LIGO and the Open Science Grid

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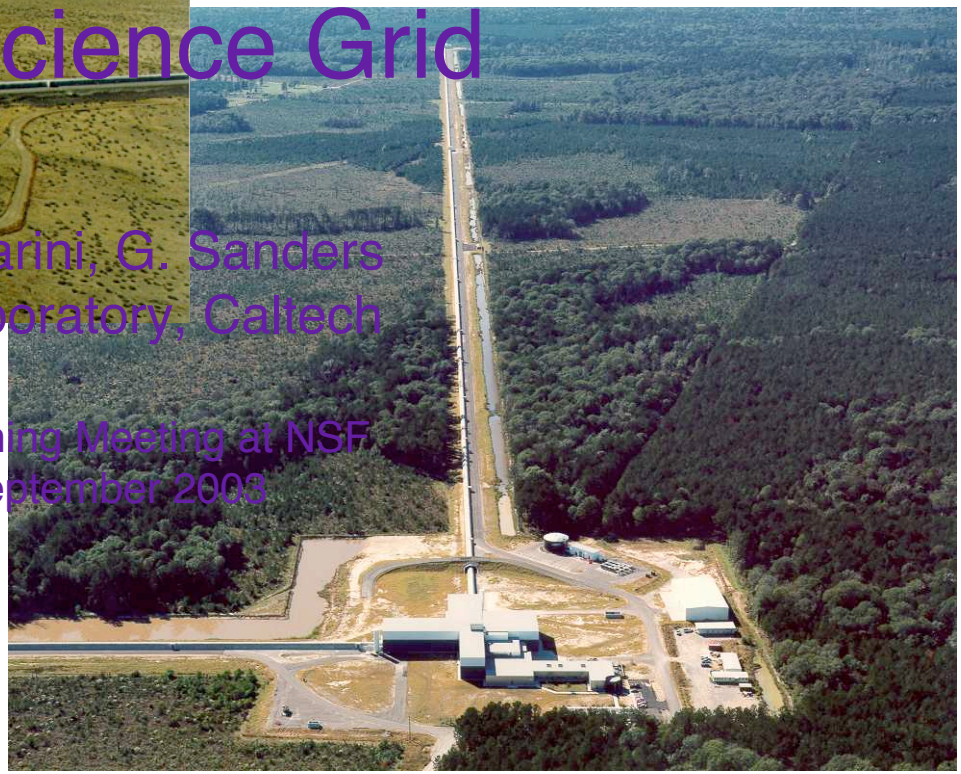
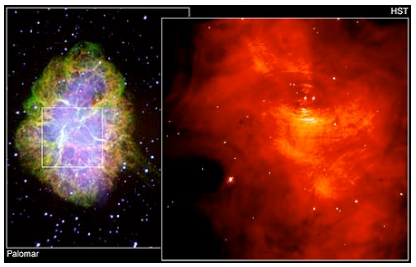


LIGO: Laser Interferometer Gravitational-wave Observatory

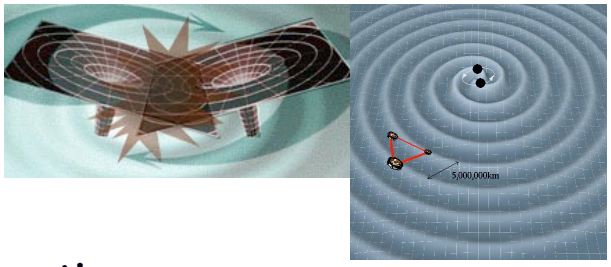
- LIGO is opening a new frontier in observational astrophysics
  - Detect & use gravitational waves (GW) to observe the Universe, provide a more complete picture of the Cosmos.
  - Complementary to radio/infrared/optical/X-ray/□-ray astronomy (electromagnetic waves --- EM)
    - EM emitters not likely to be strong GW emitters & *vice versa*
  - Detect & observe cataclysmic events leading to death of stars, birth of neutron stars & black holes
  - Opportunity to observe gravitational radiation, study Einstein's Theory of General Relativity in the strong-field regime
    - Vicinity of massive compact objects, where GW are produced
- **LIGO is now observing and acquiring science data**
  - Science extraction requires massive computational capacity and signal processing of data stream.
- LIGO has been working with other US science projects to define/develop/deploy a computational grid enabling collaborating universities to participate fully

Realizing the full science potential of LIGO

- Revealing the full science content of LIGO data is a computationally and data intense challenge
  - Several classes of data analysis challenges ***require*** large-scale computational resources
- Search for gravitational wave (GW) analogs of electromagnetic (EM) pulsars
  - GW sources not likely to have EM counterparts
    - Fast (millisecond) EM pulsars are stable, old neutron stars (NS)
  - GW emission likely to come shortly after birth of a rapidly rotating (deformed, hot) NS
  - GW sky is **unknown**
    - Searches will need to survey a large parameter space
  - All-sky search for previously unidentified periodic sources requires > 10^{15} floating point operations per second (FLOPS)



- Coalescence of compact binary systems ("inspiral chirps") which include spin-spin interactions will cover a huge parameter space (~ 10^6 greater than spinless systems)
  - Important for more massive systems
  - Massive systems have greater GW luminosities
  - Likely to be the first detected



- **These analyses are ideally suited for distributed (grid-based) computing**

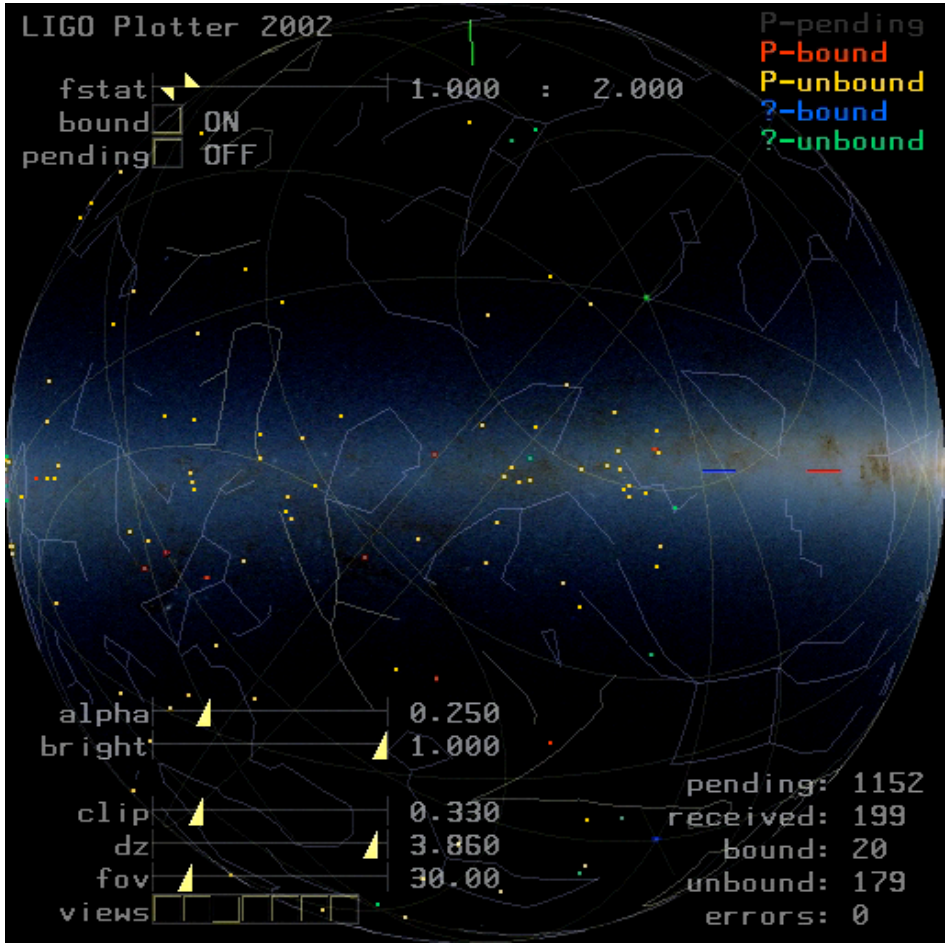
Example of grid-based LIGO data analysis: GW pulsar search

Goal: Implement a ***production-level*** GW pulsar search over a patch (less than 4□ of sky) search running for 30 days on ~10x more resources than LIGO has -- use the grid (e.g., ***10,000*** CPUs for **1** month)

Phase I: Subscale implementation using ONLY LIGO-owned resources under development at present time;

Joint effort with computer scientists on GriPhyN project

Phase II: When additional resources become available, will scale production run to expand beyond LIGO resources.



The LIGO Scientific Collaboration and the LIGO Grid

LIGO Grid: 6 US sites + 2 EU sites (Cardiff/UK, AEI/Germany)

Collaboration: ~40 institutions world wide; 400+ members

*LHO, LLO: observatory sites

* LSC - LIGO Scientific Collaboration

LIGO Education and Outreach

- LIGO Lab outreach has been primarily observatory centered (1997 – present)
- TWO proposals now under review at NSF address an expanded outreach role within LIGO:
  1. **Advanced LIGO proposal calls for an LSC-wide education and outreach program**
  2. **Follow-on proposal submitted by LIGO Laboratory in February 2003 to the NSF Education & Outreach Program**
     - Construct an educational outreach center on-site at LLO.
     - Place hands-on exhibits from Exploratorium in center.
     - Implement teacher pre-service and in-service training initiative to teach inquiry based science techniques at SUBR
     - Use LIGO staff to provide science leadership in selection of exhibits, development of science content in teacher training programs

LIGO Education and Outreach
LSC Collaborative Program

- LIGO Grid activities are an LSC-wide activity that can be *naturally* integrated into the LIGO outreach program:
  - Survey the collaboration education/outreach programs
  - Develop a coordinated computational outreach program from a subset of these
- Emphasis: LIGO science and grid-computing
  - Expose educators, students to IT technology in the context of gravitational wave astrophysics