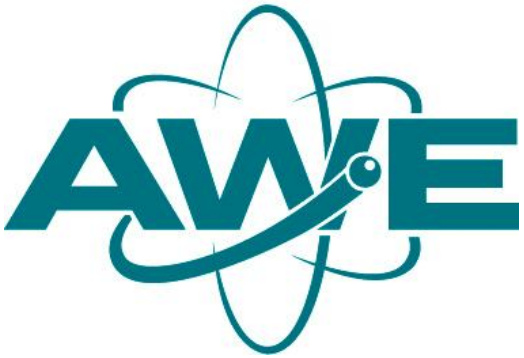

Assorted Results from Initiation Train Experiments PDV Workshop 2011

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Introduction

- Explosive Initiation Science (XIS) Group at AWE responsible for initiation train design
- Need velocimetry as core capability
  - But no customer driver for “blue-sky” development
- Historically, VISAR (Sandia ~1991)
- VISAR capability lost (both equipment and expertise)
- PDV capability development began 2006
  - Mike Bowden – Technical Lead, Optical Diagnostics
  - Matthew Maisey – Technical Lead, Modelling and Software Development

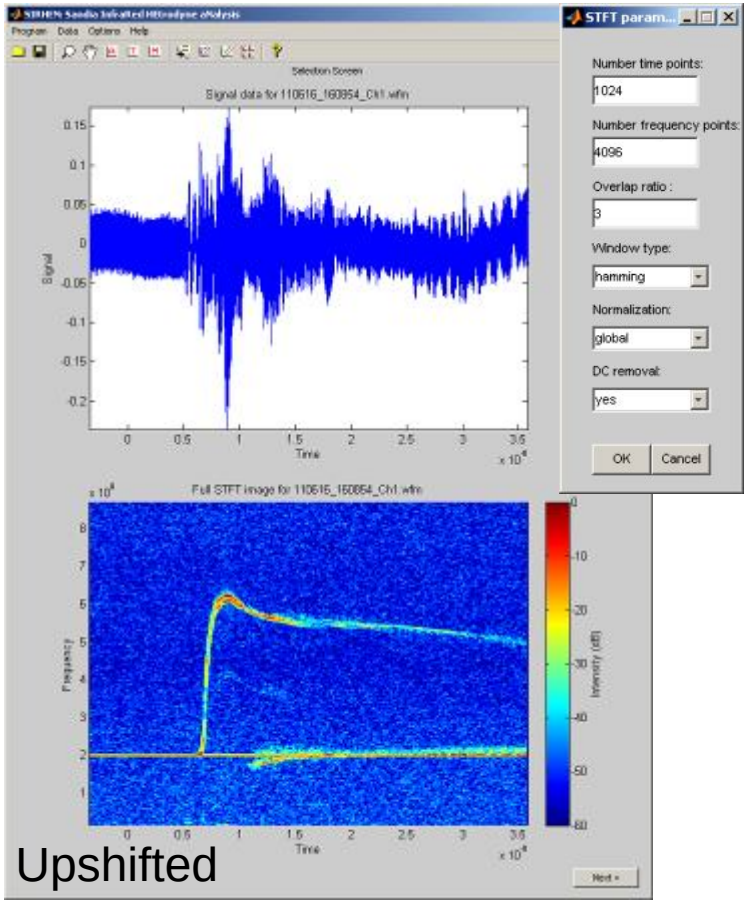
Developments since 2009

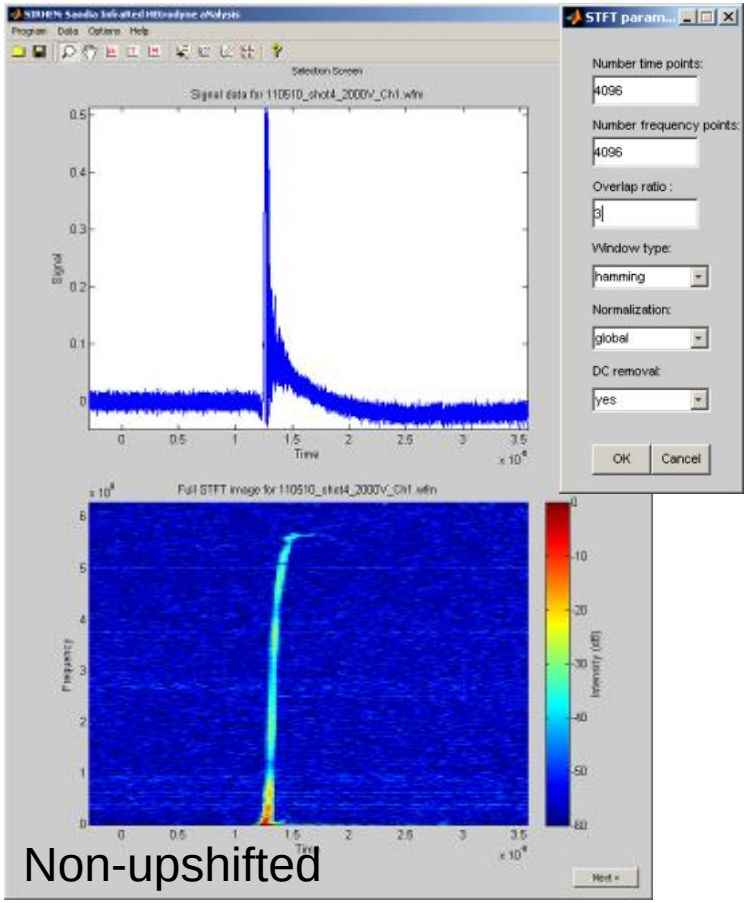
- We have switched to optically-upshifted PDV
  - NP Photonics locker
- Significant development of MEDUSA 32 channel PDV system
- Fielded on more experiments
- Measured time delay from probe to detector using ps pulsed laser

Optically-upshifted PDV

- Laser 1: 150-2000 mW
- Laser 2: 25 mW
- Combined with 10/90 combiner (~2 mW of laser 2 at detector)
- First tried without solid locking between lasers
  - Offset would vary on a minute to hour timescale
- Now set using NP Photonics locker
  - 2 GHz offset typical
- Typical turn-on time is ~1 hour from cold start to locked offset
- Has *greatly* improved ease of setup, alignment and data quality
- No need to balance signal and reference

A Comparison of Standard and Optically-upshifted PDV

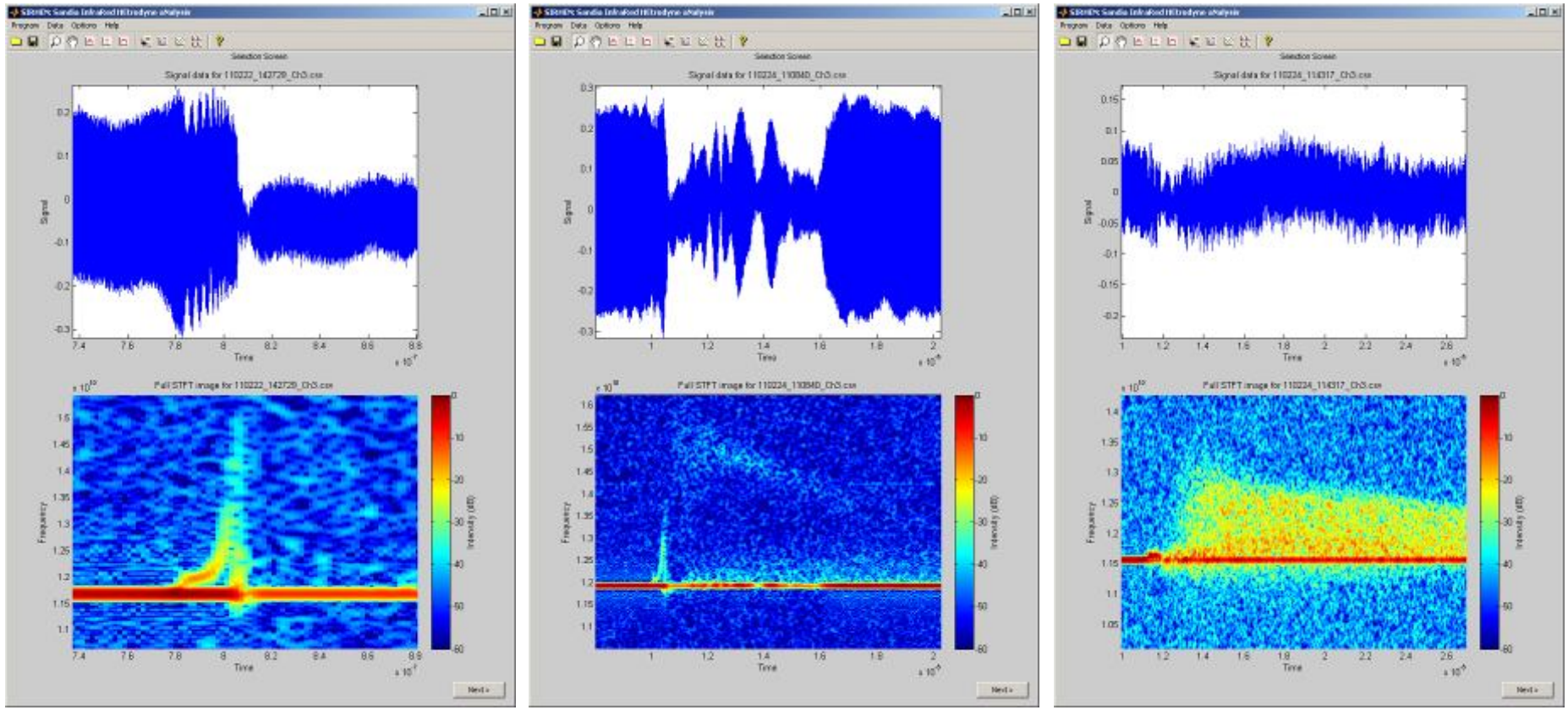




25 µm dielectric flyers. Non-upshifted data courtesy of Gary Liechty (LANL)

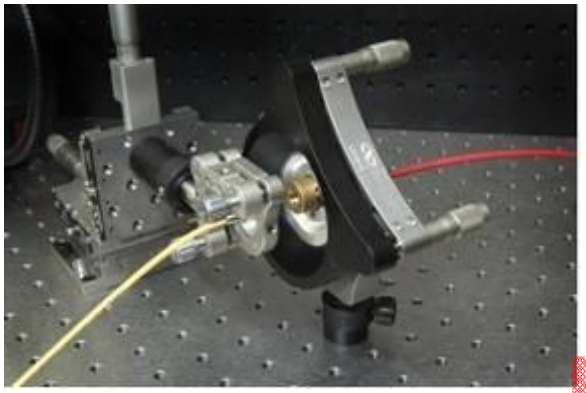
Exploding Bridgewires

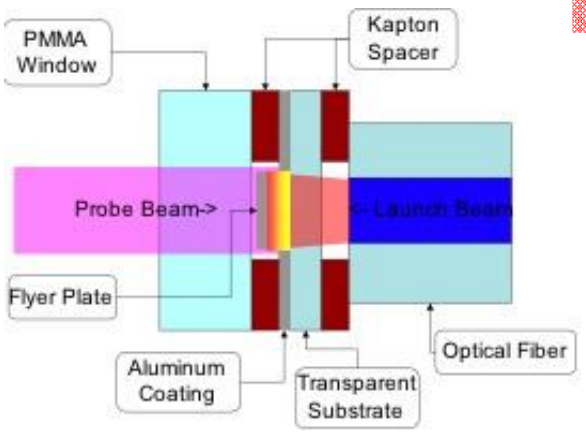
- Alignment is *very* hard – most shots have no or very little data

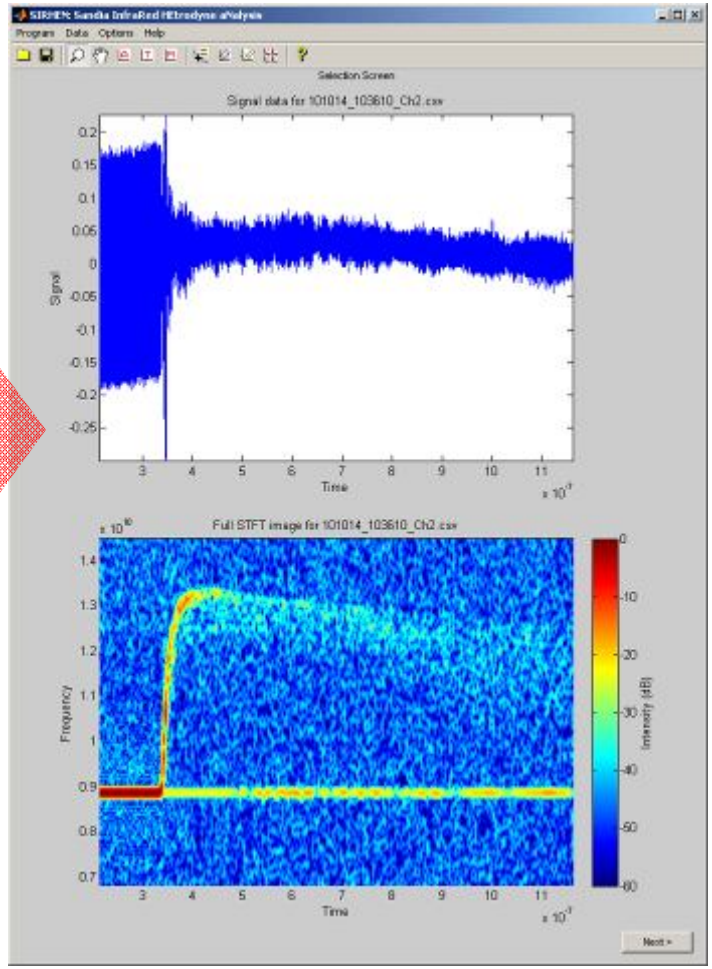


Courtesy of Elizabeth Lee (AWE)

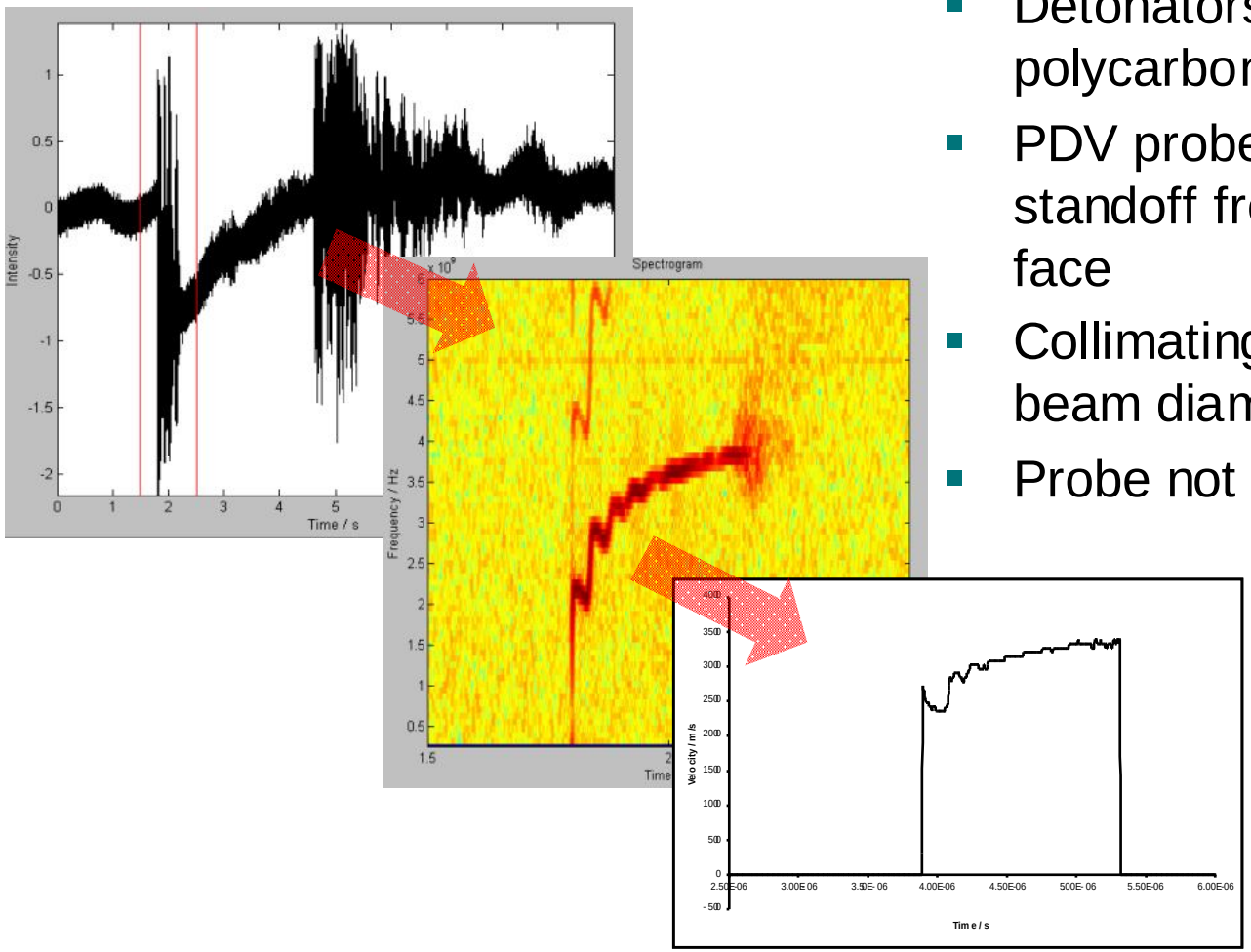
Laser-driven Flyer Plates





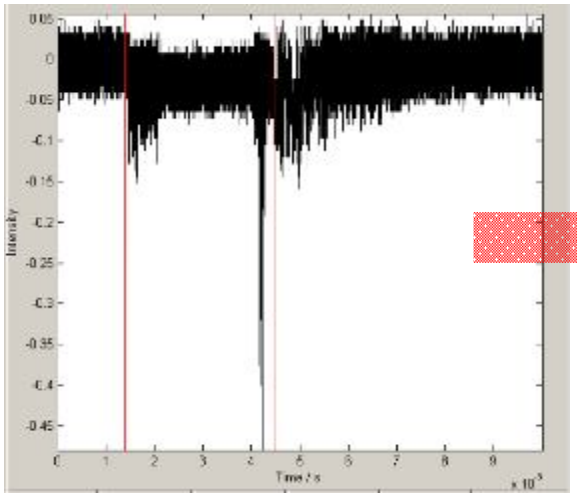


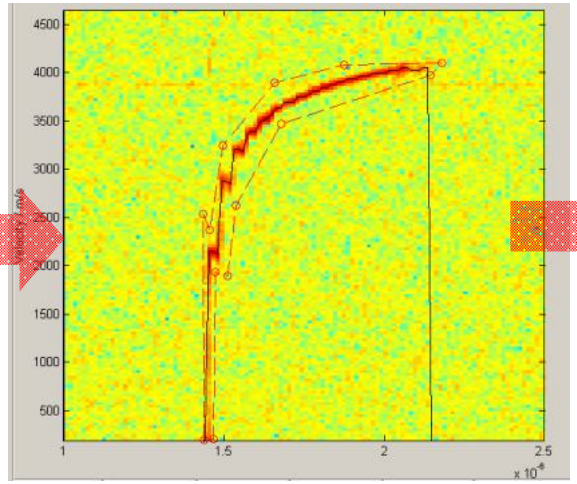
Detonator Can Output

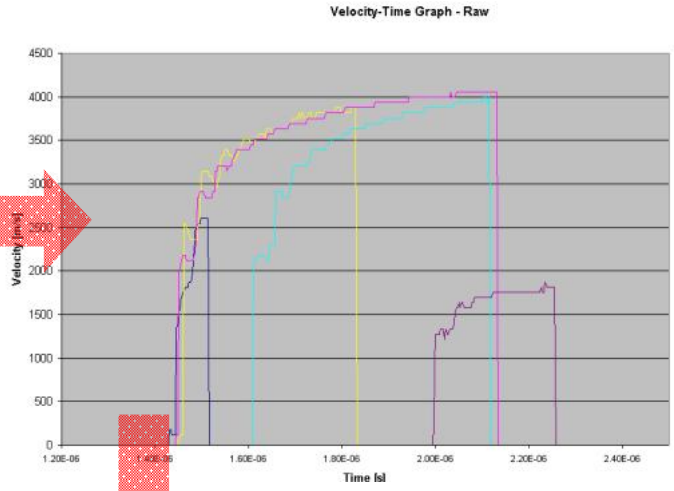


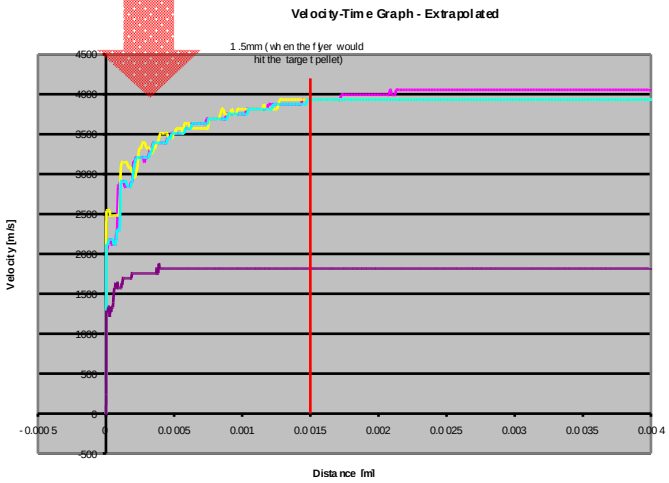
- Detonators mounted in a polycarbonate fixture
- PDV probes held at ~ 3-4 mm standoff from detonator output face
- Collimating probes with 0.5 mm beam diameter
- Probe not precision aligned

Explosively-driven Flyer



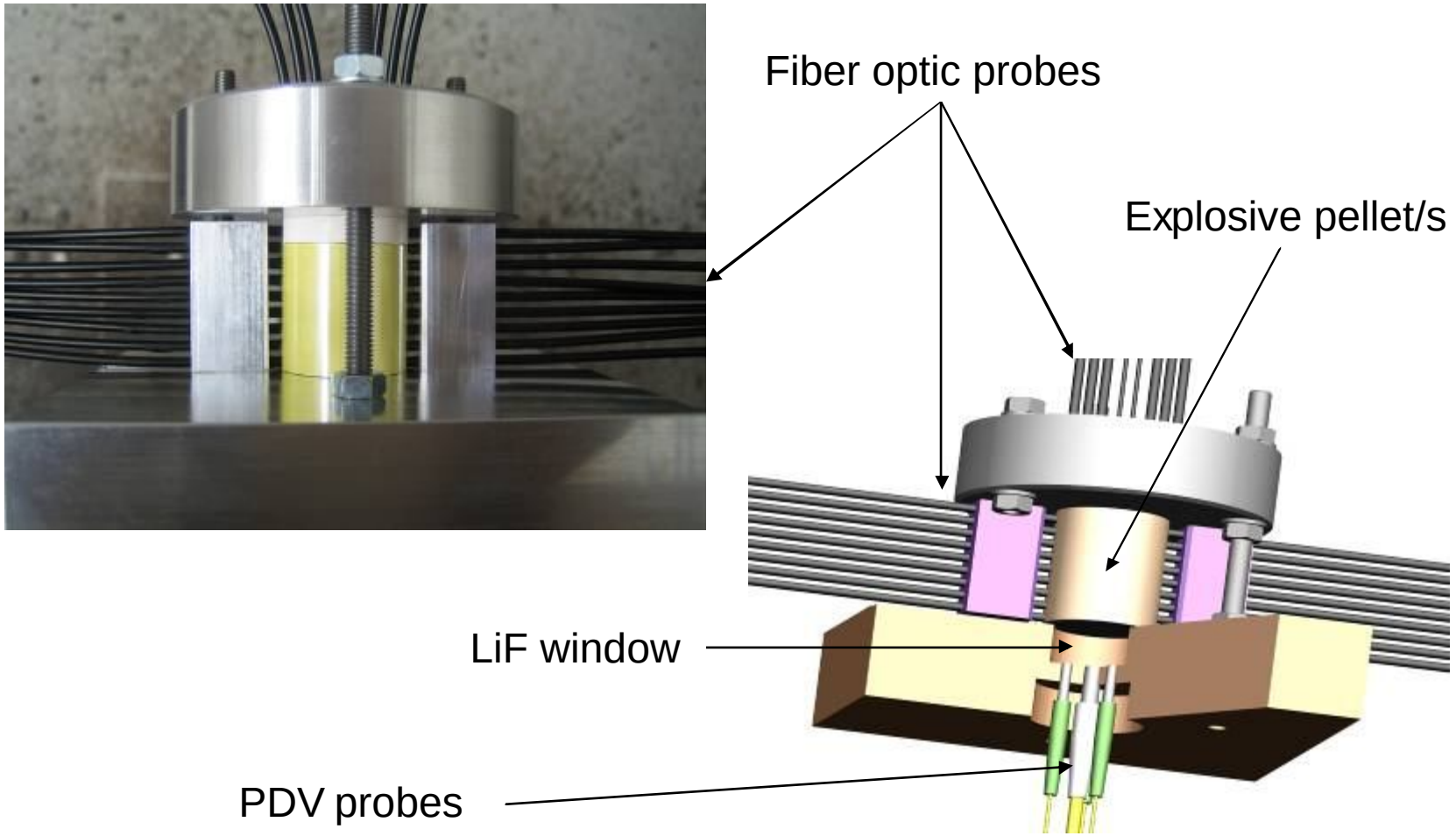




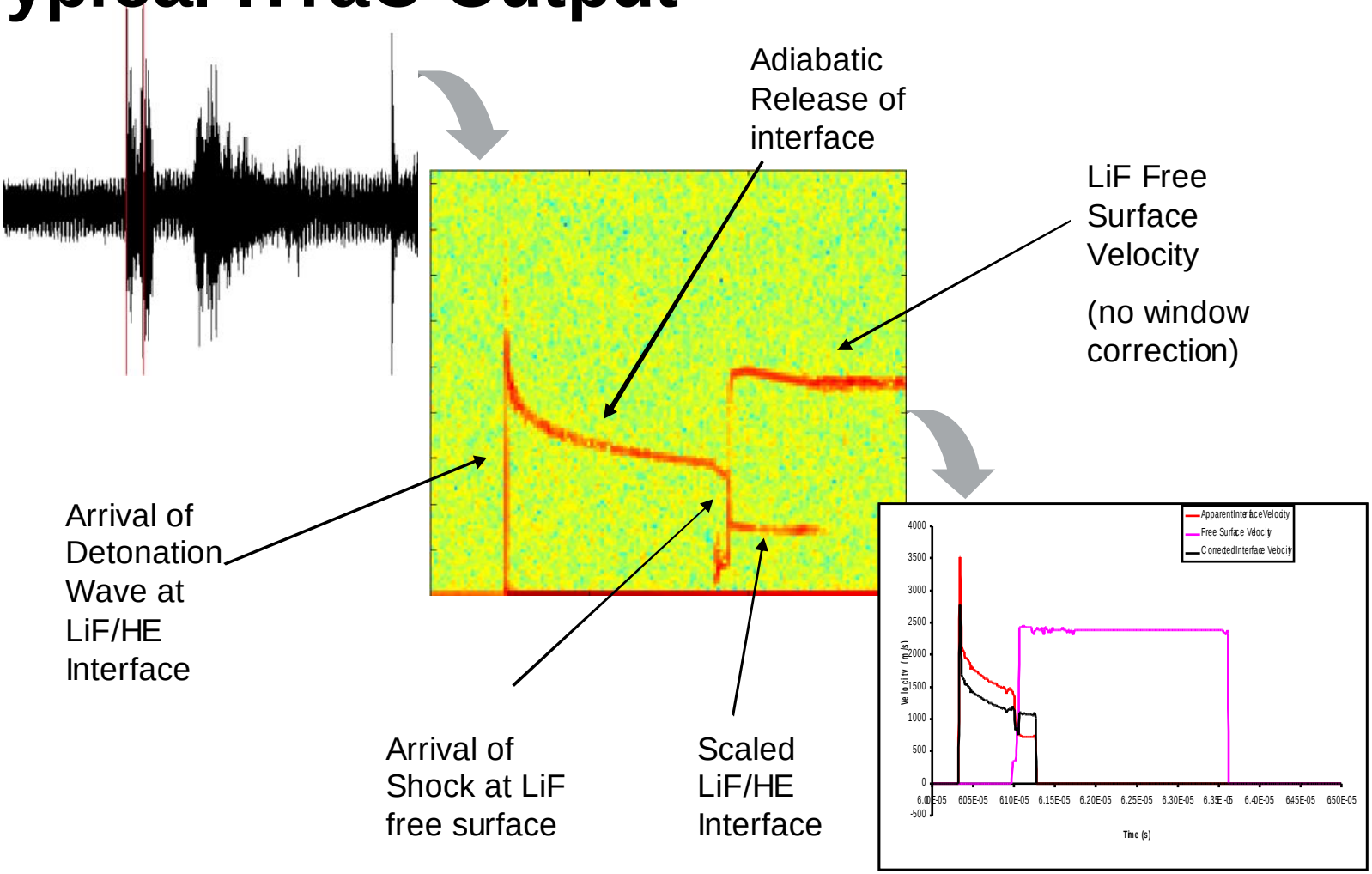


- Flyers of different diameters studied
- Compared difference between flyer diameter and the velocity after travelling 1.5mm (when flyer would hit target pellet)

Initiation Train Characterisation Experiment (ITraC)

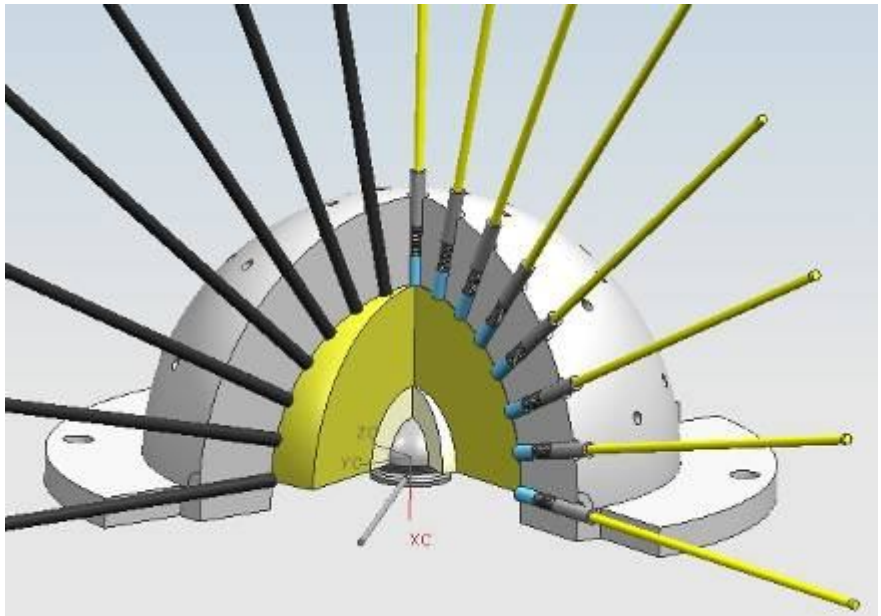


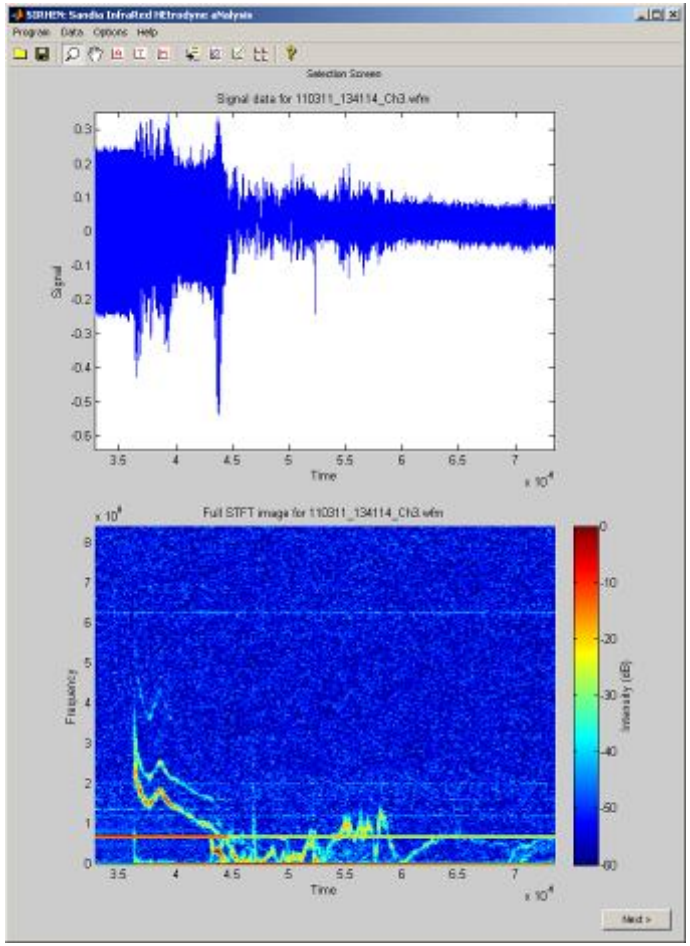
Typical ITraC Output



Half Peach / Onion Skin / Snowball

- This shows the importance of getting your upshift right…
- Data bounces off zero and is inverted – very hard to deconvolve!





MEDUSA 32 Channel PDV System

- Use fibre coils to time-delay return signals (2 km = 10 μs)
- 8 channels multiplexed onto each scope channel
- Optically-upshifted
- All combined signals should share same laser to minimise interference and noise
- Delay legs procured (2, 4, 6 km in 19” rack unit)

MEDUSA System Customer Requirement

- To develop a highly-multipoint PDV system for ITraC and half peach experiments
  - Minimum 8 channels
  - Goal >30 channels
  - Maximum velocity of 5 km/s
  - Time resolution of <1 ns
  - Transportable

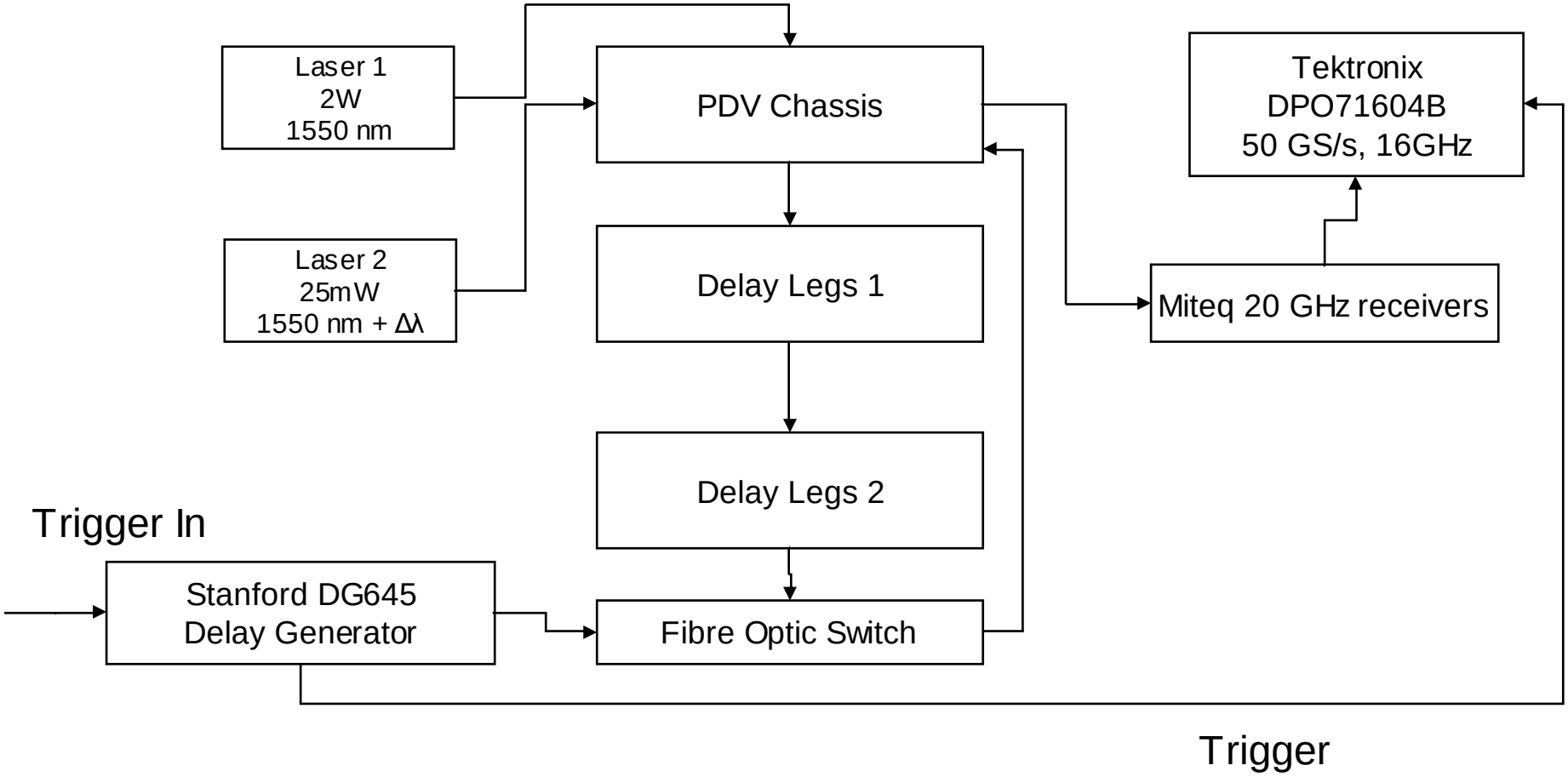
Solution

- Time domain multiplexing
- Use delay legs to combine signals
- 2 km = 10 μs spacing
- Oscilloscope record length 10 MPts = 200 μs
  - Maximum 20 channels per oscilloscope channel
- 8 channels per oscilloscope channel
  - 32 channels, room for expansion
- Simpler than frequency-multiplexing
- Twin laser (optical upshifting) to improve signal to noise
  - Aim for 2 GHz upshift

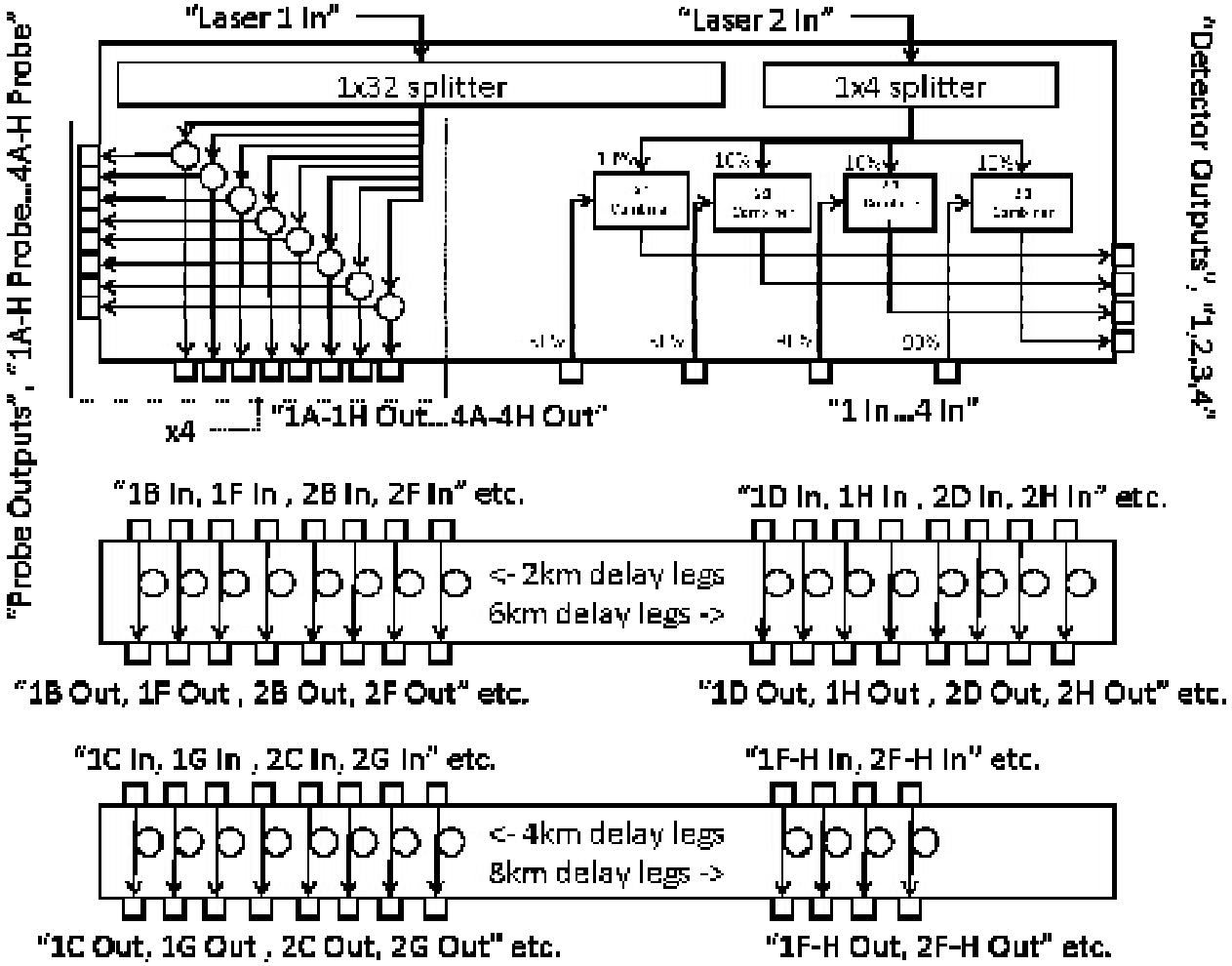
Combination Options

- 8 to 1 combiner
  - Cheap
  - Very high insertion loss (-10 dB)
  - Cross talk between channels
- Fast fibre switch
  - Expensive
  - Fast switching time (300 ns)
  - Low insertion loss (-2 dB)
- Fibre switch recommended

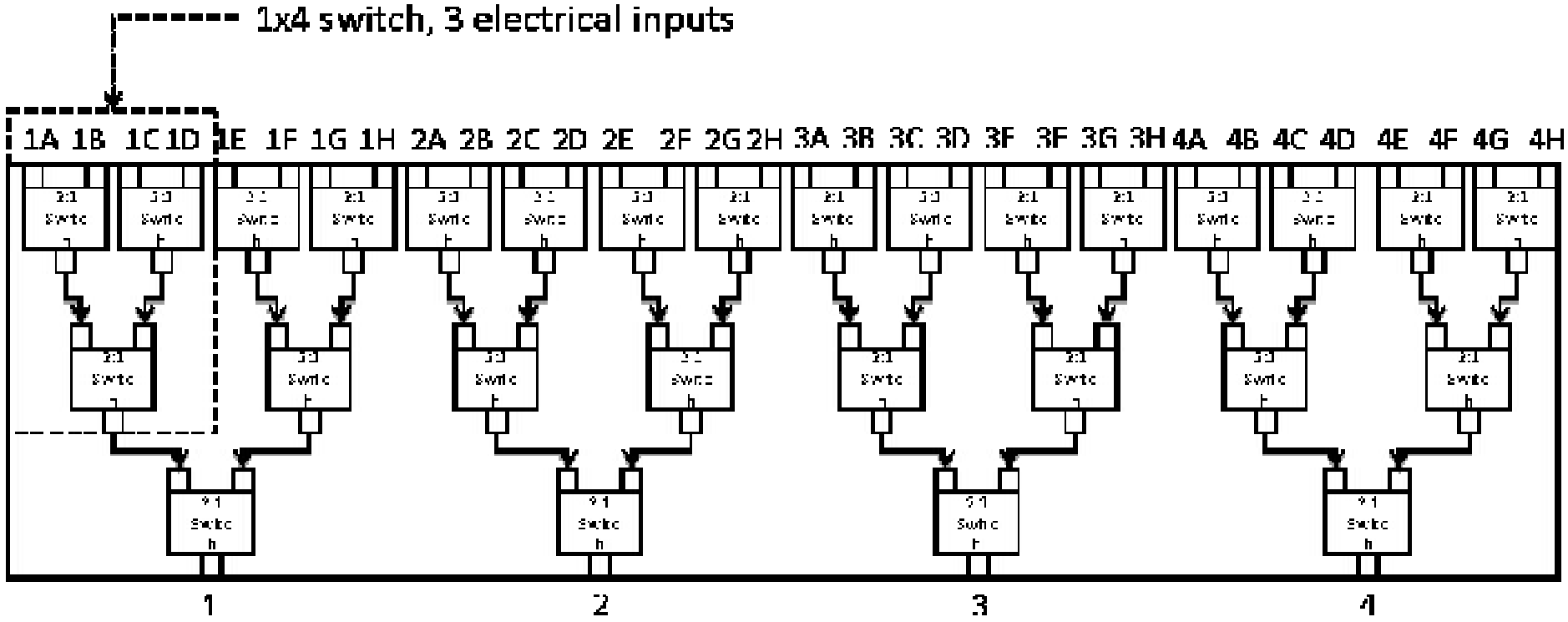
System Architecture



System Architecture (Detailed)



Fibre Switch



Future Plans

- Integration NP Photonics lasers and locker into 4 channel “COTS” system
- Distributed PDV system
  - 2 lasers, 10 locations, distributed on timeshare basis using optical switch
  - Lasers run 24/7, maximise stability, minimise setup time
- Commissioning of MEDUSA system