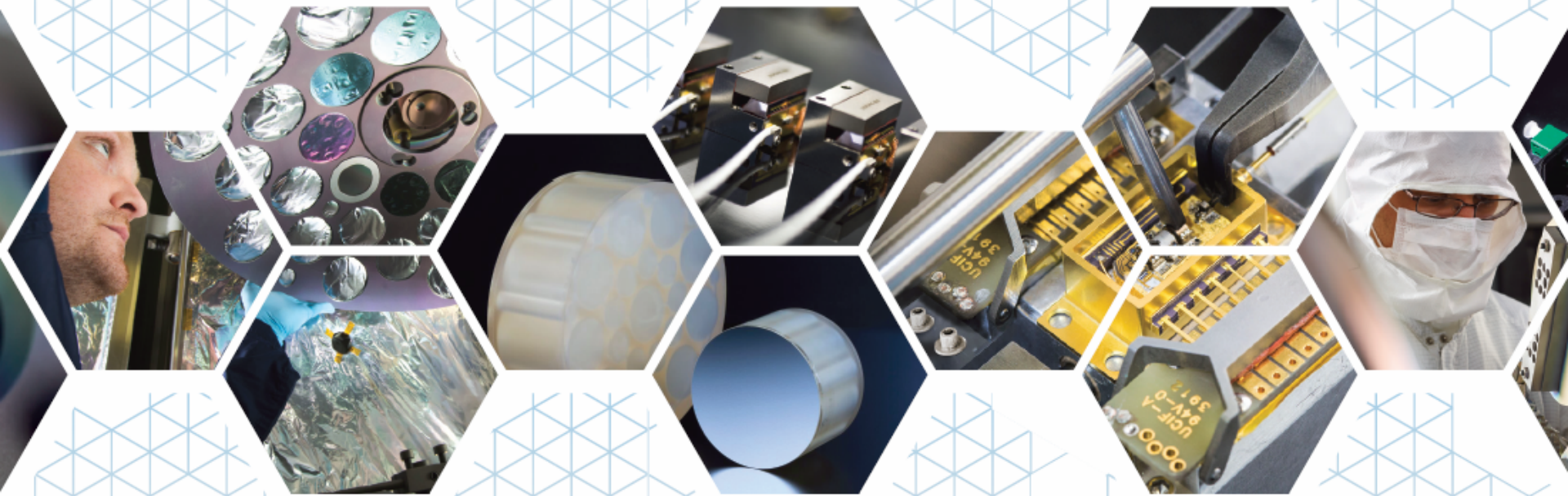




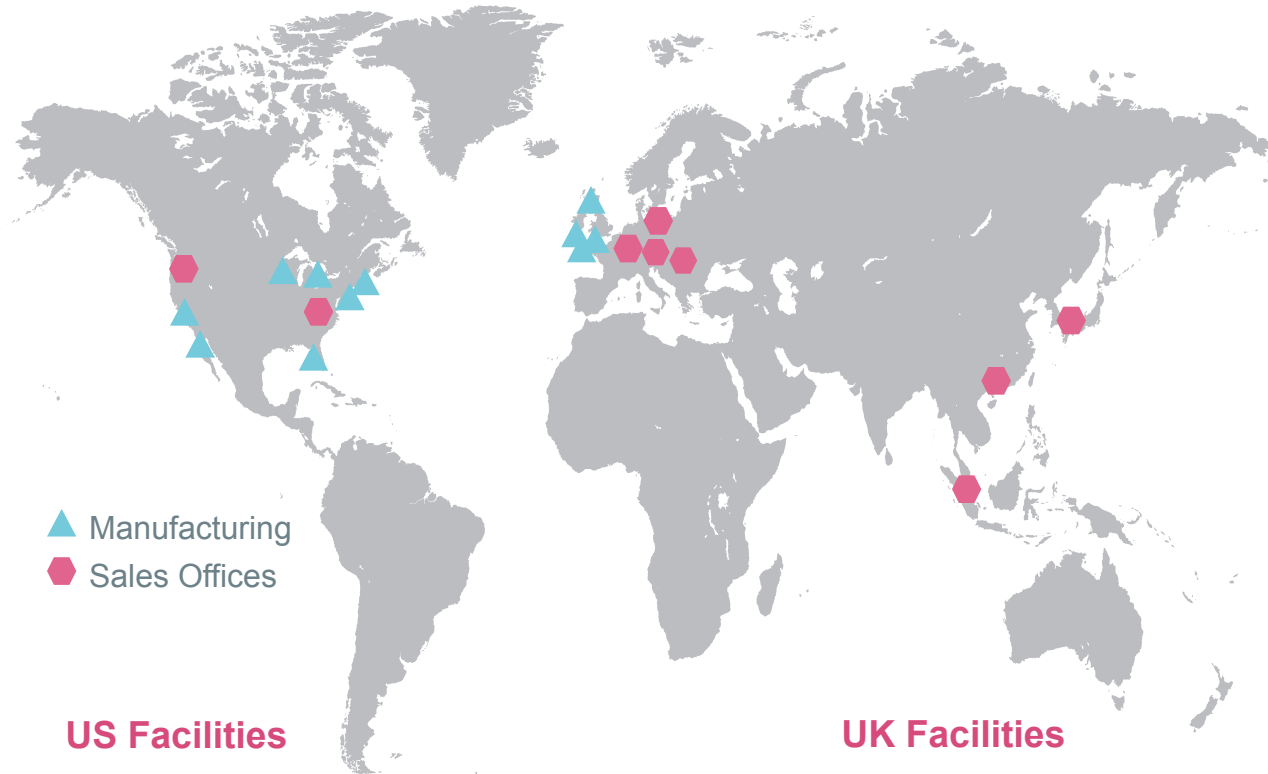
Space photonic components & sub-systems

SCYLIGHT ROADMAP WORKSHOP

Stratos Kehayas, VP R&D

12 July 2017

G&H SITES & ENABLING TECHNOLOGIES



US Facilities

Cleveland | Electro Optics & Non-Linear Optics

Freemont | Acousto Optics & RF Modules

Boston | Fiber Optics

Madison | Electro-optic systems

Moorpark | Ultra Precision Optics

Orlando | Light Measurement & Imaging Systems

Keene | Precision-optical assemblies

UK Facilities

Ilminster | Acousto Optics & Precision Optics

Torquay | Fiber Optics

Glenrothes | Precision Optics

St Asaph | Periscope systems

TOTAL
REVENUE
£86.1m
(2015 £78.7m)

OUR MARKET SECTORS

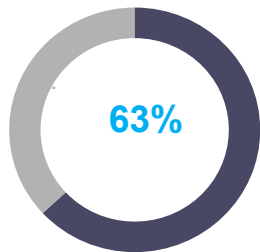
Industrial

Revenue:

£54.3m

(2015: £46.1m)

Percentage of
Company Revenue:



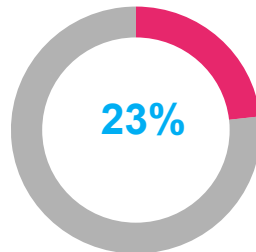
Aerospace & Defence

Revenue:

£20.0m

(2015: £19.8m)

Percentage of
Company Revenue:



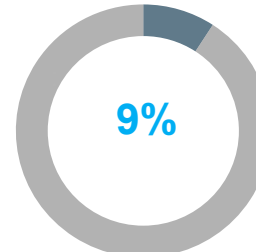
Life Sciences

Revenue:

£7.9m

(2015: £9m)

Percentage of
Company Revenue:



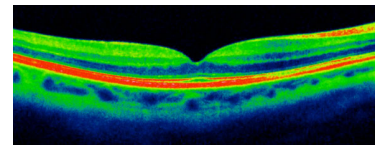
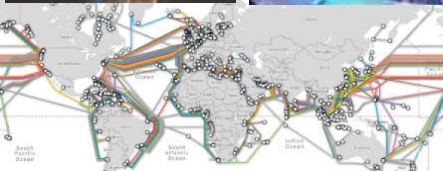
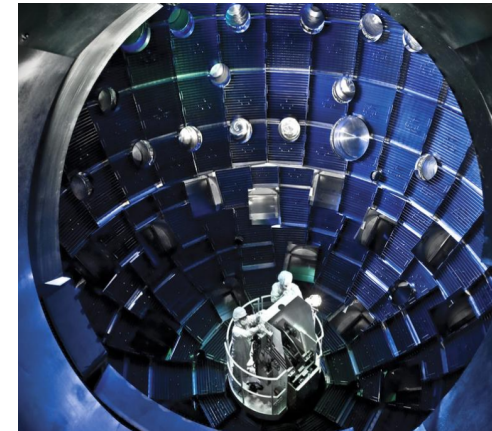
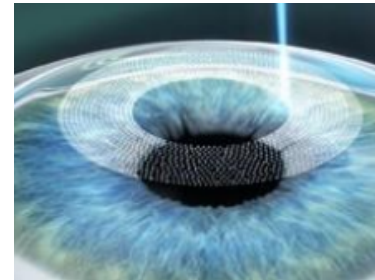
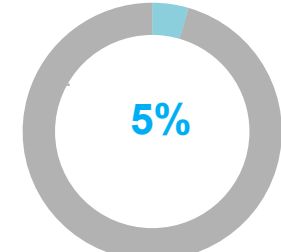
Scientific Research

Revenue:

£3.9m

(2015: £3.9m)

Percentage of
Company Revenue:





SPACE OPTICS & PHOTONICS
FUSED



ACOUSTO-OPTICS



OPTO-ELECTRONICS



SYSTEMS



FIBER COUPLER COMPONENTS & MODULES

Coupler modules flying since 2009

Tested against radiation, TVAC and mechanical tests

Developing a full range of space-grade fused product line

PM and non-PM couplers

WDM couplers

1xN coupler modules

Pump combiners

Power combiners

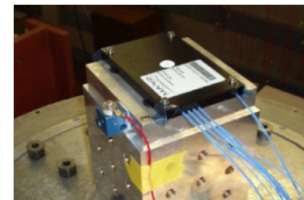
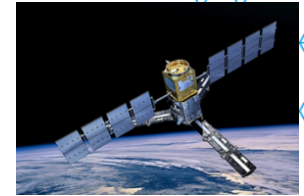
Diverse applications

Laser communications (downlinks, ISLs)

IR-sounding

Metrology

Scientific satellites



OPTO-ELECTRONICS

Modules designed, built, qualified or in process of being qualified for space applications

High-Power DFB Laser

Flown on the International Space Station (ISS)

Intended for use on multiple ESA, NASA, other programs

Low power consumption version in qualification for ESA

Single Mode Pump Laser

Completed Qualification for space mission

Designed into and under qualification for multiple space programs

High Speed detector

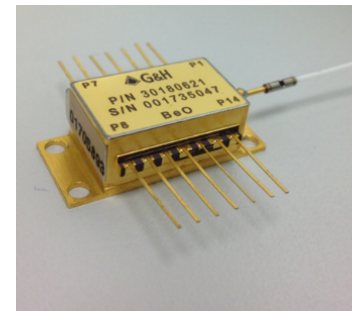
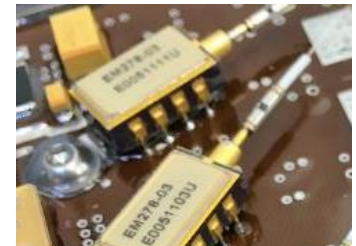
Delivered to Space Mission

Undergoing qualification for new ESA and other mission

High Power Multi-mode Pump Laser

Radiation Tested

Designed into and beginning qualification for multiple space applications



AMPLIFIER PRODUCTS UNDER DEVELOPMENT

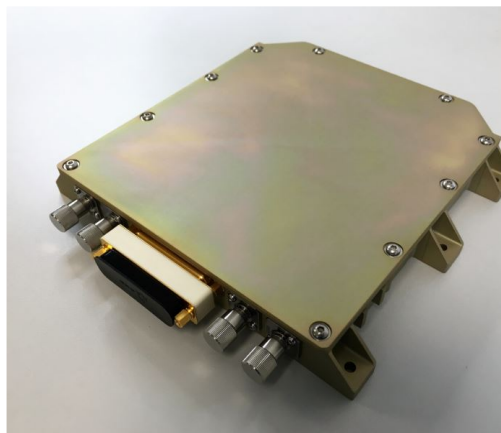
PEGASUS



- **Pre-amplifiers**
- High gain
- Low-Noise
- TRL 6



HYDRA



- **Mid-power**
- ~+20dBm
- Amplifier arrays
- TRL 7



CENTAURUS



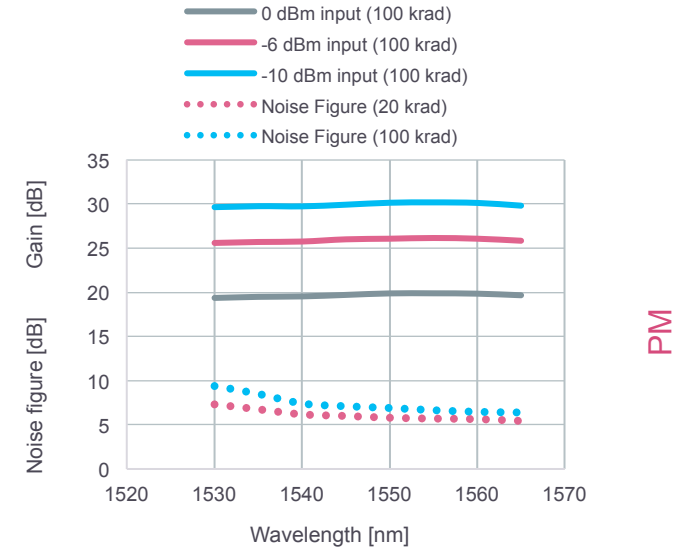
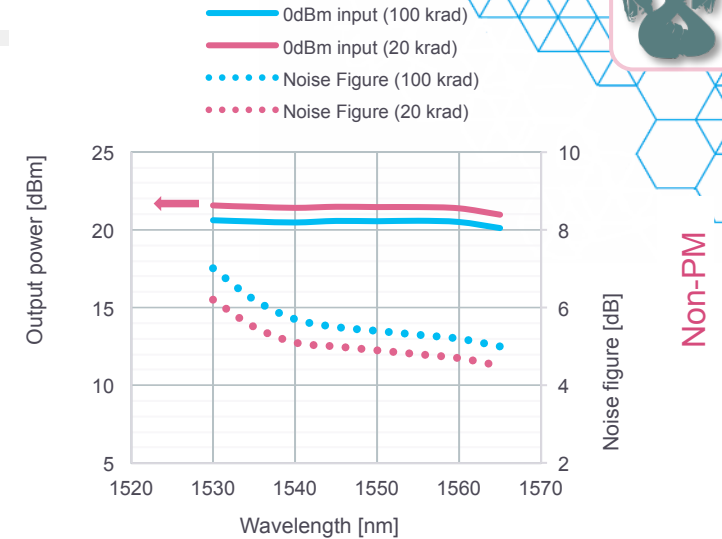
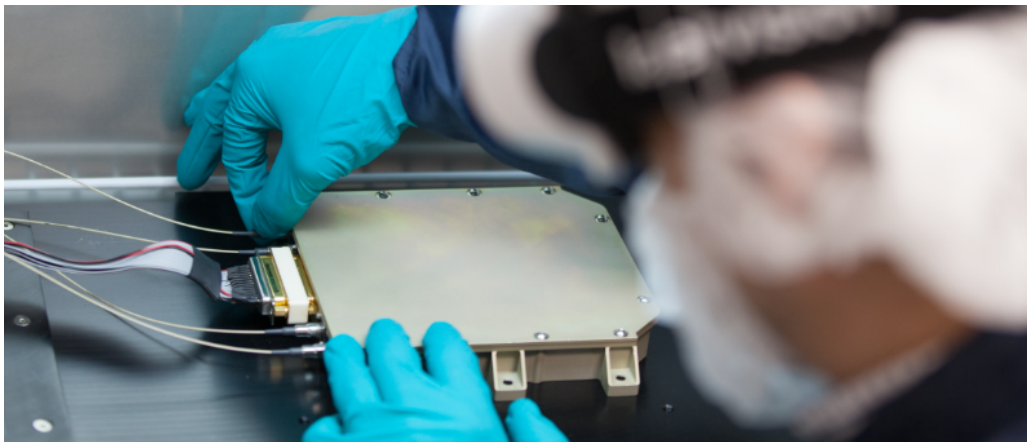
- **High-power**
- +30dBm to +40dBm
- High gain
- TRL 4/5



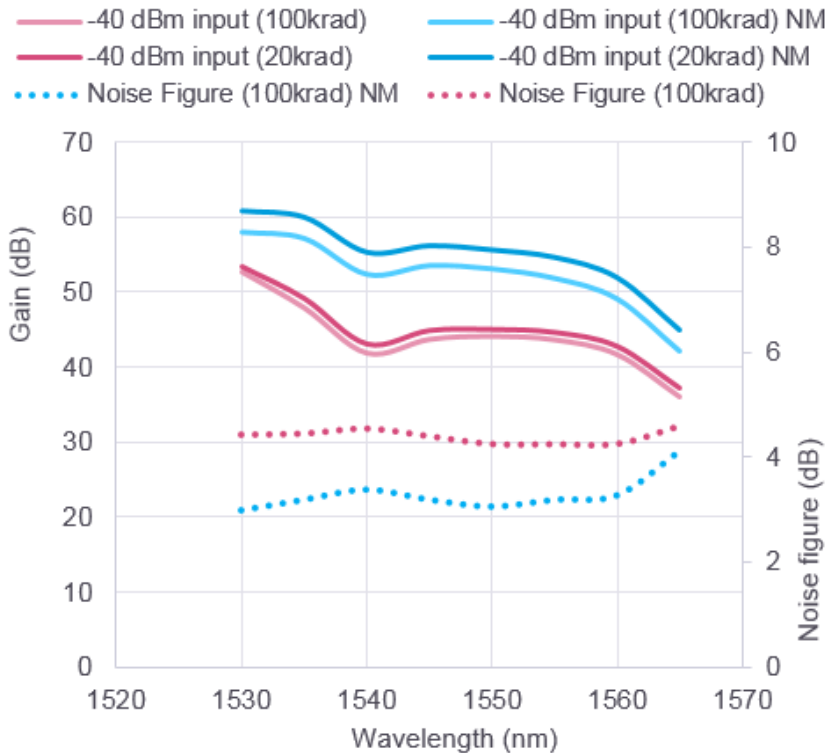
HYDRA: MID-POWER BOOSTER AMPLIFIER

TRL: 6-7 (QM / PFM)

Specifications (BOL)	Random Polarization	Polarization Maintaining
Saturated output power ¹ (dBm)	+16 to +21	
Wavelength range (nm)	C-band (1530 – 1565)	
Small signal gain (dB)	>28	>31
Static gain flatness (dB)	<0.5	
Noise figure (typ. @1550 nm)	<4.5	<5.5
Polarization extinction ratio (dB)	-	>24
Optical interface	Mini-AVIM	
Electrical interface	D-sb-44 / LVDS ANSI/TIA/EIA-644	
Power supply (VDC)	5 ± 5%	
Power consumption (Watt)	<2.5	<3.5
Operating temperature (°C)	0 to 50	
Size W x D x H (mm) (EM)	143 x 158 x 27.5	
Size W x D x H (mm) (EQM/FM)	143 x 153 x 24	
Mass (g)	<700	



PEGASUS: LOW NOISE PRE-AMPLIFIER



Specifications (BOL)			
Saturated output power (dBm)	< +15dBm		
Wavelength range (nm)	1530	1565	
Small signal gain (dB)	>55		
Noise figure (typ. @1550nm)	< 4		
Optical interface	Mini-AVIM		
Electrical interface	44-pin HD D-Sub		
Power supply (VDC)	5 ± 5%		
Power consumption (Watt)	< 3.5		
Size W x D x H (mm) (EM)	146	159.5	27.5
Size W x D x H (mm) (EQM/FM)	146	159.5	24.5
Mass (g)	<650		

TRL: 5-6 (EM/QM)

C-band >45 dB gain (>55 dB with NM)

PM and non-PM versions



HYDRA & PEGASUS QUALIFICATION

Both qualification campaigns complete

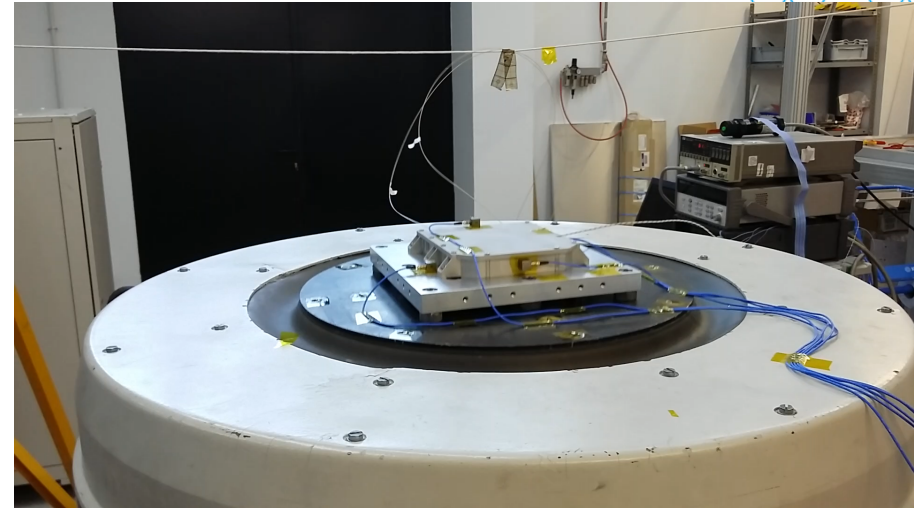
Following ECSS Unit-level test flow
TVAC, Shock, Vibration, EMC

1) GAIN BLOCK

No electronics

Pre-qualification of full EDFA

Extended shock (1,000 -> 2,500g)



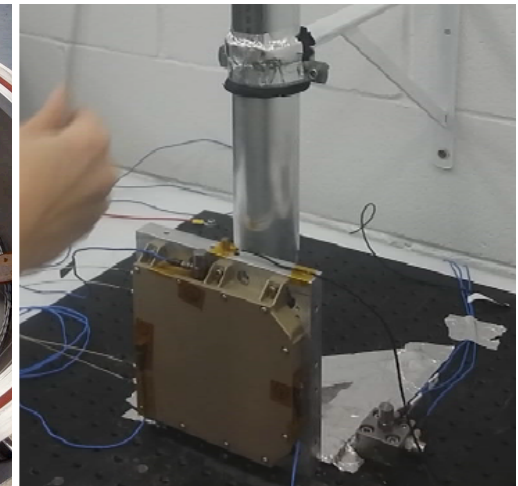
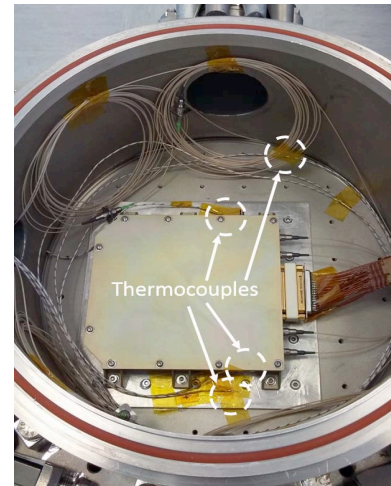
2) AMPLIFIER MODULE

Multi-channel amplifier for OPTEL-u

Unit includes space-qual electronics

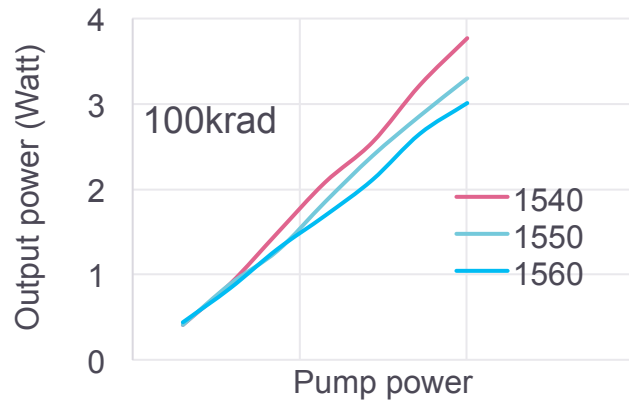
PCB_A as per ECSS

To be delivered to TAS by end July-17



- *Assembly, Integration & Test processes verified*
- *Components robust*

CENTAURUS: HIGH-POWER AMPLIFIERS



+35 dBm Amplifier System

TRL 5

EM delivered to customers

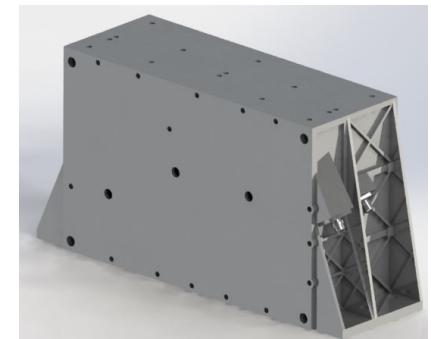
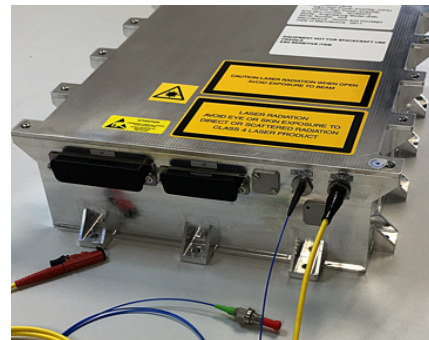
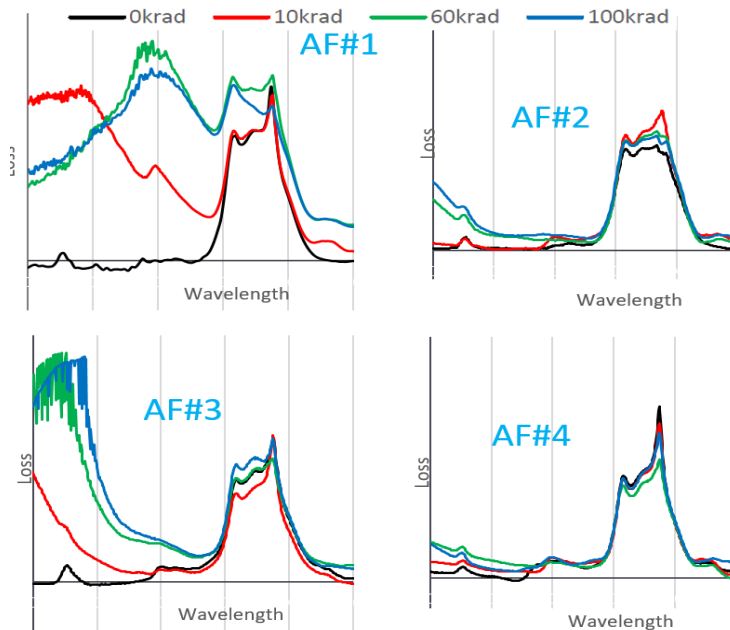
FM delivery in 2018



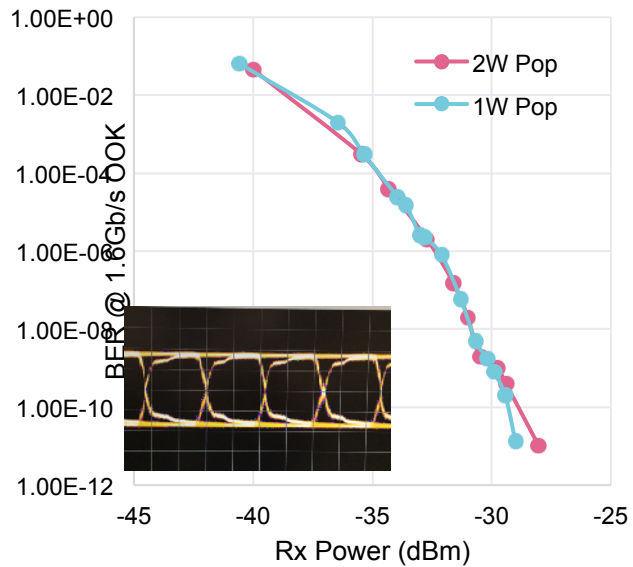
+27 to +37 dBm Gain Blocks

TRL 4

Qualification scheduled for 2018



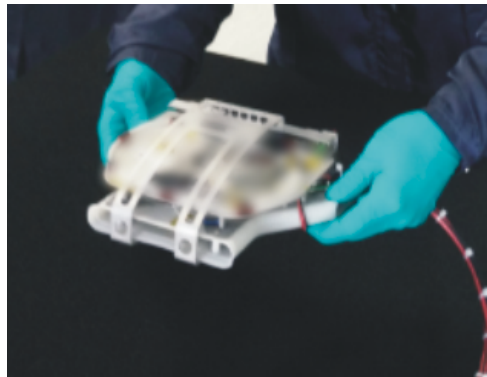
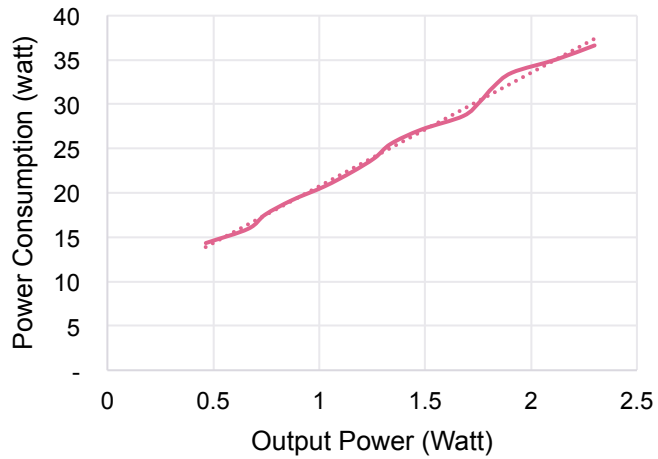
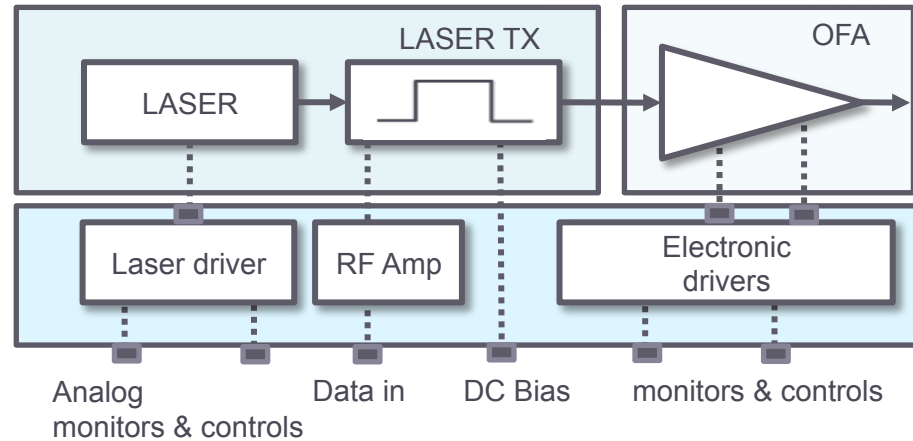
UAV LASER TRANSMITTERS



2W O/P power

<35Watt Power Consumption (excl RF driver)

<550gr mass



First flight successful

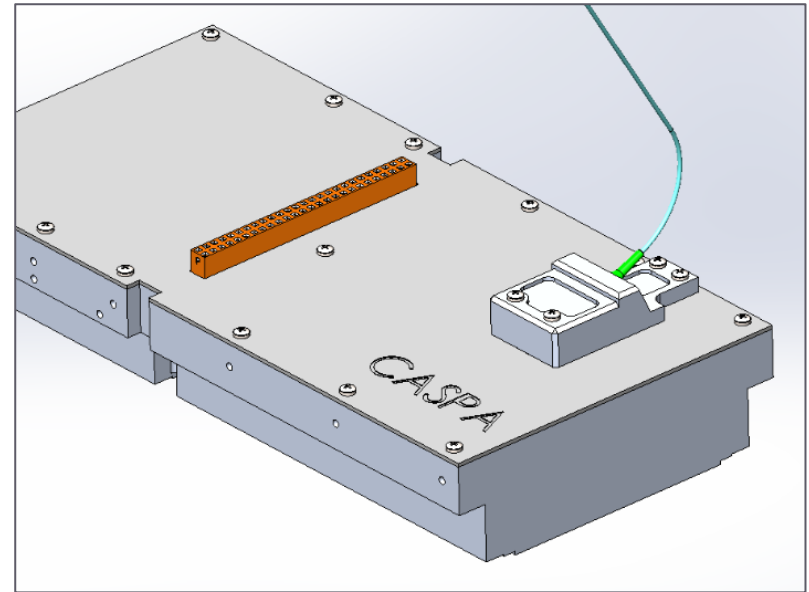
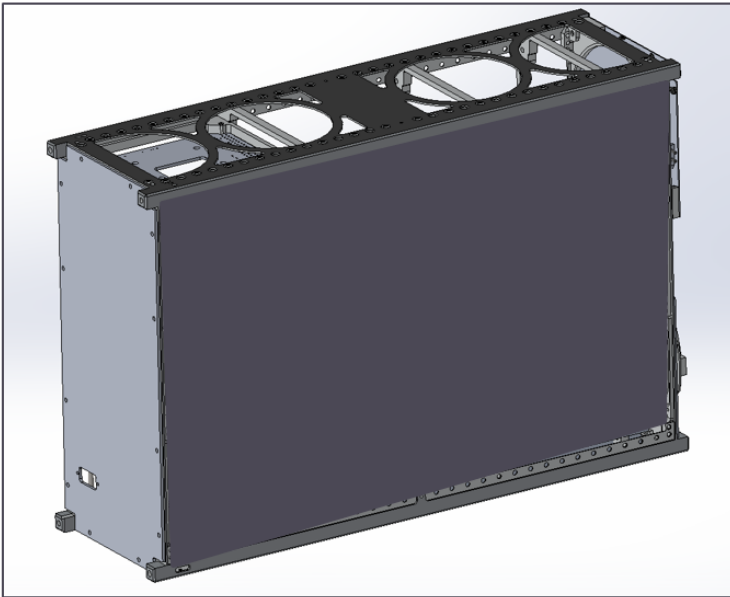
QUANTUM TECH: STABLE LASER SOURCES

Atomic clocks for navigation satellites

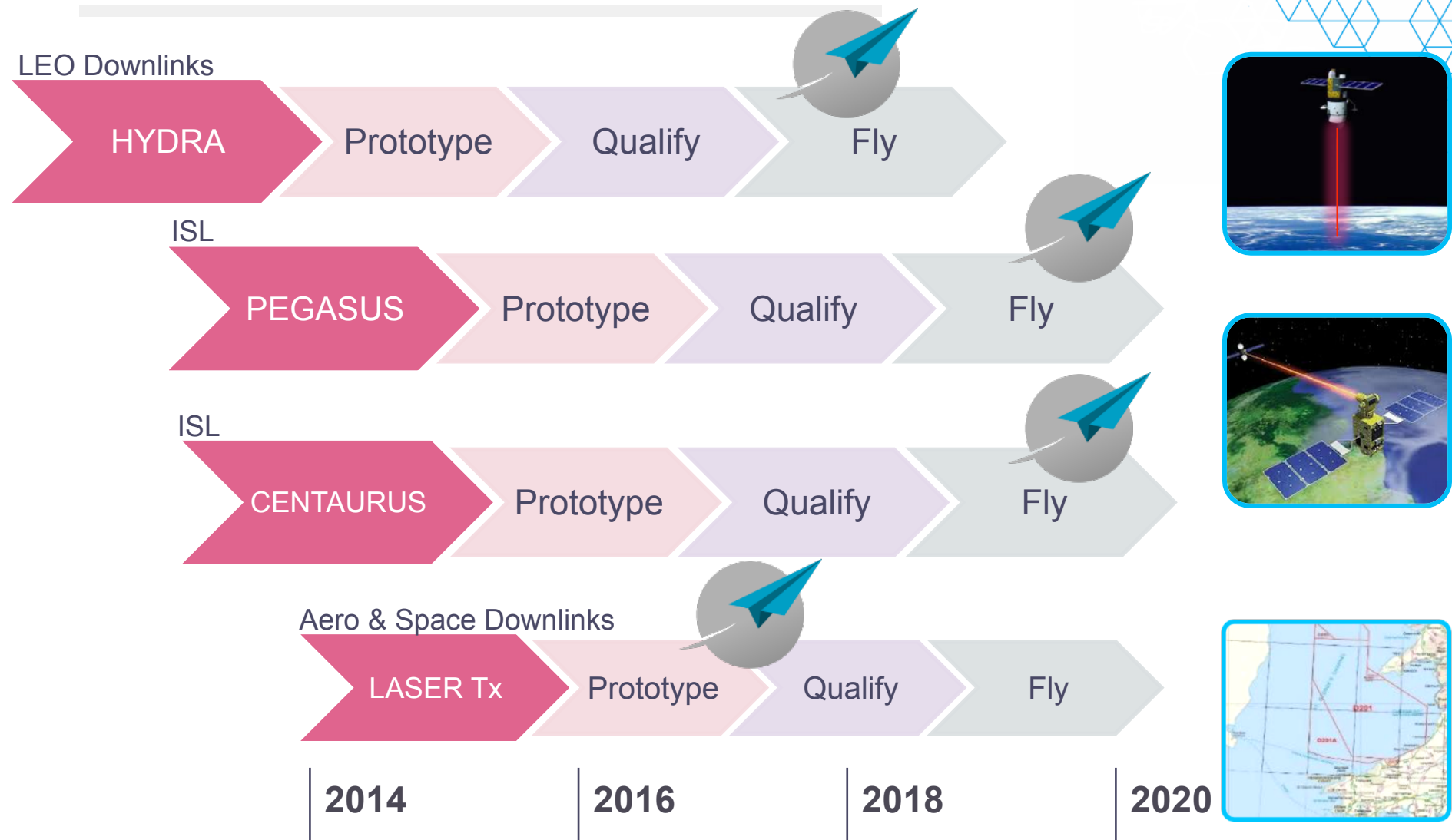
Atom cooling for remote sensing

Cold Atom Space Payload (CASPA)

Developing a stable frequency doubled 780nm laser source to be deployed on cubesats



G&H LAUNCH OPPORTUNITIES





THANK YOU