Mark 5 Status

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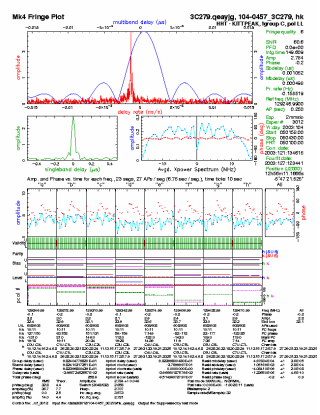
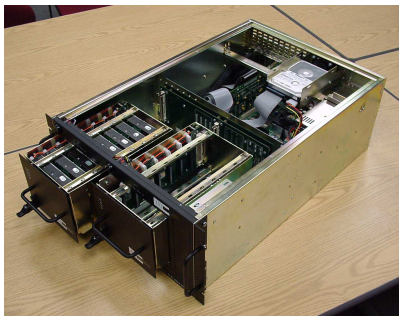
Current Mark 5 Status

- ~35 Mark 5 systems deployed
- ~200 Mark 5A '8-pack' disk modules now in use
- Daily Intensive UT1 observations Wettzell-Hawaii have been exclusively Mark 5 for ~10 months with almost no problems
- Westford recorded 15-day CONT02 experiment entirely on Mark 5
- Several astronomy experiments have now successfully used Mark 5A at rates to 1 Gbps, including a successful mm-wavelength experiment
- A number of e-VLBI experiments have been conducted with Mark 5A
- Current Mark 5A price ~$16K from Conduant Corp
- Mark 5B (VSI-compatible) system under development
  - VLBA DAS with VSI interface → 1 Gbps
  - Mark 4 DAS with VSI interface → 2 Gbps

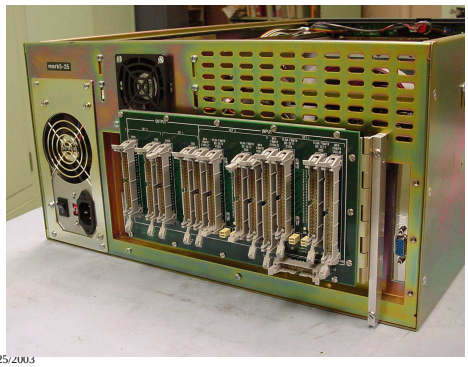


Mark 5A 1-Gbps fringes
HHT-to-Kitt Peak at 2mm λ
April 2003

Mark 5 '8-pack' chassis



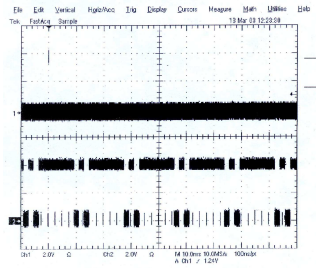
Mark 5A I/O Panel



Mark 5A Data System

- Direct plug-compatible replacement for 64-track Mark4 or VLBA tape drives
- Will record 8, 16, 32 or 64 tracks from Mark4 formatter (1024 Mbps max) or VLBA formatter (512 Mbps max)
- Parity bits are stripped before recording; re-inserted on playback
- Arbitrary mixing of modes (#tracks, data rate, bits/sample) is allowed, always using 100% of installed disk capacity
- Playback at any rate up to 1024 Mbps
- Reliability features
  - All channels are always distributed over all recorded disks; no need for barrel-roll
  - Recording: loss or substandard performance of a disk on record is compensated for automatically (in progress)
  - Playback: loss of a disk will lose only fractional data equally over all 'tracks'
  - Individual disk-performance statistics are kept to detect marginal or failing disks

Mark 5 Data-recovery Example



CONT02 experiment, Oct 2002

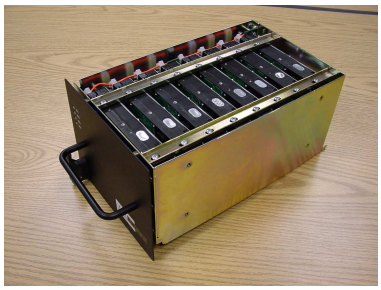
Westford antenna

2 of 10 disks missing

~77% data recovered

Requires careful correlator setup

Mark 5 '8-pack' disk module



- Drastically simplifies disk-handling logistics by keeping all disks together as a single unit
- Each module can be managed just like a reel of Mark4/VLBA tape, using nearly identical management and tracking software
- Shipping covers completely enclose disks and connector

Disk-Media Status

- Hard disk price vs capacity/performance will continue to drop rapidly
  - Now ~$1.00/GB, expected to drop to ~$0.50/GB by ~2005 (Mark 4/VLBA tape is ~$2.00/GB)
- 200 GB disks now available – 27 hours @ 256 Mbps unattended
- (comparable to ~5 VLBA/Mark 4 tapes)
- 320 GB disks expected soon – 22 hours @ 512 Mbps unattended (comparable to ~9 VLBA/Mark 4 tapes)
- 700 GB disks expected ~2005 – 24 hours @ 1 Gbps unattended (comparable to ~19 VLBA/Mark 4 tapes)
- Serial-ATA disks just beginning to be available; Mark 5 will be upgraded

Disk Conditioning

- Disk modules should be 'conditioned' before field usage
- We feel some of the disk problems encountered during the April mm VLBI experiment were due to unconditioned disks (but we didn't know any better at the time)
- Modern commodity disk drives do not have surfaces fully checked
  - First write is done with no checks
  - First read marks bad sectors
  - Next write spares bad sectors, but slow process
  - Special software ("SSErase –c1") to condition with just two passes (read/write) at full data rate to maximize efficiency. See `http://fourier.haystack.edu/Mark5/UpdateMark5.html`

Western Digital vs. IBM

- WD disks have generally been recommended due to large capacity, low price and general high reliability
- However, more WD failures of shipped disks have been observed than expected
- We have recently learned a significant difference between WD and IBM disks
  - Powered-down 3.5" WD disks leave head in contact with surface (at either innermost or outermost diameter)
  - Powered-down 3.5" IBM disks move heads off surface onto a 'ramp', offering better protection to the heads and the surface.
- Apparently, 2.5" disk drives used in notebook computers use a similar 'ramp' parking scheme for ruggedization
- Though IBM disks are currently not available with the same capacities as WD disks, the price is about the same per GB
- We recommend purchasing IBM disks for the near future.
- Careful statistics must be kept to determine which is better
- Head-parking schemes used by other manufacturers is not known

Mark 5 Software Status

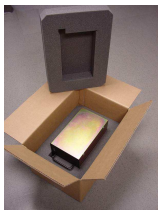
- 'Bank mode' now supported
- Bank switching can be done either with key switches or under software control
- Automatic bank switching is in development
- 'Write-protect' has been implemented
- 'Permanent' VSN's can be written to the module
- Automatic playback recovery from bad disk in module
- Still some problems to be solved, but being addressed
- All software available on-line at `http://web.haystack.mit.edu/mark5/Mark5.htm`
- Full Field System support is in development

Documentation

- On-line documentation at www.haystack.edu
- Overview
- Mark 5A Users Manual
- Mark 5A Test Procedures
- Assembly and Test of Modules
- Disk-module management and handling
- Mark 5A command set
- Software Updates
- Software FAQ
- Downloads
- Newsletter

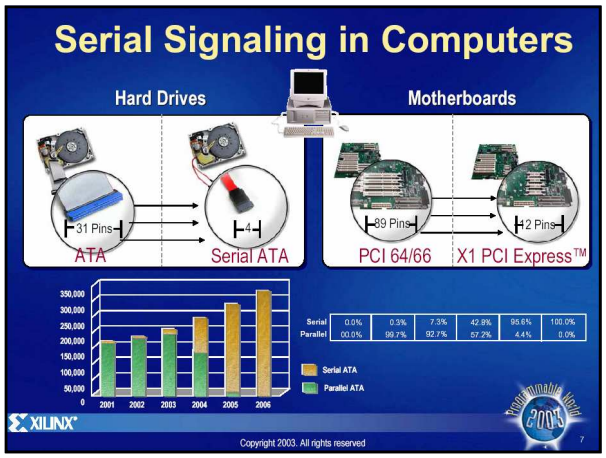
Other Problems and Issues

- Cabling: We suspect that failures to properly record at 1 Gbps at Pico Veleta and HHT in April 03 are due to cabling problems.
- Disk modules should not be handled on hard surfaces
  - Very easy to subject disk to quite high shocks
- For shipping: Shipping covers should be installed to protect disks from debris and, perhaps, prying eyes
- Use special shipping boxes:
  - Boxes may not yet be adequate
  - Plan to instrument some shipments with accelerometers



Plans for Serial-ATA Support

- Parallel and Serial disk modules will be interchangeable in Mark 5 chassis
- How this will be done:
  - New Serial disk module with connector on Right side of module (connector on Parallel module is on Left)
  - Ejector lever moved to Right (on Left on Parallel module)
  - New chassis backplane
  - New sheet metal piece to accept module with ejector lever on R or L
  - No other changes
- Expected upgrade price ~$1000
- Module price ~$260 (same as Parallel module)
- ~$35K development cost; hope to complete by end 2003



Mark 5B Data System

- Full VSI (VLBI Standard Interface) capability
- Up to 1024 Mbps
- Requires new Mark 5B IO card
- Eliminates need for Mark 4 or VLBA formatter
- Same chassis as Mark 5A
- Will need an adapter for Mark 4 and VLBA Samplers to provide VSI-compatible output
- Expect Mark 5B to be ready early 2004

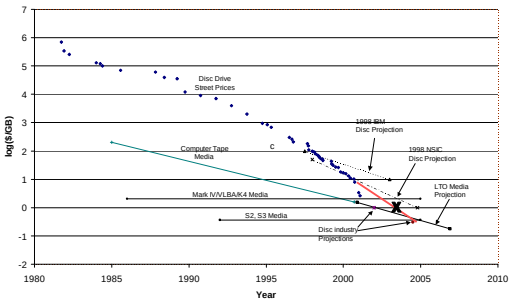
Mark 5B Compatibility Matrix

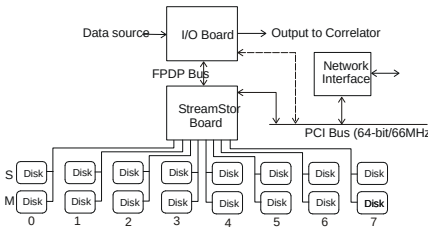
			Playback					
			System	Mark 5A		Mark 5B		
Record	System ↓	Data input ↓	Play format →	Mark 4	VLBA	VSI	Mark 4	VLBA
	Mark 5A	Mark 4	→	ü			ü	
	Mark 5A	VLBA			ü			ü
	Mark 5B	VSI				ü		ü

Most important:

- Mark 5B units at correlator will be able to playback Mark 5A data as well as VSI-format (Mark 5B) data

Tape vs. Disc Price Comparison





Mark 5 Block Diagram

So how does the Mark 5 scorecard look?

- Minimum of 1 Gbps data rate – yes
- Low cost - ~$12K components; $17.5K system
- Based primarily on modified COTS components – yes, for most part
- Modular, easily upgradeable – yes, certainly upgradeable to 2 Gbps
- Robust operation, low maintenance cost – we think so
- Easy transportability – single 5U chassis, ~27 kg
- Conformance to VSI specification – Mark 5B, 2003
- Compatibility with existing VLBI systems during transition – yes (Mark4/VLBA)
- Support e-VLBI – yes
- 24-hour unattended operation at 1 Gbps – ~7 hrs now with 200 GB disks, expect 24-hour in ~2004-5