The Astronaut Science Advisor: Ground Testing During SLS-1

Michael M. Compton

Artificial Intelligence Research Branch

NASA Ames Research Center

Space Station Evolution Symposium

August 7, 1991

Mail Stop 244-17

Moffett Field, CA 94035-1000

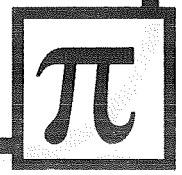
(415) 604-6776

compton@ptolemy.arc.nasa.gov

Motivation

Time and resource constraints severely limit flexibility during space experimentation:

- PI is physically distant from experiment.
- Communication is often of insufficient bandwidth or not timely enough.
- Experiments are numerous and varied.
- Space Station environment is likely to exacerbate the situation.



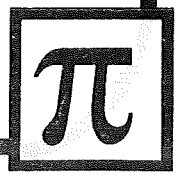
ASA Overview

- **Objective:**

  To improve the scientific return of experiments performed in space.

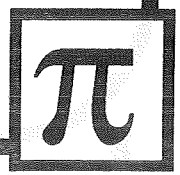
- **Approach:**

  Use expert systems technology to encode the domain and experiment knowledge commanded by the Principal Investigator and make it available to the astronaut experimenters.



Functions of the ASA

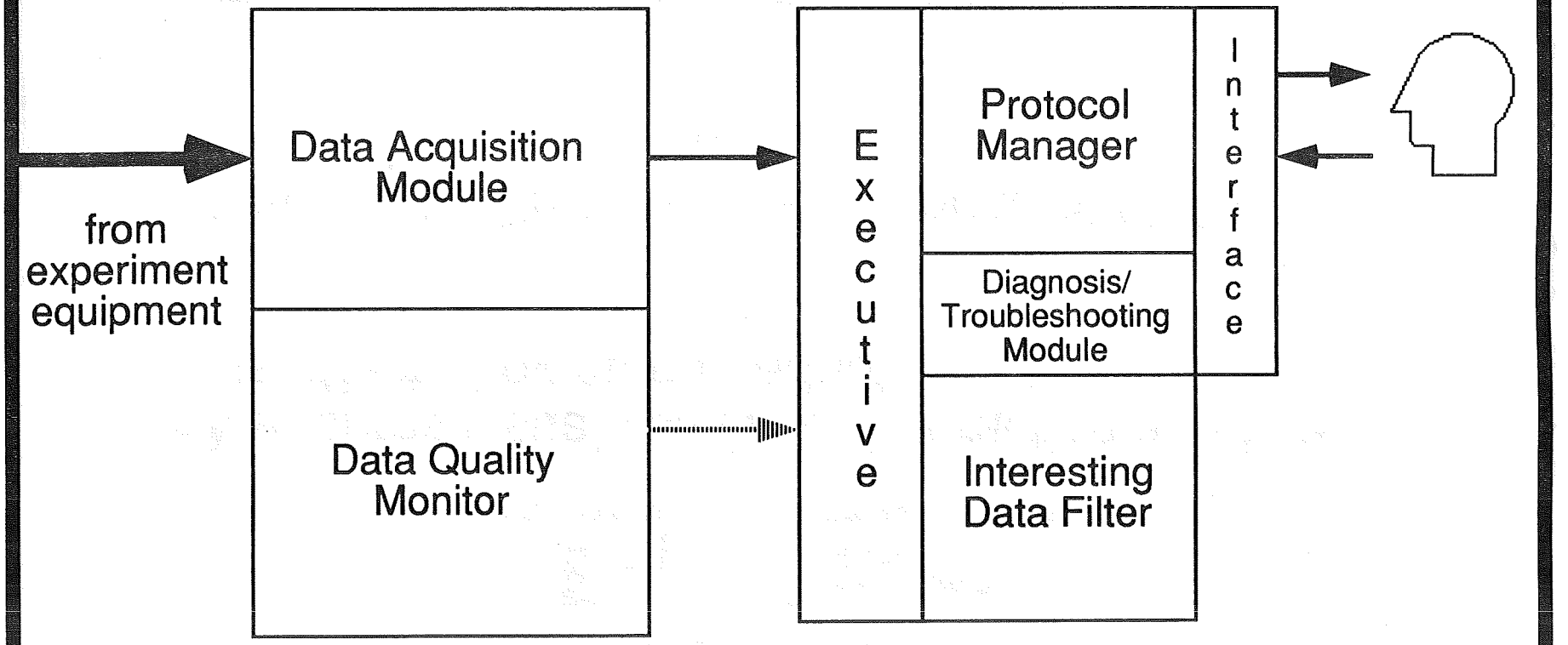
- Capture, reduce, and archive experimental data
- Monitor data quality and help diagnose problems with equipment when experimental data is erratic or poor
- Identify and permit investigation of "interesting" data
- Suggest protocol changes that would result in better utilization of remaining time



Project Team

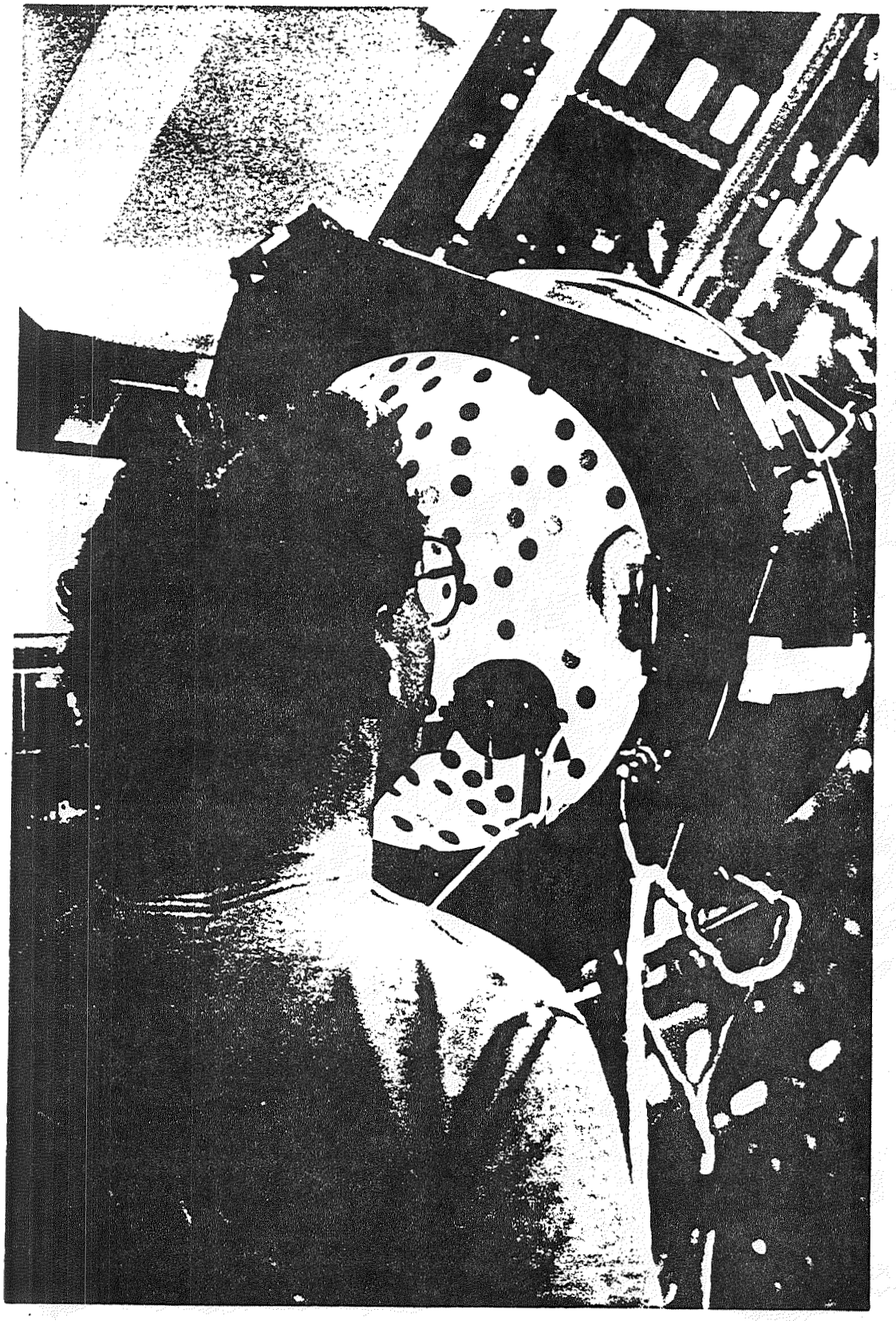
- **Ames Research Center**
  - Silvano Colombano
  - Michael Compton
  - Richard Frainier
  - Irving Statler
- **Johnson Space Center**
  - Jurine Adolf
  - Tina Holden
- **M.I.T.**
  - Prof. Laurence R. Young *(experiment PI)*
  - Nicolas Groleau
  - Peter Szolovits

System Architecture

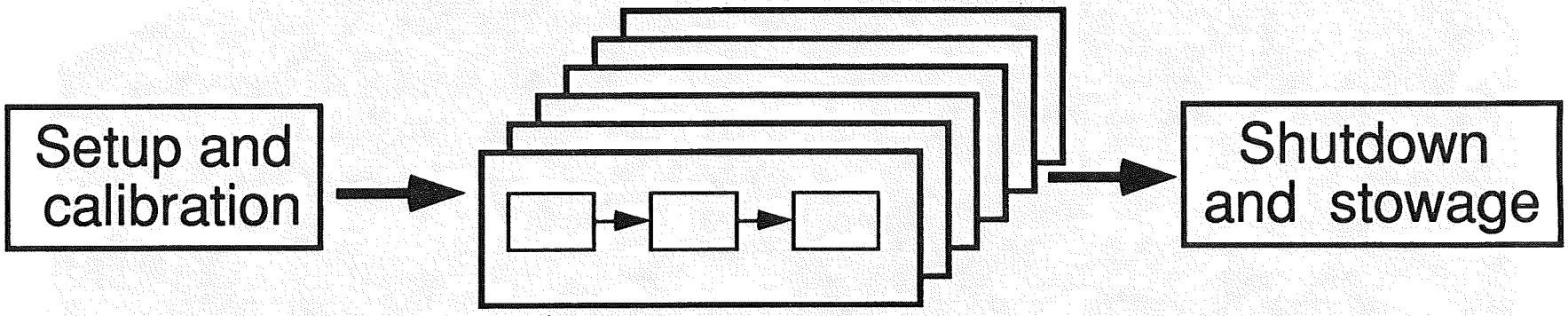


The Rotating Dome Experiment

- Measures visual/vestibular interaction and how it is affected by human adaptation to microgravity
- Devised by Professor Larry Young of MIT's Man-Vehicle Laboratory
- Flown on two previous Spacelab missions (including SLS-1 in June, 1991)
- Scheduled for flight aboard SLS-2 (in May, 1993)



Typical Experiment Session



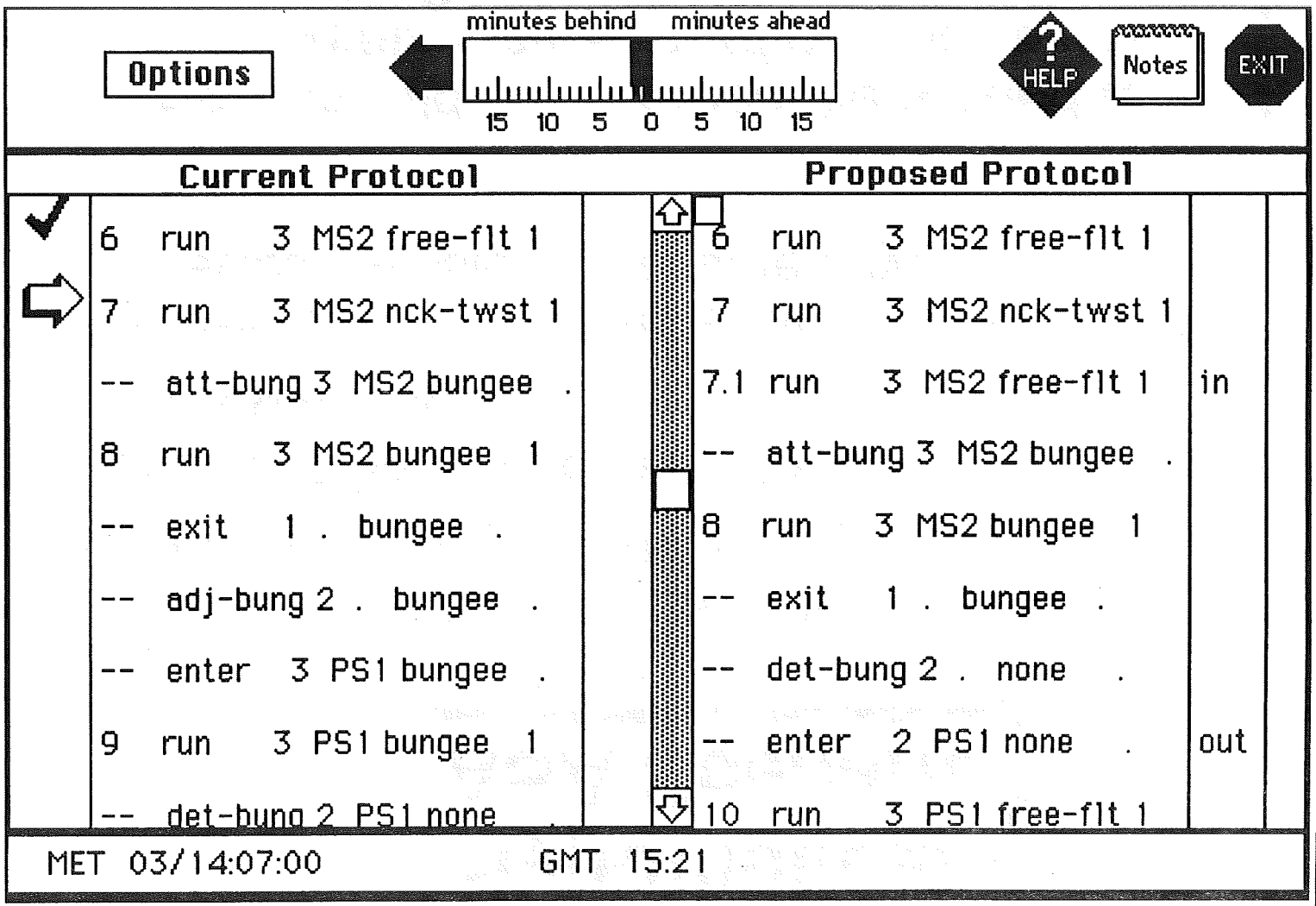
Data collection

Hypothetical ASA Scenario

- The dome experiment, with two subjects, is running slightly behind schedule.
- Subject 1 had exhibited "interesting data" on the previous day.
- Subject 2 had exhibited erratic data during the previous session that same day.

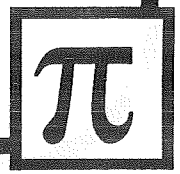
How should the protocol be refined to maximize the scientific return of this session?

The "Proposed" Protocol



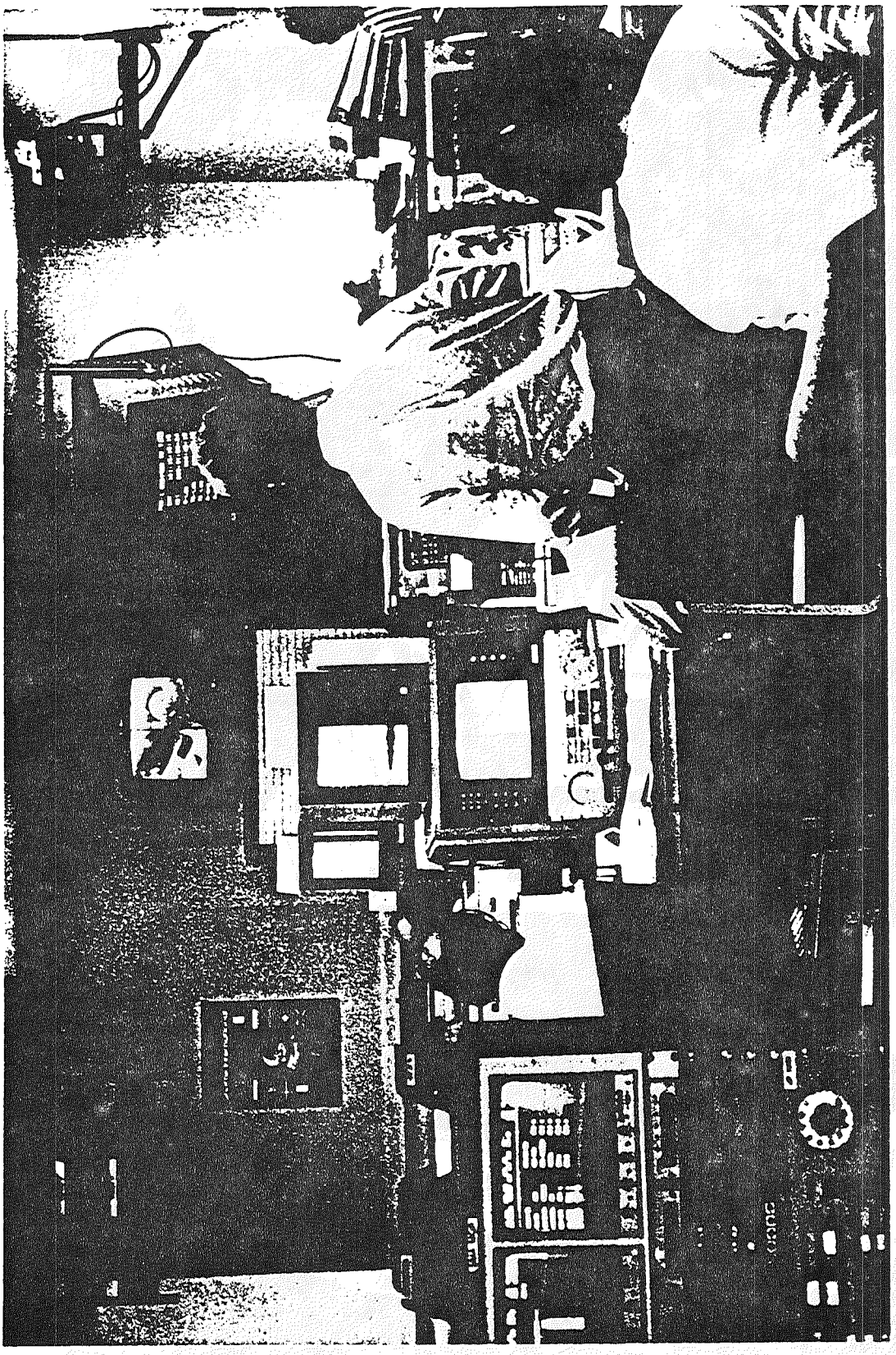
Diagnosis and Troubleshooting Example

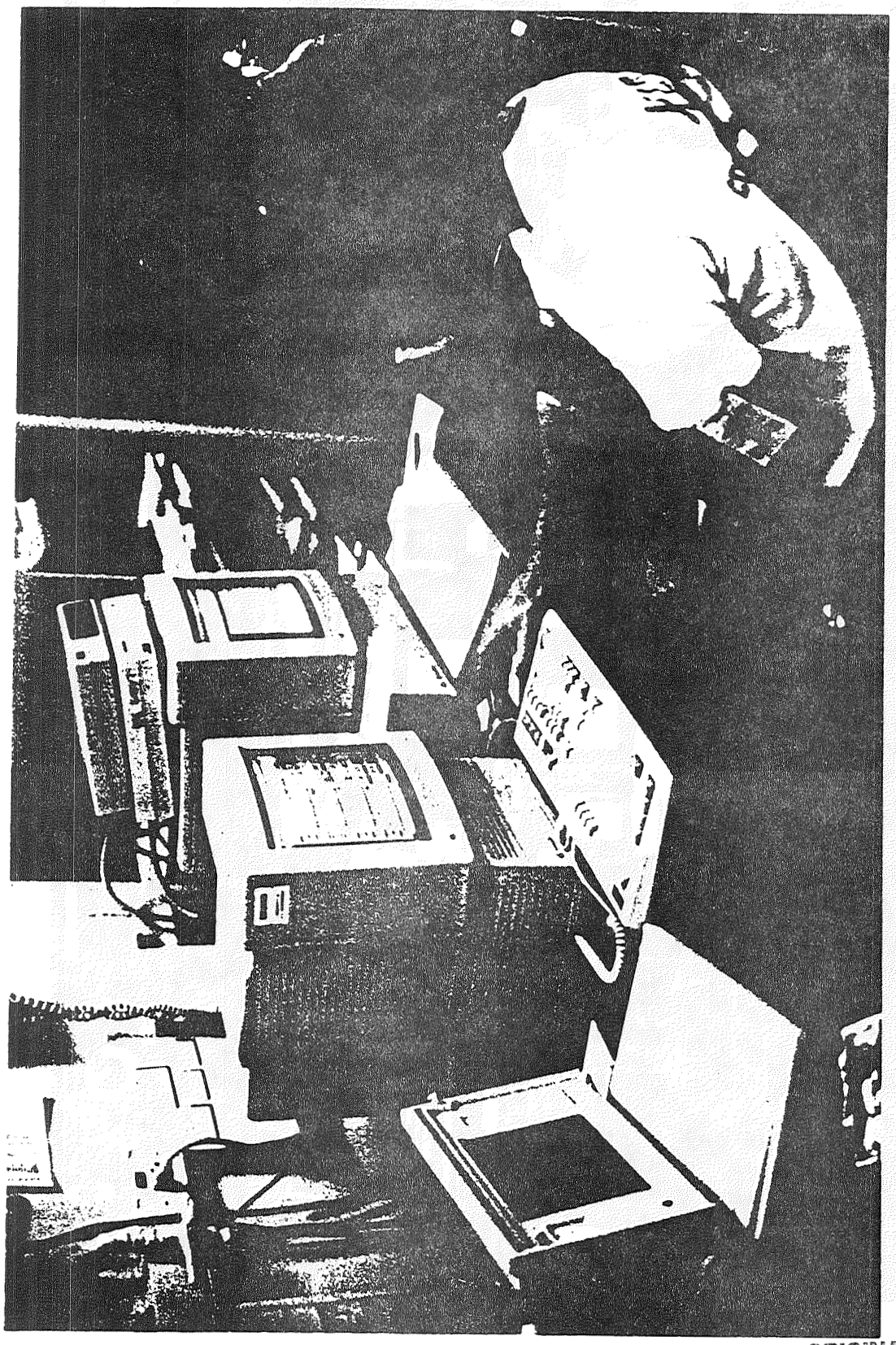
- During setup for a new subject, one of the signals that convey neck muscle activity "goes flat".
- Without the ASA, the problem might go unnoticed until PIs on the ground recognize the problem, notify the astronauts (and perhaps convey a troubleshooting procedure).
- With the ASA, the system would immediately notice the bad signal and invoke the diagnosis and troubleshooting module and help the astronauts correct the problem (or recommend that the experiment proceed without that signal).



Support of SLS-1 Mission

- **Pre-flight baseline data collection:**
  - system used to collect and analyze data from Rotating Dome experiment in the Baseline Data Collection Facility at JSC on L-150, L-75, L-45, L-30, and L-15 sessions
- **Ground support during flight experiment:**
  - system used in the Science Monitoring Area at JSC to collect and analyze in-flight data from the Dome experiment downlinked from Spacelab
- **Post-flight data collection:**
  - system used at Dryden to collect and analyze data from the Dome experiment on R+0, R+1, R+2, R+4, R+7, and R+10 sessions





Accomplishments

The system worked under realistic conditions.

- Collection and archival of downlinked data
- Quick-look analysis and summary of data
- Generation of potential new protocols

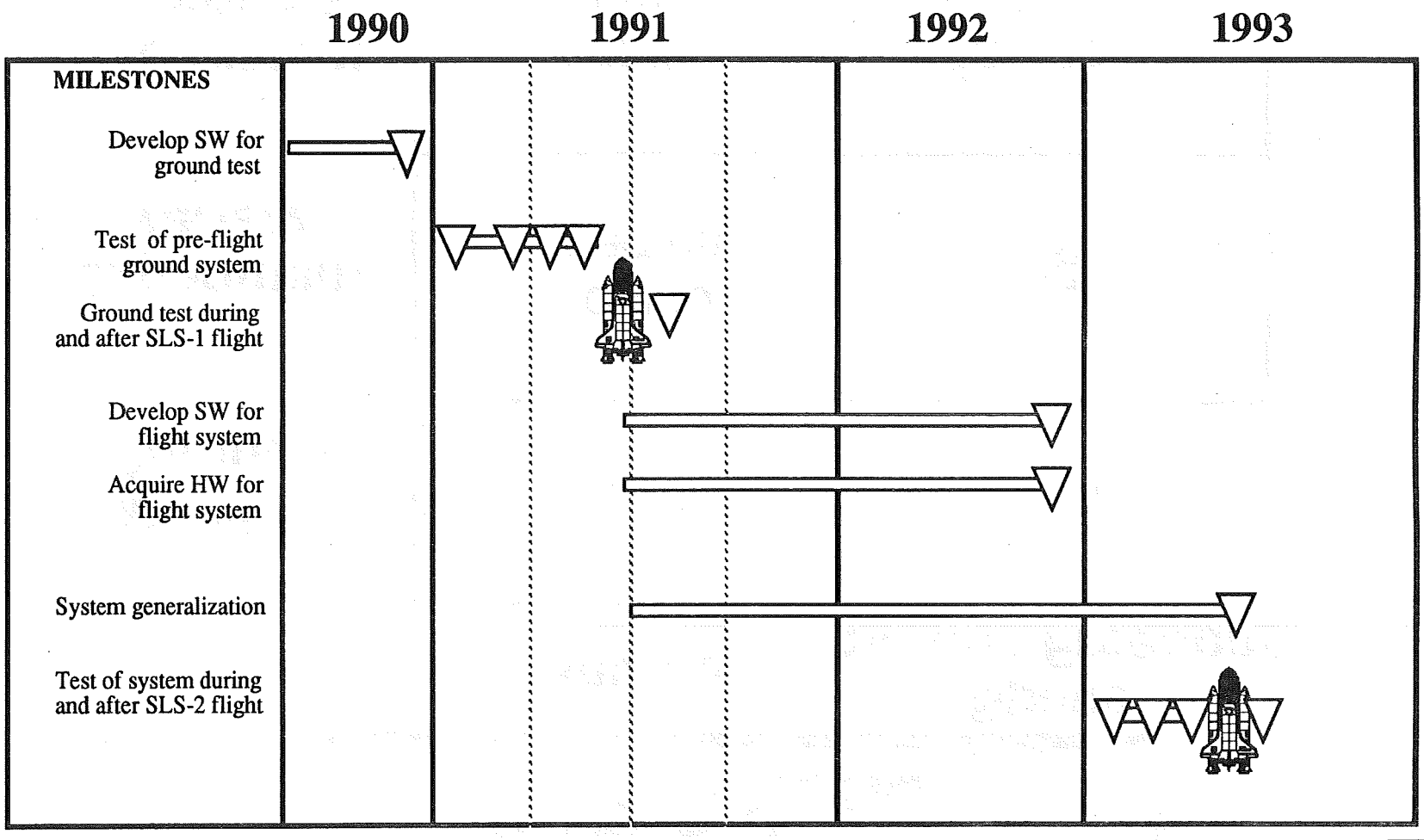
Lessons Learned

- Space science should permit reactivity to
  - cope with problems
  - pursue unexpected opportunities
- The ASA would have been very useful to crew in-flight (particularly for troubleshooting and replanning).
- Conduct of the experiment suggested an increased emphasis on experiment set-up would be useful.
- An in-flight system could avoid many of the limitations inherent in ground-based systems.

"Shuttle Science" vs SSF Science

	Shuttle	Space Station Freedom
Mission Duration	days	months
Experiment Variety	low to medium	high
Experiment Protocols	tightly scripted	adaptable to initial results

Milestones


1990
1991
1992
1993
MILESTONES
Develop SW for ground test
Test of pre-flight ground system
Ground test during and after SLS-1 flight
Develop SW for flight system
Acquire HW for flight system
System generalization
Test of system during and after SLS-2 flight

Potential Applications

- The Vestibular Sled Experiment
- Simulation of Titan Atmosphere in Gas Grain Simulation Facility (GGSF)
- Cell Growth in Wiessman Apparatus
- Biomedical Monitoring and Space Research Centrifuge

Conclusions: Implications for SSF

- Long-term "missions" aboard SSF will require a different approach to ground support of experiments
- Scientific return increases with reactivity
- Automation techniques can reduce reliance on ground