

International Science Development Teams (ISDT)

Time-domain Science

Masaomi Tanaka

(National Astronomical Observatory of Japan)

ISDT members

- **Initial member (2013 May) <= From each partner**
 - **G. C. Anupama (India) Convener (will join later via skype)**
 - **Lucas Macri (US)**
 - **Enrico Ramirez-Luiz (UC)**
 - **Masaomi Tanaka (Japan) Convener**
 - **Xiaofeng Wang (China)**
- **New members (2014 Feb) <= Call for application (2014 Jan)**
 - **Manjari Bagchi (India)**
 - **Varun Bhalerao (India)**
 - **U. S. Kamath (India)**
 - **Keiichi Maeda (Japan)**
 - **Shashi Pandey (India)**
 - **Warren Skidmore (US) Chapter editor**
 - **Nozomu Tominaga (Japan)**
 - **Lingzhi Wang (China)**
 - **Chao Wu (China)**
 - **Xufeng Wu (China)**

Update of Detailed Science Case (2014 July)

1. Introduction
2. Overview
3. Fundamental physics and cosmology
4. The early Universe
5. Galaxy formation and the intergalactic medium
6. Extragalactic supermassive black holes
7. Exploration of nearby galaxies
8. The formation of stars and planets
9. Exoplanets
10. Our solar system

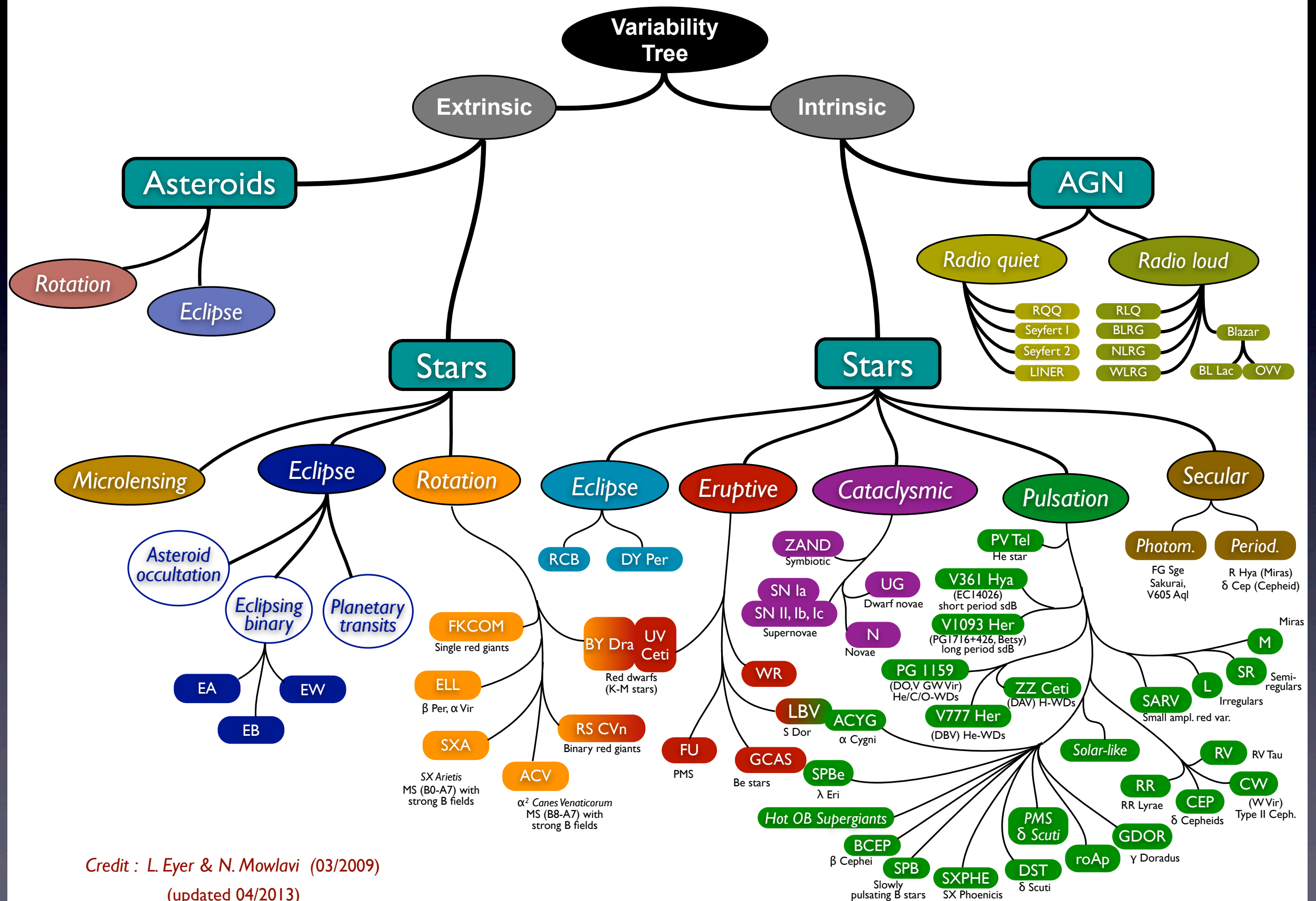
No section for time-domain science

Thirty Meter Telescope
Detailed Science Case: 2007

TMT Science Advisory Committee



Time-domain science??



Credit : L. Eyer & N. Mowlavi (03/2009)
(updated 04/2013)

DSC 2014 draft

Type Ia SN

Core-collapse SN

SN progenitor

GW sources

GRBs

Tidal disruption

CVs

Radio pulsars

Cepheids

5. TIME-DOMAIN SCIENCE	53
5.1 Overview.....	53
5.2 Understanding the Nature of Type Ia Supernovae	54
5.2.1 Characterizing high-z Type Ia Supernovae: Towards a Better Standard Candle	54
5.2.2 Unveiling Explosion Mechanism of Type Ia Supernovae	55
5.3 Identifying Shock Breakout of Core-Collapse Supernovae.....	56
5.4 Tracing high-z Universe with Supernovae.....	57
5.5 Hunt for Progenitor Systems of Supernovae.....	58
5.5.1 Detecting Progenitor and Companion of Supernovae	58
5.5.2 Characterizing Circumstellar environment around Supernovae.....	59
5.5.3 Probing the Final Stages of Massive Star Evolution: LBVs and Supernova Impostors.....	60
5.6 Identification of Gravitational-Wave Sources	60
5.7 Understanding Progenitors of Gamma-ray Bursts: Connection to Supernovae and Kilonovae	61
5.8 Probing High-z Universe with Gamma-ray Bursts	62
5.9 Studying Tidal Disruption Events and Supermassive Black Holes.....	63
5.10 Cataclysmic Variables.....	64
5.10.1 Investigating the Dissipative Process in Cataclysmic Variable Accretion Discs and Disc Evolution During Outburst Cycles	65
5.10.2 Revealing Geometry and Populations of Classical Novae	66
5.11 Companions of Binary Radio Pulsars.....	67
5.12 Improving the Hubble Constant and Measuring Extragalactic Distances	68
5.13 Summary of Requirements	69
5.14 References	72

Time-domain science??

**Target of opportunity
observations**

Type Ia SN

GW sources

Tidal disruption

Core-collapse SN

GRBs

Classical novae

**Rapid response
(telescope, operation)**

**Time-resolved
observations**

**CVs, X-ray binary
(accretion disk)**

Pulsars

**Rapid sampling
(instruments)**

**Monitoring
observations**

**Cepheids
Binaries**

**RR Lyrae
AGNs**

**Flexible
time allocation**

ToO observations => “transient” objects

Theoretically expected

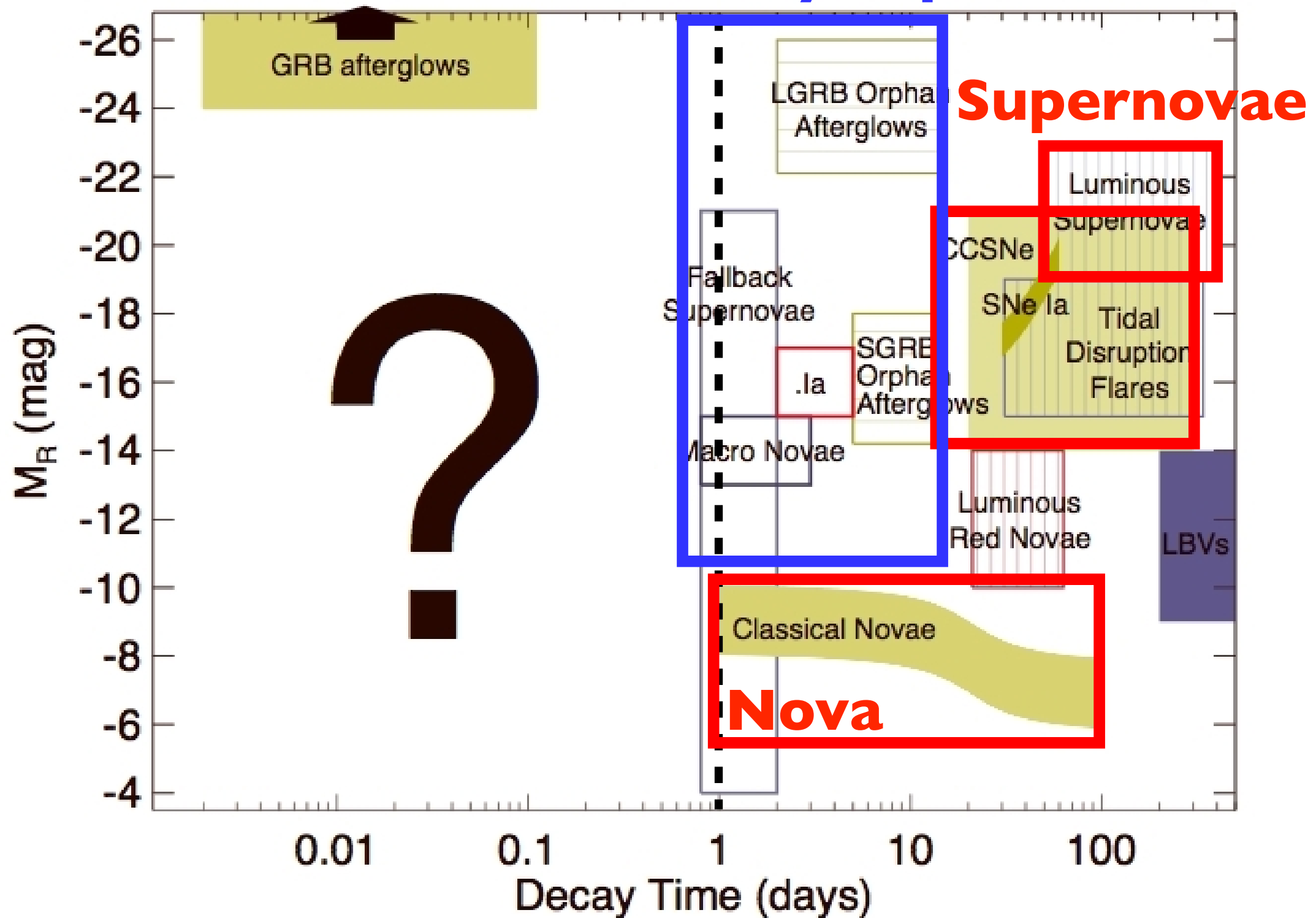
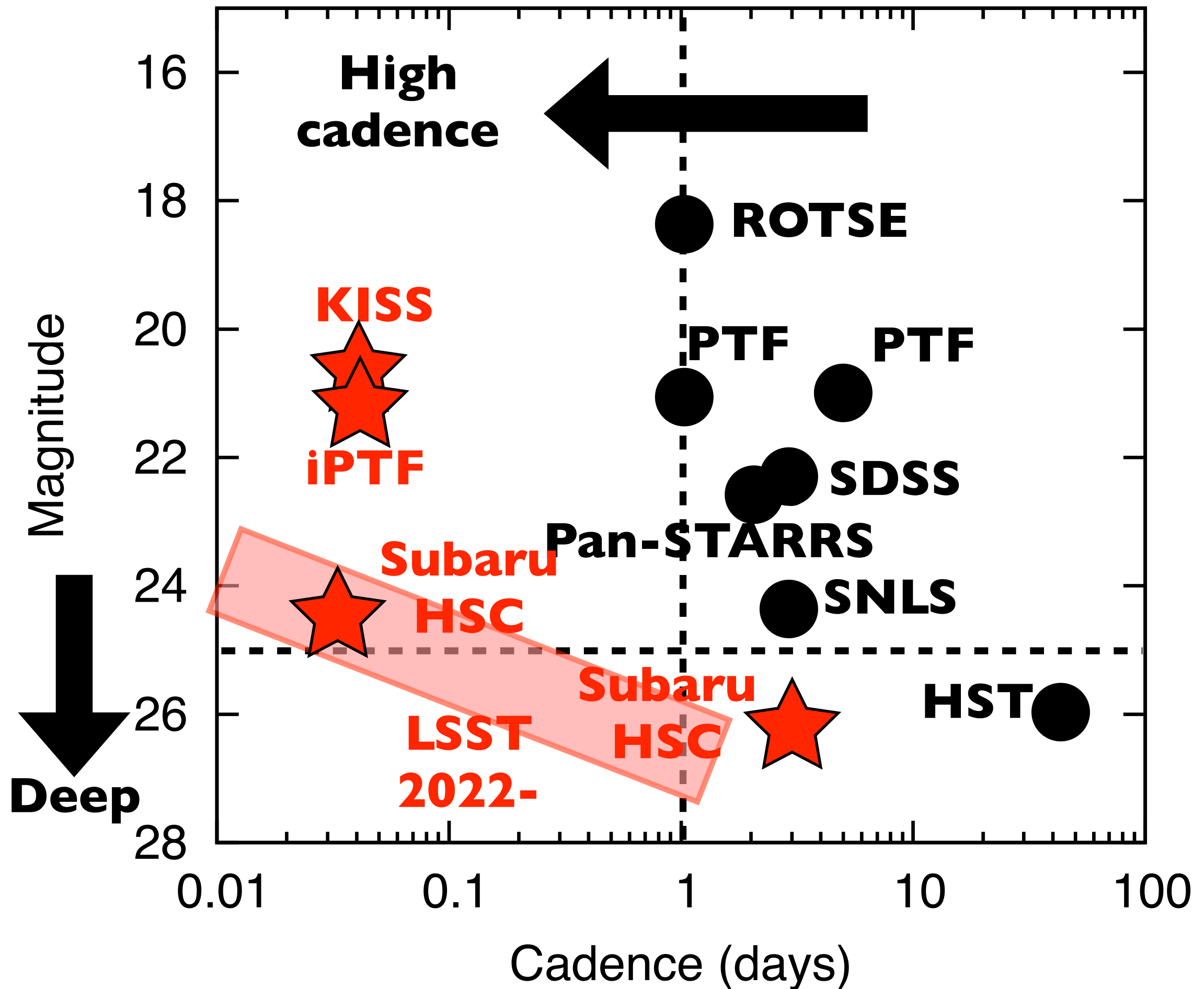
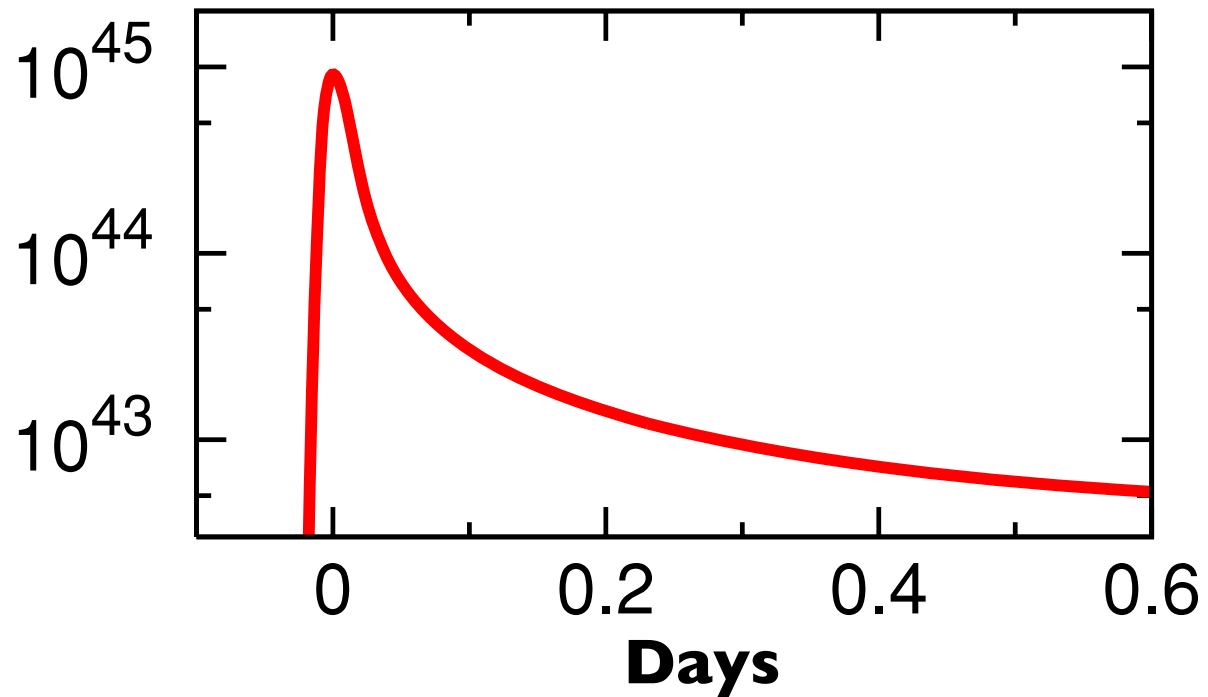


Figure from LSST Science Book
(after PTF collaboration, Rau+09, Kasliwal+, Kulkarni+)



The moment of supernova explosion



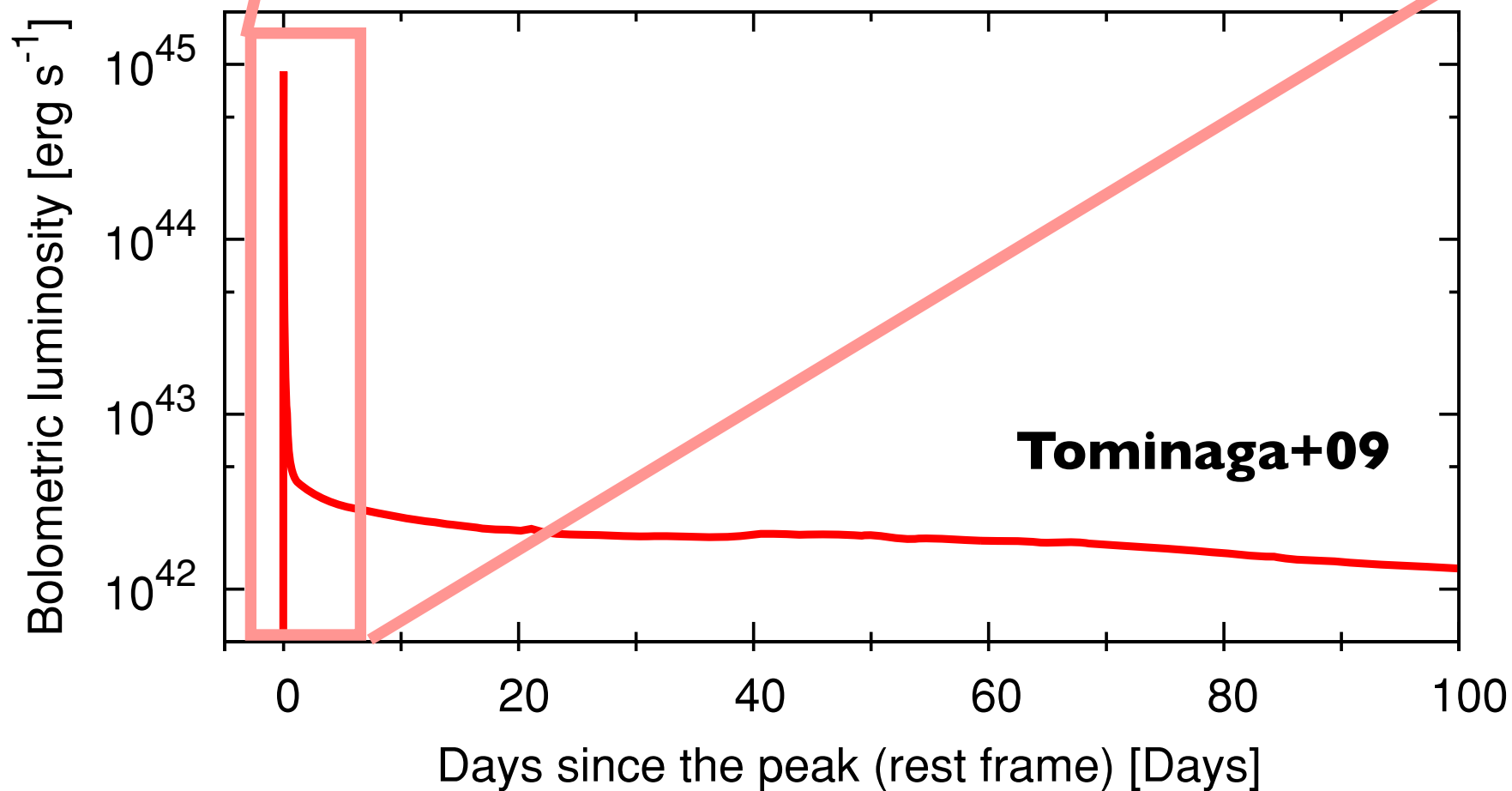
progenitor star

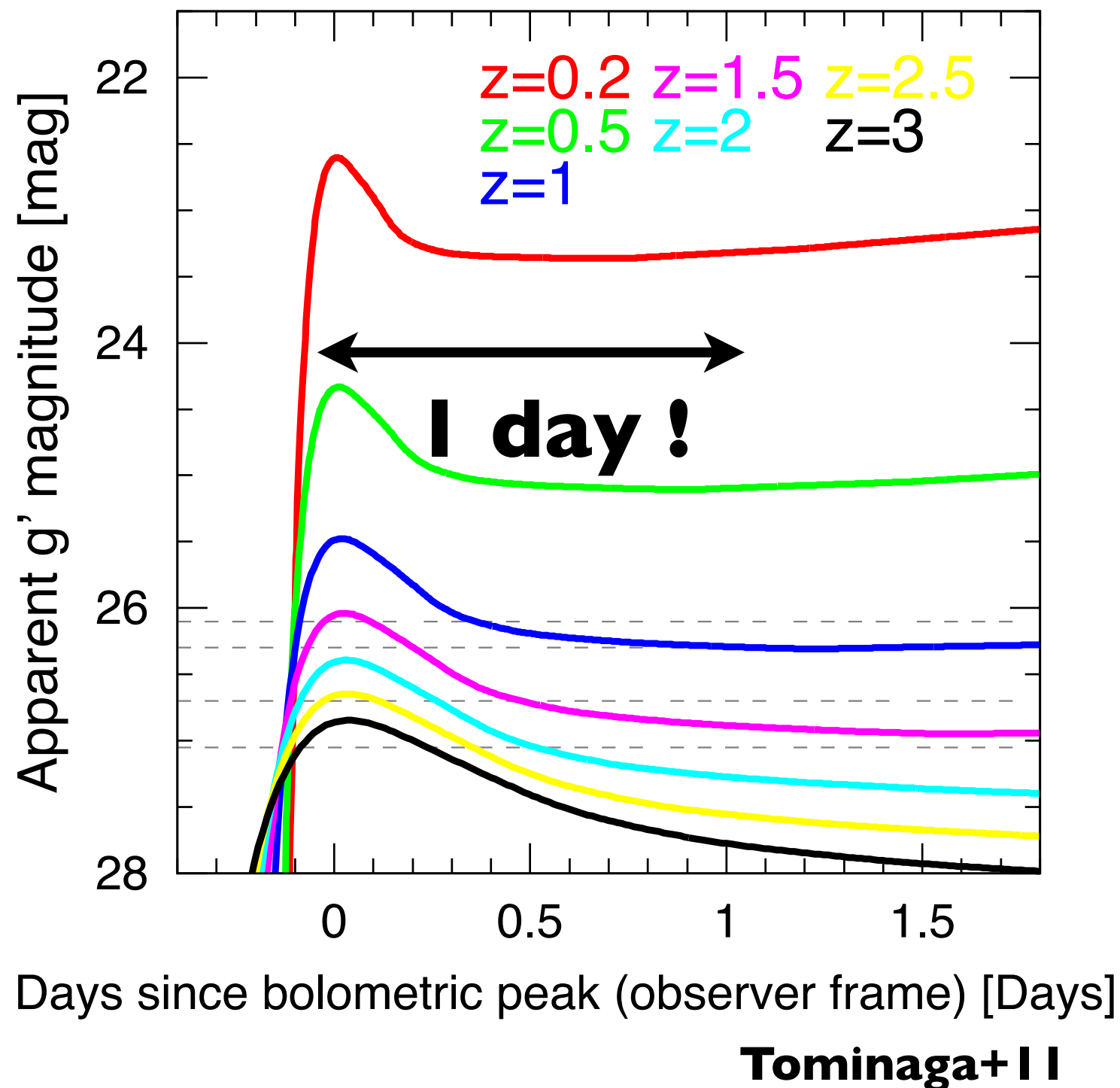


Shock breakout



> a few days





**High-cadence
10 deg² survey
with 27 mag (g)**



**Typical supernovae
at $z \sim 2$**

$R \sim 500-1000$

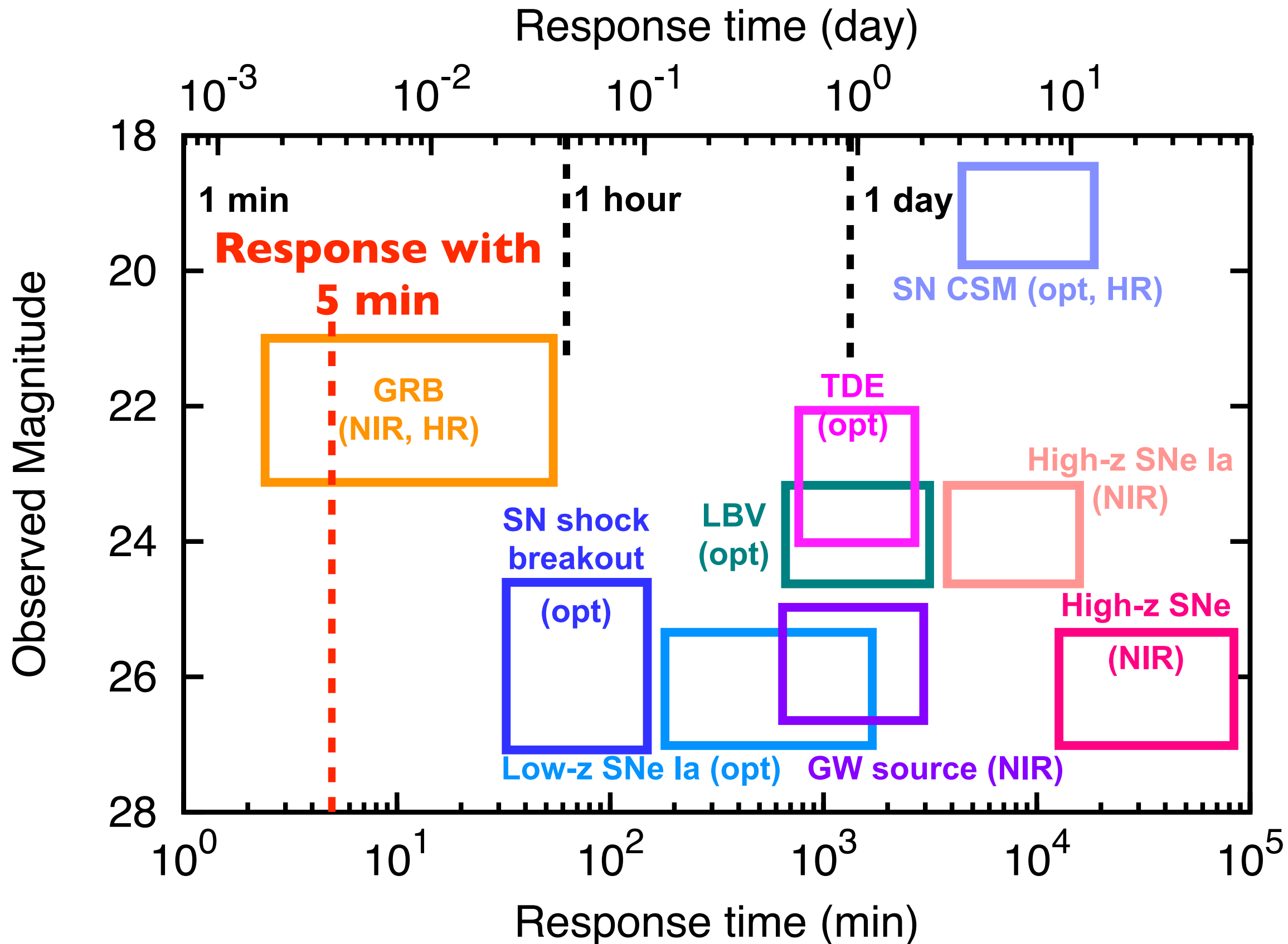
Opt (g): ~ 27 AB mag

Prompt (< 30 min) Optical spectroscopy with TMT



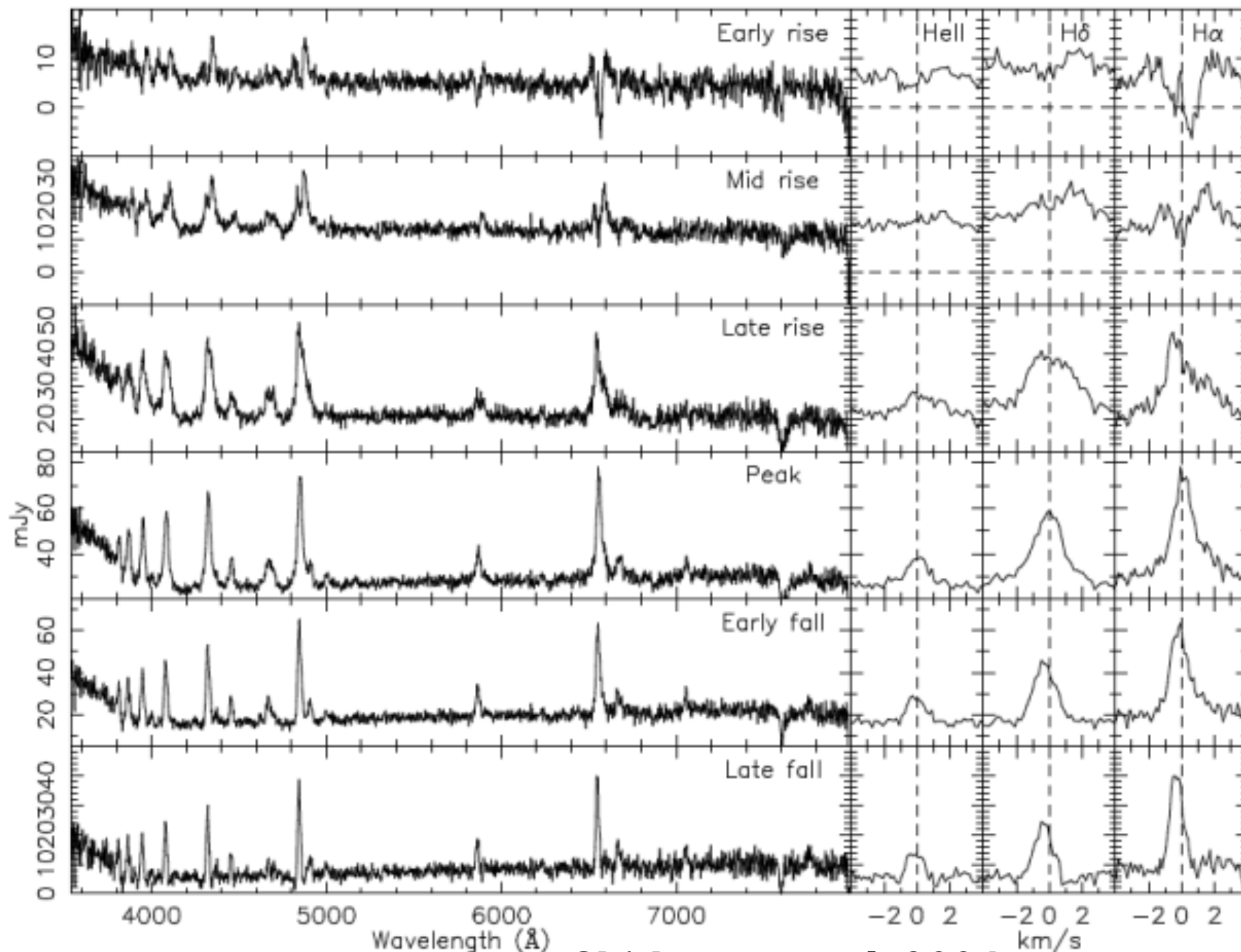
**New window to study supernovae
(progenitor mass/radius, kinetic energy)**

Required response time



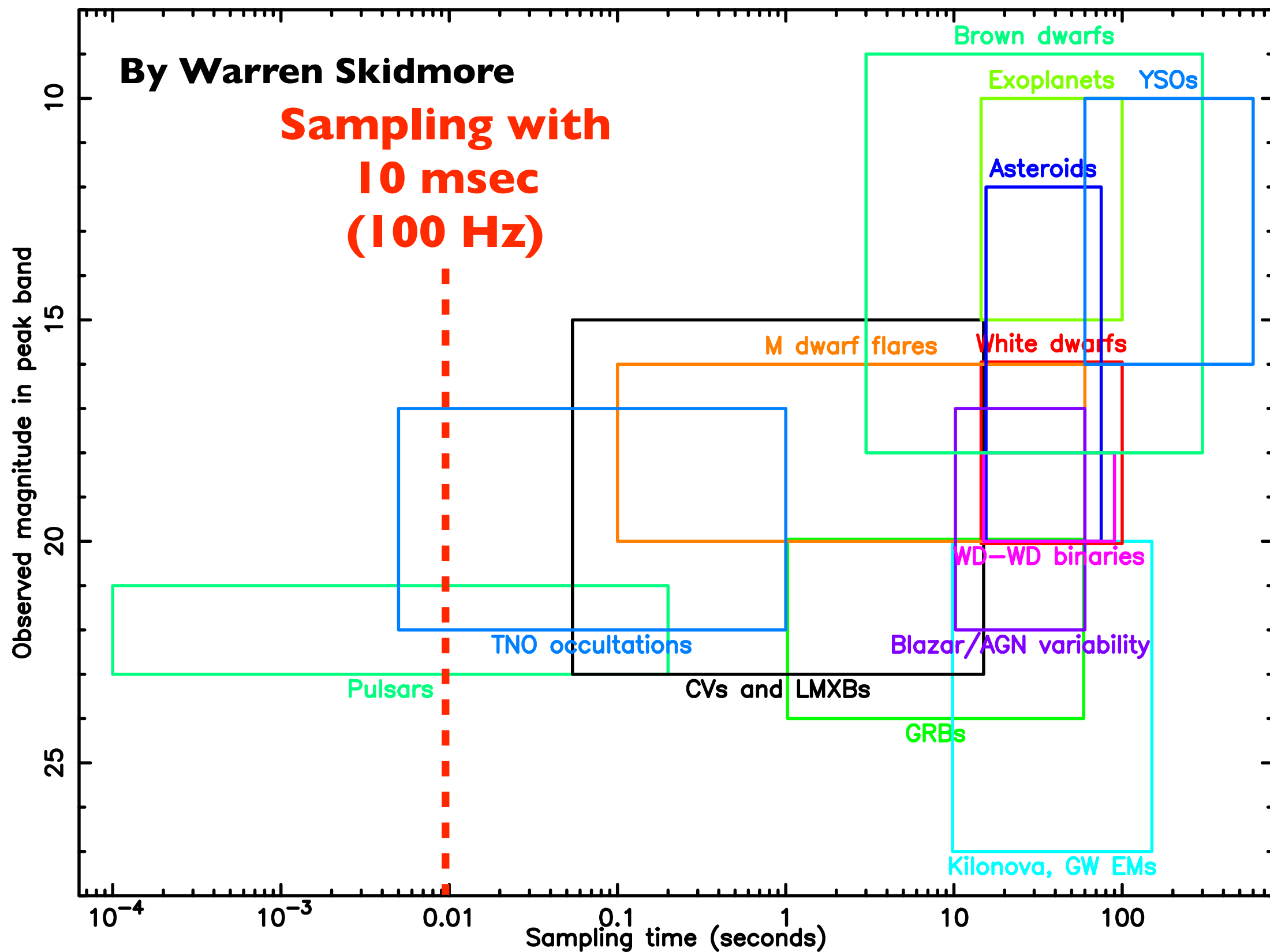
Time-resolved observations

75 ms spectroscopic sampling for cataclysmic variables



Skidmore et al. 2004

Required sampling time



TODAY

- **Antonino Cucchiara**

- **The Swift mission as high- z explorer: the GRBs legacy for TMT**

- **Jennifer Hoffman**

- **The Supernova Spectropolarimetry Project:
Probing the Evolution of Asymmetries in Supernovae**

- **(Coffee break)**

- **Warren Skidmore**

- **Summary of time-resolved/polarimetric science**

- **Discussion**

Agenda for discussion

- I. Feedback to TMT instrument/telescope teams**
 - 1. Response time (telescope/operation) 5 min?**
 - 2. Time-resolving capability (instrument) 50 msec?**
 - 3. Polarimetric capability (instrument/telescope)**
- 2. Inter-partner programs for ToO observations**
- 3. TMT Key/Legacy programs**