LIGO Commissioning Status

PAC Meeting,
LHO, December 12, 2005

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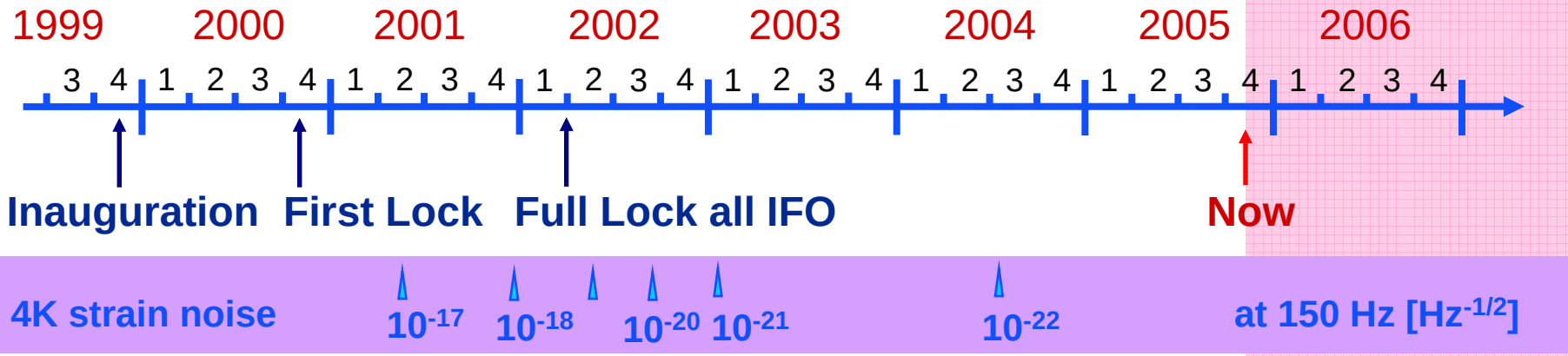
G050643-00-D

Are we there yet?

…the NSF review panel gave us a strong pat on the back for bringing initial LIGO to design sensitivity and beginning S5…

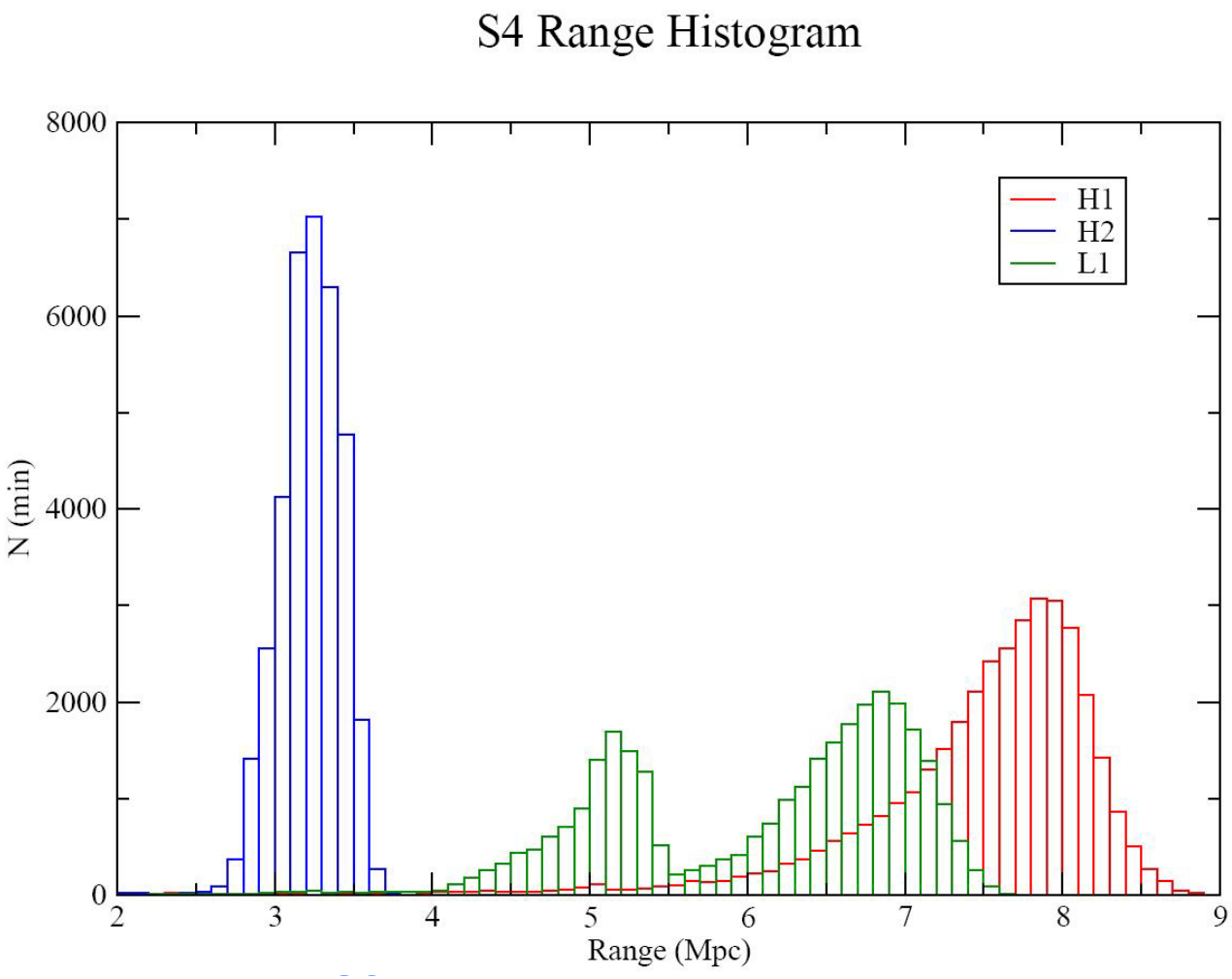
Time Line

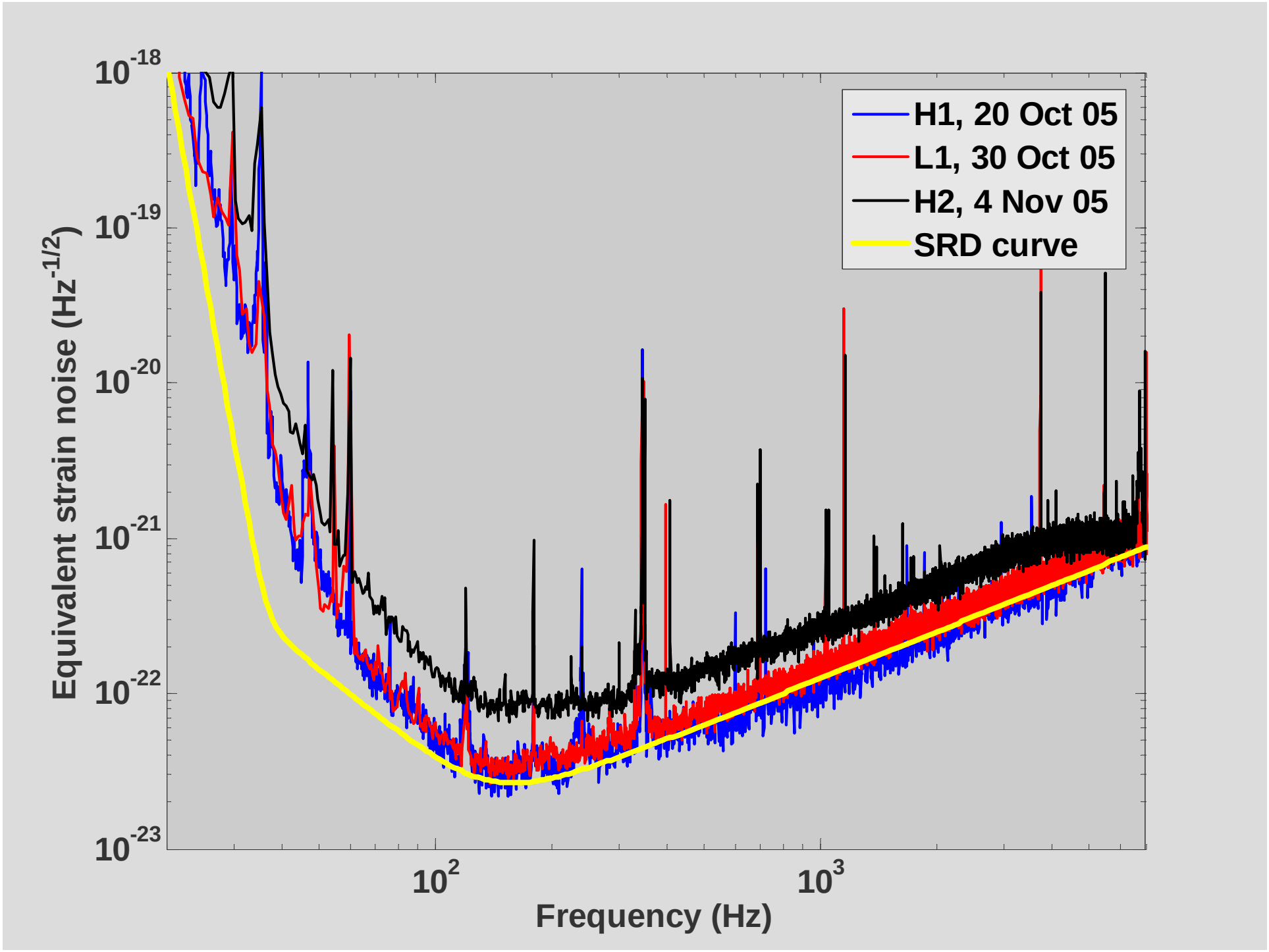

1999
2000
2001
2002
2003
2004
2005
2006
3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4 1 2 3 4
Inauguration
First Lock
Full Lock all IFO
Now
4K strain noise
10-17
10-18
10-20
10-21
10-22
at 150 Hz [Hz-1/2]


Engineering
E2
E3
E5
E7
E8
E9
E10
E11
Science
S1
S2
S3
S4
S5
Runs
First
Science
Data

The 4th Science Run

- Dates (2005):
  - Start: 22 Feb
  - Stop: 23 Mar
- Duty cycle:
  - H1: 80%
  - L1: 74%
  - H2: 81%
  - Triple coincidence: 57%




H1, 20 Oct 05
L1, 30 Oct 05
H2, 4 Nov 05
SRD curve
Equivalent strain noise (Hz^-1/2)
Frequency (Hz)
10^-18
10^-19
10^-20
10^-21
10^-22
10^-23
10^2
10^3

Recent Improvements

- Efforts to reduce H1-H2 correlated noise
  - 2 new acoustic enclosures for the REFLected port tables
  - Anti-Symmetric port table of H2 is ‘floated’ on pneumatic isolators
  - Factor of 5 less acoustic coupling for each LHO ifo
- REFL port beam direction stabilization (L1, H1)
  - High-power induced deflection in the Faraday
  - Corrected with PZT-mirrors on the REFL table
- Low noise oscillators for main modulation
- Timing system upgraded on H2
  - Distribution via fiber; better diagnostics
- Reworked & wider bandwidth laser frequency & power stabilization loops
- Photon calibrators in place as a calibration check
- Operating at high input power

High Power Operations

- A mixed bag:
  - Best Sensitivity!
  - … but only when it is quiet
- 2K limited at 2W-3W input power
  4K: 5W(?)-8W
- High duty cycle during day may require reduced input laser power
- At LLO: Compounded by construction & cutting trees near end station
- Need more AS photodetectors(?)

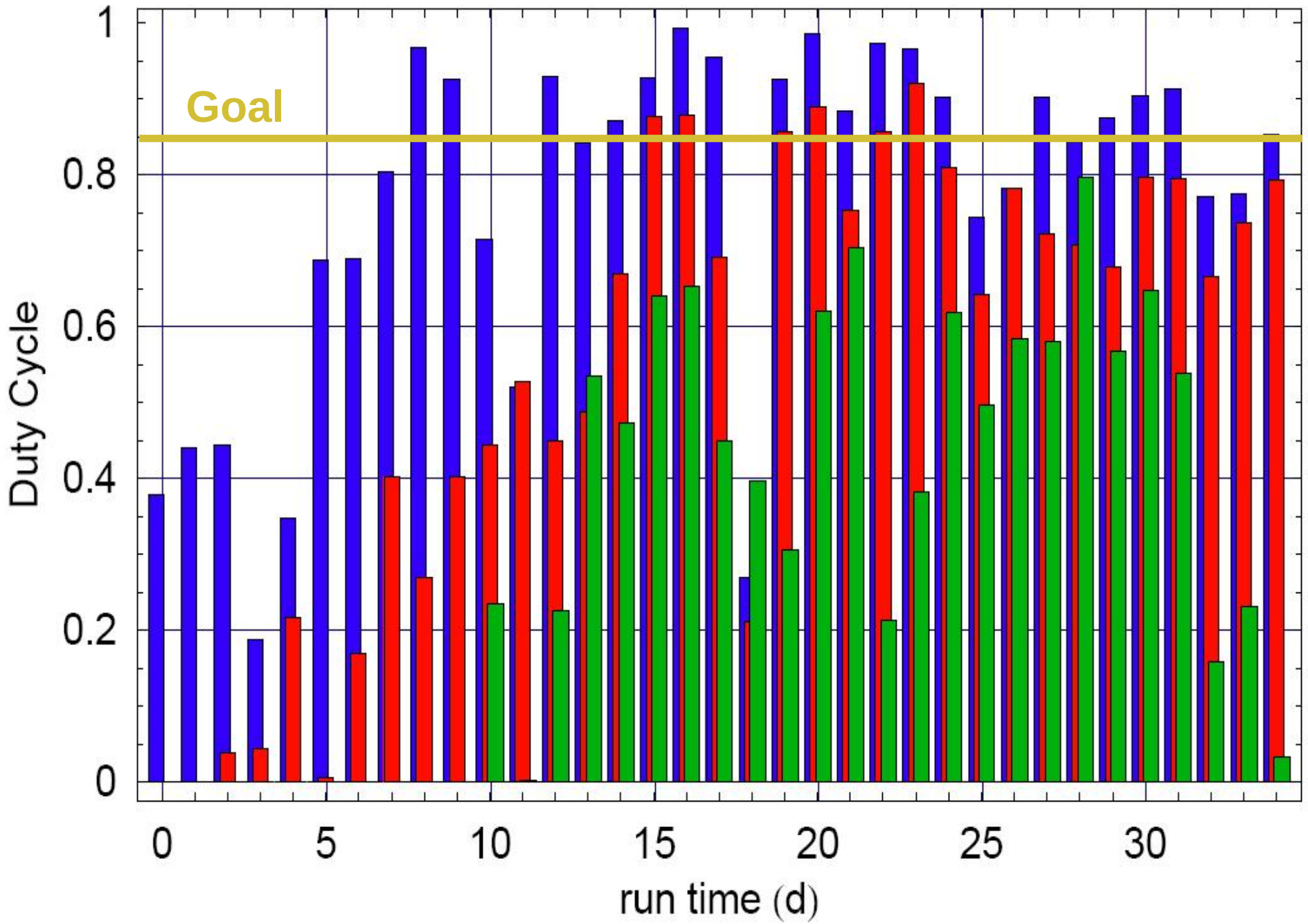
S5 Goals

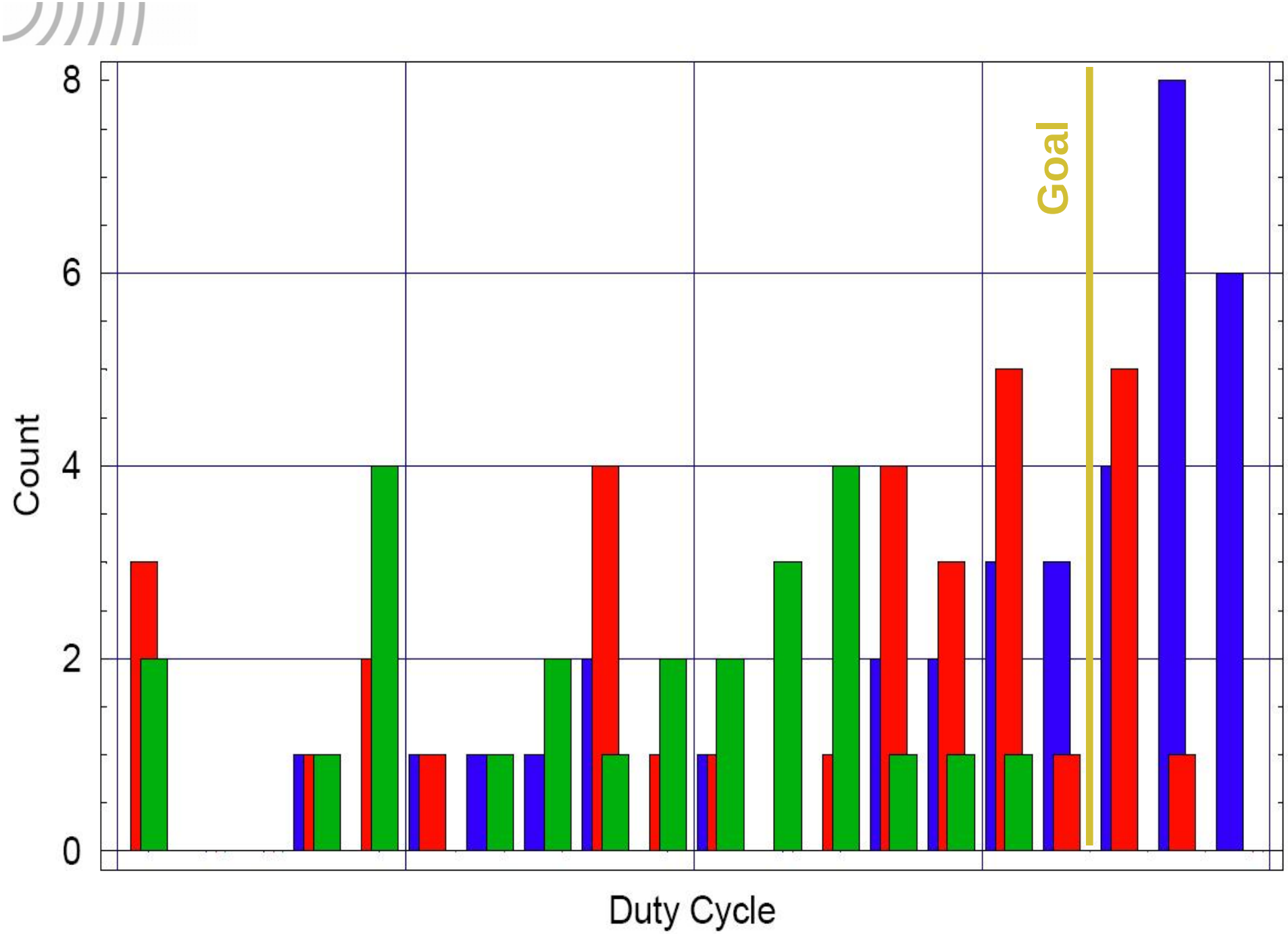
- *"Collect at least a year's data of coincident operation at the science goal sensitivity"*
- Expect S5 to last about 1.5 yrs
- 4K ~ 10Mpc
- 2K ~ 5Mpc

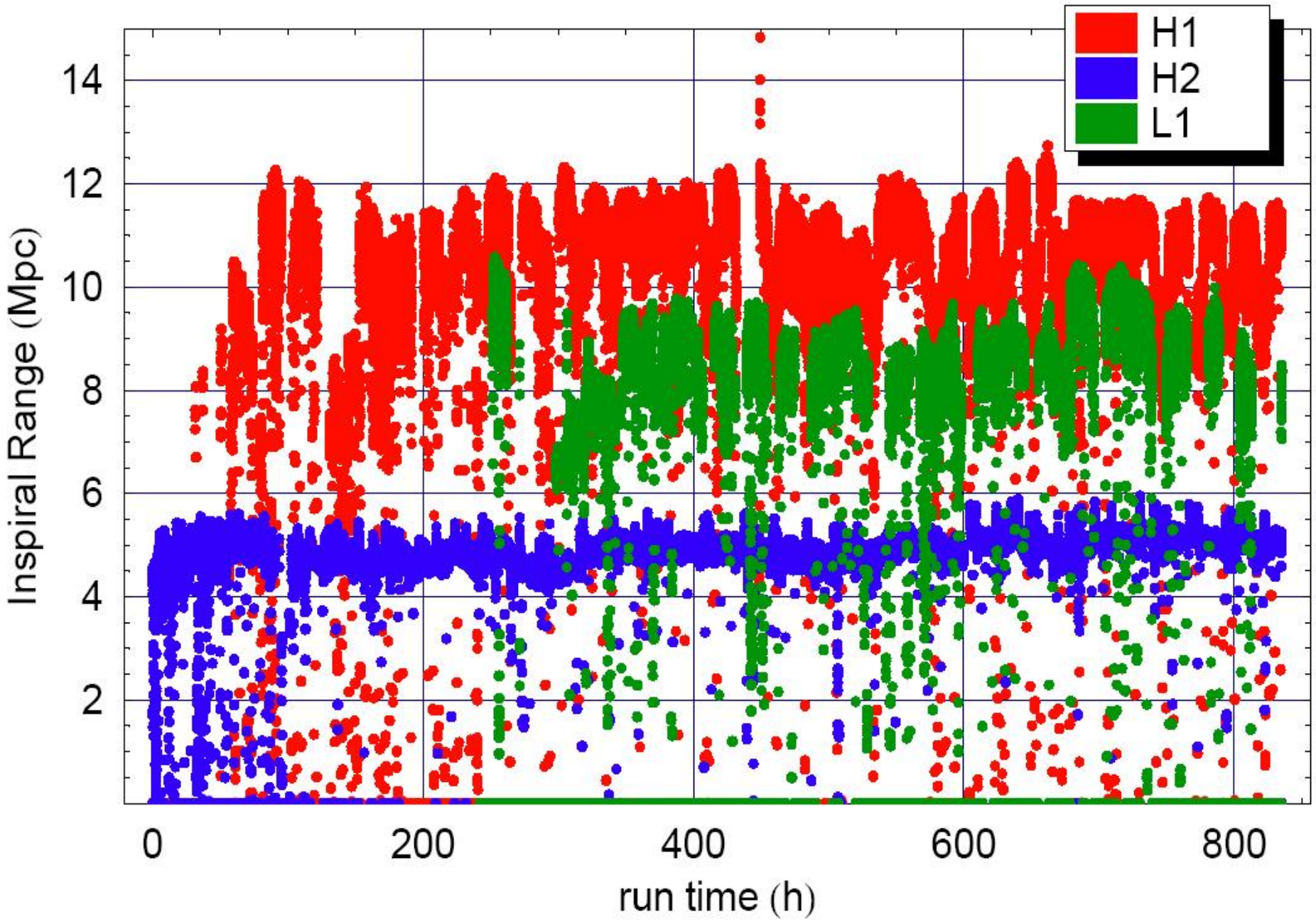
Run	*S2*	*S3*	*S4*	*S5 Target*
L1	37%	22%	75%	85%
H1	74%	69%	81%	85%
H2	58%	63%	81%	85%
3-way	22%	16%	57%	70%

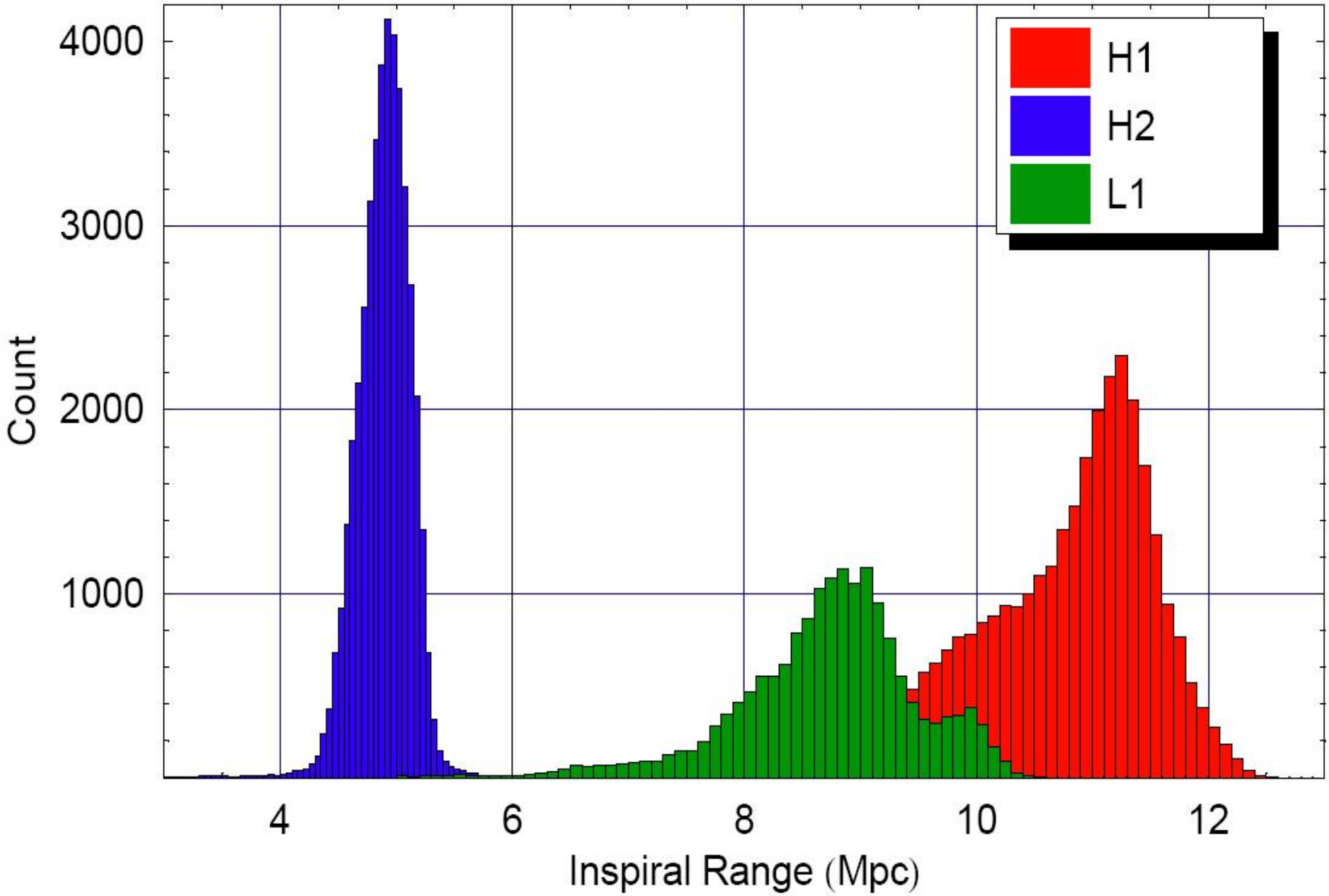
During S5

- S5 will not be completely ‘hands-off’
  - ~4 hour maintenance period every week
  - Not everything was completed at beginning of run
- Expect to take 1-2 week breaks (every few months?) to try improvements
- For example:
  - Sensitivity improvements for H2
  - Additional AS port photodetectors
  - Beam tube baffles
  - Power increase steps: new PMC, new laser
  - Propagate timing system upgrade
  - RF system upgrade


Goal
Duty Cycle
1
0.8
0.6
0.4
0.2
0
0
5
10
15
20
25
30
run time (d)


8
6
4
2
0
Count
Goal
Duty Cycle


H1
H2
L1
Inspiral Range (Mpc)
2
4
6
8
10
12
14
0
200
400
600
800
run time (h)


H1
H2
L1
Count
4000
3000
2000
1000
4
6
8
10
12
Inspiral Range (Mpc)

Conclusion

- S5 is well under the way
- All instruments have demonstrated that they can operate at or near S5 sensitivity and duty cycle goals
- Some problems remain:
  - Operation not consistent yet to meet S5 goals at all times
  - Still need to finish a couple of commissioning tasks