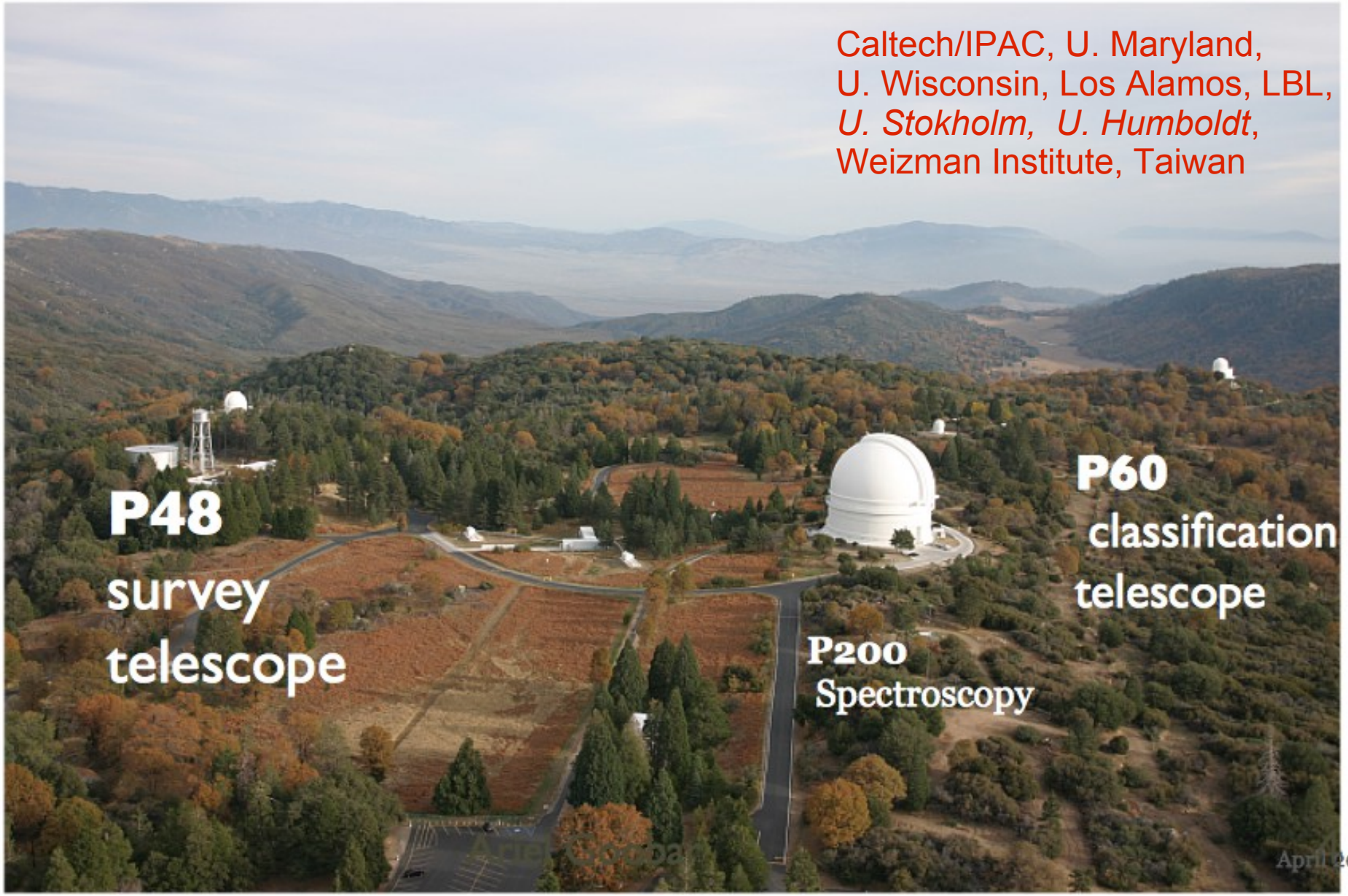
Supernova programs in Europe

A (somewhat) biased summary from Berlin Meeting

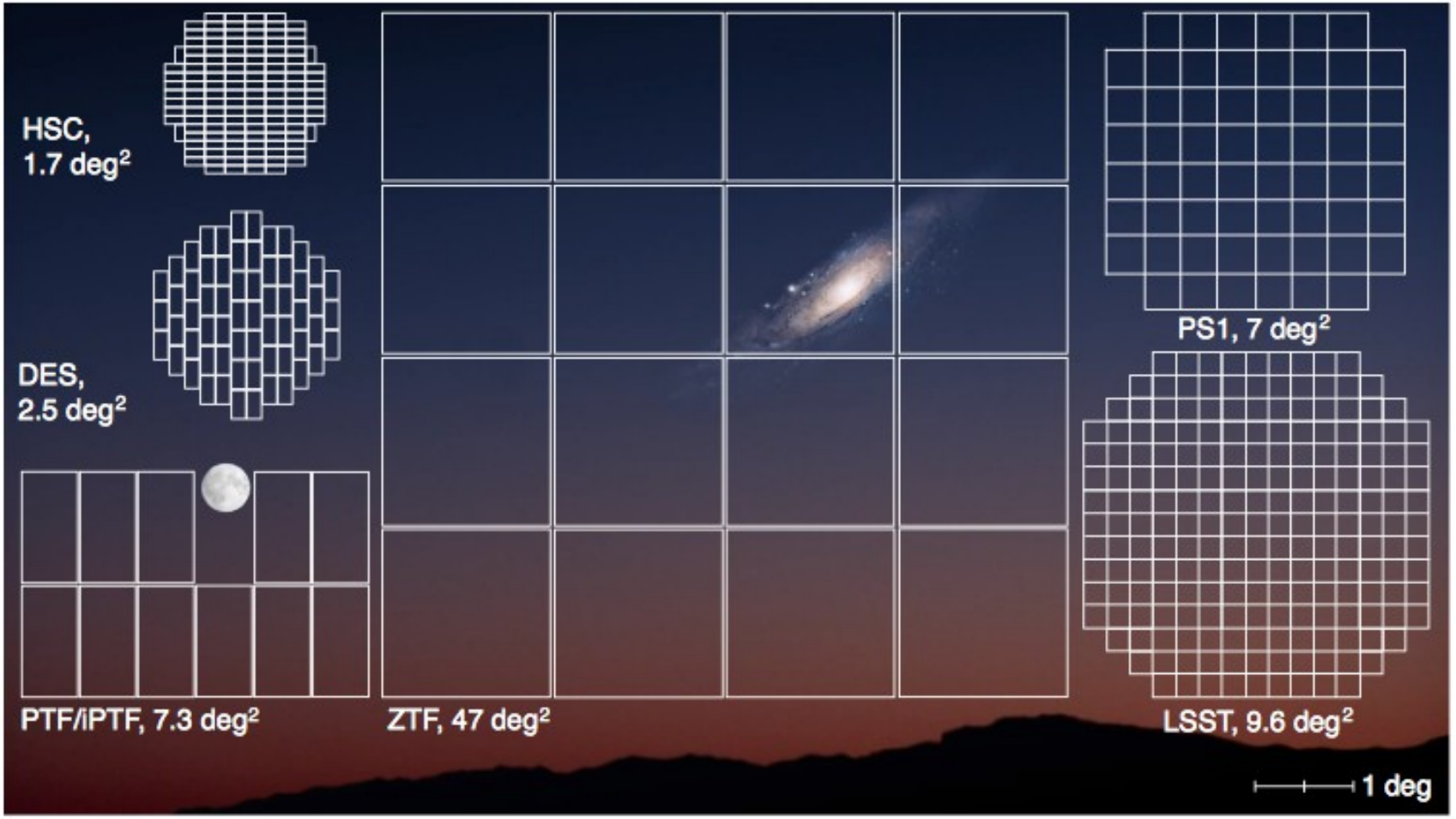
The Next Decade of European SN Cosmology

Within the next few years, several new major surveys – DES, ZTF, LSST, WFIRST, etc. – will be operational, increasing by several orders of magnitude the amount of observed Type Ia supernovae, while JWST and HSC provides new capabilities. In order to discuss these strategic opportunities and the role of the European SN-cosmology community we will host a 1.5 day meeting April 14/15 2016 at the Humboldt University of Berlin.

The intermediate Palomar Transient Factory (iPTF): 2013-2016
Zwicky Transient Facility (ZTF): 2017-2020



ZTFx15 faster than iPTF



Precursor for LSST in time-domain astro

ZTF Characteristics

- Primary goal : **transients**
  - Supernovae (Young), GRB, AGN, Variable, Fast/Rare
- 47 sq. degree. FoV
  - 16 CCD e2v 6k x 6k e2v
  - 1" / pixel ; Median seeing 2"/pixel
- Area : 3750 sq. degree/hour
  - 30 sec. exposure time
  - Filters : g, R (ZTF bandpass) ; R 5-sigma depth = 20.4 mag
- Survey modes :
  - High-cadence : 300 epochs/year (2000 sq.degree)

Target SNIa sample with ZTF

- 1800 spectroscopicaliy ID:ed SNe Ia in galaxies in the DESI footprint and within PTF H-alpha survey.
- Redshift range $z \leq 0.08$; with up to 1 mag reddening discovered 2 mag below peak.
- High galactic latitude, $E(B-V)_{MW} < 0.1$
- **P48 photometric coverage**: gR + (some I?)
- 2-filter lightcurves (gR) with 3-day cadence, SNR>10 (TBD), ≥15 points. Minimal coverage to day +40
- High-cadence sample, single band(~2000 sq.deg), for *very early* discoveries
- Multi-band (+ spectroscopy) follow-up from better site?

ZTF SNIa science goals

- Cosmological sample: new low-z anchoring set
- Bulk-flow measurement, precision TBD
- Systematics study: set floor for LSST, WFIRST: Host environment dependencies, dust
- Feasibility of photometric ID for e.g., LSST
- Sample to trigger NIR SNIa Hubble diagram
- Rates as a function of galaxy types and Ia-subtypes.
- Interaction and surface radioactivity, dark phase of SNIa (first 4 days).
- Late time lightcurves and spectra to understand nebular physics and interaction (>100 d).
- High-resolution spectroscopy: CSM and ISM studies.
- Progenitor systems vs Ia properties
- Lensed SNe

Oskar Klein centre

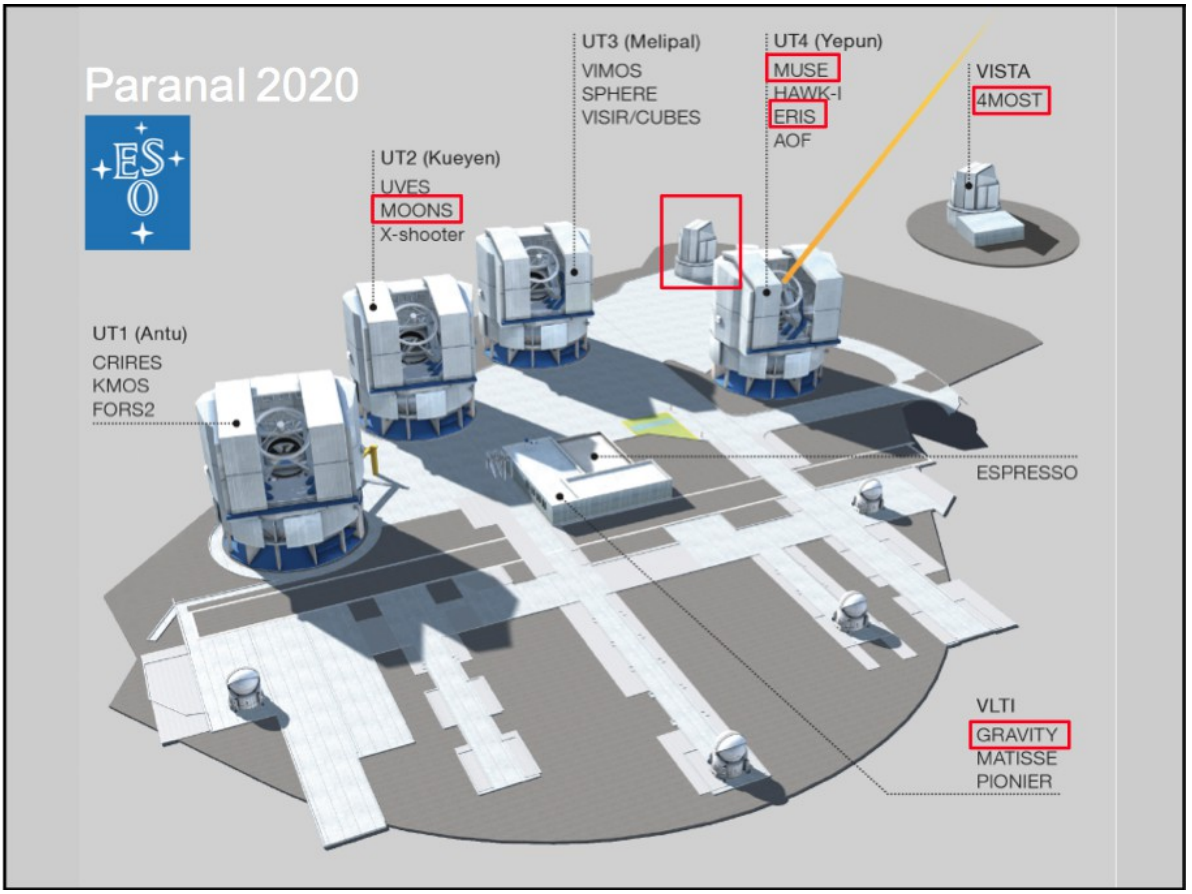
ZTF Summary

- ZTF excellent discovery machine for low-z SNe
- Spectroscopic screening of "young" transients on P60 SEDM
- But(!), not a good site for precission photometry
- Follow-up instruments in good locations could add significant value to the SNIa program for cosmology: ugriz + NIR + multi-epoch spectroscopy
- Great warm-up for LSST!

… but is not the ideal precursor
→ May serve as a plan B

Can be strategic for us:
SN scientists with follow-up capabilities will have an edge !

European perspective
→ ESO facilities



Interesting instruments for SN :

- MOS (Multi-Object Spec.)
  - 4MOST (Vis);
  - MOONS (IR)

    Change in operating mode:

    Surveys run in parallel

    → some fibers for SN ?

    → no systematic follow-up

    (Yet?)
- EUCLID (IR)
- FORS2 for spectro follow-up
- E-ELT : for selected objects

ESO policy change : move towards a systems approach

→ in the hands of the Supernovists to propose a programm

SN research opportunities

- Possible transient return using 2% of fibres:
  - 32 fibres/pointing x 8/night x 150 dark nights ~ 40,000 spectra / year (~8 / degree^2 per pointing)
- Can be live transients or host galaxies
- Scheduling 1–7 days in advance (TBD)
- Aim for live transients near peak in deep drilling fields?
- Use of HR fibres?

- Adding science case currently being negotiated (Bob Nichol)
- ESO member state institutes/individuals can still join
  - Individual membership: 100k€ + 1 FTE
    - 1 staff + 1 post-doc + students

SN in Europe ?

- **LSST** is the natural horizon
  - In US, *WFIRST* emerges as a competitor
- « Training » for LSST : DES, *ZTF*, ***HSC***
- Follow-up has to be anticipated
  - 4MOST ? Other ESO facilities/telescopes ?
  - Euclid for IR ?

→ European strategy under construction

(European funding …)