# 40 Meter Interferometer Schedule Planning and Tracking

Gary Sanders



## Motivation

- During LIGO research operations we will need to maintain very high "on-time" to maximize physics effectiveness
- LIGO enhancements and improvements will require use of the 40 Meter Interferometer and the LIGO interferometers for R&D, modification, shakedown of enhancements.
- These two uses of the interferometers compete for time
- System failures, repairs, idle time also compete.

# LIGO Availability Requirements

LIGO SRD:

3.6.1 Single Interferometer Operations

The goal for the initial detector is the ability to maintain at least one interferometer in operation at an annually integrated availability of 90% with minimum continuous operating periods of 40 hours, allowing for short term loss of lock. Such loss of lock may occur in order to accommodate long-term, low frequency drift (i.e., out of the GW measurement band) by shifting resonant operation from one longitudinal mode to another.

3.6.2 Multiple Coincidence Operations

As a goal, LIGO shall have the ability to operate in triple coincidence mode for an annually averaged availability of 75%. As a goal, operation in double coincidence mode (defined as operation of the Livingston interferometer with either of the two Hanford interferometers) shall be possible with an annually averaged duty cycle of 85%. For both these modes, the minimum period of continuous operation shall be 100 hours. The same allowances as in §3.6.1 are permitted for short term loss of lock.

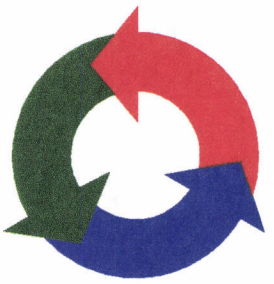


# LIGO Availability

- Is this requirement realistic?
- Circular accelerators (non-storage ring) achieve:
  - » 65% - 85% availability for 30 - 35 scheduled weeks per year
  - » pushing these two numbers higher is not cost effective
  - » cost rises very steeply
- Are 4 km interferometers different from accelerators?
  - » how many parts?
  - » control loops, orthogonality...
  - » a new kind of system...
  - » human insight and processes different...
- 40 Meter Interferometer is the only validation system

## Achieving High Availability

- Reliability built into design
- Operational process
  - » preventive maintenance, spares
  - » required monitoring
  - » training
- Performance measurement
- Operational Planning
- Closing the loop between the last two bullets in a way that emphasizes end user goals
  - » research time
  - » system enhancement





## Characteristics of LIGO and 40 Meter Operations

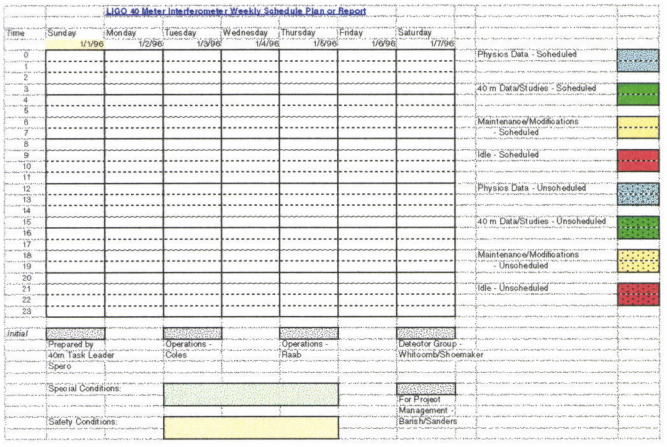
| Characteristic | 40 Meter | LIGO |
|---|---|---|
| Primary Goal | IFO Science | Grav. Wave Data |
| Secondary Goal | Oper. Pathfinder | IFO Science |
| Tertiary Goal | Grav. Wave Data | Oper. Pathfinder |
| Run Mode Today | Work Days | Round the Clock |
| Planning Unit | Work Days | 8 hour shift |
| Operating Presence | user staffed | operator team + user staffed |

# Needed Approach

- Work to accomplish operational pathfinder and gravity wave data at 40 Meter
- Change planning unit and runnning mode to shifts instead of work days
- Tightly close planning and tracking loop and involve 40 Meter staff and management, operations managements, detector management and LIGO management every week.



# An Example of an Algorithm



Week of

## LIGO 40 Meter Interferometer Weekly Schedule Plan or Report

| Time | Sunday 1/1/96 | Monday 1/2/96 | Tuesday 1/3/96 | Wednesday 1/4/96 | Thursday 1/5/96 | Friday 1/6/96 | Saturday 1/7/96 |
|---|---|---|---|---|---|---|---|
| 0 | | | | | | | |
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| 23 | | | | | | | |

Physics Data - Scheduled

40 m Data/Studies - Scheduled

Maintenance/Modifications - Scheduled

Idle - Scheduled

Physics Data - Unscheduled

40 m Data/Studies - Unscheduled

Maintenance/Modifications - Unscheduled

Idle - Unscheduled

*Initial*

Prepared by
40m Task Leader
Spero

Operations -
Coles

Operations -
Raab

Detector Group -
Whitcomb/Shoemaker

Special Conditions:

Safety Conditions:

For Project Management -
Barish/Sanders

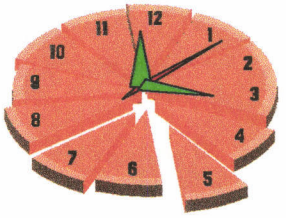
## New Scheduling Process: Strawman

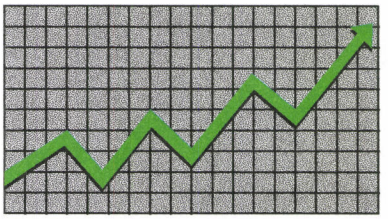
- Establish 3 month 40 Meter rolling schedule by shift
- Establish weekly schedule by shift for 2-3 weeks at a time, including schedule of personnel
- Each Monday
  - » review shift by shift record for past week (Monday through Sunday) and record in same format as past week schedule
  - » prepare revised schedule for following week at 40 Meter Task Leader level
  - » By each Thursday that schedule and supporting documents should reach Project Management endorsed by intermediate levels
  - » Project Management endorses by Friday
- Entire process operates against set goals



## Major Goals

- Number of scheduled IFO Science, Grav. Wave Data shifts per week
- Fraction of scheduled IFO Science and Grav. Wave Data shifts accomplished vs. scheduled
- Operational Pathfinder Goals
  - » making this process work
  - » number of "qualified" personnel at 40 Meter who can operate a shift with one of several possible skill levels
- Milestones Accomplished
- Reduction of Idle Time



## Tracking Categories

My Suggestion

- Physics Data - Scheduled
- 40 M Data/Studies - Scheduled
- Maint./Mods. - Scheduled
- Idle - Scheduled
- *Physics Data - Unscheduled*
- *40 M Data/Studies - Unsch.*
- *Maint./Mods. - Unscheduled*
- *Idle - Unscheduled*
- Shutdown
- Checkout/Shakedown

40 M Staff Suggestion

- Grav. Wave Data
- IFO Science
- Align./Lock
- Trouble/Repair
- Mods./Improvements
- Config. Change
- Diags./Maint.
- Offline Tasks/Other



## Using the Tracking to Meet Schedule

- Develop workaround strategy every week
- Build up qualified cadre for staffing 40 Meter shifts
- Stretch hours per day
- Use night shifts and weekends
- Do not quit at crucial times - push through to goals
- Call on others and on management for support
- Measure response to slippages
- Do not let weekly slippages cascade

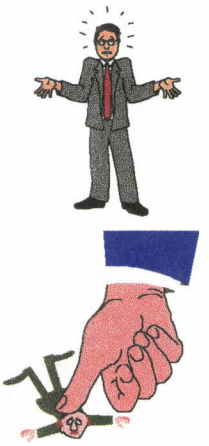
How to do this? Discussion needed but plan is urgent.

Weekly meeting needed for at least 3 months.

Coles/Raab to take this scheduling meeting over then.

## Issues and Challenges

- How to use more time each week
- How to involve additional people with diverse skill levels
- How to make more effective use of technicians
- How to overcome geographic isolation
- How to increase 40 Meter visibility in LIGO organization and planning (mirroring the visibility to be given to LIGO IFO's)
  - » Is construction in Louisiana really more important than 40m?
- How to avoid burnout in present 40 Meter staff





## Agenda for Next Week (April 22, 16:00, ECR)

- Bob Spero to present:
  - » 3 month rolling schedule (draft)
  - » Planned schedule for week of April 15 (Not until first week in May)
  - » Actual schedule for week of April 15 by shift, including staffing
  - » Discussion of issues, planning changes, lessons learned, responses
  - » Proposed schedule for week of April 22
  - » Proposed format for scheduling and tracking
  - » Discussion of involvement of additional staff, technician involvement, stretching hours per week
  - » Discussion of starting gravitational wave data collection and analysis (Can data collection begin first week in May ?)