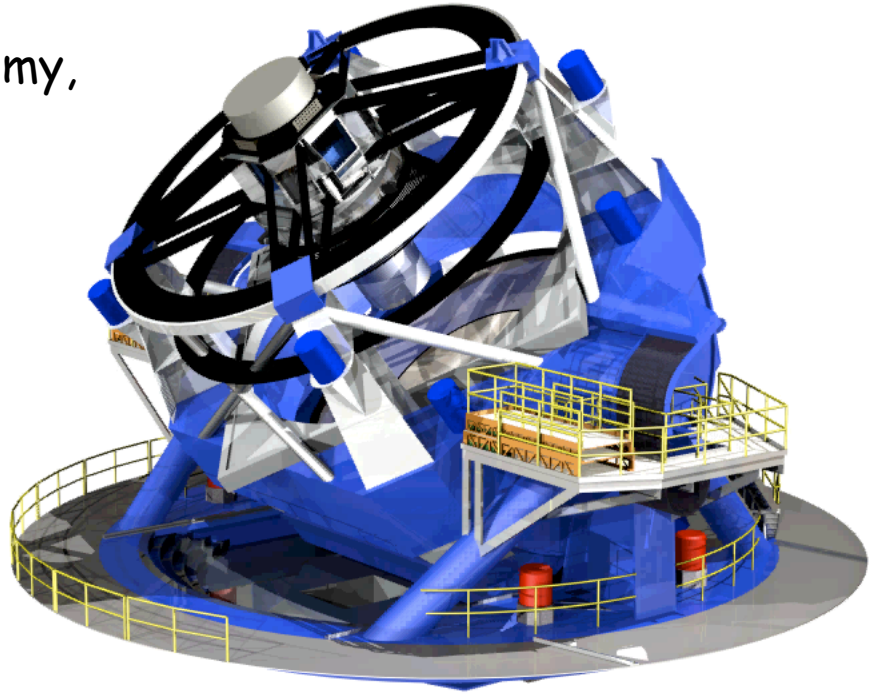
Large Synoptic Survey Telescope(LSST) and Europe

Richard McMahon, Institute of Astronomy,
University of Cambridge



Reference material

A LIVING LSST DOCUMENT (ASTRO-PH/0805.2366); VERSION 1.0 OF MAY 15, 2008
Preprint typeset using LaTeX style emulateapj v. 03/07/07

LSST: FROM SCIENCE DRIVERS TO REFERENCE DESIGN AND ANTICIPATED DATA PRODUCTS

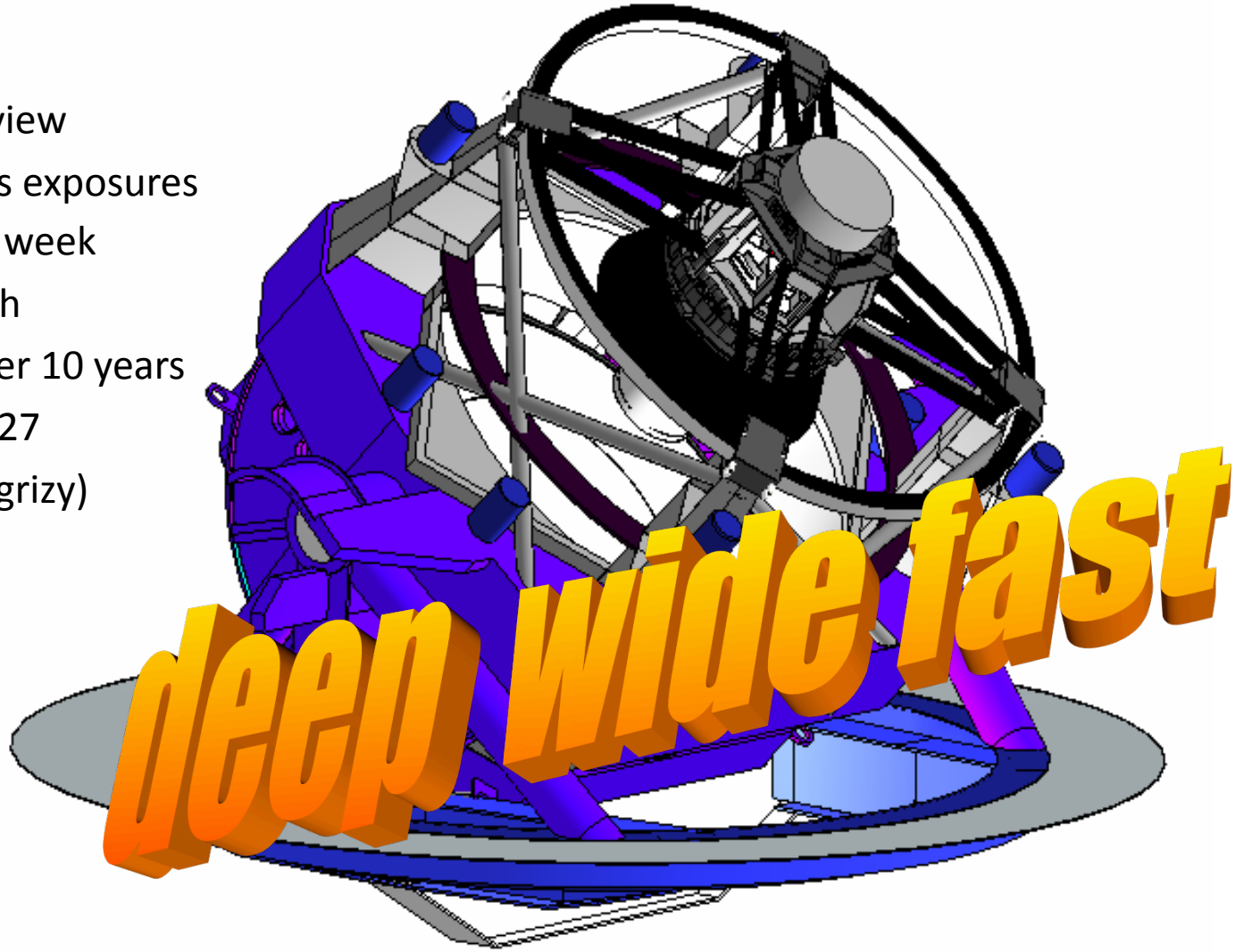
Ž. IVEZIĆ[1], J.A. TYSON[2], R. ALLSMAN[3], J. ANDREW[4], R. ANGEL[5], T. AXELROD[3], J.D. BARR[4], A.C. BECKER[1], J. BECLA[6], C. BELDICA[7], R.D. BLANDFORD[6], W.N. BRANDT[8], J.S. BULLOCK[9], D.L. BURKE[6], S. CHANDRASEKHARAN[4], S. CHESLEY[10], C.F. CLAVER[4], A. CONNOLLY[1], K.H. COOK[11], A. COORAY[9], C. CRIBBS[7], R. CUTRI[12], G. DAUES[7], F. DELGADO[13], H. FERGUSON[14], J.C. GEARY[15], P. GEE[2], D.K. GILMORE[6], W.J. GRESSLER[4], C. HOGAN[1], M.E. HUFFER[6], S.H. JACOBY[3], B. JAIN[16], J.G. JERNIGAN[17], R.L. JONES[1], M. JURIĆ[18], S.M. KAHN[6], J.S. KALIRAI[19], J.P. KANTOR[3], D. KIRKBY[9], L. KNOX[2], V.L. KRABBENDAM[4], S. KRUGHOFF[1], S. KULKARNI[20], R. LAMBERT[13], D. LEVINE[12], M. LIANG[4], K-T. LIM[6], R.H. LUPTON[21], P. MARSHALL[22], S. MARSHALL[6], M. MAY[24], M. MILLER[4], D.J. MILLS[4], D.G. MONET[23], D.R. NEILL[4], M. NORDBY[6], P. O'CONNOR[24], J. OLIVER[25], S.S. OLIVIER[11], R.E. OWEN[1], J.R. PETERSON[26], C.E. PETRY[5], F. PIERFEDERICI[3], S. PIETROWICZ[7], R. PIKE[27], P.A. PINTO[5], R. PLANTE[7], V. RADEKA[24], A. RASMUSSEN[6], W. ROSING[28], A. SAHA[4], T.L. SCHALK[29], R.H. SCHINDLER[6], D.P. SCHNEIDER[8], G. SCHUMACHER[13], J. SEBAG[4], L.G. SEPPALA[11], I. SHIPSEY[25], N. SILVESTRI[1], J.A. SMITH[30], R.C. SMITH[13], M.A. STRAUSS[21], C.W. STUBBS[25], D. SWEENEY[3], A. SZALAY[31], J.J. THALER[32], D. VANDEN BERK[8], M. WARNER[13], B. WILLMAN[25], D. WITTMAN[2], S.C. WOLFF[4], W.M. WOOD-VASEY[25], AND H. ZHAN[2], FOR THE LSST COLLABORATION

A living LSST document (astro-ph/0805.2366); version 1.0 of May 15, 2008

www.lsst.org

Some Fast Facts

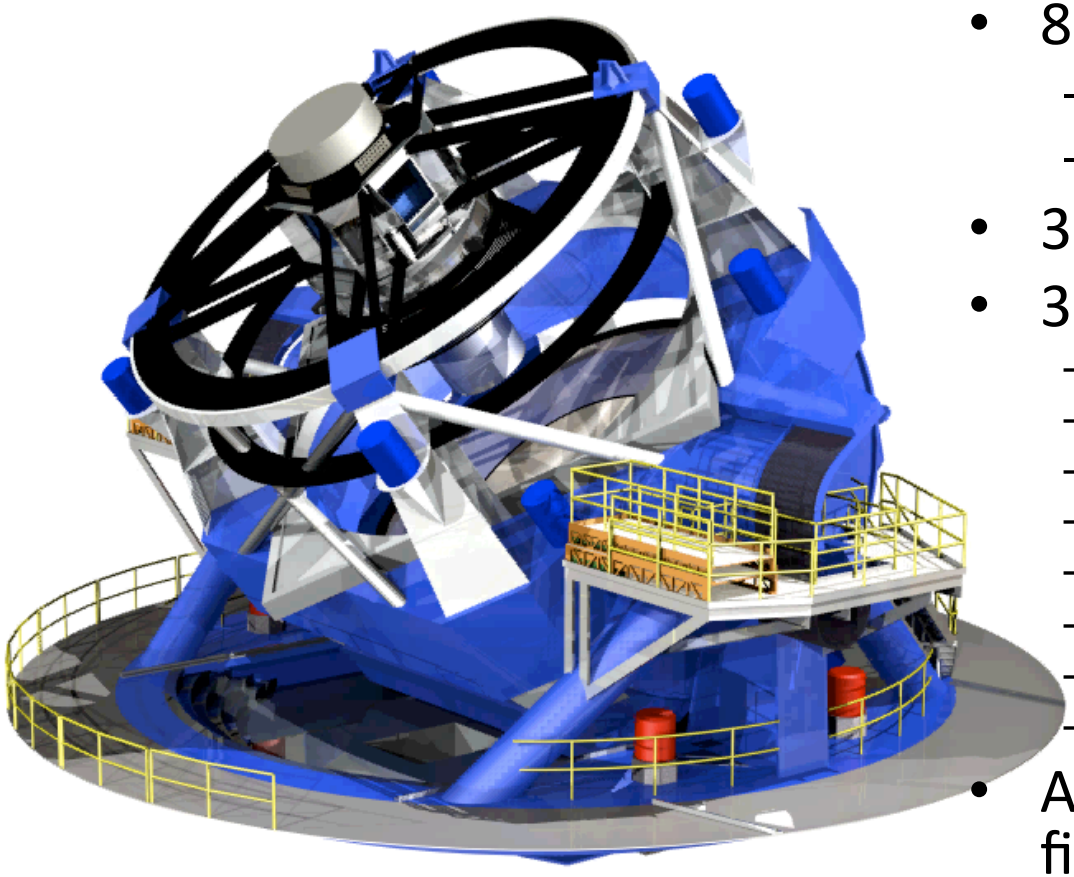
- 8.4m primary
- 10deg^2 field of view
- Nightly 2x15secs exposures
- 30,000deg^2 in 1 week
- AB=25 per epoch
- 1000 epochs over 10 years
- Final depth AB=27
- 6 wavebands (ugrizy)



Site chosen: LSST will be on peak near Cerro Pachon within Gemini site compound

1.5m photometric calibration telescope

LSST Concept Summary



- 8.4 meter (f/1.2) Primary
  - 3.4 meter Secondary
  - 5.0 meter Tertiary
- 3.5° diameter field Of View
- 3 Gigapixel Camera
  - 4k x 4k CCD Baseline
  - 201 CCDs
  - 10micron pixels; 0.2arc sec
  - 65 cm diameter
  - Six Filters (ugrizy)
  - 30 Second Cadence
  - Highly Parallel Readout
  - 16 channels per CCD
- Accumulated depth AB=27 each filter over 10 years
- Data Storage and Pipelines ~ 18Tb/night

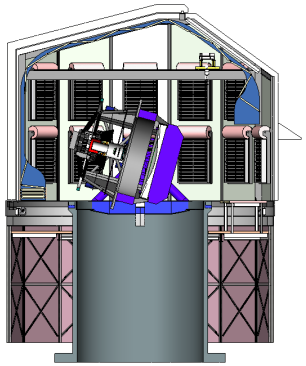
From Gilmore SPIE, Marseille, June , 2008

Etendue

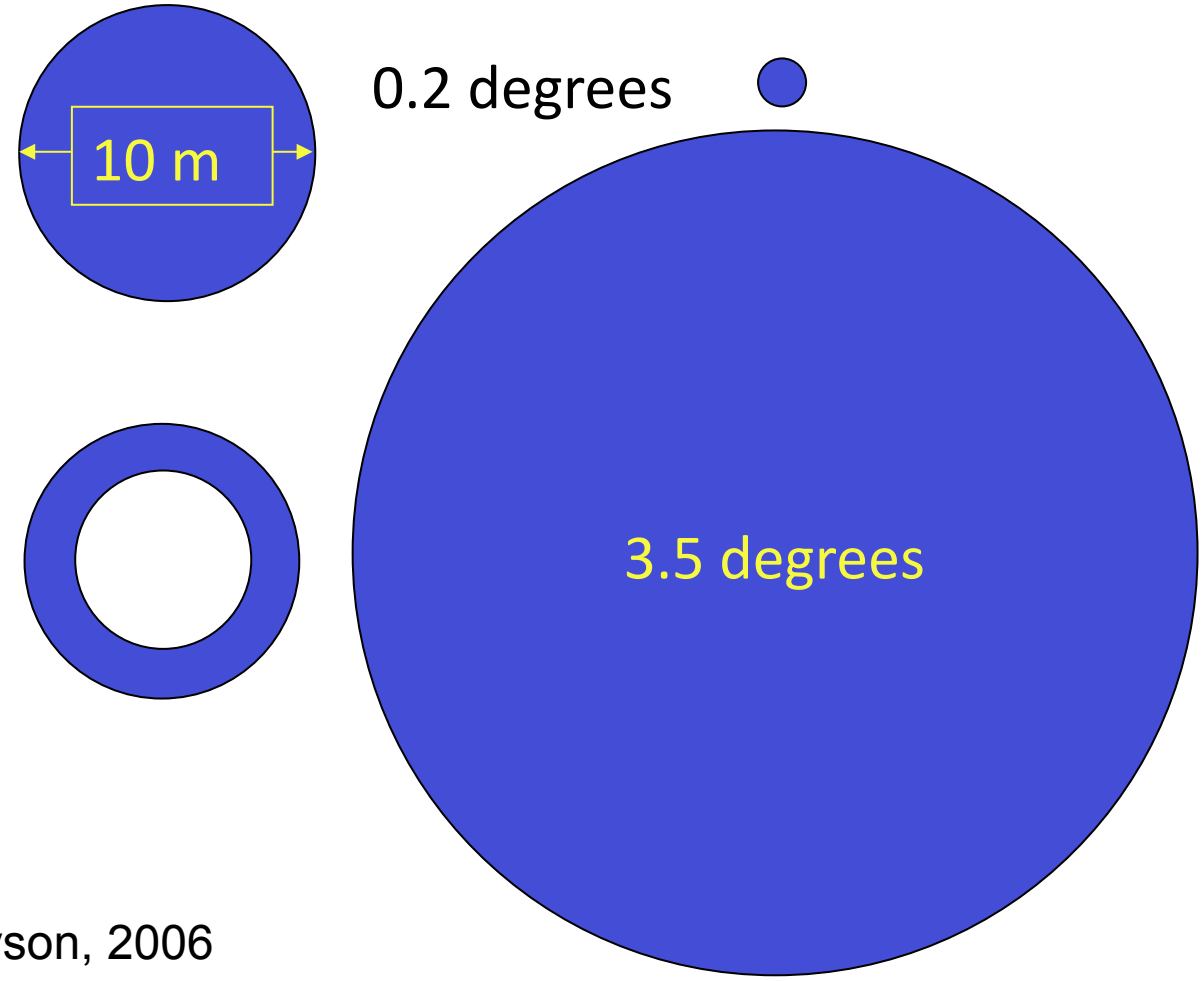
Primary mirror diameter

Field of view

Keck Telescope

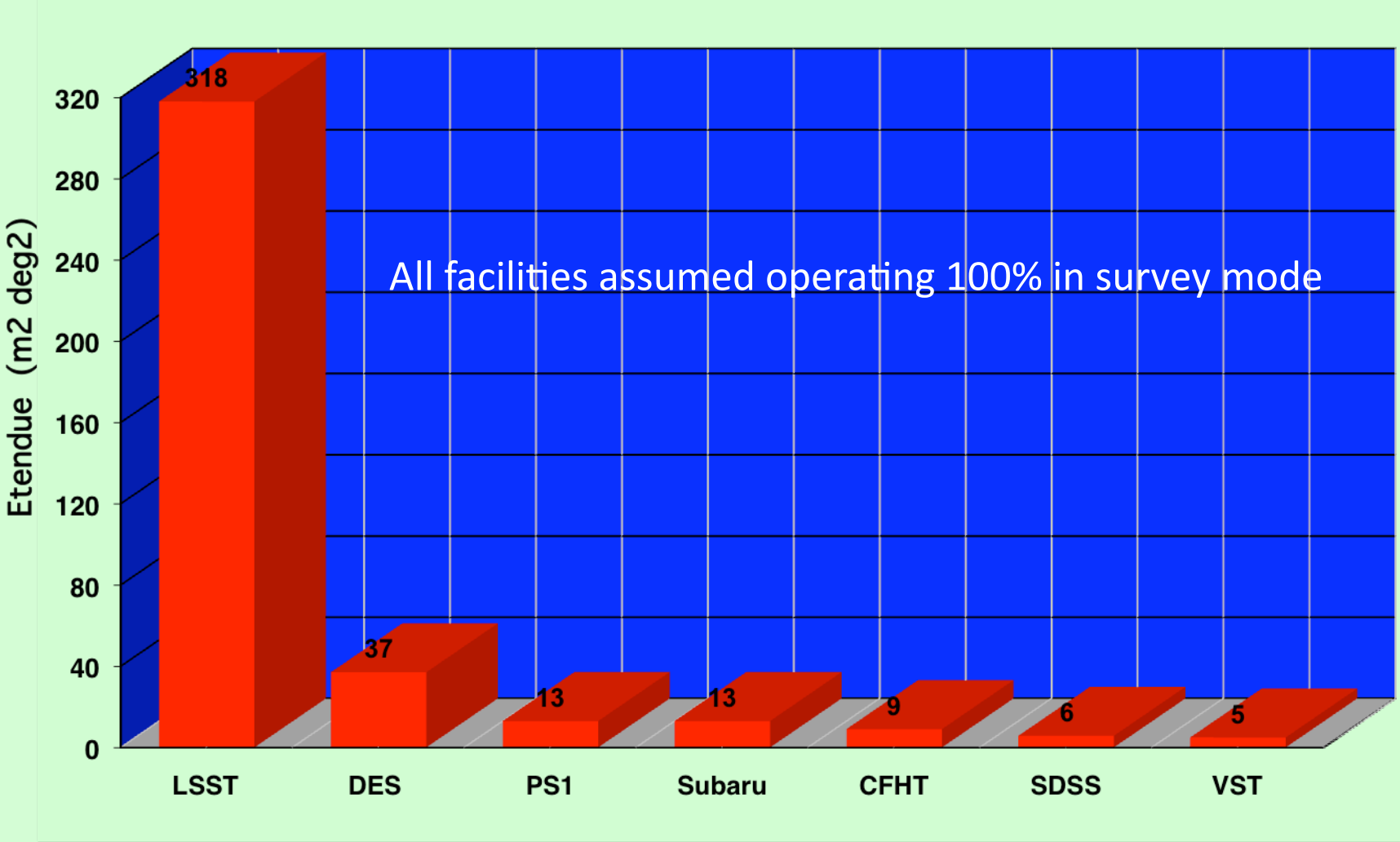


LSST



From Tyson, 2006

Relative Etendue (= AΩ)



From Tyson, 2006

Four Main Science Themes for LSST:

1. Constraining Dark Energy and Dark Matter
2. Taking an Inventory of the Solar System
3. Exploring the Transient Optical Sky
4. Mapping the Milky Way

Major Implications to the Camera:

1. Large Etendue
2. Excellent Image Quality and Control of PSF Systematics
3. High Quantum Efficiency over the Range 320 – 1,050 nm
4. Fast Readout

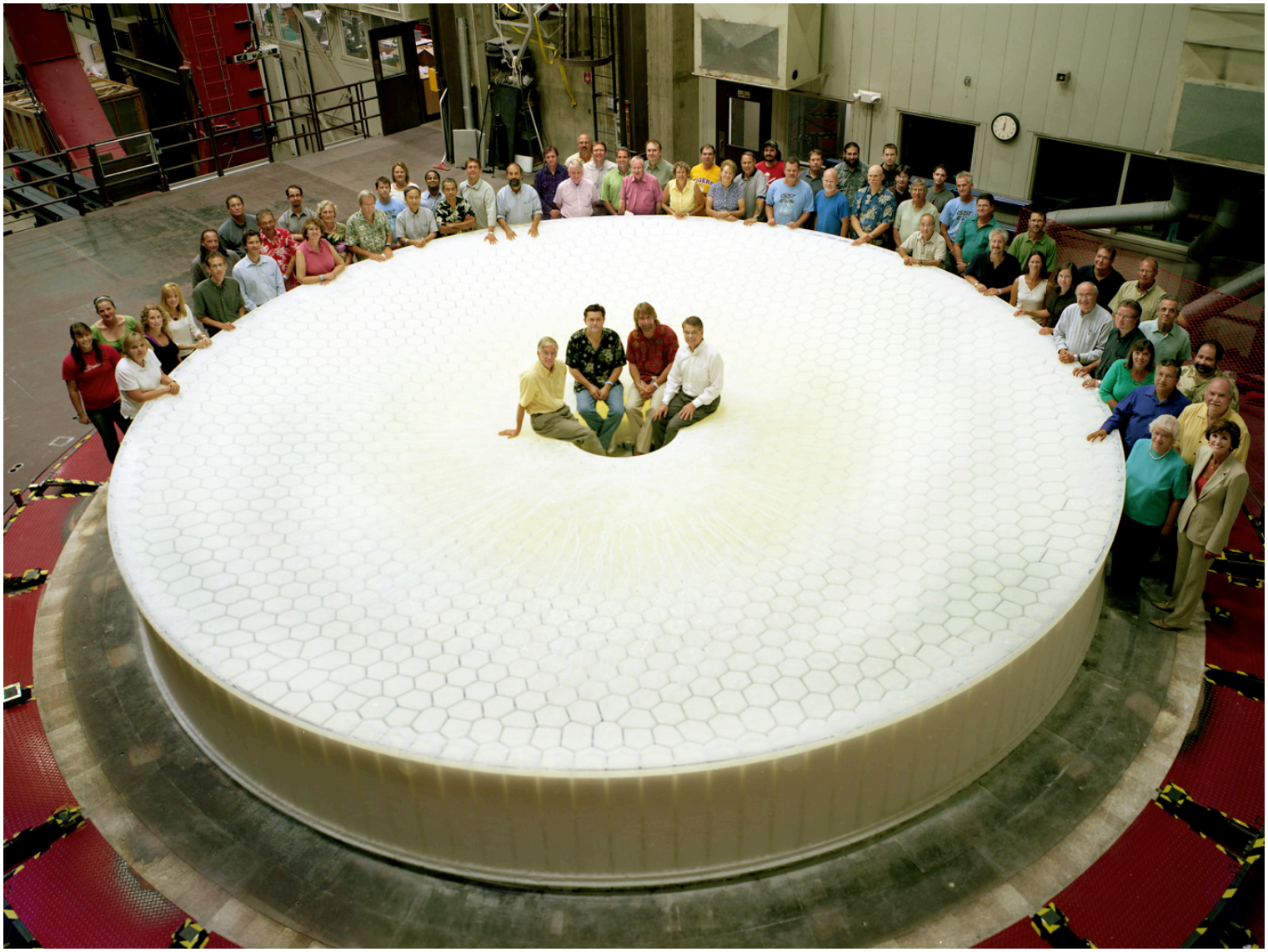
From Tyson, 2006

Massively Parallel Astrophysics

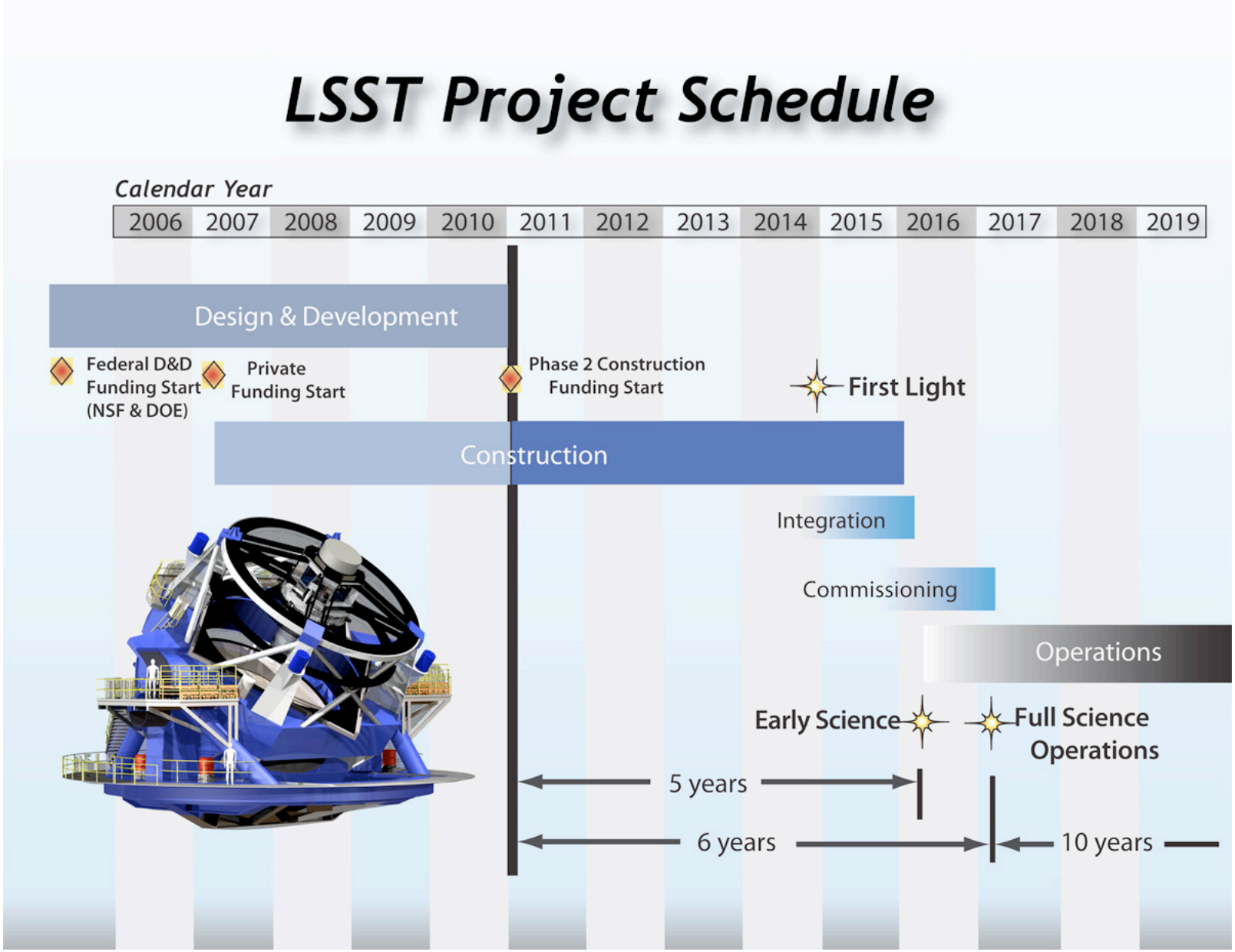
- Dark matter/dark energy via weak lensing
- Dark matter/dark energy via baryon acoustic oscillations
- Dark energy via supernovae
- Dark energy via counts of clusters of galaxies
- Galactic Structure encompassing local group
- Dense astrometry over 20000 sq.deg: rare moving objects
- Gamma Ray Bursts and transients to high redshift
- Gravitational micro-lensing
- Strong galaxy & cluster lensing: physics of dark matter
- Multi-image lensed SN time delays: separate test of cosmology
- Variable stars/galaxies: black hole accretion
- QSO time delays vs z: independent test of dark energy
- Optical bursters to 25 mag: the unknown
- 6-band AB=27 mag photometric survey: unprecedented volume
- Solar System Probes: Earth-crossing asteroids, Comets, trans- Neptunian objects

From Tyson, 2006

Aug’ 2008; 8.4m Primary Cast at University of Arizona Mirror Laboratory



From www.lsst.org



Current timeline; has slipped two years in last 2 years; not unusual for project at this stage

LSST and Europe

- 8.4m optical survey telescope located in Chile
- LSST scheduled for start of operations in 2016
- Massively parallel astrophysics from a single data set
  - Could this model be applied for spectroscopic surveys?
- **Data will be public BUT access will be limited**

Current European LSST activities

- France: Camera project (both Particle Physicists and Astronomers)
- UK participating in Data Challenges

Discussions

- UK: Data management (Andy Lawrence)
  - Possible funding tension with EUCLID
- Germany: Steinmetz
- ESO

LSST Data Philosophy & Terminology

- Access to LSST *data* should be completely open to anyone, anywhere
- Access to LSST *data processing resources* will be managed and paid for
- The vast quantity of LSST data makes it necessary to use computing located at a copy of the archive
  - Compute power to access and work with the data is a limited resource

- Foreign investigators will be granted resources beyond the base level in proportion to their country's or institution's participation in sharing costs.
- Current LSST plans are for resources to be apportioned across four service levels

Based on Kantor, May, 2008,
LSST Data Management: Making Peta-scale Data Accessible

Proposed Service Levels

Level 4 – typical/general users, no special access required

- 6 Gbps bandwidth
- 1 TFlop total

Level 3 - power user individuals, requires approval

- 2 Gbps bandwidth
- 1 TFlop at each Data Analysis Centre(DAC)

Level 2 - power user institutions, requires approval

- 2 Gbps bandwidth
- 5 TFlops at each DAC (1 TFlop/yr for 5 years)

Level 1 –most demanding applications, requires approval

- 6 Gbps
- 25 TFlops (5 TFlops/yr for 5 years)

END