Commercial Design of a Photonic Doppler Velocimeter

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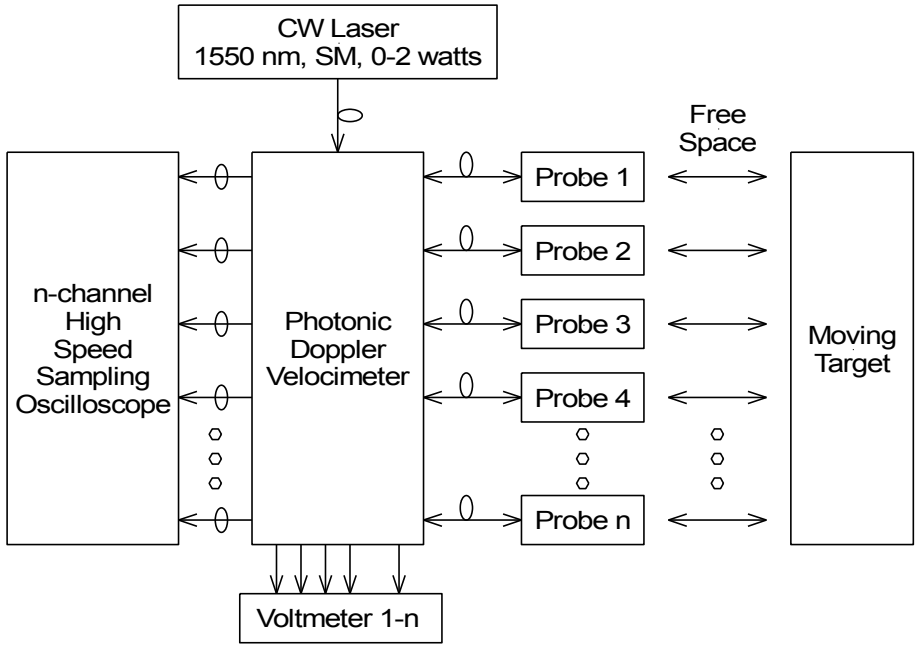
Brief Photonic Doppler Velocimeter (PDV) History

- Technology developed for over a decade, well established, very successful
- Systems produced within government community using off-the-shelf parts
- Government wanted outsourcing to commercial sector, initiated early 2007 by Gerrit Sutherland, Naval Surface Warfare Center, Indian Head MD
- TME won contract to produce a commercial unit, mid 2008
- TME commercial design subject of this presentation, model 1CF41A

Basic PDV System



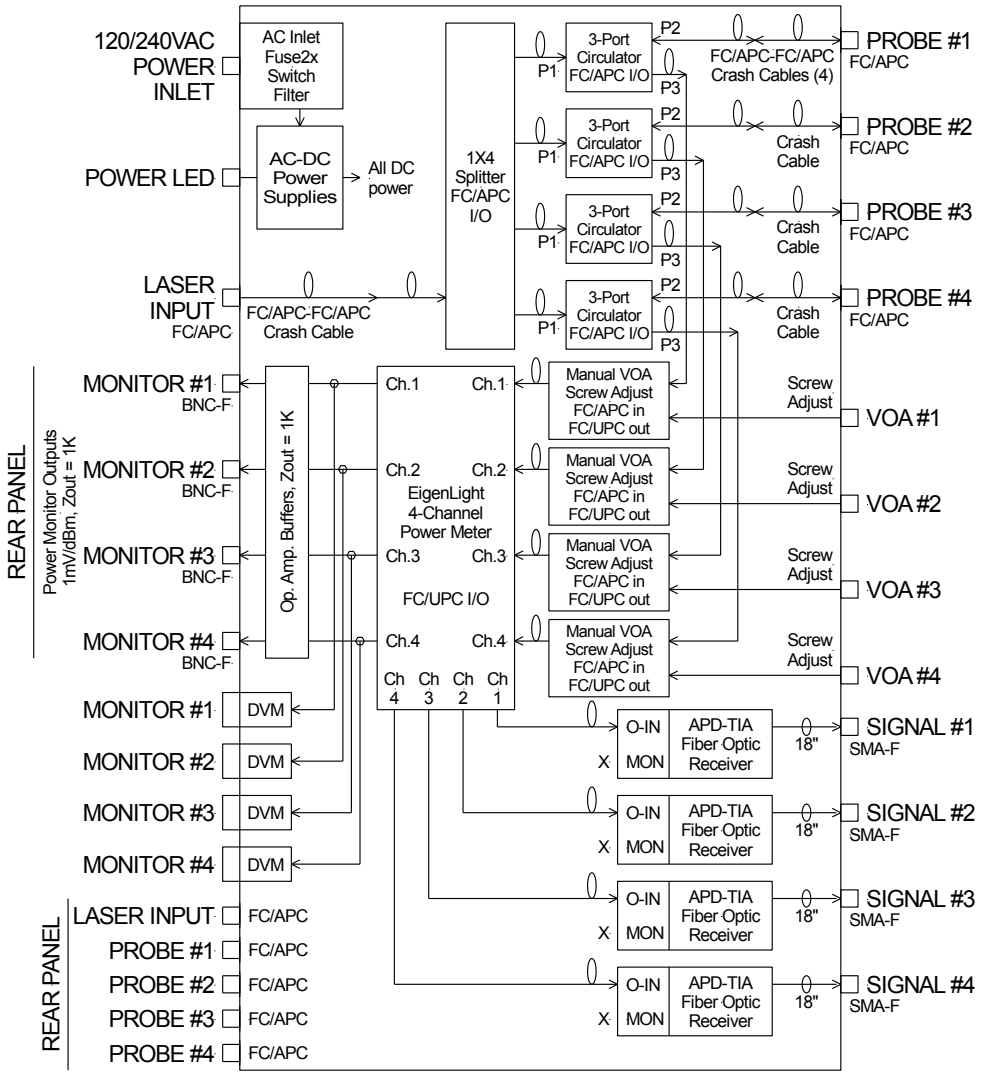
PDV Design Considerations

- Packaging
  - Previous PDV's typically used "off the shelf" chassis (large) and components, more complex optical circuits
  - TME analysis found that a basic 4-channel unit could be packaged in 1U chassis x 22" deep, no fan needed
  - TME internal modularity style used on sub-assemblies for manufacturing and maintainability ease
  - Anti-static, black anodized, machined aluminum chassis with white epoxy graphics (laser engraving optional)
- Electronics
  - TME custom power supply assembly used - fits in 1U chassis, provides efficient utility cabling, insures load ratings are met, provides fused and switched 120/240 VAC input capability with line filtering and transient protection, provides ±10% DC power monitoring of ±5 volt outputs using single front panel bi-color LED power indicator
  - TME custom front panel display assembly used - provides user monitoring ease, provides four 3.5 digit green digital voltmeters, analog buffering of rear panel BNC outputs, efficient utility cabling
  - 5 TME custom connectorized utility cables and 4 low loss SMA cables used
- Optics
  - Newport O/E converters and Eigenlight power monitors used (alternate devices possible)
  - Manually adjustable OZ attenuators used (electronic attenuators possible, adds more electronics)
  - 1x4 coupler used for laser input distribution (<4W, connector limited)
  - TME fiber hub with fiber tie-downs used, no fiber take-up reels (fiber work difficult with reels)
  - FC/APC narrow key connectors used (FC/UPC might be possible, more common)
  - All internal fiber optic cables are 900um OD
  - Front panel optical I/O access, user changeable for rear panel access
  - User replaceable internal fiber optic "crash" cables used on all optical I/O ("cleanliness is next to Godliness")

Simplified PDV Design Process

- Procure critical, long lead-time, and known commodity components
- Decide on design for all 3D solid models and artwork (the hard part, iterative)
- Generate prints, procure all custom machined items
- Create custom electronics (components, schematics, pc boards, cabling)
- Procure pc boards, electronic components, all remaining items
- Create and verify performance test setup
- Receive in all machined items, fab pc boards, commodity parts, etc.
- Assemble PDV as parts arrive
- Final test – DC checks, performance tests
- Documentation, packing, shipping, invoicing, and support

PDV Block Diagram – TME Model 1CF41A



- 1x4 splitter
- Four 3-port circulators
- Four manual VOA's
- 4-channel power monitor
  - Four front panel 3.5 digit DVM's
  - Four rear panel BNC's, buffered
- Four fast APD O/E converters
- 5 fiber optic "crash cables"
- Universal AC power input
- DC power monitoring
- Front or rear panel FC/APC I/O optical ports

  (Not shown)
- Internally modular construction
- Fiber "hub", manages 26 fibers
- 5 custom utility cables

TME Model 1CF41A, Photonic Doppler Velocimeter (PDV)

- Used with laser, high speed oscilloscope, and 1-4 probes for complete PDV system
- PDV system used to optically measure high velocities of surfaces without contact
- Laser input, ~1550nm, 2W max.
- 4 optical channels, front (default) or rear access FC/APC connectors
- 4 manually variable optical attenuators
- 4 optical channel power monitors via front panel 3.5 digit panel meters and/or rear panel BNC-F connectors with buffering
- 4 high speed O/E converters, DC coupled to front panel SMA-F connectors
- 5 internal fiber optic “crash” cables, user replaceable & front to rear access changeable
- ~6 meters fiber length from input to probe, ~6 meters fiber length from probe to receiver
- 120/240VAC <25W, bi-color Power LED monitoring that internal supplies are within 10%
- 1Ux22” deep, rack or desk mountable, black with white graphics, internally modular, with operating manual
- ~$96K, ~8-10 weeks

Front and Rear Panel Views

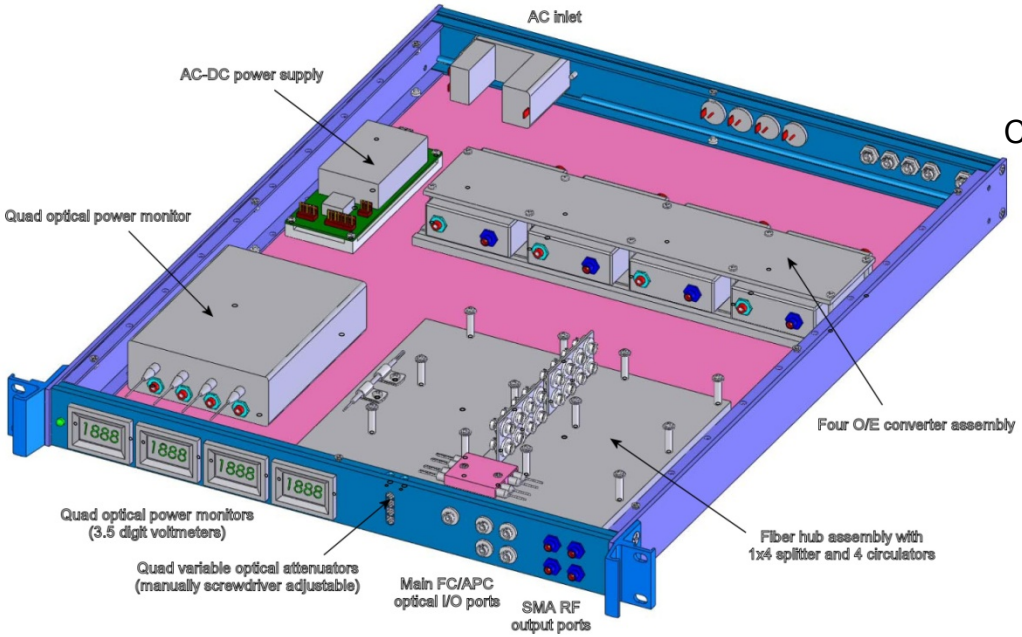
Front View

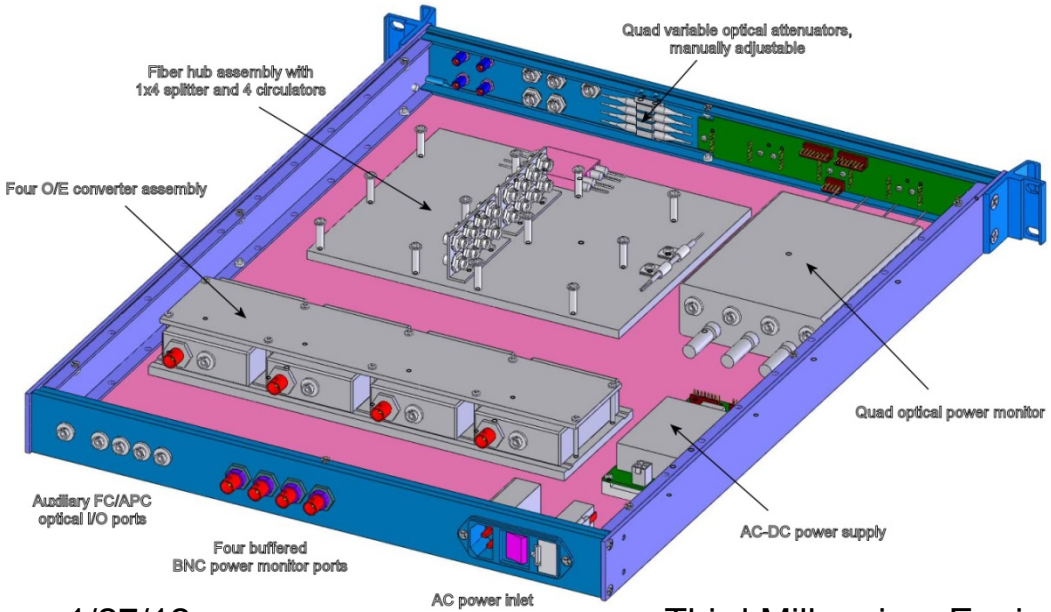
Rear View

- Chassis is black anodized aluminum (anti-static)
- Graphics are silk-screened white epoxy (laser engraving optional, rugged)
- User warnings provided
  - Maximum optical input power, FC/APC optical connectors, clean optical connectors before use, ESD sensitive RF ports, fusing, safety agency

Internal Views

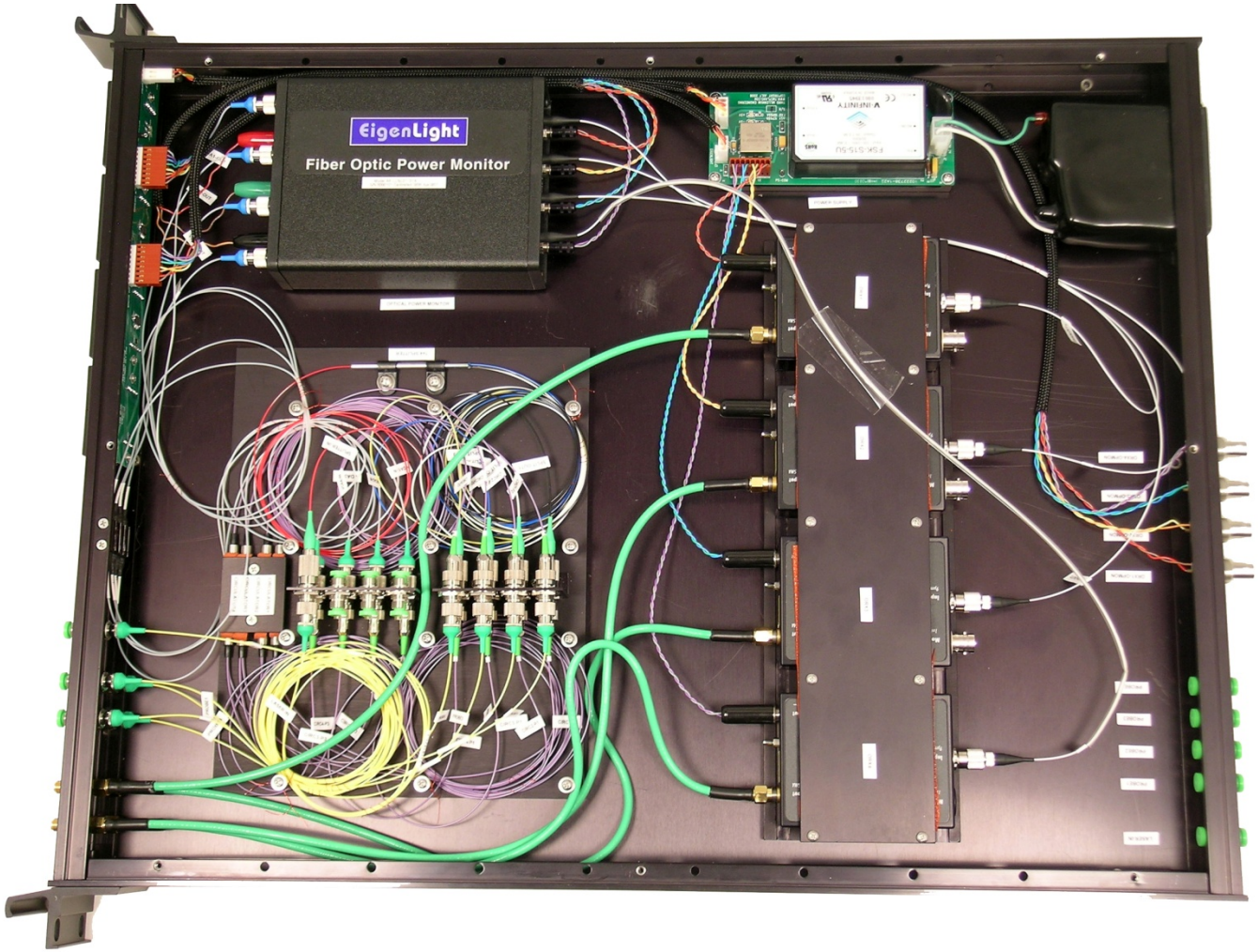
CAD models, top cover removed, cabling not shown





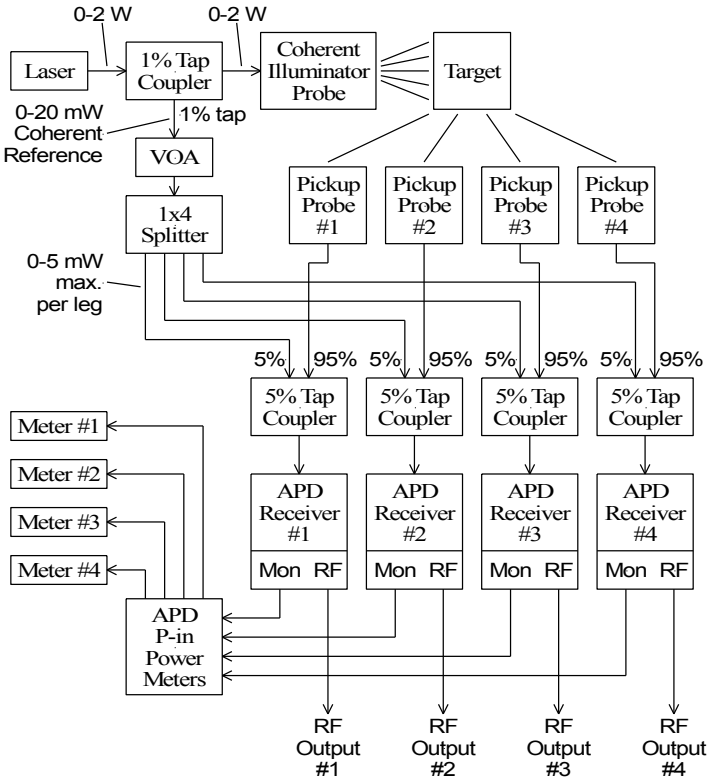
- Internally modular
- AC Inlet
  - Dual fused, dual pole switch
  - AC line filter, separable cord
- AC-DC power supply
  - 120/240VAC input
  - +5V @ 3A, -5V @ 0.3A
  - ±10% voltage monitoring
- DVM assembly
  - 4 digital voltmeters, 3.5 digit
  - DVM, buffers, utility ports
  - Utility cable distribution
- Fiber hub assembly
  - Manages 26 optical fibers
  - 13 FC/APC adapters
  - 1x4 splitter, 4 circulators
- O/E converter assembly
  - Holds 4 O/E converters

Internal View



Future Commercial PDV Options

- Different channel counts
  - >4 channels, chassis height increases from 1U to 2U or 3U
- Use of alternate components
  - O/E converters, optical power monitor
  - Electronic variable optical attenuators
  - FC/UPC connectors instead of FC/APC (similar performance?)
- Possible integration of laser and/or 12G sampling oscilloscope
  - More electronics needed, internal controller & software required
  - Front panel controls and display added for manual use
  - LAN port added for computer use, basic GUI provided
- Alternate architectures
  - For higher laser power, lower cost, telecom laser modules (less coherency 10 MHz → 20 meters, less power <1W)



Alterative architecture example
(based on quick data acquisition)

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