Optical Hybrids

WBS 1.1.1.4

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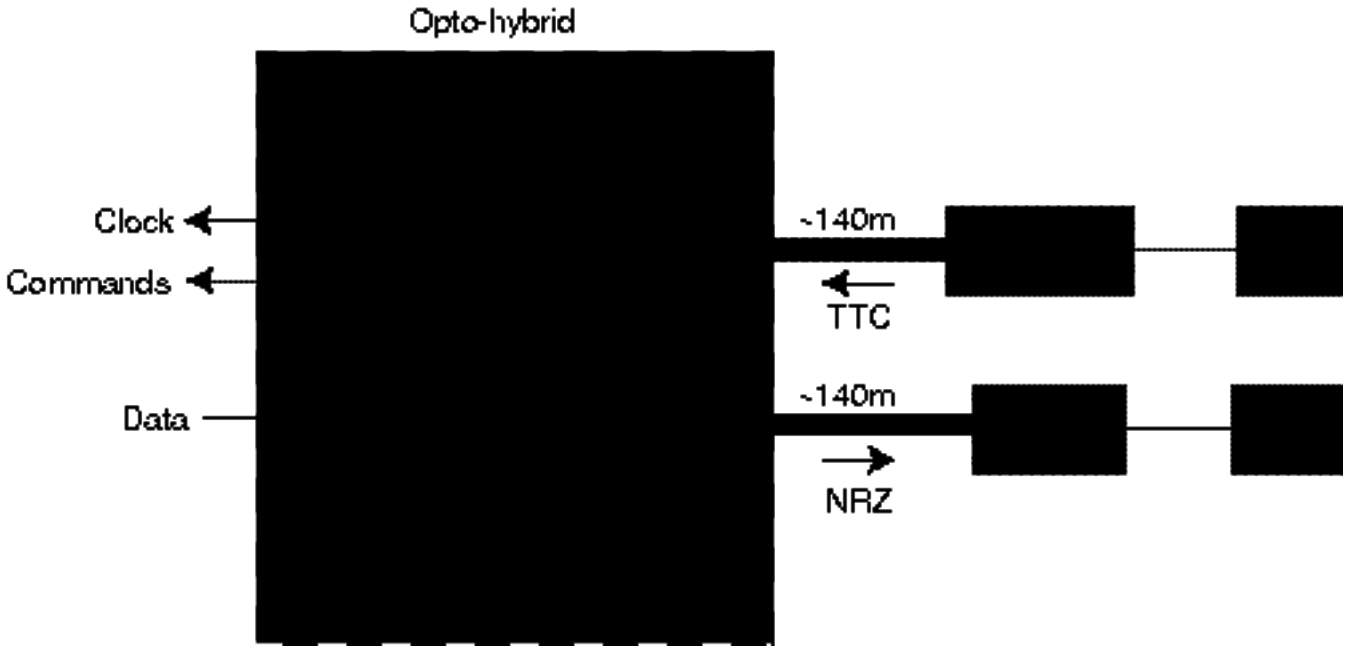
Outline

- Introduction
- Opto-package prototypes
- Opto-hybrid board design
- Cost and schedule summary
- Conclusions

ATLAS Pixel Opto-link



Opto-package

- 2 fibres + VCSEL + PIN
- coupled VCSEL power > 300 μW @ 10 mA
- VCSEL tolerance:
  - 50 μm in z (along fibre)
  - 25 μm in r (transverse to fibre)

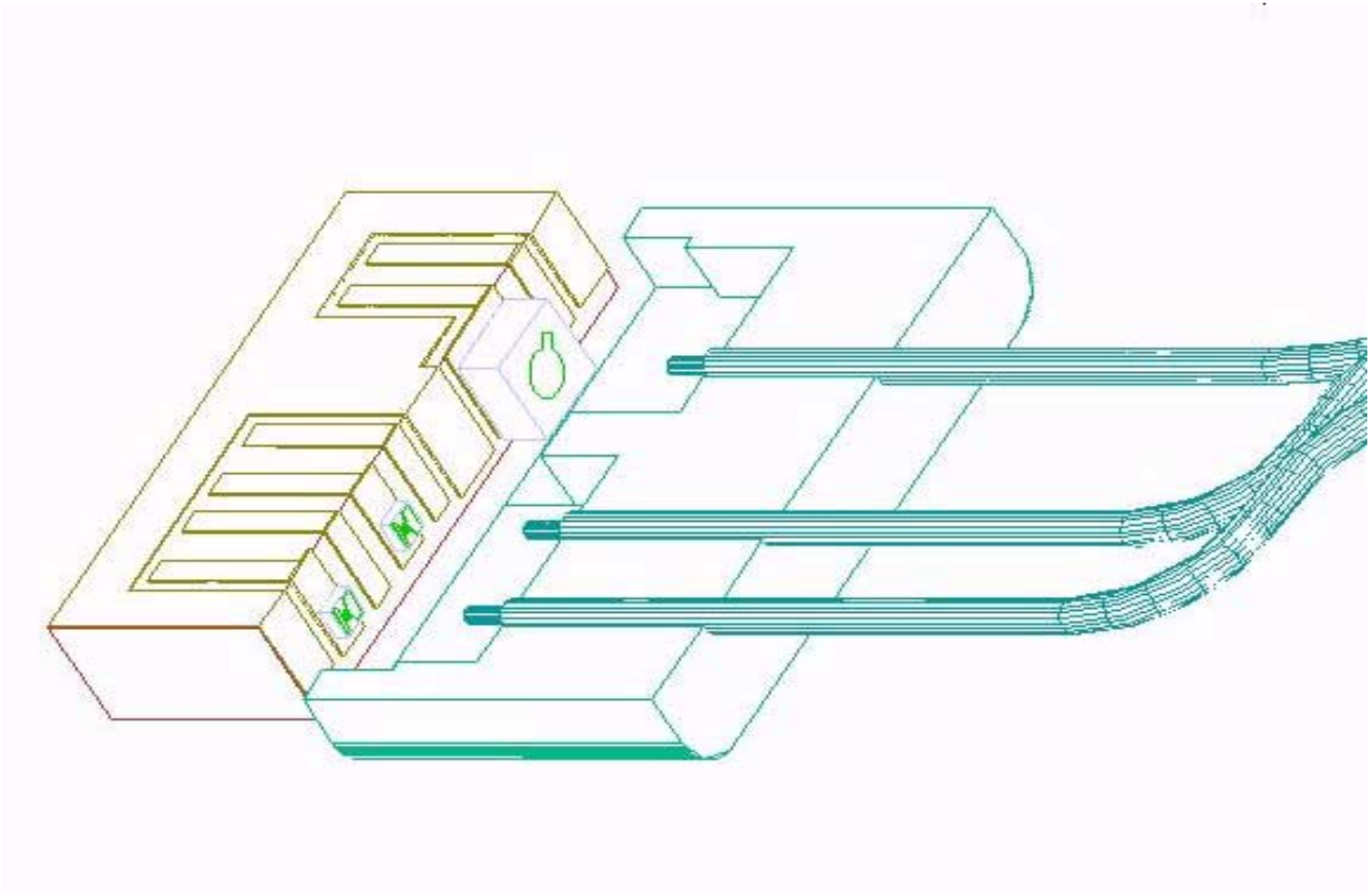
Opto-package Designs

- Marconi
  - 8 silicon/alumina pieces
  - use silicon mirror for 45^0 light reflection
  - high cost
- Taiwan
  - 3 G-10 pieces
  - cleave fibre at 45^0
  - fibers permanently attached: need voliton connector
  - low cost
- OSU
  - 2 pieces
  - cap with fibers can be attached to package at end of module assembly
  - low cost

OSU Design

- connector concept design
  - ☆ use precisely fabricated cap and base for alignment
  - ☆ simple two-piece design for mass production and cost reduction
- cap
  - ☆ 2 holes for fibers
- base
  - ☆ deposit gold traces for wire bonding, VCSEL and PIN placements

Base and Cap



Cap and Base Prototypes

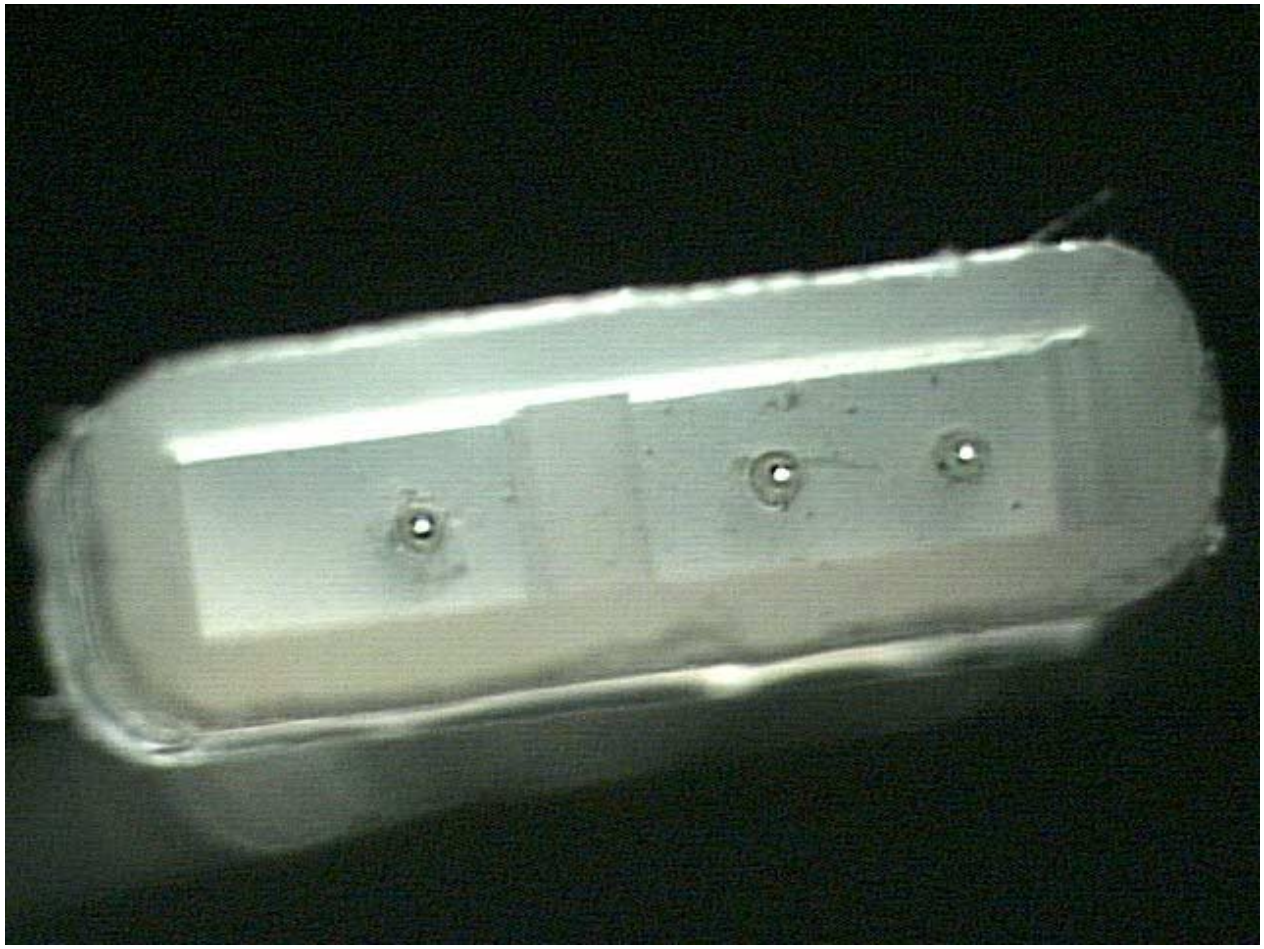
- produced caps and bases (rounded corners) using machinable ceramic
  - ☆ material tested: aluminum silicate and macor
  - ☆ difficult to obtain consistent precision

  - ⇨ redesign base with square corners for ease of fabrication by Hybrid-Tek
    - ☆ alumina sheet ground to proper thickness and cut into strips
    - ☆ have produced bases with precision within specification
    - ☆ 3D traces have good connectivity
  - ⇨ fabricate cap with Ultem (polyetherimide) for radiation tolerance (10 Grad)
    - ☆ use manual micro mold injection to save development time
    - ☆ can fabricate several quality caps per hour

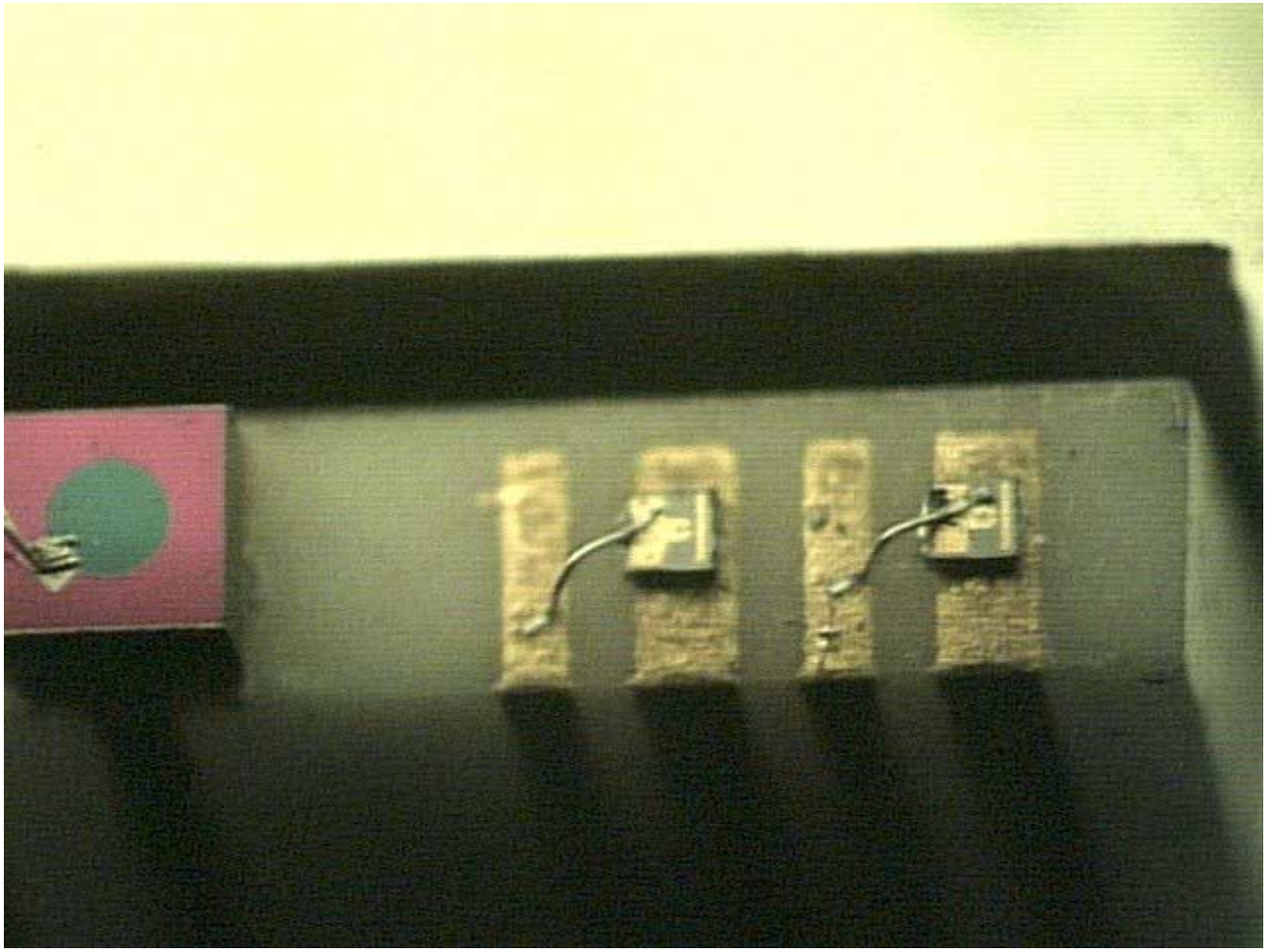
Prototype Result

- produced 10 packages
- VCSELs have fast rise and fall time: < 1 ns
- PINs have good responsitivity: 0.5 A/W
- coupled power > 300 μW in both VCSELs simultaneously
  for 8 packages with different combinations of bases and caps
  ⇨ demonstrated feasibility of fabricating high precision caps and bases
- no cross-talk between VCSEL and PIN above 20 μA

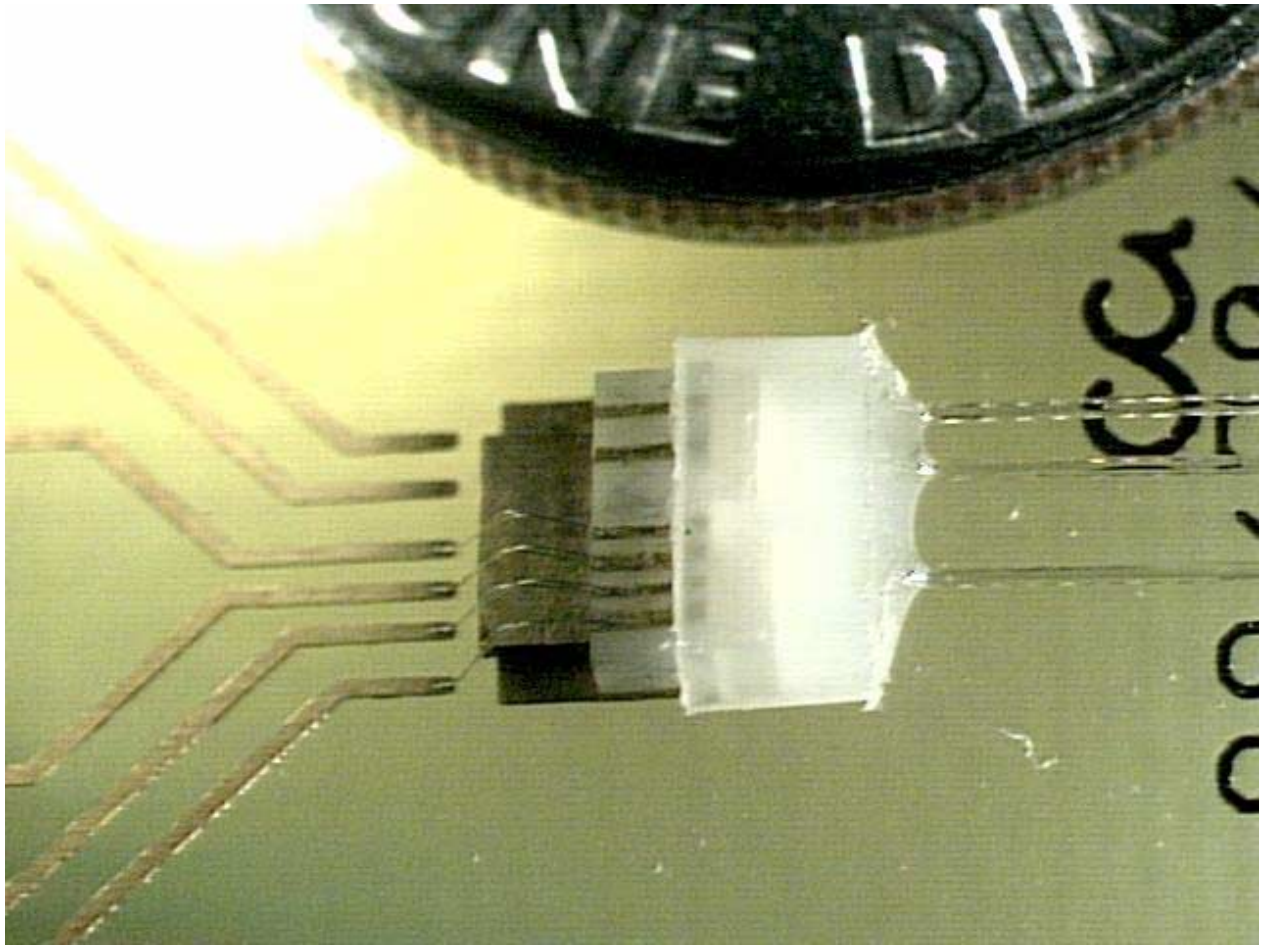
Cap with Precisely Fabricated Cavity



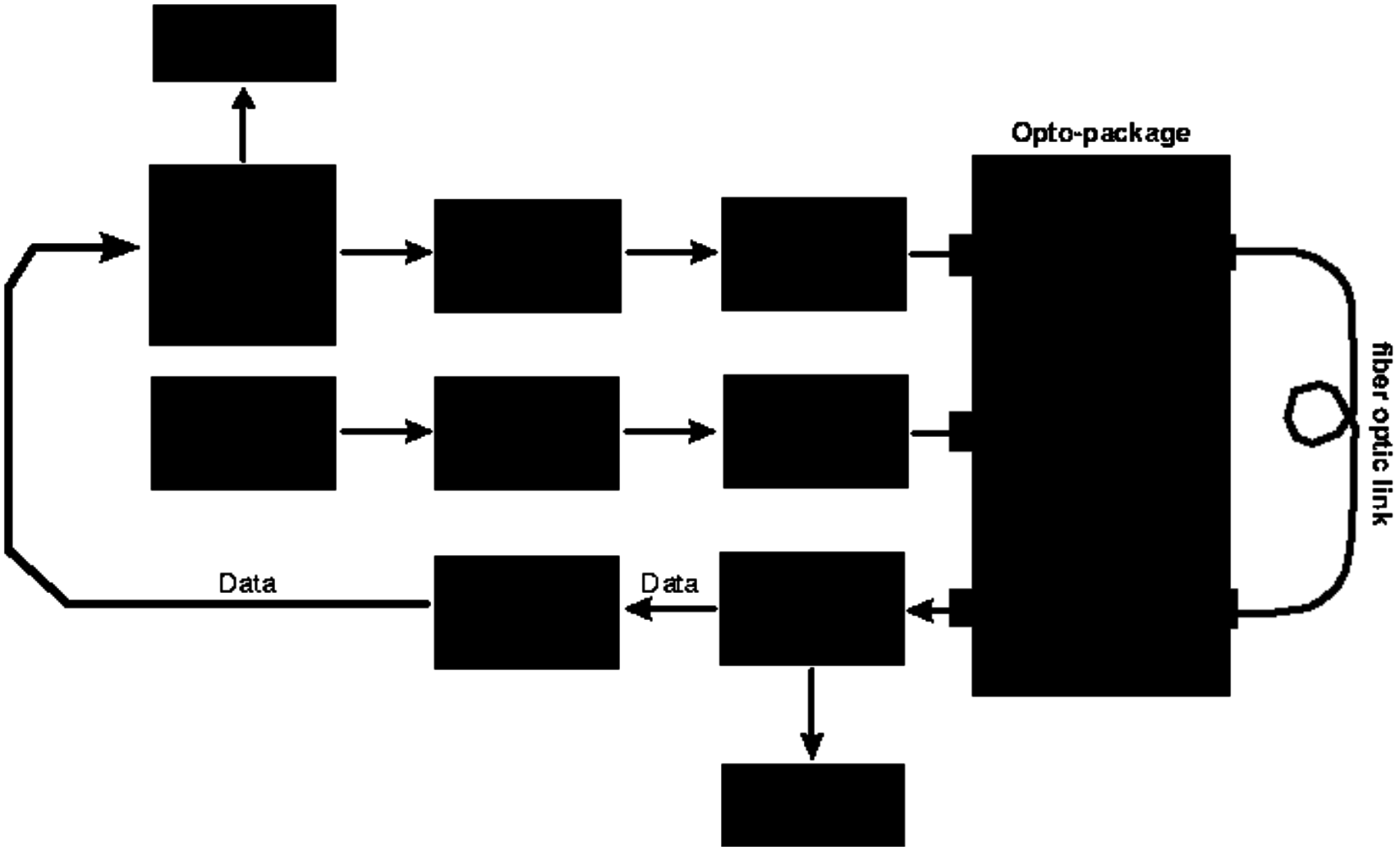
Base with PIN and VCSELs

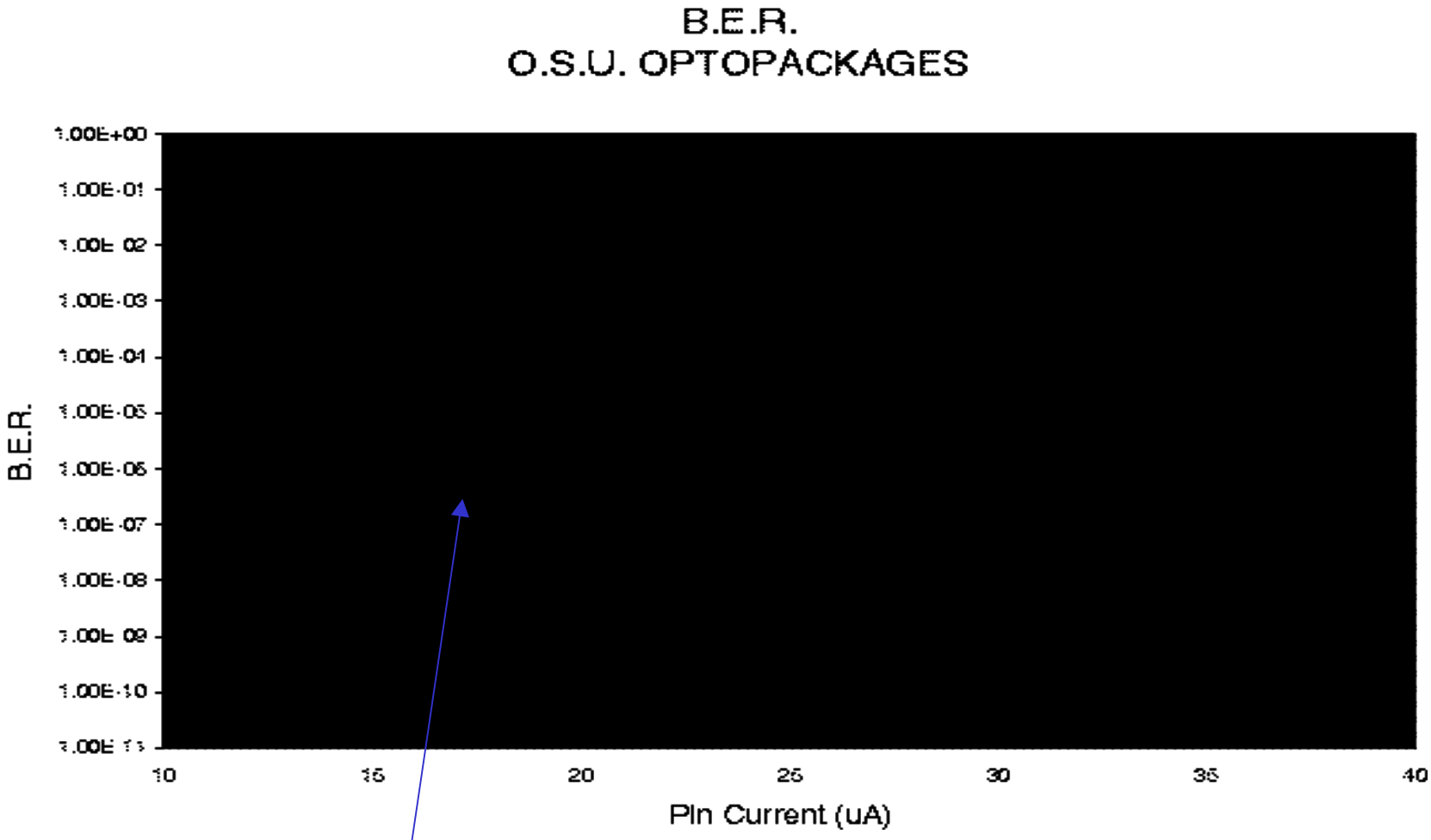


Completed Opto-package



BER/Crosstalk Measurement with DORIC and VDC





no cross talk above 20 μA

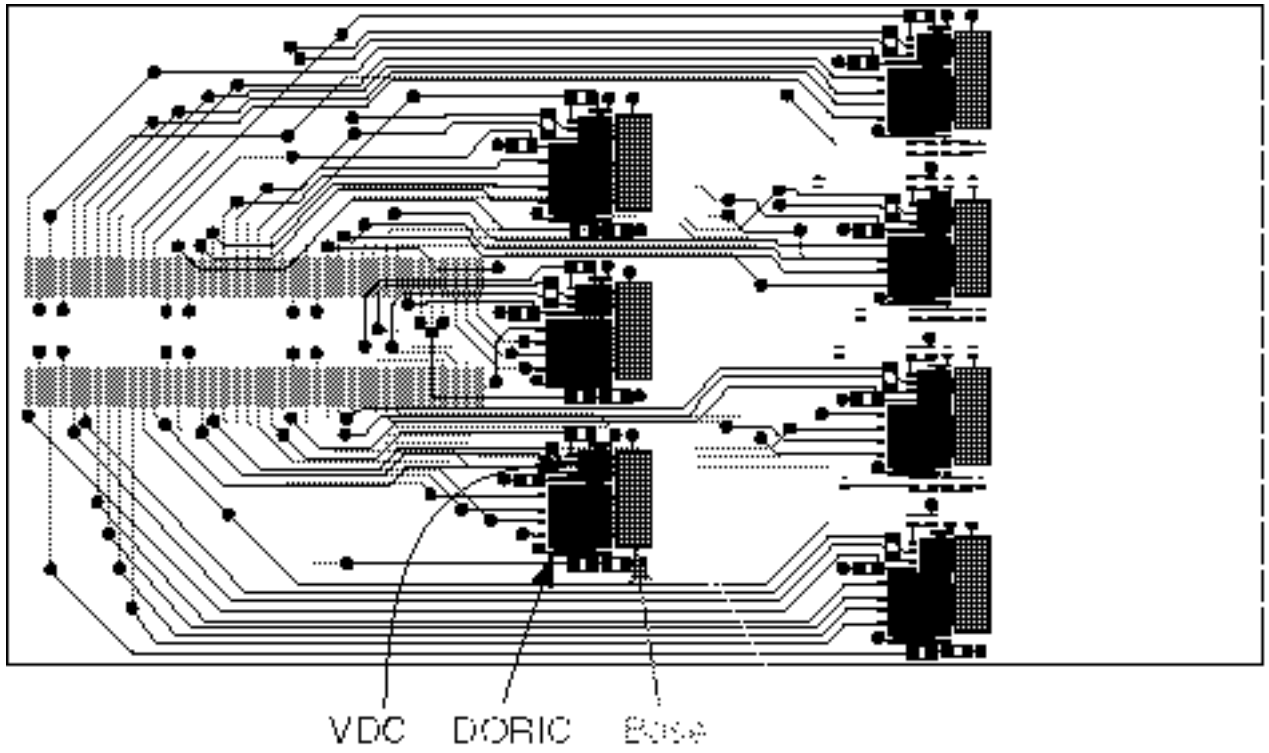
Summary on Opto-package

- principle of two-piece connector concept demonstrated
  - ☆ precision bases with 3D traces of good connectivity fabricated
  - ☆ precision caps fabricated
  - ⇨ packages produce optical power above specification
  - ⇨ negligible cross-talk between VCSEL and PIN
- ability to produce precise die placement jig is a concern
  - ☆ required six trials (one week) for current jig

Opto-hybrid Board

- convert optical signal into electrical signal and vice verse
- contains 6 sets of opto-pack, VDC, and DORIC
- electrical signal to/from module channel through 60-pin connector
- layout to serve 7 modules is ready
  - ☆ will convert to serve 6 modules
  - ☆ first submission will use FR-4 for cost saving
  - ☆ 2nd and 3rd prototypes will use BeO
- board is compatible with Taiwan opto-pack

Opto-hybrid



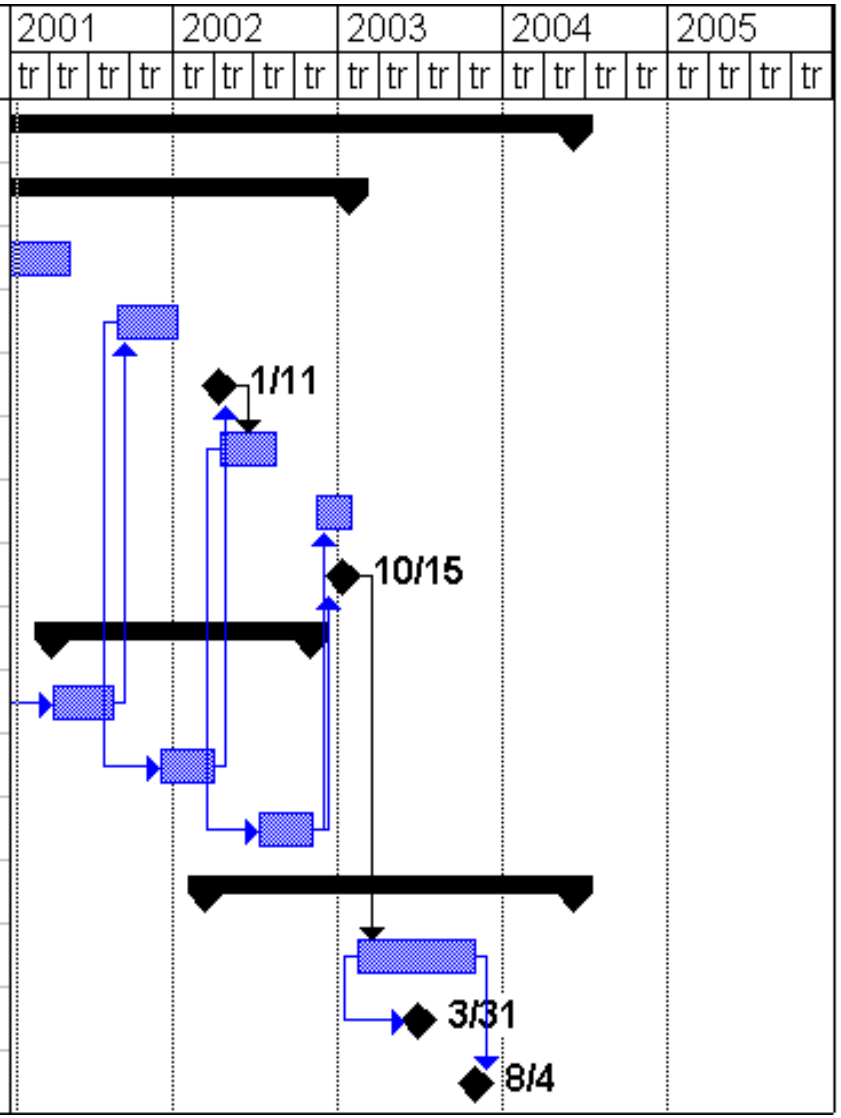
U.S. ATLAS E.T.C.
WBS Profile Estimates

Funding Source: All **Funding Type:** Project 10/24/09 5:02 PM

Institutions: All

WBS Number	Description	FY96 (k$)	FY97 (k$)	FY98 (k$)	FY99 (k$)	FY00 (k$)	FY01 (k$)	FY02 (k$)	FY03 (k$)	FY04 (k$)	FY05 (k$)	Total (k$)
1.1.1.4	Flex Hybrids/Optical Hybrids	0	0	0	0	0	110	258	422	0	0	790
1.1.1.4.1	Design / Engineering	0	0	0	0	0	18	50	9	0	0	77
1.1.1.4.1.1	Prototype design	0	0	0	0	0	18	0	0	0	0	18
1.1.1.4.1.2	Production design	0	0	0	0	0	0	50	9	0	0	59
1.1.1.4.2	Development and Prototypes	0	0	0	0	0	92	62	0	0	0	154
1.1.1.4.2.1	Flex hybrids	0	0	0	0	0	35	10	0	0	0	45
1.1.1.4.2.2	Optical prototypes	0	0	0	0	0	41	41	0	0	0	82
1.1.1.4.2.3	Pigtails prototypes	0	0	0	0	0	16	11	0	0	0	27
1.1.1.4.3	Production	0	0	0	0	0	0	146	413	0	0	559
1.1.1.4.3.1	Flex hybrid	0	0	0	0	0	0	136	251	0	0	387
1.1.1.4.3.2	Pigtails	0	0	0	0	0	0	0	33	0	0	33
1.1.1.4.3.3	Optical hybrids	0	0	0	0	0	0	10	130	0	0	140

WBS	Task Name
1.1.1.4	**Flex Hybrids/Optical Hybrids**
1.1.1.4.1	**Design**
	1st Optical Prototype Design
	2nd Optical Prototype Design
	Optical FDR
	3rd Optical Prototype Design
	Optical Preproduction Design
	Optical PRR
1.1.1.4.2	**Development Prototypes**
	1st Optical Prototype Fab and Test
	2nd Optical Prototype Fab and Test
	3rd Optical Prototype Fab and Test
1.1.1.4.3	**Production**
	Optical (Pre)Production
	First optical boards
	Optical production complete



Conclusions

- principle of fabrication of opto-pack demonstrated
- no major technical challenge in opto-hybrid board fabrication
  - ☆ compatible with Taiwan opto-pack
  - ☆ experience in opto-pack prototyping is very useful for mounting opto-packs on opto-hybrid board