Opto-Board

WBS 1.1.1.4

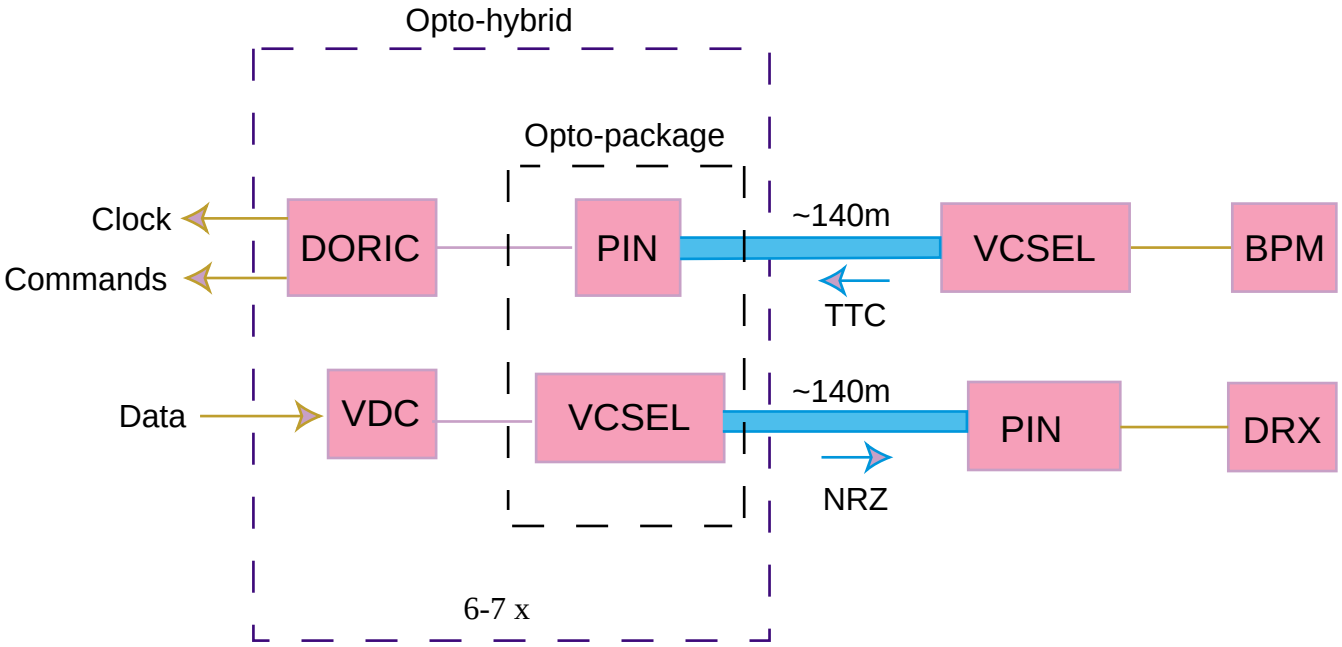
K.K. Gan

The Ohio State University

Outline

- Introduction
- Opto-board design
- Cost and schedule summary
- Conclusions

ATLAS Pixel Opto-link



OSU Responsibilities

- design and testing of VDC and DORIC
  - testing 50% of final production
- design, fabrication, and testing of opto-boards
  - fabrication and testing of disk sector in final production

OSU ATLAS Personnel

- Faculty
  K.K. Gan, Harris Kagan, Richard Kass
- Post-docs
  Mike Zoeller + offer pending
- Graduate Students
  Kregg Arms, Rouben Ter-Antonian
- Engineers
  Mark Johnson, Chuck Rush
- Technicians
  Jim Burns, Shane Smith, Bob Wells

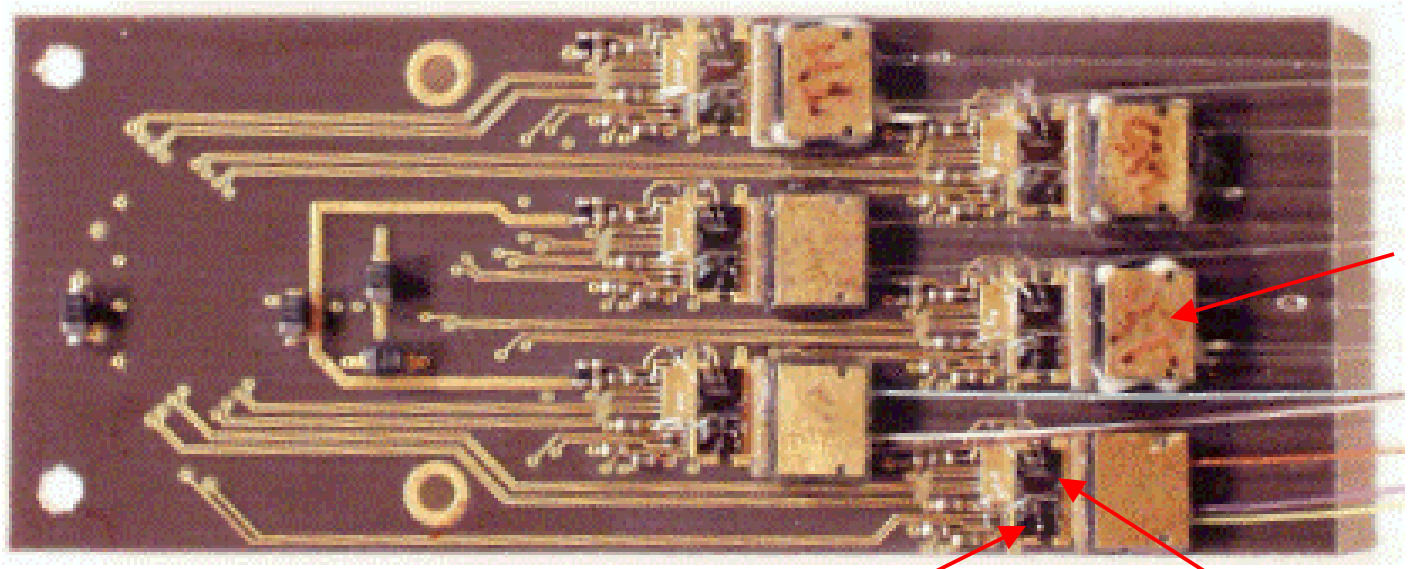
Opto-Board

- converts: optical signal↔electrical signal
- contains 6-7 optical links:
  - ☆ layers 1 and 2 optical link:
    - ◆ DORIC, VDC, PIN/VCSEL (opto-pack)
  - ☆ B layer optical link:
    - ◆ DORIC, 2 VDC, PIN/2 VCSEL (opto-pack)
- use BeO for heat management but prototype initially in FR4 for fast turnaround and cost saving

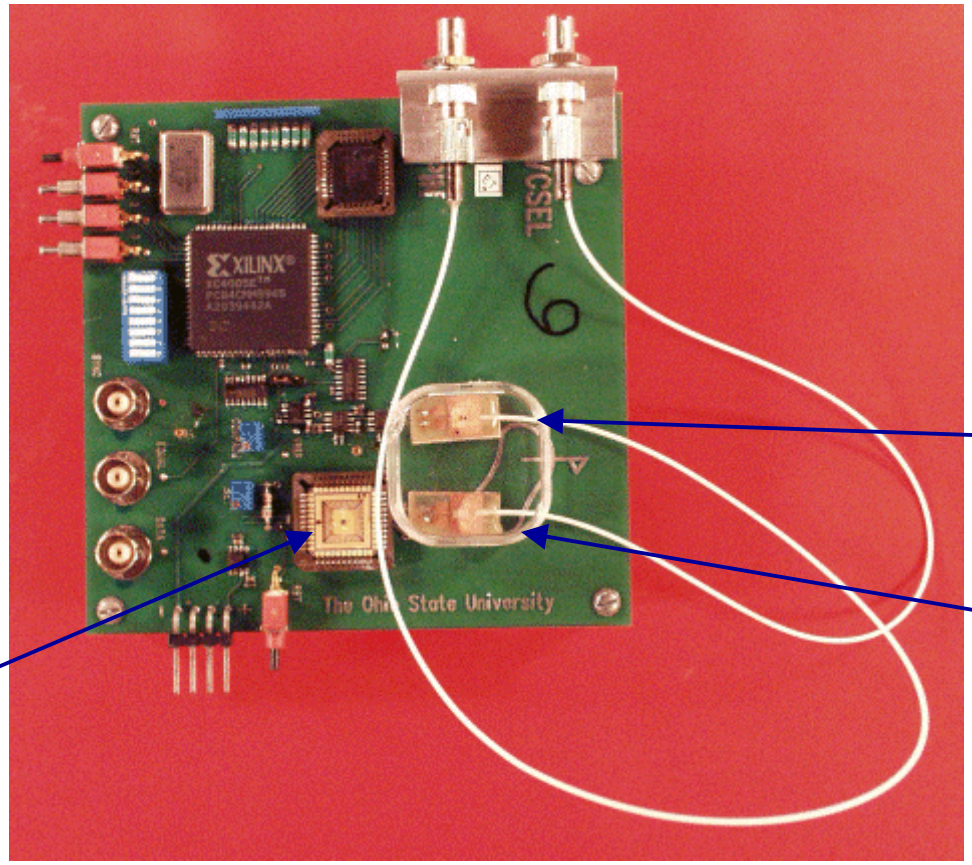
Opto-Board Prototype I

- design for DORIC-D2/VDC-D2
- contain 6 opto-links for use in disk sector
- use SCT style opto-packs
- use 50-pin connector
- fabricated using FR4 in January 2001

Opto-Board Prototype I

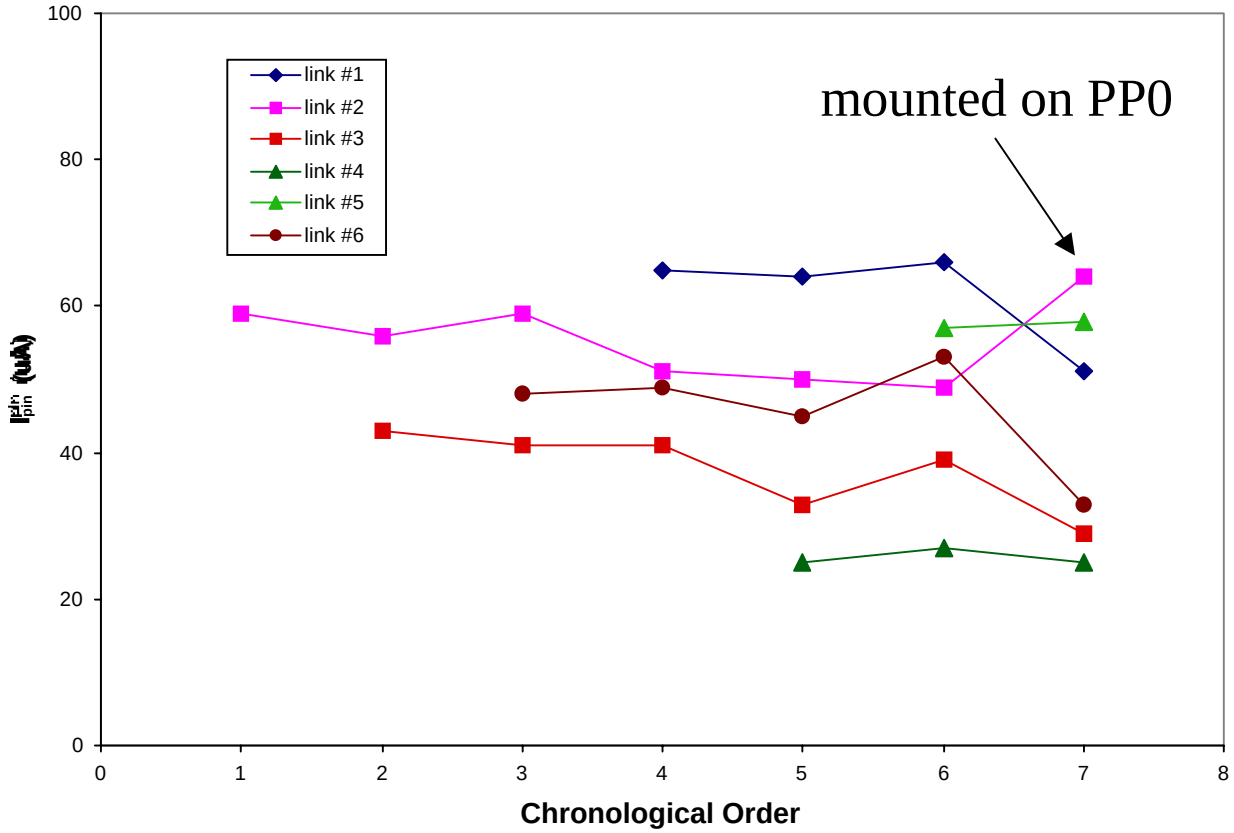


Bit Error Rate Tester



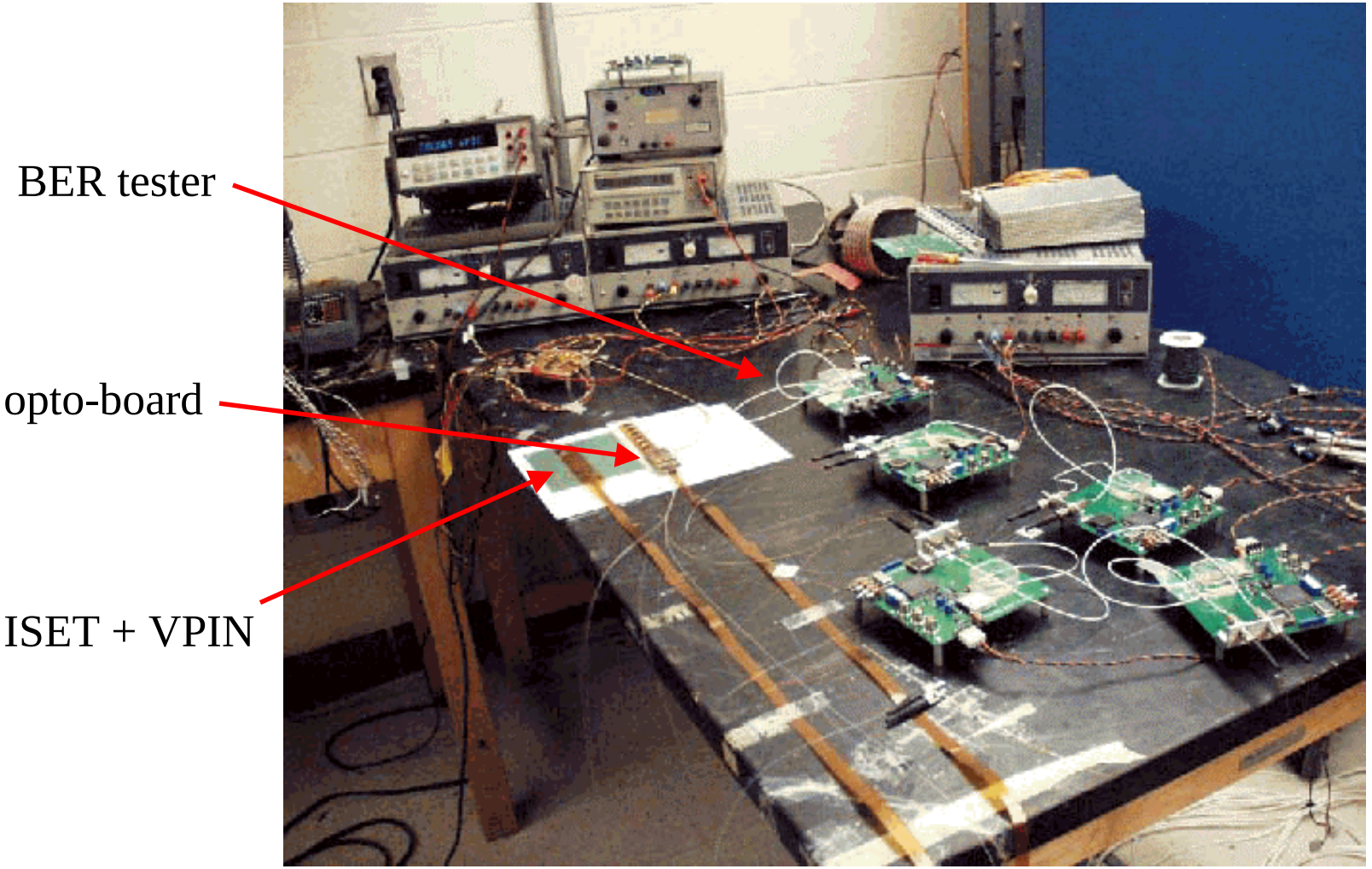
- send bi-phase marked pseudo random data to VCSEL via VDC
- check returned data for bit errors

PIN Current Threshold of DORIC-I1

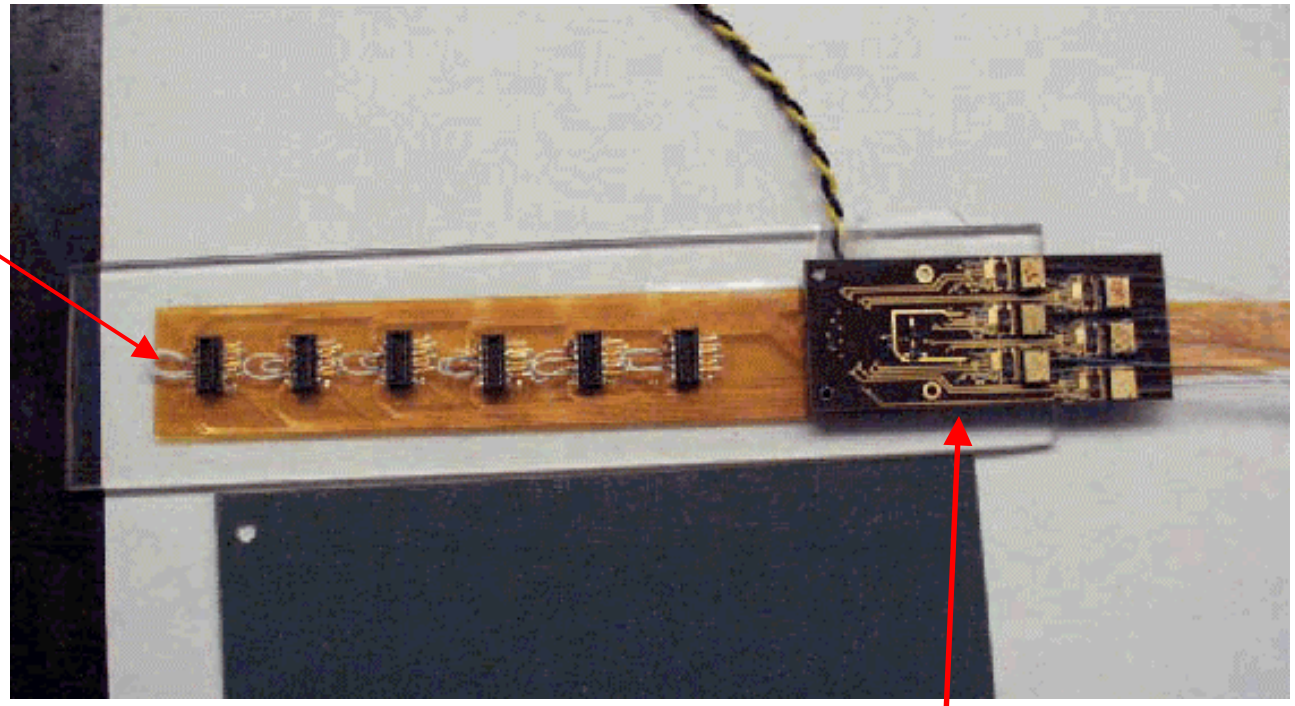


- no degradation of PIN current threshold for no bit errors as more links are added on opto-board and PP0

Setup with PP0



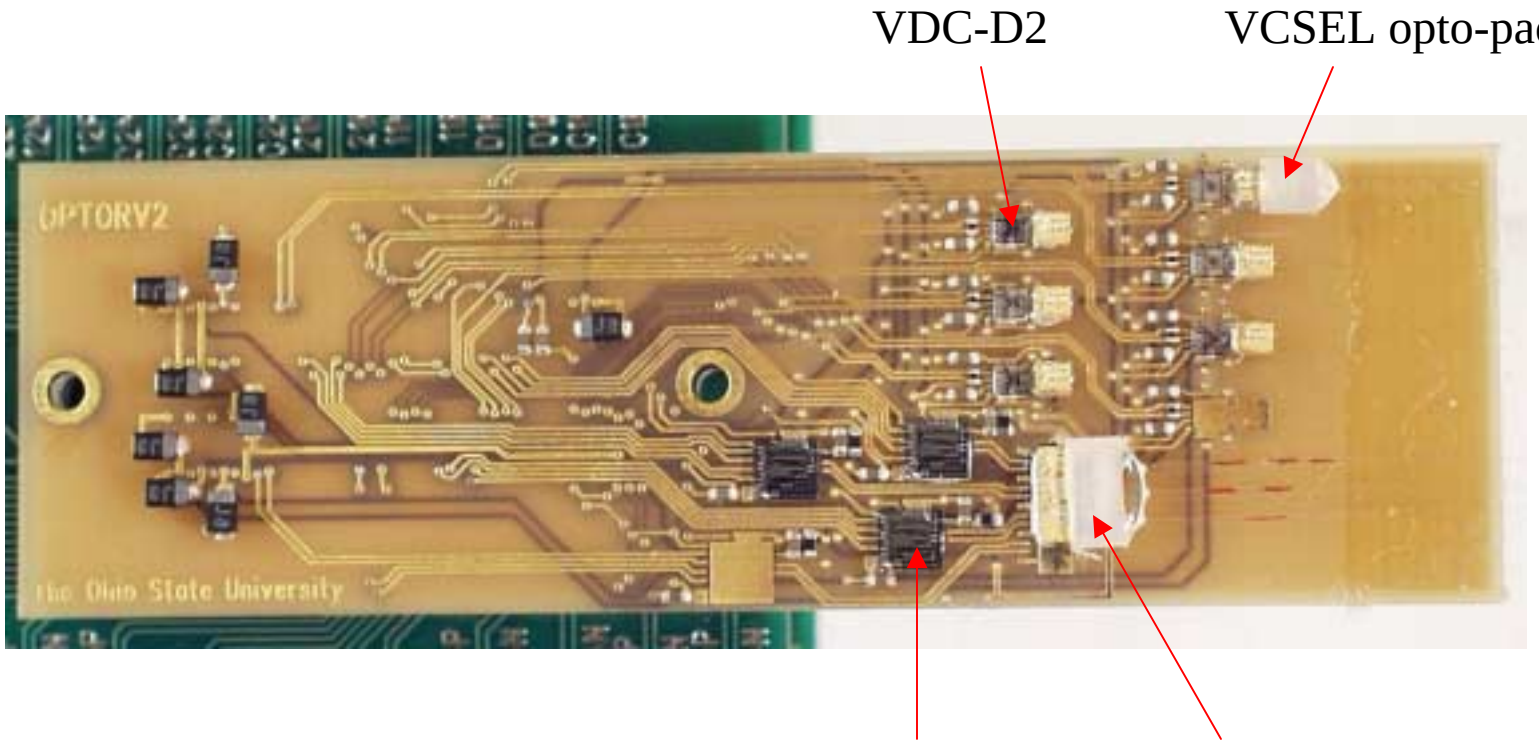
Setup with PP0



Opto-Board Prototype II

- design for DORIC-D2/VDC-D2 and DORIC- I1/VDC-I1
- contain 7 opto-links for use in barrel and disk
- use opto-packs with multiple PINs
- use 80-pin connector
- fabricated using FR4 in April 2001

Opto-Board Prototype II

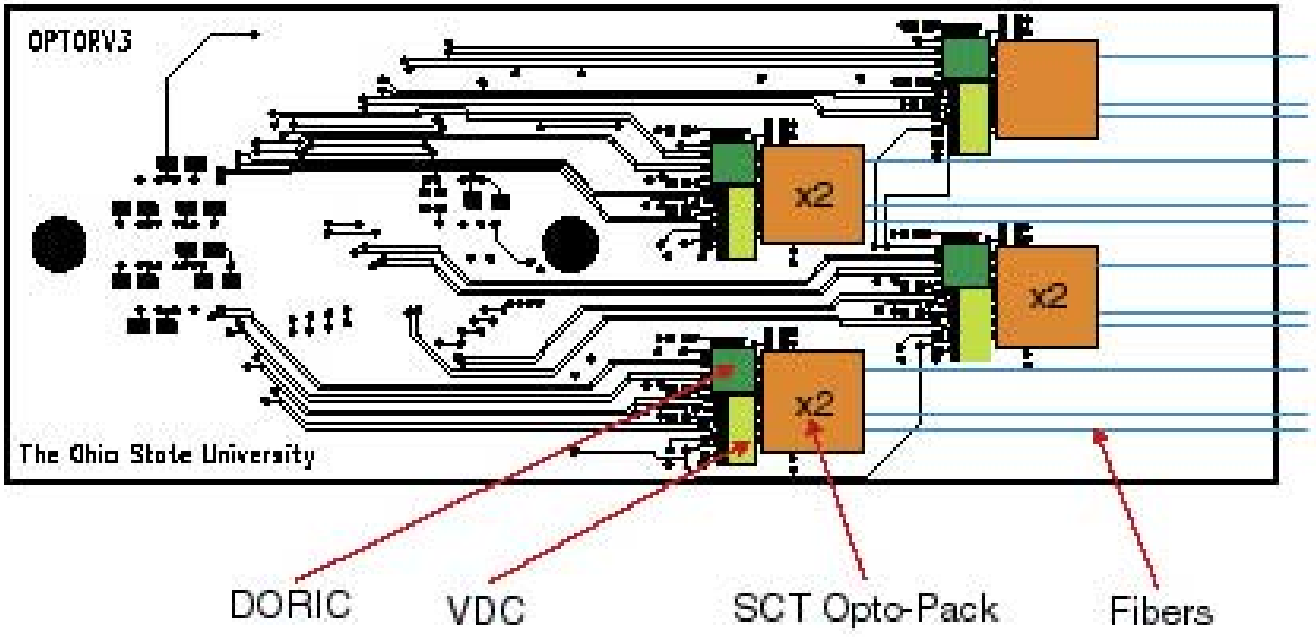


- large distance between DORIC and PIN
- PIN current thresholds for no bit errors comparable with prototype I

Opto-Board Prototype III

- design for DORIC-D3/VDC-D3
  and DORIC- I2/4-channel VDC-I2
- contain 7 opto-links for use in barrel and disk
- use SCT style opto-packs
- use 80-pin connector
- fabricated using FR4
- expect delivery by November 15

Opto-Board Prototype III



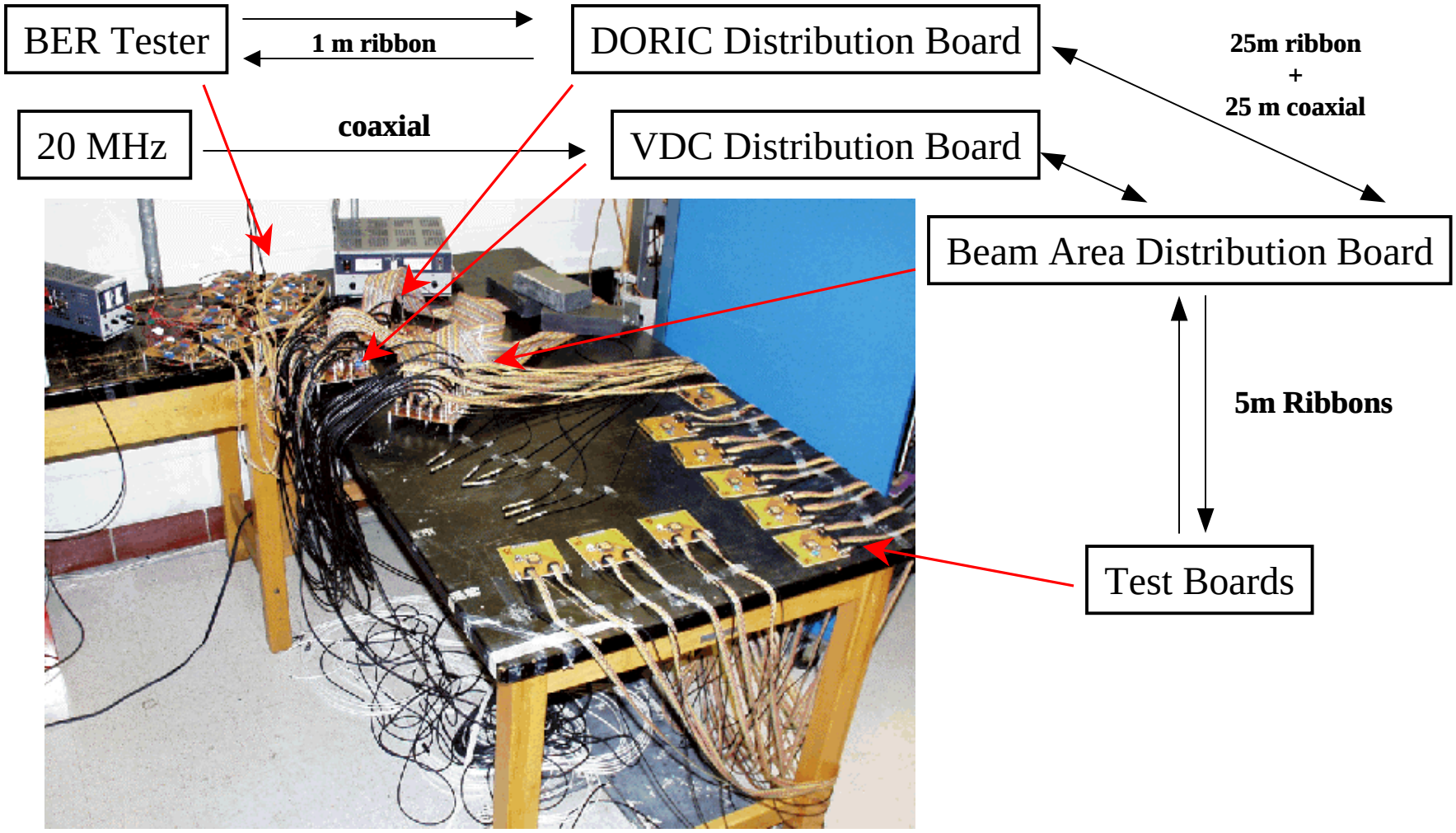
Opto-Board Prototype IV

- design for 4-channel DORIC- I4 and VDC-I4
- contain 7 opto-links for use in barrel and disk
- use 8-channel opto-packs
- use 80-pin connector
- fabricated using FR4
- expect submission in summer 2002
- last submission before using BeO

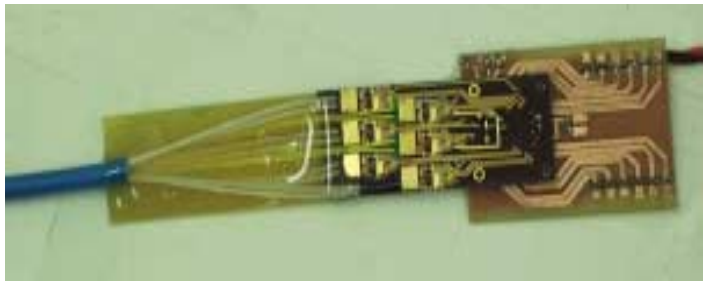
Opto-Link Proton Irradiation

- April 2000:
  - designed and fabricated test boards for VDC-D1 irradiation
- April 2001:
  - designed and fabricated test systems:
    - packaged DORIC-D2 and VDC-D2 irradiation in cold box
    - optical link irradiation on shuttle
    - some dice started failing after several Mrad
- September 2001:
  - designed and fabricated much improved test systems:
    - packaged DORIC-I1 and VDC-I1 irradiation in cold box
    - optical link irradiation on shuttle

Test Boards for Irradiation in Cold Box



Test Boards for Irradiation in Shuttle



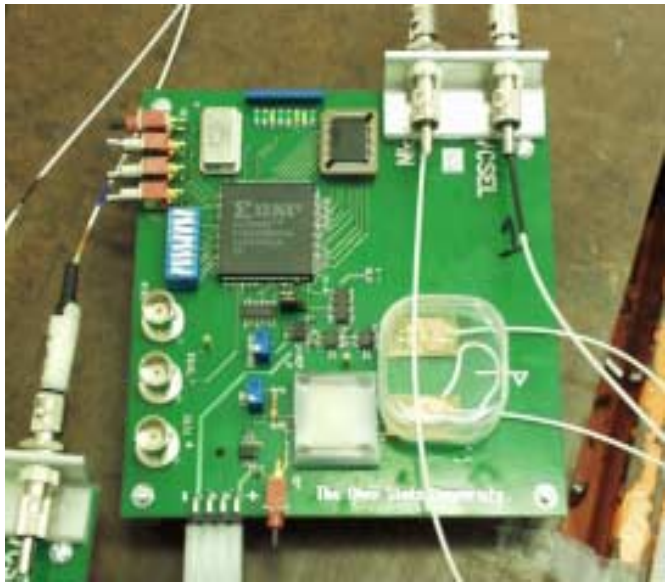
Opto-board with 6 opto-links

Bi-phase marked optical signal

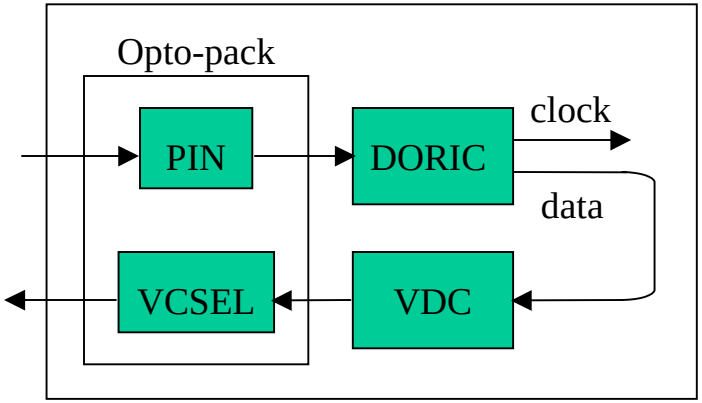
25 m fibers/wires

Decoded data

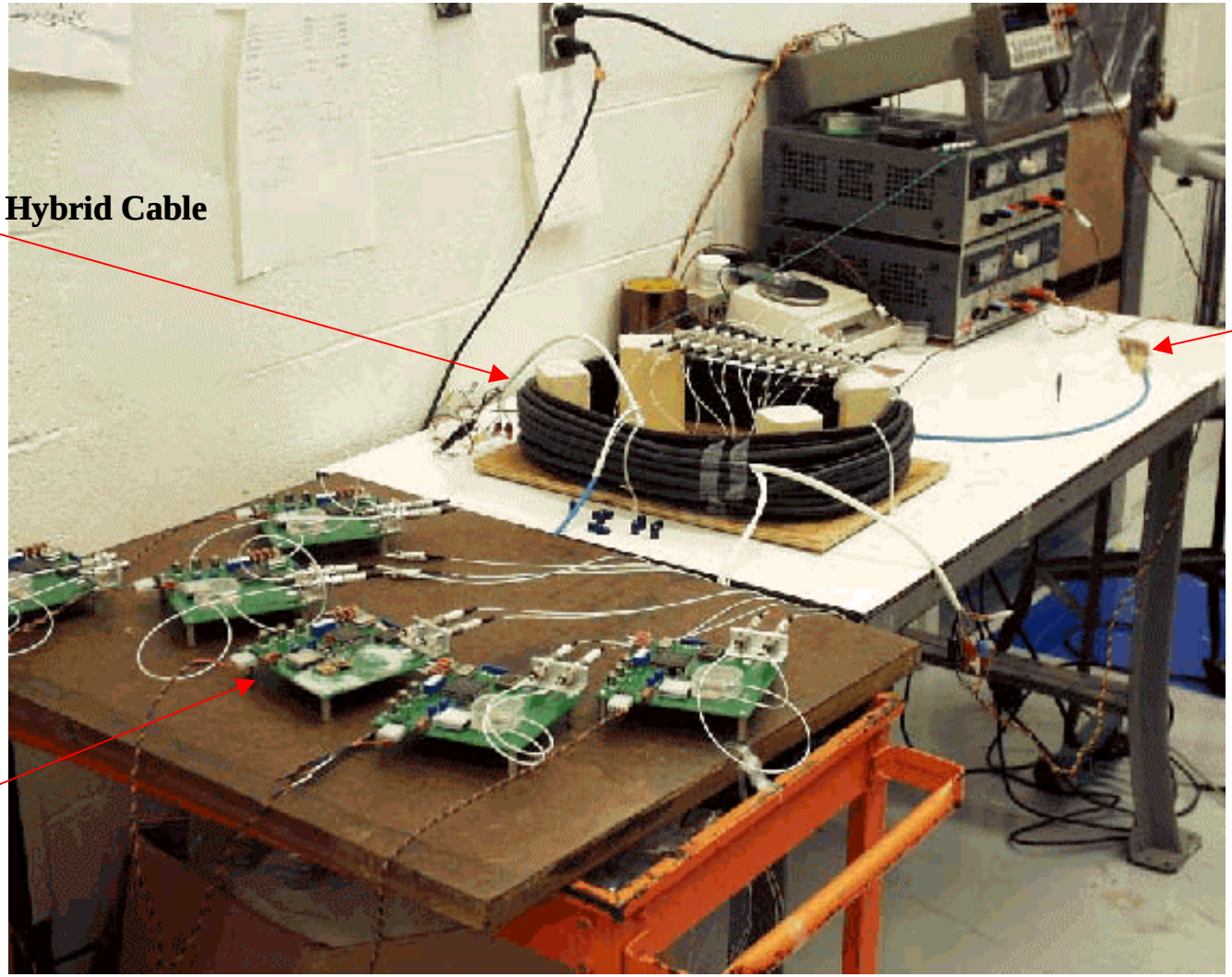
Bit error rate tester in control room
(6 boards)



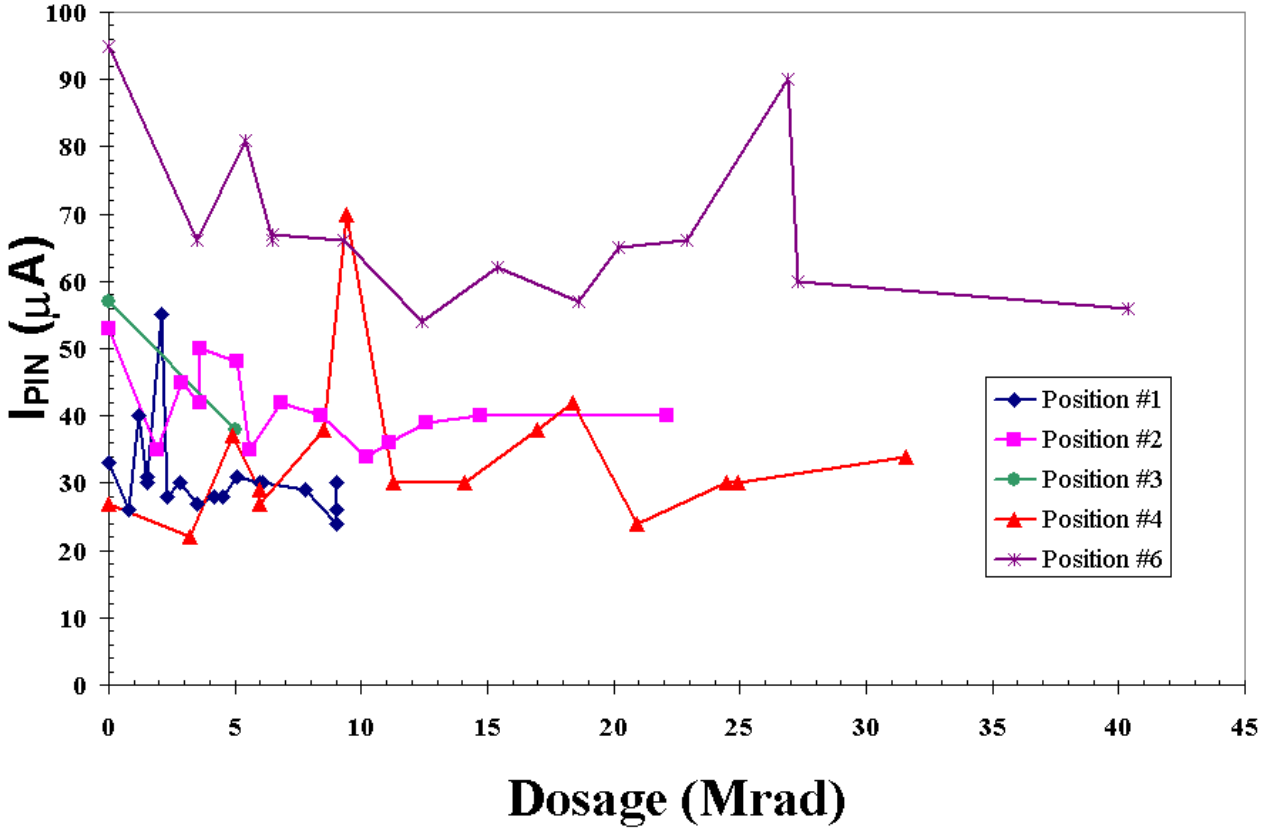
Opto-link



Opto-Board Test System for Shuttle

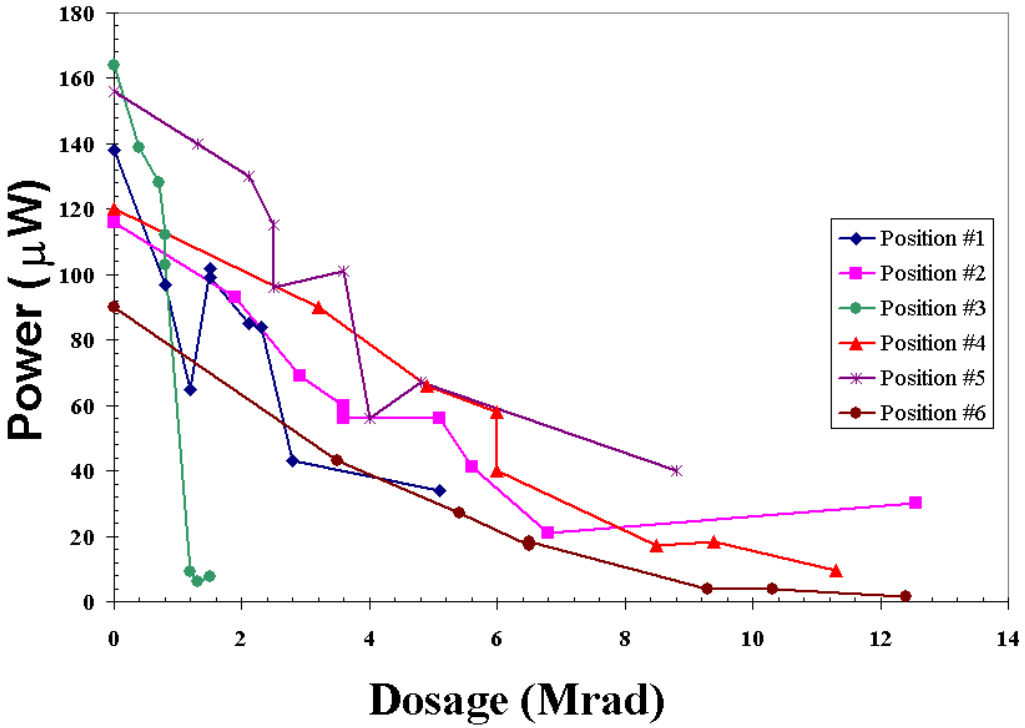


Opto-Board Bit Error Threshold vs Dosage



- PIN current threshold for no bit errors remains constant up to 40 Mrad
- no further degradation a month after irradiation

Optical Power vs. Dosage



- optical power decreases drastically with dosage:
  - ☆ annealing at ~ 3 Mrad failed to yield more light
    - ⇨ need longer annealing further away from beam
    - ⇨ will add one more meter of rad-hard fibers
- robust system allows continuous monitoring of BER with low light

Summary of VDC-I1/DORIC-I1 Irradiation

- VDC-I1/DORIC-I1 continue to perform well after 40-50 Mrad
- ☆ new robust test system allows continuous monitoring of BER with diminishing light return

Changes from ETC01

- ETC01 based on 2 DMILL test runs piggybacked on FE runs
- DMILL dice appears inadequate in radiation hardness
  - ⇨ adapt IBM as new baseline
  - ⇨ up to 4 IBM test runs expected
    - ☆ including development of single-ended pre-amp
  - ⇨ change from one to four FR4 opto-board prototypes:
    - ☆ IBM ⇨ DMILL dice
    - ☆ connector: 50 ⇨ 80 pins
    - ☆ single ⇨ multiple channel dice
    - ☆ SCT ⇨ pixel opto-packs

Changes from ETC01 (continued)

- much more sophisticated proton irradiation test systems
  - ETC01 based on cost for irradiating VDC-D1
- request by Pixel Collaboration to distribute opto-boards and testers
- WBS 1.1.1.4 FY02
  - ETC01: $51 K
  - ETC02: $75 K

Opto-Board Milestones

ID	WBS	Task Name	Baseline Date	ETC02 Date
206	1.1.1.4.1	Optical package decision	15-Jun-01	done
208		Optical FDR	31-Jan-02	1-Jun-02
211		Optical PRR	5-Mar-03	
212		Release initial MC for optical components	19-Mar-03	
239	1.1.1.4.3	First optical boards	20-Aug-03	
240		Optical production complete	24-Dec-03	

Manpower FTE (DOE Base Funding)

MANPOWER ESTIMATE SUMMARY IN FTEs

WBSNo: 1.1.1.4 | Funding Type: Base | 11/2/01 10:33:48 AM

Description: Flex Hybrids/Optical Hybrids | Institutions: Ohio State U. | Funding Source : All

PROFESSIONAL	*FY 96*	*FY 97*	*FY 98*	*FY 99*	*FY 00*	*FY 01*	*FY 02*	*FY 03*	*FY 04*	*FY 05*	*Calculated Total*	*Entered*
	FY 96											*Entered*
Software Prof.											.0	.0
Engineer - EE											.0	.0
Engineer - ME											.0	.0
TECHNICAL												
Design & Draft							.2	.2			.4	.0
Electrical Technician											.0	.0
Mechanical Technician											.0	.0
Admin. Supervisor											.0	.0
Other Admin.											.0	.0
TRADES												
Contract Labor											.0	.0
Shops											.0	.0
Technical Services											.0	.0
Student											.0	.0
TOTAL LABOR	.0	.0	.0	.0	.0	.0	.2	.2	.0	.0	.4	.0

Trades Legend:
Contract Labor = Job Shopper
Shops = Fabrication (in-house facility) from raw materials
Technical Services = Rigging, electricans, etc.

Manpower FTE (Project Funding)

MANPOWER ESTIMATE SUMMARY IN FTEs

WBSNo: 1.1.1.4 | Funding Type: Project | 11/2/01 10:31:09 AM

Description: Flex Hybrids/Optical Hybrids | Institutions: Ohio State U. | Funding Source : All

PROFESSIONAL	FY 96 FY 96	FY 97	FY 98	FY 99	FY 00	FY 01	FY 02	FY 03	FY 04	FY 05	Calcu-lated Total	Entered Entered
Software Prof.											.0	.0
Engineer - EE											.0	.0
Engineer - ME											.0	.0
TECHNICAL												
Design & Draft											.0	.0
Electrical Technician								.5	.1		.6	.0
Mechanical Technician											.0	.0
Admin. Supervisor											.0	.0
Other Admin.											.0	.0
TRADES												
Contract Labor											.0	.0
Shops											.0	.0
Technical Services											.0	.0
Student						.0	.3	.1	.0		.4	.0
TOTAL LABOR	.0	.0	.0	.0	.0	.0	.3	.6	.1	.0	1.0	.0

Trades Legend:
Contract Labor = Job Shopper
Shops = Fabrication (in-house facility) from raw materials
Technical Services = Rigging, electricans, etc.

U.S. ATLAS E.T.C.
WBS Profile Estimates

Funding Source: All **Funding Type:** Project 11/2/01 9:18:06 AM

Institutions: OSU

WBS Number	Description	FY 96 (k$)	FY 97 (k$)	FY 98 (k$)	FY 99 (k$)	FY 00 (k$)	FY 01 (k$)	FY 02 (k$)	FY 03 (k$)	FY 04 (k$)	FY 05 (k$)	Total (k$)
1.1.1.4	Flex Hybrids/Optical Hybrids	0	0	0	0	0	0	75	61	5	0	141
1.1.1.4.1	Design/Engineering	0	0	0	0	0	0	0	0	0	0	0
1.1.1.4.1.1	Prototype design	0	0	0	0	0	0	0	0	0	0	0
1.1.1.4.1.1.3	Optical Hybrids	0	0	0	0	0	0	0	0	0	0	0
1.1.1.4.1.2	Production design	0	0	0	0	0	0	0	0	0	0	0
1.1.1.4.1.2.3	Optical components	0	0	0	0	0	0	0	0	0	0	0
1.1.1.4.2	Development and Prototypes	0	0	0	0	0	0	65	0	0	0	65
1.1.1.4.2.2	Optical prototypes	0	0	0	0	0	0	65	0	0	0	65
1.1.1.4.3	Production	0	0	0	0	0	0	10	61	5	0	76
1.1.1.4.3.3	Optical hybrids	0	0	0	0	0	0	10	61	5	0	76
1.1.1.4.3.3.1	Optical packages and	0	0	0	0	0	0	0	0	0	0	0
1.1.1.4.3.3.2	Optical hybrids	0	0	0	0	0	0	0	33	0	0	33
1.1.1.4.3.3.3	Testing	0	0	0	0	0	0	10	28	5	0	43

Summary

- has produced two FR4 opto-board prototypes
  - ☆ both opto-boards can operate with low noise
- has submitted third FR4 prototype
- expect one more FR4 prototype submission in summer 2002 before submitting first BeO prototype
- has almost perfected opto-link proton irradiation test systems