

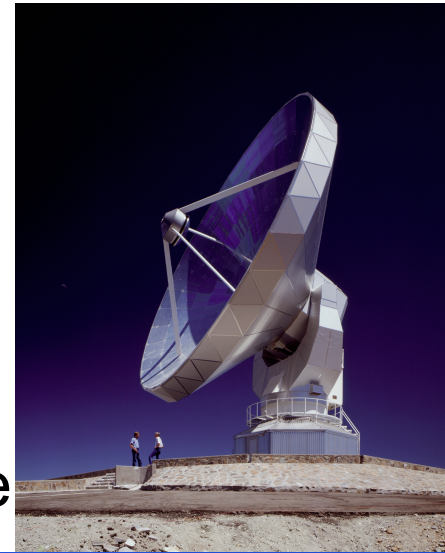
ESO Single Dish Science Strategy WG Report

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Submm ESO facilities

- ESO adventure with (sub)mm astronomy:
 - SEST – 15m Swedish-ESO Submm Telescope
 - La Silla 1987-2003
 - APEX – 12m Atacama Pathfinder Experiment
 - Chajnantor plateau 2005-
 - ALMA...
- ESO goal
 - Guarantee access to the best facilities/science



ESO Science Priorities Process

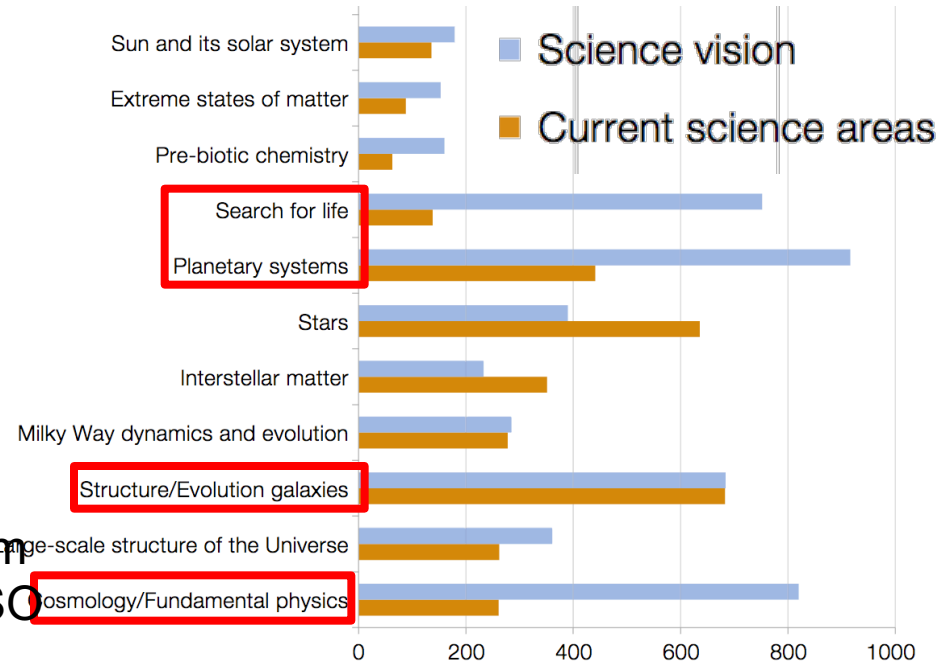
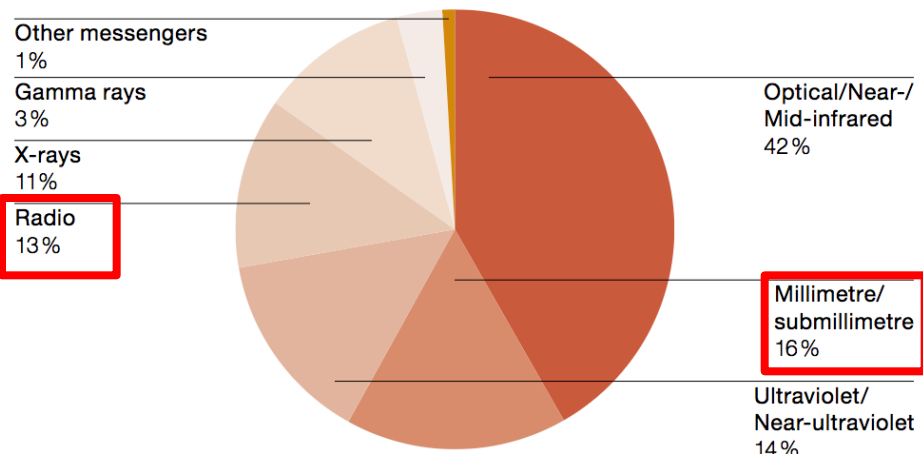
- Executed by the Directorate for Science:
 - Initiated in 2014 to review current and future ESO scientific priorities
 - Review of the scientific breadth and prospect of current program and future plans
 - Community engagement to provide input:
 - Community poll
 - ESO in the 2020s workshop

- Process continues with specific WGs
 - Future Submm Single Dish
 - Archives
 - Time allocation
 - Spectroscopic telescope

User poll

Demographics and science areas

- Traditional but evolving optical community
- Traditional science with an outlook into the future



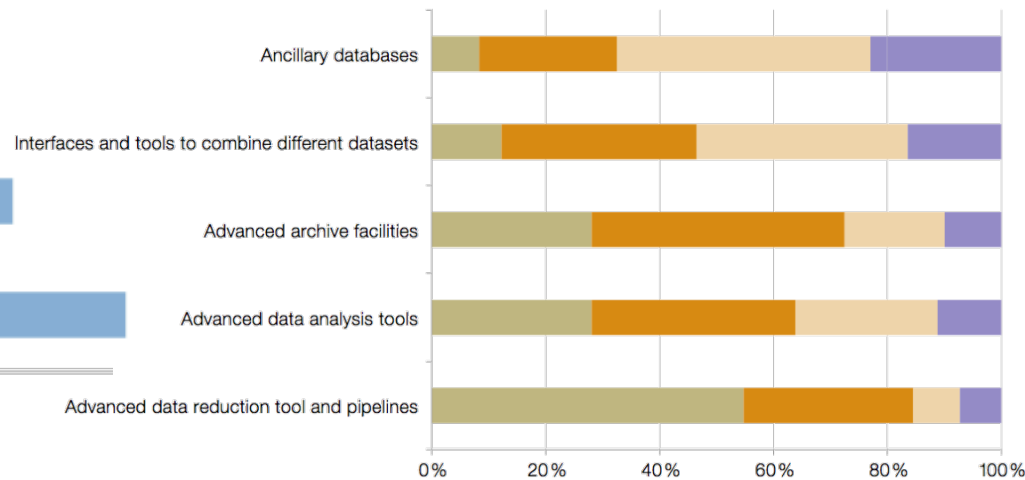
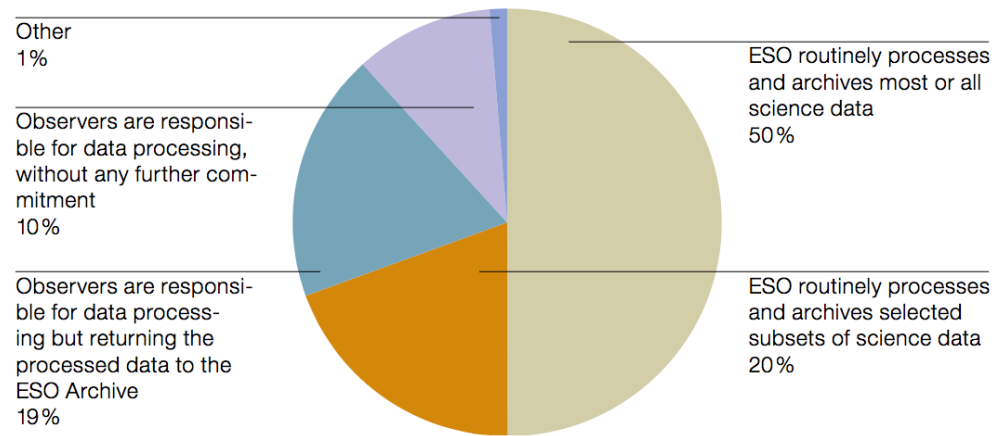
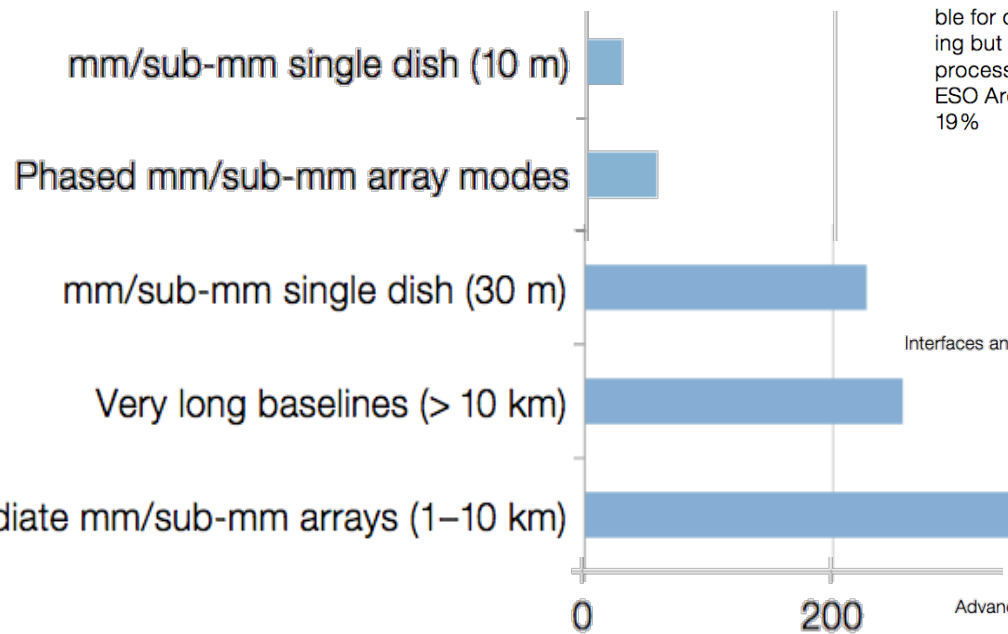
~30% identified themselves as Radio/Submm and yet we receive the ~same number of ESO community proposals at the ALMA or LaSilla/Paranal (which includes APEX) deadlines!

(Primas et al. 2015)

User poll

Requirements on (submm) facilities

- ALMA!
- Large single dish
- Processed data



(Primas et al. 2015)

ESO in the 2020s workshop Jan 2015

- Large Single Dish
 - CCAT or other option
 - As a survey telescope

- Phased Array Applications
 - Not only mmVLBI

- Band 2 (and 1)

- Supra-THz band

- Polarimetry and Bandwidth

- Archive Science-Grade Data



ESO in the 2020s workshop Jan 2015

After this meeting



■ Continue efforts towards:

- Delivery of Band 5 and ALMA Phased Array modes
- Develop new broad band, high sensitivity, low frequency receivers
- R&D towards broad band transport and processing, data rate and archive enhancements



■ Explore options for providing a large single dish facility

- Review science cases
- Evaluate current landscape and suggest way forward



■ Work by the end of the decade on the planning for a major ALMA upgrade in the 2020-2030 timeframe

ESO Single Dish Strategy WG

■ Set up by Director for Science:

➤ Membership:

- ESO: L. Testi, C de Breuck, R. Siebenmorgen
- Community: K. Knudsen (OSO), S. Molinari (INAF), I. Smail (Durham), F. Wyrowski (MPIfR)

➤ Task:

- Investigate the scientific case and opportunities for single dish (sub)mm capabilities at ESO in the 2020s

■ Methodology:

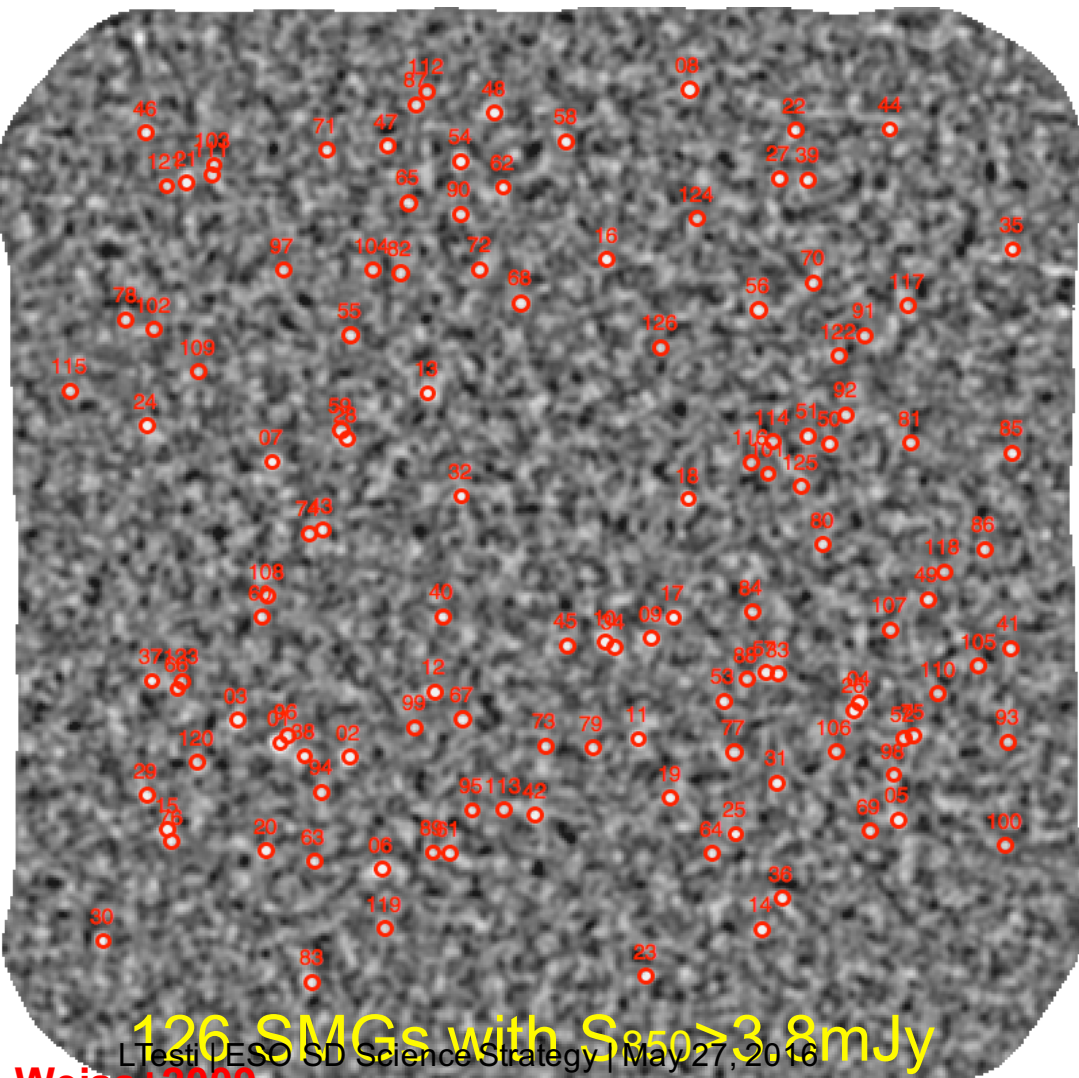
- Critical review of existing science cases in the context of ALMA, its possible long term evolution, and complementary observatories
- ~weekly telecons April-November 2015
- Report discussed with ESAC and STC

Science Cases

- Cosmology and Galaxy Evolution
- Galaxies as ecosystems (incl MW)
- Astrobiology
- Solar System
- Magnetic Fields, mmVLBI, SupraTHz windows
- Identified 18 major science cases
 - Science requirements to address the cases
 - Need for a dedicated facility
 - Complementarity to existing/planned facilities

Examples: galaxy surveys

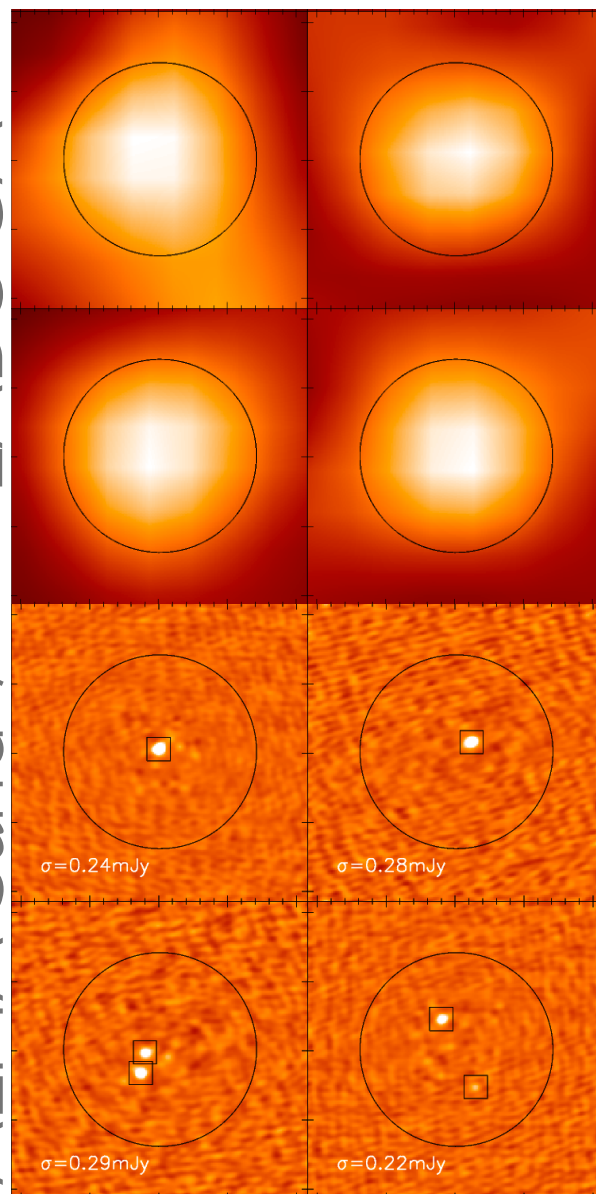
■ LESS => ALESS



Weiss+2009

LTesti | ESO SD Science Strategy | May 27, 2016

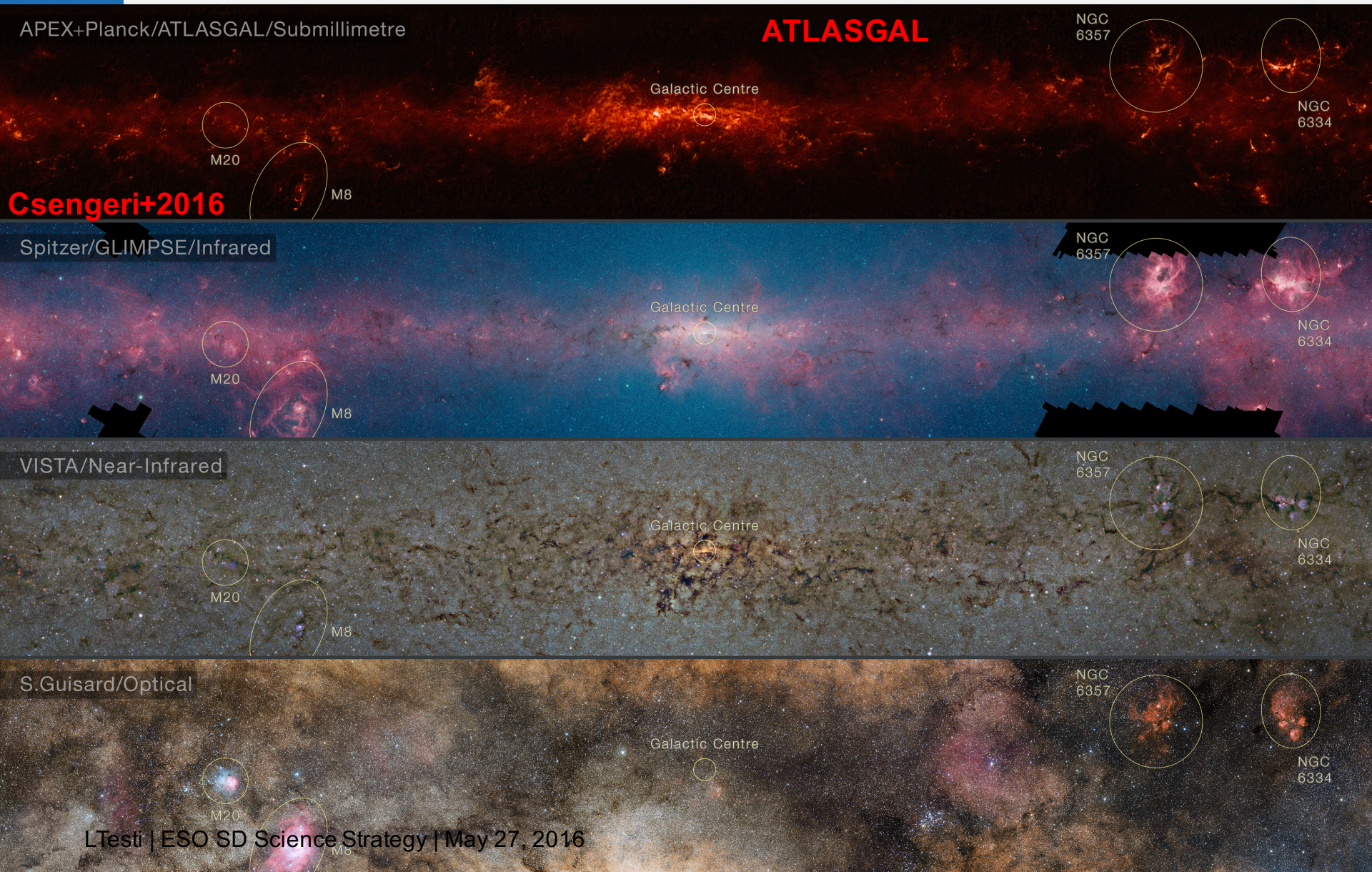
ALMA band 7 LABOCA



Karim+2013



Galactic ecosystems



Csengeri+2016

Cases/Facilities Matrix

■ Six classes of facilities

- Upgraded APEX in 2030
- Upgraded ALMA-SD
- 40m class on ALMA site
- 12m class at 5600m
- 25m class at 5600m
- Submm capable E-ELT

■ Coding

- **Green:** provides unique contribution to science
- **Yellow:** non unique or non optimal
- **Red:** not competitive

	APEX+	ALMA-SD+	40m 5000m	12m 5600m	25m 5600m	E-ELT
2.1.1 cont. exgal survey	Red	Red	Green	Red	Green	Yellow
2.1.2 gal line survey	Red	Red	Green	Red	Green	Yellow
2.1.3 atomic FS lines	Red	Red	Yellow	Yellow	Green	Red
2.2.1 Continuum Milky Way surveys	Red	Red	Green	Red	Yellow	Red
2.2.2 Molecular and atomic line galactic surveys	Red	Red	Green	Yellow	Green	Yellow
2.2.3 Magellanic clouds	Red	Red	Green	Yellow	Green	Yellow
2.2.4 Nearby galaxies	Yellow	Yellow	Green	Yellow	Green	Yellow
2.2.5 Massive star formation	Red	Red	Green	Red	Yellow	Green
2.2.6 Magnetic fields	Green	Green	Green	Green	Green	Yellow
2.2.7 Astrobiology	Red	Red	Green	Red	Green	Yellow
2.2.8 Protoplanetary and debris disks	Red	Red	Yellow	Red	Yellow	Red
2.3.1 Stellar winds and ISM	Red	Red	Green	Red	Yellow	Yellow
2.3.2 Dust in supernova remnants	Red	Red	Green	Green	Green	Yellow
2.4.1 Planetary atmospheres	Green	Green	Green	Green	Green	Green
2.4.2 TNOs and Asteroids	Red	Red	Green	Red	Yellow	Yellow
2.4.3 Comets	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2.5 mmVLBI	Yellow	Yellow	Yellow	Yellow	Yellow	Yellow
2.6 SupraTHz	Red	Red	Yellow	Yellow	Green	Red

Recommendations

- I. Focus ALMA development to continue to optimize its operations as a sensitive, high angular resolution and high fidelity observatory for the submm.
- II. ESO should develop a strategy to allow access for its community to a large submm single dish telescope by mid-2020s. Preferably a 40m class with state of the art line and continuum cameras.
- III. Compatible with recommendations I and II, ESO should maintain the APEX capabilities at least up to the early 2020s

Next steps

- Complete report delivered to DSC in Nov 2015
 - Discussed with STC
 - Recommendations may lead to follow-up if adopted
- Community input
 - Discussion with community (Gothenburg workshop)
 - Possibly organize a dedicated workshop after the APEX possible extension has been clarified
- Collaboration with ALMA and partners
 - ALMA Development Vision WG



Discussion

■ Submm astronomy in the ALMA era

- Community exploding, transformational science
- Positive effects
 - Fantastic push of the technological community
 - Huge potential of further development and new science
 - Other observatories benefited from the synergies
- Difficulties
 - "You have ALMA now, go away and let me alone"
 - Available funding for other submm observatories/initiatives difficult to secure

■ Need for a future vision for our field

- Needed to do cutting-edge science with ALMA in 2030
- Needed to ensure the health of our technical community