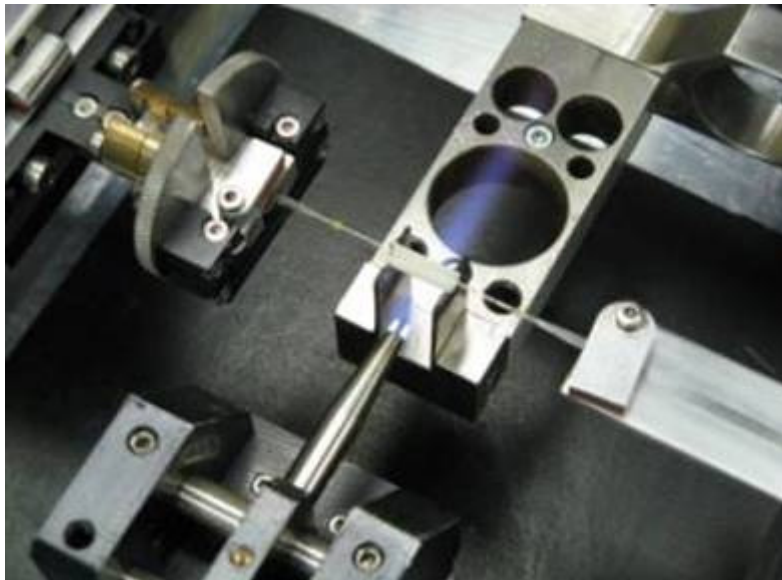




# Gooch & Housego

## Optical Fibre Capabilities

Dr Andrew Robertson – Senior Vice President



# Presentation Contents

- **Manufacturing Capability**
  - **Passive components**
  - **Active components**
  - **Additional Fiber Laser Components**
- **Sub-assembly capability**
  - **Optical Sub-assemblies**

# Fibre Optic Facility Basics

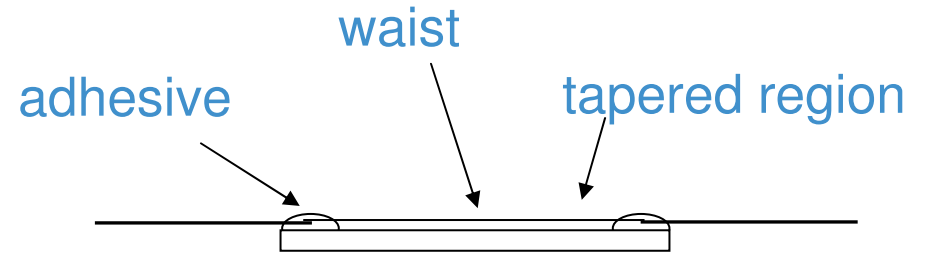
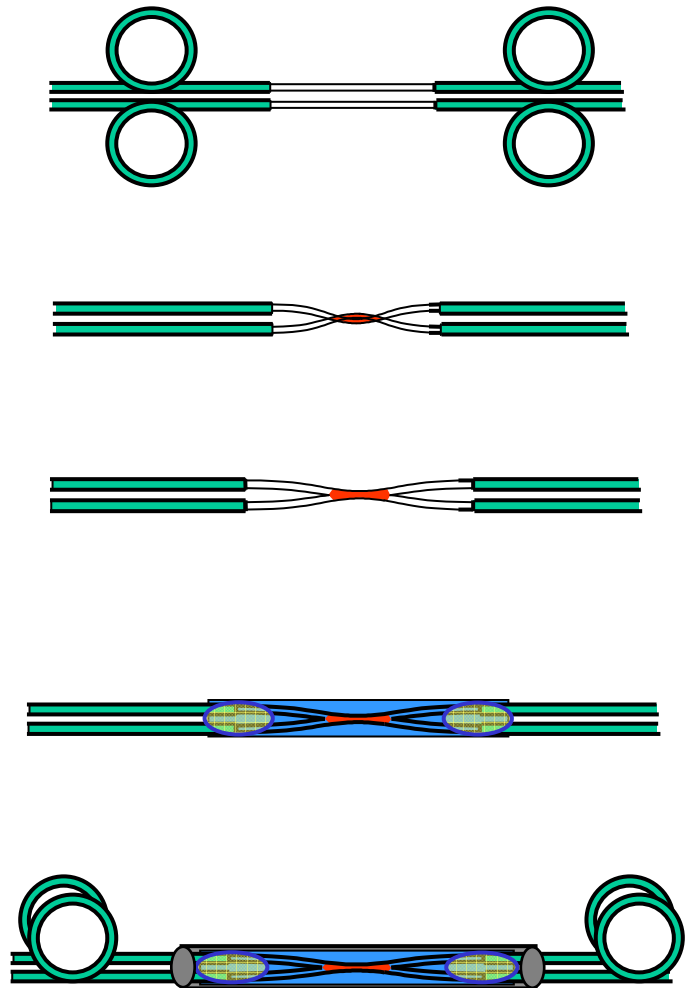
- **UK Factory**
  - 27,000 sq ft
  - ISO 9001
  - 115 employees
  - Submarine qualified
  
- **Czech Republic**
  - Contract Manufacturing
  - ISO 9001
  - 45 fused operators
  - Submarine qualified



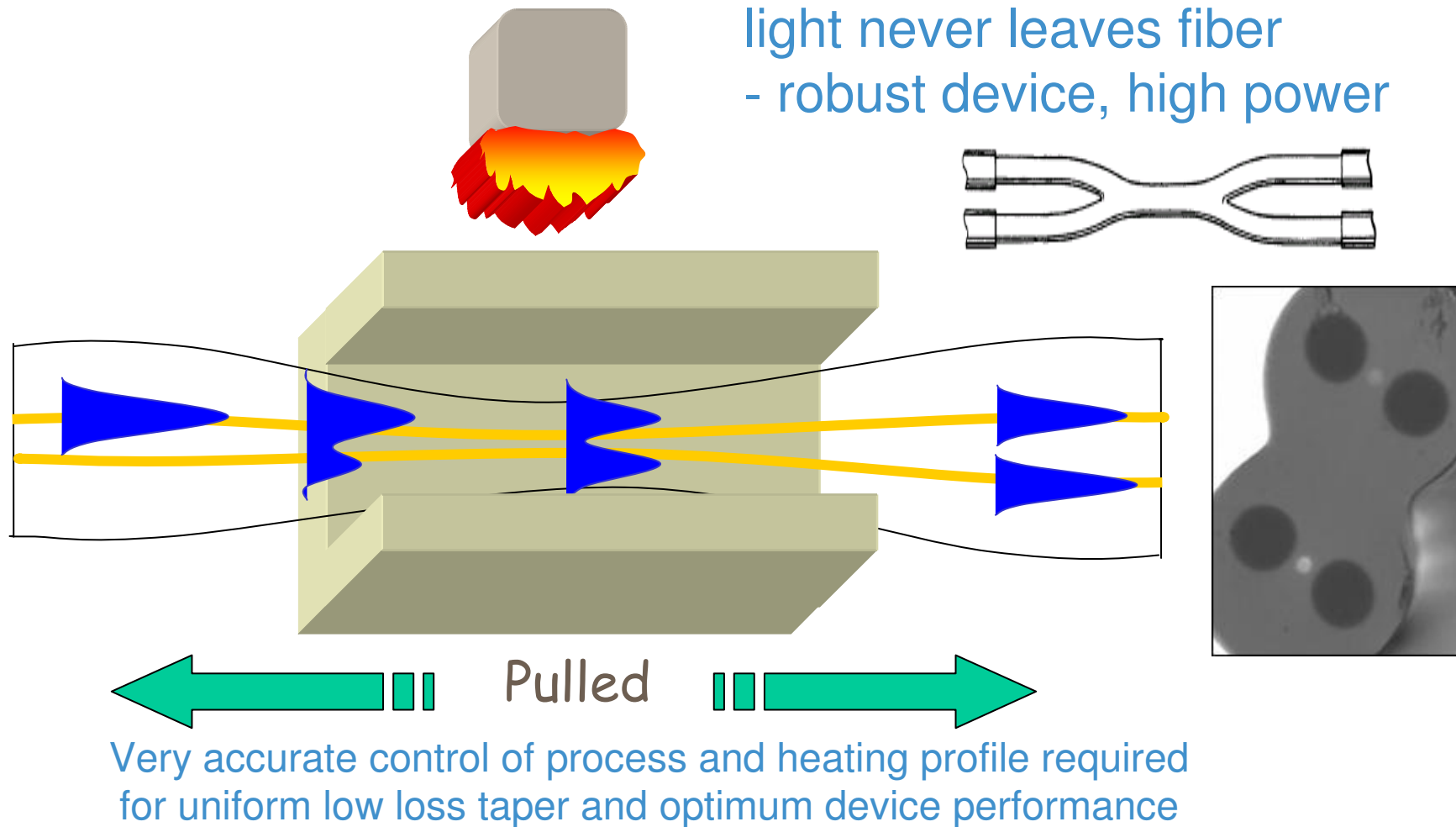
# Fused Components

- **SM Components**
  - Tap couplers and wavelength combiners
  - Polarization Maintaining
  - Visible to 2um
  - Fibre laser tap monitor and pilot beam delivery
- **MM components**
  - Power Combiners
  - Signal feedthrough amplifier components
  - LMA taps

# Fused Biconic Taper Technology



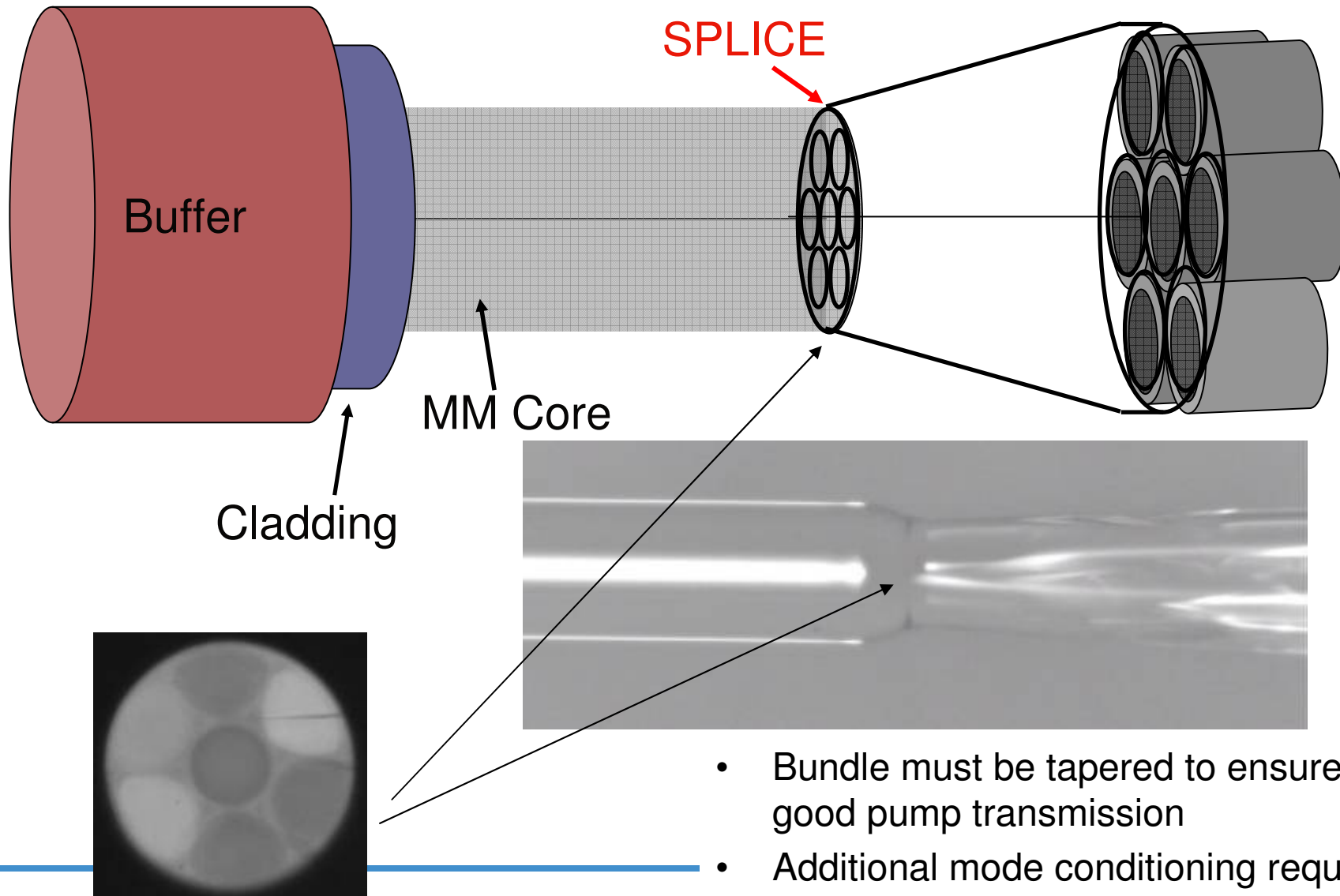
# Fusion Process



# Tapered Fibre Bundles

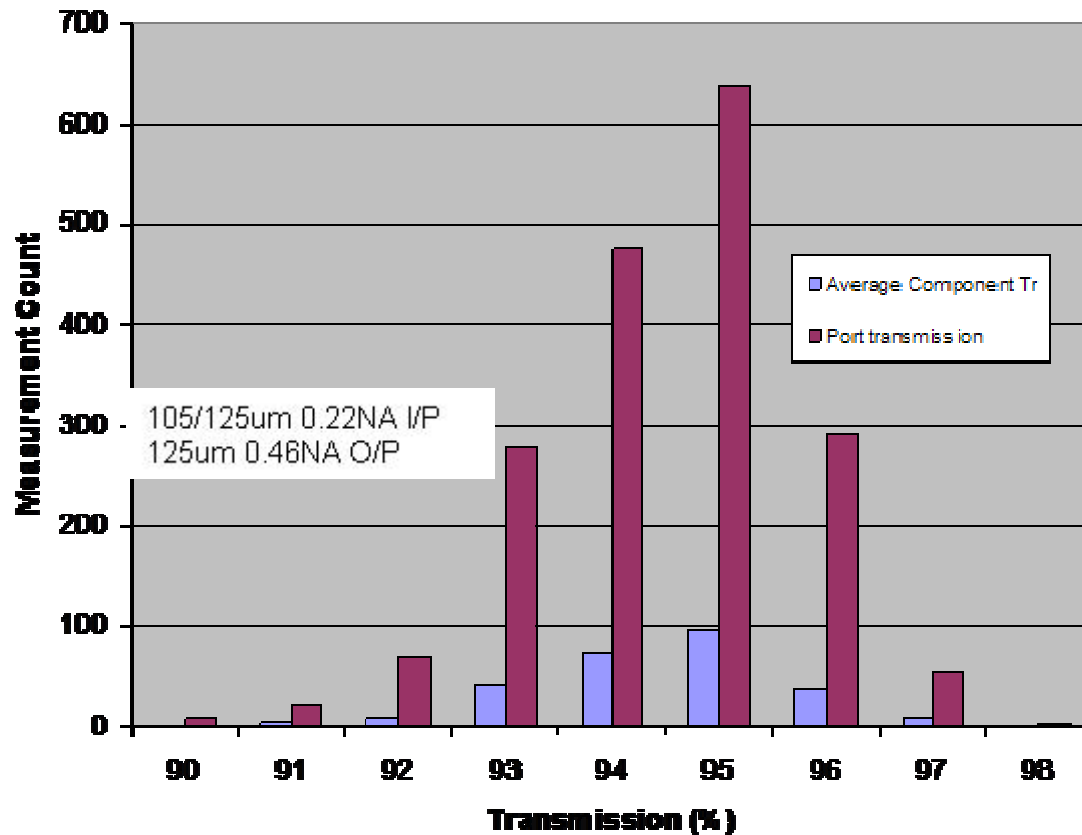
e.g. Double Clad Fibre

Fibre Bundle

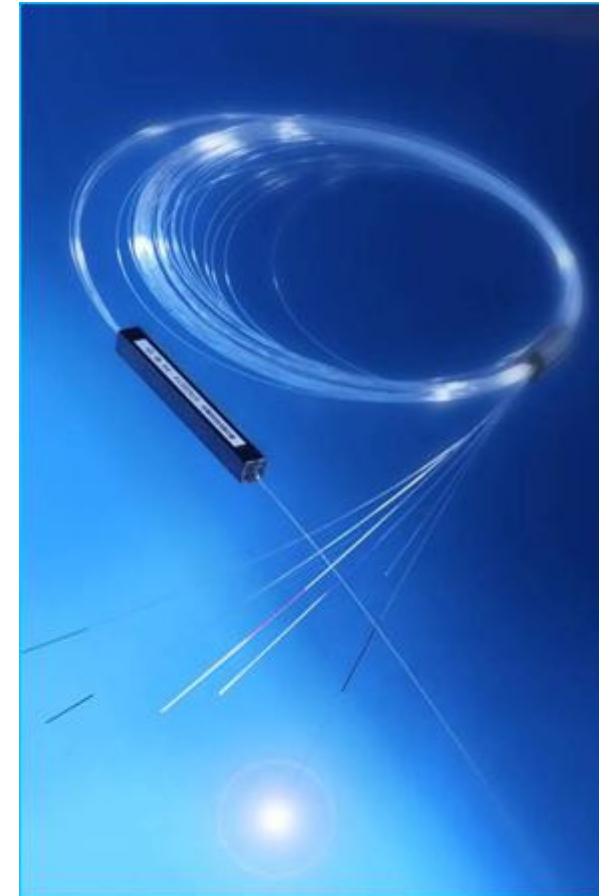


- Bundle must be tapered to ensure good pump transmission
- Additional mode conditioning required if signal feedthrough needed

# 7x1 MM Combiner

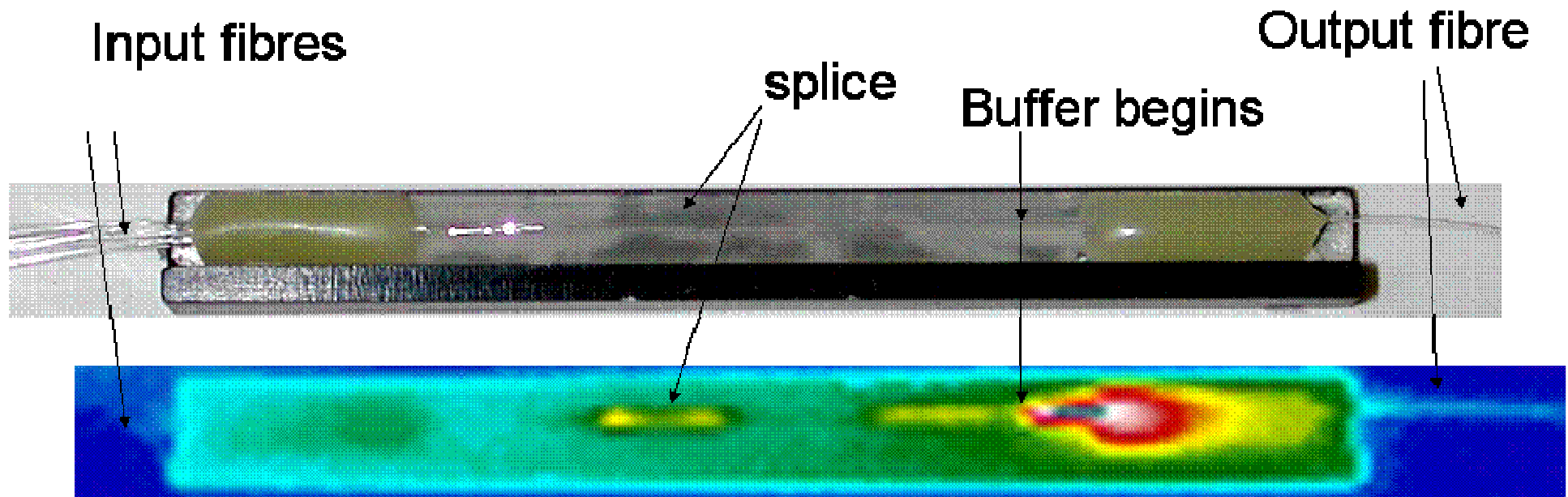


- Data from 260 devices (1820 ports)
- Average port Tr = 94%
- Average combiner Tr = 94%
- Reliability Test program
  - 50,000 device hours under full operating conditions





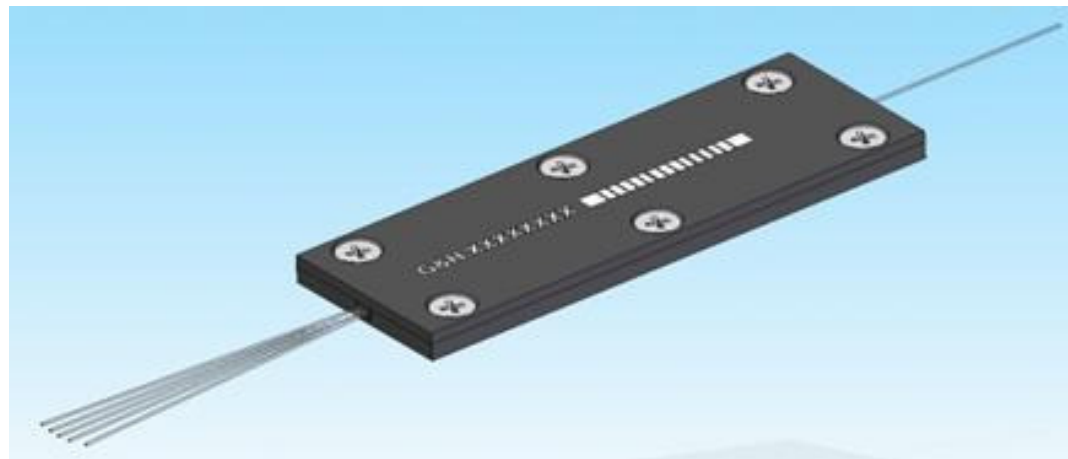
# Tapered Fibre Bundles – power handling comments



- Negligible power lost in down taper
- Small power lost in splice
- Most light lost where buffer begins
  - Light of higher NA cannot be captured
  - Buffer strips out light & generates heat
  - Thermal management required

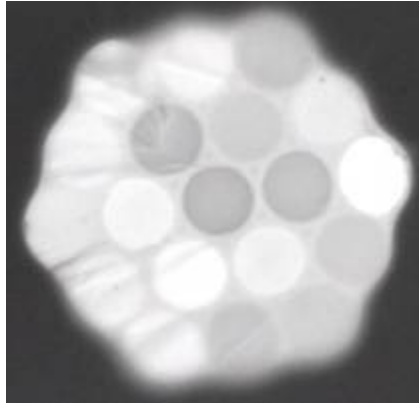
# Power Limits – MM Combiner

- Power combiner designs can be optimized for 1kW+ long term use.
  - Cooling helps
- Alternative design requires different buffer can also be used
  - Polyimide, silicone
- Housing design for high power transmission
  - Improved thermal transmission
  - Heat removal

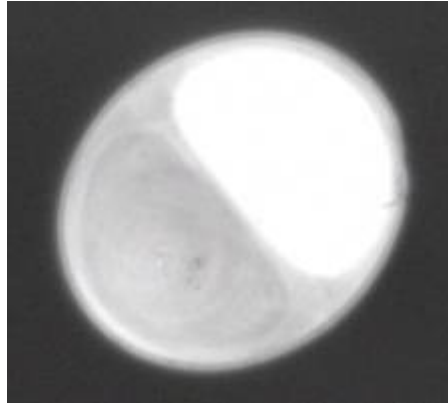


Level 3, kW class housing

# Additional MM components



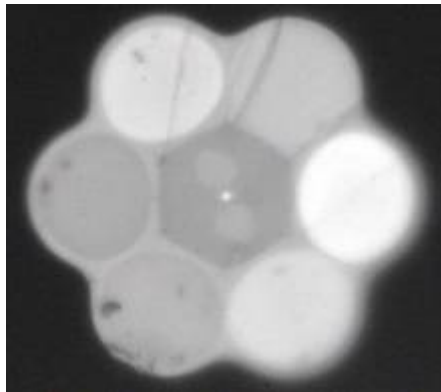
19x1



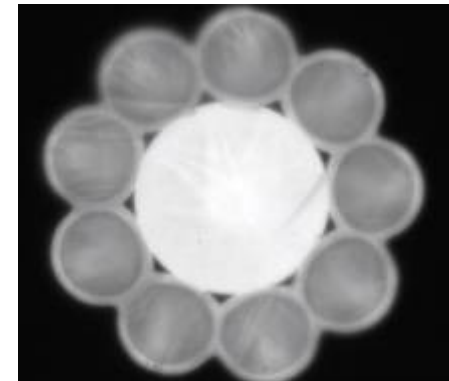
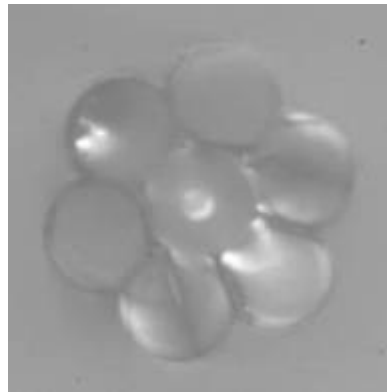
2x1



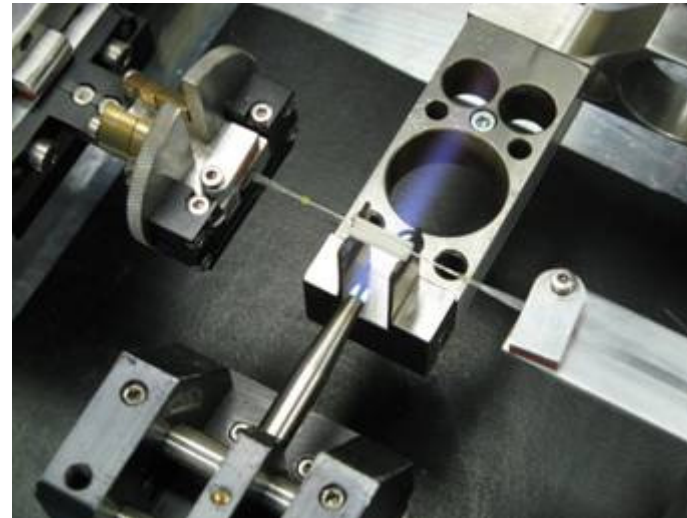
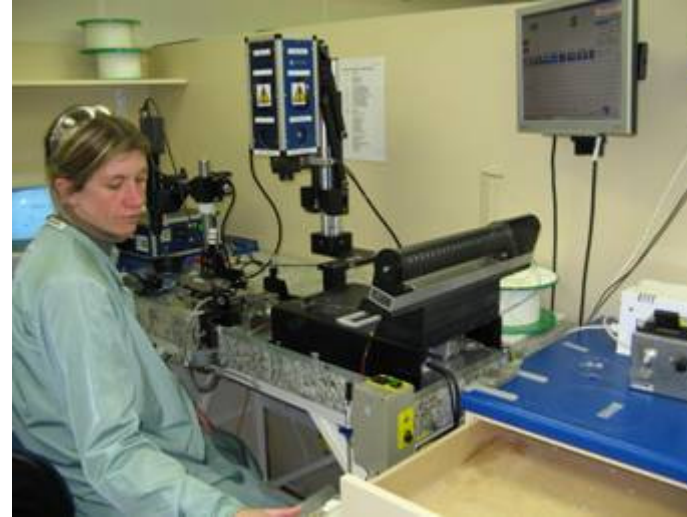
1+1x1



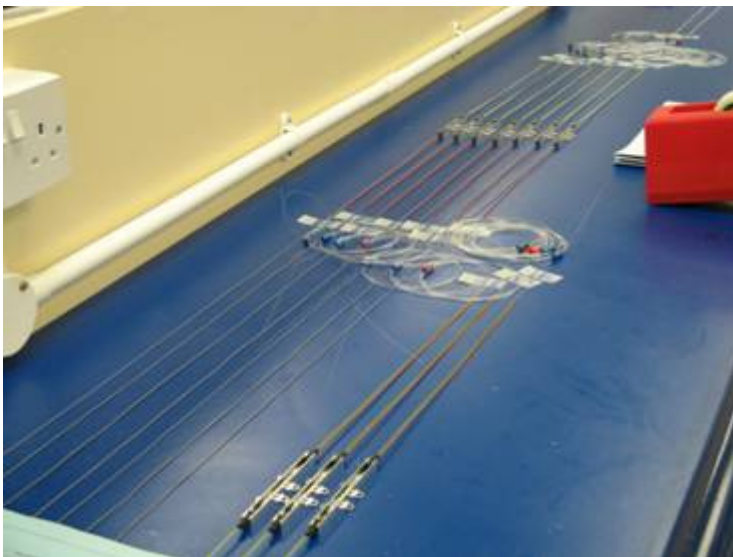
PM 6+1x1



# Fused Component Manufacturing



# Screening, Measurement, QA



# Measurements Database

- All measurements logged and saved on central database
  - With serial number of component, measurement data can be recalled immediately
  - 10 years worth of components!

**All Data Associated with Device 00579972**

**Rig Data**

ITEMNO	WORKORDER	ITEMNUMBER	OPERATOR	INDATE	TIME MADE	INC	FINNBR	CRATOR	CKATXID	CMATXID	CMATXID	CMATXID	CMATXID
00579972	2002280	2002280	MARCHER	28/03/2004	11:21:18	6480	12423771	00	00	00	00	00	00

**Terrestrial Tracking History Data**

DATE	TIME	OPERATOR	LOCATION
28/03/2004	10:11:33	PEARSONBROOK	BROOKHILL WAY - TORQUAY
28/03/2004	13:08:31	LAVERNE	BROOKHILL WAY - TORQUAY
28/03/2004	09:32:06	SLEY	BROOKHILL WAY - TORQUAY
28/03/2004	09:57:19	SLEY	BROOKHILL WAY - TORQUAY
01/10/2004	06:11:42	OKEVANS	BROOKHILL WAY - TORQUAY
07/10/2004	11:38:27	CLARKE	BROOKHILL WAY - TORQUAY
07/10/2004	10:48:43	DWALSH	BROOKHILL WAY - TORQUAY
08/10/2004	10:25:05	MOOPREY	BROOKHILL WAY - TORQUAY

**Terrestrial Shipping Data**

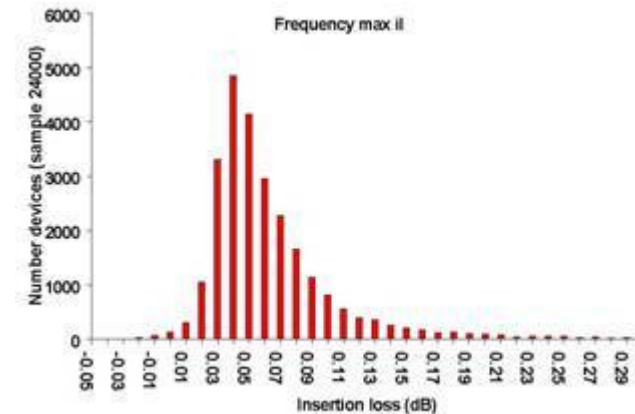
ITEMNO	SHIPDATE	SHIPTIME	TERMO	LOCATION	OPERATOR
00579972	08/10/2004	10:25:05	2002280	BROOKHILL WAY - TORQUAY	MOOPREY

**SMR Standard Measurement (Ambient Temperature)**

SMRCODE	ITEMNO	OPERATOR	TESTDATE	TESTTIME	INC	TESTTYPE	TESTSPTS	SCALETYPE	UNIT	UPC
0000000	00579972	DRACADURY	08/10/2004	09:37:51	6480	A	6480	2.0	TRUE	2002280

**SMR Standard Measurement (Frequency max)**

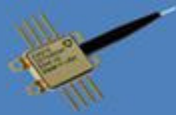
SMRCODE	WAVELENGTH	RESULTS1	RESULTS2	RESULTS3	RESULTS4	OUTBACK1	OUTBACK2	AL1	AL2	AL3	AL4	EXCESSLOSS1	EXCESSLOSS2	CR1	CR2	CR3
00019972A	300	0.28115	0.001215	0	0	0.28915	0	0.0158175	33.8172725	0	0	0.0102871	0	00	00	0
00019972A	360	0.32747	0.000940	0	0	0.32964	0	0.0164862	36.8367132	0	0	0.0148326	0	00	00	0
00019972A	420	0.35215	0.000196	0	0	0.35385	0	0.0164432	38.2504289	0	0	0.0113383	0	00	00	0
00019972A	480	0.378195	0.001215	0	0	0.38011	0	0.01786787	34.7426494	0	0	0.0134631	0	00	00	0
00019972A	540	0.40432	0.001378	0	0	0.40571	0	0.0186862	33.52772618	0	0	0.0137362	0	00	00	0
00019972A	600	0.42971	0.001142	0	0	0.43275	0	0.0198107	34.75467447	0	0	0.0130679	0	00	00	0
00019972A	660	0.451795	0.001516	0	0	0.45325	0	0.02488919	0.884883	0	0	0.0023713	0	00	00	0
00019972A	720	0.465166	0.000196	0	0	0.46675	0	0.02077178	0.6403025	0	0	0.002371	0	00	00	0
00019972A	780	0.480811	0.001516	0	0	0.48203	0	0.02488919	0.8427067	0	0	0.00175488	0	00	00	0
00019972A	840	0.495526	0.000196	0	0	0.49691	0	0.024002247	0.01320641	0	0	0.0018762	0	00	00	0
00019972A	900	0.509521	0.001378	0	0	0.51085	0	0.024544371	0.00588896	0	0	0.0025878	0	00	00	0
00019972A	960	0.523164	0.000196	0	0	0.52461	0	0.02488919	0.0000000	0	0	0.0018762	0	00	00	0



# Active Fibre Optics



Singlemode Pump Lasers



Multimode Pump Lasers



Transmission Lasers



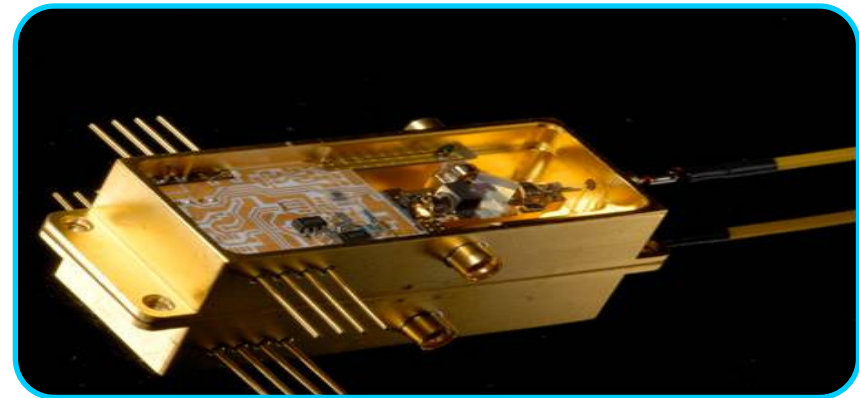
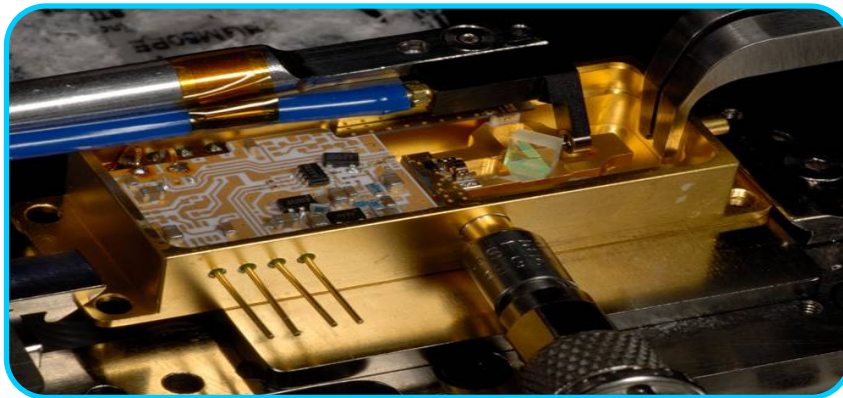
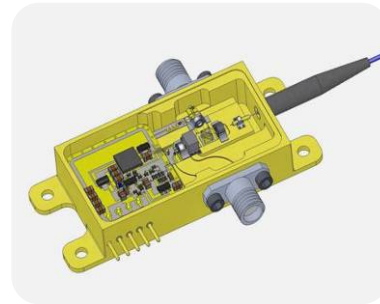
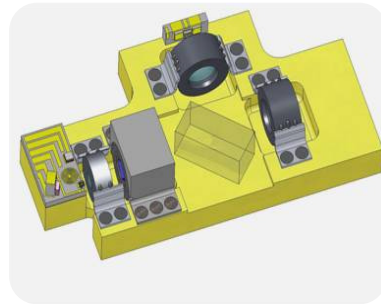
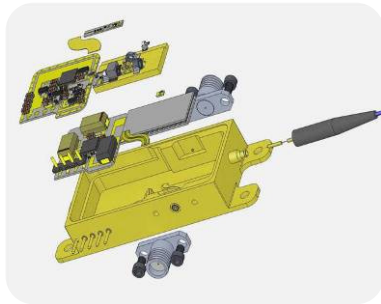
Integrated Modules



High Speed Detectors

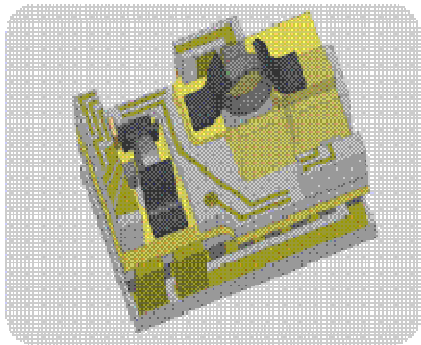
# High reliability active components

- Laser welded technology
- Proprietary patented advanced glass solder materials
- Market leader in emerging Avionic & Defence ‘actives’ photonics
- This example shows a transceiver for ‘towed decoy’ applications

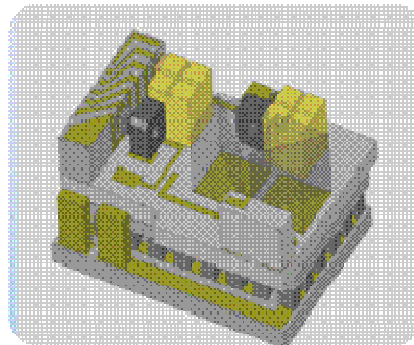




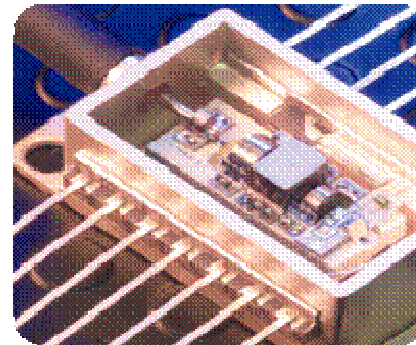
# Multi-element optical design



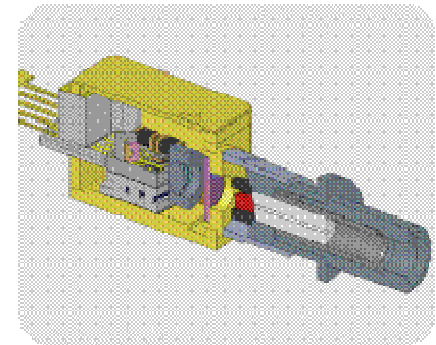
Laser Welded Designs



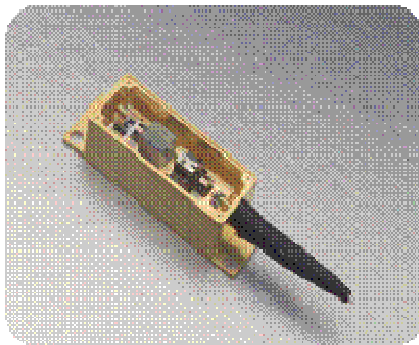
Soldered Designs



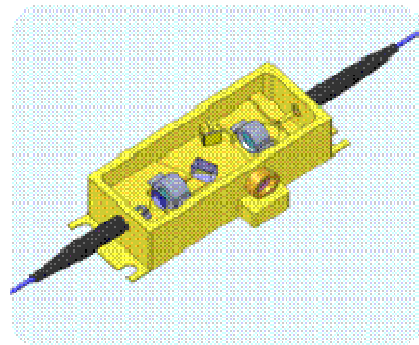
Rugged Space Qual. Designs



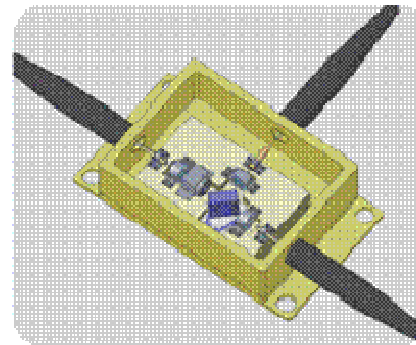
TOSA / ROSA Designs



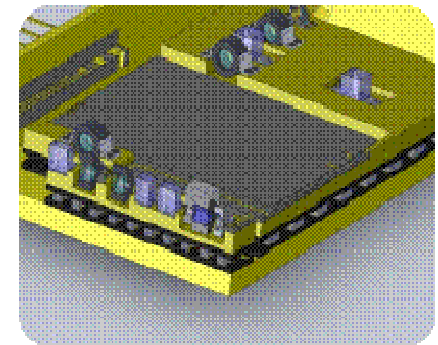
Exotic Material Designs



Fiber Coupled & Free Space



High Power Designs



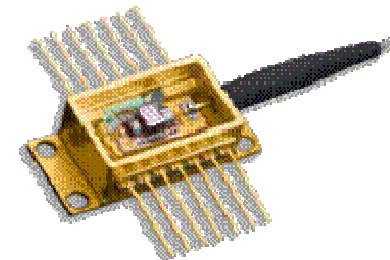
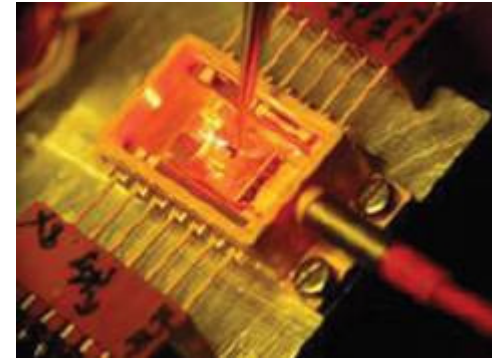
Optical Subsystem Designs

# Cleanroom packaging facilities



# Photonic Packaging Design Capability

- Specialist designers of optoelectronic packaging
  - In-house skill set
  - Custom design
    - Active devices
    - Optical
    - Mechanical
- Extensive experience of practical packaging issues
  - Design for manufacture
  - Thermal management
  - Hermetic design
  - Fibre handling



# Wide Product capability

- **Fibre pigtailed, recepticalized & free space sources**
  - Lasers & LEDs
  - SLEDs & SOAs
  - DFB, FP & VSELs
- **Fibre pigtailed & recepticalized detectors**
  - APDs & PIN diodes
  - Arrays

# Actives & Passives Reliability

- **Regular Telcordia qualification**
  - Actives & Passives
  - All facilities
- **Harsh Environment testing**
  - Military, avionic & space requirements
- **Customer specific testing programmes**
  - Sub-marine cable customers
  - Avionic gyroscope customers
  - Satellite customers
  - Military customers
- **High Power Test Program**
  - MM fibre laser components
  - SM fibre laser components

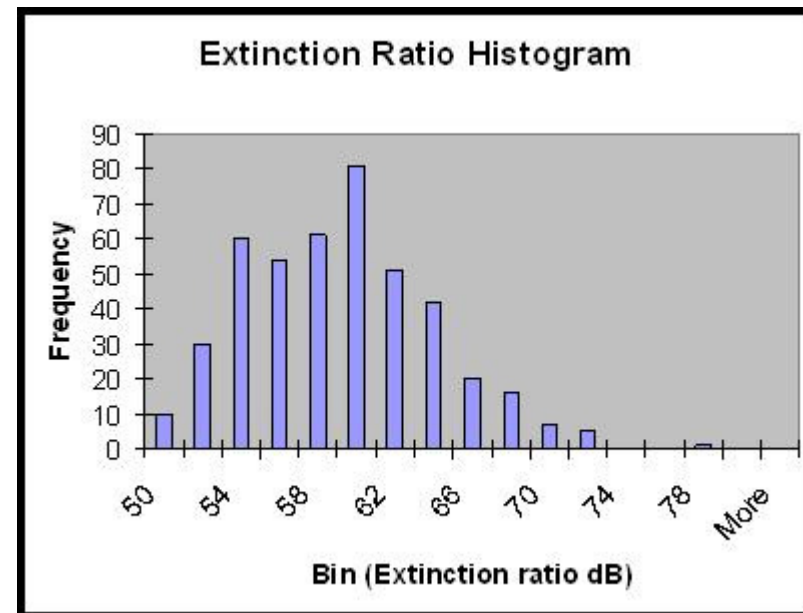
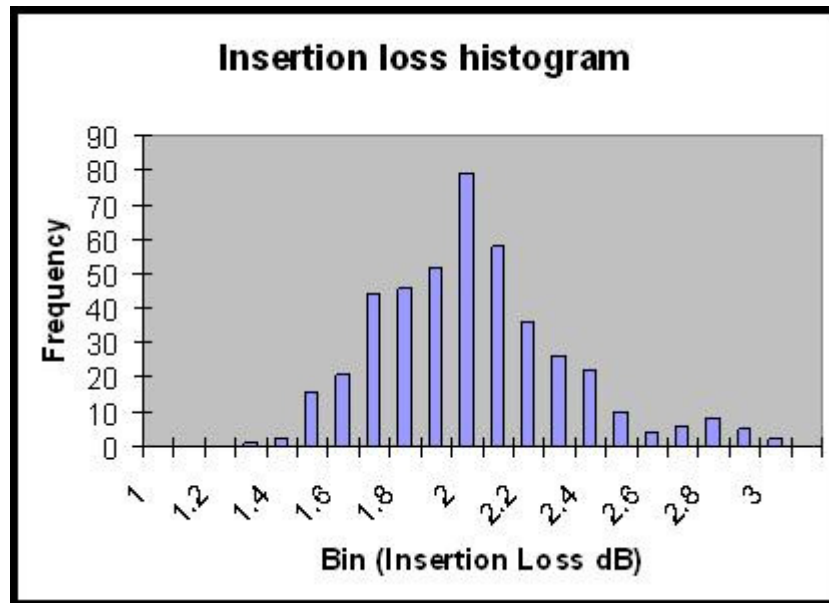
# Advanced Fibre Laser Components

- **Fibre coupled AOM**
  - Hermetic version for sensor and space applications
  - Non-hermetic version
    - Targeting price sensitive fibre laser market



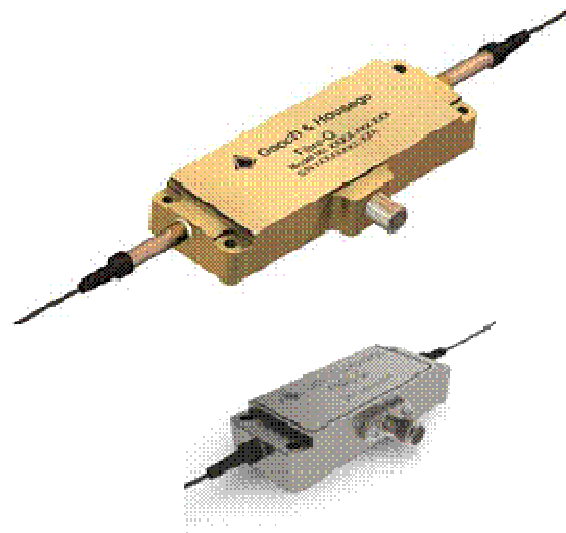
# Fibre-Q performance

- Data from 440 devices
- 80MHz, 1060nm, 35ns rise time
- Specification
  - Specification Insertion Loss < 3dB
  - Extinction ratio > 50dB



# Fibre-Q summary

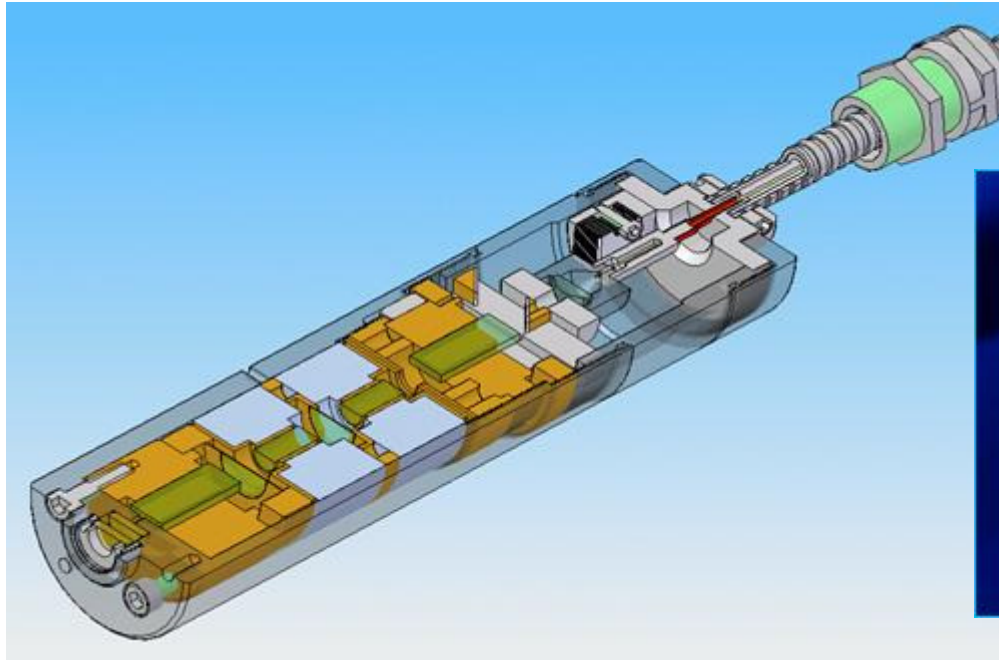
- Hermetic and non hermetic version
- 1060nm & 1550nm
  - 2um in development
- 1W and 5W version
- 1500+ shipped
- Space qualified version



- Up to 5W CW power
- Typical 75% transmission fibre to fibre

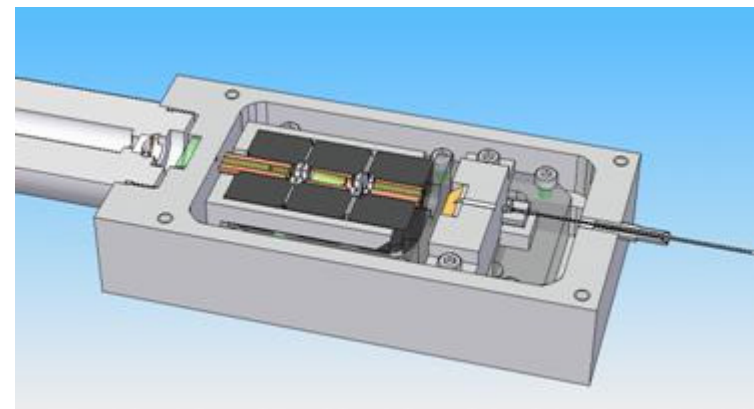


# Fibre coupled isolator

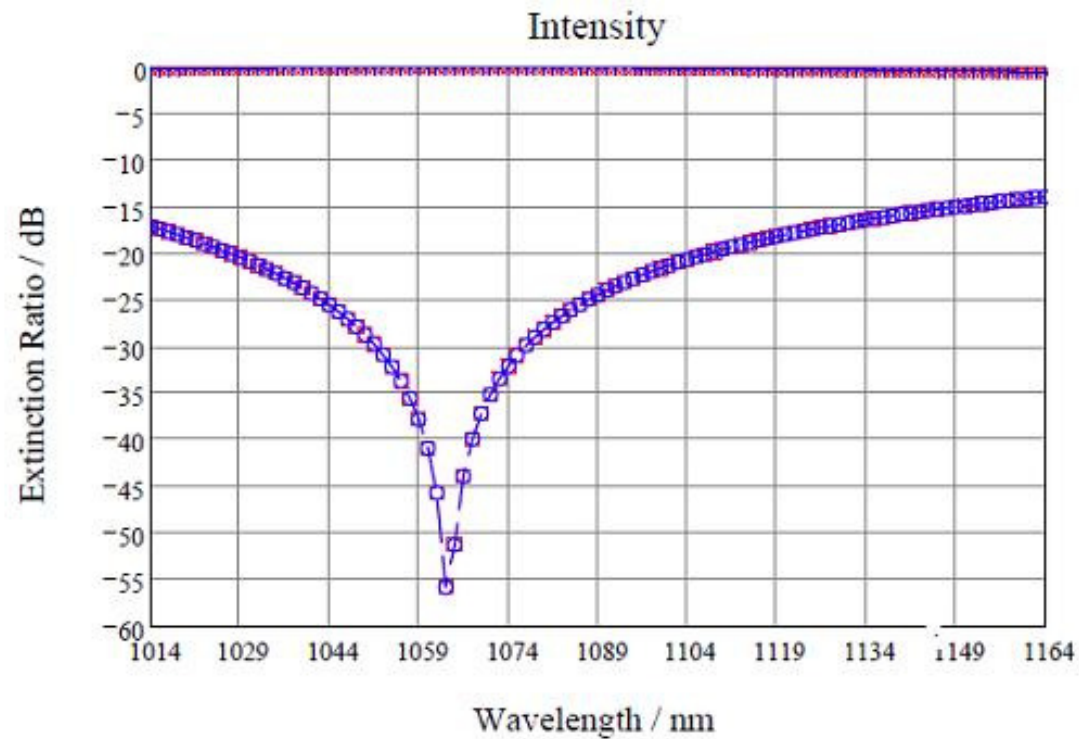


High power Isolator 30 -100W

20W Isolator Design



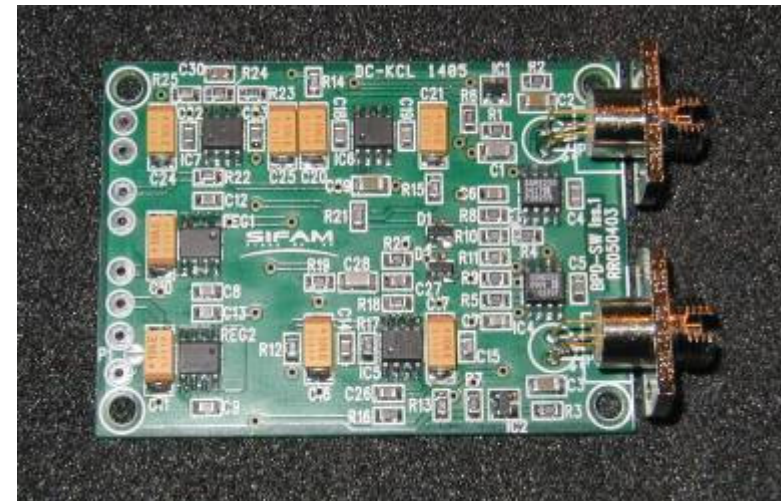
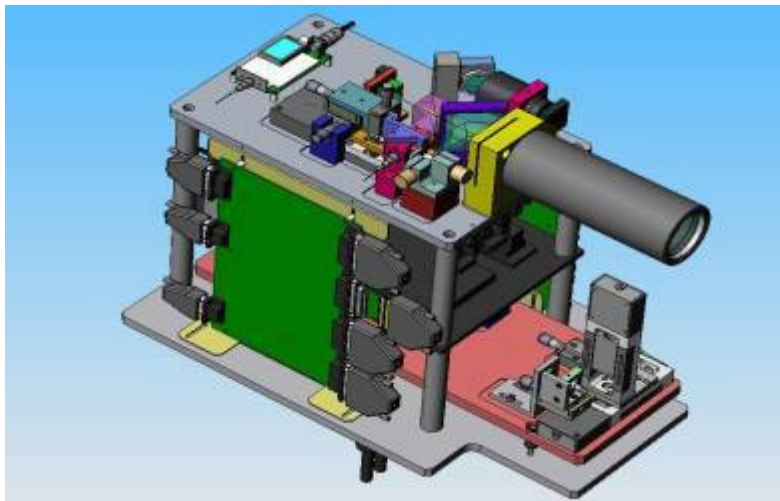
# High Power Isolator Performance



- Measured Data
- Isolation = 35dB
- Insertion Loss ~ 0.4dB
- Return Loss >50dB

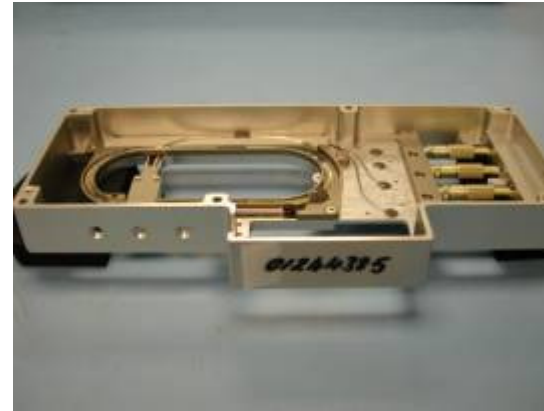
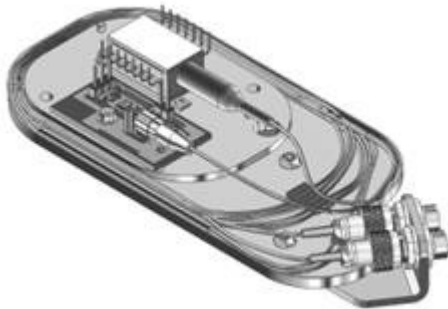
# Integrated Optical Modules

- Full design or “build to print” to meet footprint, fibre routing, components, PCBs
- Complete supply chain management of core technologies
- Extensive knowledge of passive & active components, power supplies, computer interface, motion control, thermal management
- Assembly technicians skilled in handling, routing and splicing all types of fibres & components



# Optical Integrated Modules

- OEM sub-assembly



- Turnkey systems



# Modules Facility



# Fibre Handling Knowledge

- **Constant module throughput**
  - Sensor, Telecoms, Biomedical
  - 10-100 per week
  - Varying complexity
  - Leverage full G&H optics capabilities
  - Manufacturing capability in UK, CZ, and North America



# Summary

- **Comprehensive active and passive fibre product range**
- **Emphasis on high specification and high reliability**
- **Mature manufacturing capability with proven cost reduction roadmap**
- **High quality sub-assembly facility**
- **G&H Advanced Product Development**

# Additional Information



光技術をサポートする  
**株式会社オプトサイエンス**  
<http://www.optoscience.com>

東京本社 〒160-0014 東京都新宿区内藤町1番地 内藤町ビルディング  
TEL: 03 (3356) 1064 FAX: 03 (3356) 3466 E-mail: info@optoscience.com  
大阪支店 〒532-0011 大阪市淀川区西中島7-7-2 新大阪ビル西館  
TEL: 06 (6305) 2064 FAX: 06 (6305) 1030 E-mail: osk@optoscience.com  
名古屋営業所 〒450-0002 名古屋市中村区名駅2-37-21 東海ソフトビル  
TEL: 052 (569) 6064 FAX: 052 (569) 8064 E-mail: ngo@optoscience.com