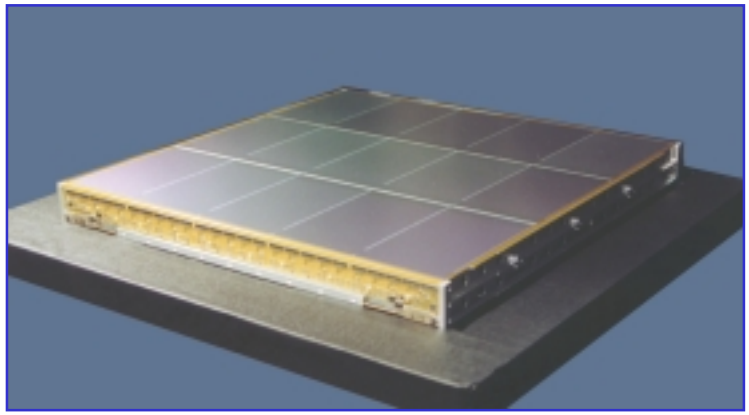
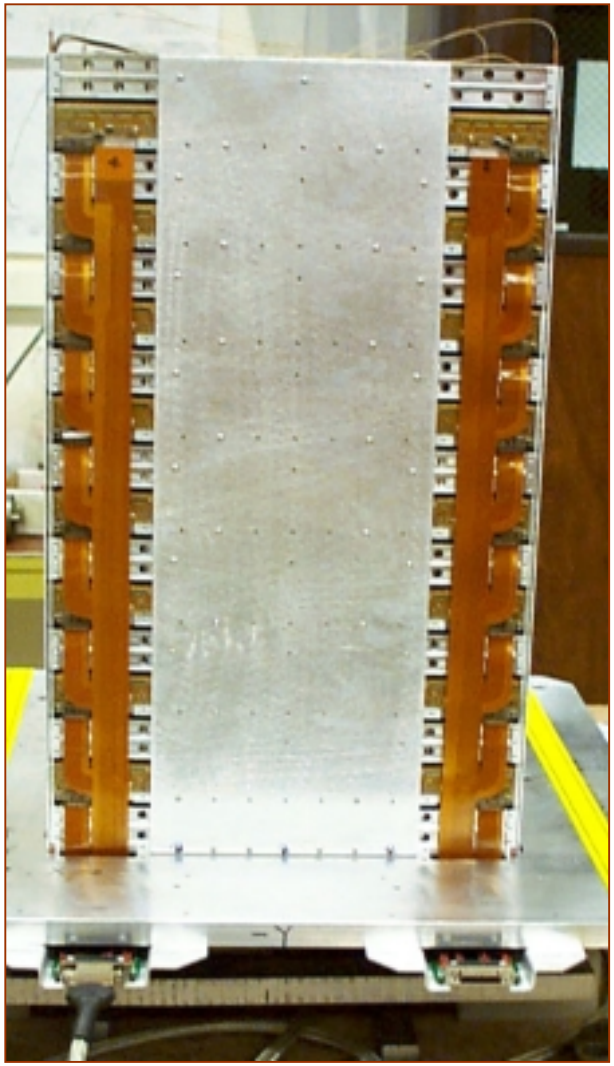
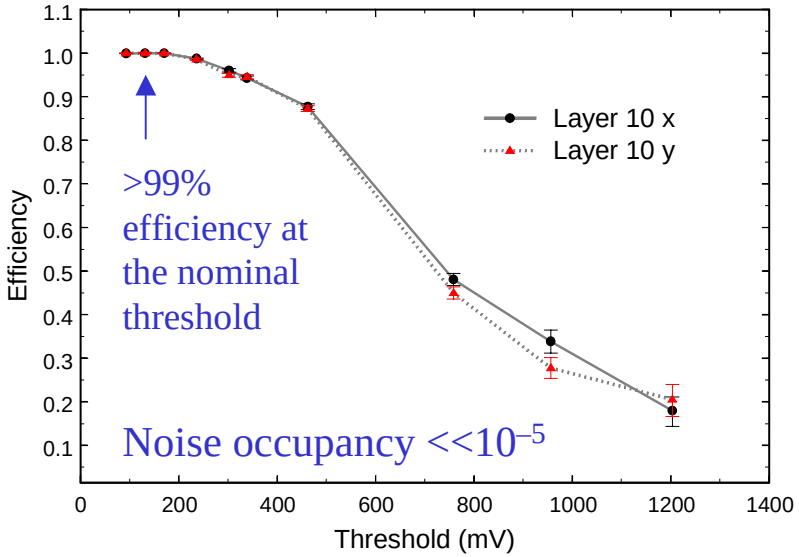
# The GLAST Silicon-Strip Tracker-Converter

**R.P. Johnson**
**Tracker Subsystem Manager**



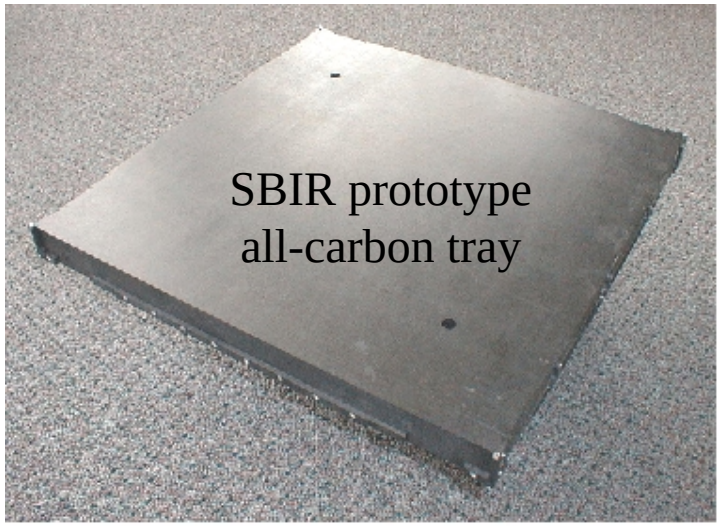
# BTEM Tracker






- Our successful beam test has proven
  - Design signal-to-noise performance
  - Complete FEE readout scheme
  - Integration of detectors and electronics into the mechanical structure, with minimal dead space
- Analysis of data to extract “physics” performance (PSF etc.) is in progress

# Mechanical Structure

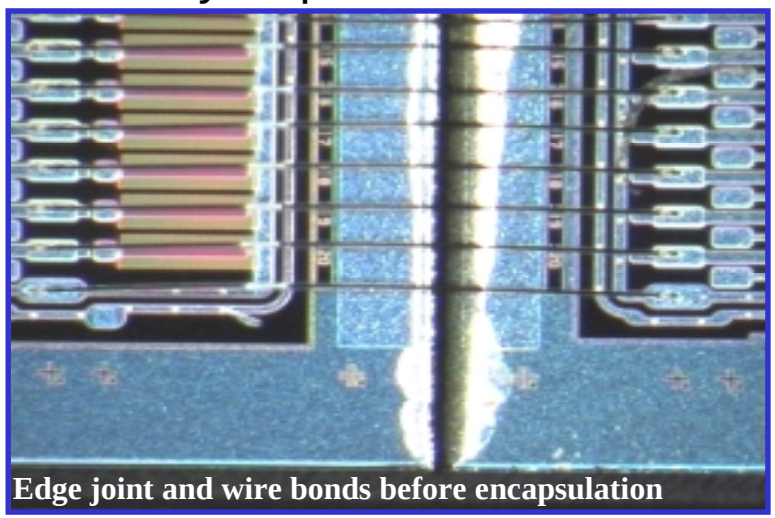



Hytec Inc. is making progress on the final carbon-fiber tray and tower structure:

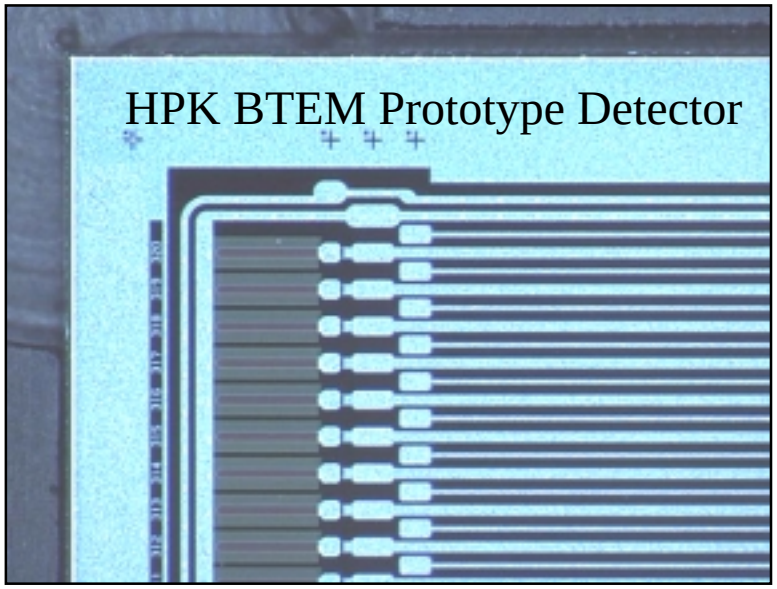
- All-carbon prototype tray (from SBIR)
- Mechanical and thermal analysis of the full tower with carbon-fiber walls
- Intensive work is in progress on understanding CTE mismatch issues and the detailed design of the tray payload attachment

# Silicon Detectors and Ladders

- The final SSD size and strip pitch has been established:
  - 8.95 cm and 228 micron
  - Reduces TKR channel count and power requirement by about 15%
- Final SSD specification under review
- Begin HPK qual. run this month
- Prototypes are being made by STM (Italy) for testing as 2nd vendor
- Discussions with Micron (UK) underway as possible 3rd vendor



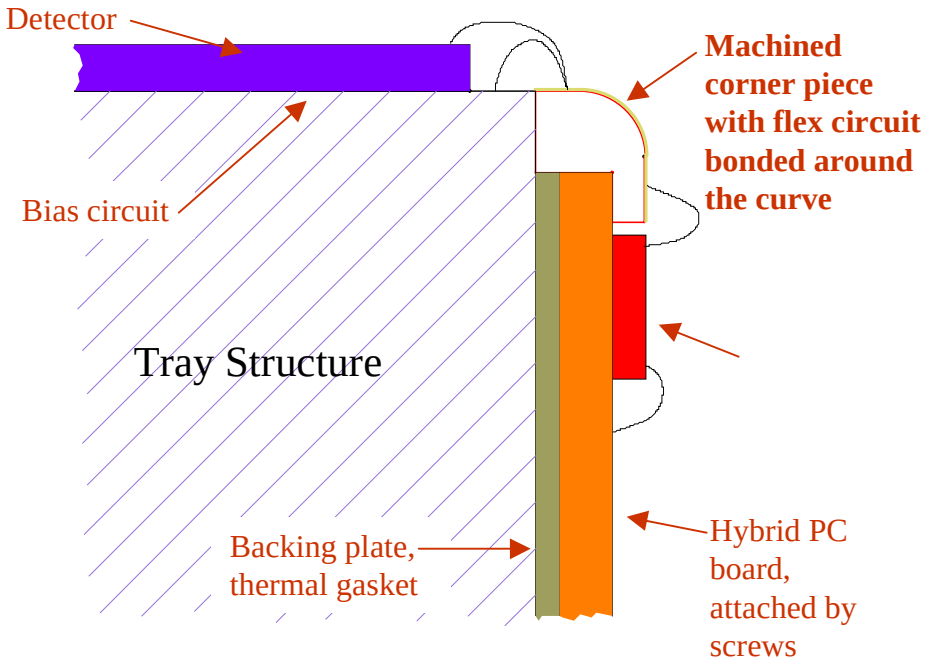
Edge joint and wire bonds before encapsulation



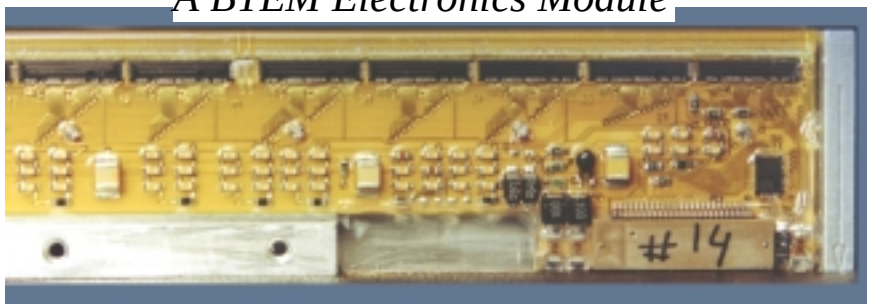

- The ladder assembly process is being improved at SLAC:
  - New edge gluing jig with better alignment control
  - Improved QC during assembly
  - Selection of final space-qualified adhesives
  - Testing of other methods for wire-bond encapsulation

# Tracker Front-End Electronics

- Redesign of the amp/disc chip in progress:
  - Analog portion tested in 0.5 μm HP process
  - Various tweaks to the amp/disc design are being studied by simulation
  - Command decoder redesigned & prototyped
- 1st SEL test at end of July in Japan
- Review of the requirements, specifications, and design tentatively planned for August.




*A BTEM Electronics Module*

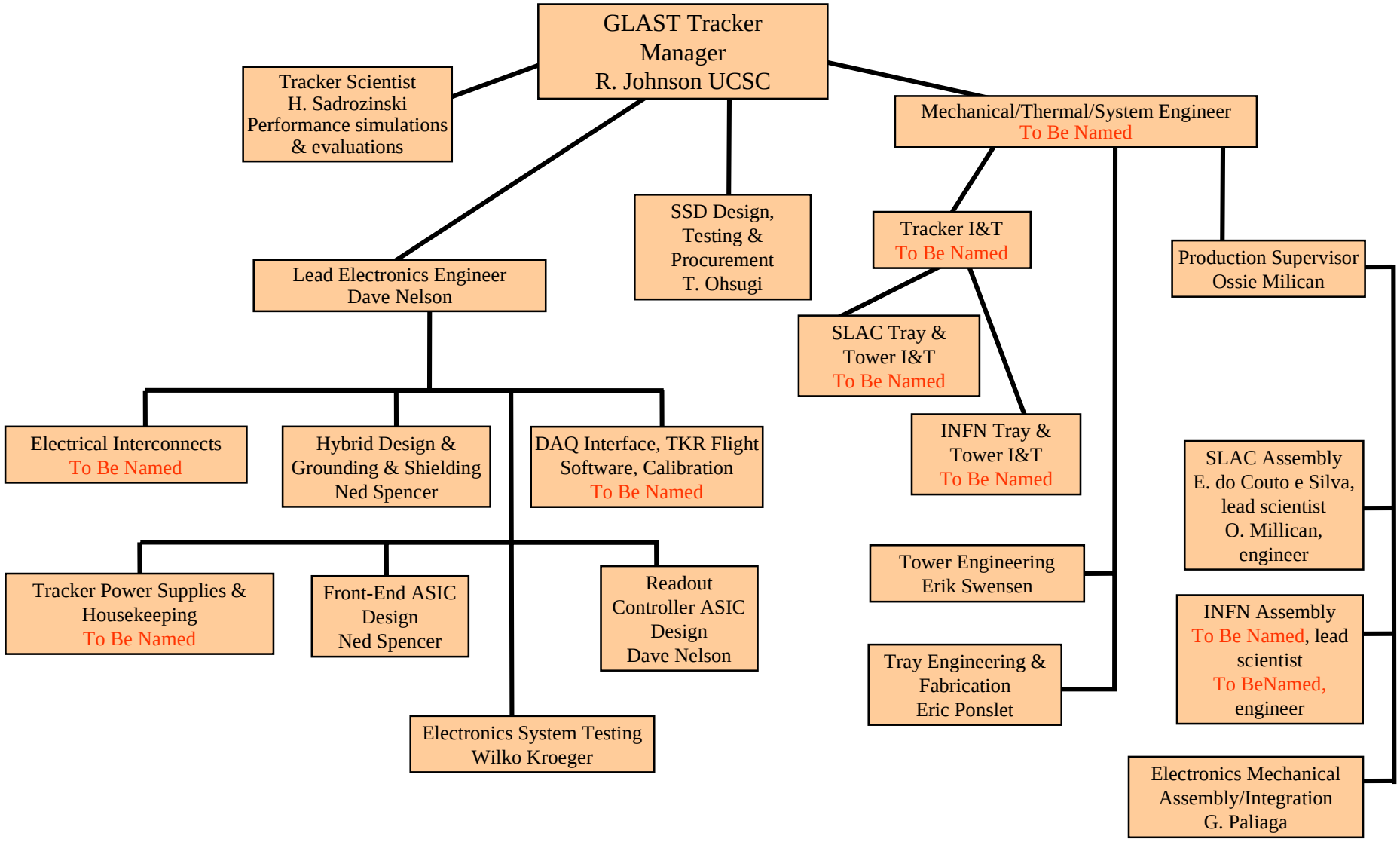



- The mechanical interface of the front-end electronics is being redesigned, as illustrated at the left:
  - A solid machined corner piece with narrow gold traces is bonded to the PC board and wire bonded to the FE chips.
  - This tested, encapsulated unit is mounted to the tray with screws.
  - Wire bonding to the detectors is the final step.
  - Prototypes have already been successfully machined and assembled at UCSC.

# Organization of the Tracker Subsystem

- Management (UCSC & SLAC):
  - Subsystem Manager
  - System/Mechanical Engineer
  - Electrical Engineer
  - Production Supervisor
- SSD Specification, Procurement, and testing:
  - Lead: Hiroshima U. in Japan
  - Funding from Japan & Italy
  - Suppliers: HPK and STM?
- FE Electronics Design and Fab:
  - Design at UCSC & SLAC
  - Readout module fabrication and testing by UCSC
- Power Supplies: Perugia?
- Mechanical/Thermal Engineering
  - Hytec Inc., Los Alamos
  - Supervision from SLAC
- Detector Ladder Fabrication
  - Development work at SLAC
  - Production and testing at SLAC & Italy
- Tray module assembly
  - Development at SLAC, Pisa, & UCSC
  - Production and QC at SLAC and Italy
- Tray module test and calibration
  - SLAC and Roma-II
- Tower module I&T:
  - At SLAC with support from collaborators

# Tracker Organization Chart



# Tracker Design Status, BTEM

- Proven Design Solutions:
  - Signal-to-noise of the readout (>99% efficiency, low noise occupancy).
  - Low power.
  - Readout rate & redundancy.
  - Self triggering without concurrent readout.
  - Compact packaging of detectors and electronics to minimize dead space.
  - Structural soundness (vibration testing).
  - PSF performance at 90º (off-axis analysis in progress).
- Issues Not Addressed in the Beam Test:
  - Self triggering with concurrent readout. The hardware capability exists and is being tested on the bench at UCSC.
  - Survival over a large $\Delta T$.
  - SEU and SEL testing of electronics.
  - Space-qualification of many of the parts and adhesives.
  - Structural and thermal issues associated with thick Pb lyrs.
  - Large-scale production of 18 towers.
  - Cooling: designed but not proven.
  - Final external interfaces.

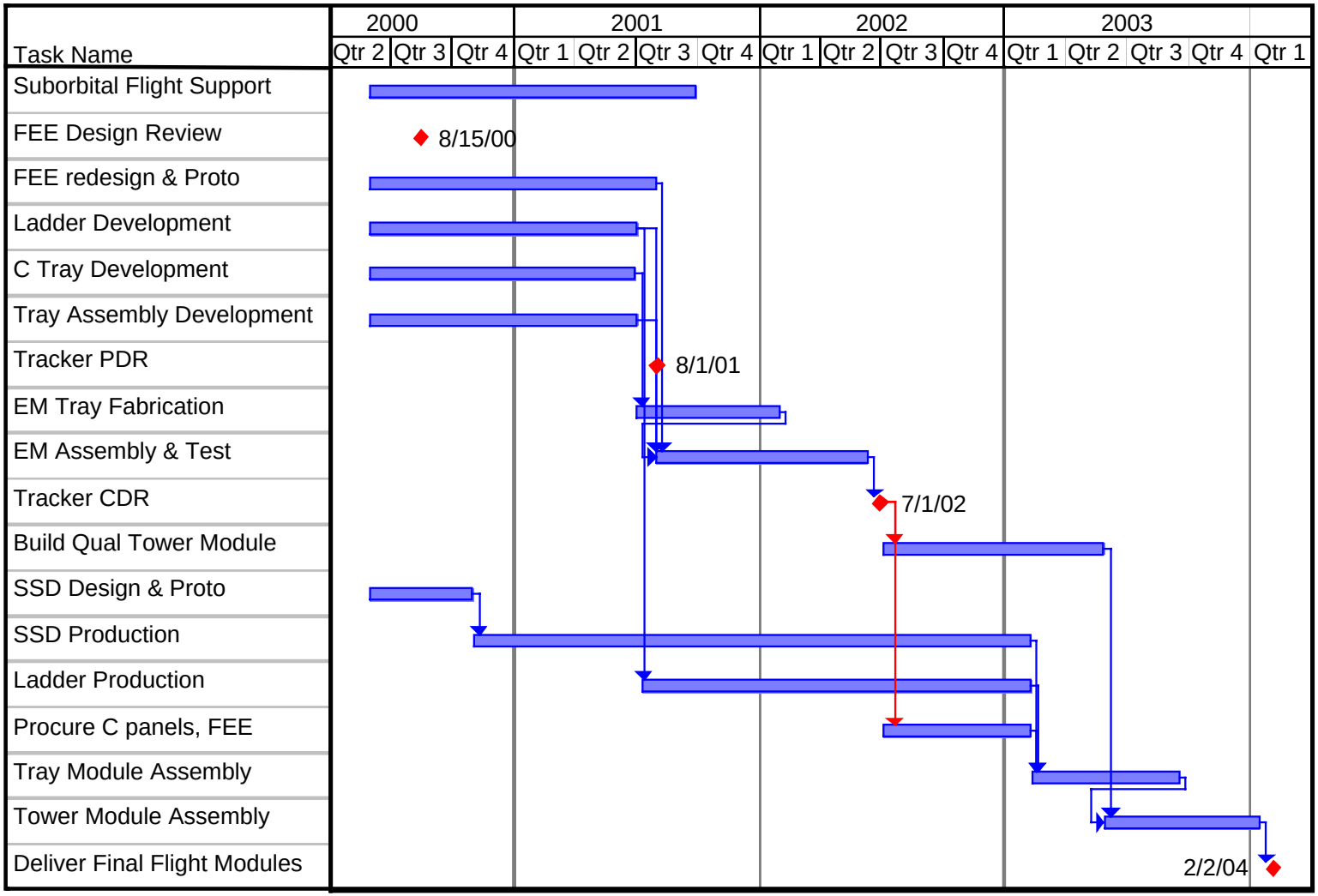
# Tracker Design Status, Outstanding Issues

- Trays
  - Hytec produced an all-carbon prototype with SBIR-I funding.
  - Issues:
    - Surface treatment
    - Space qualification
    - Cost & schedule
  - Aluminum closeout alternative
    - Degraded PSF
    - CTE mismatch problems
- Tower Walls and Assembly
  - A design exists that satisfies our mechanical/thermal requirements.
  - Issues:
    - Surface treatment
    - Cost vs. thermal performance
    - Fasteners
- ASICs
  - Design in progress in new process (HP 0.5 micron)
  - 6-ch. Amp-Discr. chip tested in the new process
  - Command-decoder test chip submitted
  - Specification & design review in August
  - Issues:
    - SEU safe config. Registers
    - SEL testing (laser and heavy ion tests this summer)
    - Digital-analog interference during readout, currently being evaluated in the BTEM system.

# Tracker Design Status, Outstanding Issues

- Detectors
  - Size, pitch, other specifications completed; prototype in progress at HPK and STM
  - Issues
    - Evaluation of 2nd supplier; detector thickness
    - Long-lead procurement
- Readout Hybrids and Cables
  - PC board and flex circuit redesign can begin after the specifications review
  - New right-angle interconnect scheme is under development which will greatly facilitate tray assembly.
- Detector Ladder Assembly
  - New edge-gluing and potting procedures under development at SLAC.
  - Issues:
    - Adhesives
    - Improved alignment and QC
    - Volume manufacturing
- Tray Assembly
  - Issues:
    - CTE between C, Pb, Si
    - Adhesives
    - Need improvements in alignment and QC wrt BTEM
    - Encapsulation of wire bonds from SSD to ASIC

# Tracker Schedule



# Tracker Cost Estimates

## Funding Sources:

| Tracker | FY00 | FY01 | FY02 | FY03 | FY04 | FY05 | Total |
|---|---|---|---|---|---|---|---|
| SU-SLAC | $1,657 | $2,145 | $1,739 | $2,996 | $817 | $523 | **$9,877** |
| UCSC | $102 | $204 | $204 | $204 | $205 | $168 | **$1,087** |
| Hiroshima University | $740 | $1,655 | $2,916 | $394 | $280 | $0 | **$5,984** |
| INFN | $570 | $3,288 | $3,548 | $1,994 | $1,570 | $1,140 | **$12,110** |
| **Total** | **$3,068** | **$7,291** | **$8,407** | **$5,589** | **$2,872** | **$1,832** | **$29,059** |

## Budget Breakdown by WBS Item:

| Tracker | | |
|---|---|---|
| Tracker Management | $ | 7,351 |
| Reliability and Quality Assurance | $ | 143 |
| Tray Sub-Assembly | $ | 19,843 |
| Tower Structure and Assembly | $ | 1,167 |
| Tracker Test and Calibration | $ | 223 |
| Sub-Orbital Integration and Test | $ | 50 |
| Instrument Integration and Test | $ | 147 |
| Mission Integration and Test | $ | 135 |
| **Total** | **$** | **29,059** |

**All costs in FY99 k$**