



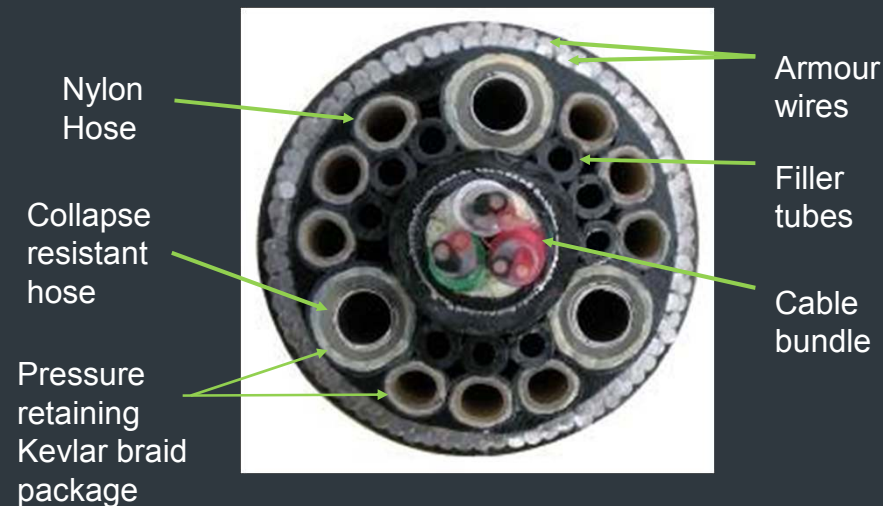
Fibre Optics In Subsea and Downhole Environments

Paul Machin

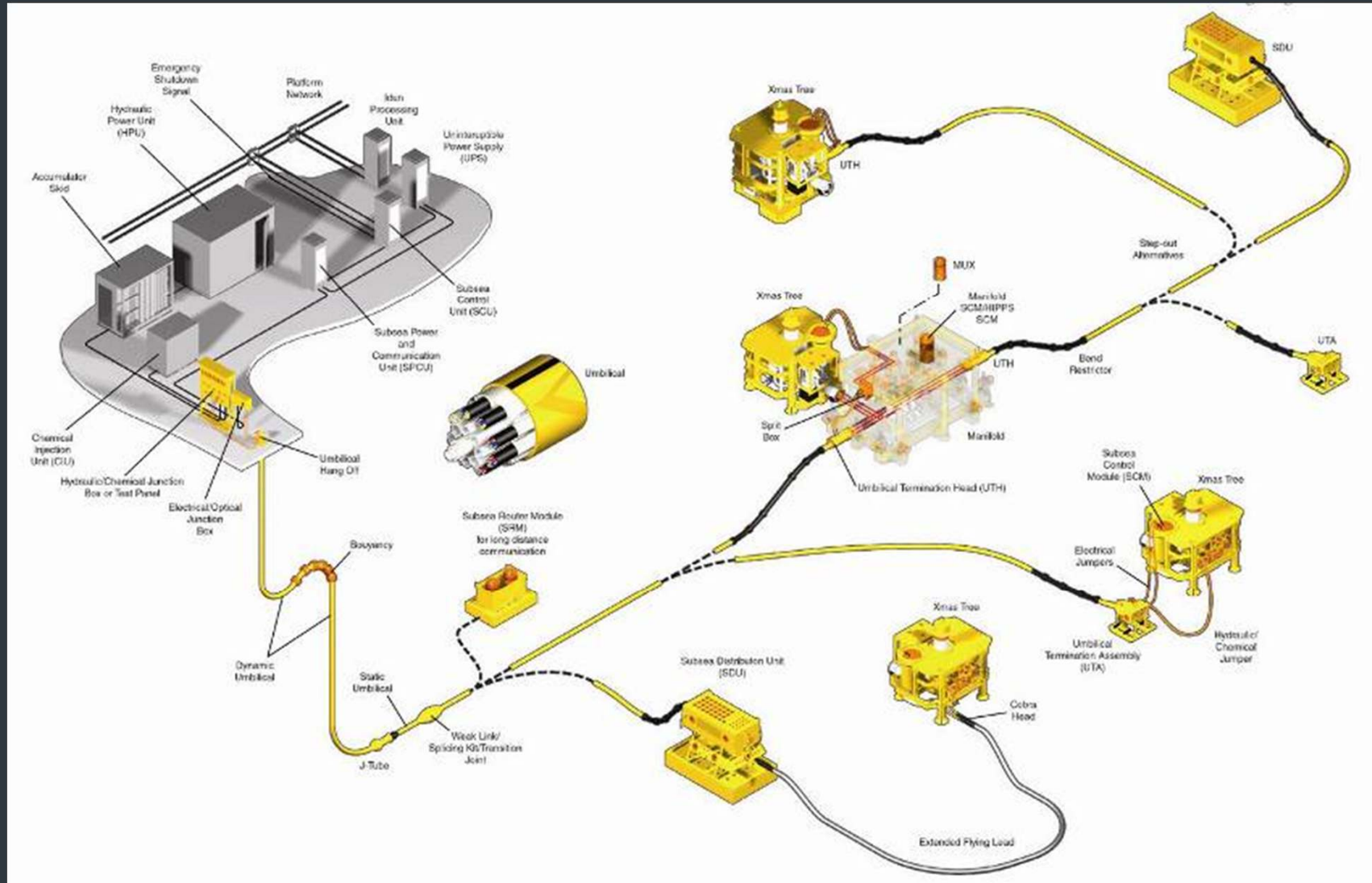
HALLIBURTON

Umbilical

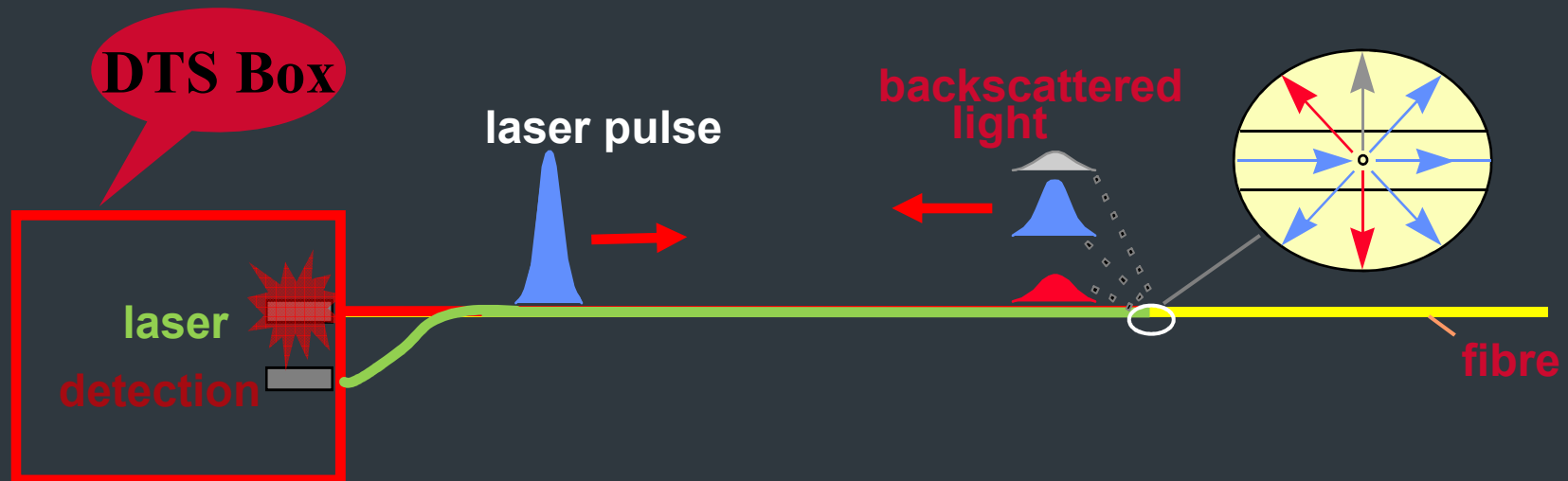
- Common Meaning
 - Adj. of navel, **Umbilical cord**, cord like structure connecting foetus with placenta of mother.
- Meaning within the Offshore Industry
 - a collection of hoses/tubes, electrical conductors, and/or optical fibres designed for subsea use.



Typical Umbilical Installations

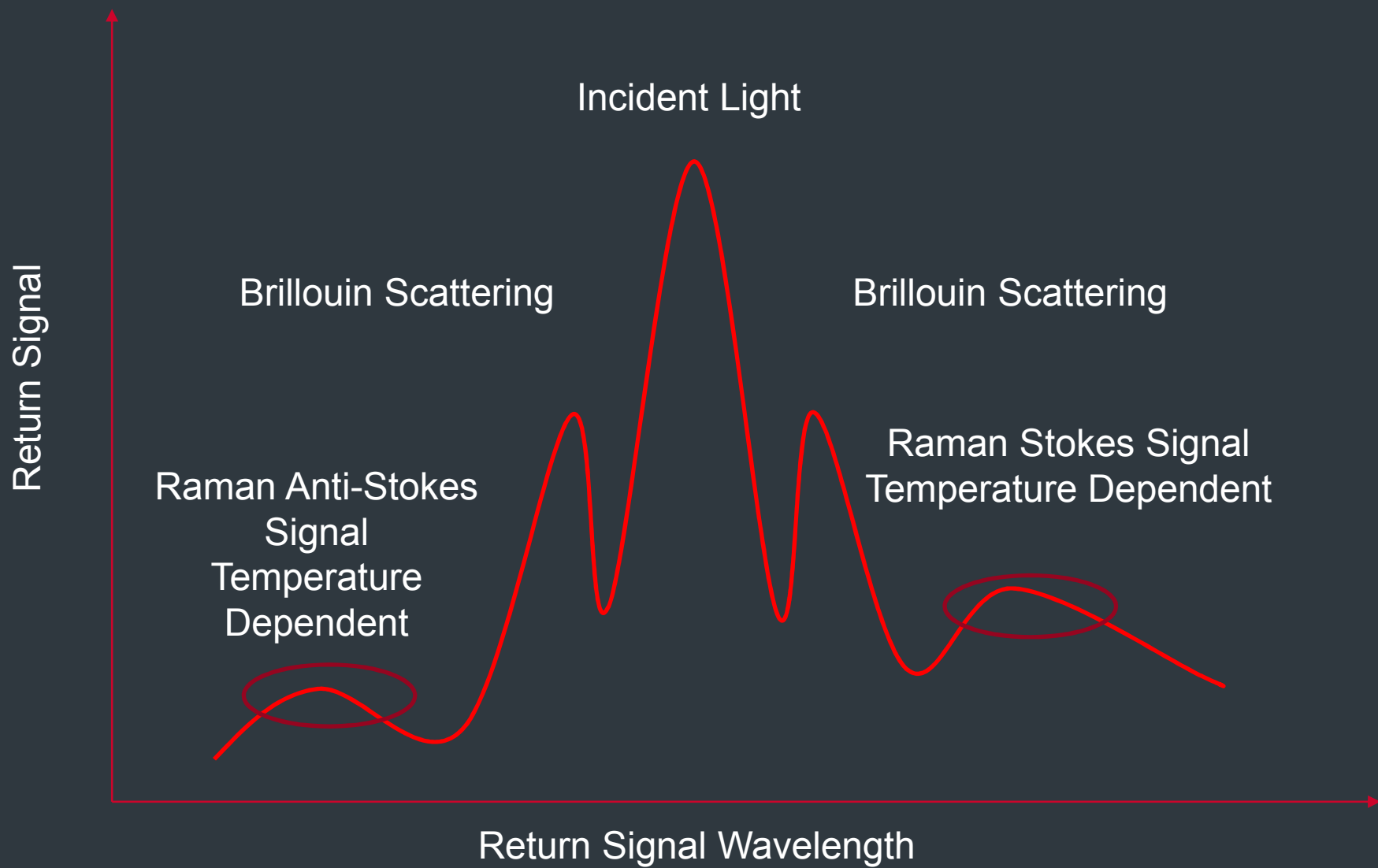


Distributed Temperature Sensing (DTS) Operating Principles



Depth → Depth determined from total travel time of light

Temperature → Function of Raman Stokes and Anti-stokes Backscatter



DTS - Applications

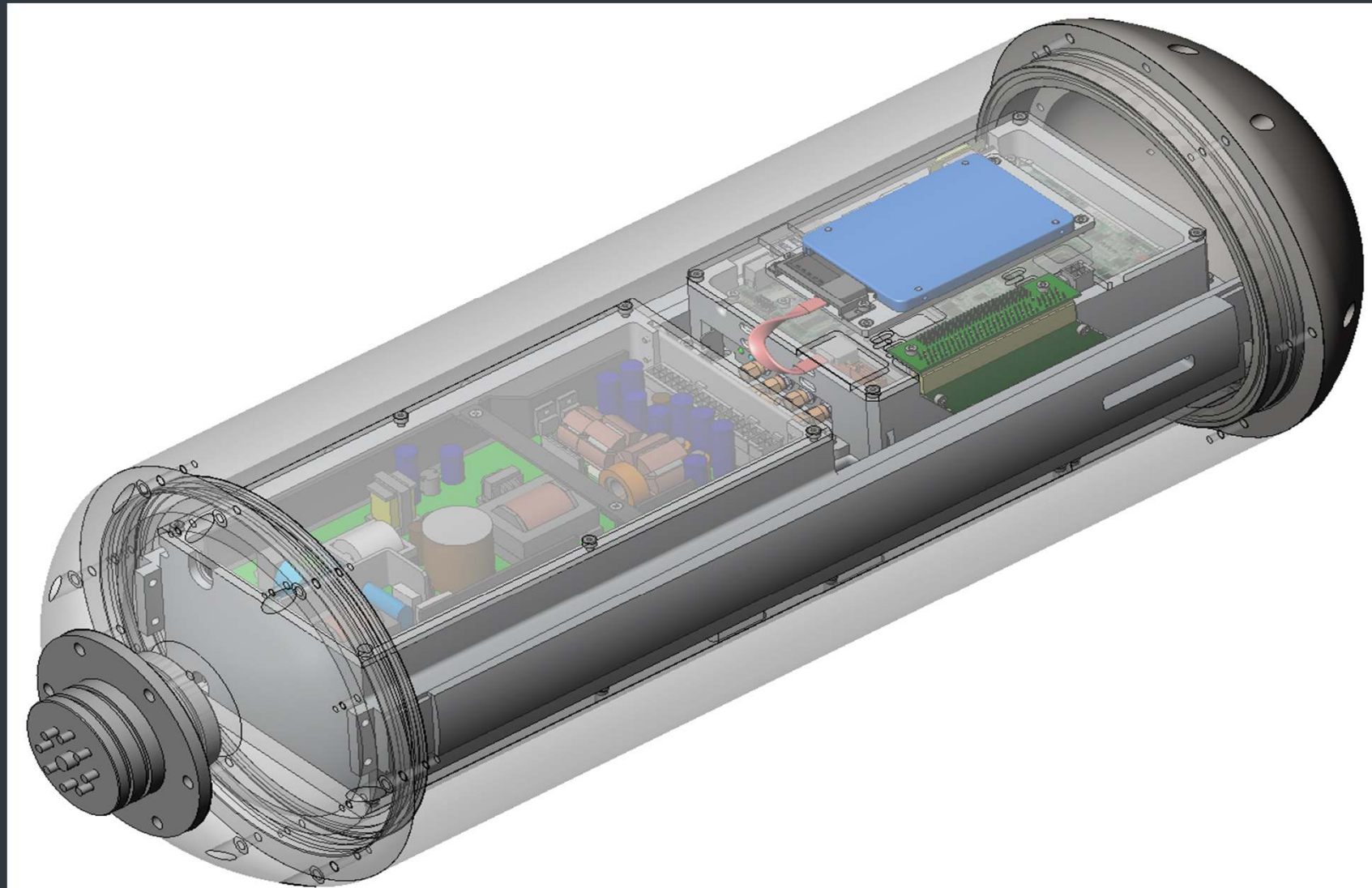
- Pipeline monitoring
 - Leak detection (gas, cryogenic)
 - Flow assurance (sulphur, heavy oil, etc)
 - Process monitoring (risers, LNG cool-down, etc)
- Oil, gas & geothermal well performance monitoring
- Power cable (hot-spot) monitoring
- Process & industrial plant monitoring
 - Leak detection
 - Condition monitoring
 - Process monitoring

Neptune™



- 1st Subsea DTS
 - Multi-year development program with super major – System deployment Q3-11
 - Gas lift monitoring & optimisation
 - Flow allocation & Production optimisation
 - Avoid/defer well intervention
 - Subsea pipeline monitoring for leak detection, hydrate detection and flow-assurance
 - Power cable and pump monitoring
 - Patent pending design

Neptune™ Subsea DTS Module



Stimwatch™ – applications

- Fluid Placement
 - Localise where fluid leaves wellbore
 - Localise thief zones
 - Evaluate diversion effectiveness
 - Evaluate target zone treatment
 - Continuous injection profile quantification
- Fracture height identification
- Cross flow identification

Deployment Options

- Retrievable Deployment Options
 - Capillary tubing based system
 - 10K ft Depths, real-time BH pressure, slickline deployable
 - Braided wireline cable
 - Tractor deployment, cased hole tools, H₂S/CO₂ options
 - Fiber Optic inside CT String
 - Fluid pumped backside of CT, cased hole tools, horizontals, fracturing
- Permanent Deployment Options
 - Strapped to casing
 - cemented in place, magnetically oriented perforating
 - Strapped to tubing
 - Capillary tubing placed across the perforations
 - Fiber optic cable pumped into capillary tubing

QUESTIONS