Tomo-e Gozen Transient Survey

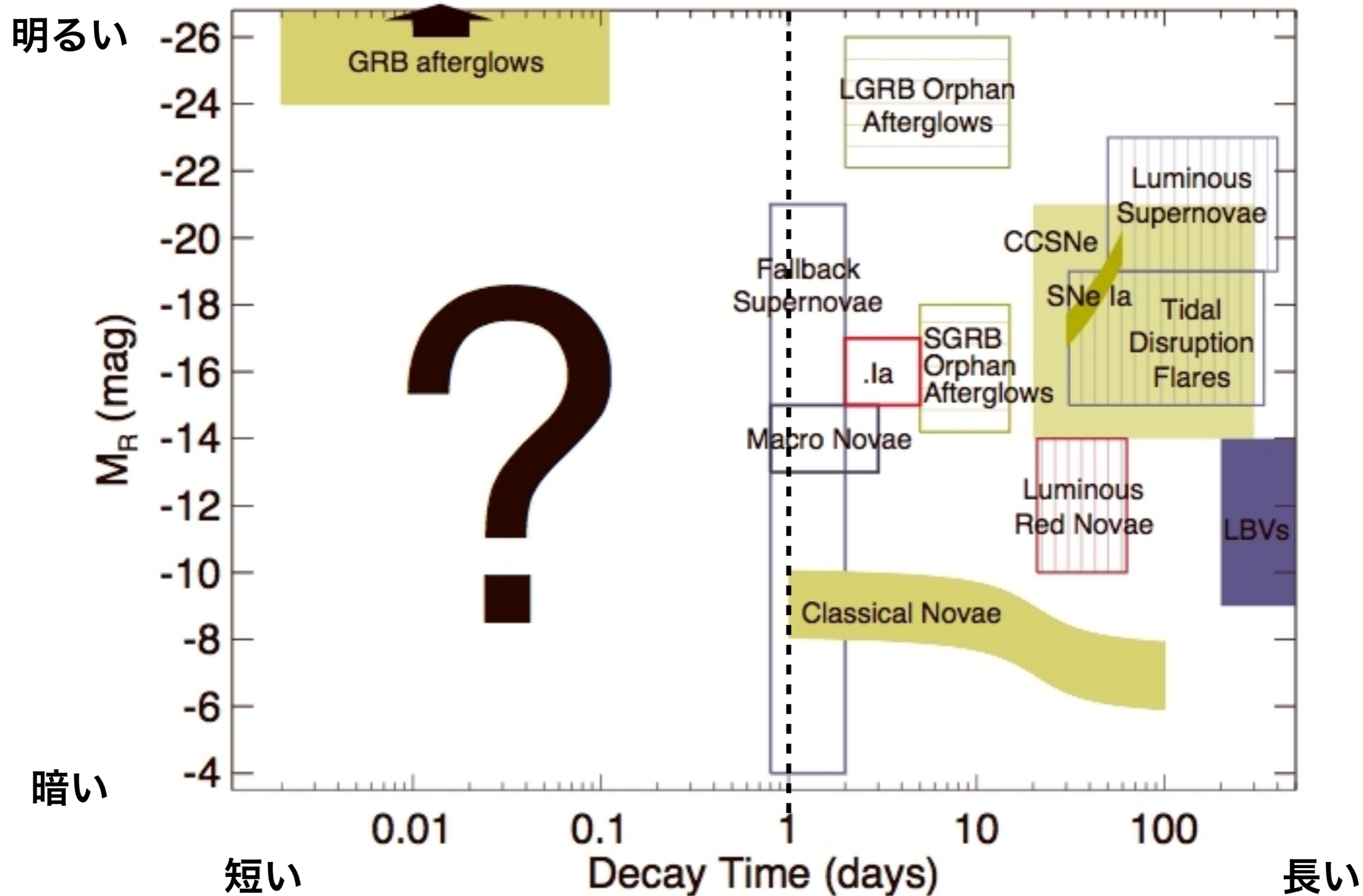**Masaomi Tanaka (Tohoku U.)**
on behalf of Tomo-e Gozen Transient Survey Team

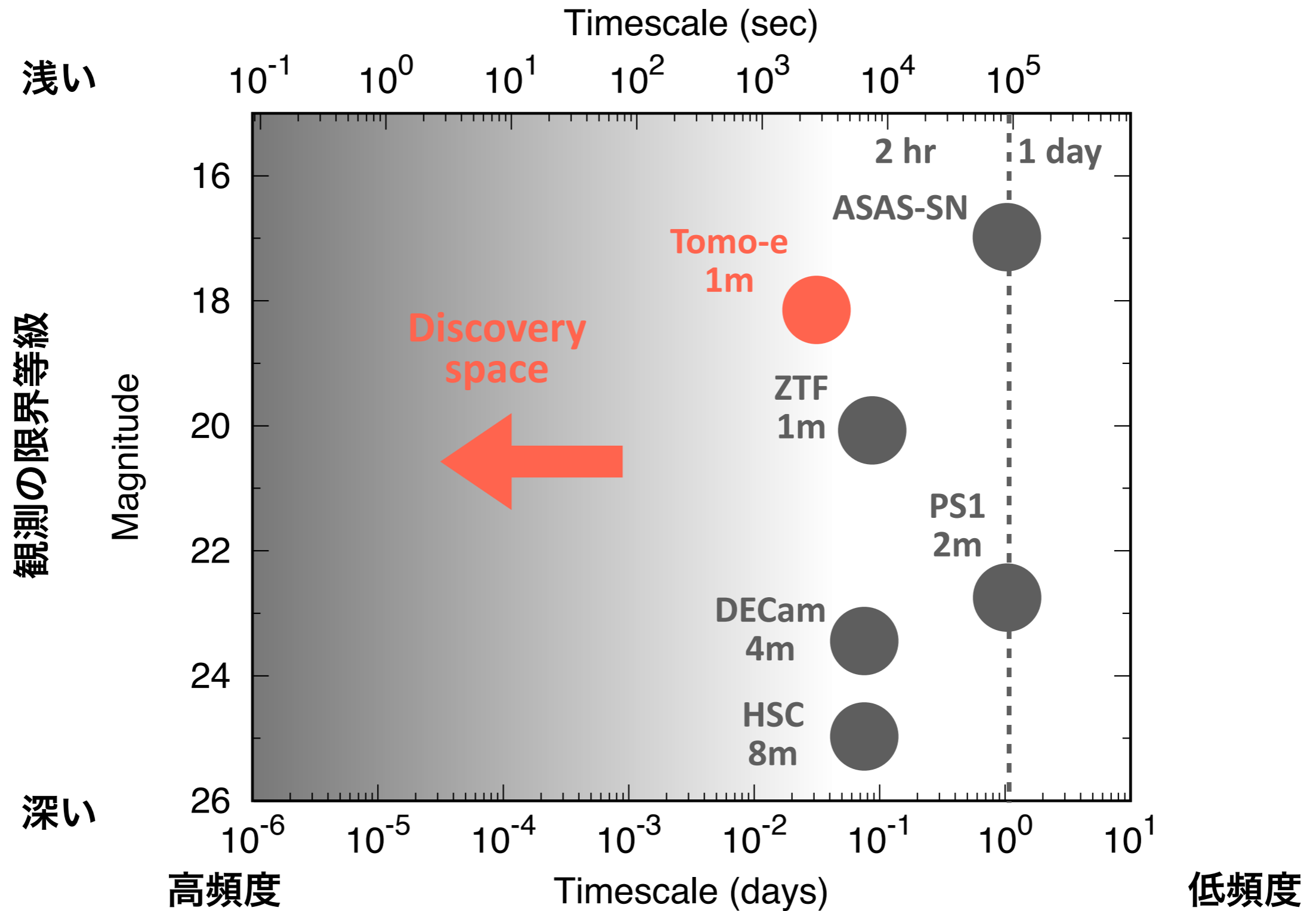**Tomo-e Gozen Transient Survey**

- **Motivation and survey design**

- **System, data products, and recent updates**

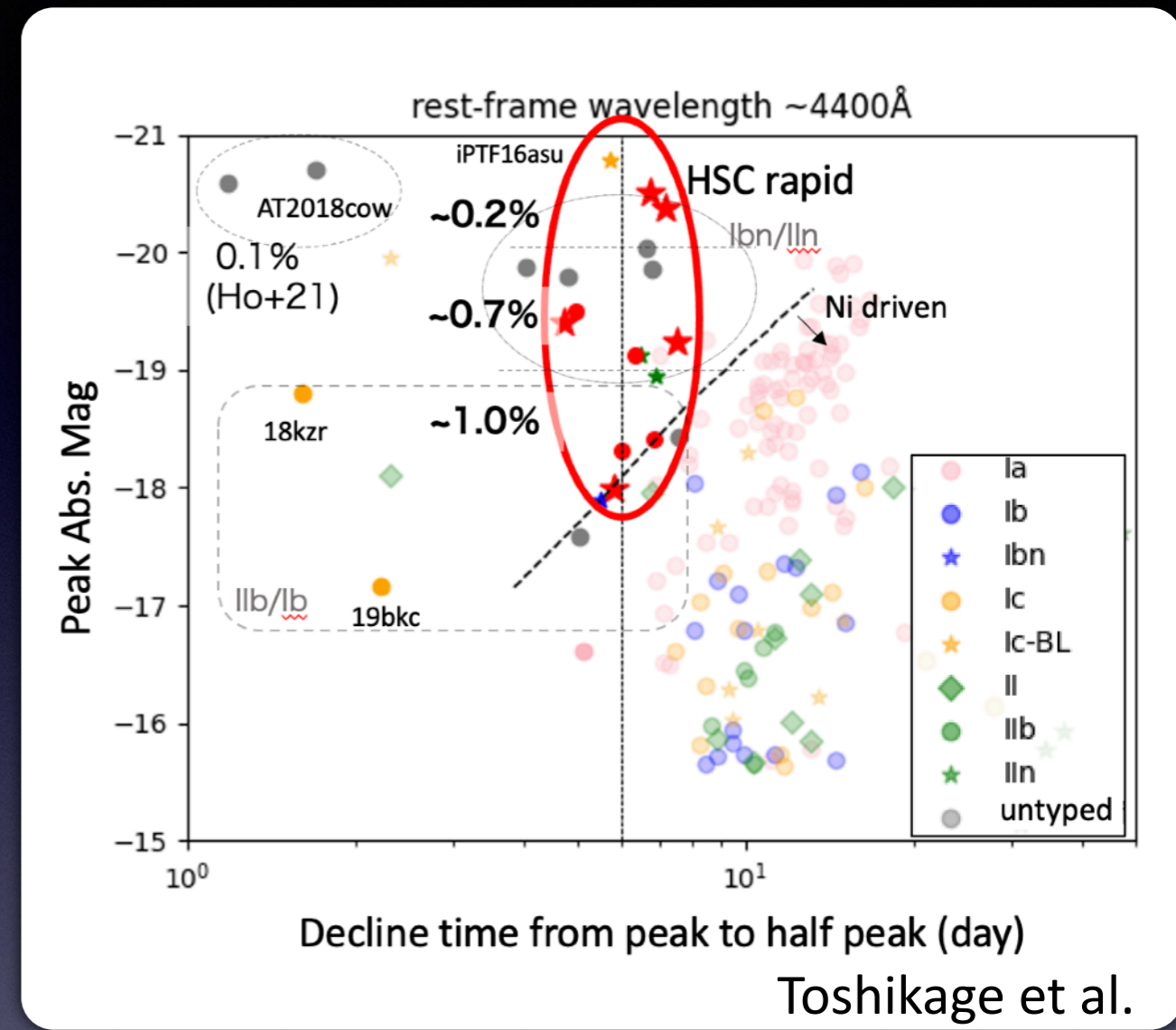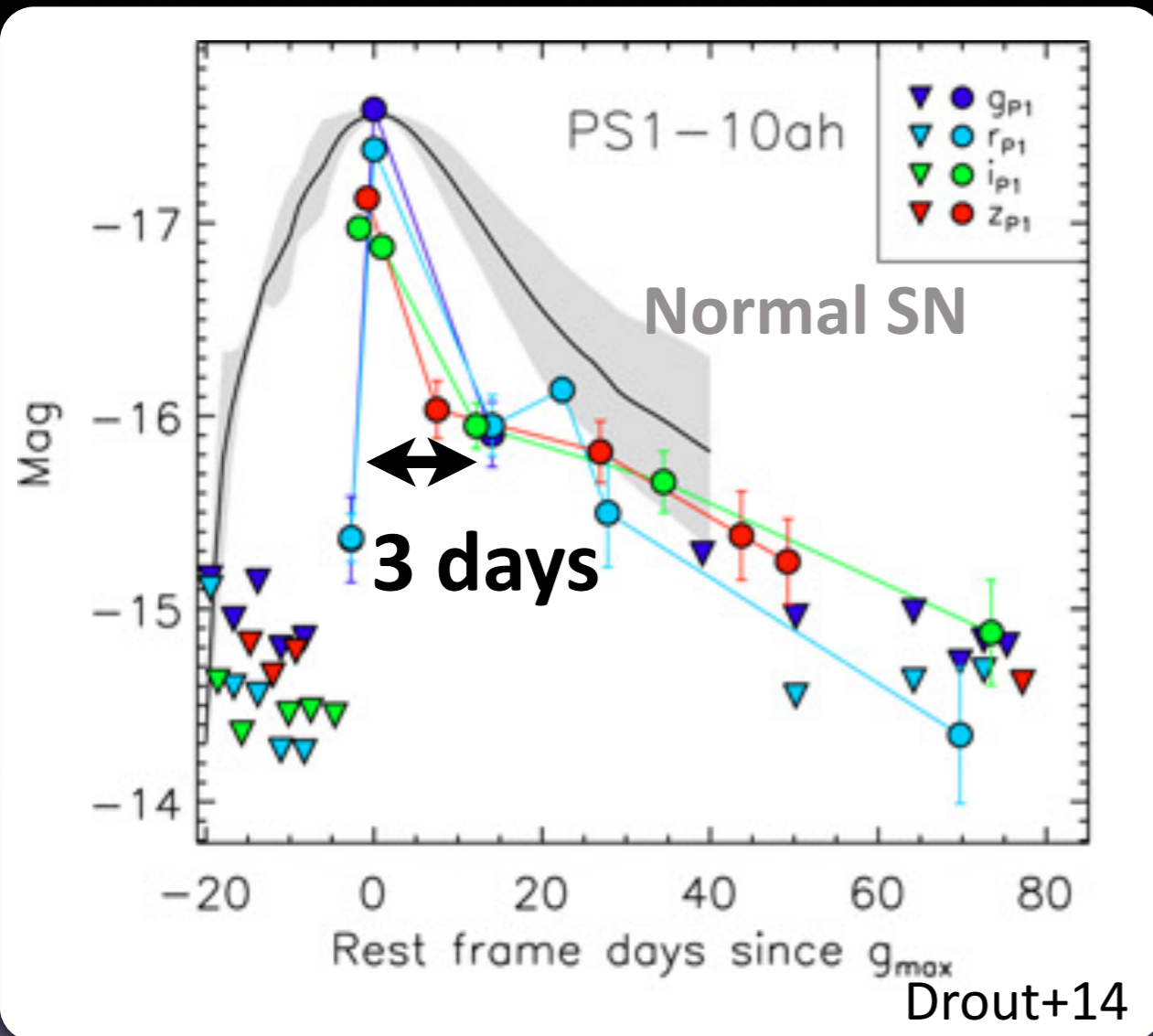- **Wish list**

Frontier of transient sky

LSST Science Book (after Rau+09, Kasliwal+,Kulkarni+)

Transient survey

Discovery of rapid transients

Normal SN

3 days

PS1-10ah

Drout+14

rest-frame wavelength ~4400Å

HSC rapid

Toshikage et al.

By Seiji Toshikage
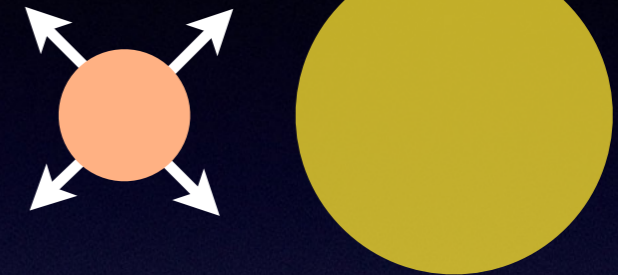
Compared with normal supernovae:
- **Similar or higher luminosity (w/ large diversity)**
- **Shorter time scale (= small mass involved)**
- **~< a few % event rate**

New probes for stellar evolution, compact object formation, and high-energy phenomena

Mej ~ 0.1 Msun

- **Ultra-stripped envelope supernova?**

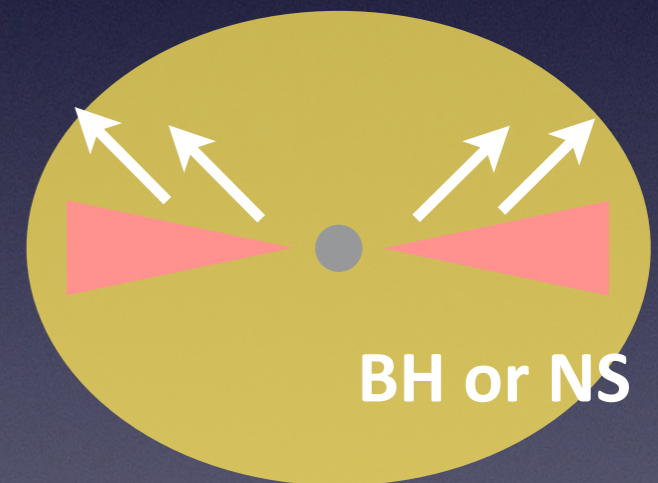 - Mej ~0.1 Msun by binary interaction
    (e.g., Tauris+13, Moriya+17) ?

Mej ~ 0.01 Msun

- **Interaction with circumstellar material?**

  - Objects with emission line spectra
    (e.g., Rest+18, Ho+22, Maeda & Moriya 22)

- **Black hole-forming supernova?**

  BH or NS

  - Accretion-powered transients?
    (e.g., Dexter & Kasen 13, Kashiyama+15)

Distant objects: difficult to perform spectroscopy

=> Need to discover nearby (bright) objects for spectroscopy

Tomo-e Gozen Transient Survey (2019/4-)

- **All sky survey (~12,000 deg2)**

  - 0.5 sec x 18 = 9 sec exposure

- **High cadence (~3,000 deg2)**

  - 0.5 sec x 12 = 6 sec exposure
    => ~18 mag (5 sigma)

  - ~0.5-1 hour cadence

  - ~ a few rapid transients / 0.5 yr
    (< 200 Mpc)

Pointing parttern
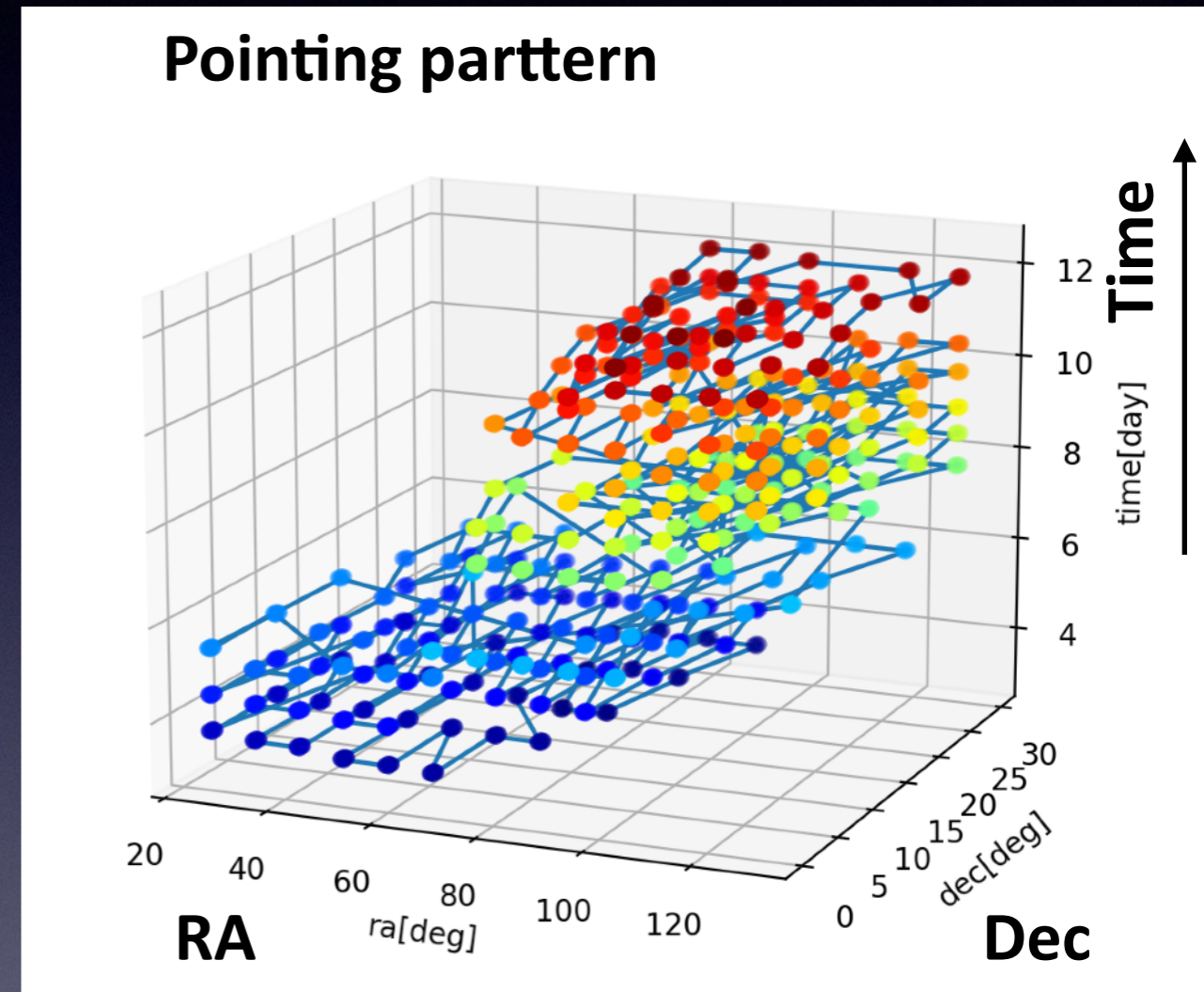
By Kakeru Oshikiri

Fast Optical Transientの探査 => 押切さん (東北大)トーク

Tomo-e Gozen Transient Survey

- Motivation and survey design

- System, data products, and recent updates

- Wish list

Data flow

Overall structure (冨永 望さん)

Measurement (諸隈 智貴さん)

Reference images (新納 悠さん)

Standard reduction (+ astrometry)

Stack

Image subtraction (PS1, r-band) => Tomo-e

Raw image (0.5 sec x 12) **

Reduced image (0.5 sec x 12) **

Stacked image (6 sec)

Subtracted image

30 TB/night

**deleted in 1 week

Measurement

Catalog (0.5 sec)
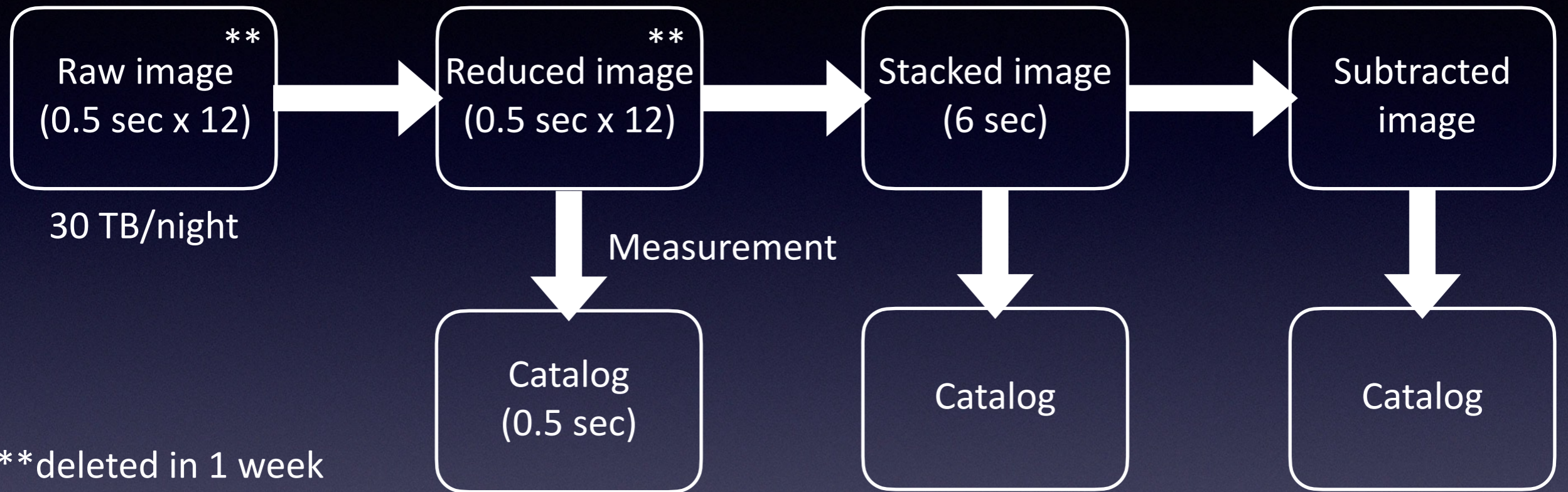
Catalog

Limiting magnitude

image subtraction (田中)

Real-bogus classification (高橋 一郎さん)

Web interface (瀧田 怜さん)

Catalog

Real/bogus classification
Match with internal and external catalogs

Web Interface
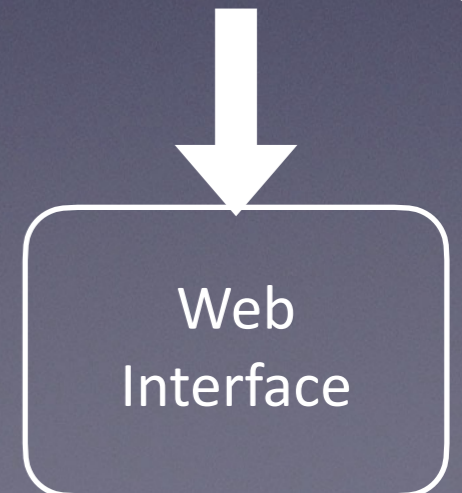
突発天体の分類性能が大幅に改善

2022年6月22日

トモエゴゼン突発天体探査のデータから機械学習によって本物の突発天体を分類する高性能な分類器が開発されました。この分類器は自身で学習データに含まれる誤ラベルを検出し、「半教師あり学習」を行います。この新しい分類機によって、実際の観測データに対する分類成績が従来のものに比べて100倍以上向上しました。
— DOI:10.1093/pasj/psac047

Led by 高橋 一郎さん (東北大)
Takahashi et al. 2022

https://tomoe.mtk.ioa.s.u-tokyo.ac.jp/ja/news.html
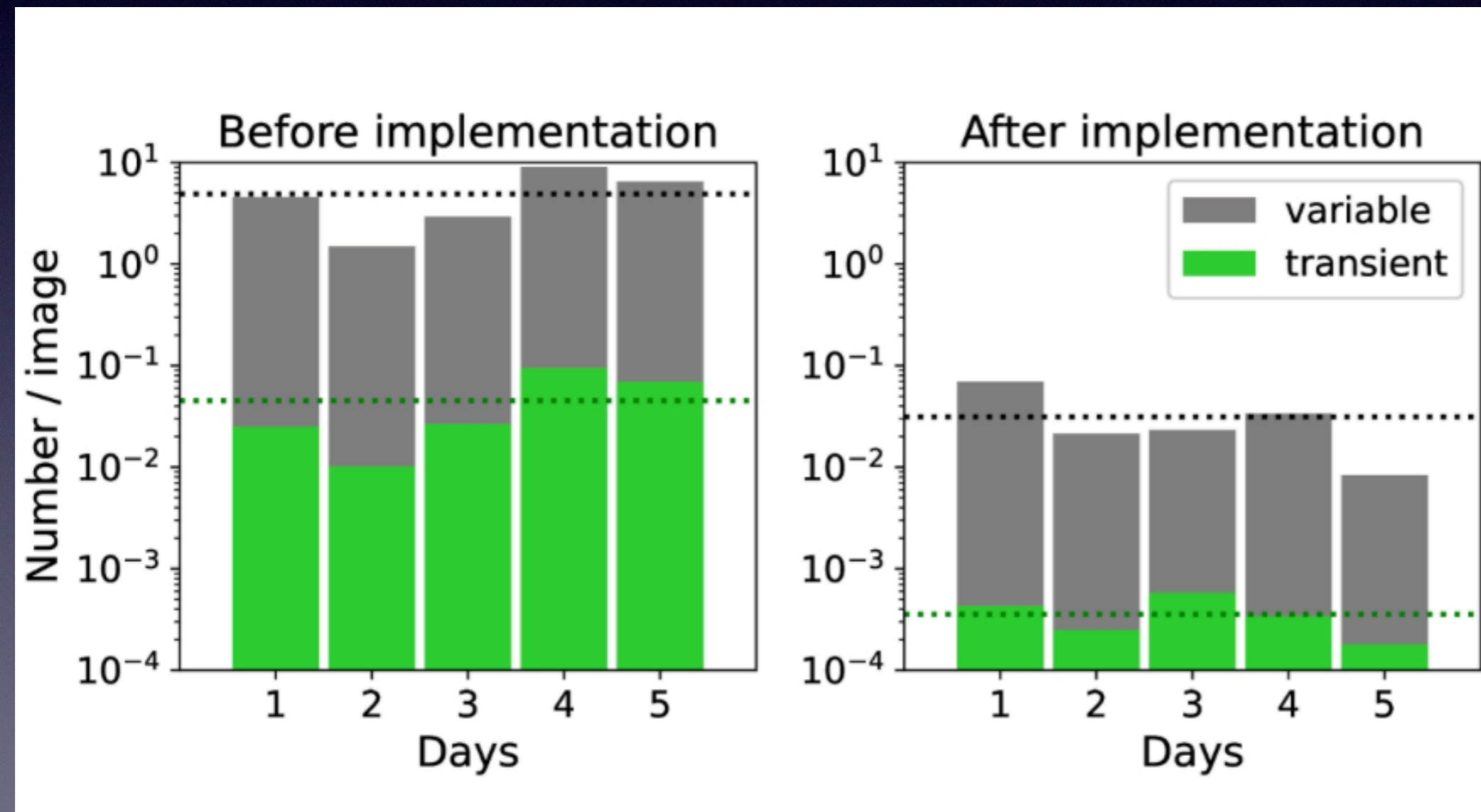
Web interface

Led by 瀧田 怜さん (東京大)

Forced photometry for objects in Transient Name Server   Led by 冨永 望さん

Discovery by other surveys
(ZTF, ATLAS, …)
=> Transient Name Server

重力崩壊型超新星
=> 村井さん(東北大)トーク

Ia型超新星

=> 越さん (東京大)

Automatic alert

Led by 冨永 望さん

Tomo-e Slack

Automatically create observational scripts for Seimei telescope

Early detection of Type Ia supernova

Jiang et al. 2021
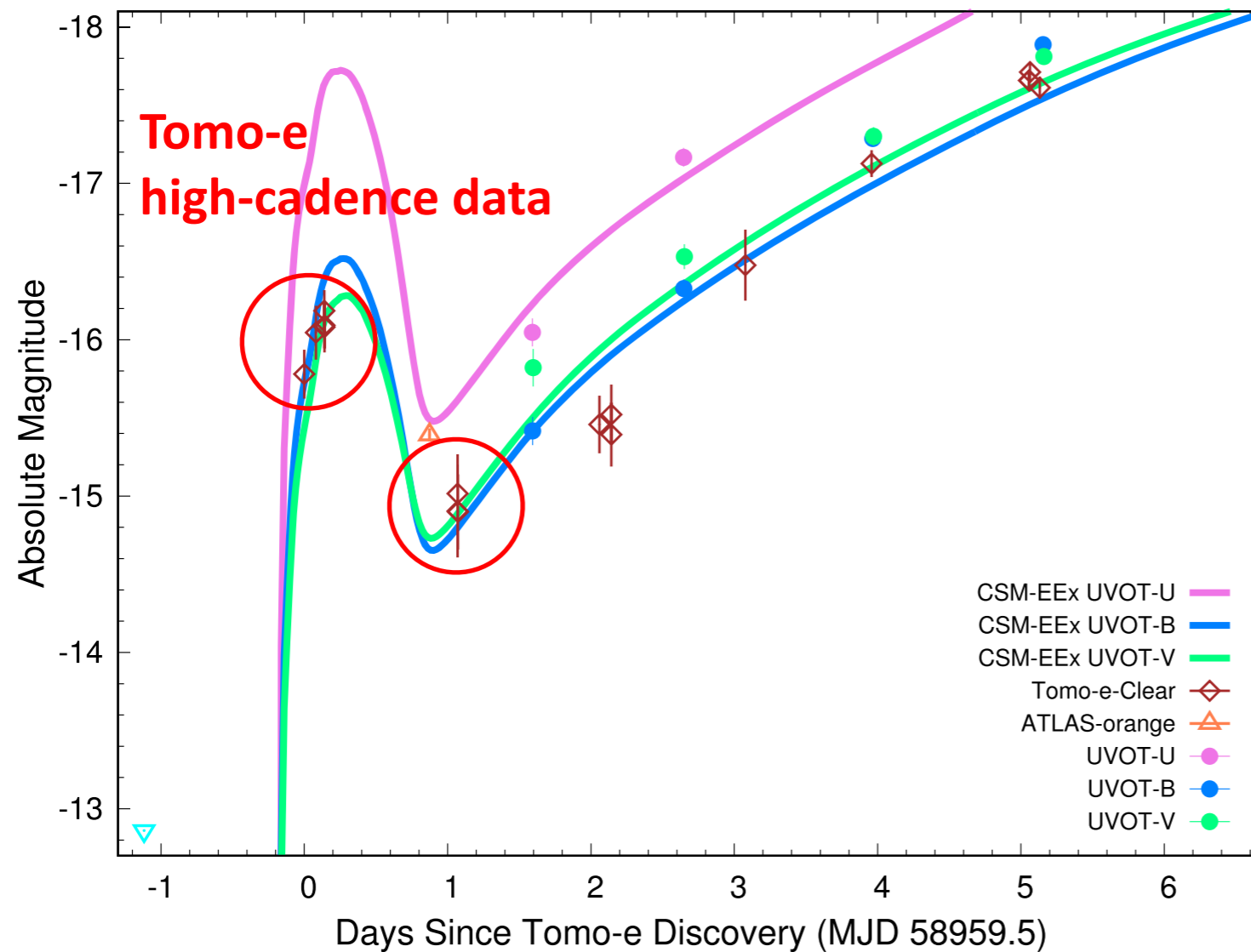
Probe of circumstellar environment of Type Ia SN

Tomo-e deep coadd reference for 20,000 deg² sky

Led by 新納 悠さん (東京大)

Single exposure

Deep coadd
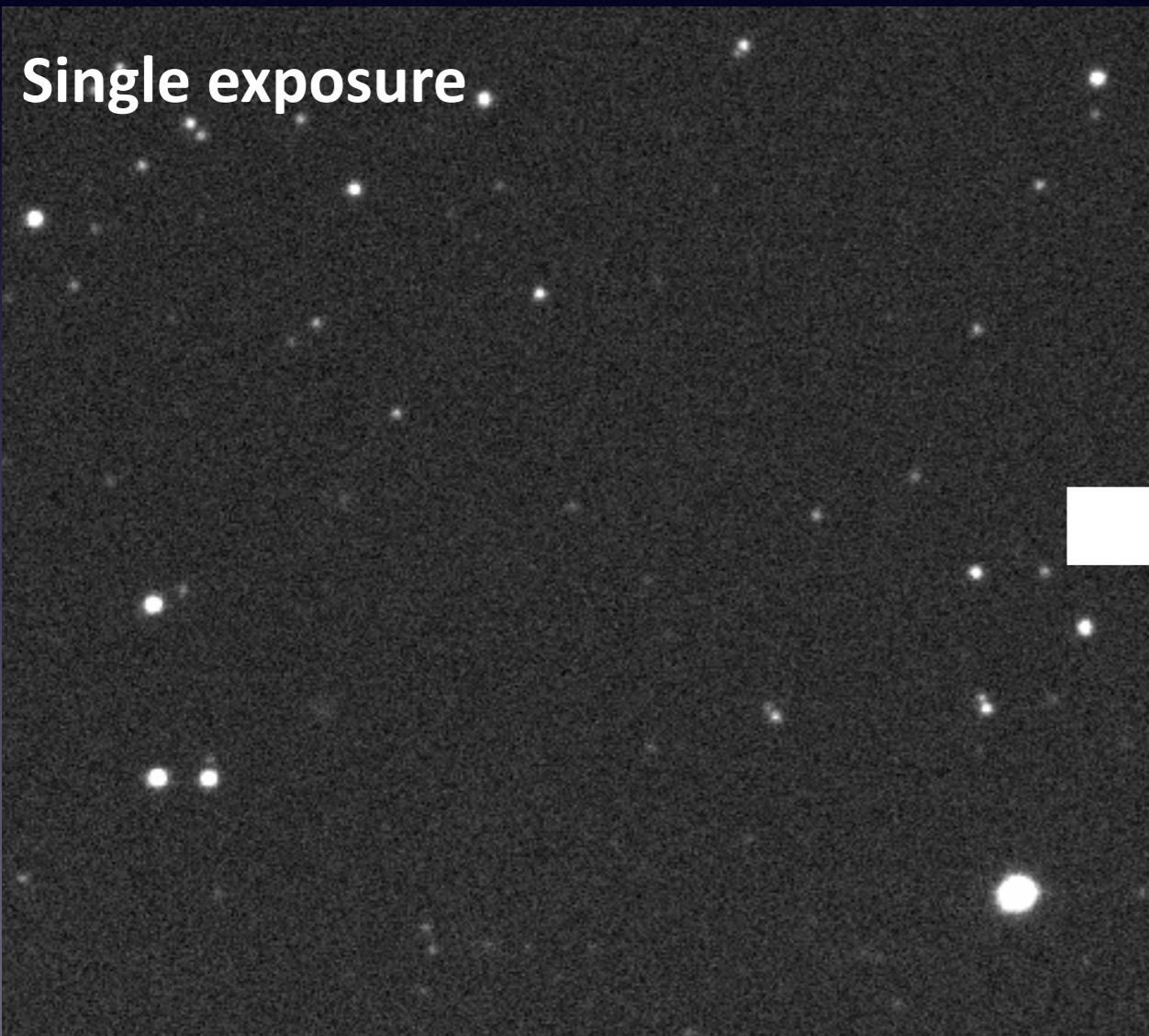
Improvement in image subtraction

Led by 新納 悠さん (東京大)

冨永さん2021年 シュミットシンポ資料より
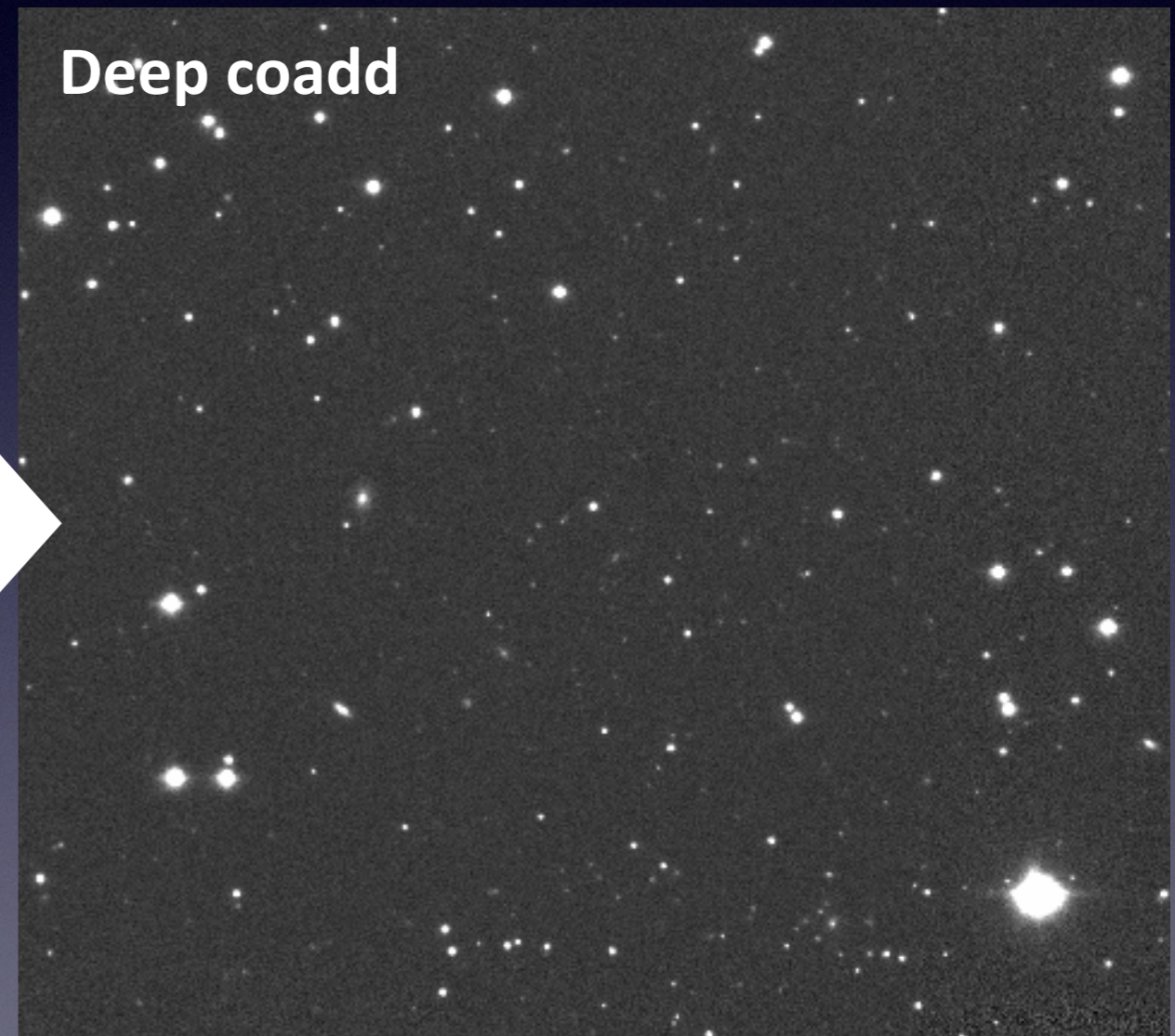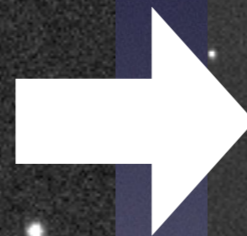

=> **Implementation of machine learning (高橋さん)**

Photometric catalog
(before image subtraction)

銀河系内突発天体 (classical nova, dwarf nova)
マイクロレンズイベント

Improvement in photometric stability

=> start to use aperture mag + Gaia zeromag

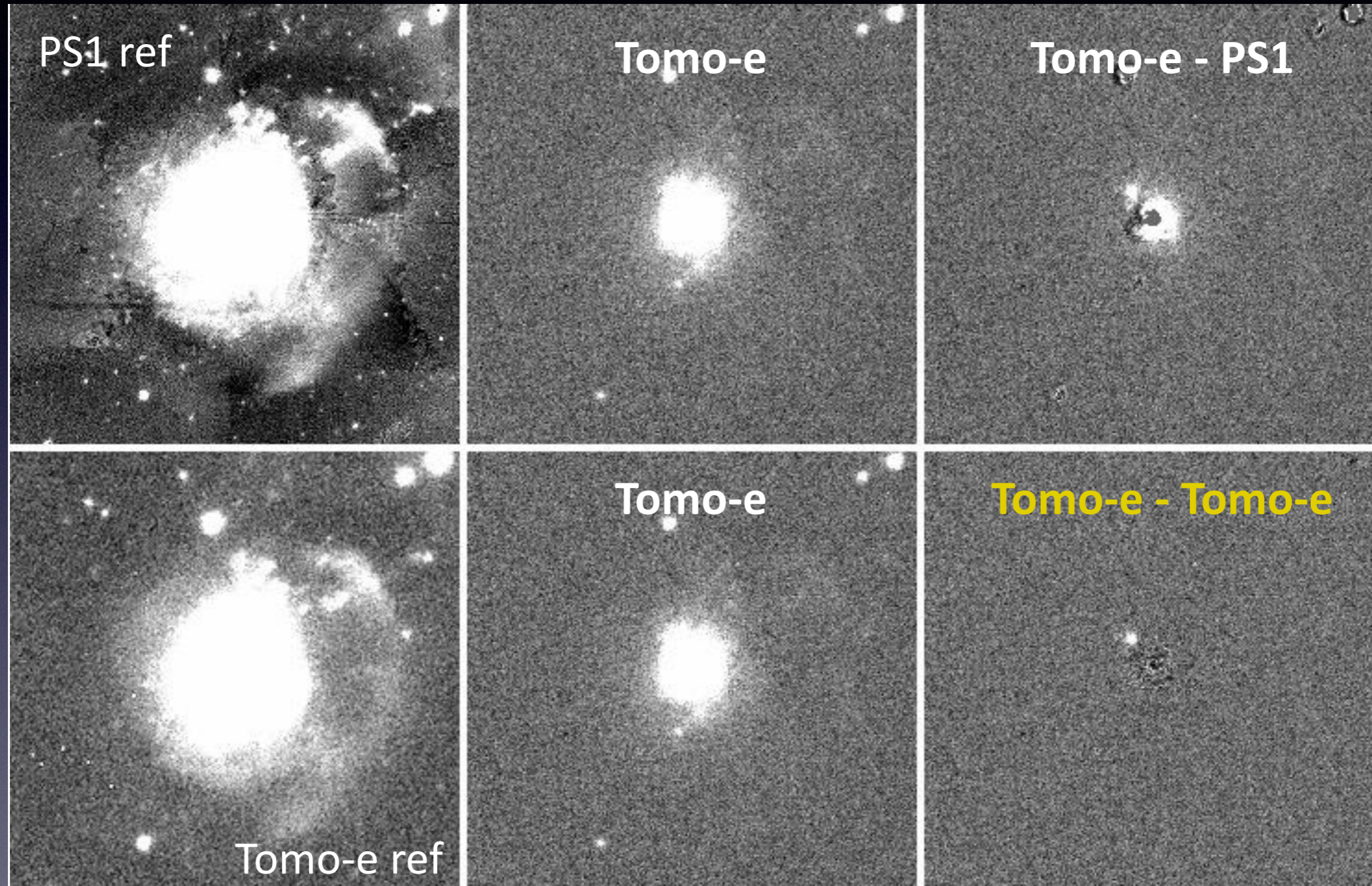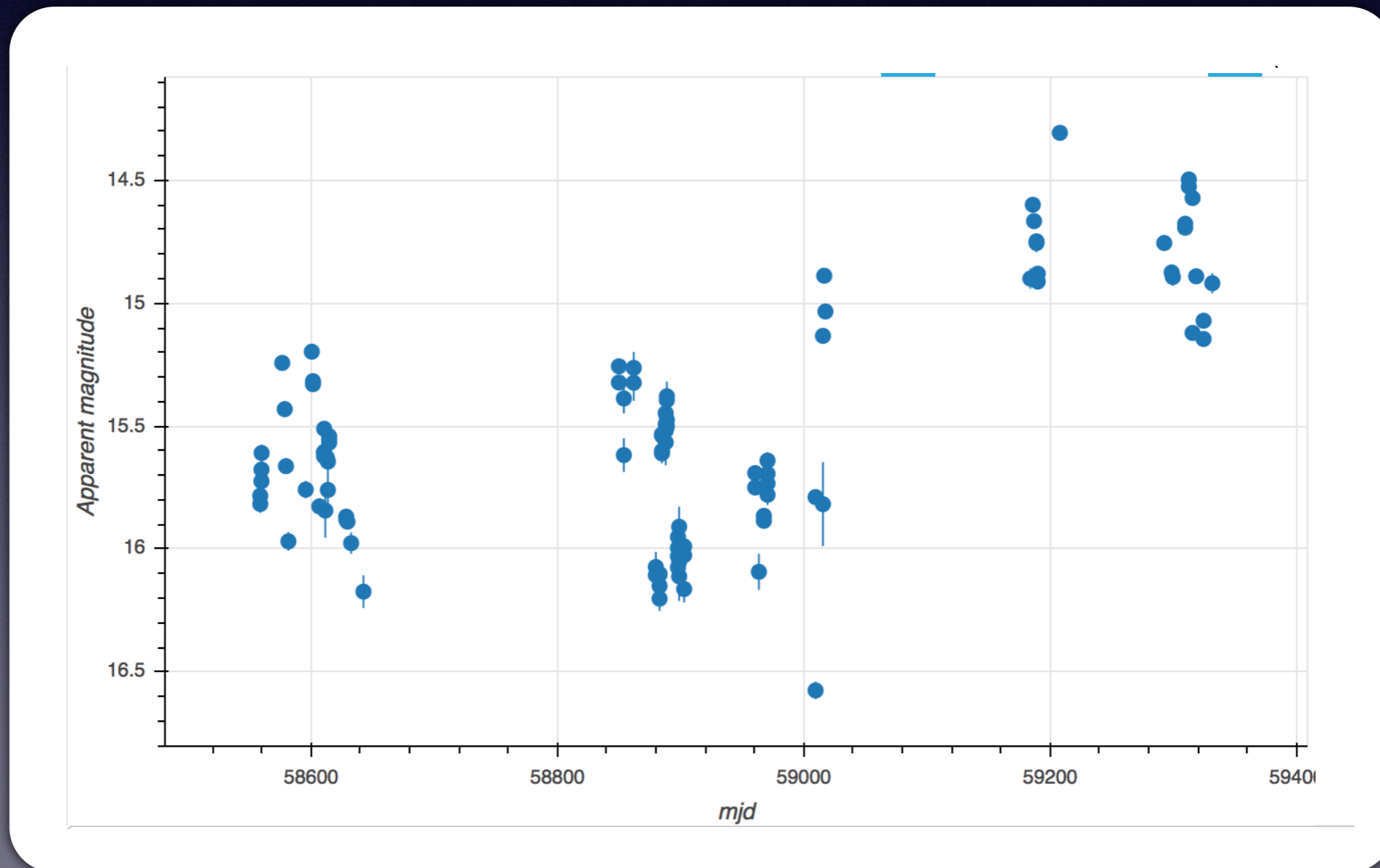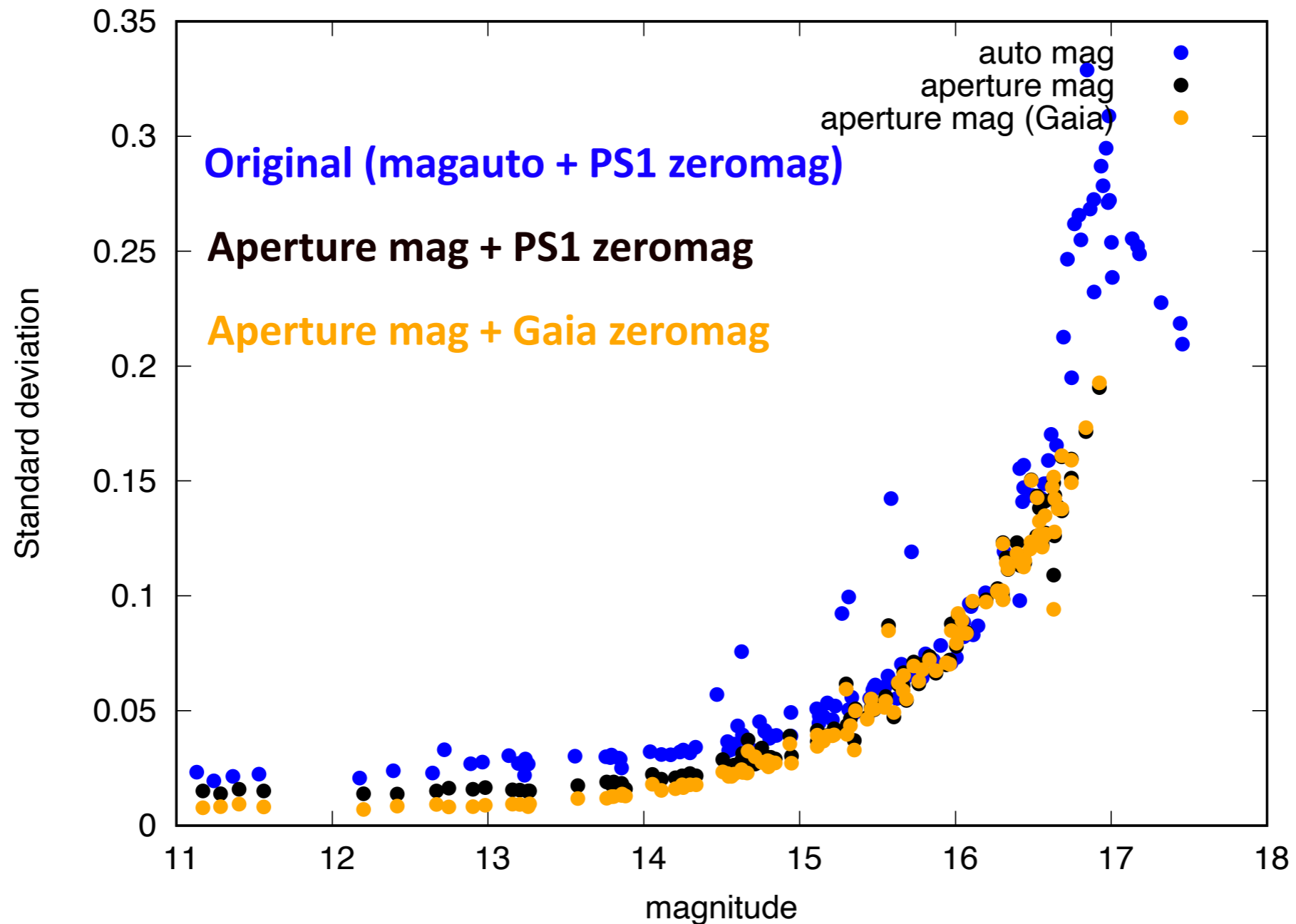**Tomo-e Gozen Transient Survey**

- **Motivation and survey design**
- **System, data products, and recent updates**
- **Wish list**

まとめに代えて (今後の予定)

- **System update**
  - Tomo-e reference image + real-bogus classification
  - New measurements (zeromag, aperture photometry)
- **Rapid follow-up observations**
  - Response to multi-messenger/multi-wavelength trigger
  - Check rising/decline rate (to discover early transients)
  - Machine learning classifier
  - Automatic observations at Seimei
- **Exploration for shorter-duration objects**
  - Transient detection in 2 fps data => 高橋さんトーク
- **Anything else?**
  - Your comments are always welcome!

データ利用に興味がある方はご連絡下さい