

Optical Hybrids

WBS 1.1.1.4

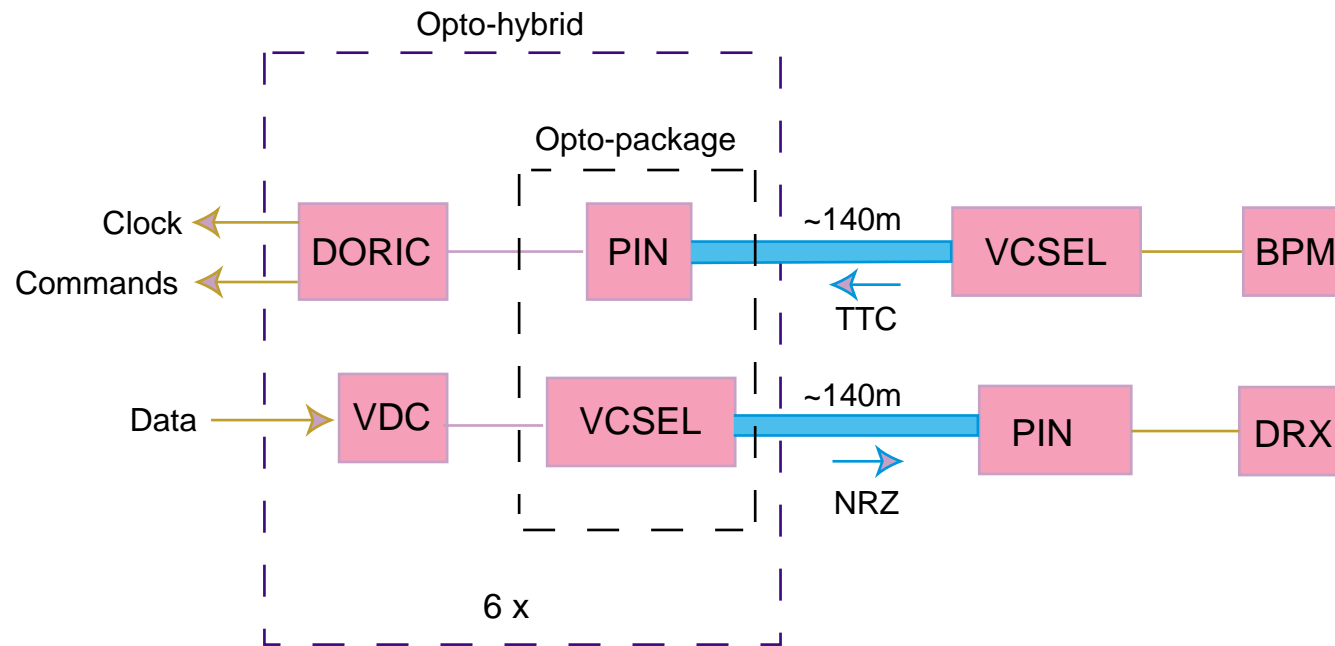
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Outline

- 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 $> 300 \mu\text{W}$ @ 10 mA
- VCSEL tolerance:
 - 50 μm in z (along fibre)
 - 25 μm in r (transverse to fibre)

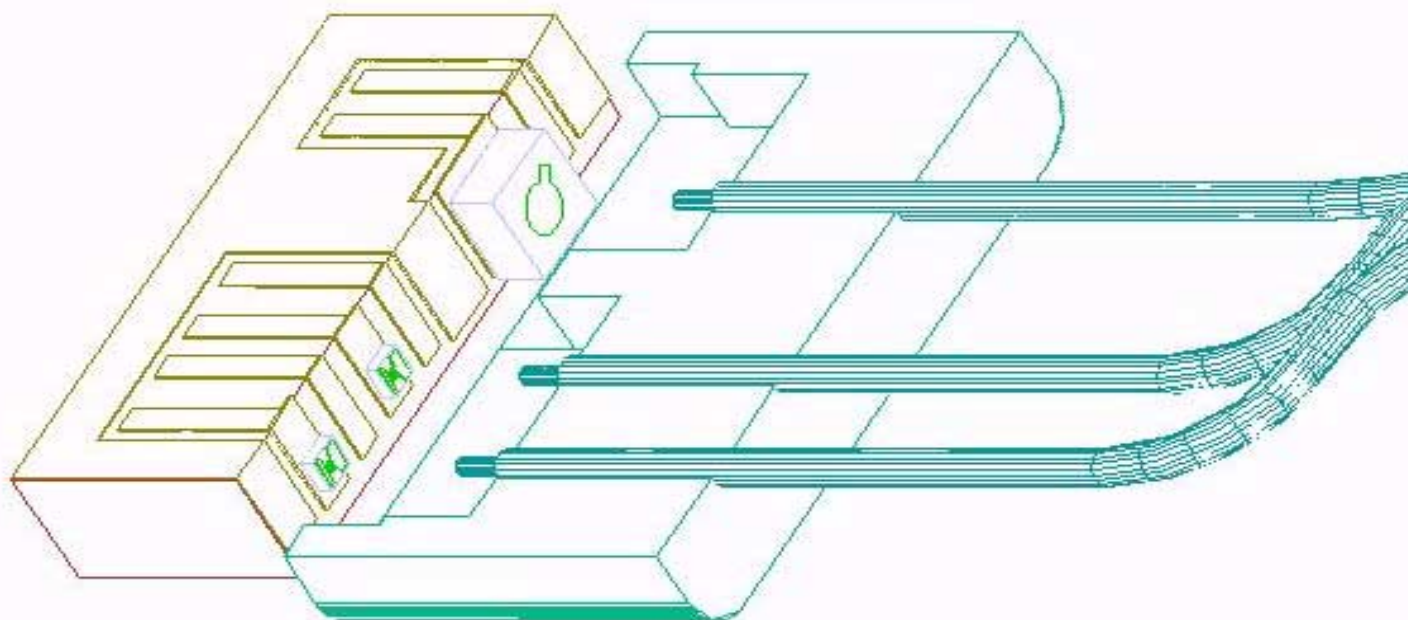
Opto-package Designs

- Marconi
 - ☆ 8 silicon/alumina pieces
 - ☆ use silicon mirror for 45° light reflection
 - ☆ high cost
- Taiwan
 - ☆ 3 G-10 pieces
 - ☆ cleave fibre at 45°
 - ☆ 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



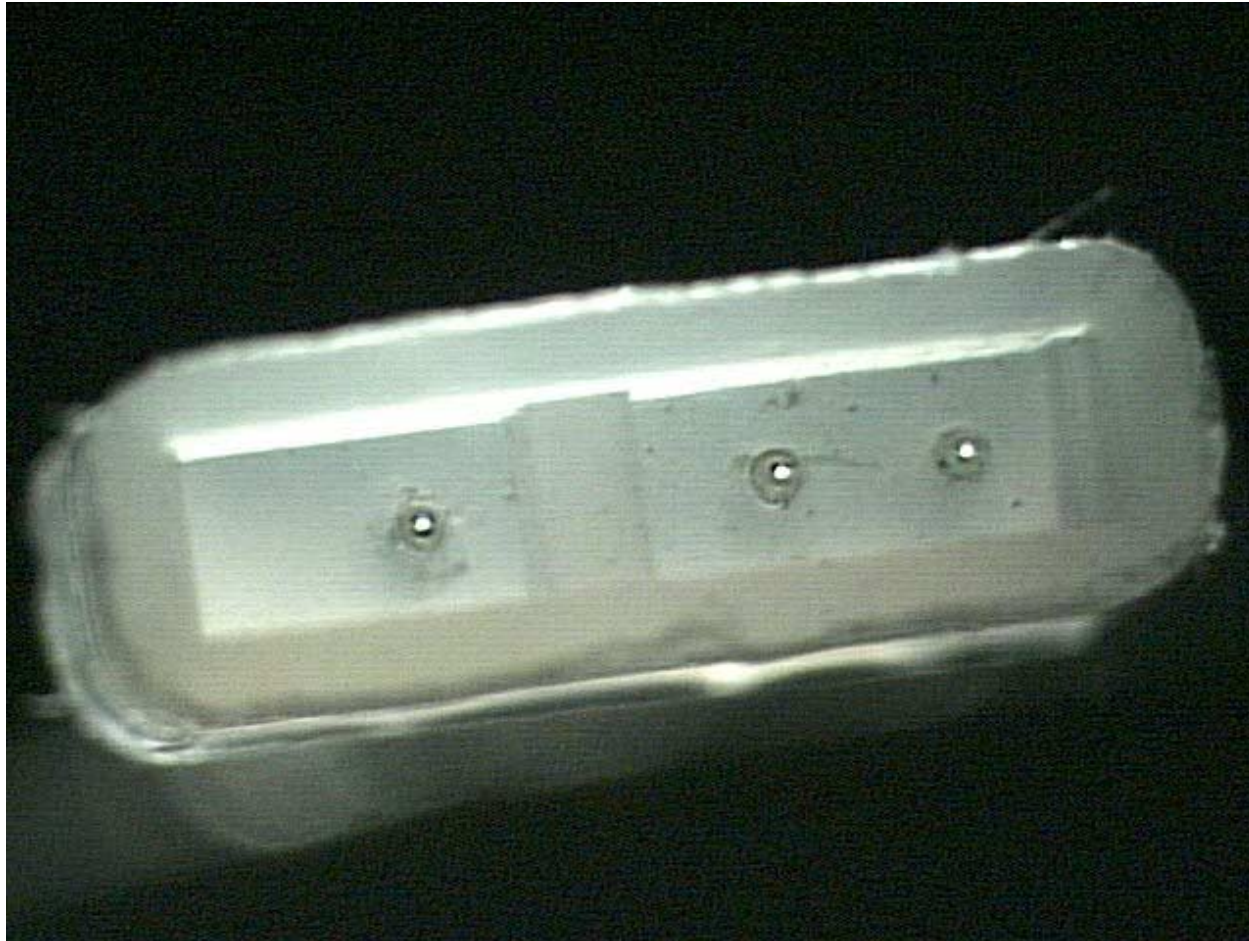
Cap and Base Prototypes

- 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

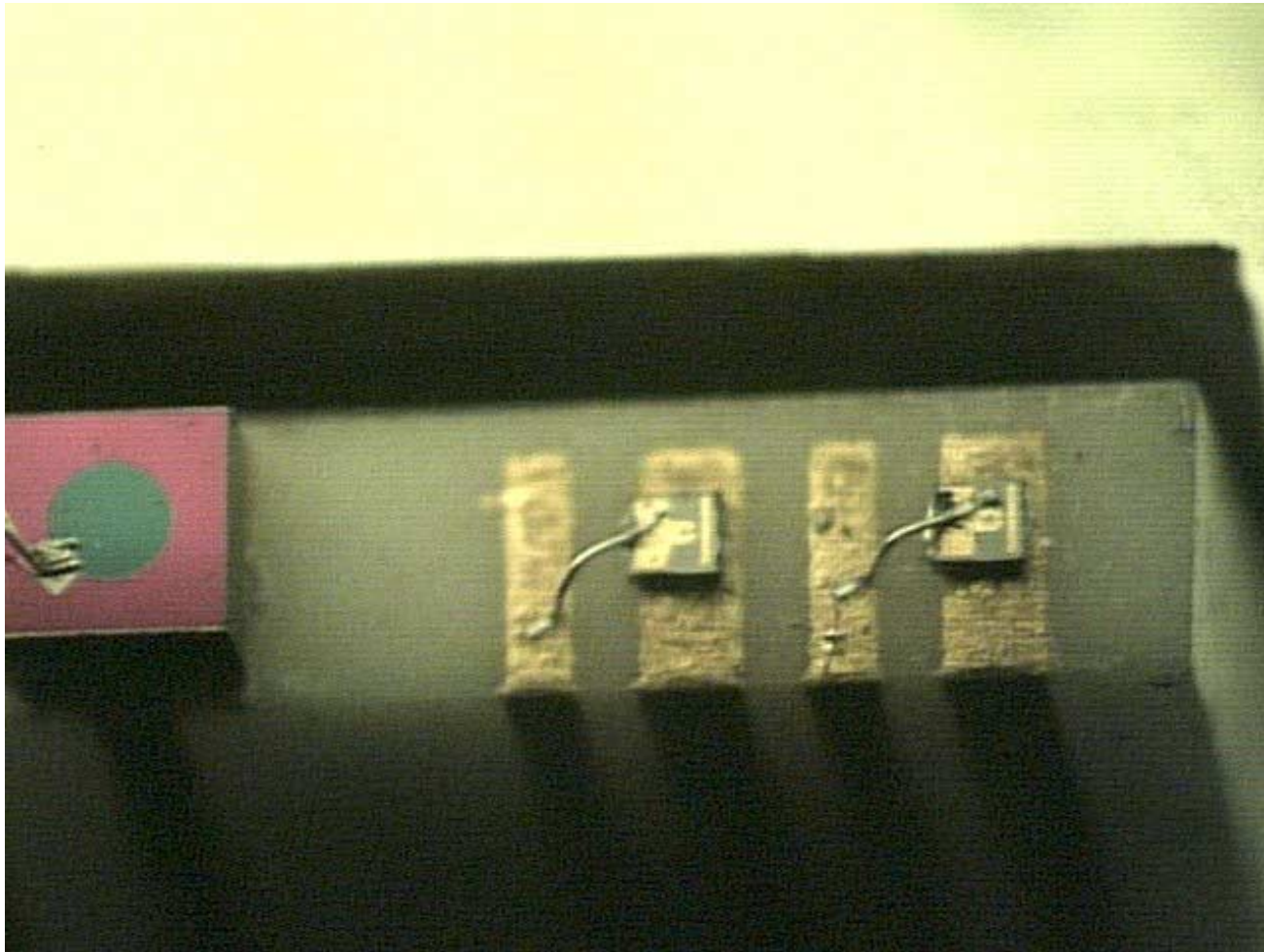
Prototype Result

- produced 10 packages
- VCSELs have fast rise and fall time: < 1 ns
- PINs have good responsivity: 0.5 A/W
- coupled power > 300 μ W 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 μ A

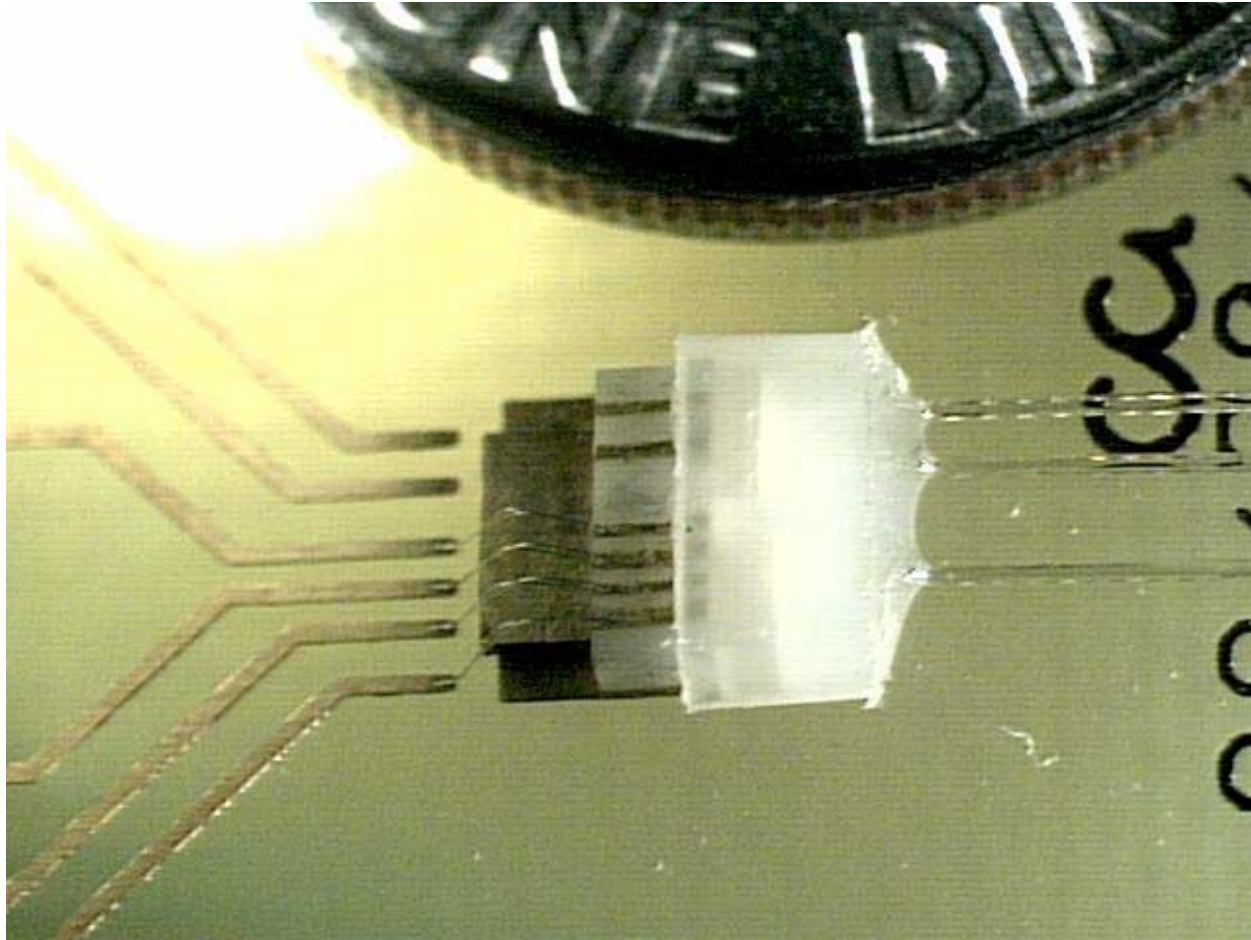
Cap with Precisely Fabricated Cavity



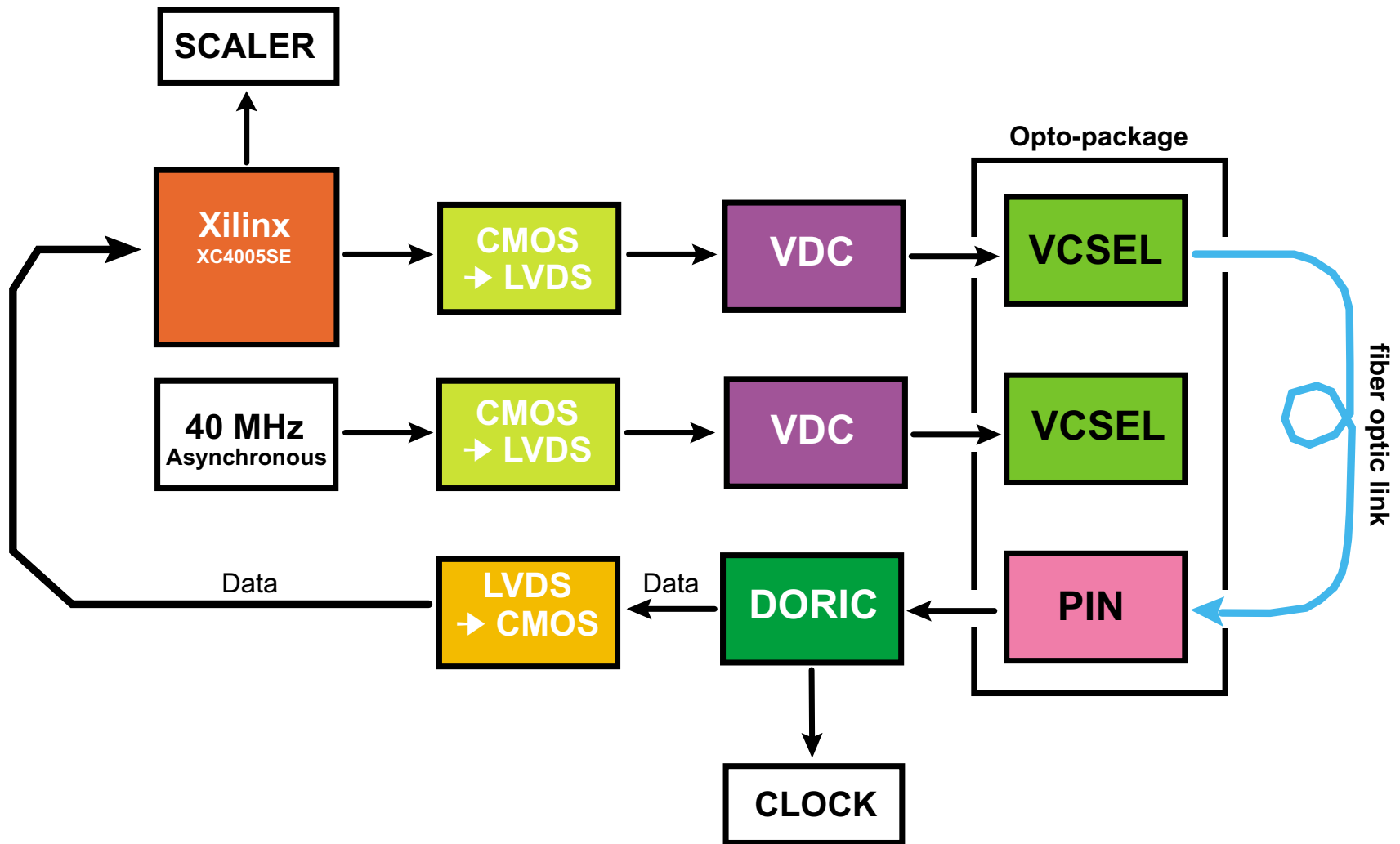
Base with PIN and VCSELs



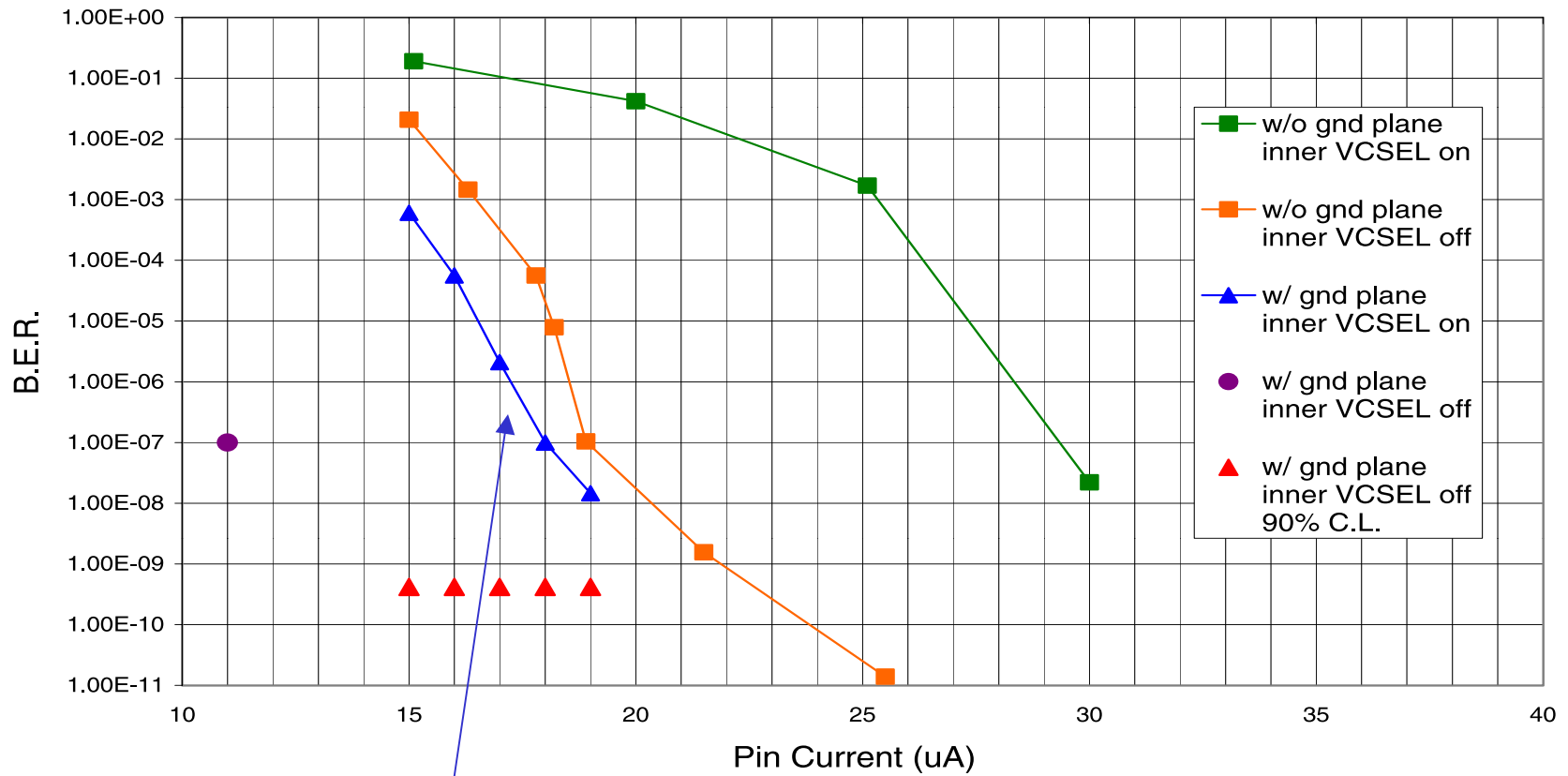
Completed Opto-package



BER/Crosstalk Measurement with DORIC and VDC



B.E.R. O.S.U. OPTOPACKAGES



no cross talk above 20 μ A

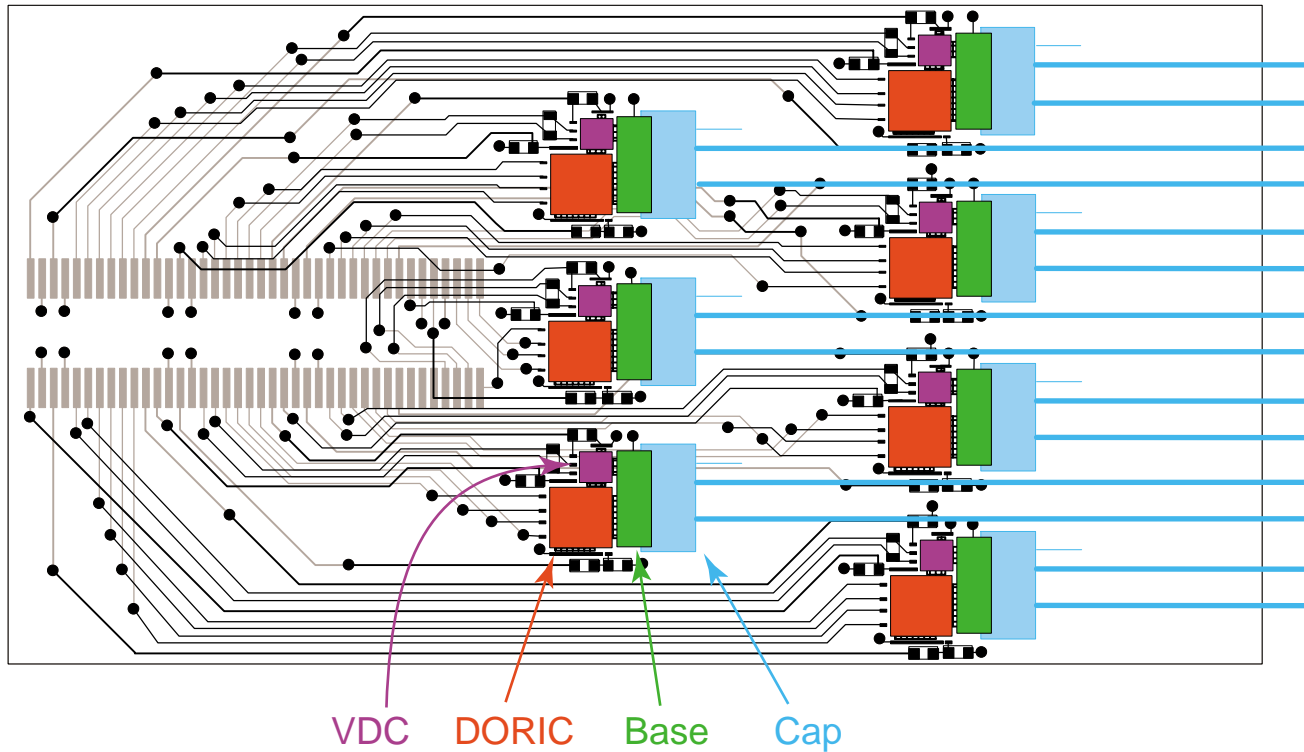
Summary on Opto-package

- 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

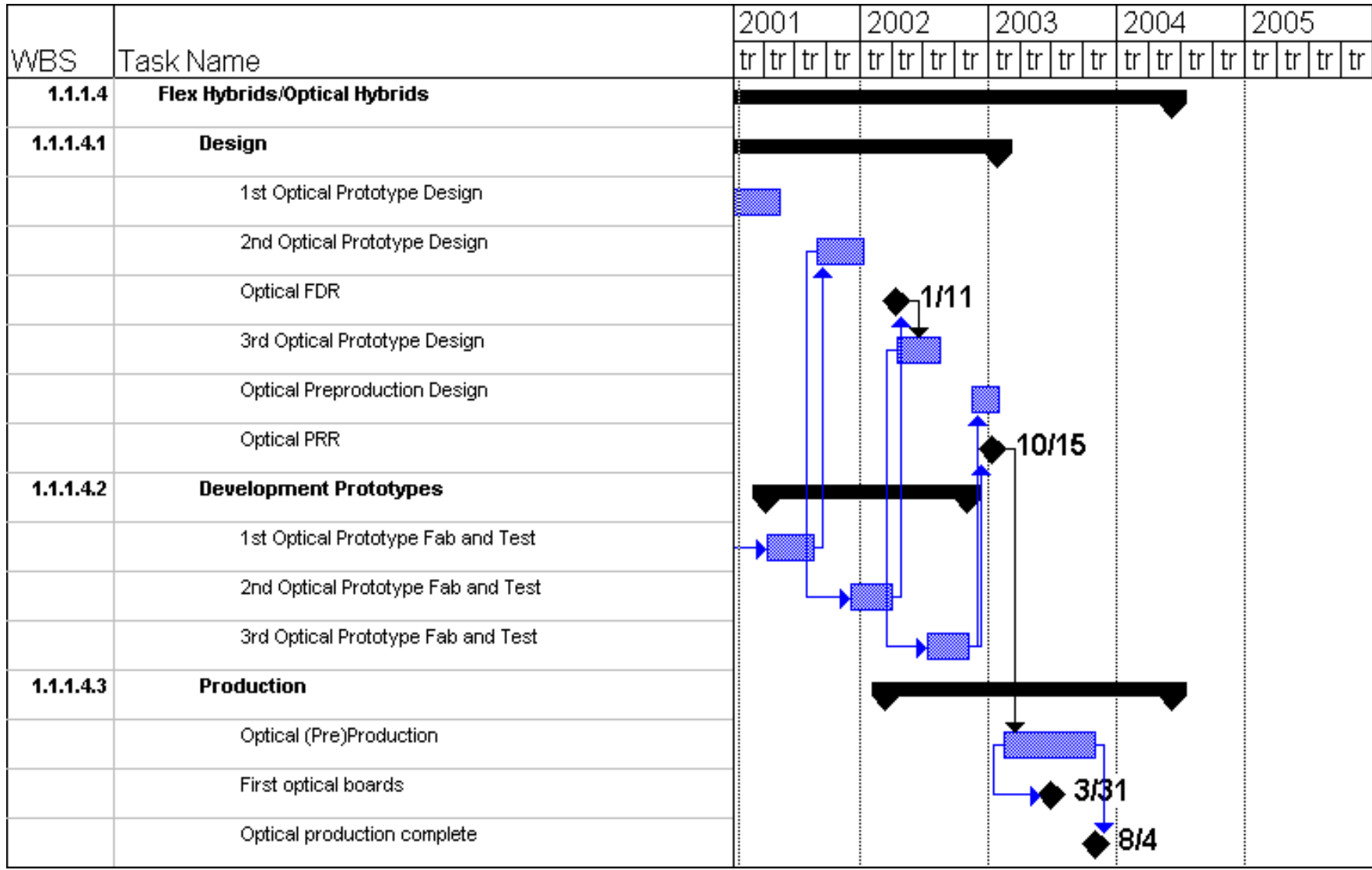
Funding Source: All

Funding Type: Project

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Institutions: All

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	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



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