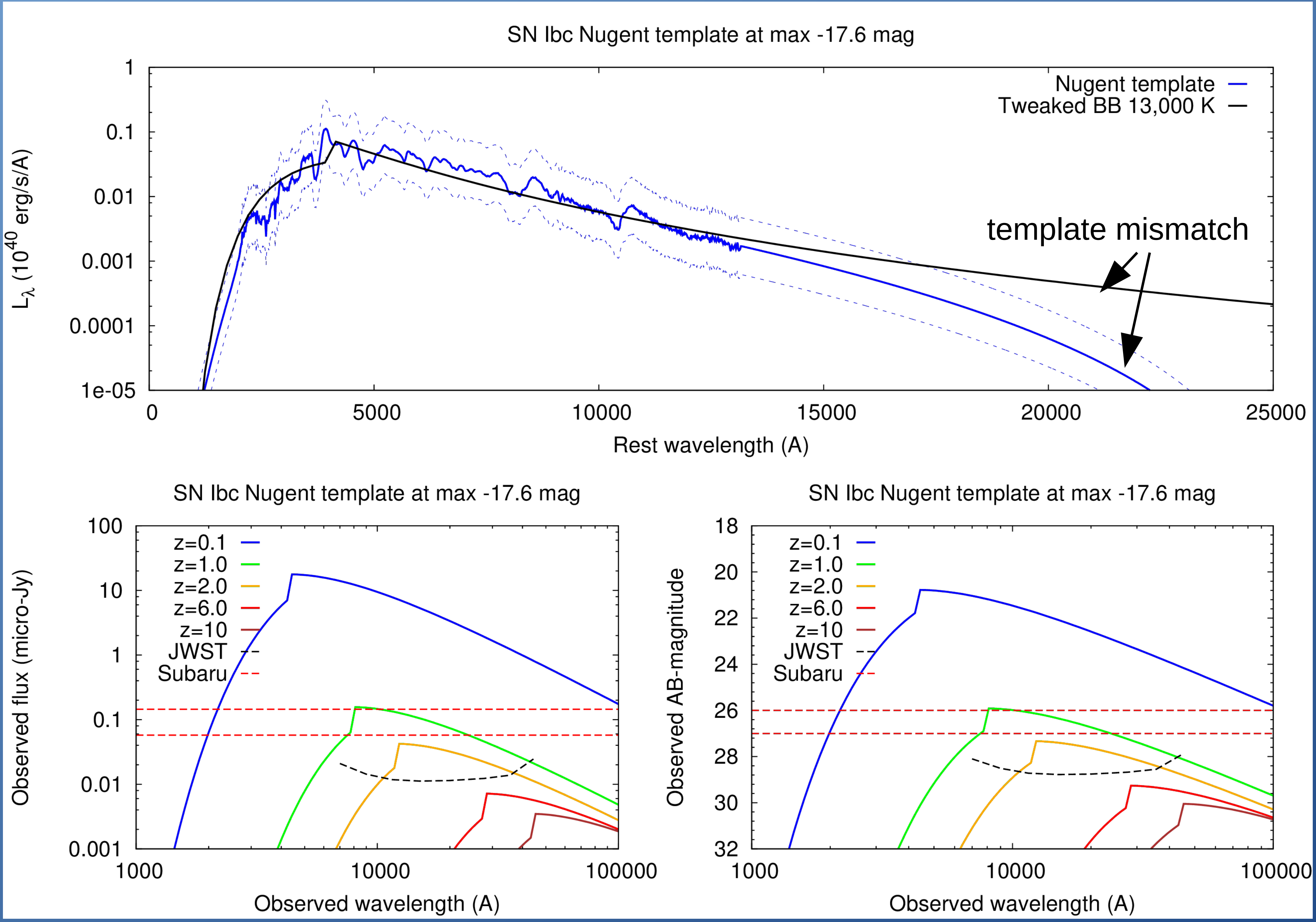
Detection limits (from flux limits only):
- from the ground: z ~ 2.5 (Y-band)
- with JWST: z ~ 5 (K-band), z < 8 (4.4 micron)

Detection in all 3 bands (Y,K,4.4u):
==> maybe a SN Ia at 0 < z < 2

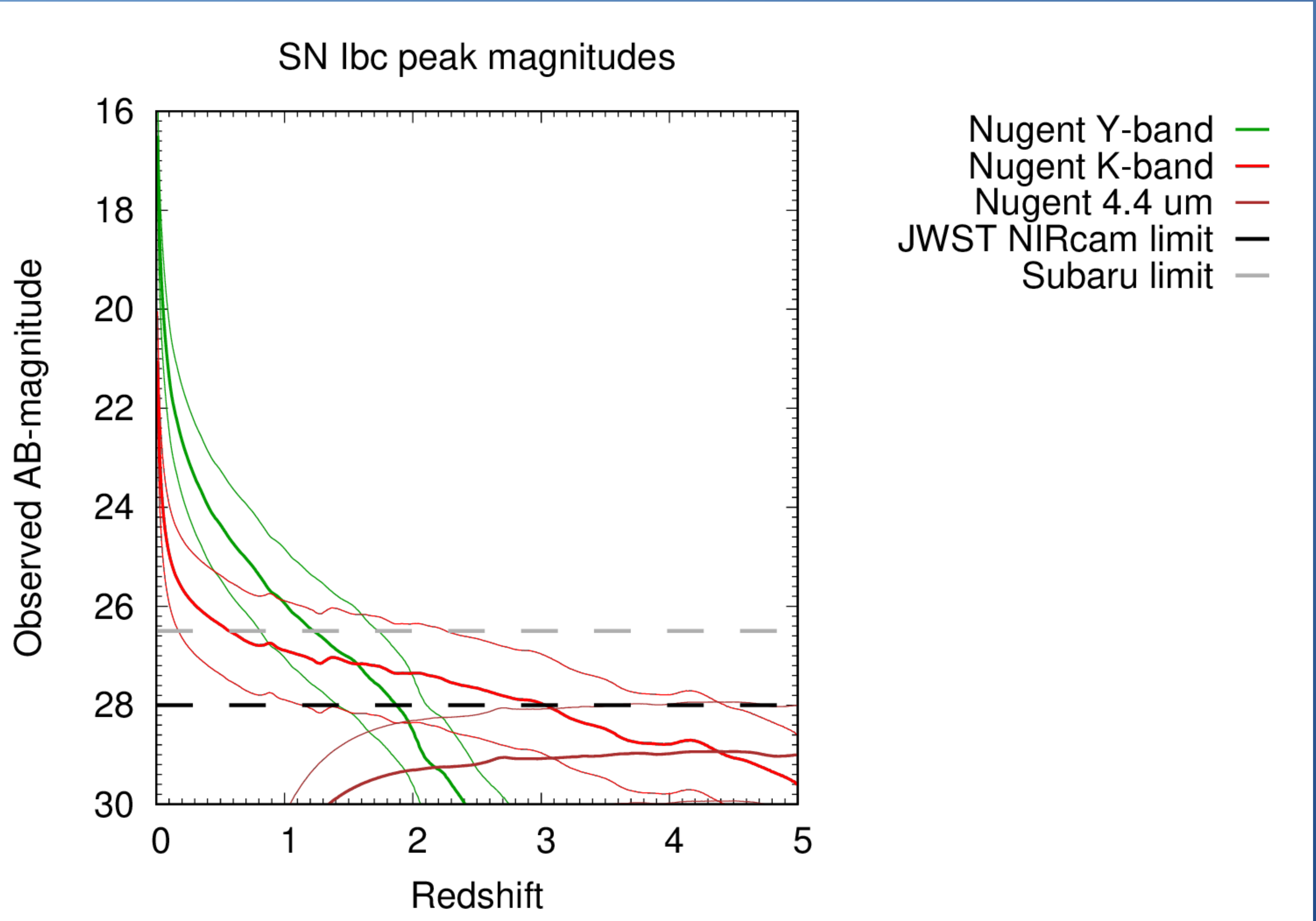
Detection in K, 4.4u, but not in Y:
==> perhaps a SN Ia at 2.5 < z < 5

Might be possible to detect SNe Ia from the prompt explosion channel

SN Ib/c templates redshifted to 0.1 < z < 10



SN Ib/c templates redshifted to 0.1 < z < 5



SN Ib/c templates redshifted to 0.1 < z < 5

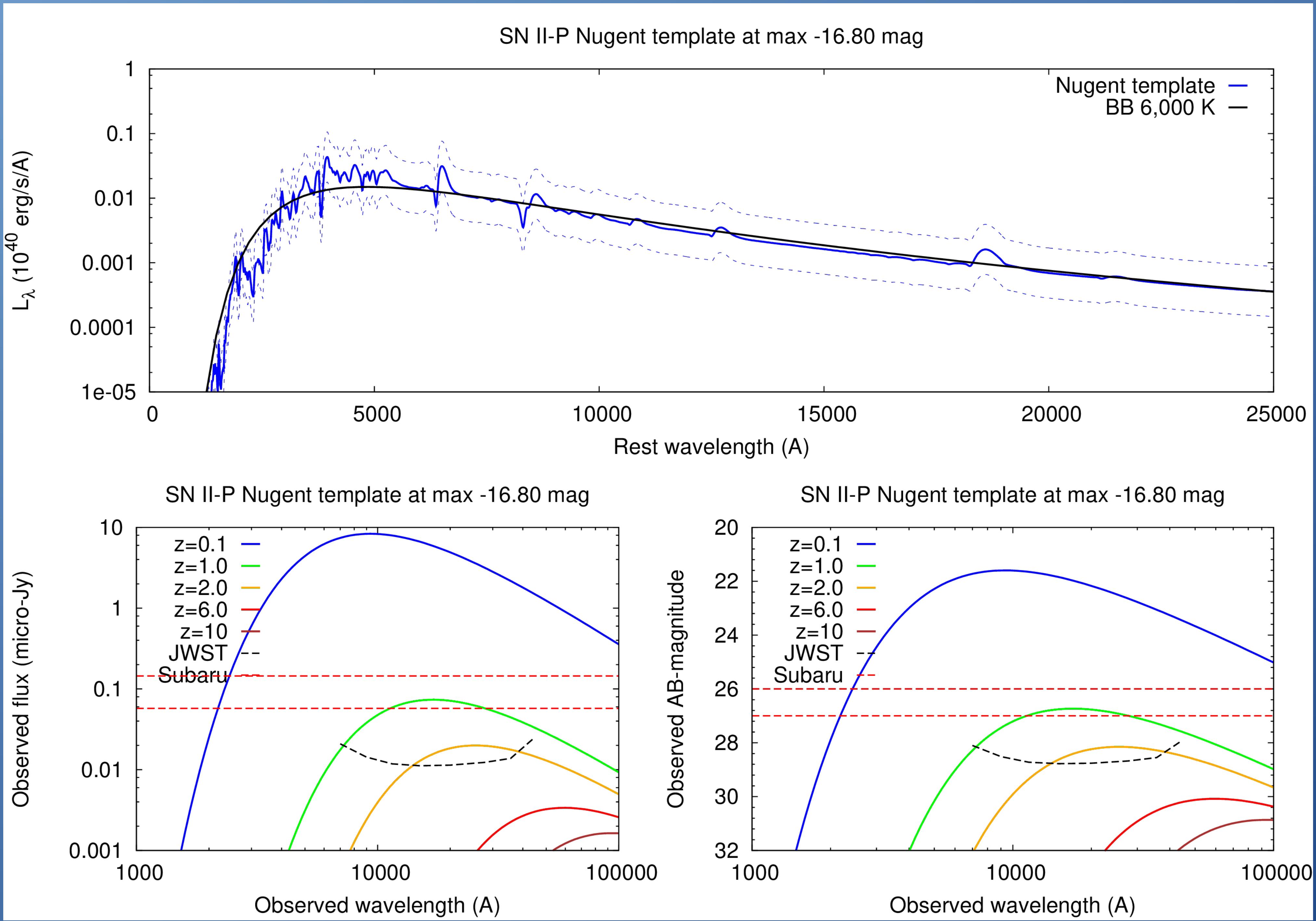
Detection limits (from flux limits only):
- from the ground: z ~ 1 -- 1.5 (Y-band)
- with JWST: z ~ 3 -- 4 (K-band only)
- no detection at 4.4 micron with JWST

==> might be due to poorly known Ibc template

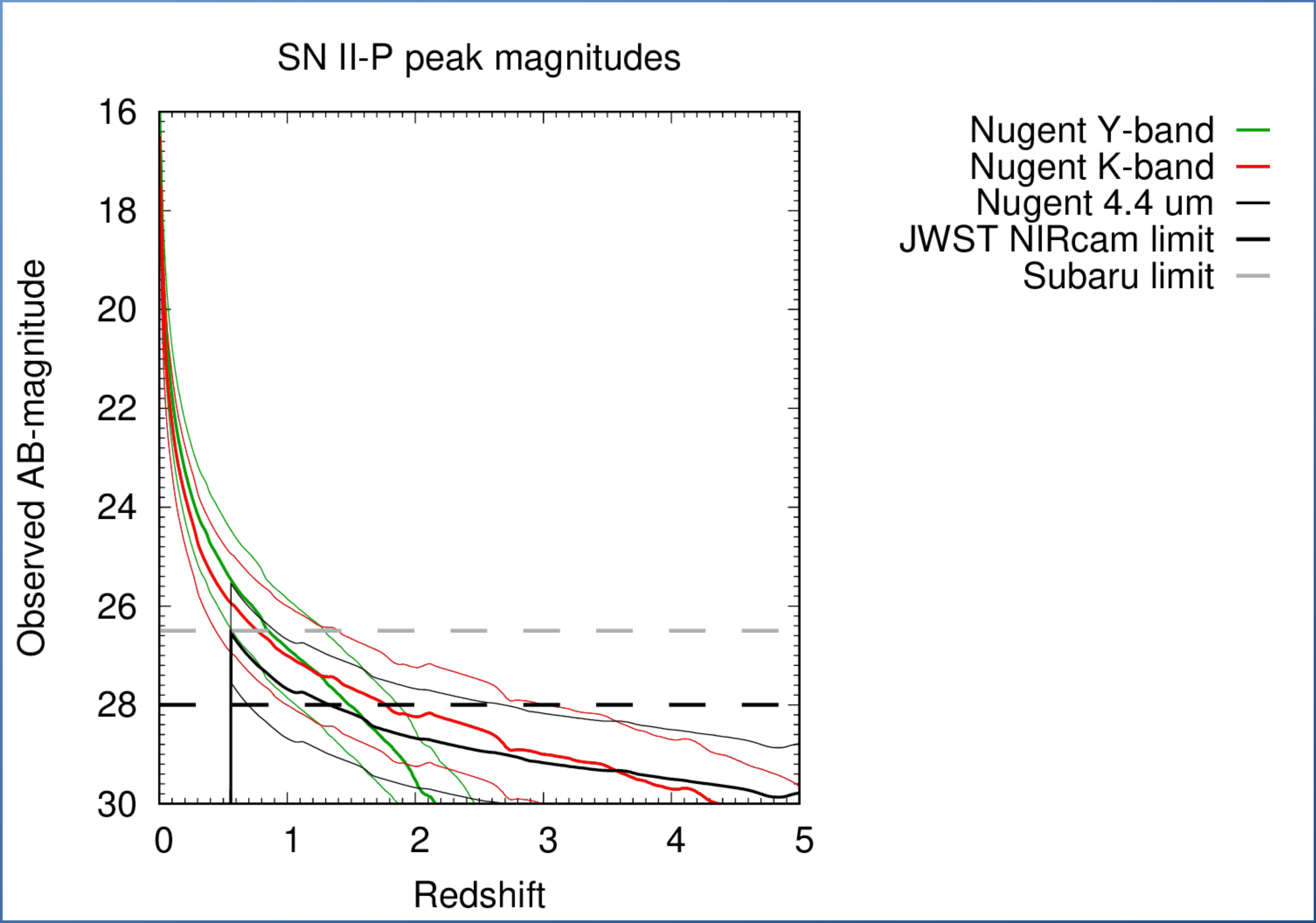
Detection in both K and Y:
==> could be a SN Ibc at z < 1

Detection in K-band only:
==> could be a SN Ibc at 1 < z < 3--4

SN II-P templates redshifted to 0.1 < z < 10



SN II-P templates redshifted to 0.1 < z < 5



SN II-P templates redshifted to 0.1 < z < 5

Detection limits (from flux limits only):
- from the ground: z ~ 1 -- 1.5 (Y-band)
- with JWST: z ~ 2 -- 3 (K-band)
- with JWST: z ~ 1.5 -- 2.5 (4.4u)

Detection in all 3 bands:
==> could be a bright SN II-P at z < 1 -- 1.5

Detection in K and 4.4u, but not in Y:
==> could be a bright SN II-P at 1 < z < 3

Classification

Y-band (1.03 u)	K-band (2.2 u)	F440W (4.4 u)	Possibilities
+	+	+	Ia: 0 < z < 2 II-P: 0 < z < 1 -- 1.5
+	+	-	Ibc: z < 1 (?)
-	+	+	Ia: 2.5 < z < 5 II-P: 1 < z < 3
-	+	-	Ibc: 1 < z < 3 -- 4

+ : detection

- : non-detection

Expected numbers of SNe

work in progress

how many SNe are expected to show up in the survey volume during the survey time

$$N = \sum_i SNR(z_i) \cdot \epsilon_i \frac{T}{1+z_i} dV_i(z_i)$$

T: survey time; z_i: redshift of the i-th bin

$SNR(z_i)$: supernova rate in each bin

$dV(z_i)$: differential comoving volume

ε_i: survey efficiency (set to 1 for now)

Expected numbers of SNe

In general, the supernova rate is

$$SNR(z) = \int SFH(z,t') \cdot DTD(t-t')\,dt'$$

SFH(z,t): star formation history at given z
DTD(t): delay-time distribution for a given SN type

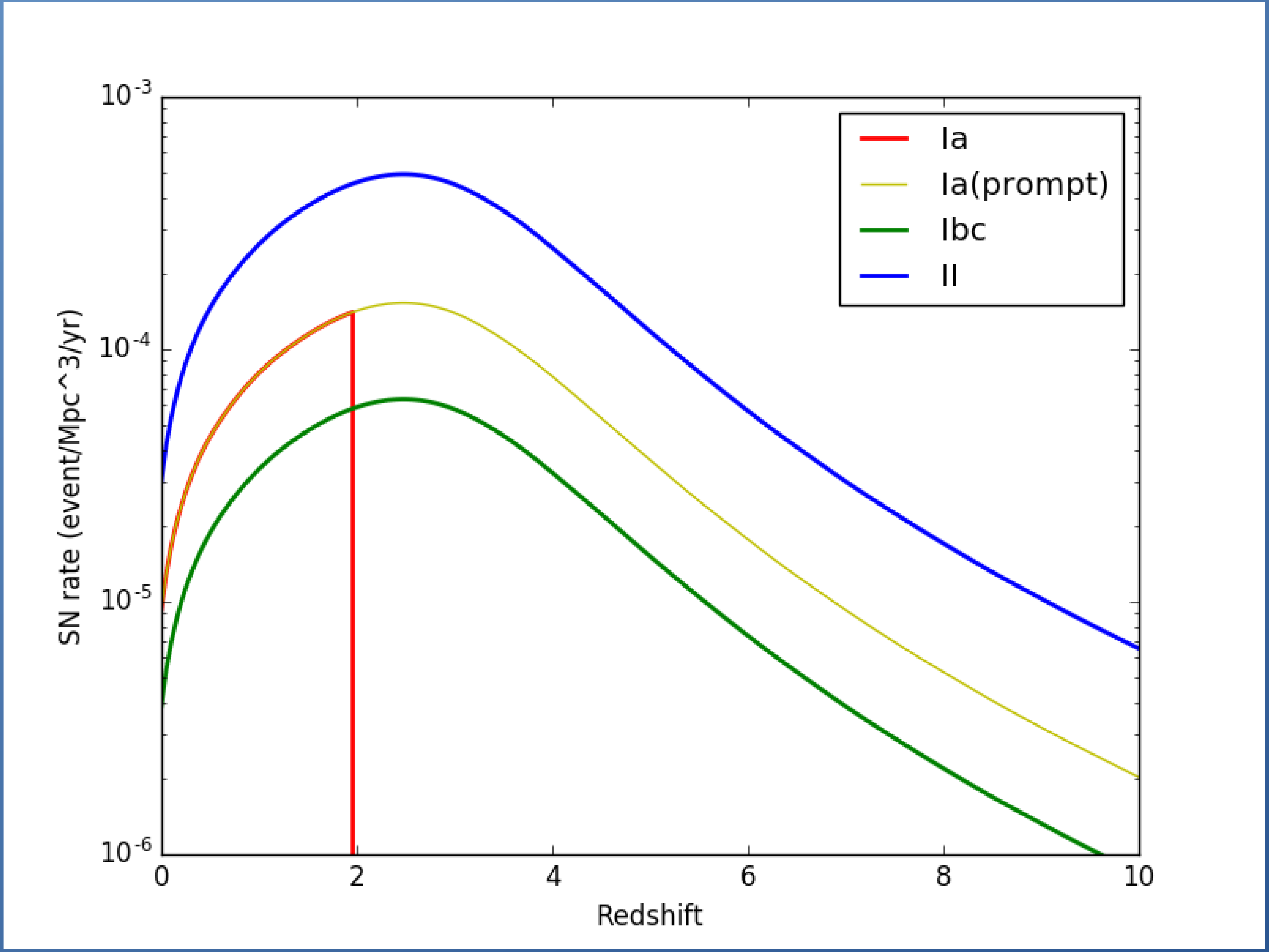
- for CC SNe DTD(t) is assumed as a delta-function
  ==> SNR(z) = SFH(z)

- for Ia SNe DTD(t) is broader ==> the number
  of Ia SNe decrease quickly beyond z > 2

I ignored DTD for Ia-s ==> upper limit for N(Ia)

Expected numbers of SNe

The SFH(z) function was adopted from
Hopkins & Beacon ApJ 651, 142 (2006)



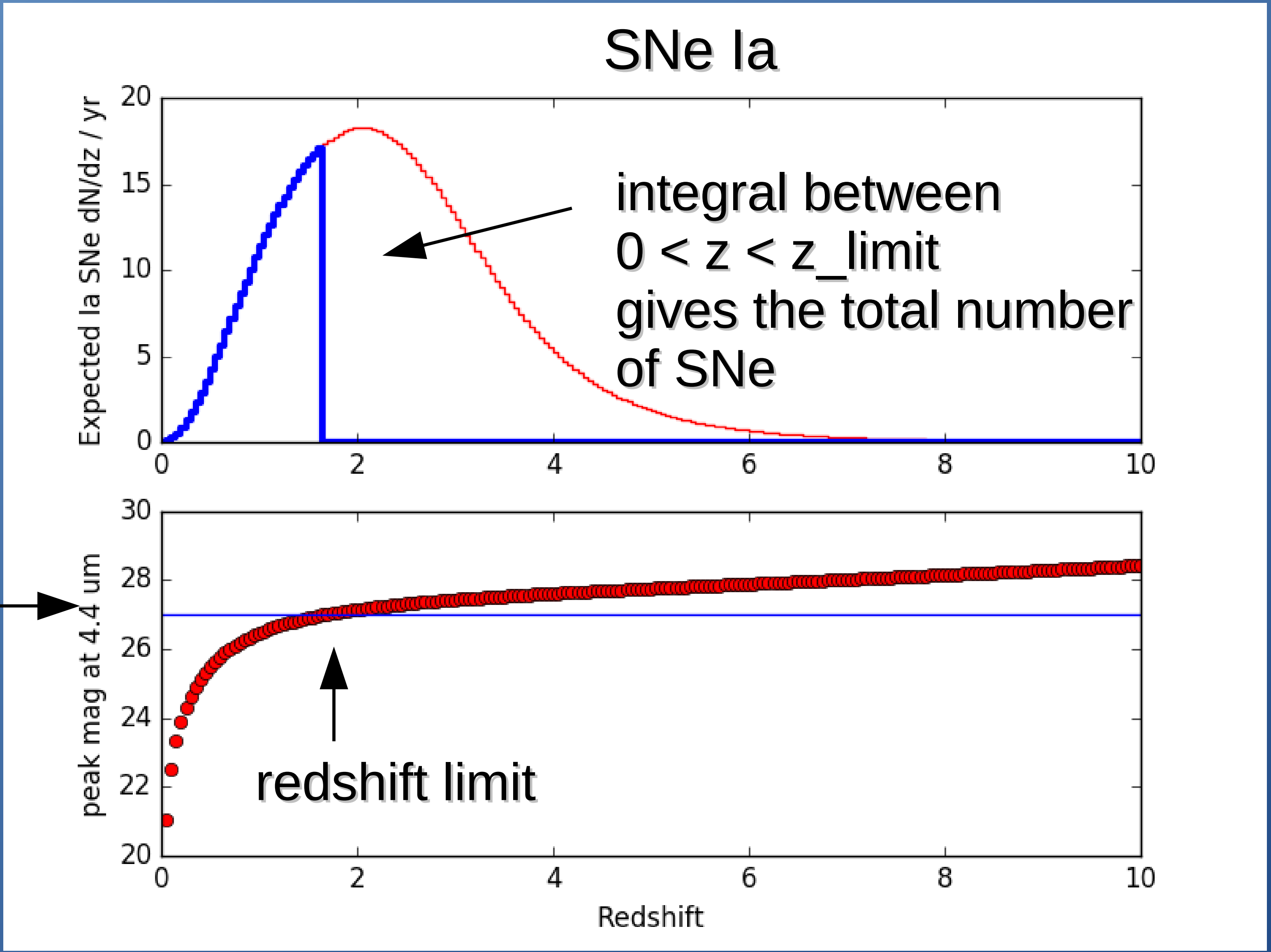
for each SN type the SFH(z) function was scaled to the measured SNR of that type:

SNR(II) = 1.4e-4 at z = 0.3

SNR(Ia) = 4.2e-5 at z=0.3 (Bazin+ 2009)

Expected numbers of SNe

Method of calculation



detection limit

Expected numbers of SNe

Assumed magnitude limits for detection

Filter name	Wavelength (micron)	m_AB
Y (ground)	1.03	26.0
F220W (JWST)	2.2	27.0
F440W (JWST)	4.4	27.0

Expected numbers of SNe

Results

SN type	M_peak (V-band)	N (1.03μ)	z_limit (1.03μ)	N (2.2μ)	z_limit (2.2μ)	N (4.4μ)	z_limit (4.4μ)
Ia w/o promp	-19.3	19	2.0	19	2.0	13	1.65
Ia w prompt	-19.3	23	2.2	45	4.0	13	1.65
Ibc	-17.6	5	0.95	6	1.05	0	--
II	-16.8	4	0.65	16	1.05	4	0.65

These numbers do not contain the effects of sampling (only 2 epochs), peak mag distributions, dust/reddening, etc. Work is still in progress.

Conclusions

We can expect

~ 45 Type Ia SNe at $z < 6$ ($2 < z < 4$ uncertain)
~ 6 Type Ibc SNe at $z < 1$
~ 16 Type II-P SNe at $z < 1$

to appear above the detection limit in the survey volume during the survey time (~ 100 days).

We will not detect many of them due to the limited sampling (only 2 epochs).

Next step will be the estimate of the sampling.