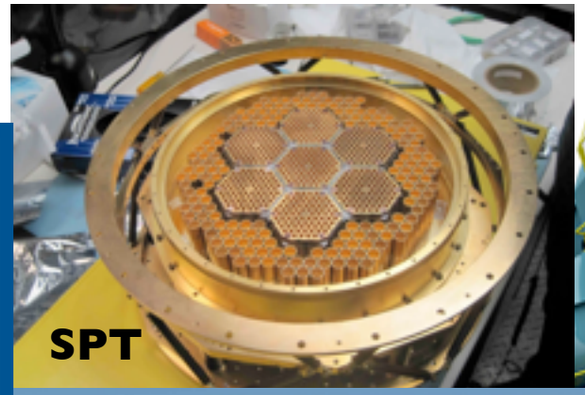
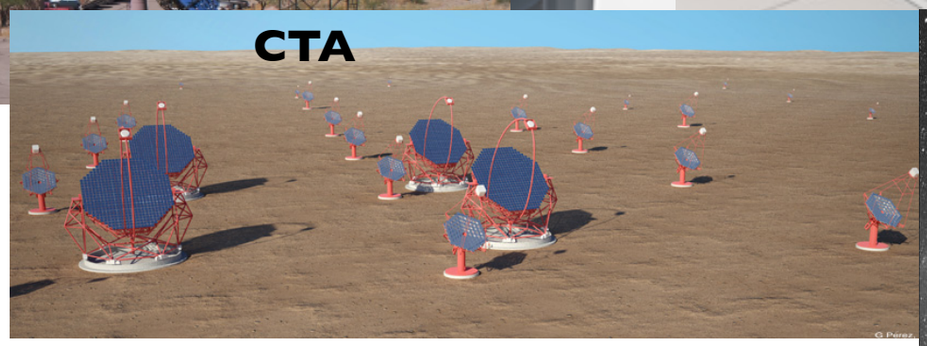
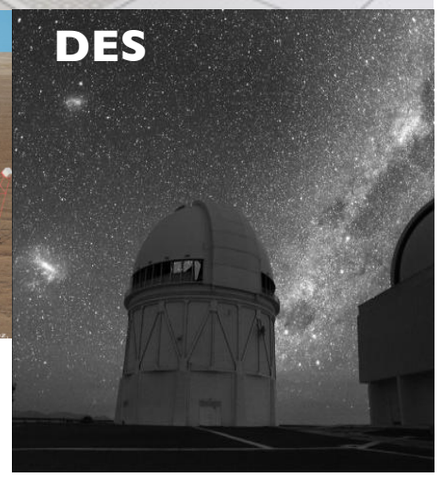
Astro/Cosmology @ Argonne

Experiment
Instrumentation
Observation
Theory
Computing
Analysis







Salman Habib
HEP & MCS Division
Argonne National Laboratory

HEP Experimental Astro/Cosmology Program

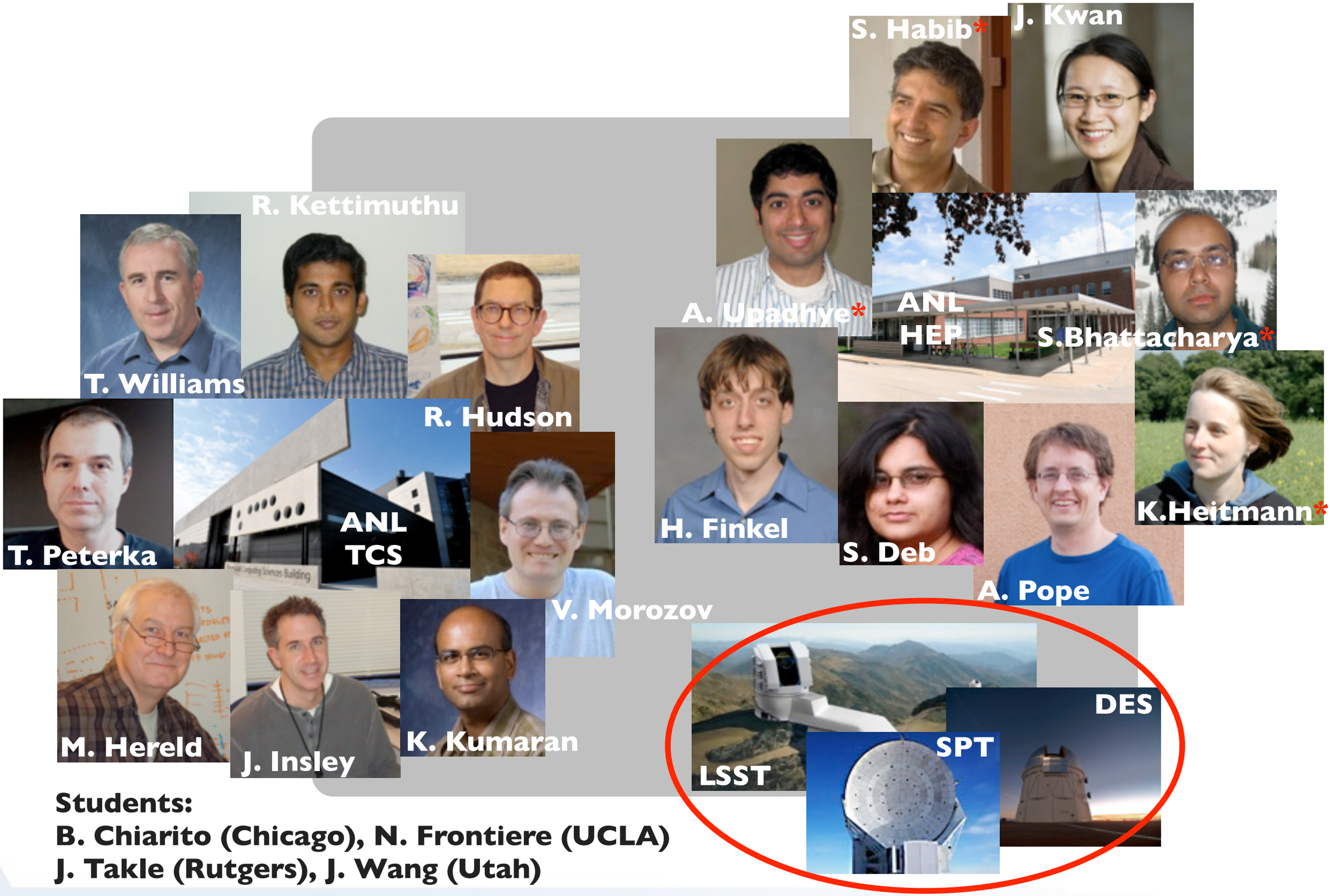
Covered by Clarence --

- CMB (SPTPol)
  - J. Carlstrom (UC/ANL)
  - C. Chang (UC/ANL)
  - V. Novosad (ANL)
  - G. Wang (ANL)
  - V. Yefremenko (ANL)

- Indirect Dark Matter Search
  - K. Byrum (ANL)
  - G. Decerprit (ANL/DESY)
  - R. Wagner (ANL)
  - B. Zitzer (ANL)

- Dark Energy (DES)
  - K. Barbary (ANL)*
  - R. Biswas (ANL)
  - E. Kovacs (ANL)
  - K. Kuehn (ANL)
  - H. Spinka (ANL)
  - Students

Theory Group and Collaborators in MCS & ALCF Divisions



Students:
B. Chiarito (Chicago), N. Frontiere (UCLA)
J. Takle (Rutgers), J. Wang (Utah)

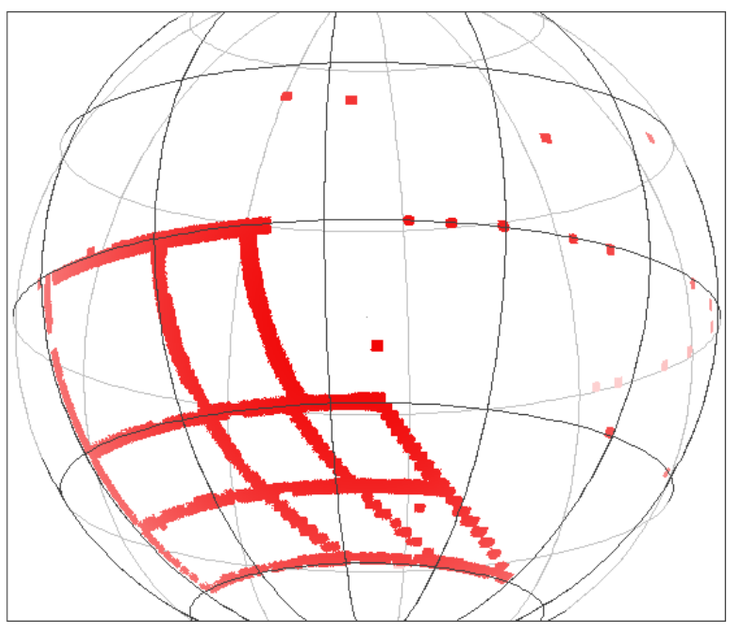
Dark Energy Survey Group at Argonne

DECam commissioning (main ANL)

- f/8 mirror handler handed off to CTIO
- Instrument controls also handed off

PreCam calibration of DES

Preparations for Supernova Cosmology



PreCam data g-band coverage (KK, SK)

Collaborations with FNAL/UC

Joint Light Curve Analysis (JLA) Involvement

SDSS: R. Kessler (UofC), J. Marriner,(FNAL) S. Kuhlmann, R. Biswas (ANL), J. Mosher (UPENN)
SNLS:J.Guy, P.Astier, N.Regnalt, R.Pain, M.Betoule (Paris)

Supernova Simulations and Strategies
For the Dark Energy Survey

ApJ accepted

J. P. Bernstein[1], R. Kessler[2,3], S. Kuhlmann[1], R. Biswas[1], E. Kovacs[1], G. Aldering[4], I. Crane[1,5], D. A. Finley[6], J. A. Frieman[2,3,6], T. Hufford[1], M. J. Jarvis[7,8], A. G. Kim[4], J. Marriner[6], P. Mukherjee[9], R. C. Nichol[10], P. Nugent[4], D. Parkinson[9], R. R. R. Reis[6,11], M. Sako[12], H. Spinka[1], M. Sullivan[13]

Type Ia Supernovae Selection and Forecast of Cosmology Constraints for the Dark Energy Survey

Undergrads

JCAP submitted

Eda Gjergo,[a,b] Jefferson Duggan,[c] John D. Cunningham,[c,a] Steve Kuhlmann,[a] Rahul Biswas,[a] Eve Kovacs,[a] Joseph P. Bernstein,[a] Harold Spinka[a]

Indirect Dark Matter Search

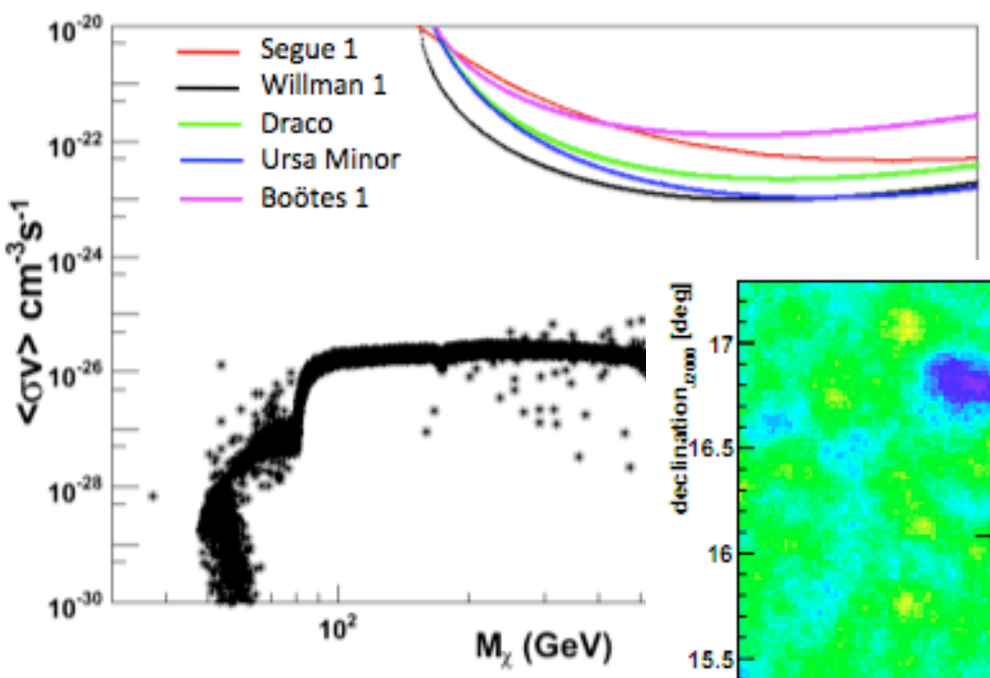
VERITAS

L2 trigger upgrade; now mostly commissioning
Data analysis focusing on Dark Matter limits, constraints on Lorentz Invariance, --

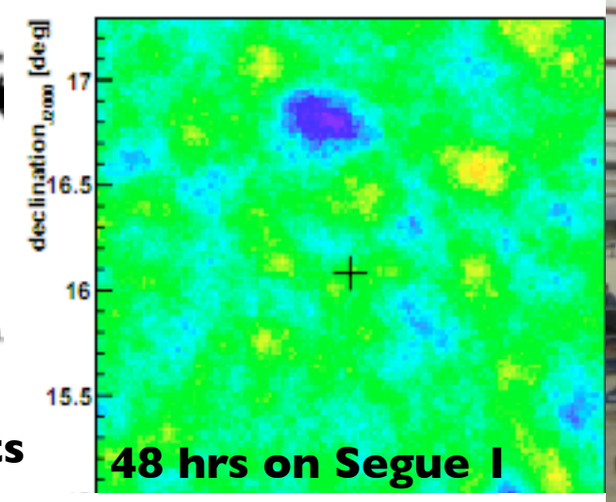
CTA

Dark Matter, fundamental science --
Provide enabling technology for next-gen instrument
- Topological Array Trigger
- Large Area Photodetectors for the camera

New mechanical telescope structures



VERITAS DM constraints



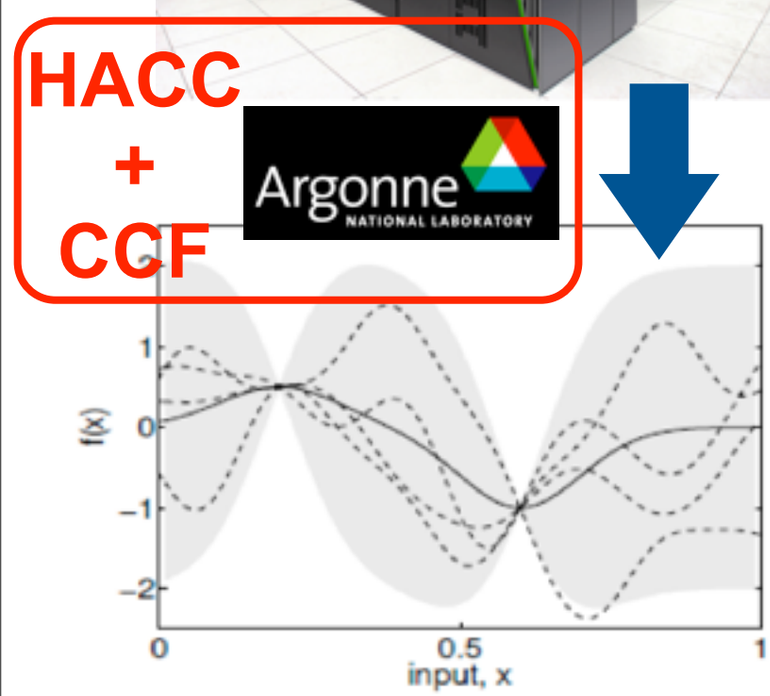
Quarter-dish (CTA) at ANL and in Berlin (with mirrors) ANL-CEA-DESY

Precision Cosmology: Calibrating the Universe

Supercomputer Simulation Campaigns

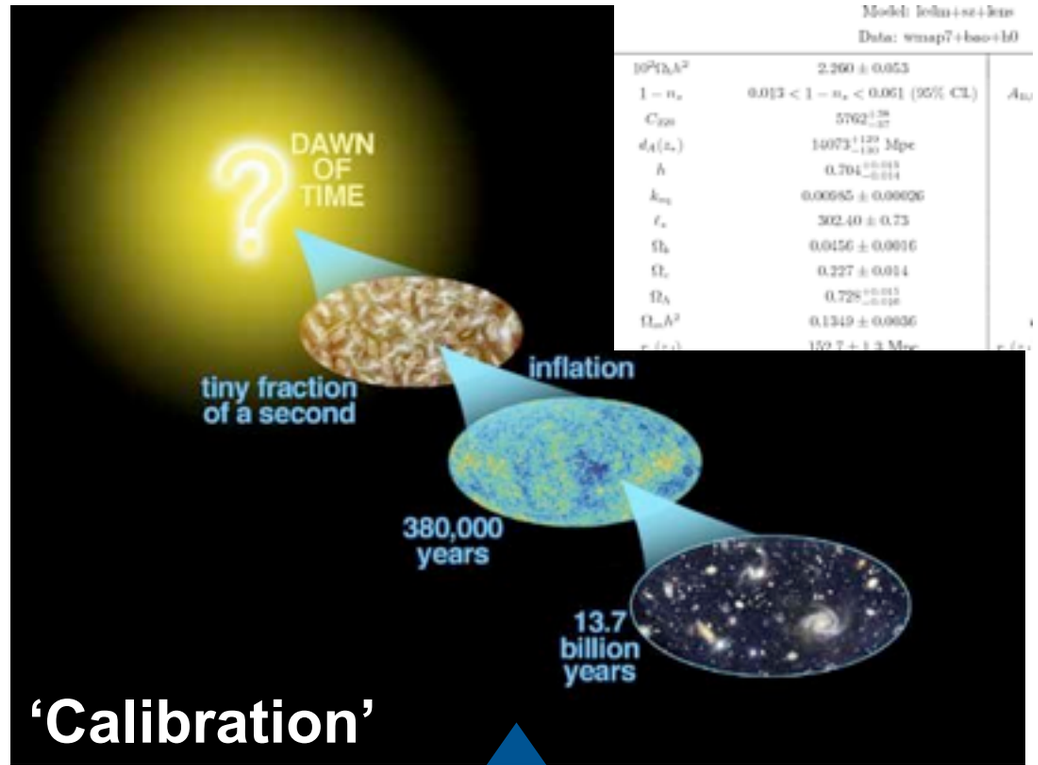
HACC + CCF

Argonne NATIONAL LABORATORY



Emulator based on GP Model Interpolation in High-Dimensional Spaces

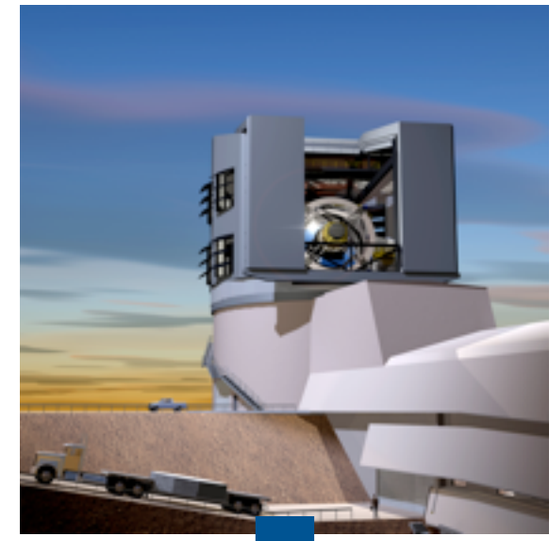
'Precision Oracle'

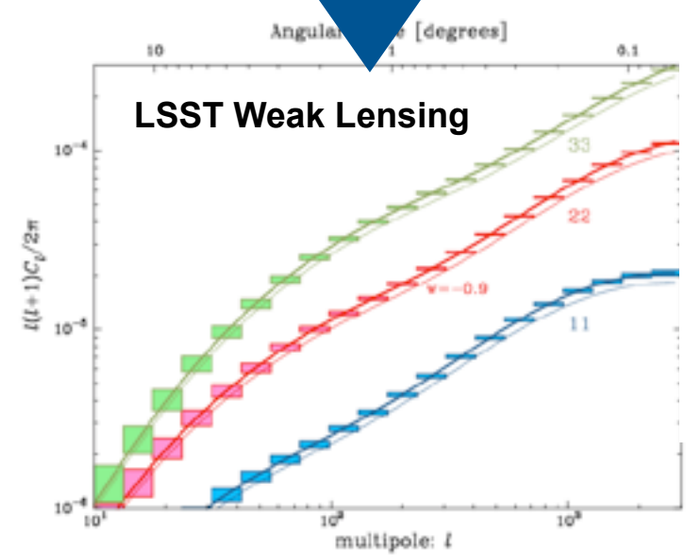


'Calibration'

Markov chain Monte Carlo

Mapping the Sky with Survey Instruments





Observations: Statistical error bars will 'disappear' soon!

HACC Port to the BG/Q Systems

- H(ardware) A(ccelerated) C(osmology) C(ode) port is making *very* good progress
- Very good performance on VEAS (Very Early Access System), 1 rack, 1024 nodes
- Test runs up to 16 racks at IBM (&24 racks at LLNL):

```
Creating rho(x,y,z)  3        39.77        17.78
Poisson solve        3        51.94        23.23
Particle move        3        2.04         0.9123
Output               3        0.53         0.237
=========================================

PXCH buffer = 2*1943590 = 3.707104 MB
InitialExchange TotalAliveParticles 1073741824000
```

One trillion+ particles!

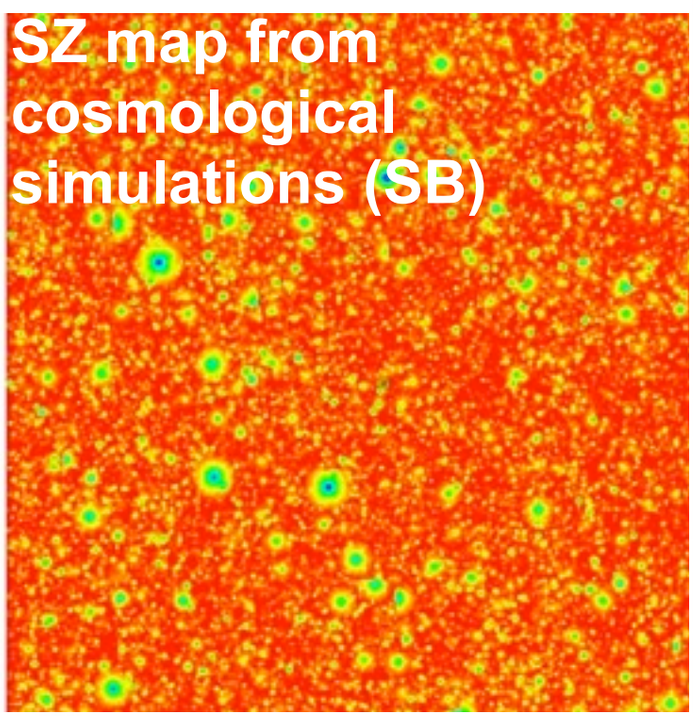
(largest hi-res cosmology run in the past: ~300 billion particles)

- Mira, ALCF's new BG/Q, will have 48 racks, our group has 150 Million CPU hours as one of 15 Early Science Projects, roughly comparable to all of annual (international) ATLAS computing

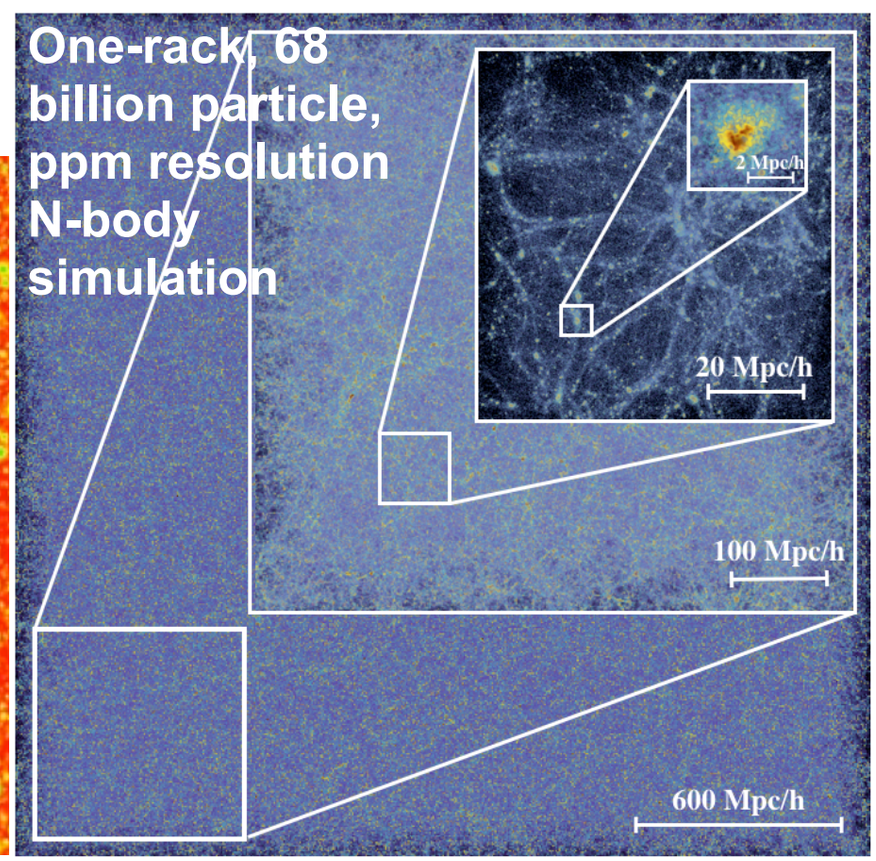
Building Collaborations

- **DOE HEP Cosmic Frontier Computing Collaboration (CFCC):** Major computing allocation at NERSC; large ALCC allocation at ANL and ORNL
- **Multi-Lab SciDAC Project:** Approval is in the works
- **NERSC Data-Intensive Computing Award for HACC:** Large storage/computing resource for cosmological simulations
- **LSST DESC:** Science/Computing/Data/Analysis
- **SPT Future:** Clarence

Cosmic Frontier Computing Collaboration



SZ map from cosmological simulations (SB)



One-rack, 68 billion particle, ppm resolution N-body simulation

Chicagoland Computational Cosmology Workshop at ANL (December 2011)