

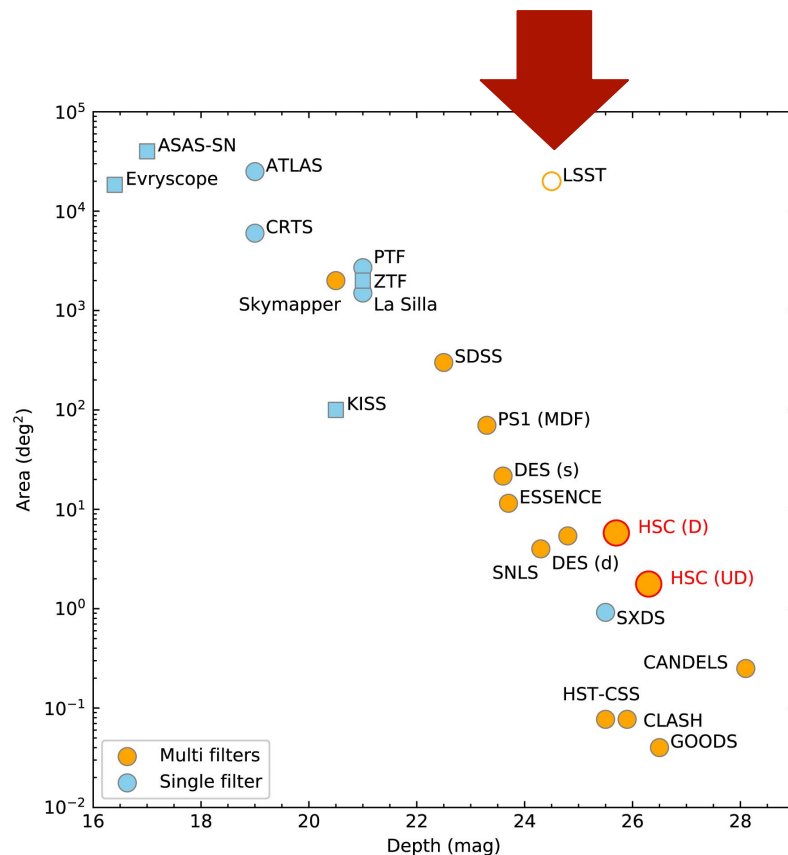


Status/News
LSST – V. Rubin Observatory
Pierre Antilogus
LPNHE-IN2P3,
Universités de Paris & Sorbonne

Action Dark Energy
Marseille 17 Nov 2022

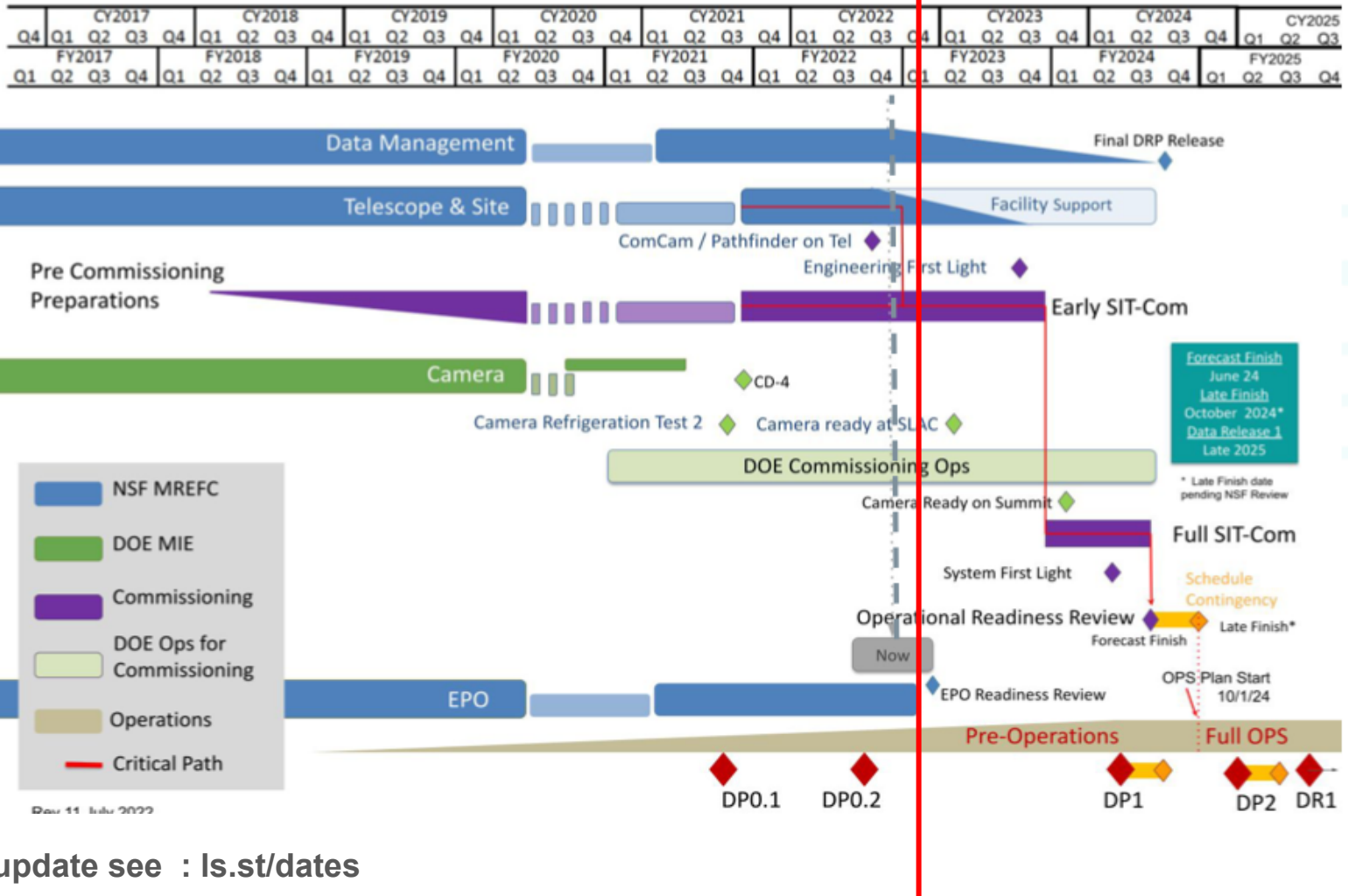
The Legacy Survey Space & Time (LSST) will start end of 2024 at the V.Rubin Observatory which is under-construction in Chile and will see its first ~light in summer 2023 :

- The LSST survey will collect optical data continuously for 10 years : deep (24 mag / pointing) , fast (1 pointing each ~ 40s) , and wide (field of view 9.6 deg² / ~ 8000 deg² per night) : 15 TB/night of data
- Over a decade LSST will acquire , analyse and made available more than 5 millions of images and a catalog of 37 10⁹ objects + a few 10 billions of transitory events made available in real time.
- LSST will cover a large research domain : Cosmology / Dark Energy indee , but also the Solar System , Milky Way , “variable sky” , Strong lensing , Galaxies .



Publ Astron Soc Jpn Nihon Tenmon Gakkai,
 Volume 71, Issue 4, August 2019, 74,
<https://doi.org/10.1093/pasj/psz050>

Rubin Observatory Schedule



Dernier Planning (sep 2022)

Real time planing update see : ls.st/dates

- 16-Dec-2022 Telescope Mount Handoff to Rubin
- 08-Nov-2023 3-Mirror Optical System Ready for Testing
- 29-Nov-2023 Engineering First Light w/ComCam
- 21-Dec-2023 Dome Complete

- 14-Feb-2024 Camera Ready for Full System AI&T
- 19-Jul-2024 System First Light
- 14-Nov-2024 Mini-Survey 2 Complete
- End 2024 Start LSST Survey

Project and Community Workshop 2022

320 attendees
+
250 virtual

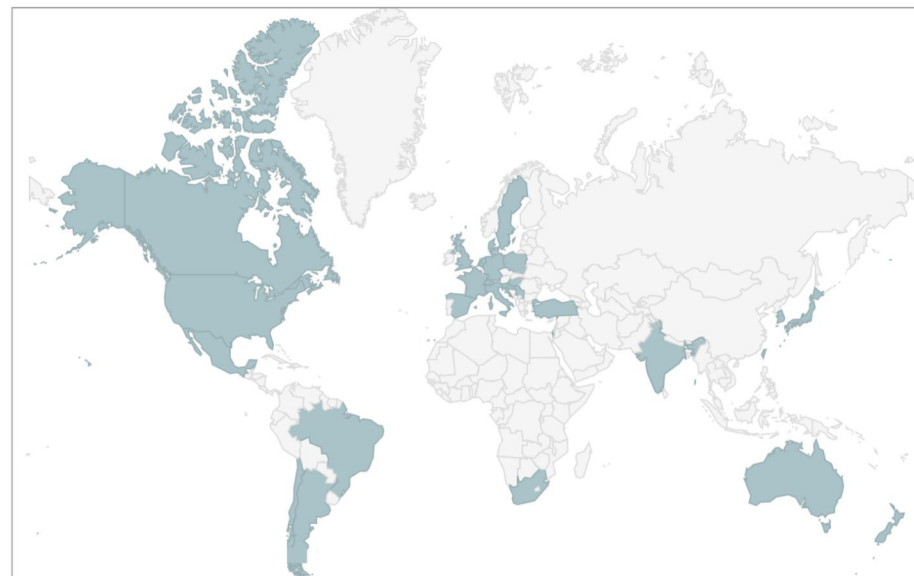


Alone , the **Dark Energy Science Collaboration (DESC)** ,
count 1188 members including
237 “Full members” (~ 40 French)

Non US :
43 International teams in 30 countries with 153
in-kind contribution project to Rubin Commissioning and
Operation.

France is “special” : big/only non-US contributor to the
construction . It counts today :
@ IN2P3 , 23 PI-Builder + 45 PI + 22 Juniors
@ INSU . 11 non-IN2P3 PIs (INSU)

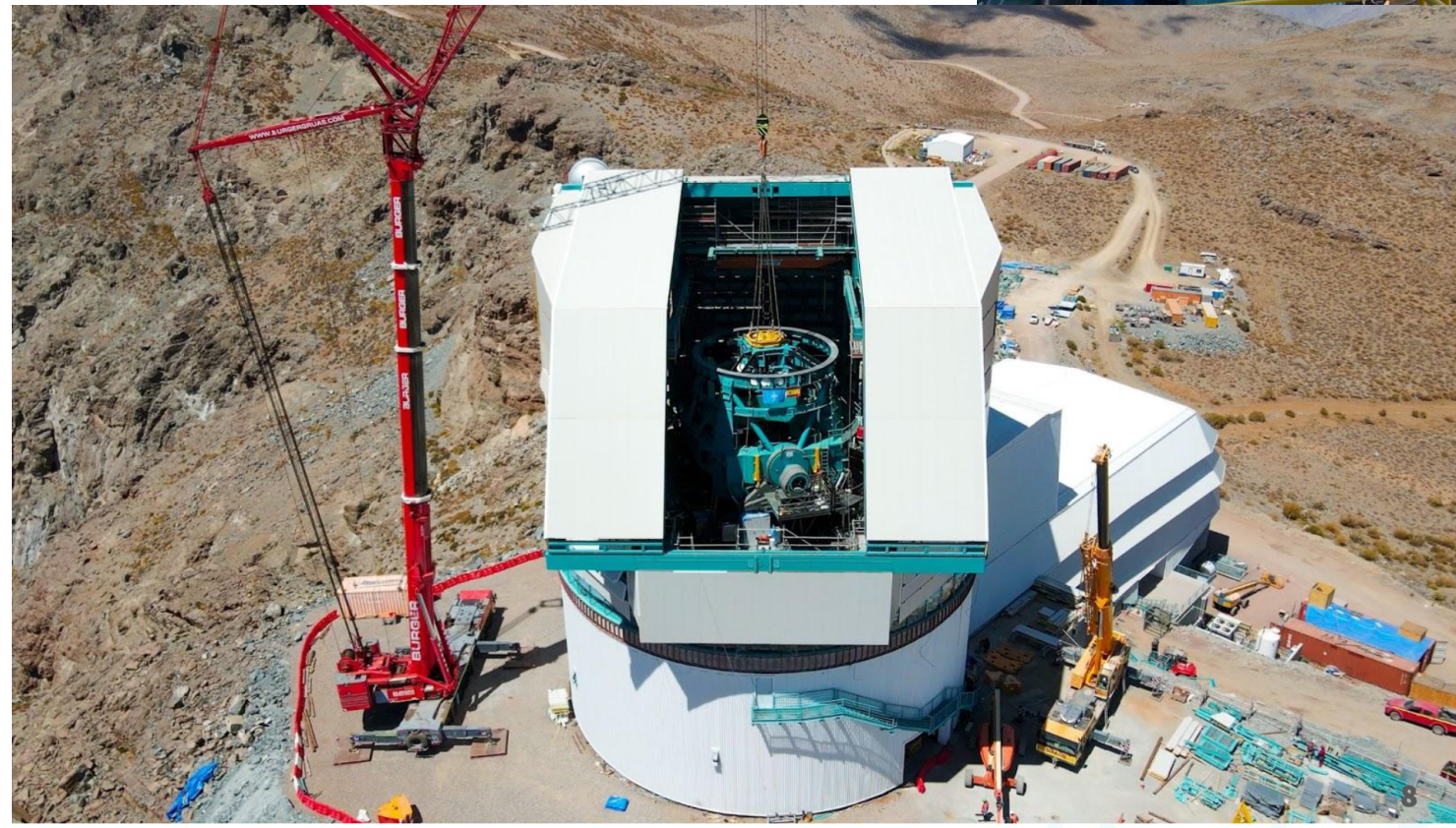
Remark : Many slides presented here are extracted from
lsst@europe4 talks : The LSST /European meeting that
append in Roma last month
(see <https://sites.google.com/inaf.it/lssteurope4/home/abstracts?authuser=0>)



Status / A Few Pictures : The Telescope (Chile)



Video of
telescope
motion:
ls.st/-dt

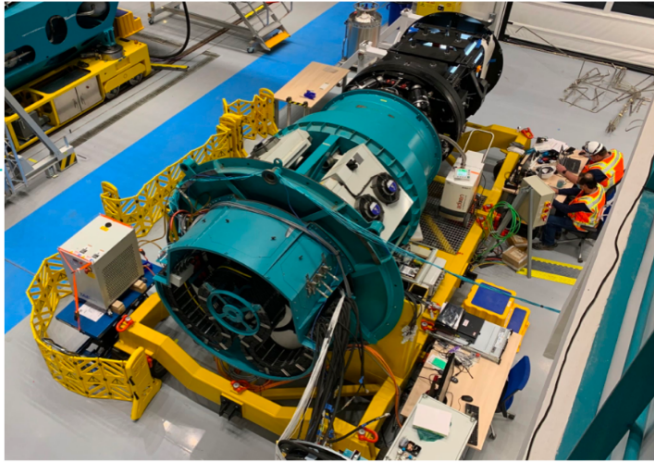


August 2022

Status / A Few Pictures : Inside the Building

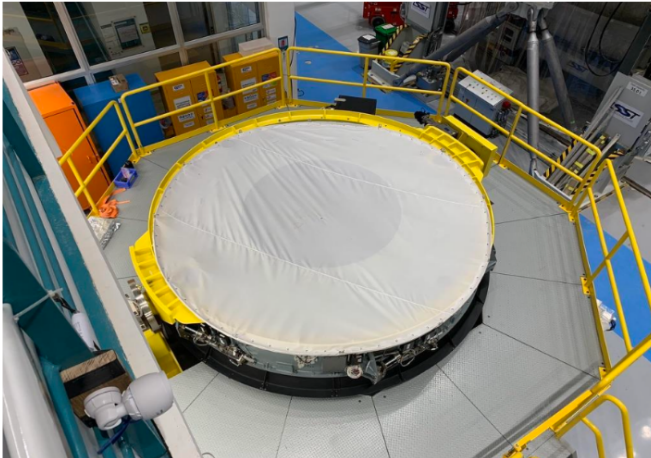


Commissioning
camera



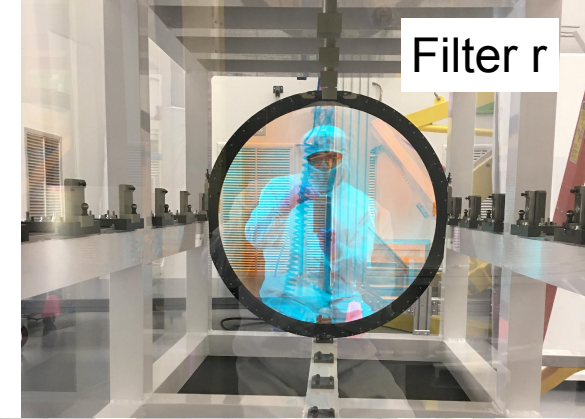
Mirror
washing
station

M2



Coating
chamber

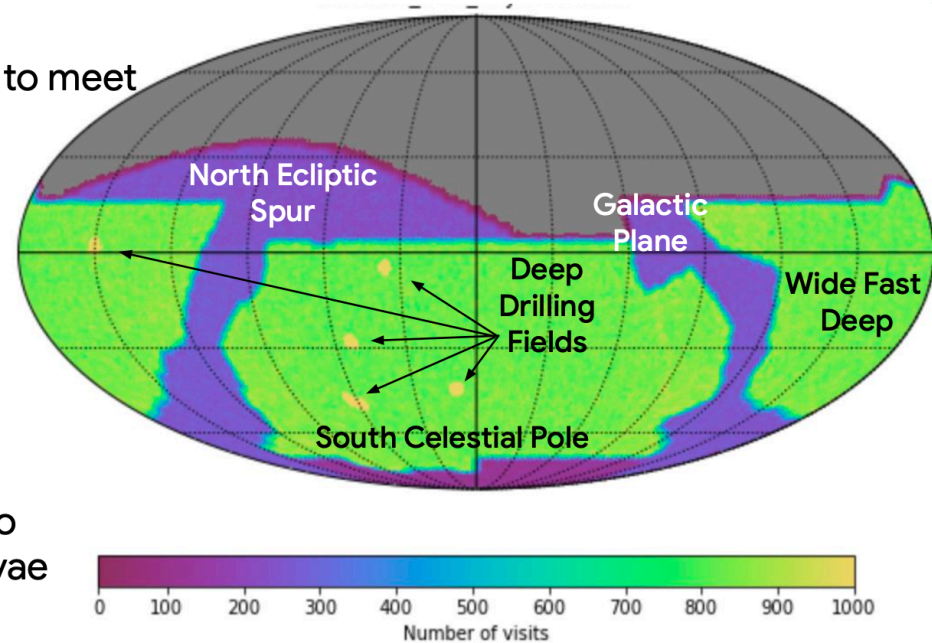
Status / A Few Pictures : The Camera (Stanford/US)



News related to LSST Science: Observing Strategy

In the first 10 years of operation, the Vera C. Rubin Observatory will execute as its prime mission the Legacy Survey of Space and Time (LSST)

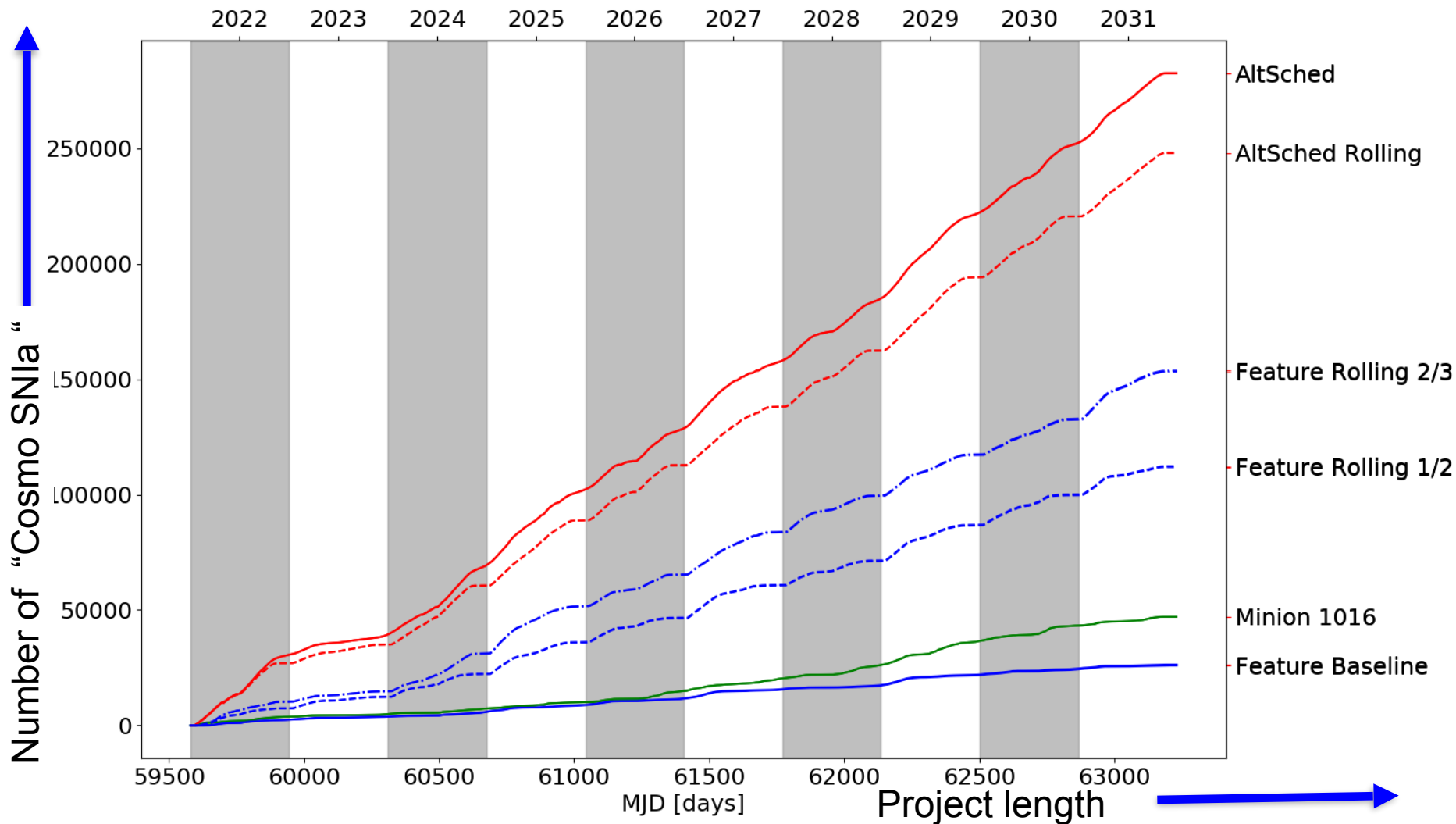
- **Main LSST Survey – Wide-Fast-Deep:** designed to meet the basic requirements to achieve the core science goals of the Legacy Survey of Space and Time (90% of time)
- **Deep Drilling Fields (DDF) :** very deep ($r \sim 26$) observations, very short revisit times (~ 1 minute)
- **Mini/Micro-Surveys:** North Ecliptic Spur, the Galactic Plane, and the South Celestial Pole
- **Target of Opportunity (ToO) mode:** reposition to observe sudden transient phenomena, e.g kilonovae



- Summary of SCOC status regarding Phase 2 questions
 - Q1: Filter Balance
 - Q2: Intranight Cadence (triplets?)
 - Q3: Footprint Refinements
 - Q4: Rolling Cadence
 - Q5: DDF Strategy
 - Q6: Early Science Options
 - Q7: ToO Time
 - Q8: Microsurvey Recommendations

LSST SCOC :

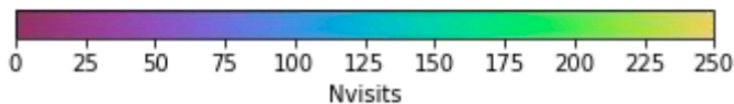
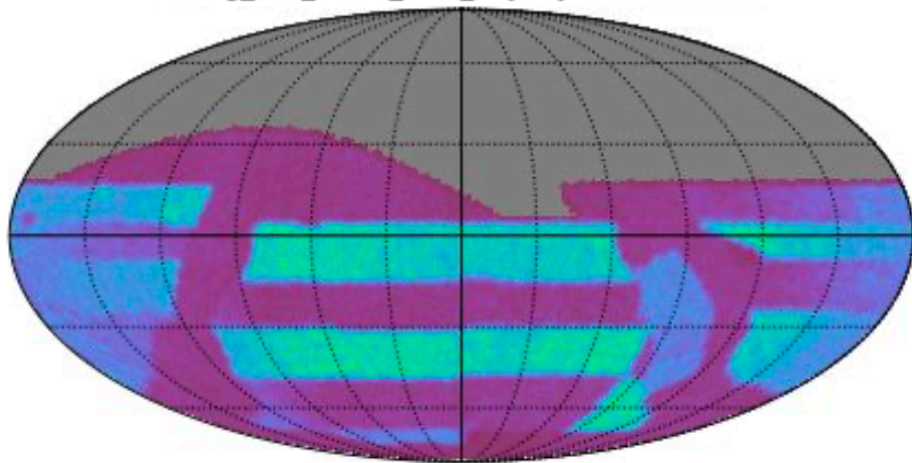
Survey Cadence Optimization
Committee



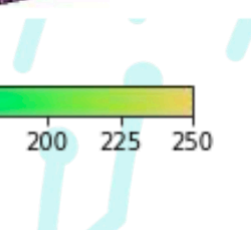
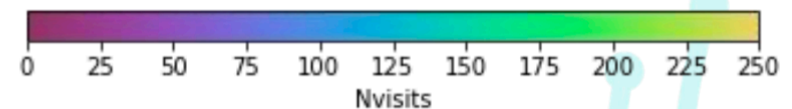
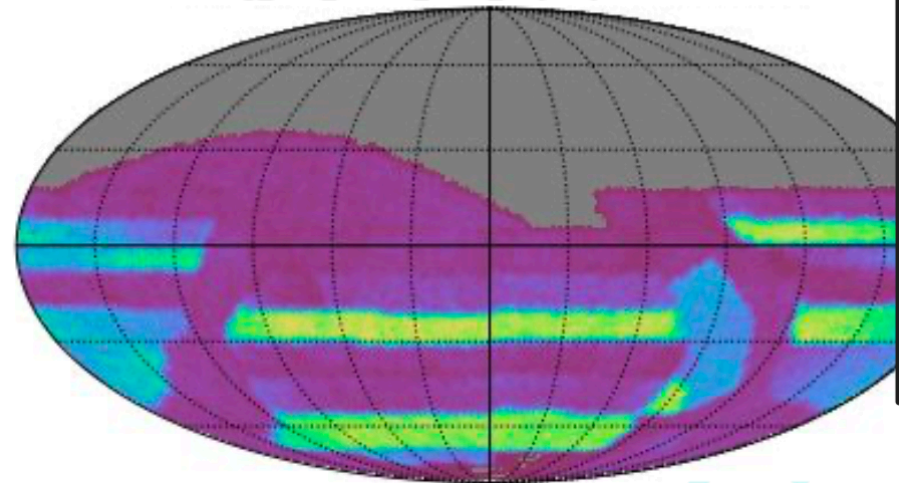
Q4: Rolling Cadence

- A 2 or 3 band, 80 or 90% rolling cadence is recommended
- Start at end of year 1 (rather than 1.5) ‘early rolling’
- Details of rolling cadence in the galactic plane TBD

rolling_ns2_rw0.9_v2.0_10yrs_year3.5: Nvisits

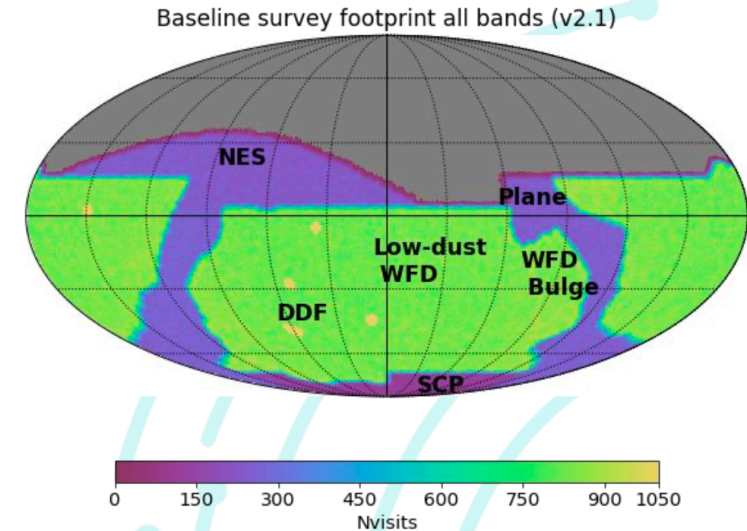


rolling_ns3_rw0.9_v2.0_10yrs_year3.5: Nvisits



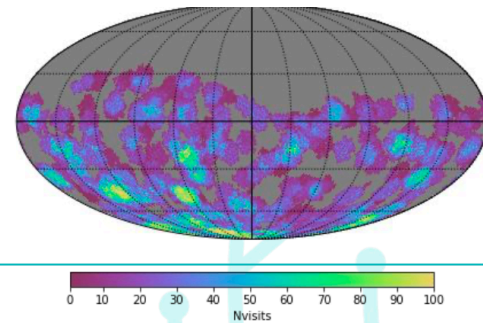
Q5: DDF Strategy

- Recommend spending >5% of survey time on DDF
- Specific DDF strategy TBD
- Different fields could have different strategies
 - COSMOS and XMM-LSS in particular
- The fifth DDF should be Euclid South
 - Details of observing strategy TBD
 - Euclid field is 'double' DDF pointing



Q7: ToO Time

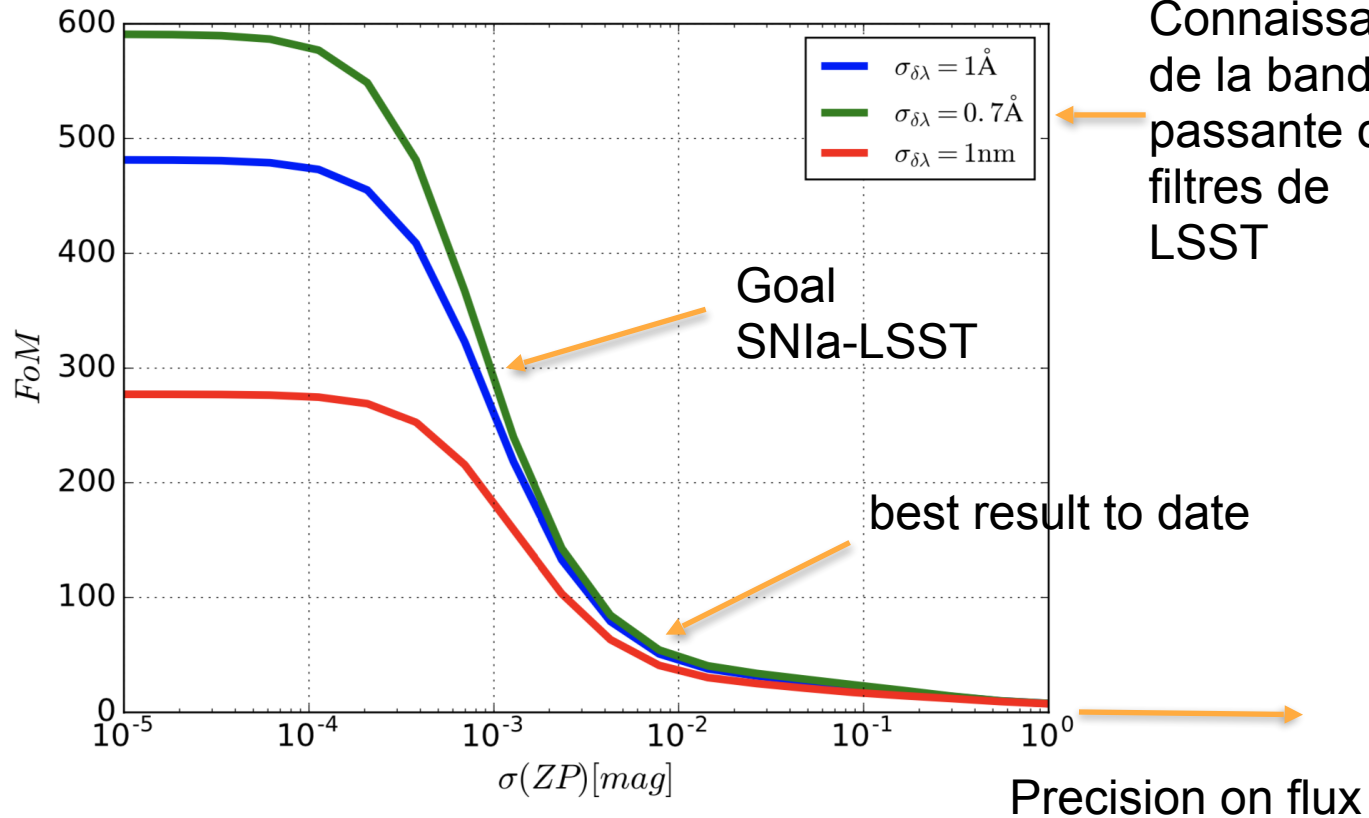
- Likely to recommend about 2.5-3% of survey time
 - Prioritize overlap with LIGO/VIRGO
- Details of ToO strategy TBD
 - Followup? Triggers?
 - Allow for ToOs which do not arise from GW triggers
- SCOC are considering holding a workshop to consolidate community ToO goals, trigger conditions, and follow up strategy



News related to LSST Science: Calibration

The quality of the calibration in flux will be a key point to take advantage of the LSST statistics !

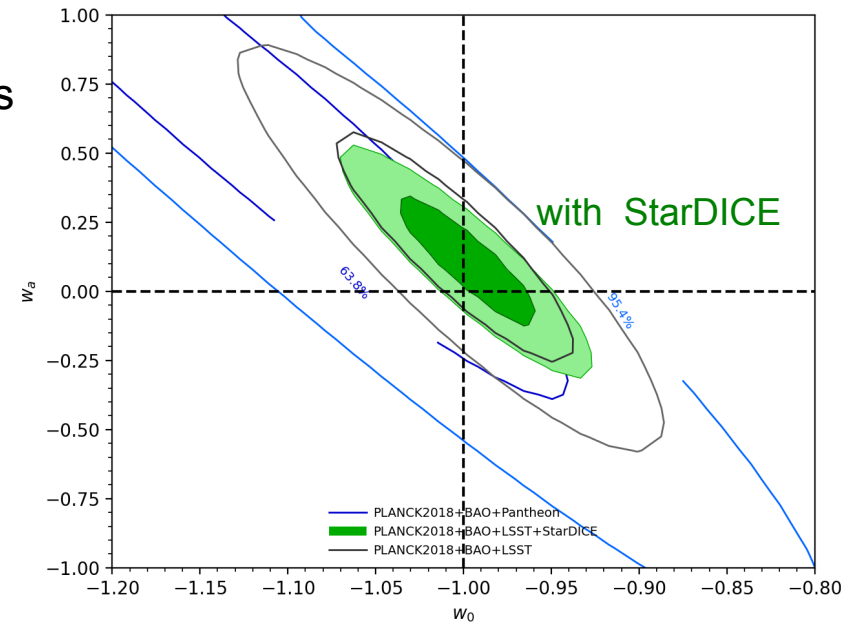
Figure of merit ("1/Precision") for the dark energy equation of state parameters



F.Hazenberg PhD 2020

Having many SNIa is useless if the measurement is not done precisely (light curve + flux calibration)

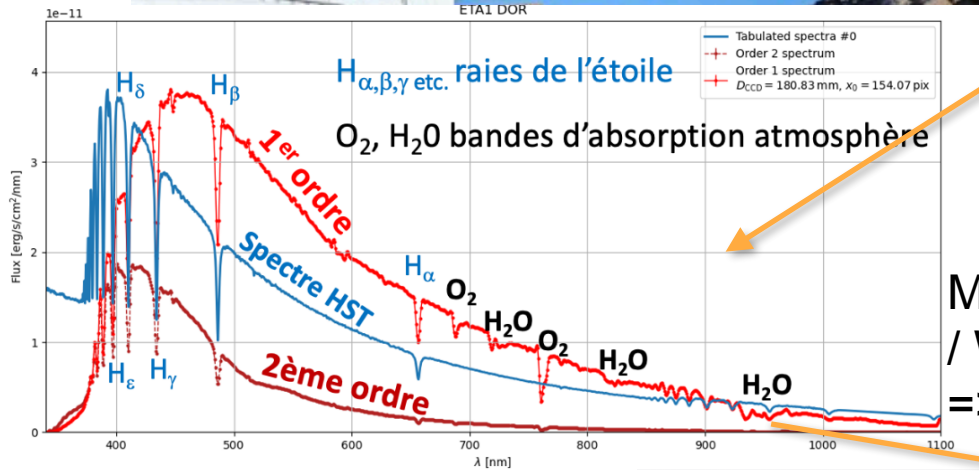
- **Forecast for a SN survey**
LSST+ZTF+HSC+StarDICE (→ FOM 300 in 2 years of data taking)
- **The Final design rely on a calibration transfert chain from NIST - to Star at 0.1% in 4 steps**
- **Key elements :**
 - **decteur calibration platform at LPNHE**
paper in prep. Upgrade on its way
 - Artificial star calibration bench Backend cablée. qualification of the prototype underway
 - Telescope Robotic Telescop at l'OHP
installed in 2022 and operational
- + "surrounding hardware" :
 - Atmospheric monitoring (auxtel like)
 - Measurement of the filter "à la LSST" (CBP RUBIN like)



AuxTel : Measure on site of the atmosphere transmission

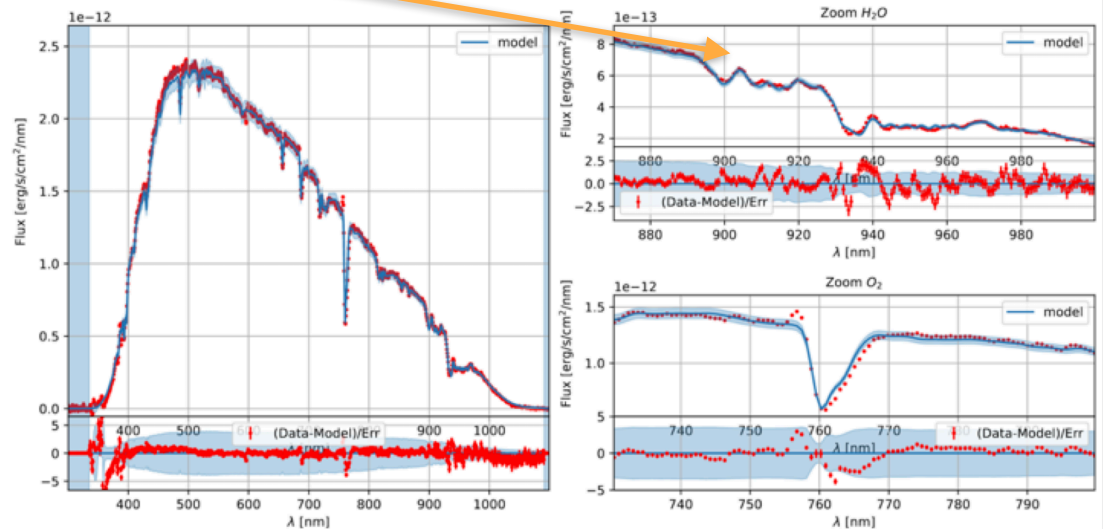


Slit less spectrograph



Modeling of the atmosphere transmission / Water vapor content in real time
=> z & y filter pass band detail.

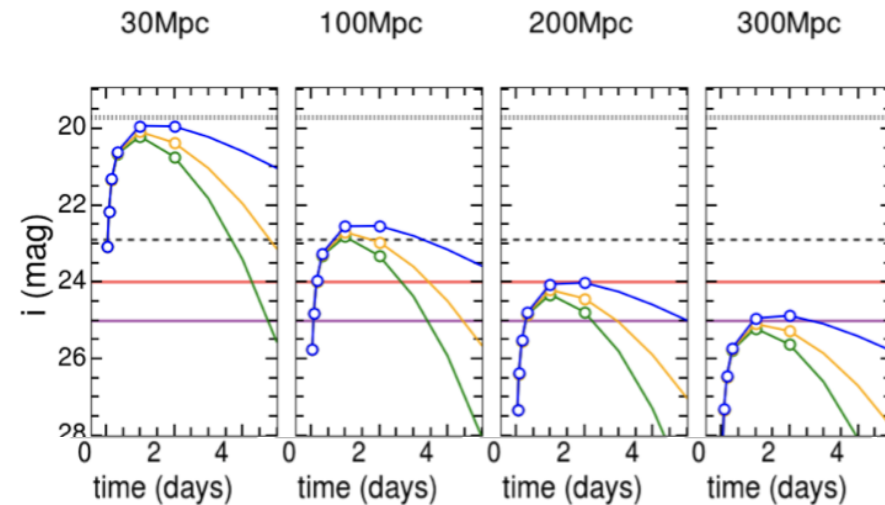
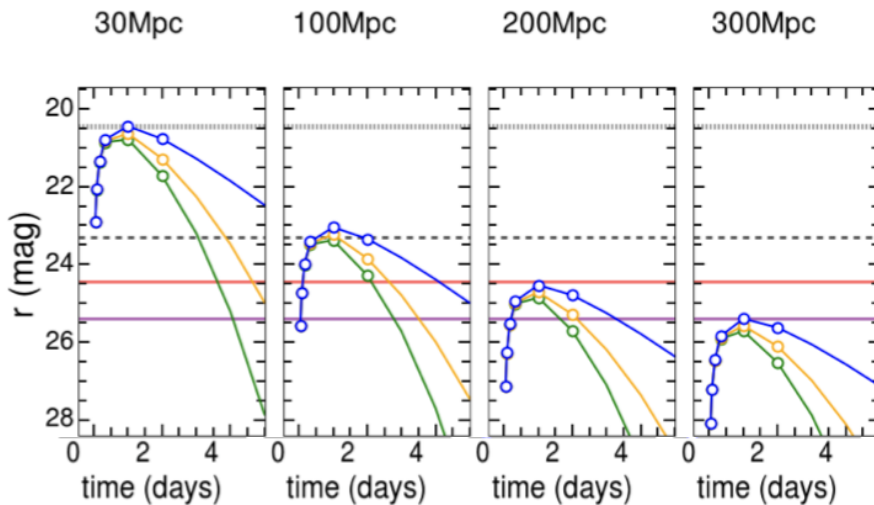
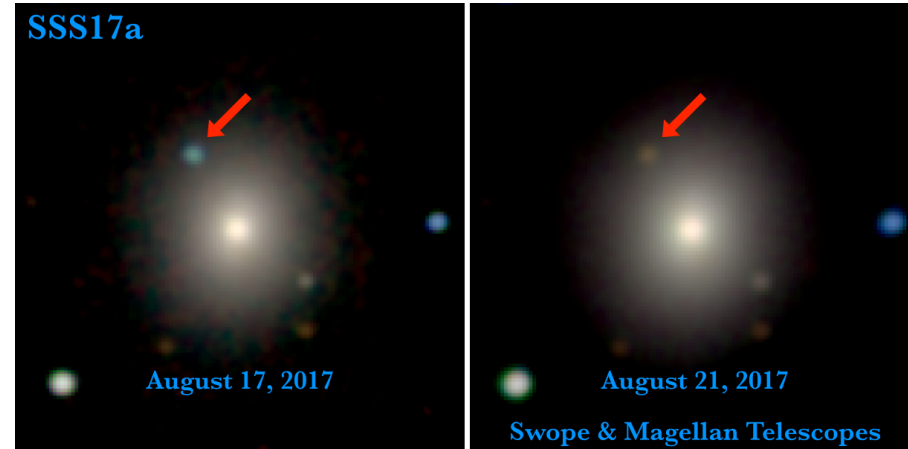
- Dedicated hologram developed at IJCLab-Orsay (M.Moniez et al.)
- Slitless spectra extraction (J.Neuve LPNHE et al.)



News related to LSST Science:
Variable Sky
Gravitational Wave & Optical Counterpart
⇒ FINK

Only one optical counterpart at ~ 40 Mpc to a GW has been observed so far: it has been detected ~ 10 h after a GW event with $i = 17.476 \pm 0.018$ mag by the collaboration 1M2H with a 1m telescope.

All the expectation today are on a LSST-Ligo-virgo-Kagra association to get GW up 200 Mpc with optical counterpart up to 24 mag



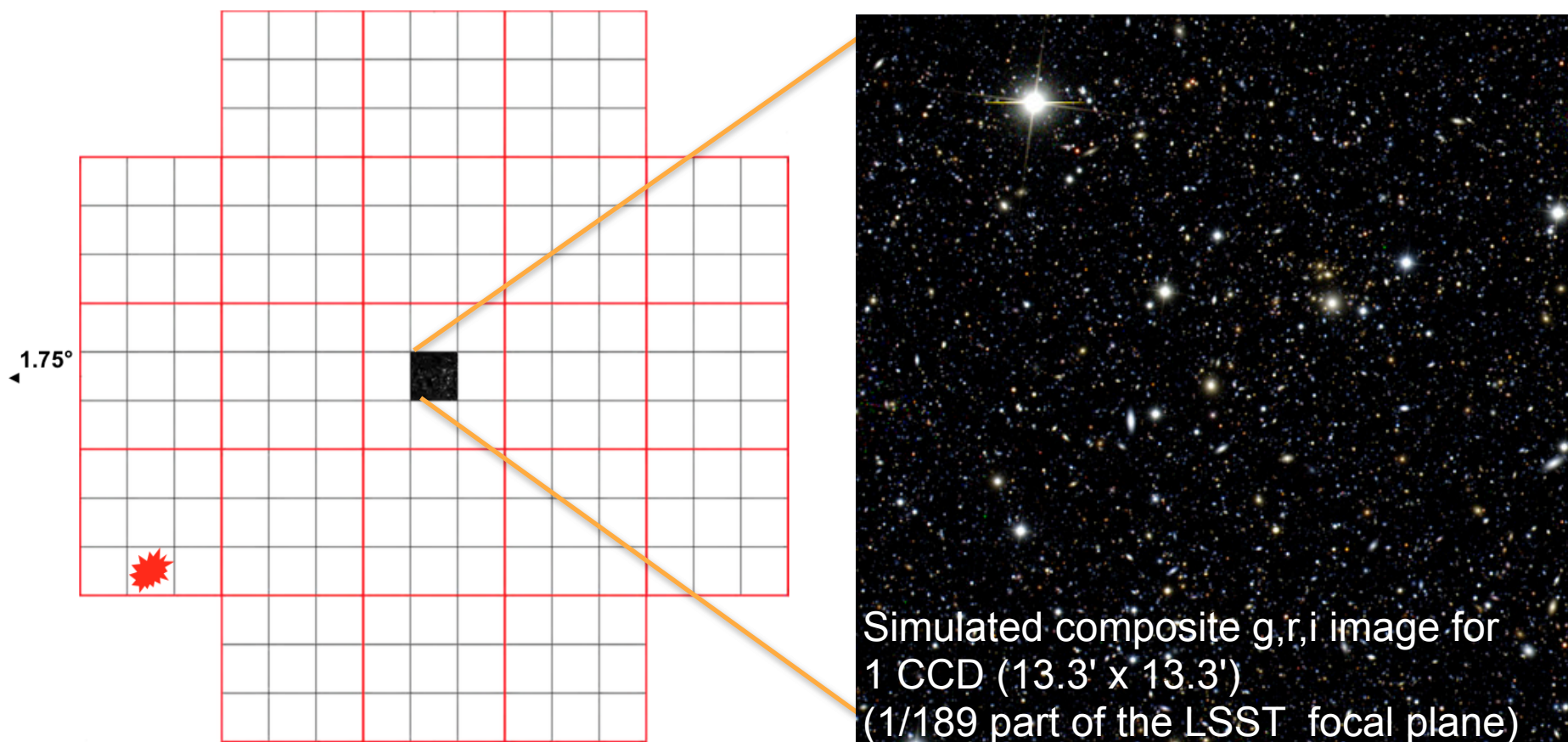
Expected Magnitude for a KiloNova event (NS-NS)



Igor Andreoni et al. ,
Target of Opportunity Observations of Gravitational Wave Events with Vera C.
Rubin Observatory,
arXiv:2111.01945v1, 2 Nov 2021

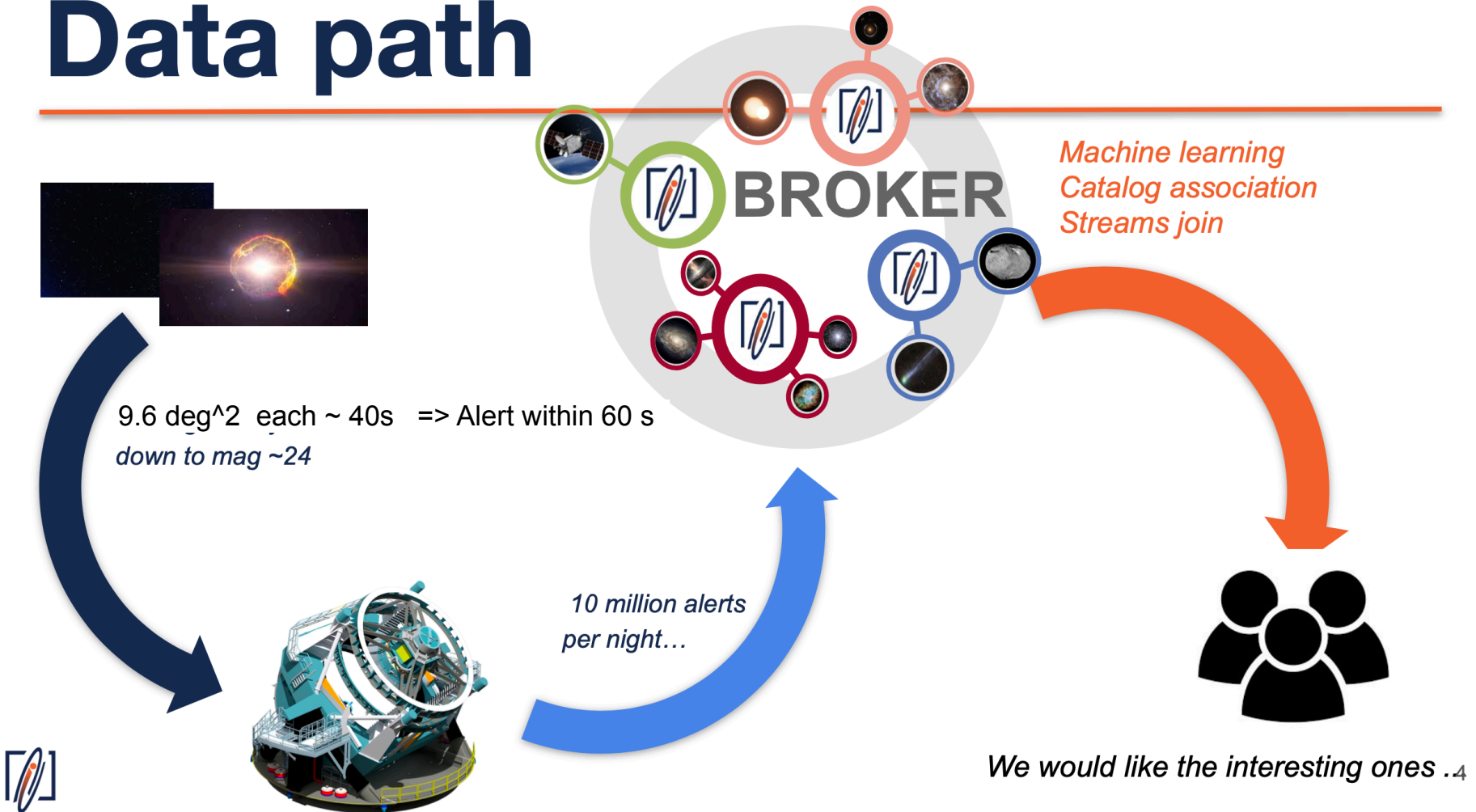
LIGO-Virgo-KAGRA will be able to provide alert with a localisation down to the size of the LSST-camera field of view . This will allow in a few pointings to cover all the expected location of the optical counter part , and the LSST survey will provide recent reference image allowing an easier identification/rejection.

All the expectation today are on a LSST-Ligo-virgo-Kagra association to get GW up 200 Mpc with optical counter part up to 24 mag



V. Rubin data are not public, still the alerts are public but there is a lot of them. Seven brokers have been selected and have direct access to the full stream of LSST data and two operate downstream of the selected brokers. LSST brokers are the tools to filter and access the alerts, 1 is developed in France (FINK), 1 in UK (Lasair), 1 in Germany (AMPEL), 3 in the US, 1 in Chile.

Data path





Fink in 2022

- *PI: E. Ishida (LPC), A. Möller (Swinburne/Australia), J. Peloton (IJCLab).*
- Fink today is more than 30 scientist (FR+international),
- it covers the full “variable sky” domain : from solar system , to the milky way and extragalactics transients .
- 2020 : Partnership signed with ZTF : best training set for LSST , 200 000 alerts per night (<https://fink-portal.org/stats>)
- 2021 : Selected by V.Rubin Observatory to be one of the 7 LSST broker
- 2021 Partnerships with other projects: GRANDMA (multi-messenger , includes GW follow-up) , SVOM
- 15 active projects as of May 2022: AGN, SN, KN, SSO, GRB, neutrinos, satellites, microlensing, anomaly detection, ...
- Deployment at CC-IN2P3 started in 2022 :
 - Transition from VirtualData to CC during summer 2022
 - 2022 allocation: 250 CPU (x2), 250 TB storage (x7).
 - What should you expect? More stability & performance!
- All Fink codes are publicly available : <https://github.com/astrolabsoftware>



Broker with a full interface/service

Scientific Portal for the various community of the “variable sky”, more than 10 To of data from ZTF (>150,000,000 alertes) in *open access*. ~100 users/day, ~10,000 queries/day .

<https://fink-portal.org>.

Fink Science Portal

Summary Supernovae Variable stars Microlensing Solar System Tracklets GRB

ZTF21acdwwwo

EARLY SN IA CANDIDATE SN CANDIDATE UNKNOWN

Discovery date: 2021-09-27 04:24:46.999
 Last detection: 2021-11-13 02:45:40.000
 Number of detections: 24
 Number of low quality alerts: 0
 Number of upper limits: 25

Individual alert classification: Early SN Ia candidate: 17% SN candidate: 67% Unknown: 17%

g band r band

Difference magnitude

Observation date

DC magnitude DC apparent flux

Information

Circles (●) with error bars show valid alerts that pass the Fink quality cuts. In addition, the *Difference magnitude* view shows:

- upper triangles with errors (▲), representing alert measurements that do not satisfy Fink quality cuts, but are nevertheless contained in the history of valid alerts and used by classifiers.
- lower triangles (▽), representing 5-sigma mag limit in difference image based on PSF-fit photometry contained in the history of valid alerts.

Last alert cutouts

Coordinates

Last alert content

Download data

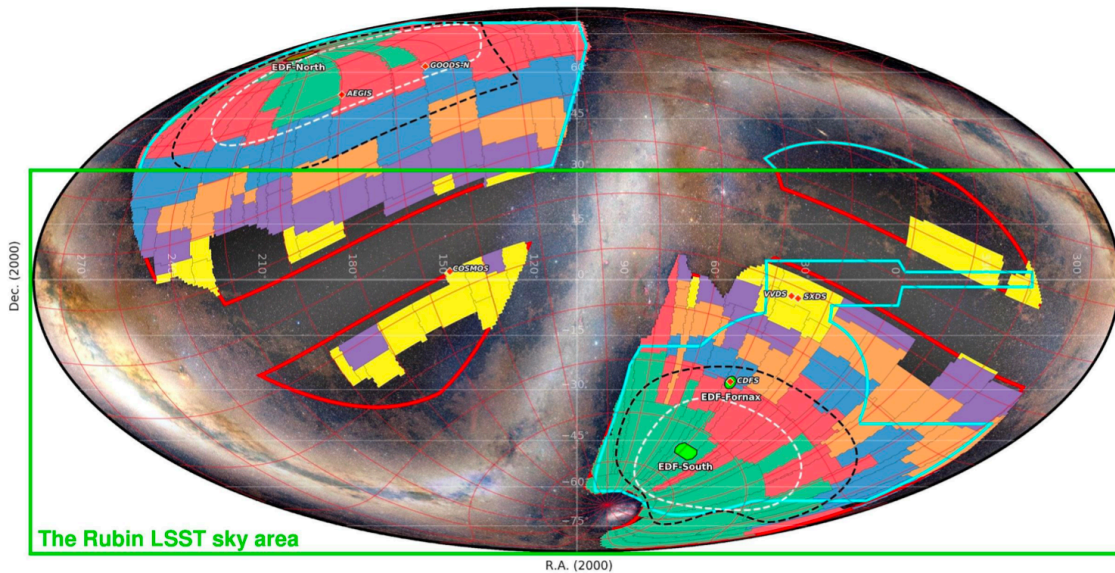
Neighbourhood

Share

J2000 18 32 26.162 +51 34 7.28

Fov: 1.5

News related to LSST Science: Euclid-LSST



The Rubin LSST sky area

65% of the Euclid Region of Interest (17,354 square degrees)

RSD 2020c ECTile realization of a Euclid Wide Survey within the 17 Kdeg.² Rol : 14,668 deg.² over 6 years in 216 patches

Red line: Euclid Wide Survey Region of Interest (Rol) : 17 Kdeg.² compliant with a 15 Kdeg.² survey

Black and white dashed lines: Best 2600 deg.² (black) and 1300 deg.² (white) SNR areas per galactic cap

Green area: Euclid Deep Fields (EDF, from north to south): 10+10+23 deg.²



Euclid Wide Survey chronology (2.5Kdeg.²/yr)



Background image: Euclid Consortium / Planck Collaboration / A. Mellinger

- Large overlap of ~ 9000- sq. deg at high galactic latitudes
- 2 overlapping DDFs: EDF-Fornax (10 sq deg) and EDF-South (23 sq deg)
- LSST Cadence Note – *Enhancing LSST Science with Euclid synergy and a mini-survey of the northern sky to Dec < +30* : modifications to the Rubin WFD towards an extended footprint driven by dust extinction limits to enhance Euclid synergy with up to a 9400 deg² overlap.

Euclid - LSST : Status

- Rubin and Euclid completed a [community and science based process](#) to identify mutually beneficial derived data products in December 2021, V1.1 October 2022. See [arXiv:2201.03862](#)
 - Exploiting the synergies between Rubin and Euclid will maximize the science return of both.
 - Cross-cutting DDPs that serve many scientific domains are championed, e.g. Photo-z catalogs
 - A tiered approach to implementation that reflects the importance & timing is recommended
- Rubin has committed to observe in the Euclid Deep Field
 - All EDF data from both missions to be shared simultaneously with both communities
 - No impact on Rubin survey strategy
 - Rubin SAC recommended, Rubin Leadership approved, Euclid Board has approved
- **Joint processing is not funded nor resourced** in the current Rubin Operations plan nor Euclid - we need to seek additional funding for DDPs
- **Next step: Rubin-Euclid letter of intent (in preparation)**

Conclusion

Almost there !!!!!