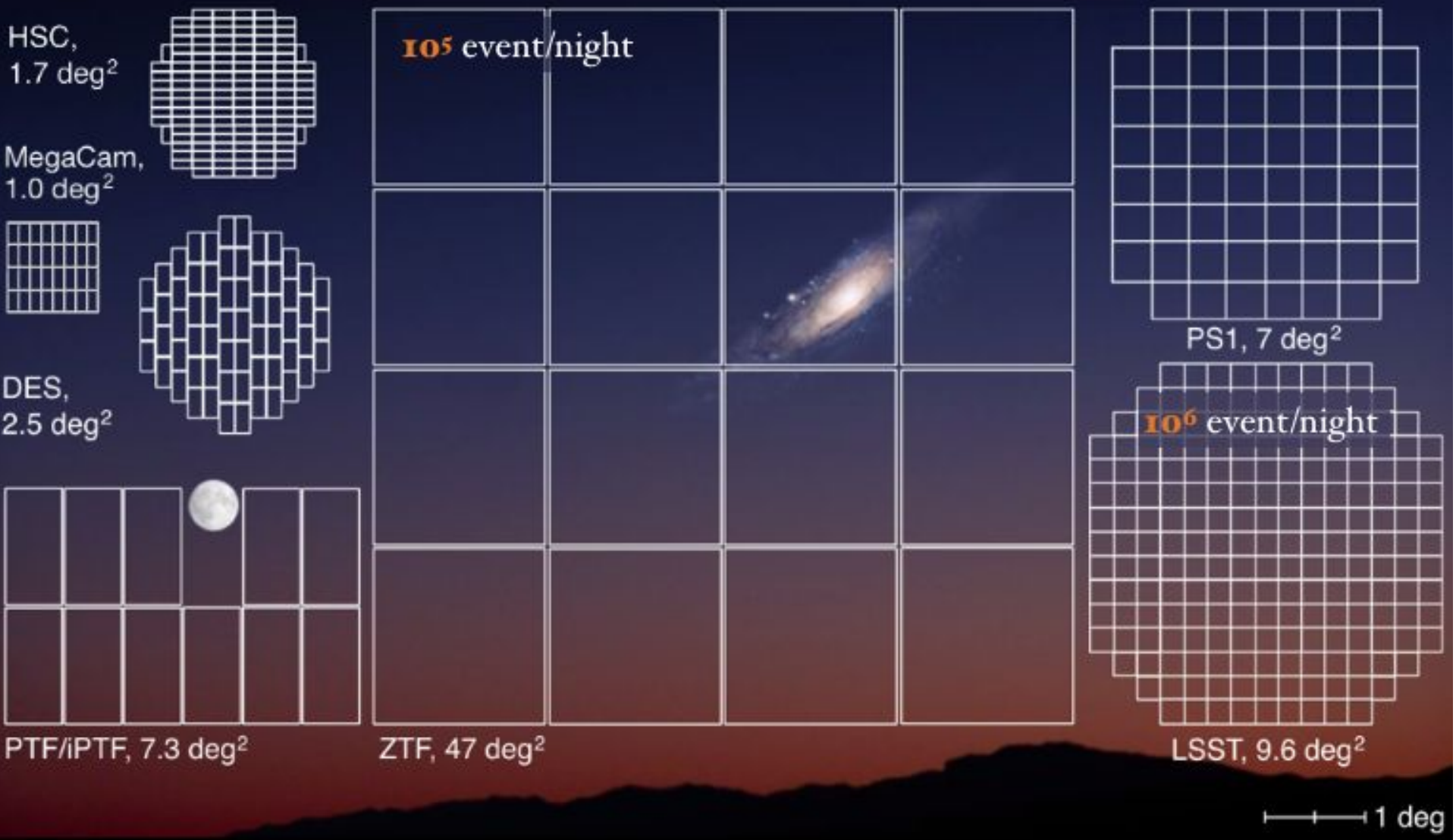
ZTF and Subaru

The stepping stones toward LSST

Nicolas Regnault & Mickael Rigault

LSST France Janv. 2018

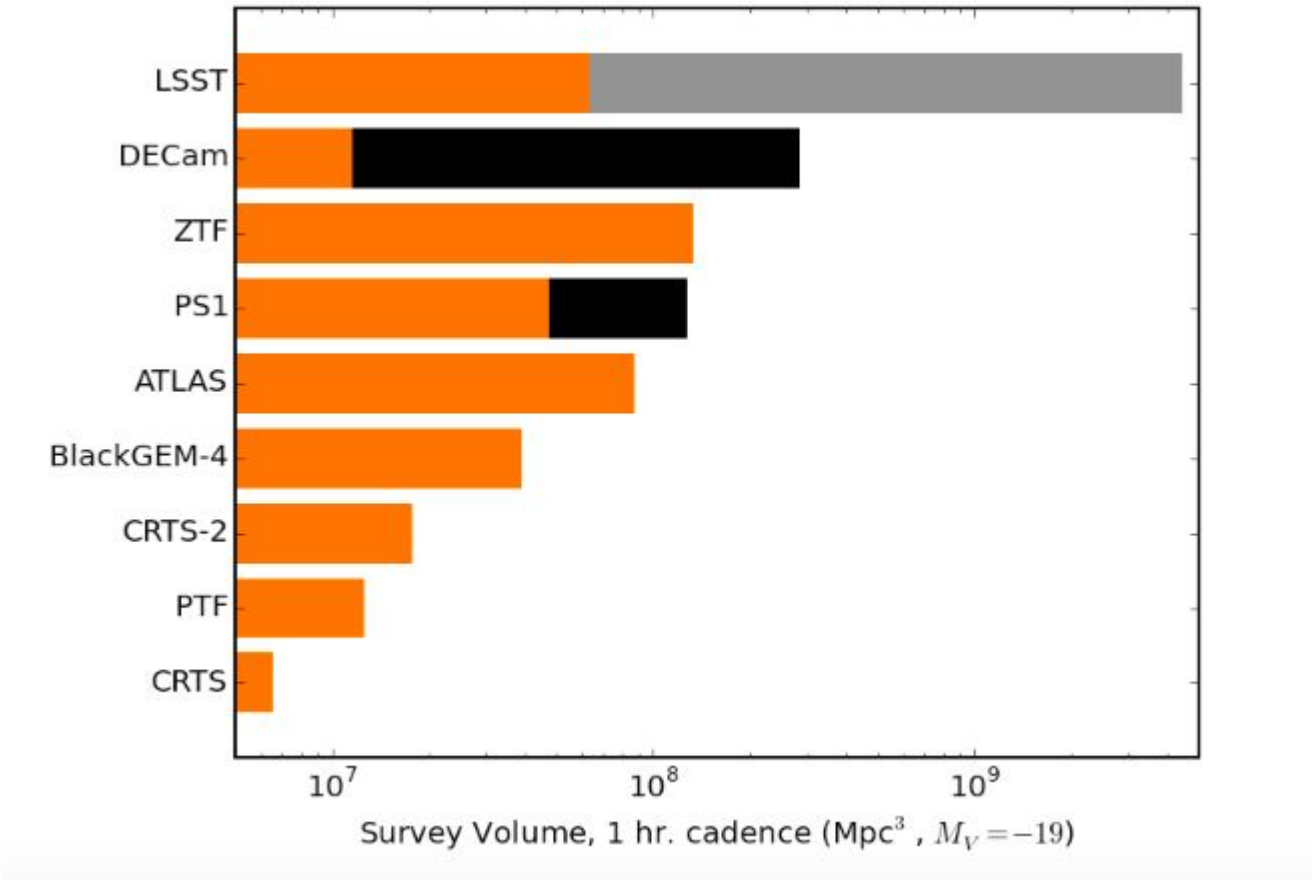
ZTF | Looking at the variable sky



ZTF @ z~0.05 = LSST @ z~0.5

\+ *IFU (SEDMachine) to type any SN brighter than 18.5/19mag*

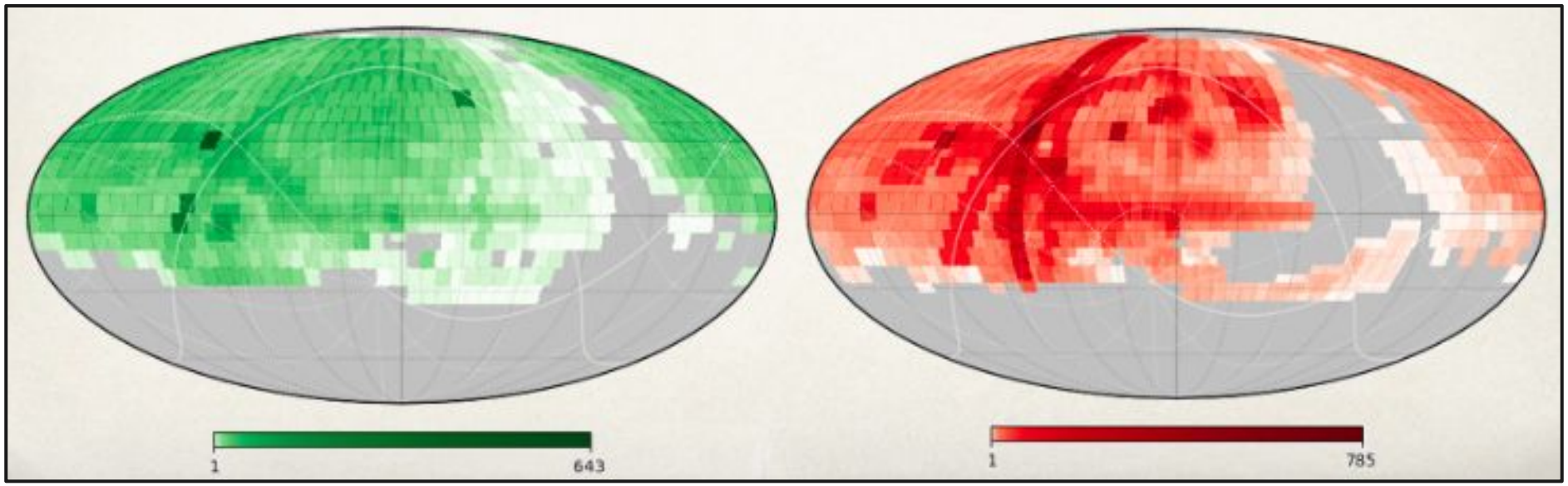
ZTF | Spectro follow up



Dedicated Spectrographer (SEDMachine, P60 1.5m)

ZTF latest news

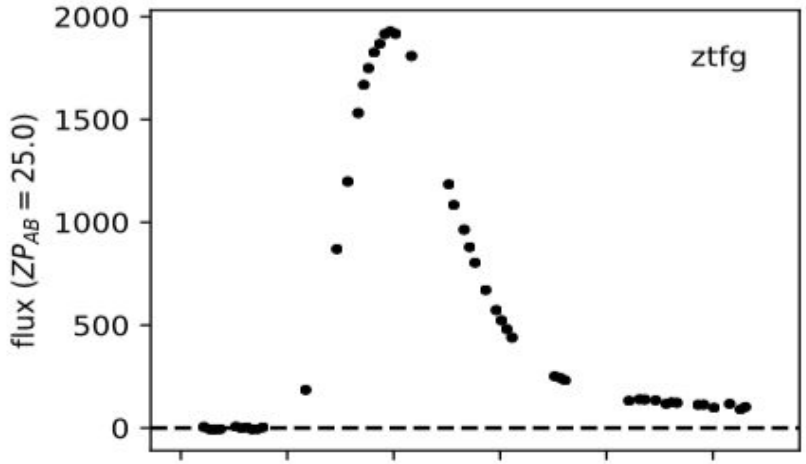
- Third Filter (I) will be installed February.
- Science Survey starts in March.
- New SEDM machine end of March.
  (all transient with mag>18.5 will be typed i.e, all SNeIa z<0.07)

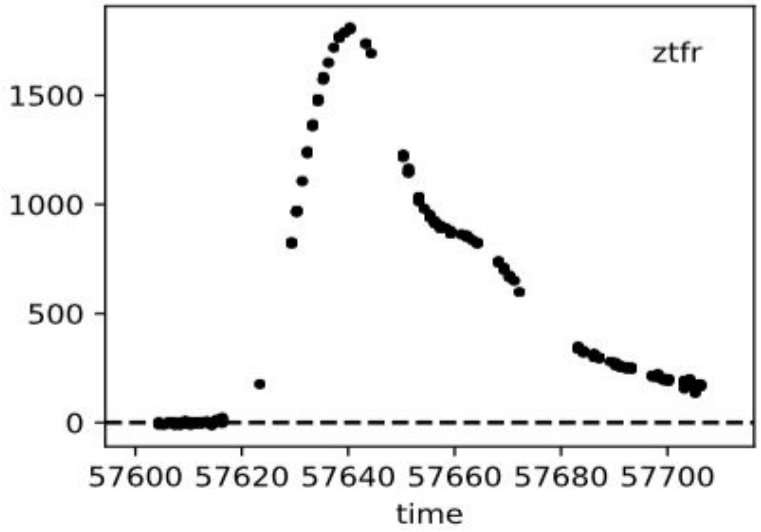


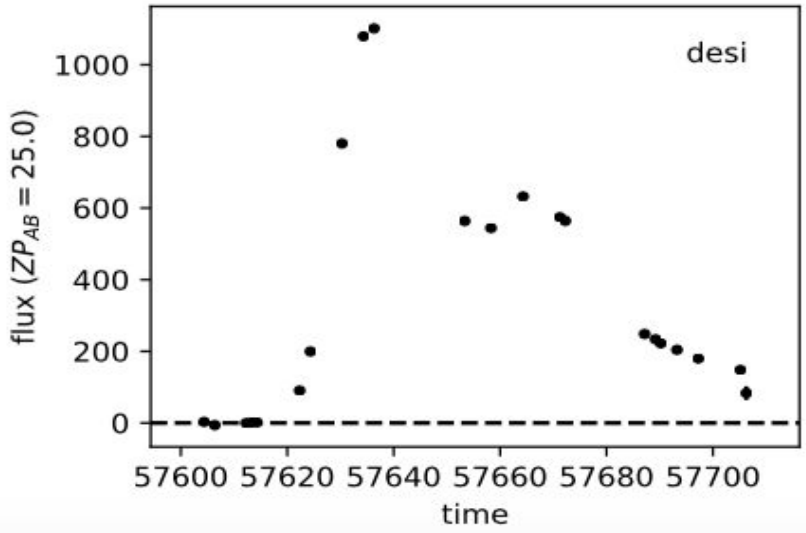
Activity in ZTFCosmo: Berlin (3 PI) | Stockholm (2+ PI) | France (1 PI) | Berkeley (1 PI)

ZTF | SNeIa Light Curve Expectation

Simulated LC



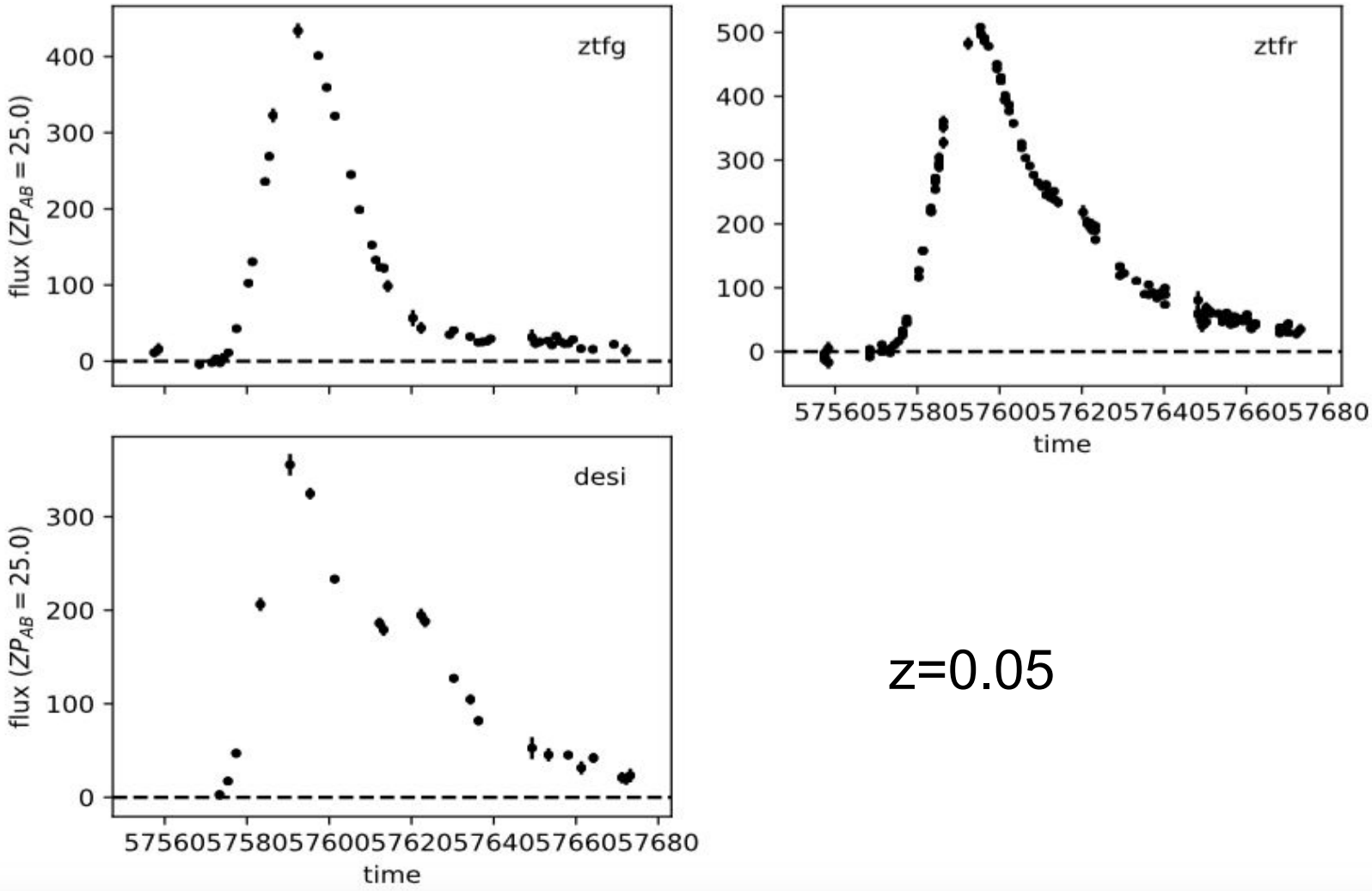




z=0.03

ZTF | SNeIa Light Curve Expectation

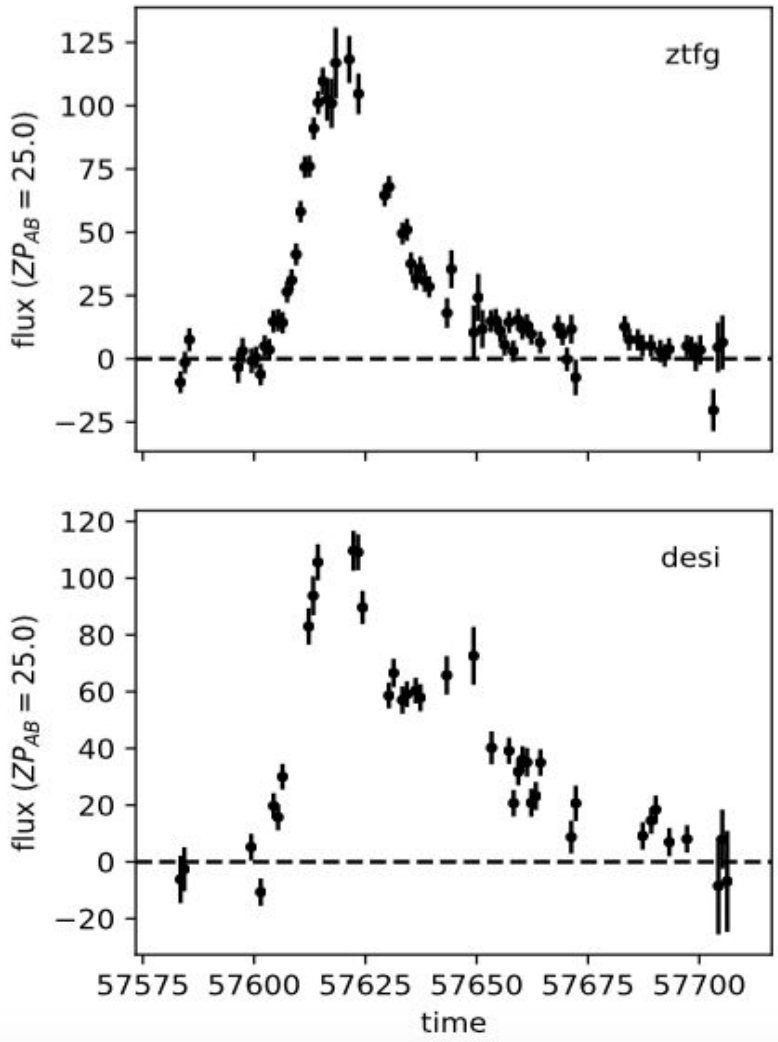
Simulated LC

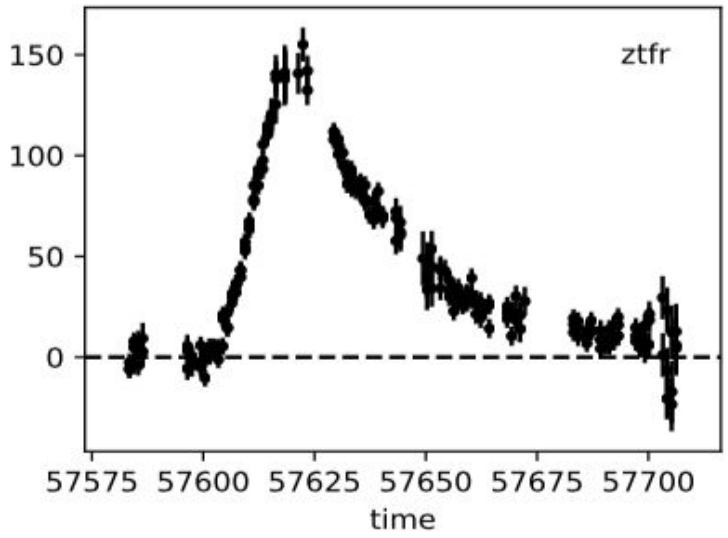


z=0.05

ZTF | SNeIa Light Curve Expectation

Simulated LC

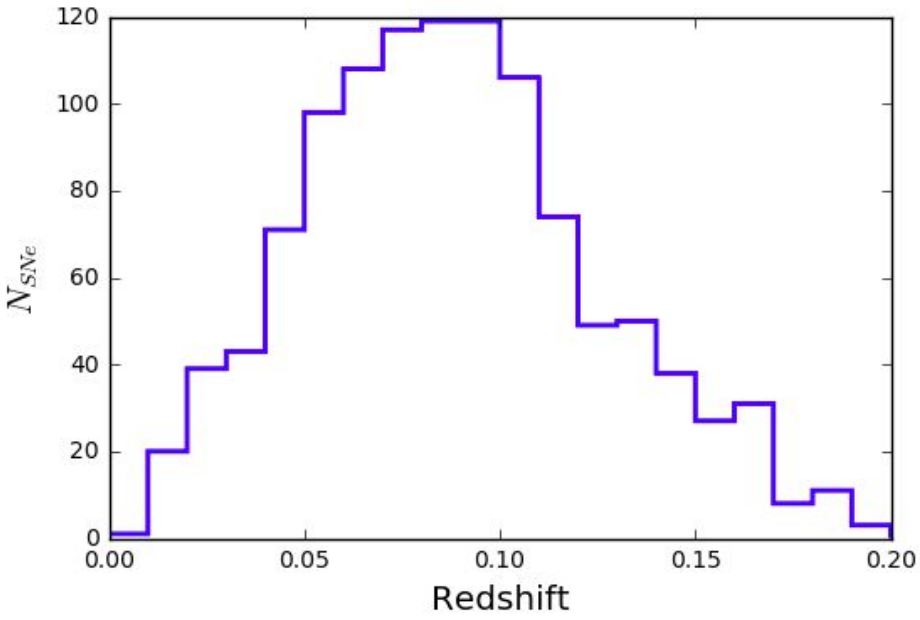


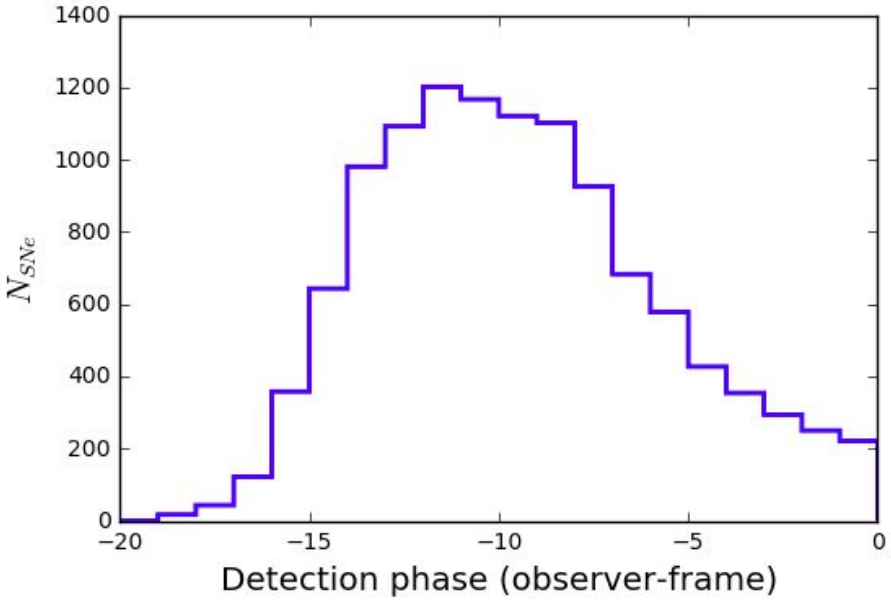


z=0.08

Building the Low redshift sample

Simulated plot



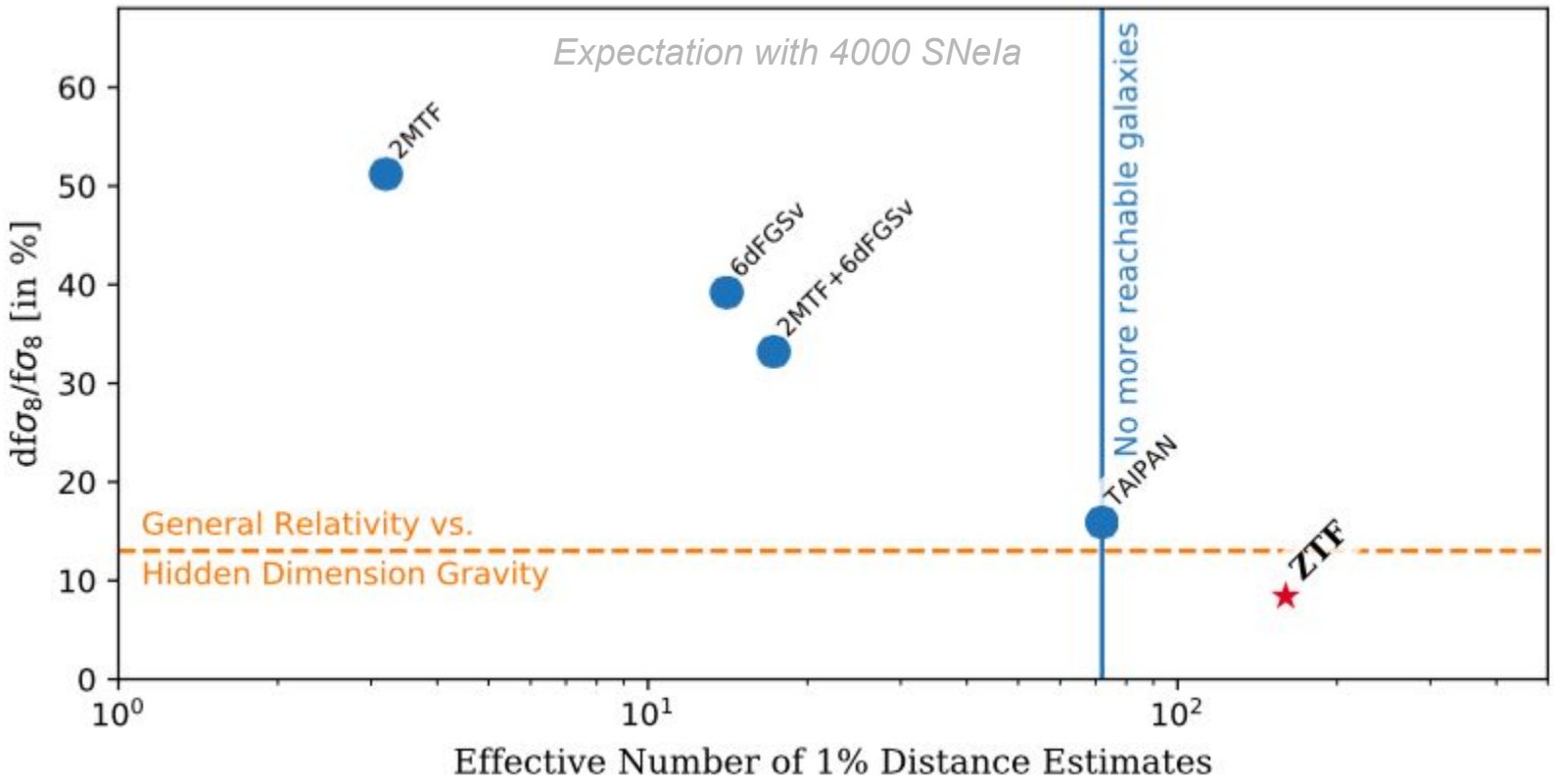


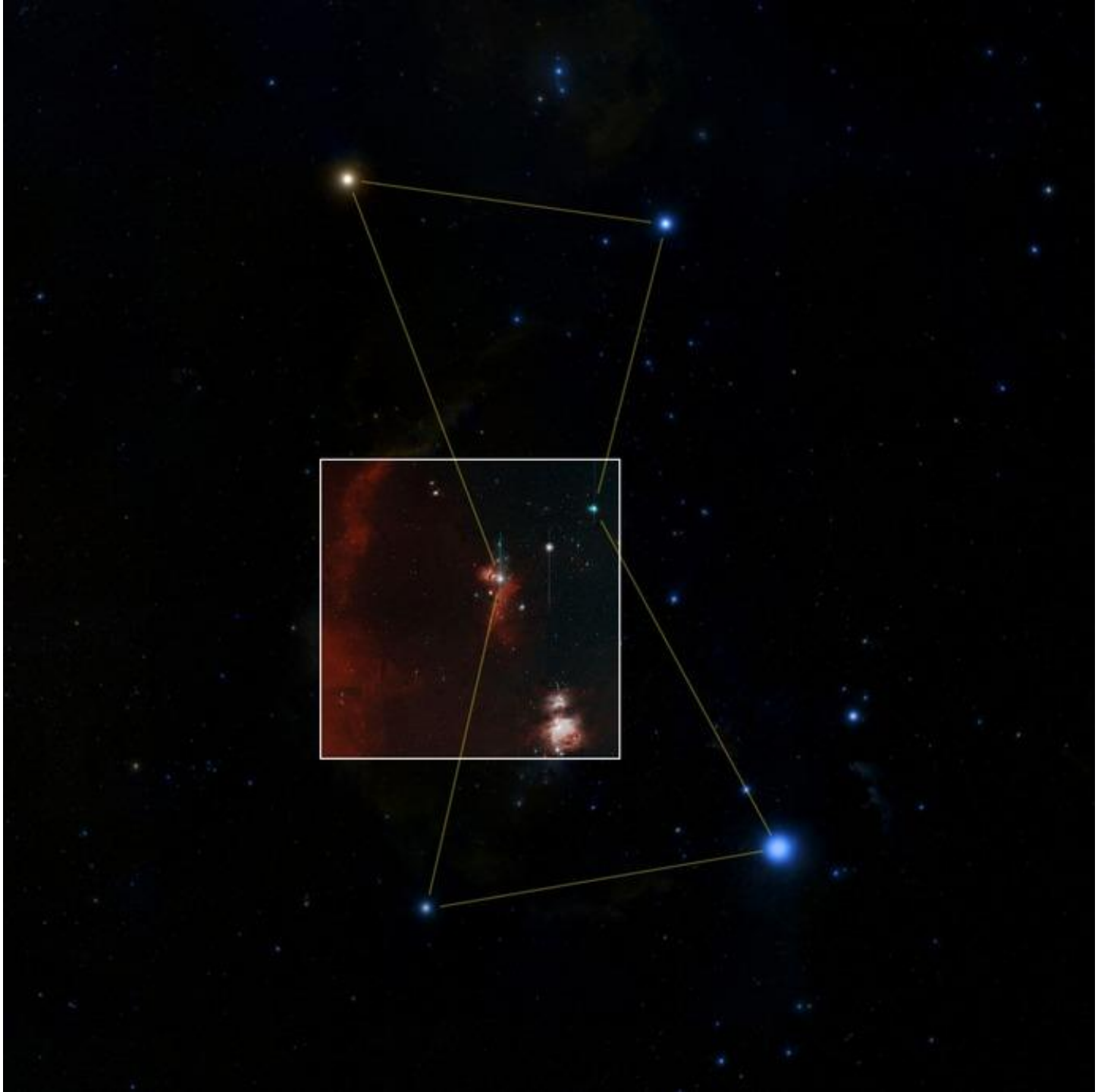
~2000 in 3 year with 3 bands (more than >10 points / band) with z<0.1

Aim at 1% photometry

All *SNeIa will be spectroscopically typed*

New era for Accurate Cosmology with nearby SNe Ia



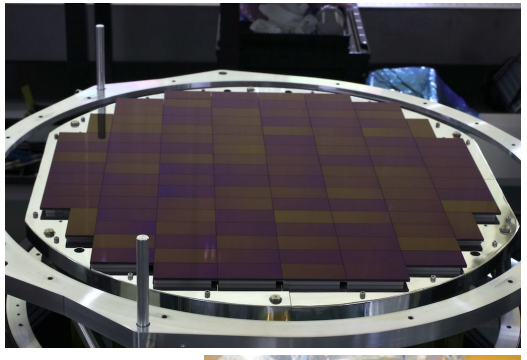


Subaru | Subaru Strategic Program (SSP)

a.k.a. Subaru Supernova Survey SuSHI

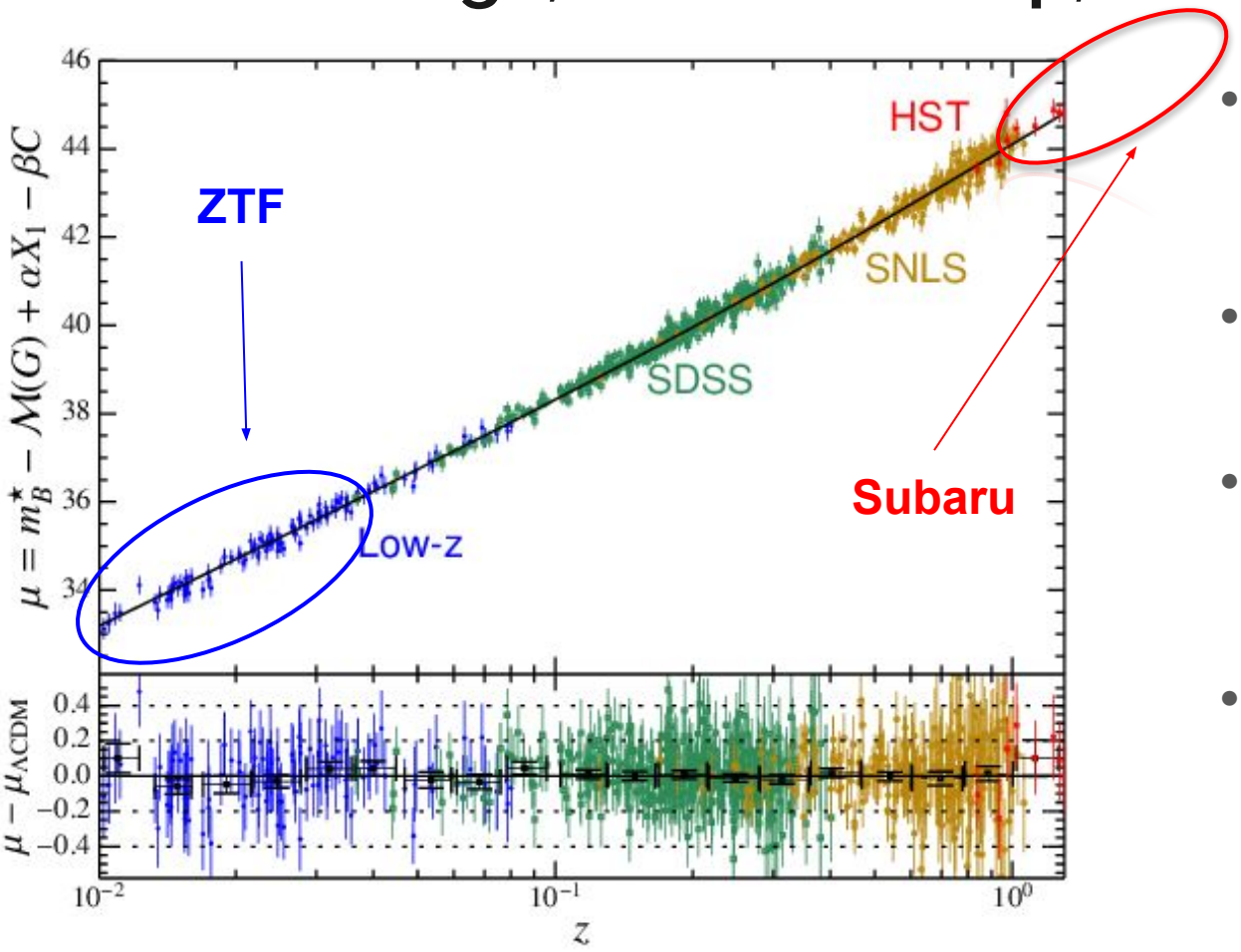
- Subaru / HyperSuprimeCam
  - Télescope de 8.2-m, caméra 1.8 deg^2
  - 104 + 8 red-sensitive CCDs
- Subaru Strategic Program
  - 300 nuits
  - 3 layers (Wide, Deep, Ultra-Deep)
  - Recadencage Ultra-DEEP
  - Survey SN ultra-profond (2 x 6 mois)
- 240 SNe Ia
  - 80 @ z < 0.8
  - 80 @ 0.8 < z < 1.2
  - 80 @ 1.2 < z < 1.5

Good training for LSST



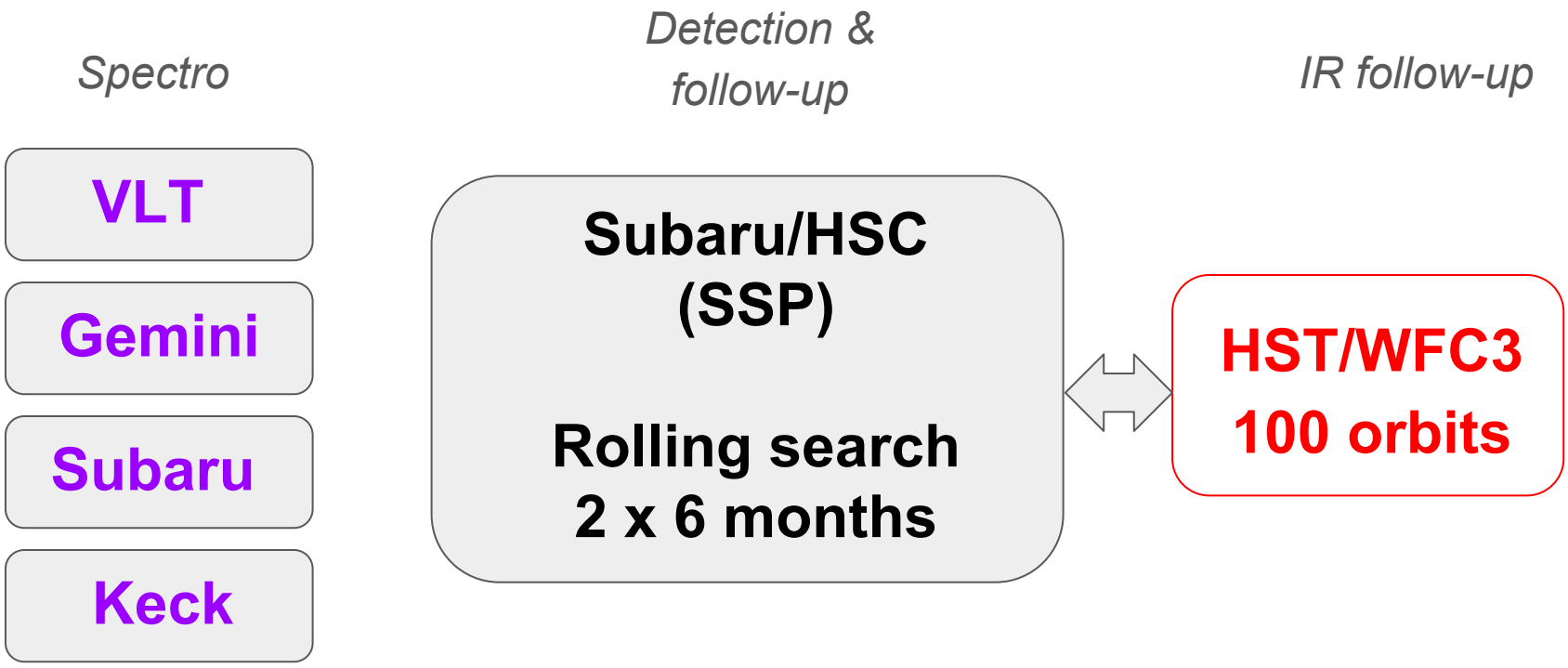
IR observations (Hubble Space Telescope)

ZTF is large, Subaru is deep, LSST is both



- **Goals**
  - Extend the redshift lever-arm
  - Combination paper by 2020
  - FoM > 50 by 2020
- **Maintain / upgrade expertise in**
  - SN photometry
  - Flux metrology
- **Explore analysis strategies -> LSST**
  - SN LC models
  - Malmquist bias
  - Combined fits (cosmo + LC models)
- **Demonstrate ground / space complementarity**
  - HST / Subaru

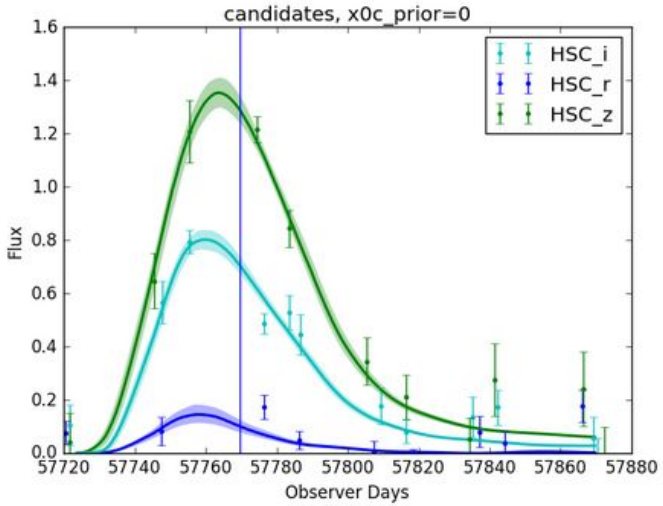
Project structure

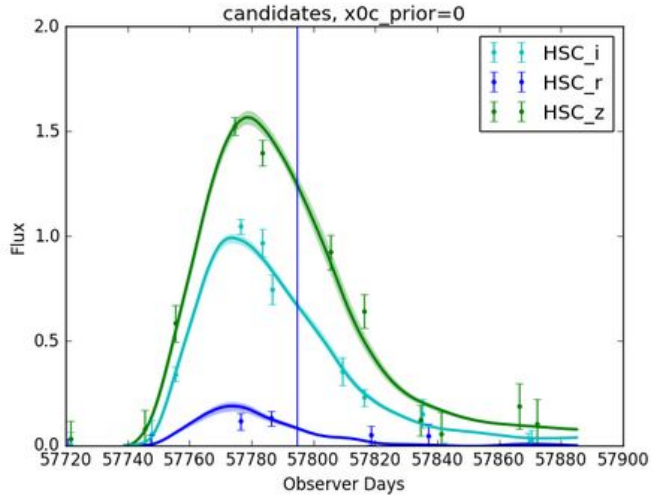


Status of the Project

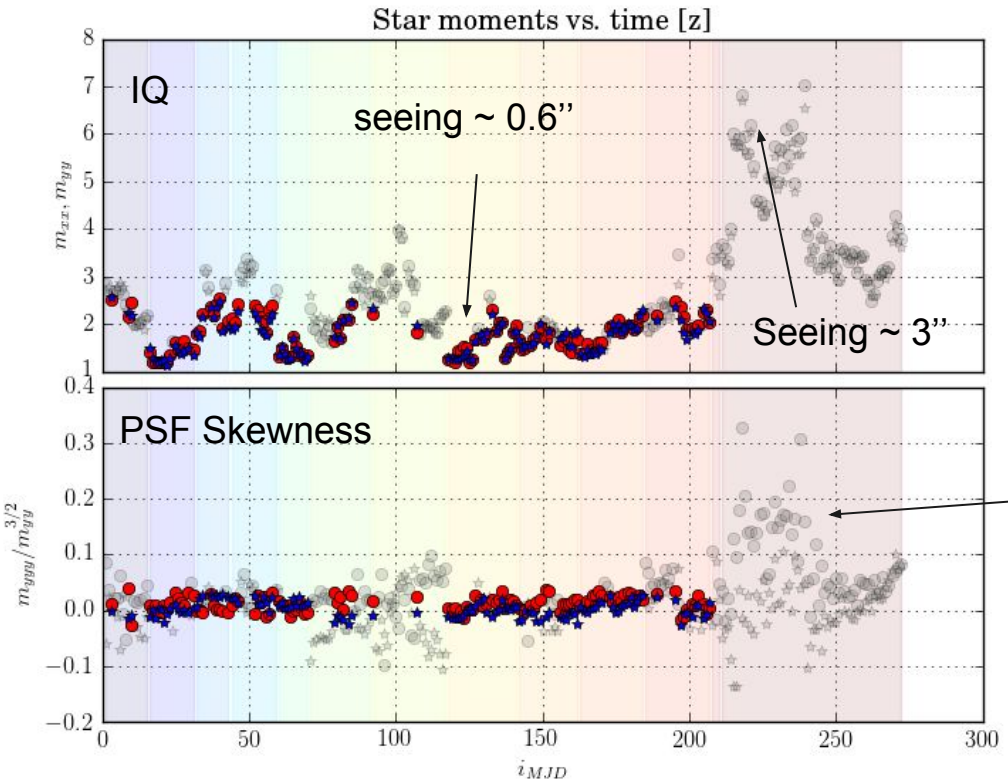
- **Data taking started in Dec. 2016**
  - 6 month search
  - COSMOS field (SNLS-D2)
  - O(1000) transients
  - O(200) SNe Ia
  - O(100) SNe Ia @ z<1.1
  - HST triggered on 25 z > 1 SNe -> **~ 50% final statistics**
- **Data taking restarted in Jan. 2018**
  - 5 month search (bad weather in Dec 2017)
  - COSMOS field again (enables deep references)
- **Third season possible (XMM field)**
  - August 2018 -> Jan 2019
  - z < 1.1 (no HST)

2 z > 1.1 SNe sent to HST





Data quality

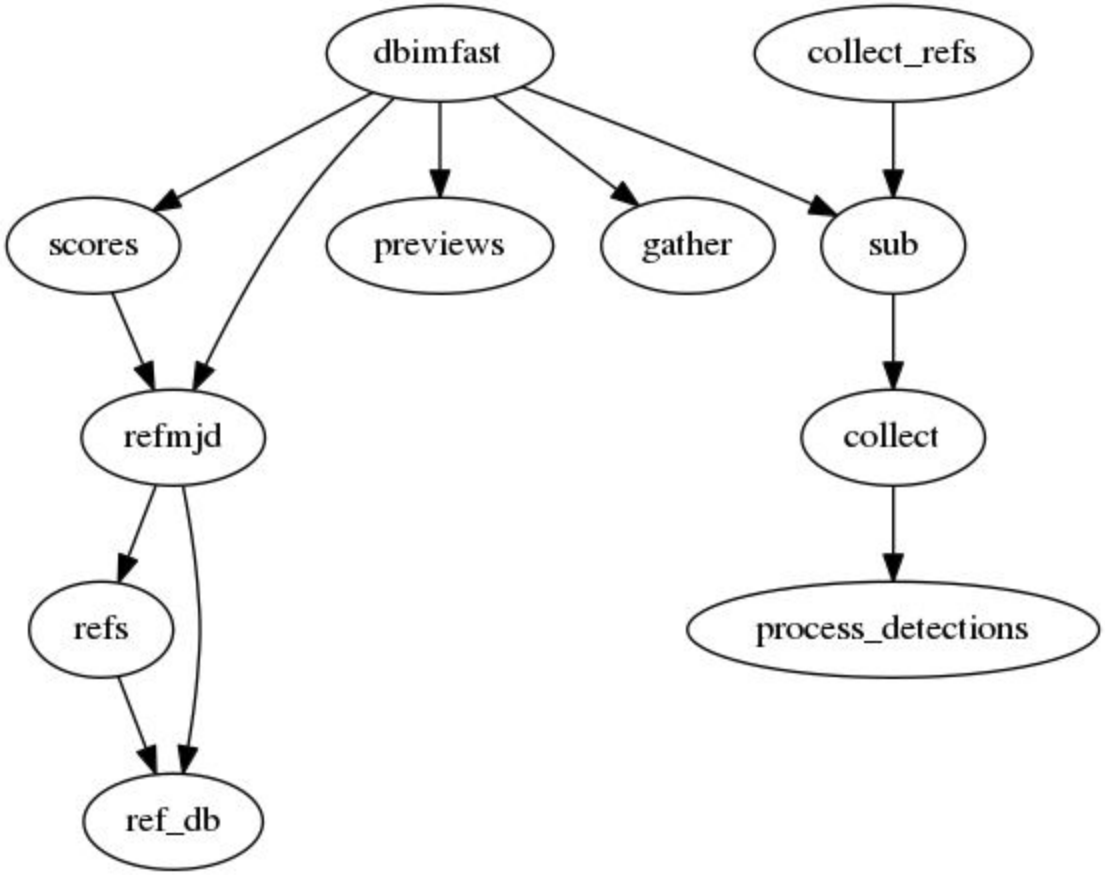


- **Great instrument**
- **Data quality is good**

… but

- **COSMOS is a winter field**
  - Variable IQ (median seeing ~ 0.8)
  - Some exposures with PSF globally skewed

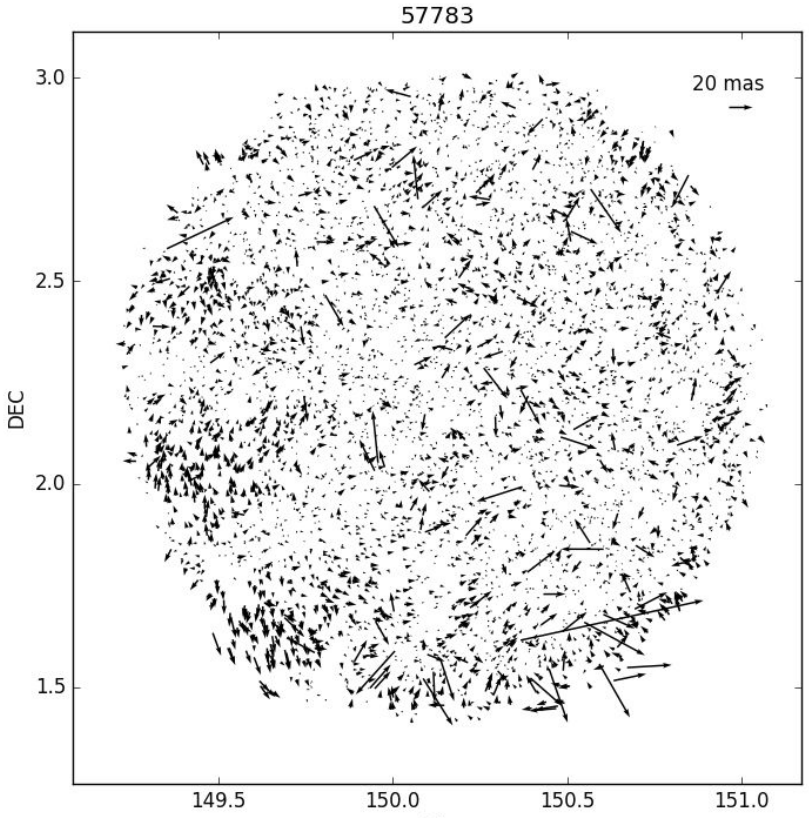
Detection & Photometry pipelines



- **In construction**
  - Adapted from SNLS pipeline
  - With recent additions (e.g. jointcal)
  - Very light and flexible pipeline infrastructure (pipelet)
- **A few more man-months worth of work before we can deliver SNLS-grade lightcurves**
- **Developments on**
  - Astrometry
  - Photometric uniformity
  - PSF model
  - Relative astrometry
  - Scene modeling fit

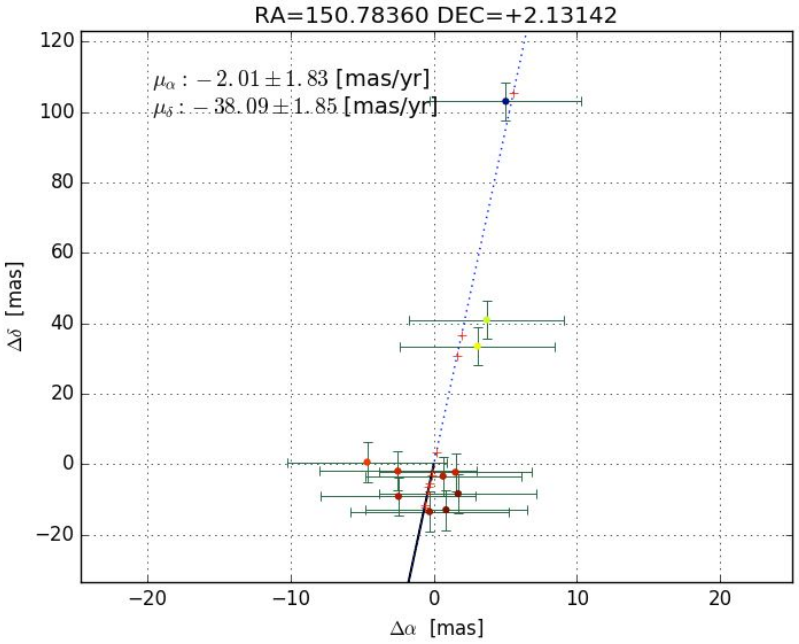
(+ pipeline / scanning infrastructure)

Ongoing work | astrometry



(see PA 's talk)

- Based on gastro/jointcal
  - Astrometric precision ~ 5 mas
  - Additional developpements pending
    - Proper motions in the global fit
    - Combined fit of several epchs



Ongoing work | Photometry / calibration

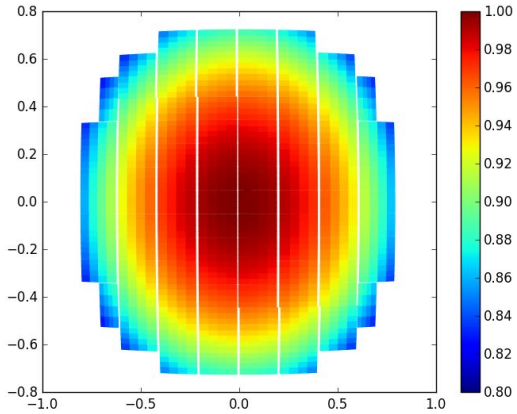
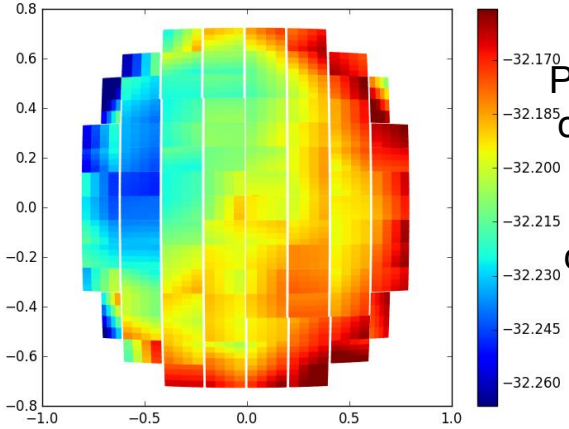


Plate scale variations ~ 20%

(from astrometry)



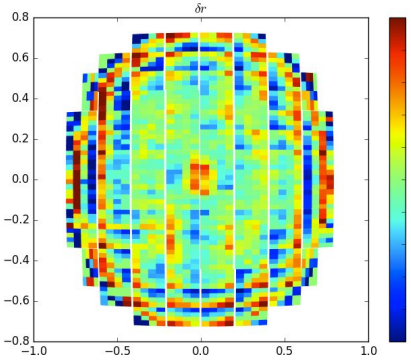
Photometric corrections

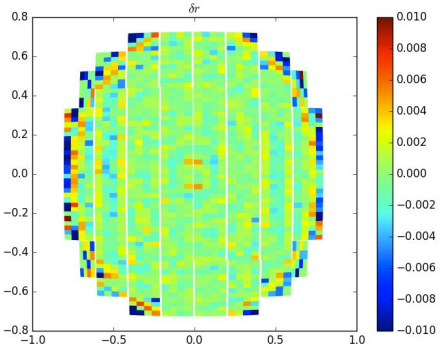
(from calibration fit)

- **Same technique : fit for**
  - Stars
  - Photometric flats
  - … from dithered exposures
  - … using an external calibration catalog
  - to anchor the flux scale
- **In developpement:**
  - Understand residuals (passbands ?)
  - Better parametrization of instrument response variations
  - Simultaneous fit of all epochs

SNLS (as of today)

Residuals : ~ 1%



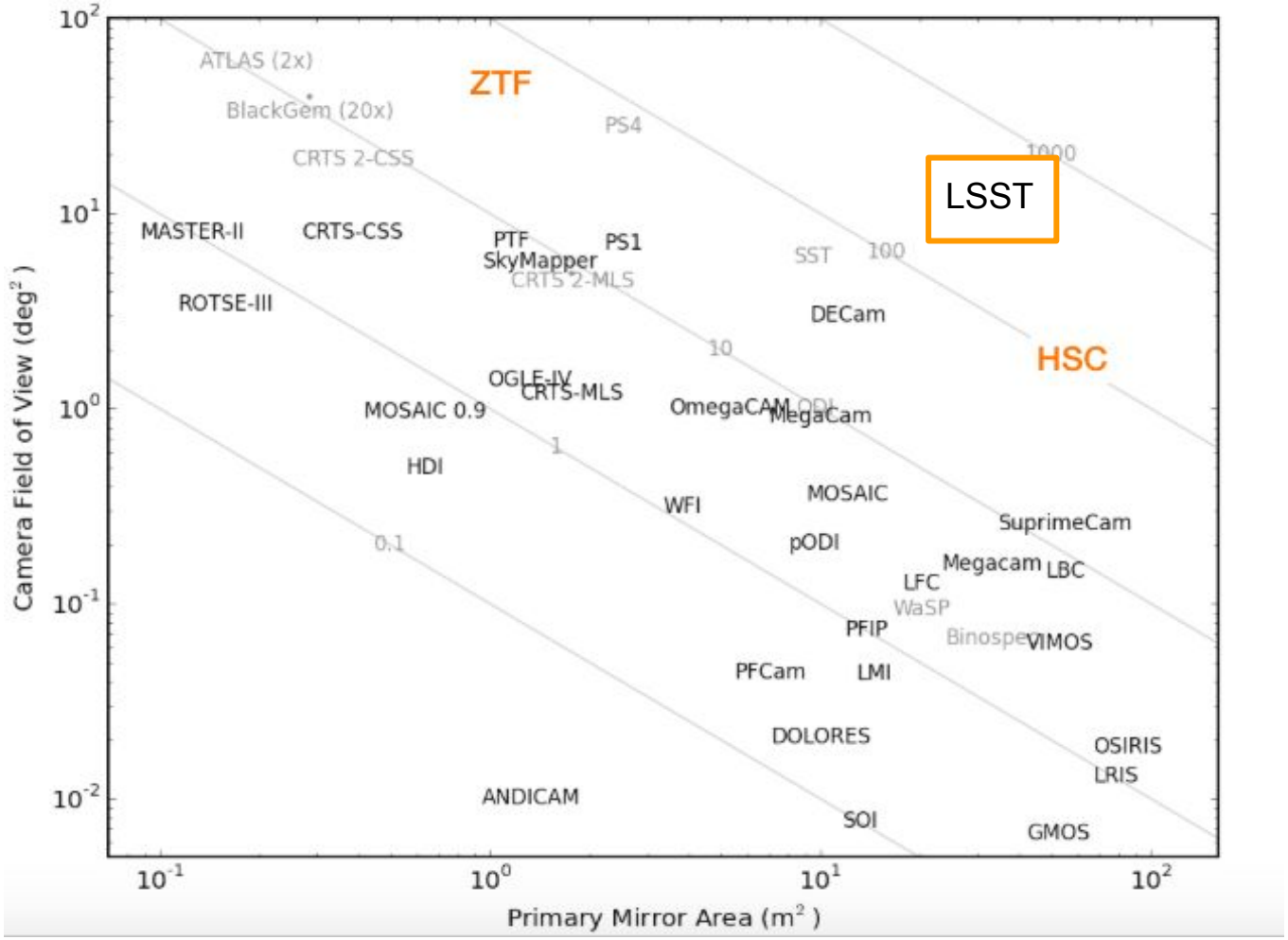


Perspectives / Forecasts

Dataset	**FoM (JLA calibration)**	**FoM (calib uncertainties halved)**
JLA	15	21
JLA + SSP	37	48
JLA + SSP + ZTF	56	69
JLA + SSP + ZTF + DES	~70	~86

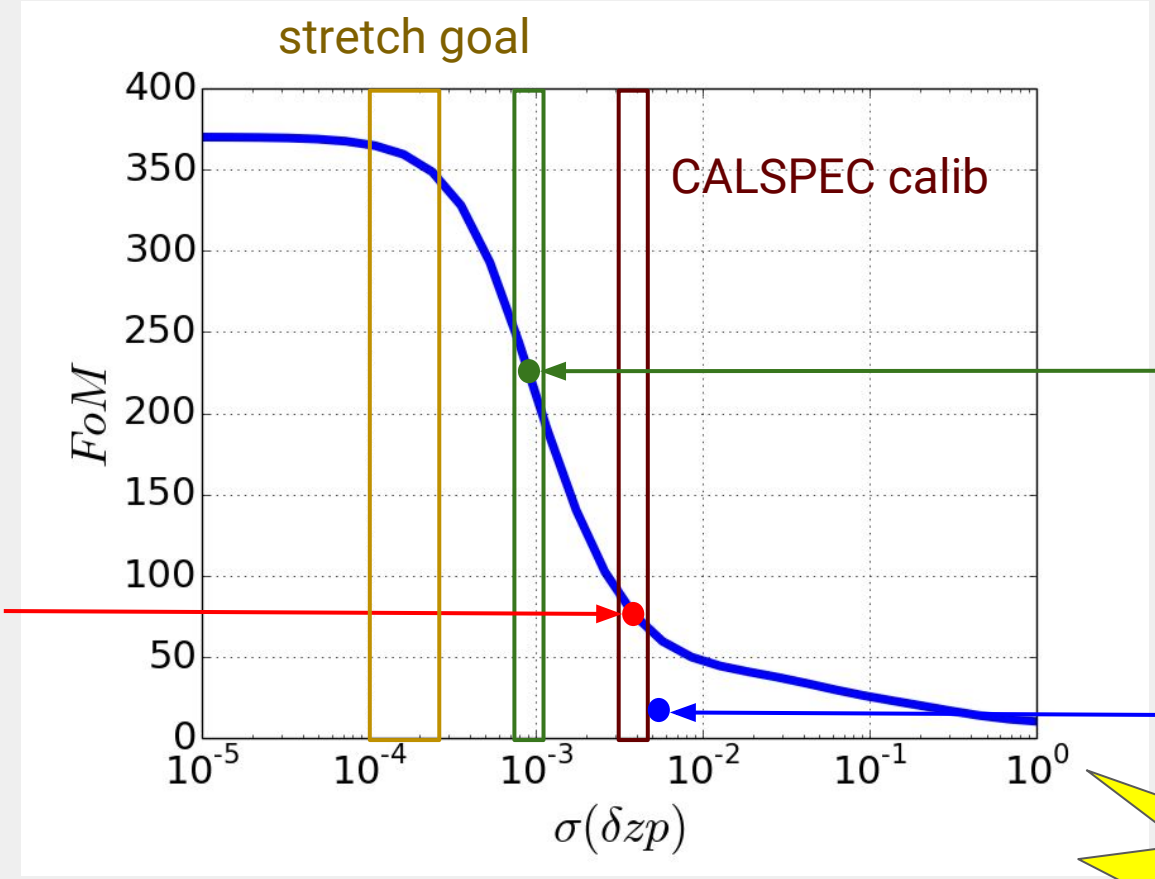
ZTF is large, Subaru is deep, LSST is both

LSST has to be an IN2P3 joined effort, not a lab-oriented activity

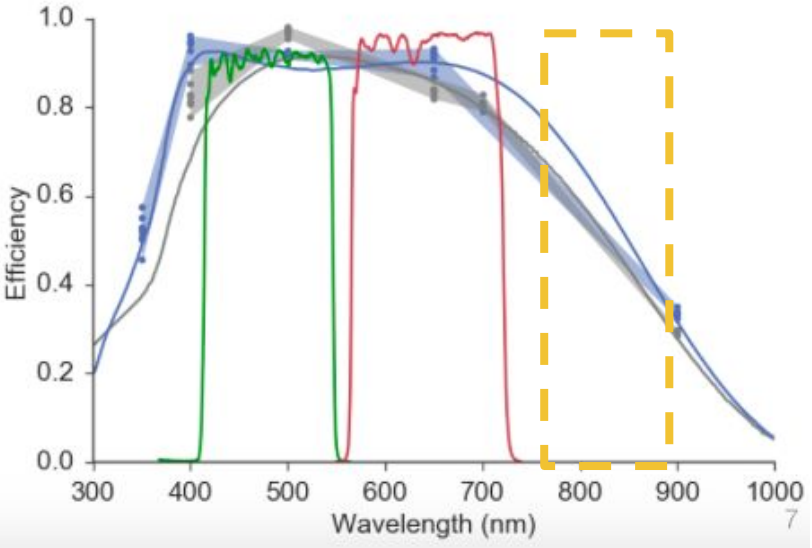
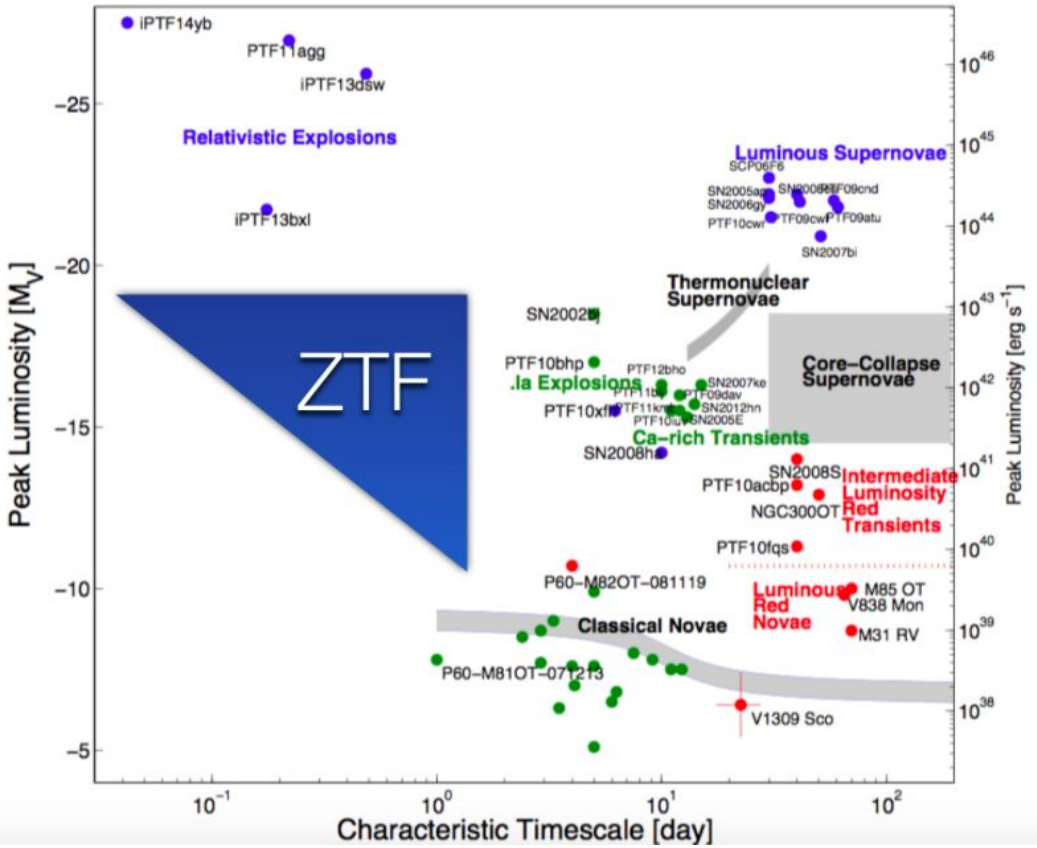


FoM (fixed filter position)

We compute the FoM from the covariance matrix for $2x10^4$ SNe Ia :



Talk by F. Hazenberg

Backup | ZTF

e2v	
dimension	9.2 x 9.2 cm
pixels	6.1k x 6.1k
pixel size	15 micron
pixel scale	1”/pixel
outputs	4