LIGO Scientific Collaboration Astrophysical Source Identification & Signature (ASIS) working group

Bruce Allen, Chair
University of Wisconsin - Milwaukee

What Is ASIS?

- 1 of 6 working groups (3 data, 3 hardware) of LSC
- Formed in March 1998
- Meets approximately once/month (~30 people)
- Mailing list:110 members of whom >20 actively doing ASIS coordinated-work
- ASIS Management:
  - » Chair: Bruce Allen
  - » Lab Liaison: Barry Barish
  - » Webmaster: Patrick Brady
  - » Meeting Organizer: Alan Wiseman
  - » Secretary: Alberto Vecchio

LIGO-G000131-00-E

ASIS Charge

- Development of technique to search for posited sources: templates, algorithms and filters for
  - » Inspiral of compact objects
  - » Periodic sources
  - » Stochastic backgrounds
  - » Impulsive sources
- Blind search methods (unknown sources)
- Source statistics (log S - log N)
- Help determine split between on/off site analysis
- User software archive

LIGO-G000131-00-E

ASIS Web Site

Documents, software, & links

Meetings announcements, agenda & minutes

Mailing list interface & archives

Active Groups within ASIS

AEI   Cardiff   CIT-TAPIR

CFA   LLO   LIGO-CIT

Michigan   Stanford   TAMA

UFG   UTB   UWM

ASIS Software Development

- **Using LAL (LIGO/LSC Algorithm Library) Standard**
  - » Overseen by LSC Software Committee (Anderson, Finn, Papa, Prince, Wiseman) & Librarian (Creighton)

- **C standard, including data structures, IO, documentation, & test code**

- **Releases:**
  - » 0.1 September 1999
  - » 0.2 December 1999
  - » 0.3 March 2000
  - » 0.4 soon

- **Release 0.3 contains contributions from more than ten individuals**

ASIS Lead Groups

- **Unmodeled source searches**
  - » **Time/Freq (Cardiff)**
  - » **Power monitor (Cornell)**
  - » **Two-site correlation (unassigned)**
- **CW (pulsar) searches**
  - » **Source database (Albert Einstein Institute)**
  - » **Full sky Hough transform (Albert Einstein Institute)**
  - » **Directed known (LIGO Caltech)**
  - » **Full sky FFT stack/slide (U. Wisconsin - Milwaukee)**
  - » **Discriminators (U. Michigan)**
  - » **Robust methods (Stanford)**

ASIS Lead Groups (continued)

- **Inspiral Signals**
  - » **Hierarchical search
    Filtering (U. Wisconsin - Milwaukee)
    Template & bank generation (Cardiff)**
  - » **Multi-detector (unassigned, but approaching potential volunteer)**

- **Stochastic Background**
  - » **Correlation Statistic (U. Texas - Brownsville)**
  - » **Robust method (Cornell)**
  - » **Maximum likelihood (unassigned)**

Pulsar Database (AEI)

- **Vecchio**

- **Dec 15, 1999: catalog definition and basic coding completed**

- **March 15, 2000: added Taylor catalog, latest Parkes survey & multi-beam survey, globular clusters.**

- **Currently converting code to LAL standard.**

Directed pulsar search (CIT)

- **S. Anderson**

- **Initial pulse profiles/power spectra**
  - » **frame data input (via GRASP)**
  - » **output to "old" light-weight data format**

- **April 2000 milestone (incomplete as of 5/8/00):**
  - » **input changed to LDAS API**
  - » **output changed to "new" light-weight data format**

FFT stack/slide pulsar search (UWM)

- **Brady, T. Creighton**
- **15 Dec 1999, low pass filter code complete (in current LAL release)**
- **15 Jan 2000, sum/slide routines: written, in next LAL release**
- **15 Feb 2000, TDC correction & re-sampling: coding completed, in next LAL release**
- **15 Mar 2000, metric for coarse gridding: harder than expected. Work now divided up:**
  - » **Coarse gridding: UWM**
 - » **Fine gridding: AEI**

Hough-transform hierarchical pulsar search code (AEI)

- **Cutler, Owen, Papa, Schutz, Sintes-Olives, Vecchio, Williams**
- **Dec 31, 1999: algorithm complete.**
  - » **loop nesting orders, data flow**
  - » **approximate time scales**
  - » **coherent first/third stage filtering code written**
- **March 31, 2000: Hough transform code development started**
- **"Good enough barycentering" package in testing**
- **Template placement code being converted to LAL standard**

a SFT signal at α=0°, δ=0°
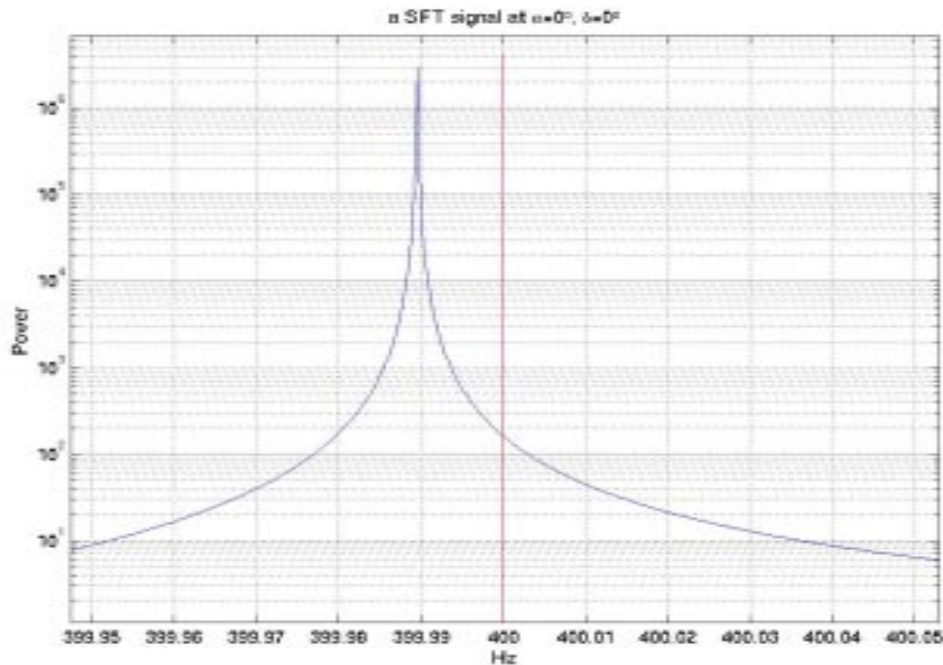
Spectrum from one of the SFTs, with time baseline Tc ~ 1 hour. The signal has f0 = 400Hz, the peak appears at a different freq. because of the Doppler modulation.

after Demod. combining 21 SFT, perfect matching
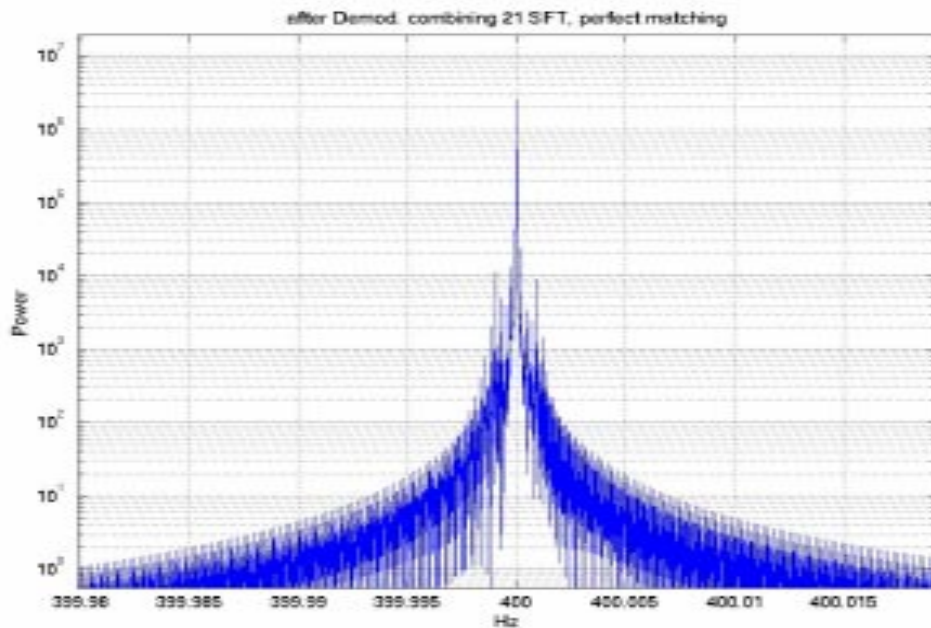
Spectrum of one of the demodulated FFTs with time baseline Tc ~ 21 hours. Since in this case there is perfect signal-template match there is no power loss and perfect shift of the peak to f0 = 400Hz.

CW discriminators (Michigan)

- **Chin, Riles**

- **31 Dec 1999, in-house algorithm for determining h(t) of source**

- **Work slowed down by incorrect results for antenna pattern in literature, theses. Now corrected (W. Anderson, Brady, Chin, Creighton)**

- **31 Mar 2000, LAL version of algorithm almost complete**

Hierarchical Inspiral Search (UWM)

- **Allen, Brown, J. Creighton**
- **Master/Slave design**
- **Code done to LAL standard**
- **Nov 31, 1999 Milestone: code for Master complete (3 weeks late). In LAL 0.3 release**
- **Feb 29, 2000 Milestone: code for Slave complete (finished in early April). In next LAL release.**
- **Filtering code being modified & used for WrapperAPI testing**

Hierarchical Inspiral Search (Cardiff)

- **Balasubramanian, Churches, Sathyaprakash**
- **Waveform & template bank generation**
- **Nov 31, 1999 milestone - time-domain Taylor and Pade approximants: submitted to LAL**
- **Feb 28, 2000 milestone - freq-domain Taylor approximant code: completed
  Time-domain including eccentricity: about one month late.**
- **Next milestone: template bank generation**

Time/Freq Line-Tracking (Cardiff)

- **W. Anderson, Balasubramanian, Chassande-Mottin**
- **Nov 31, 1999: method to veto violin-modes and other line-like features: completed**
- **April 31, 2000: code for Steger's line-tracking algorithm, Wigner-Ville, Windowed FFT, and Reassigned Spectrogram methods submitted to LAL. In next release.**
- **Next stage: testing**

Power Monitoring (Cornell)

- **Drasco, Flanagan**

- **Dec 31, 1999: re-write existing excess-power monitoring to LAL standard. Package in next LAL release: now undergoing testing.**

Stochastic Background Correlation Statistic (UTB)

- **Romano**

- **31 Dec 1999, overlap reduction function in current LAL release**

- **During first part of 2000, major emphasis on training students in the LAL standard**

- **Additional code forthcoming soon.**

Stochastic Background: robust locally-optimal statistic (Cornell)

- **Allen, J. Creighton, Drasco, Flanagan**
- **Locally-optimal method generalized to colored noise, non-coincident, non-co-aligned case**
- **March 31, 2000 milestone: late, but code currently being written to LAL standard by Drasco**

Wavelet transform method (UFG)

Not a scheduled ASIS task (at least, not yet)

- **Method being developed for detector characterization by Klimenko, Sazonov**

- **May be useful for blind signal searches**

- **Talk & ongoing discussion within ASIS group about possible applications**

Conclusions

- **ASIS group is healthy and active**
- **A number of software development projects are now underway**
- **Several holes remain: volunteers needed**
- **Success of LAL standard is a very positive development**