Technical Readiness

Functionality

Cabling

Environmental Resistance & Reliability

Functionality

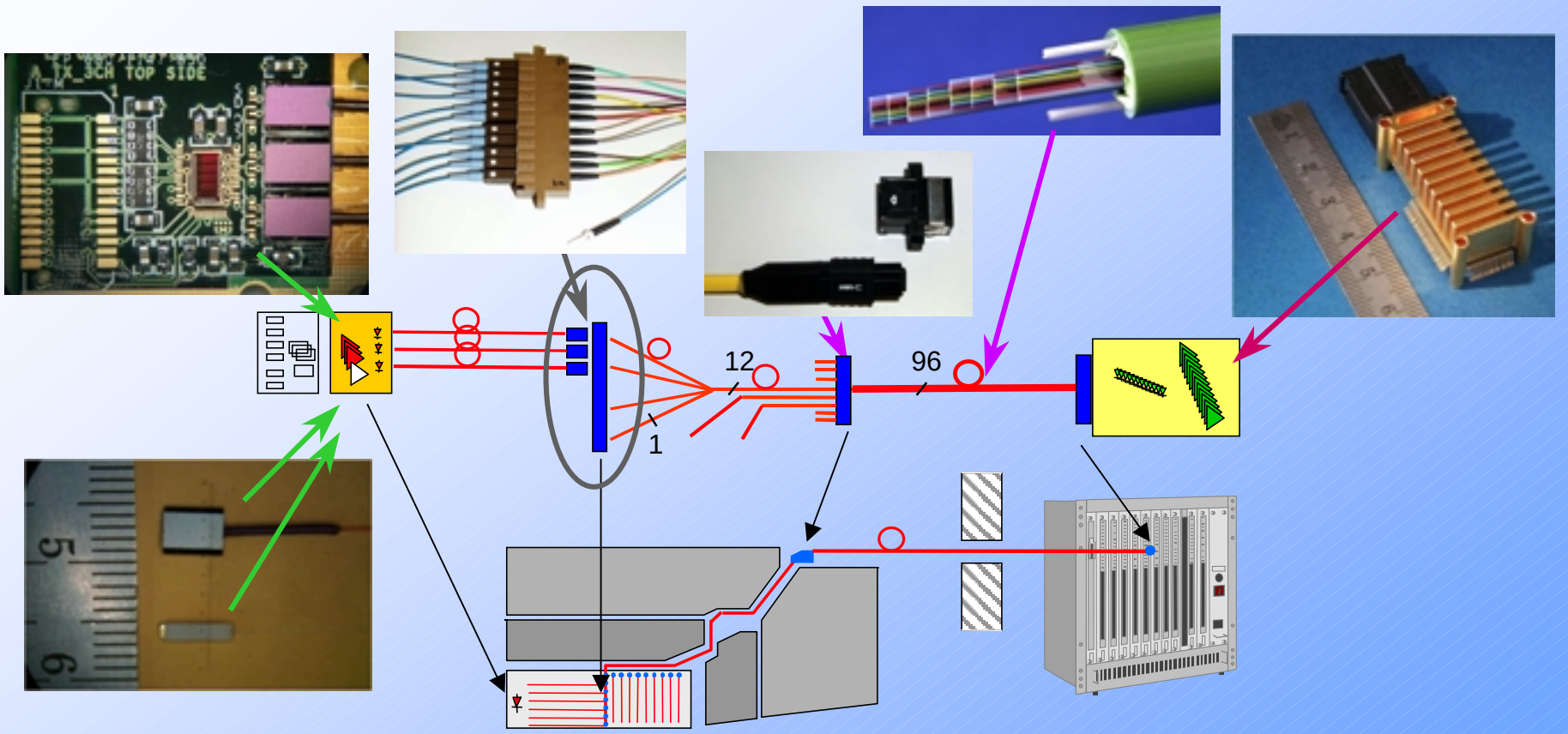
Analogue Data Readout System

Component Functionality

Overview

- Outline strategy for assessment of adequate functionality of candidate optical link components
- Show evolution of components from first use to final form
  - Details of performance obtained at each stage
- Beamtest operation
- Full optical link chain with components in final form-factors

Component Overview



- Final components in almost all cases
  - Manufacturer feedback & interaction has been imperative
  - All components already tested in pre-final form

Functionality Assessment

- Goal is to assess performance of individual components vs. Specifications
  - Focus on testing full optical link system
    - Measure performance of individual components *in-system*
- Basic Parameter test
  - Carried out routinely – assess critical parameters
- Expanded testing
  - Measurements carried out by manufacturers
    - Detailed device functionality (e.g. laser spectrum, RIN)
  - Capacity to make these measurements at CERN
    - Cross-check (e.g. production qualification)

Basic Parameter Testing

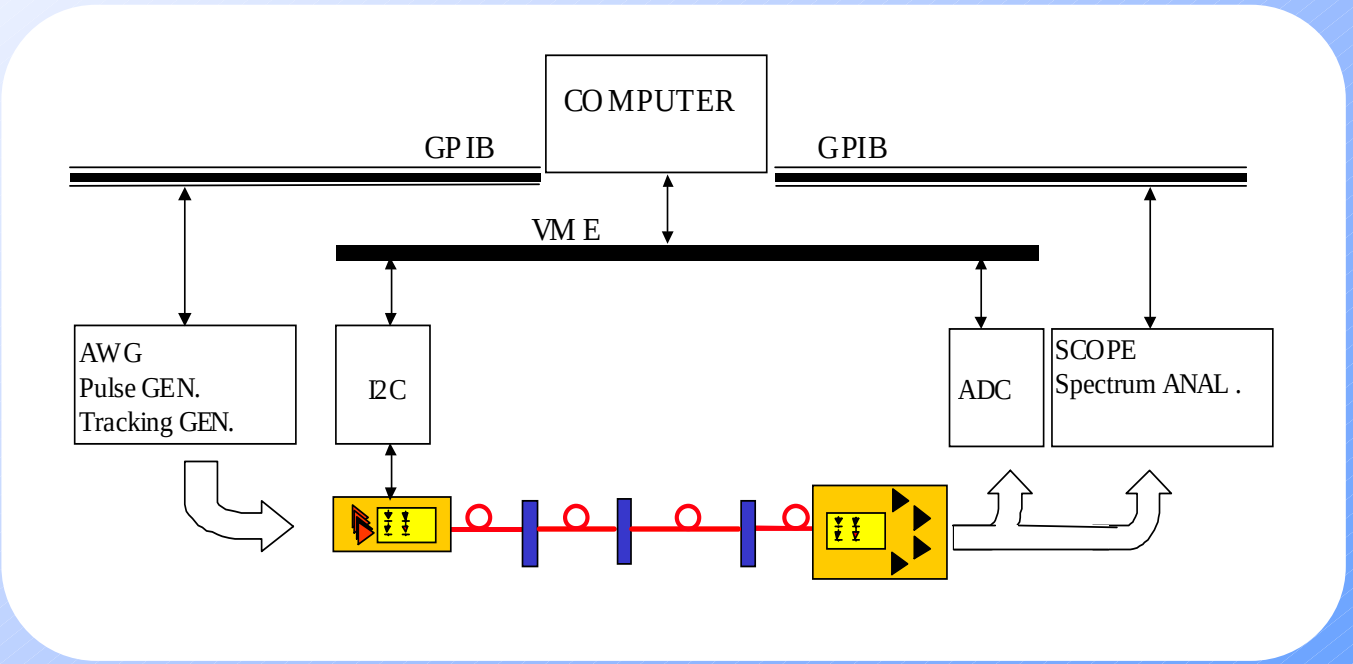
- Basic Parameter test
  - Test set carried out with all optoelectronic components
    - Use as a comparison between devices
  - Static transfer characteristic
    - Extract Gain, SNR, linear range, input & output operating range
    - Compare to Specifications
    - Feedback info to manufacturers if necessary
  - Basic Dynamic measurements
    - Bandwidth of system driven by electronic (not optoelectronic) system components.
      - Measure with new ASICs as they become available to give confidence that further measurements with different optoelectronic components will yield very similar dynamic results

Link & Test System evolution

- 1st Generation
  - Single-channel link measurements
    - Collection of laboratory instruments under computer control
- 2nd Generation (most recent)
  - 4-way link measurements
    - Tested links for distribution to users (inc. Beamtest)
    - Used to establish selection criteria
      - Same system as for 1st generation
- *3rd Generation*
  - *For use during Production*
    - *Multi-channel capability*

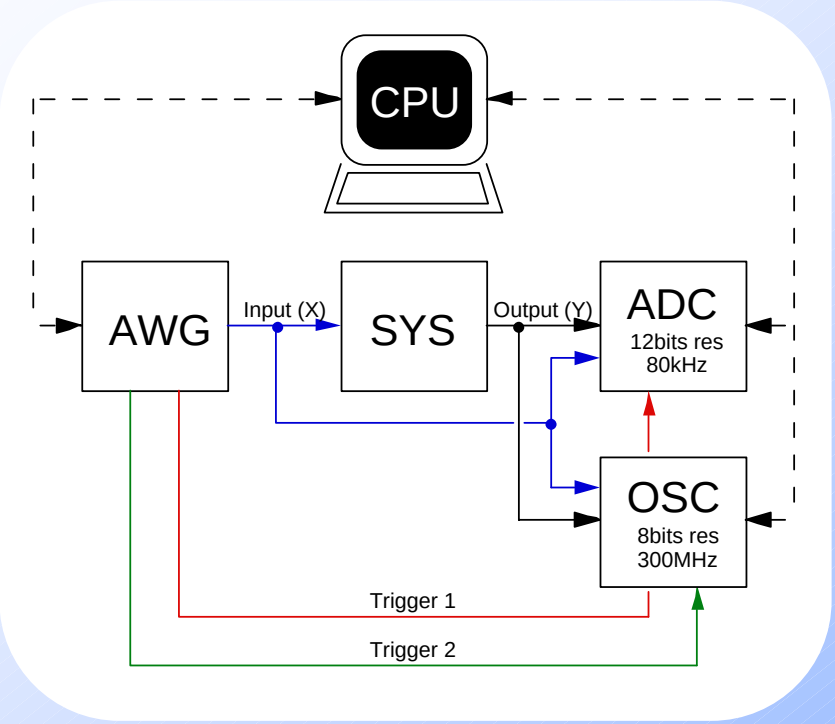
Laboratory Functionality Testing

- Test Setup
  - Computer Controlled instruments
  - Basic test suite to take ‘Static Transfer Curve’



Laboratory Functionality Testing 2

- Obtaining a static transfer curve



- Stage 1:
  - Inject fast ramp (stair-case) into system
  - Measure transfer characteristic using ADC
- Stage 2:
  - Inject slow ramp (stair-case) into system
  - Measure noise at each step

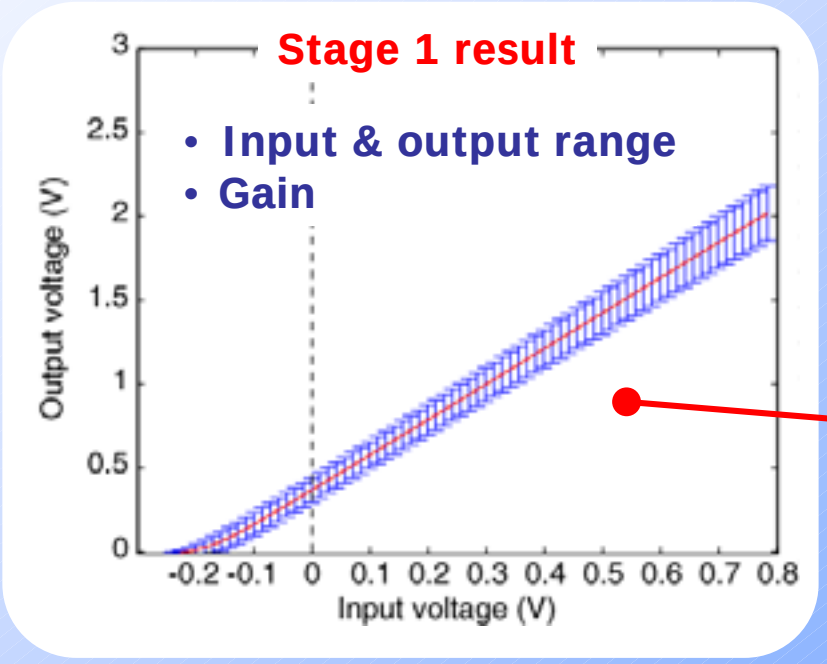
➔ Extract several parameters from the two resulting curves

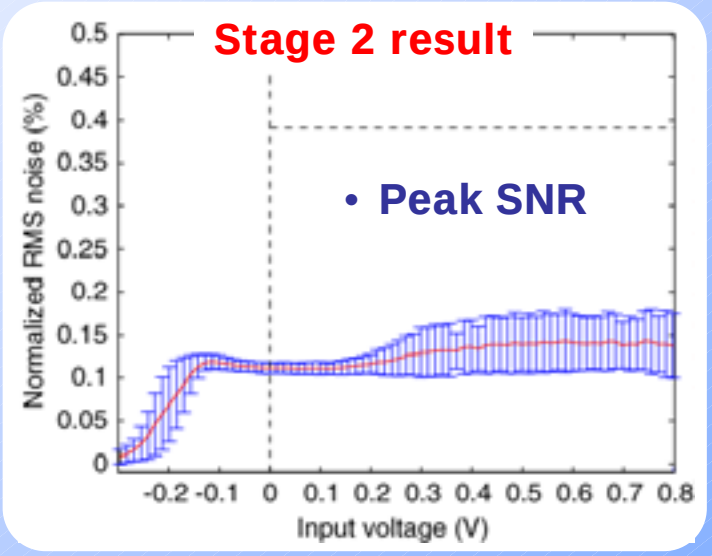
⇨ Gain, linear range, input & output operating range

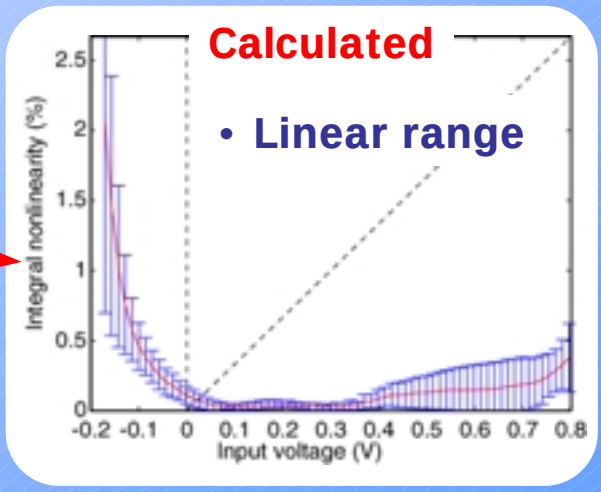
⇨ Peak signal to noise ratio

Static Characteristics

- 20 4-way links tested to yield typical performance
- Averaged data and std. devn. shown





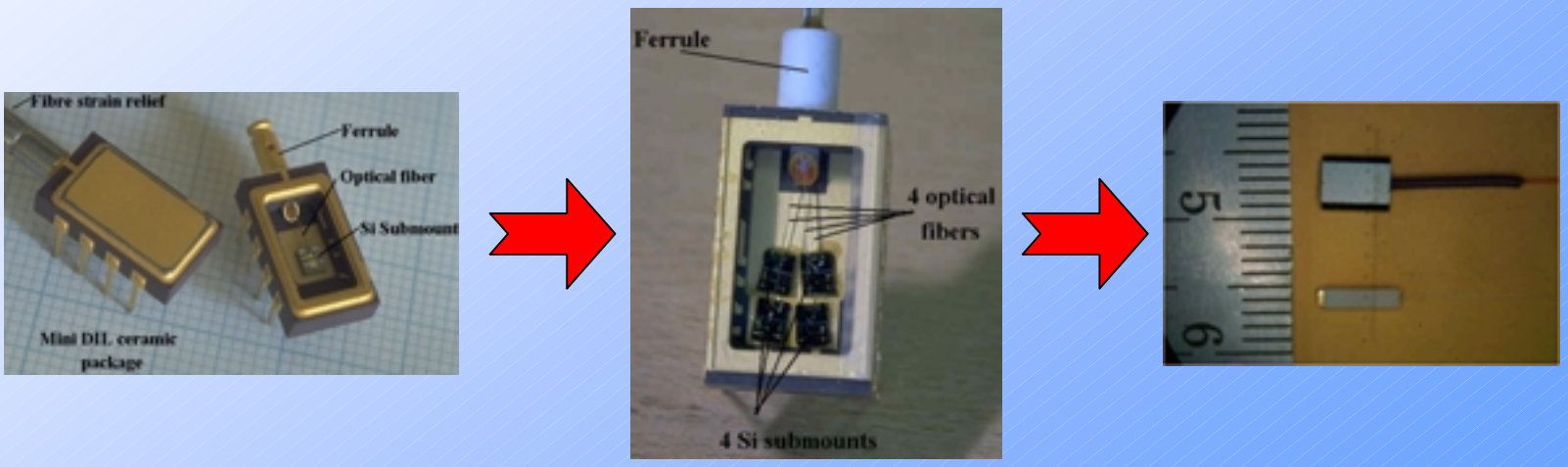


Component Evaluation

- Assessment of link components
  - Laser Transmitters
  - Optical Fibres, Cables & Connectors
  - Receiver Modules

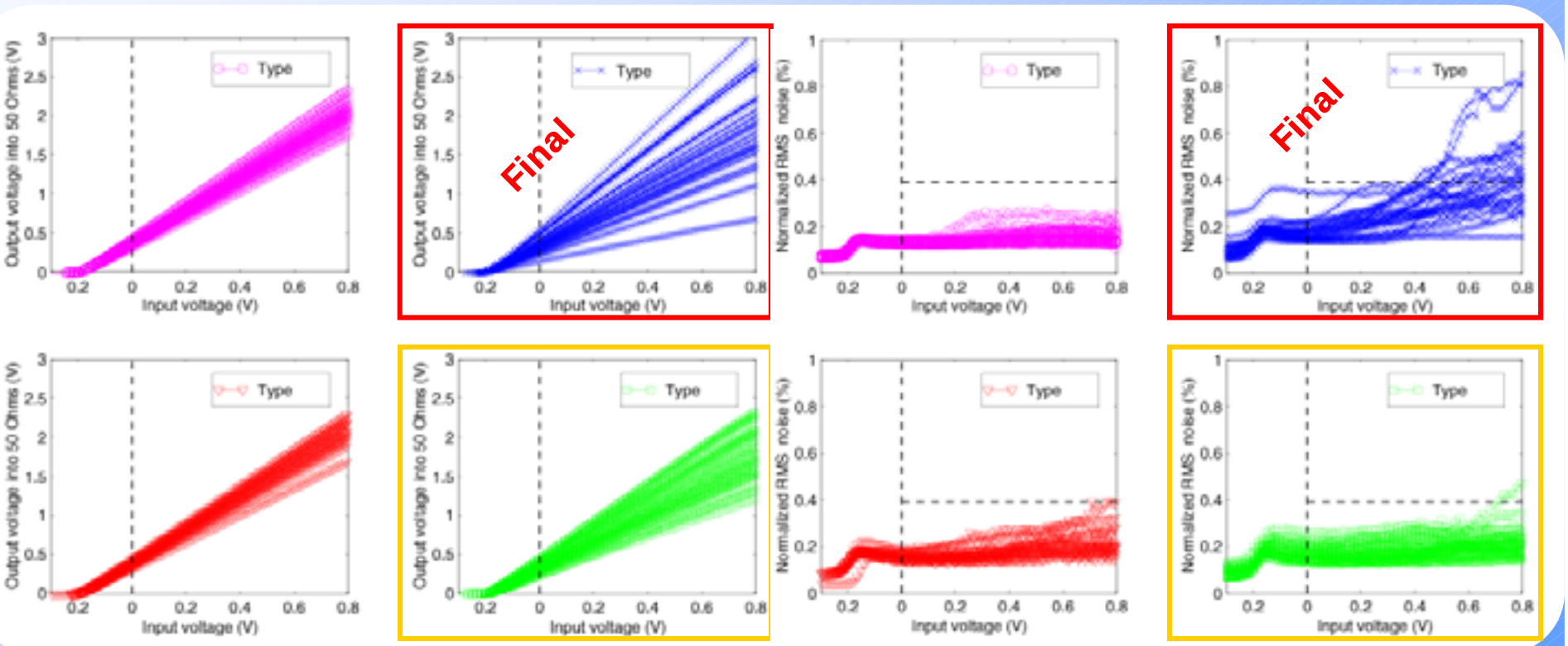
Laser Transmitters

- Evolution of devices
  - Manufacturer contacts built up
    - Many manufacturers during project lifetime
    - Confident that most-suitable devices chosen
  - 1-way to 4-way back to 1-way
  - Form factors & modularity now matched to Tracker application
    - Low mass, compact, non-magnetic



Laser Transmitters – Results

- Past component evaluation example results
  - 4 types (1- and 4-way devices)
  - Evolution of components with Manufacturer interaction



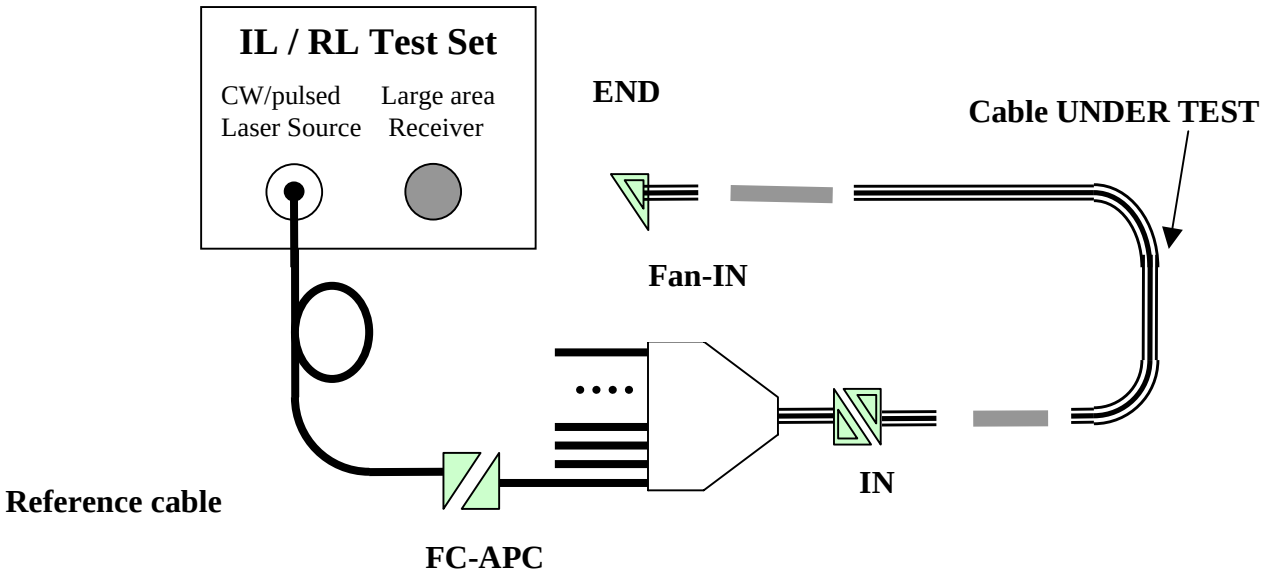
Optical Fibre and Connectors

- COTS components specified to be non-magnetic
- Single-way
  - Initial testing carried out with bulky standard types
  - Have moved to low-mass final types
- Multi-way (array)
  - Suitable connectors available at start of project
- Environmental testing also important
  - Later talk

Fibre & Connector Measurements

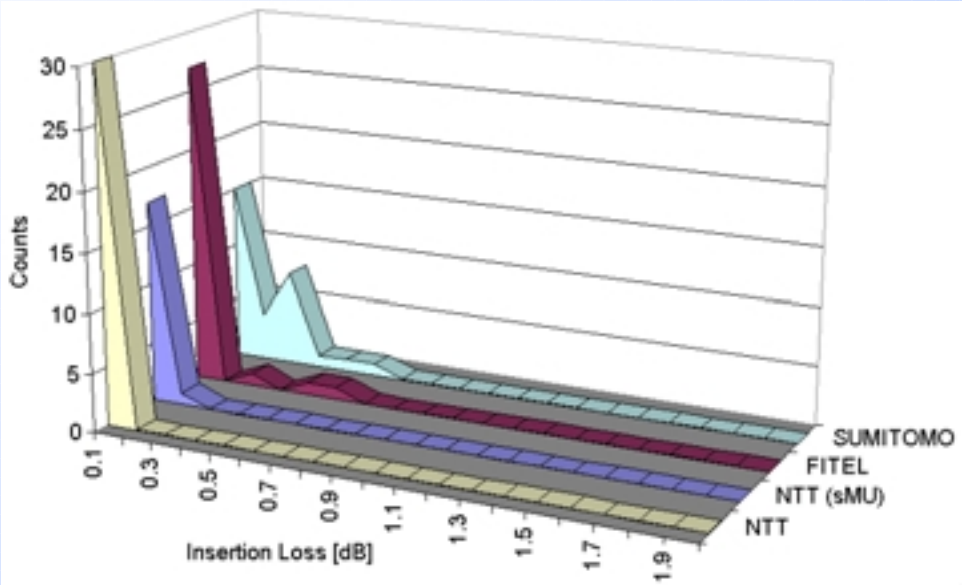
- Single fibre only measured as part of a patch lead
- Pertinent parameters
  - Insertion & Return Loss

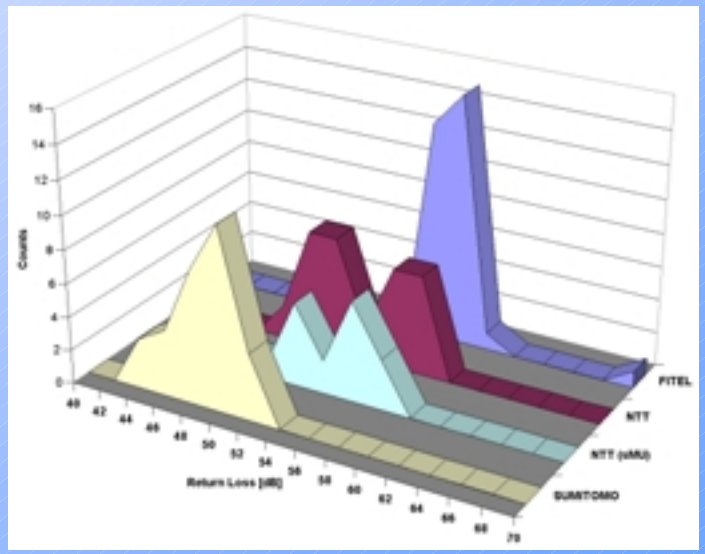
Multi-way connector Test Setup



Optical Fibre and Connectors 2

- Single-way connectors
  - 8 types assessed – 2 types retained
    - Still multiple manufacturers available
  - Example of chosen MU & sMU types:

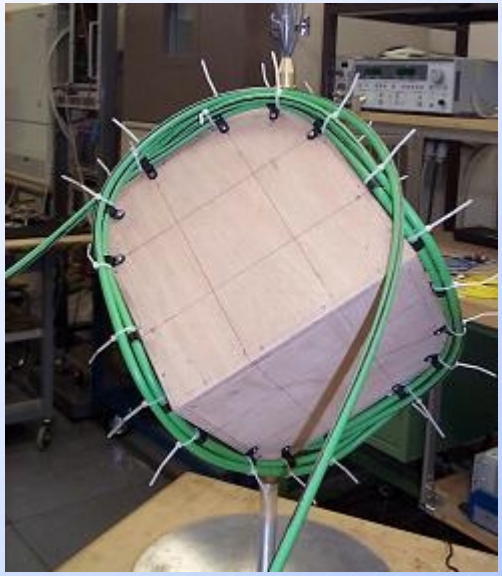


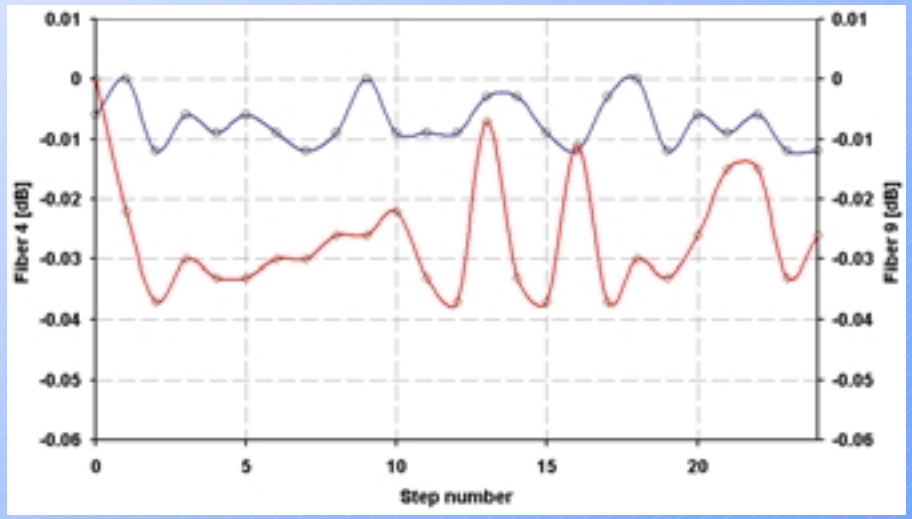


- Multi-way connectors
  - 11 types assessed – 2 types retained
    - Still multiple manufacturers

Cable Measurements

- Cable bent around cube to simulate installation
  - Steps of 90° bends (8cm radius) in orthogonal planes
  - Insertion loss measured during test



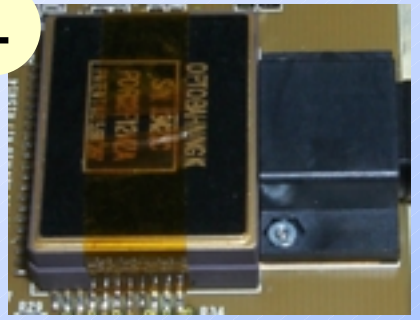


- Very small variation in IL measured
  - Cable spec met

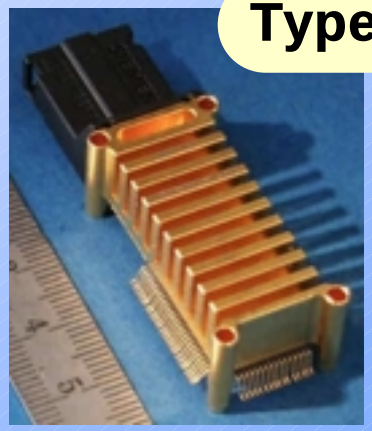
Receiver Modules

- Based upon the use of a custom Analogue Receiver ASIC design placed inside standard Digital modules
- First ASIC design successful
  - Now tested in two module types

Type 1



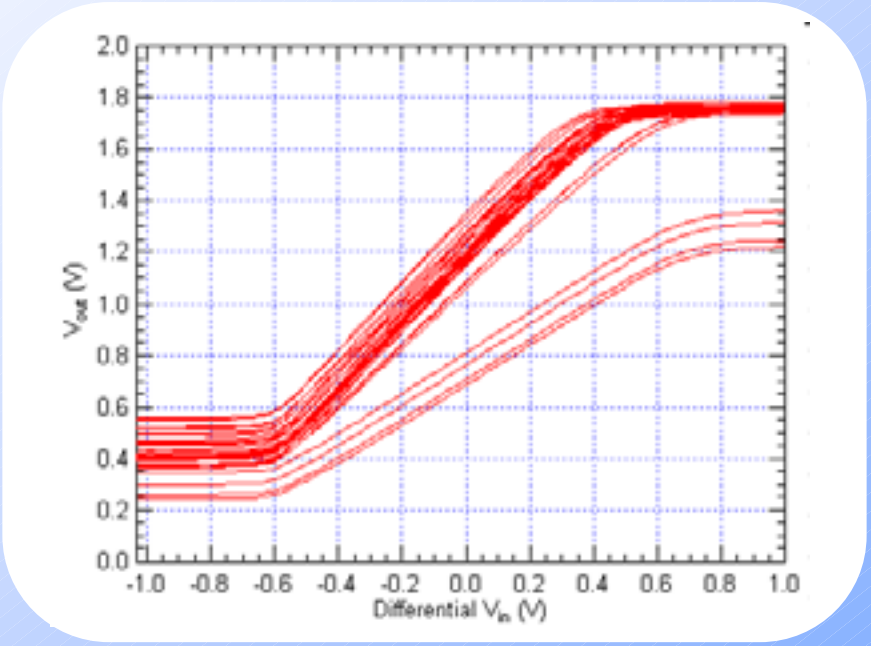
Type 2

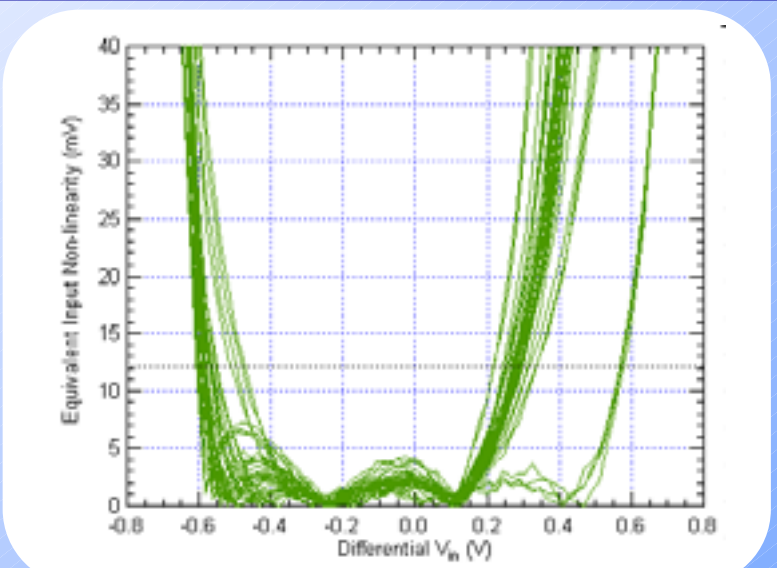


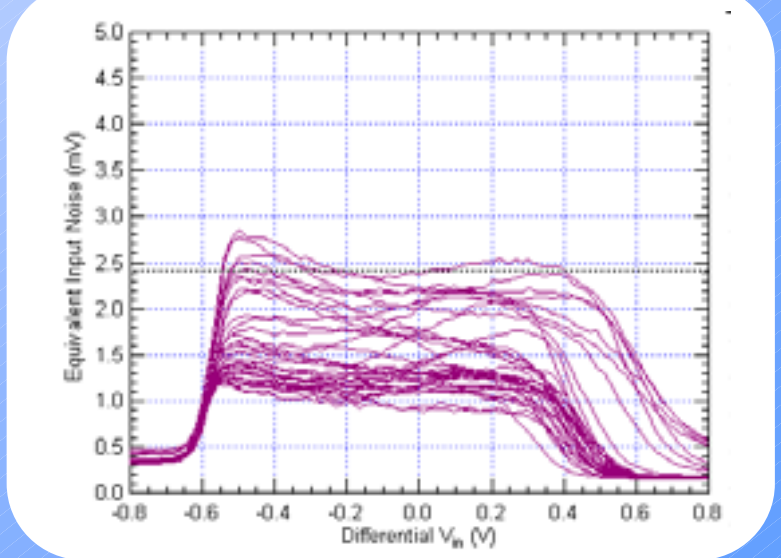
- Important to measure that link noise (in particular) is not affected by this component

Receiver Module Type 1

- **36 channels measured**
- Gain high in default configuration
  - ✓ Efficient fibre coupling unit
  - ✗ Receiver saturates
  - ✓ Can adjust using termination
- Return loss slightly low
  - Addressed for next batch

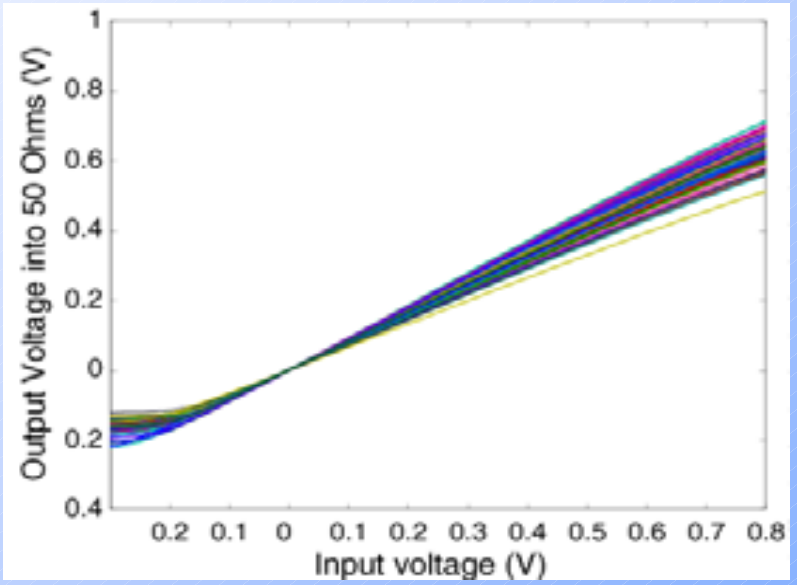


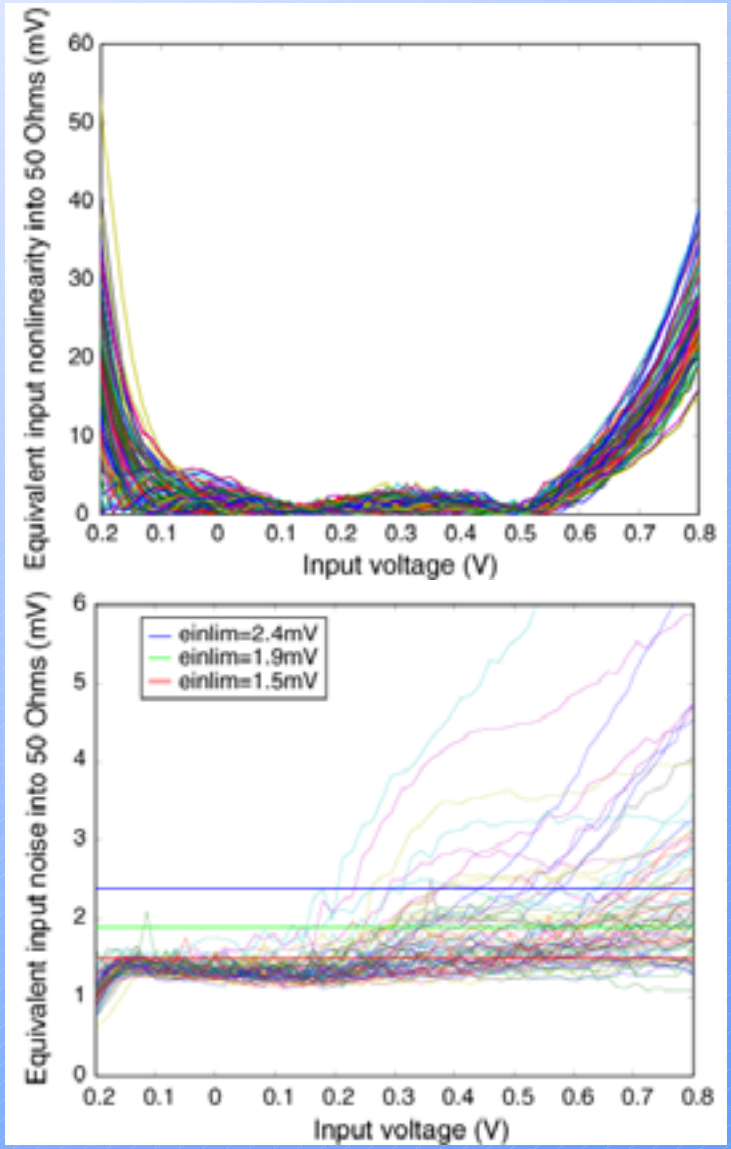




Receiver Module Type 2

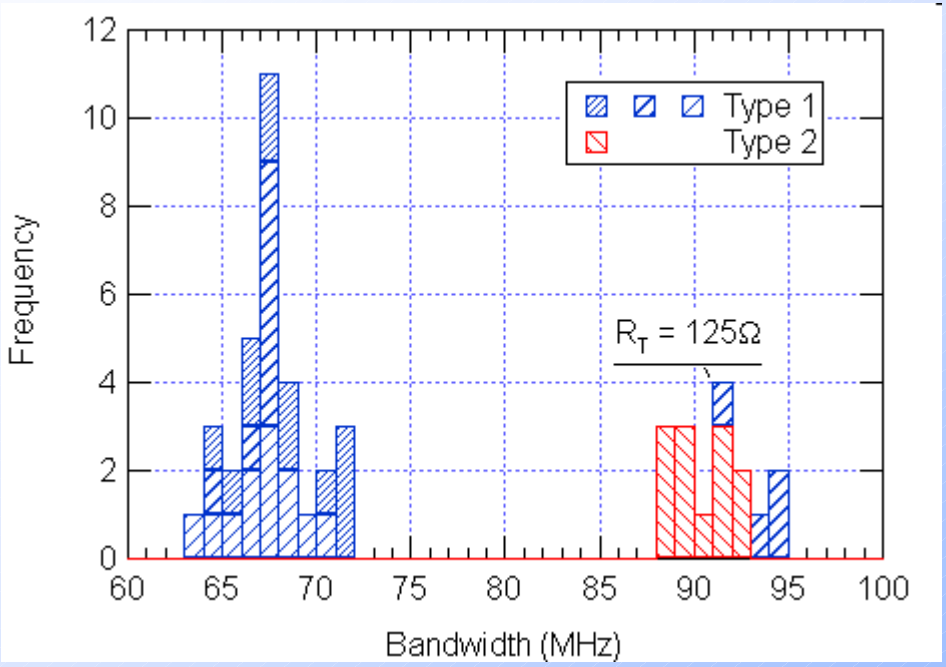
- **72 Channels measured**
- Most channels within specification
  - Noise problems understood – solved in most recent samples





Receiver Module Bandwidth

- Bandwidth measured in system



- Target for system 70MHz
- Receiver ASIC input well matched to Type 2 PD array capacitance
- Type 1 PD capacitance higher
  - Reduced bandwidth with nominal output termination
  - Bandwidth recoverable by change in output termination

Component Summary

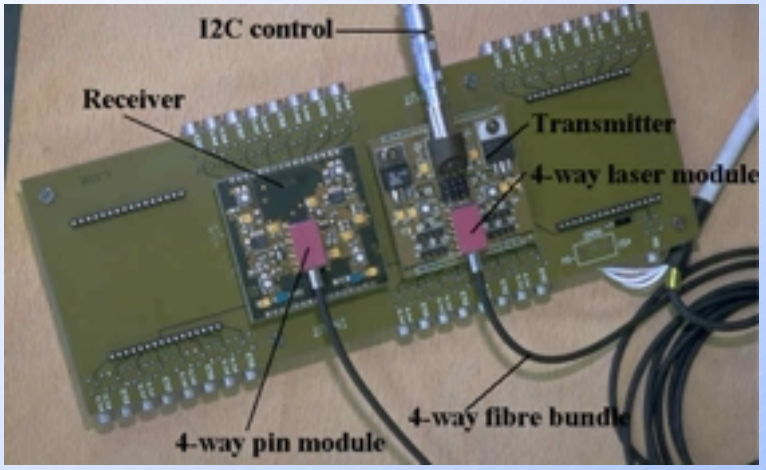
- Have identified two types of laser transmitter from two different manufacturers that meet the functional requirements
- Have identified fibre, ribbon & cable manufacturer and successfully completed the tendering
- Have chosen the single-way connector types to be used in the final system
- Have two manufacturers of receiver module suitable for use in the final system

Full Optical Link Systems

- Supply of 4-way (2nd Generation) optical links to users from the CMS Tracker community
- Several of these links used successfully in beam tests
- Latest Results from Full Link with final components

Optical Link Users

- 16 4-way optical link demonstrators with external users
  - 8 in X5 Beamtest area
    - 4 used in 25ns test



- No major problems reported by users

Evaluation Links Delivery Status - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Tracker Optical Links

Links in external/internal (CERN) use

Status: 18 January, 2001

4-channel evaluation prototypes:

Link #	Tx Serial #	Rx Serial #	Used by/at	Delivery
1	4T-803-S05	4R-804-S02	B. Barnett	11 August 1999
2	4T-803-S04	4R-804-S01	M. Petertil	11 August 1999
3	4T-804-S04	4R-805-S04	D. Kotlinski	16 August 1999
4	4T-804-S03	4R-805-S05	Beamtest CERN	
5	4T-803-S07	4R-806-S01	B. Gobbi	April 2000
6	4T-804-S07	4R-805-S07	B. Cecucci	May 2000
7	4T-803-S01	4R-804-S07	M. Pernicka	24 August 1999
11	QM-004-004	QD-001-006	Beamtest CERN	May 2000
12	QM-004-007	QD-001-007	Beamtest CERN	May 2000
13	QM-004-002	QD-001-001	Beamtest CERN	May 2000
14	QM-004-003	QD-001-004	Beamtest CERN	May 2000
15	QM-004-001	QD-001-005	Beamtest CERN	May 2000
16	QM-004-006	QD-001-003	Beamtest CERN	May 2000
17	QM-004-005	QD-001-002	Beamtest CERN	May 2000
20	QM-004-010	QD-001-012	B. Gobi - FNAL	November 2000
21	QM-004-009	QD-001-011	Internal	November 2000
22	QM-004-014	QD-001-008	Lyon - Test System	November 2000
23	QM-004-011	QD-001-013	Internal	November 2000
24	QM-004-012	QD-001-014	Internal	November 2000

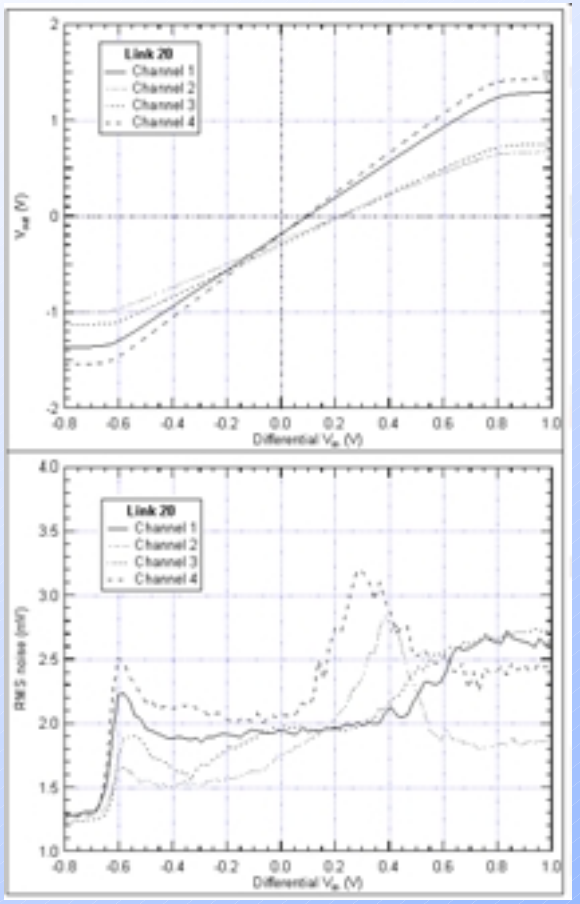
Last modified by JT: Thu, 18-Jan-2001 17:33

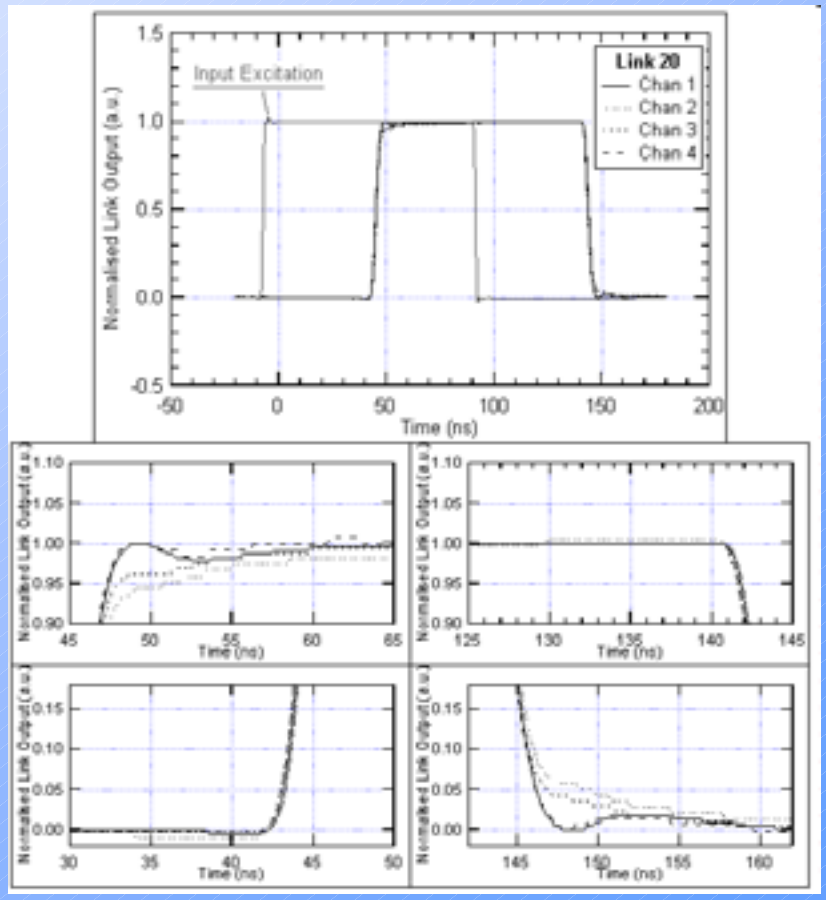
(return to home)

Local intranet

Delivered Link Performance

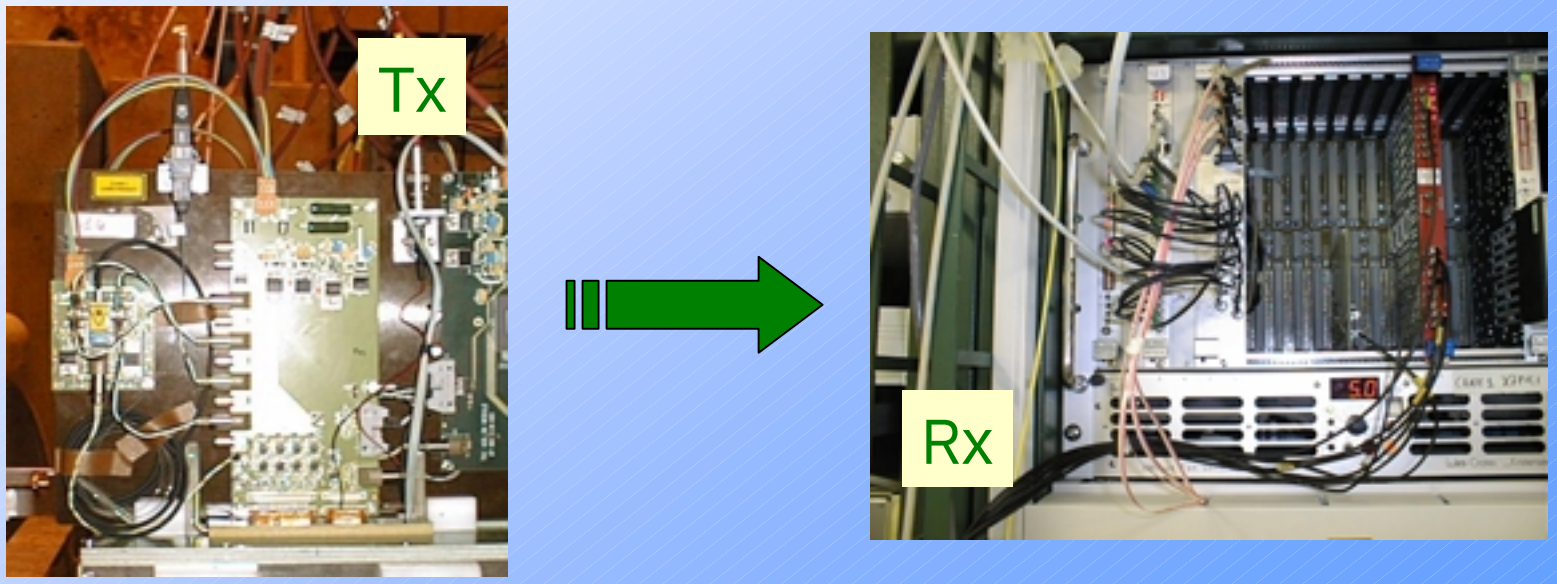
- Each link supplied with a datasheet:
  - Static Performance
  - Dynamic Performance





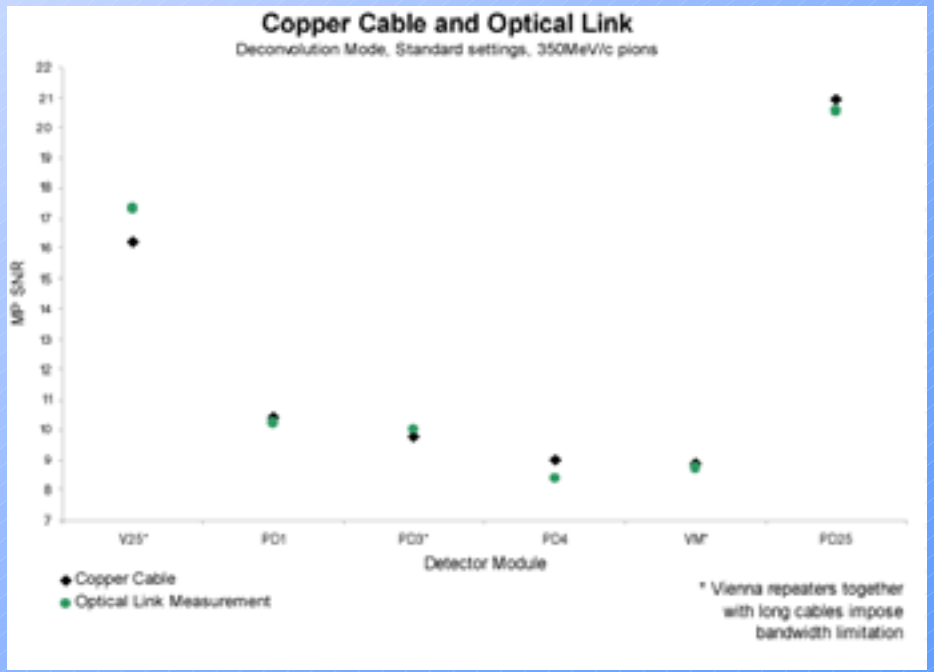
Beam Test Operation

- 8 4-way demonstrator links supplied to Tracker X5 Testbeam Summer 2000
  - 4 operated during 25ns time-structure test
- Operated successfully by variety of beam test users over a long period of time



Beam Test Operation 2

- 4-way link used in PSI testbeam May 2000
- Comparison with Copper-based data transfer
  - 25m twisted pair copper
  - 100m optical fibre
- Signal to Noise ratio very similar for the two transmission systems
  - ref. M. Friedl (Vienna)

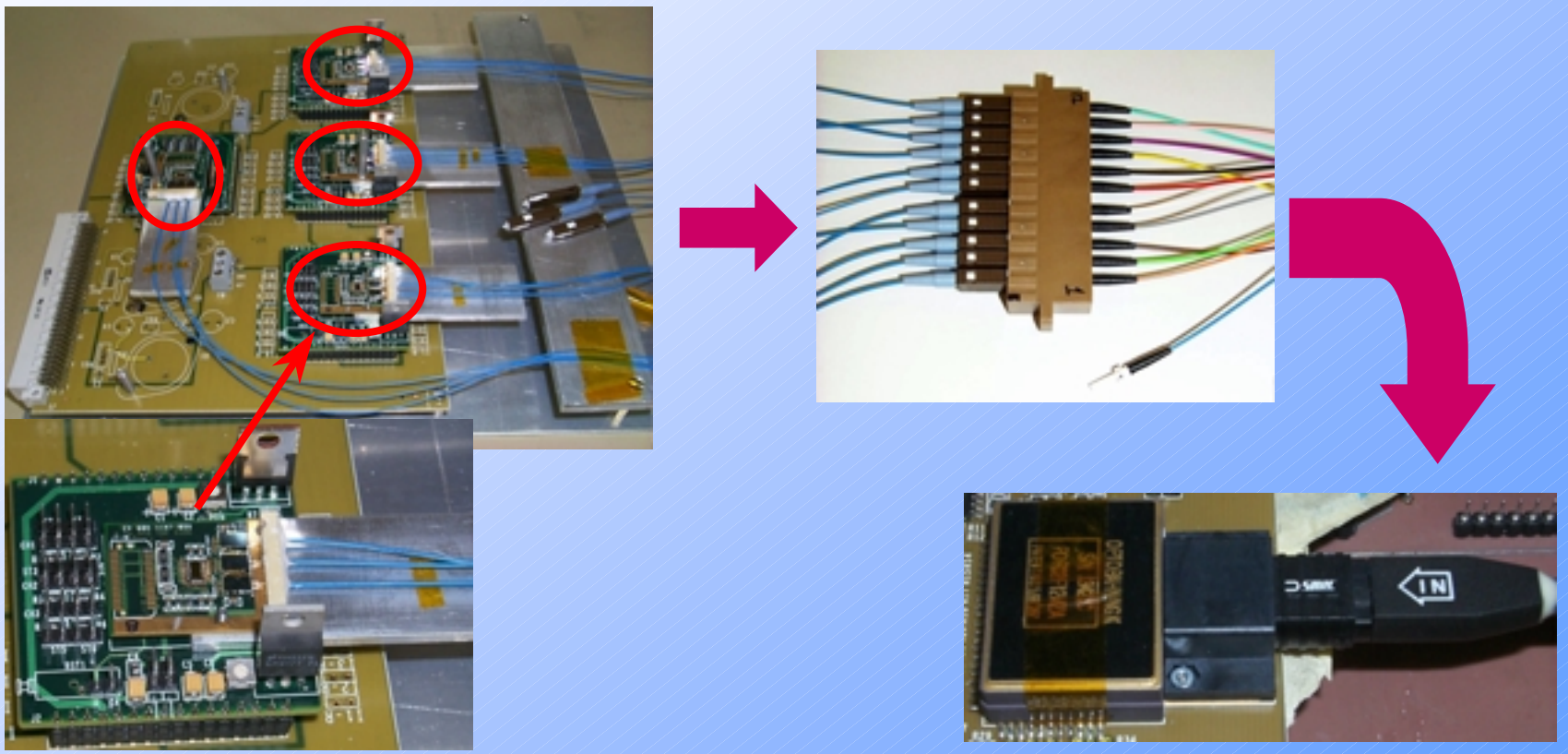


Full Optical Link Chain
with Final Components

- **Components ordered to supply needs of CMS Tracker System Test**
  - Scheduled for Summer 2001
- Transmitter components available
- Prototype Analogue Optohybrid
  - Designed by CERN for TOB/TEC use
- Fibre & Connectors available
- Receivers still first prototypes
  - Performance marginal in a few channels
- Measurements only just starting

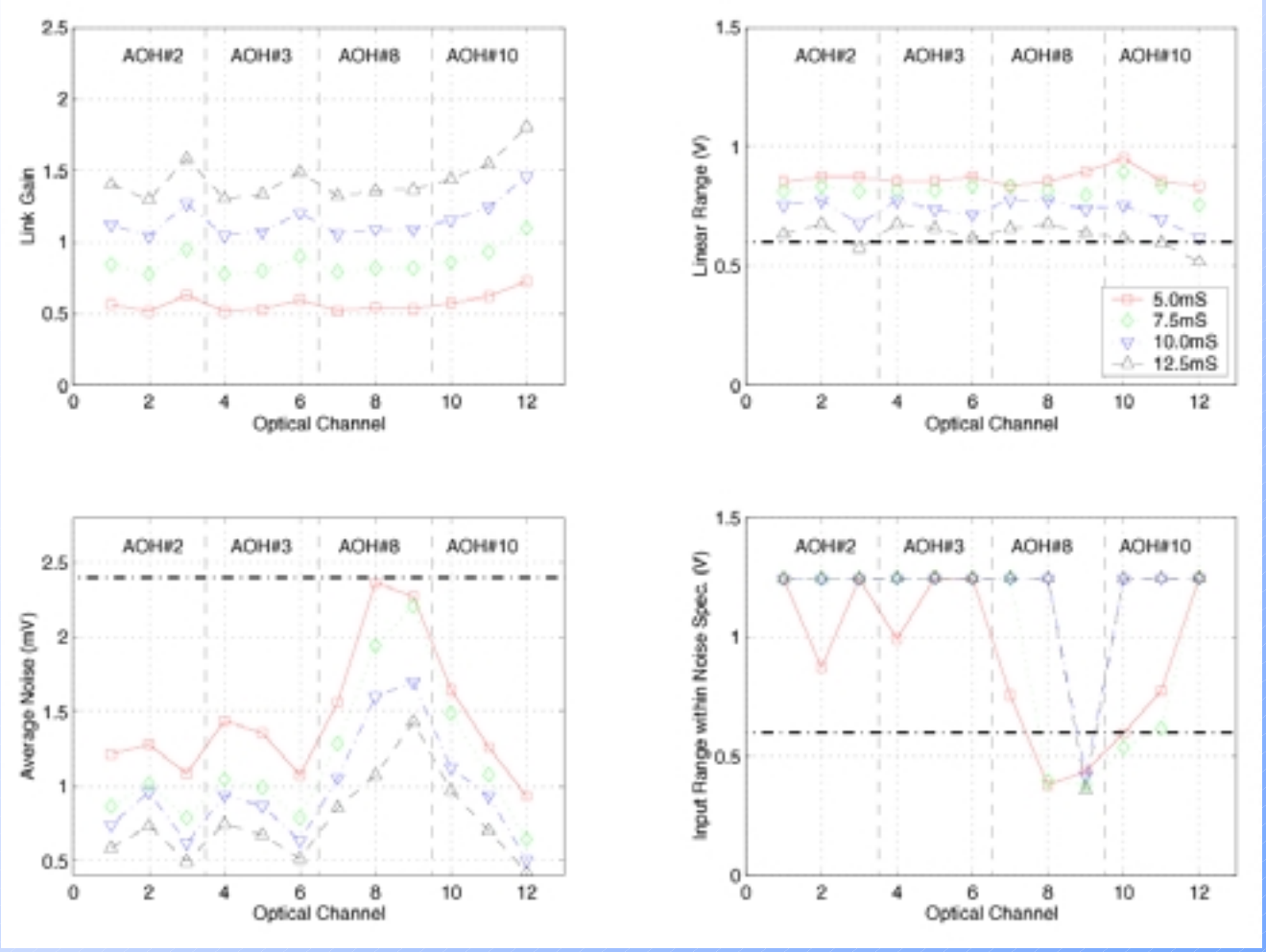
Full Chain Setup

- Final Components
  - Final form factor and modularity
  - Prototype Analogue optohybrid



Full Chain Latest News

- **Preliminary** Static Results:



- New Laser Driver
  - 4 Gain settings
  - Reduced Linear Range
  - Lower Noise
- Prototype Rx
  - Some channels with low Return Loss
  - ➔ Thus higher optical noise

✓ **Encouraging Results overall**

Summary

- Many components now tested
  - Have a solid basis of performance achieved to date
    - Have selected best performing devices for production
  - Know well how to assess performance
    - Can transfer to production testing
- Used functional constraints for initial selections of components
  - Able to work towards mechanical and modularity constraints once manufacturer contact established – now excellent communication in place for production phase
- Demonstrated use successfully in several beamtests
- Able to start demonstration of final optical link system
  - Well in advance of production