Variation of PIE-D in Multimode Fibre

Due to polarization, mechanical stress and connector offset

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Variation of PIE-D in Multimode Fibre Introduction

- **Measurements of PIE-D are reported for the effects of polarisation, mechanical stress and connector offset when applied to multimode fibre**
- **TIA FO 2.2, 1996 Round Robin fibre set are investigated using a FP source. OM2 and OM3 are also measured**
- **Ball lens, Vortex or SM fibre with and without mode conditioned patch-cord are used as launch conditions**
- **For SM launch, a polarizer is used to ascertain limits**
- **The complete transmission line incorporates a variable offset manipulator, an adjustable connector, a shaker, various lengths of fibre as well as the TIA test fibres**

Outline

Effects on PIE-D due to three offset launch configurations

What happens when polarization and single offset connector is inserted for Offset launch

How does PIE-D change with varying offset launch

What happens when two 7um offset connectors are used with Offset launch

What is the relationship between PIE-D and OFL BWDP

Effects on PIE-D due to two Centre launch configurations

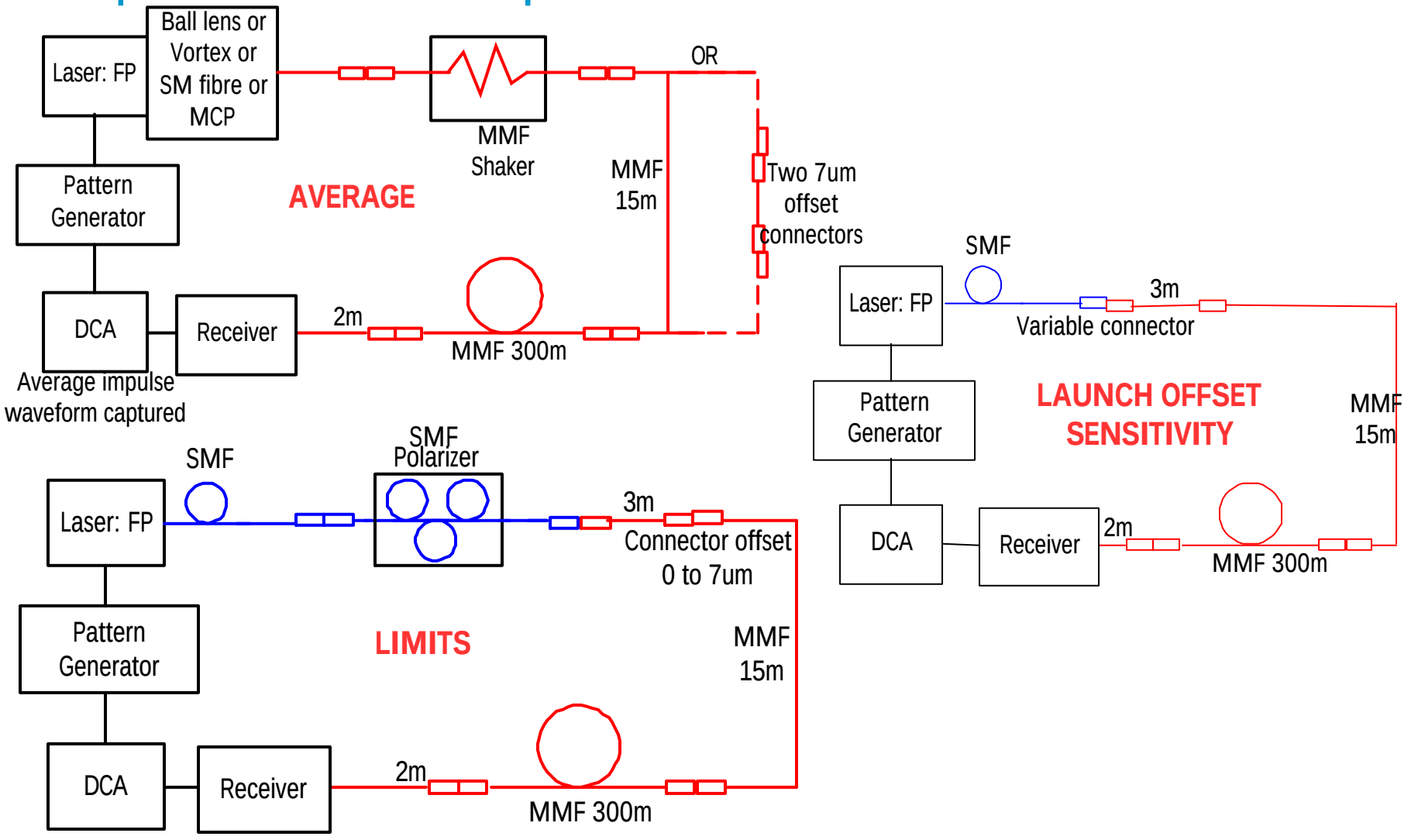
What happens when polarization and single offset connector is inserted for Centre launch

What happens when two 7um offset connectors are used with Centre launch

Comparing Offset and Centre launch

Observations

Variation of PIE-D in Multimode Fibre Experimental setups:



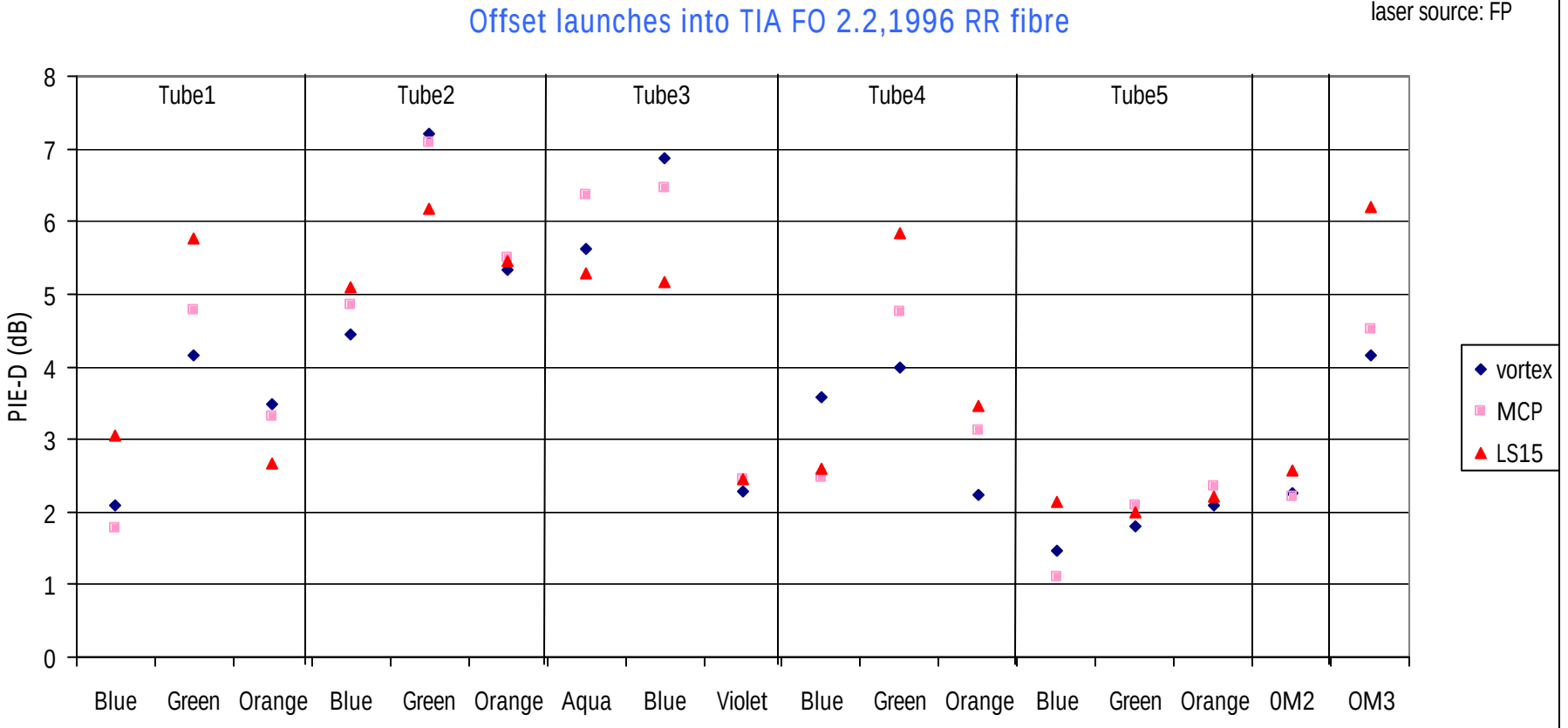
Variation of PIE-D in Multimode Fibre

- Measurements with FP laser
- PIE-D for laser and receiver are included (1.3dB)
- A 62 .5/125 Mode Conditioned Patch-cord used for all types of fibre
- Average values for different launches are compared to their ranges that can be obtained when the fibres are stressed
- The sensitivity of some fibres to offset launch is measured

OFFSET LAUNCH

Slide	Experimental set-up	Launch
6, 7	AVERAGE	Mode Conditioned Patch-cord
		Vortex
		Large Spot ,15um lateral offset
8	LIMITS	Mode Conditioned Patch-cord
9	OFFSET SENSITIVITY	Single Mode fibre into 50 / 125um fibre
10, 11	AVERAGE with 7+7um connectors	Mode Conditioned Patch-cord
		Large Spot, 15um lateral offset
12	Summary	Mode Conditioned Patch-cord
13	Scatter graph	PIE-D and OFL BWDP

Experimental setup: Average

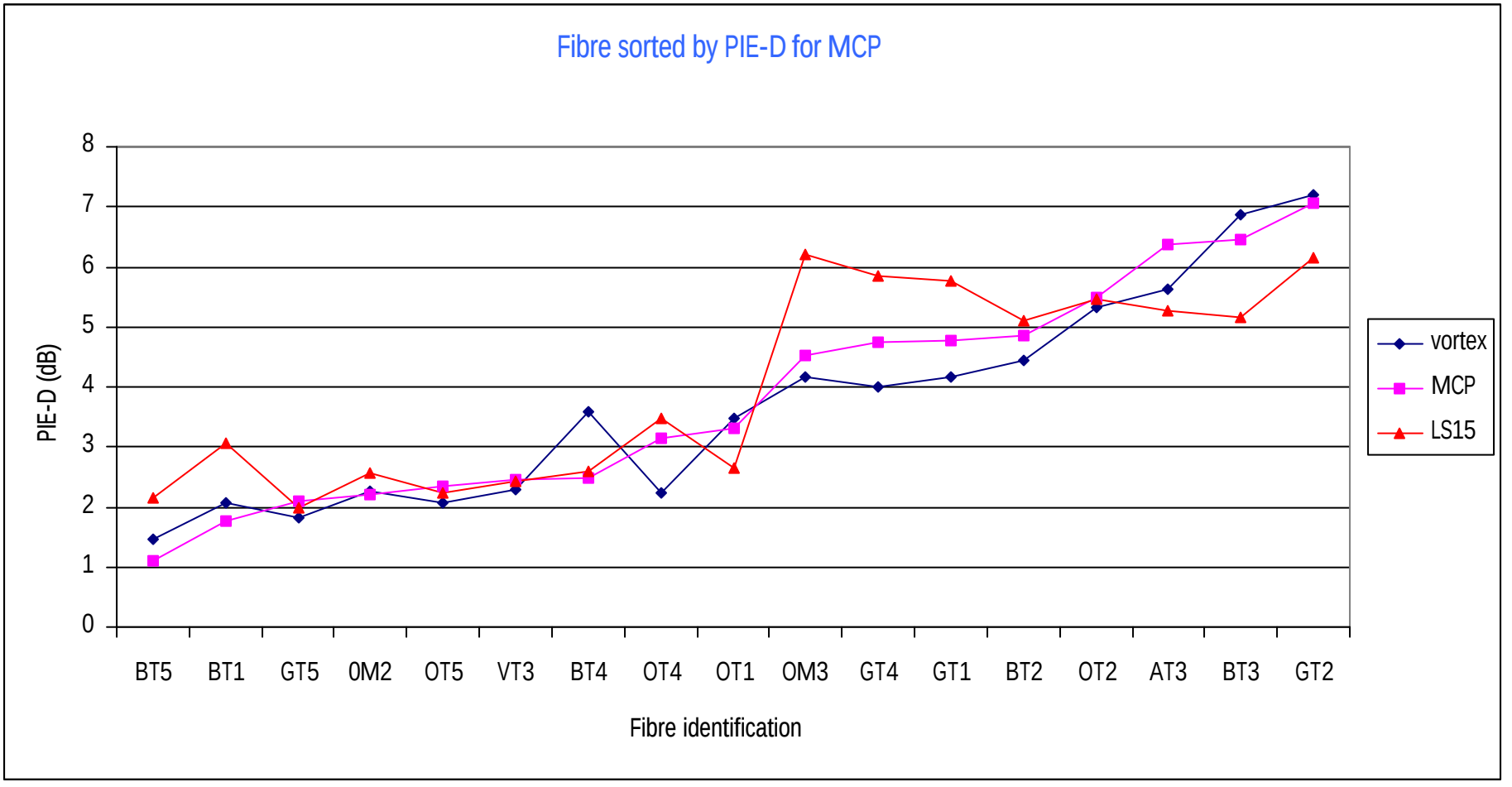


Note: Vortex. type VA7 with encircled flux<30% in 4.5um,>86% in 24um radius
MCP. Mode conditioned patchcord with encircled flux<30% in 4.5um,>86% in 24um radius
LS15. Large spot launch with encircled flux<30% in 4.5um,>86% in 20um radius

This data is with the shaker running. The impulse collected was the average waveform. As will be shown, polarization and offsets affect these values.

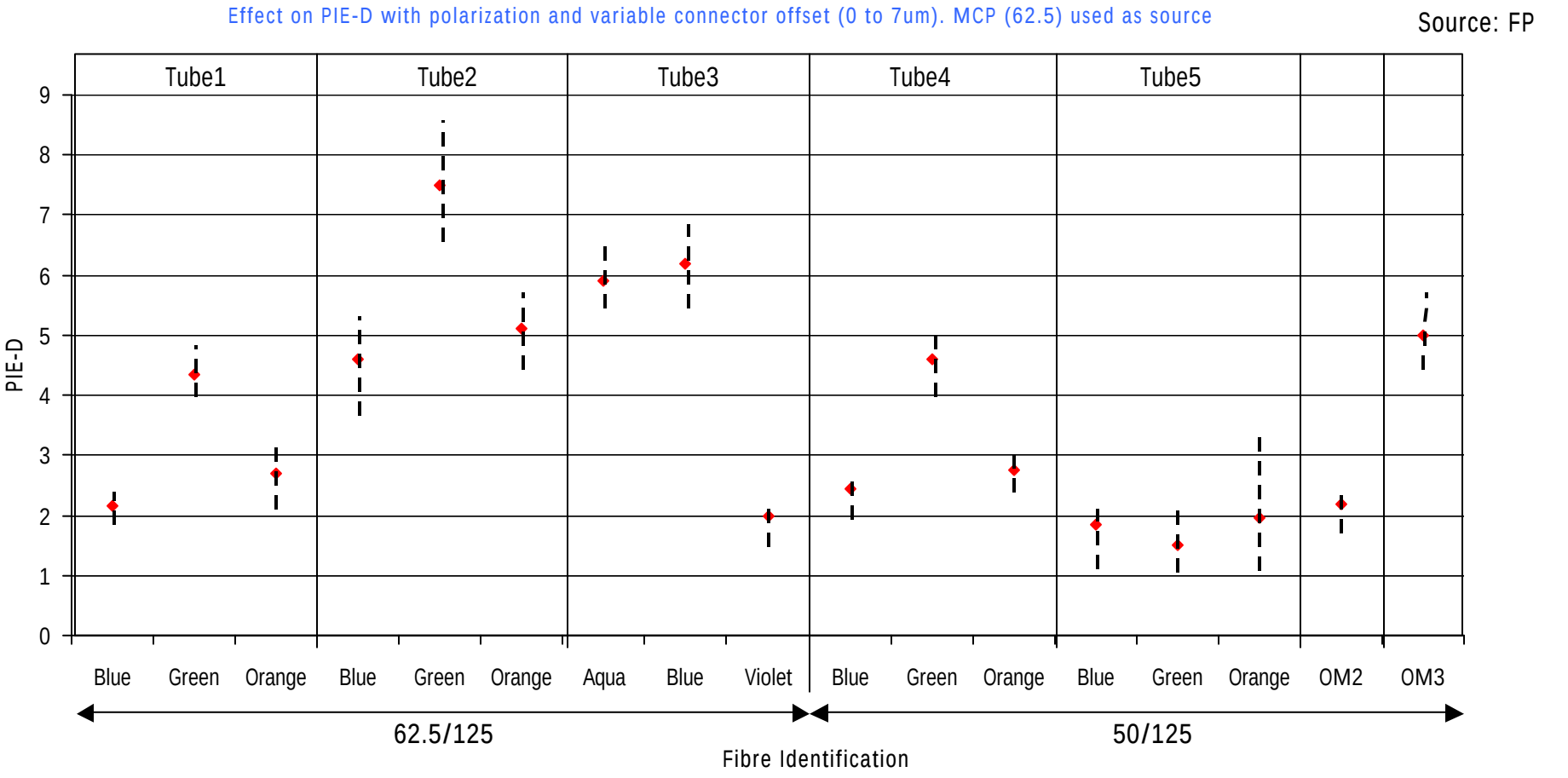
Next slide shows data sorted by PIE-D

Experimental setup: Average



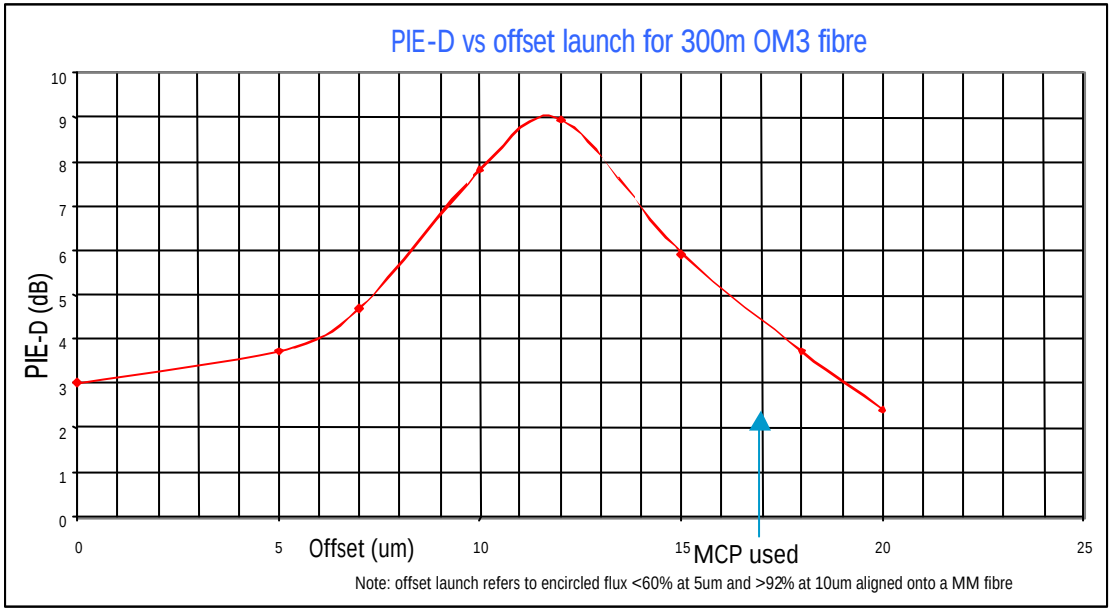
It is not only polarization that can affect the values but also the effective offset that is used. The sensitivity of a particular fibre to offset influences the results (see slide 9). In the example above there is a 3um difference in offset between the LS15 and Mode Conditioned Patch-cord.

Experimental setup: Limits



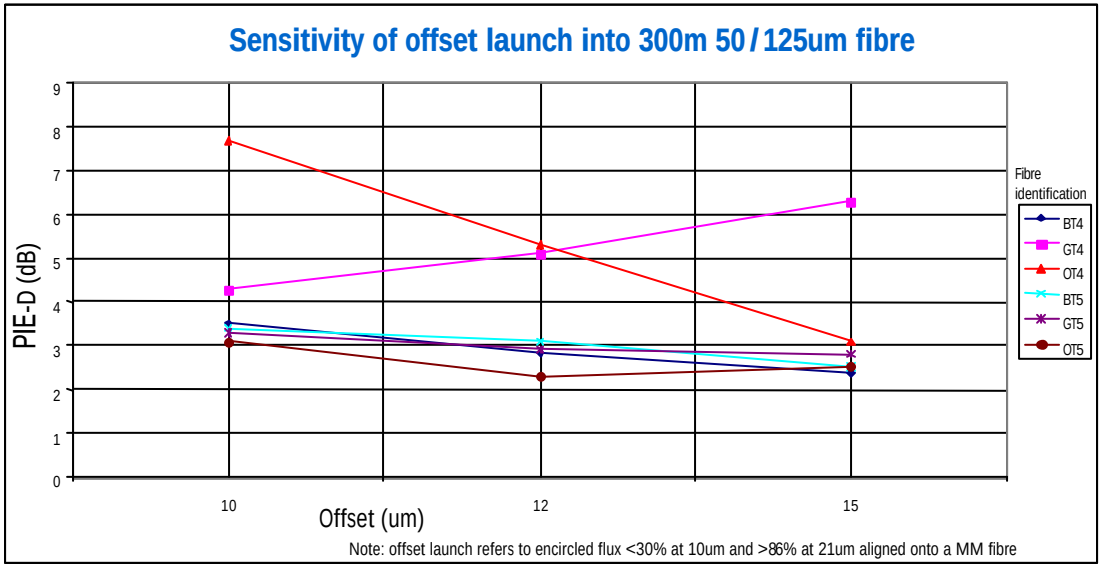
The limits observed due to polarization and variable connector are shown for Mode Conditioned Launch.

Experimental setup: Launch Offset Sensitivity

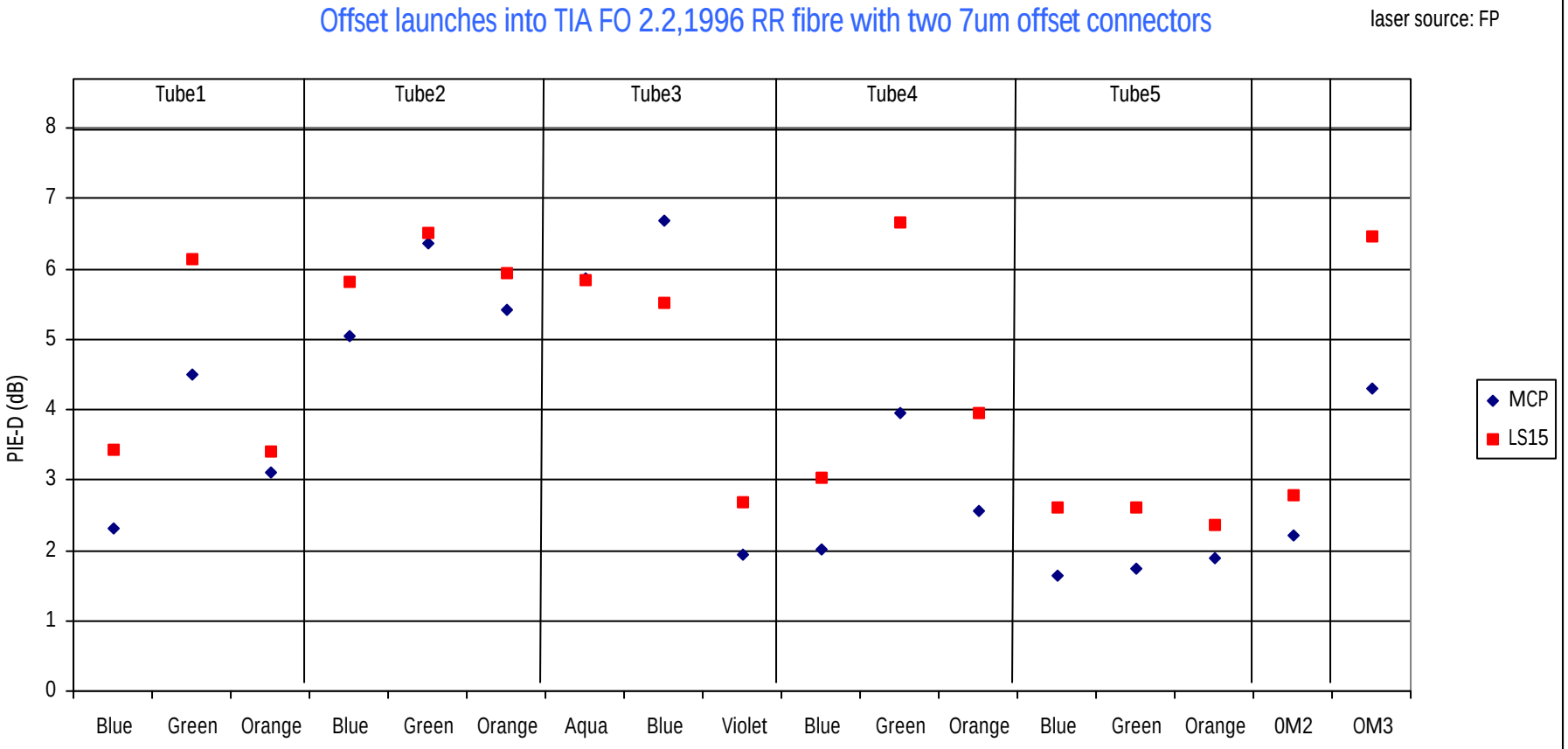


Effect of offset on OM3 fibre is shown. The effective offset of the launch can radically change the PIE-D value

Again offset sensitivity is shown for the 50/125 fibre

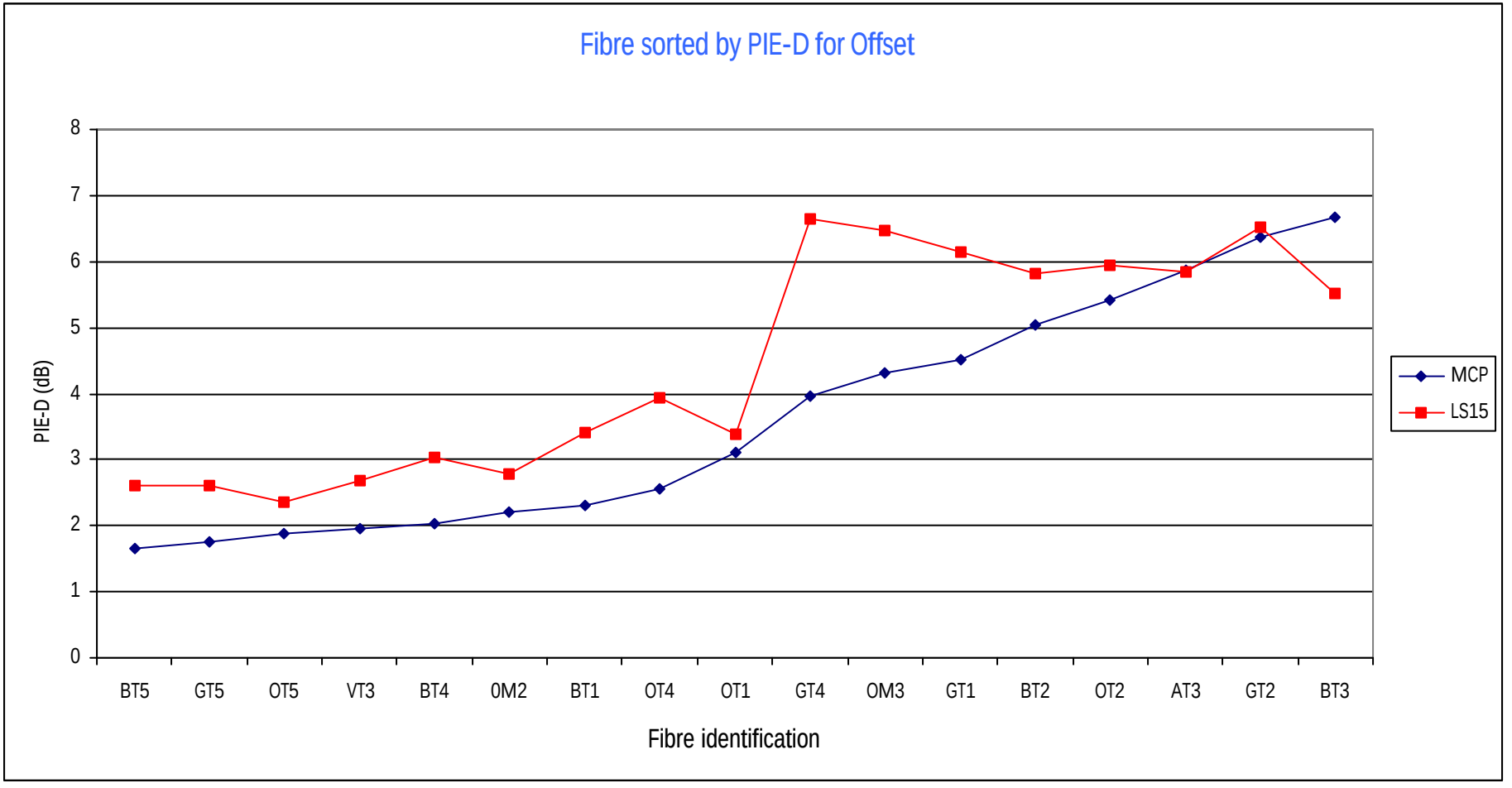


Experimental setup: Average

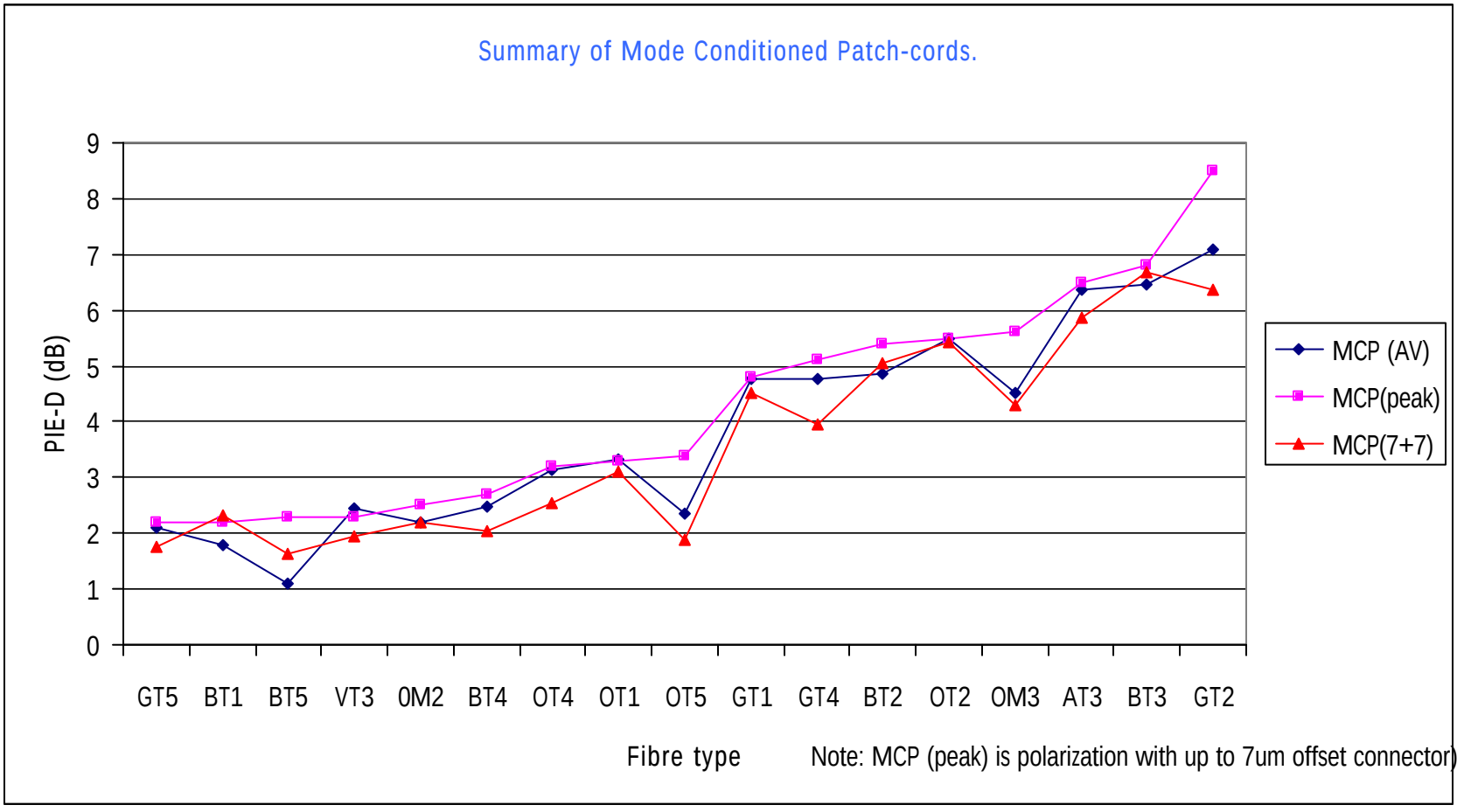


The effect of two 7um connectors in line are shown for two of the launch conditions. The Mode Conditioned Launch shows about a 1dB improvement compared to LS15.

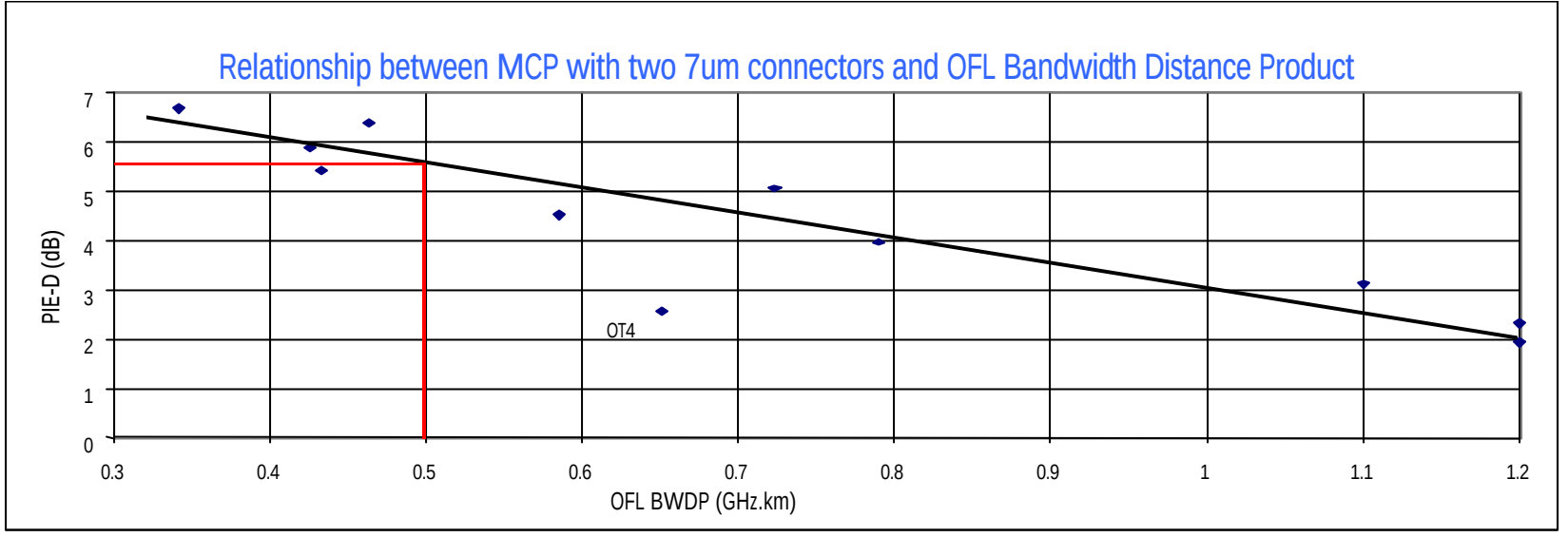
Experimental setup: Average



Previous data sorted

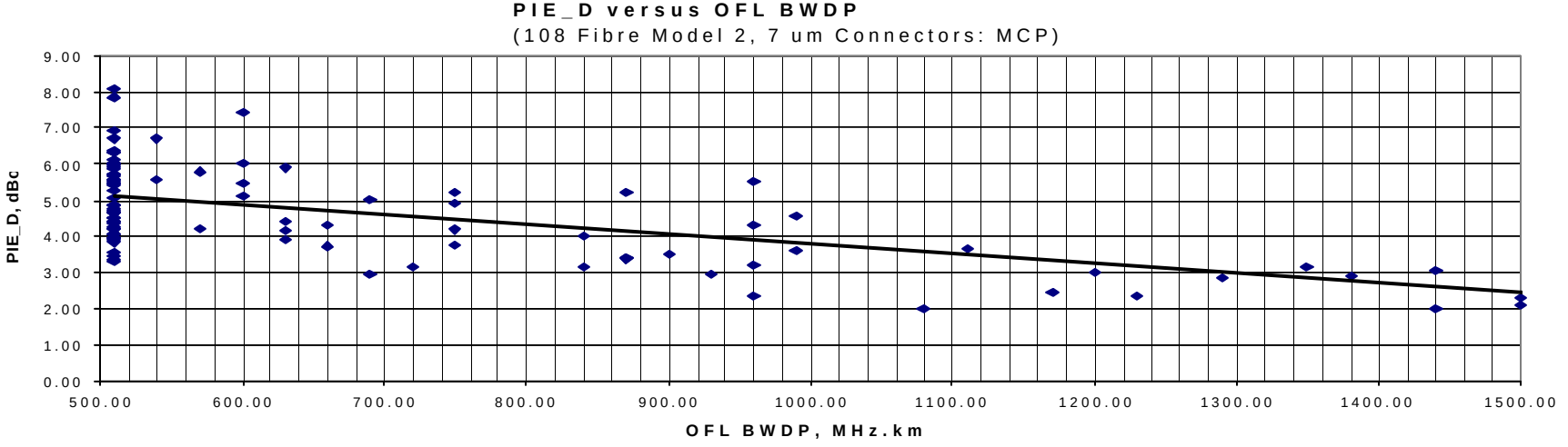


Shows the range from Mode Conditioned launches



The relationship between OFL BWDP and PIE-D is shown. With the exception of OT4, the correlation is good. The effective offset launch was 17um. At this offset the PIE-D for OT4 is low (see slide 9). If the correct offset (between 10 to 16um) had been used, the PIE-D for OT4 would have been worse.

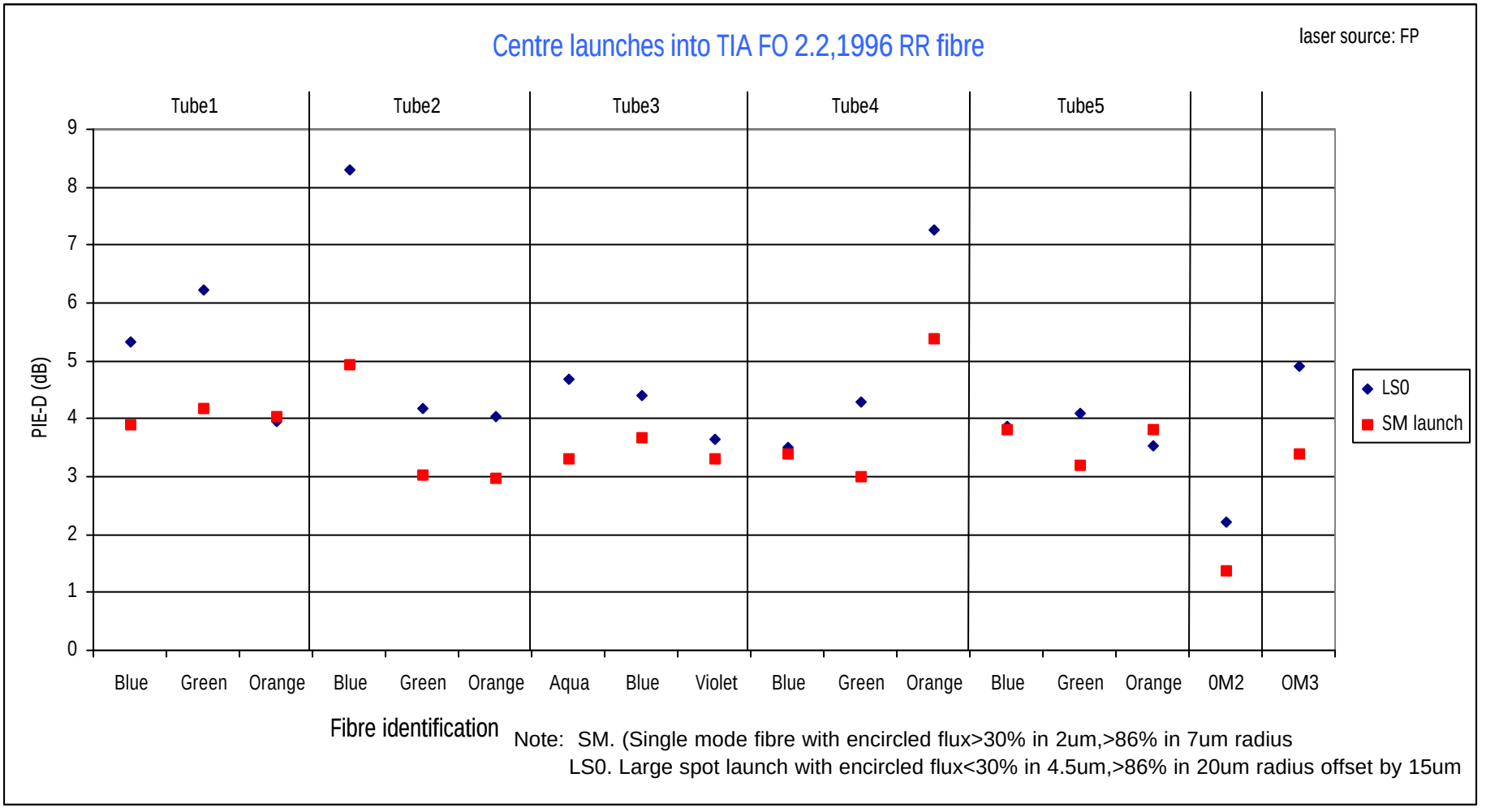
Below is the theoretical relationship.



Centre Launch

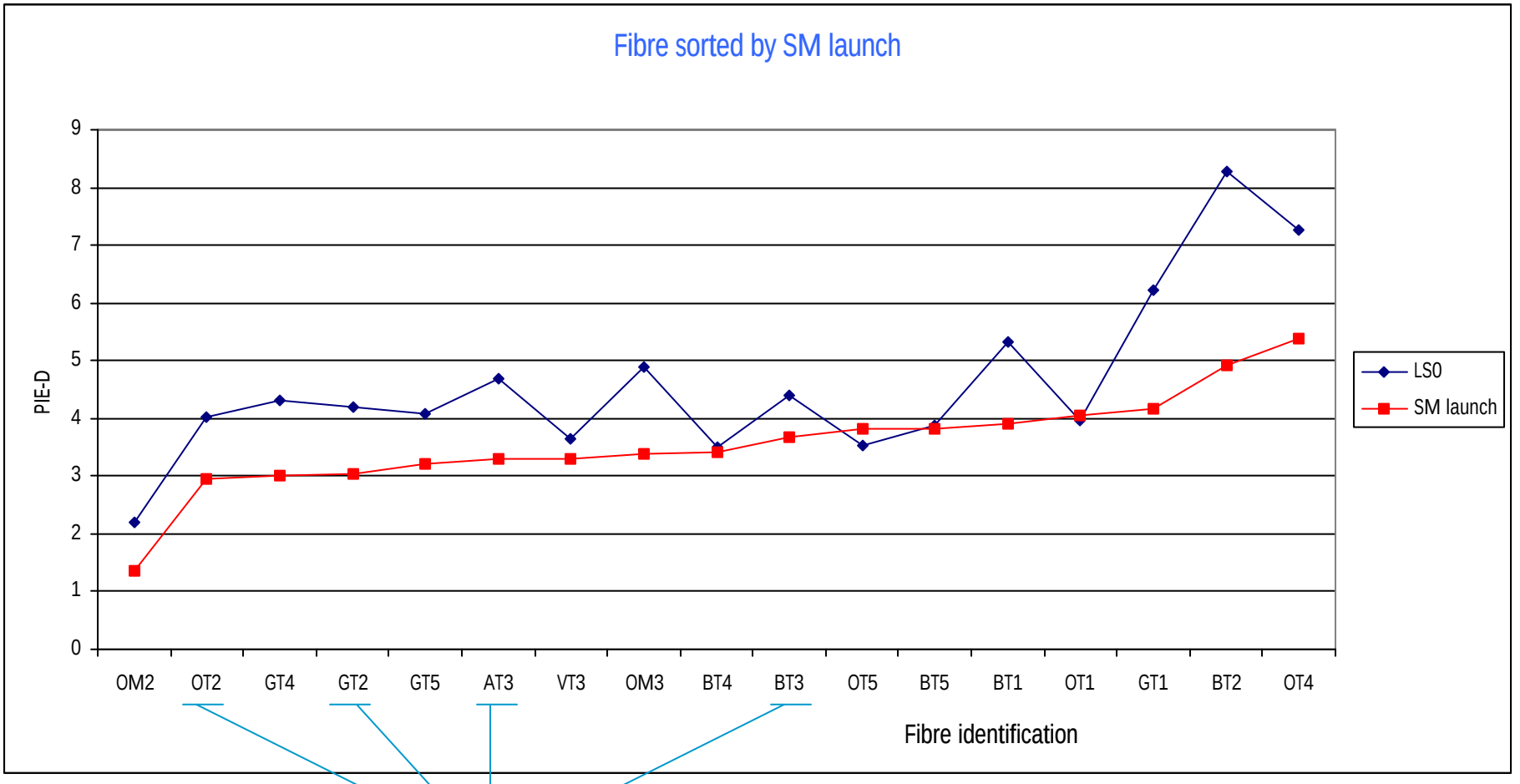
Slide	Experimental set-up	Launch
15, 16	AVERAGE	Single mode fibre
		Large Spot centre launch into MM fibre
17	LIMITS	Single mode fibre
18, 19	AVERAGE with 7+7um connectors	Single Mode fibre into 50/125um fibre
		Large Spot centre launch into MM fibre
10, 11	AVERAGE with 7+7um connectors	Mode Conditioned Patch-cord
20	Summary	

Experimental setup: Average



The exercise is repeated for Centre Launch. The above is the average impulse with the shaker on.

Experimental setup: Average



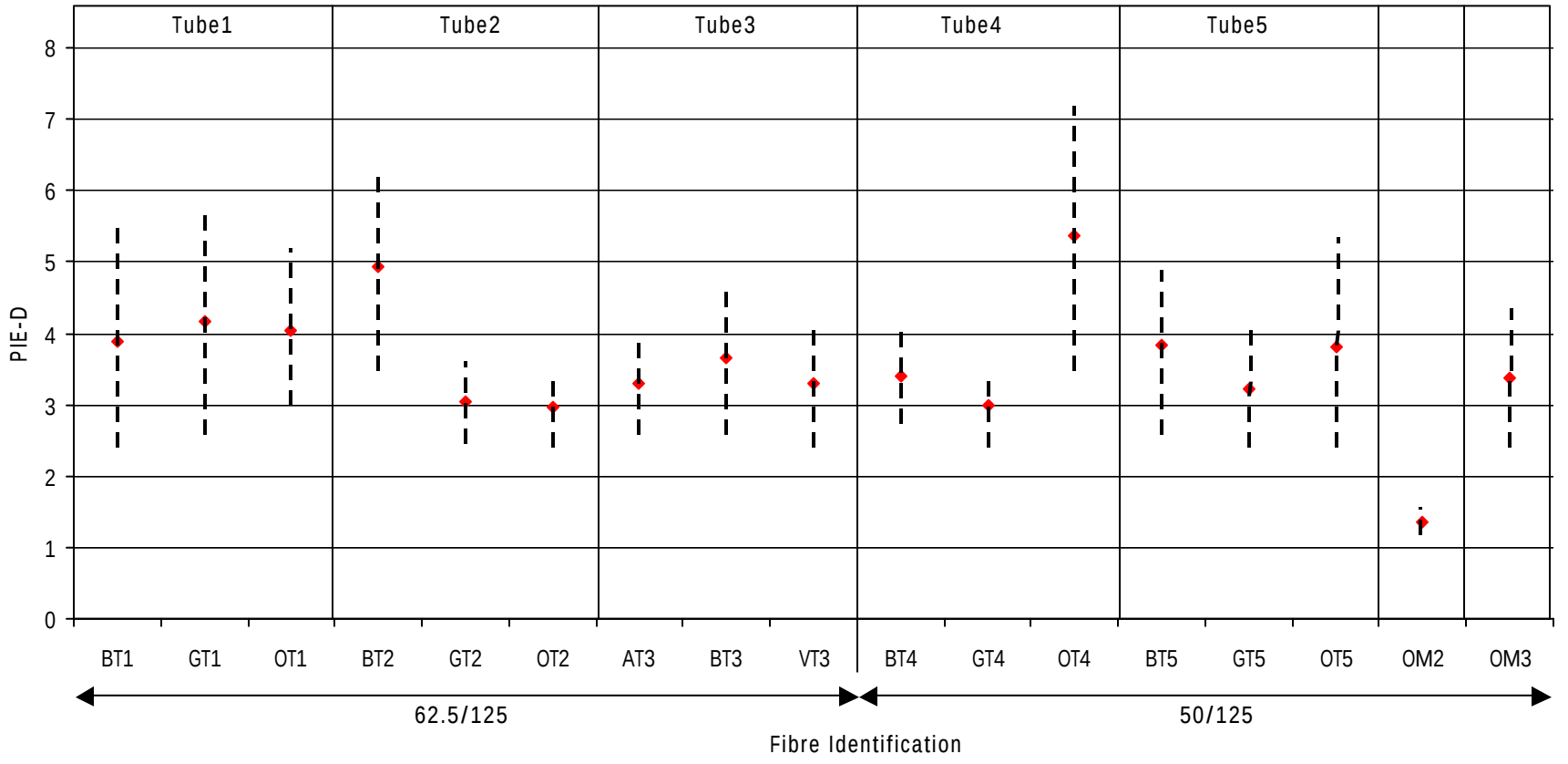
Sorted

fails for OFL BWDP

Experimental setup: Limits

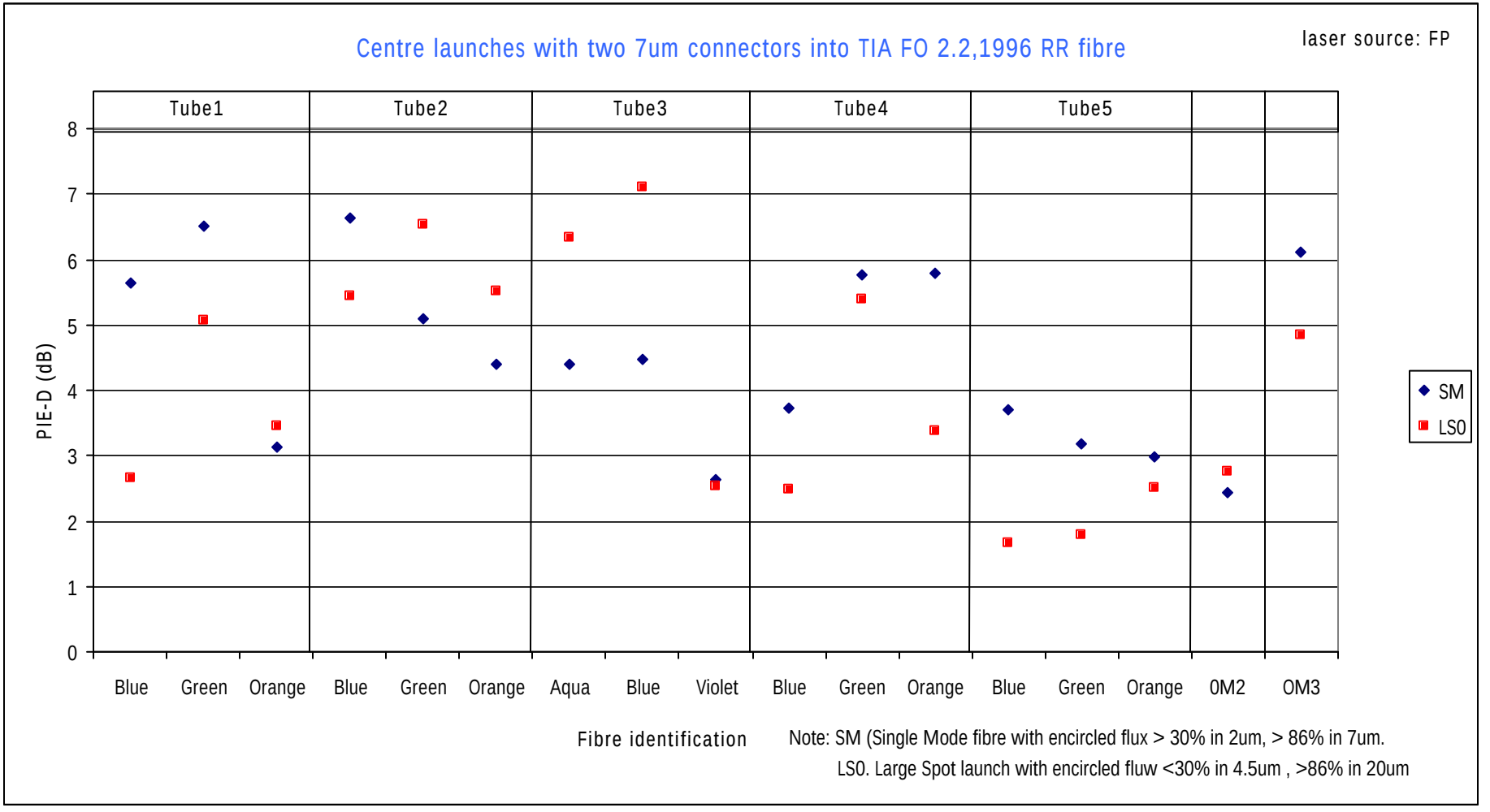
The limits observed due to polarization and variable connector are shown for SM fibre Launch.

Source: FP



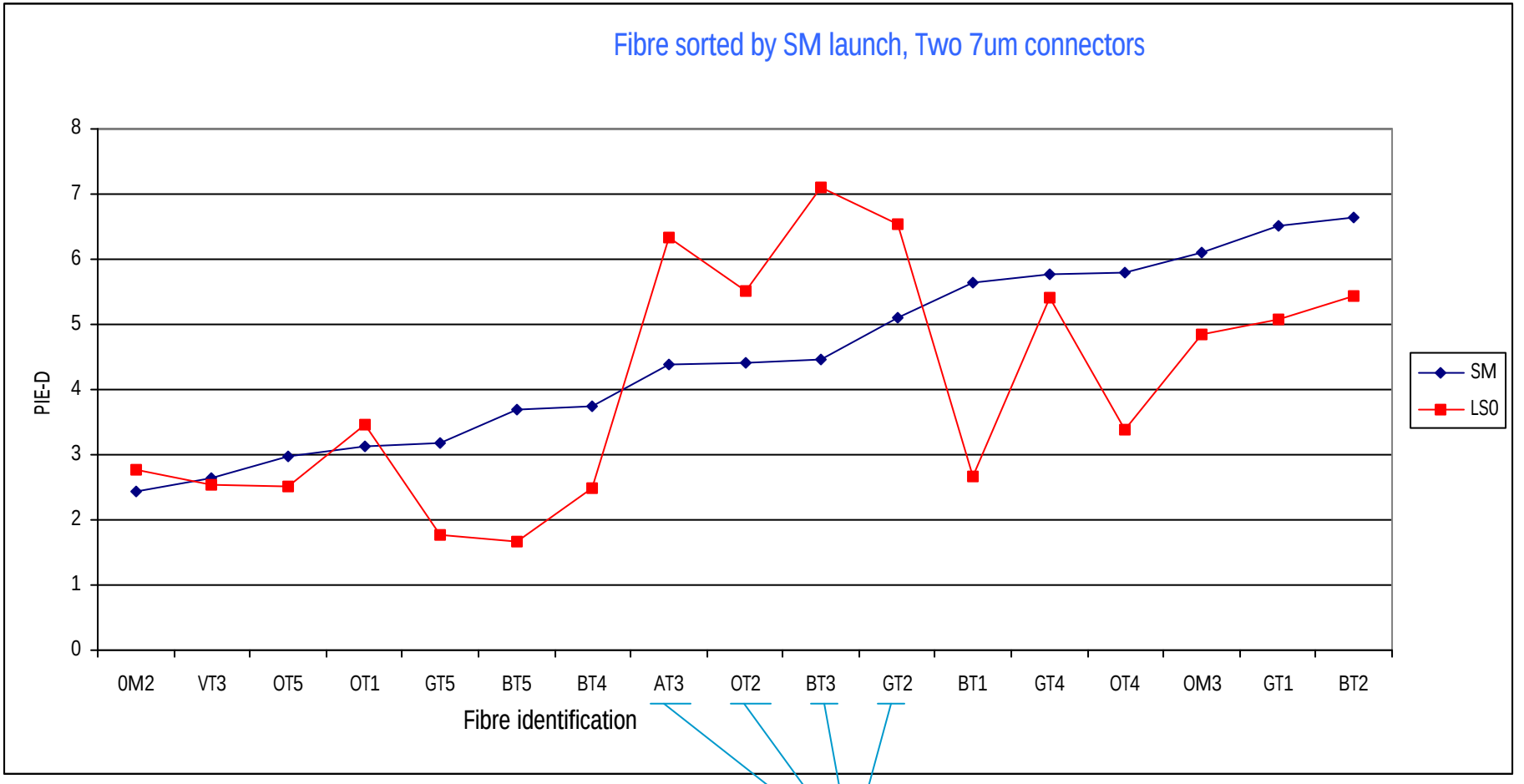
The limits observed due to polarization and variable connector are shown for Single Mode fibre launch. Notice that the majority of the ranges when compared to Mode Conditioned launch (slide 9) are greater.

Experimental setup: Average



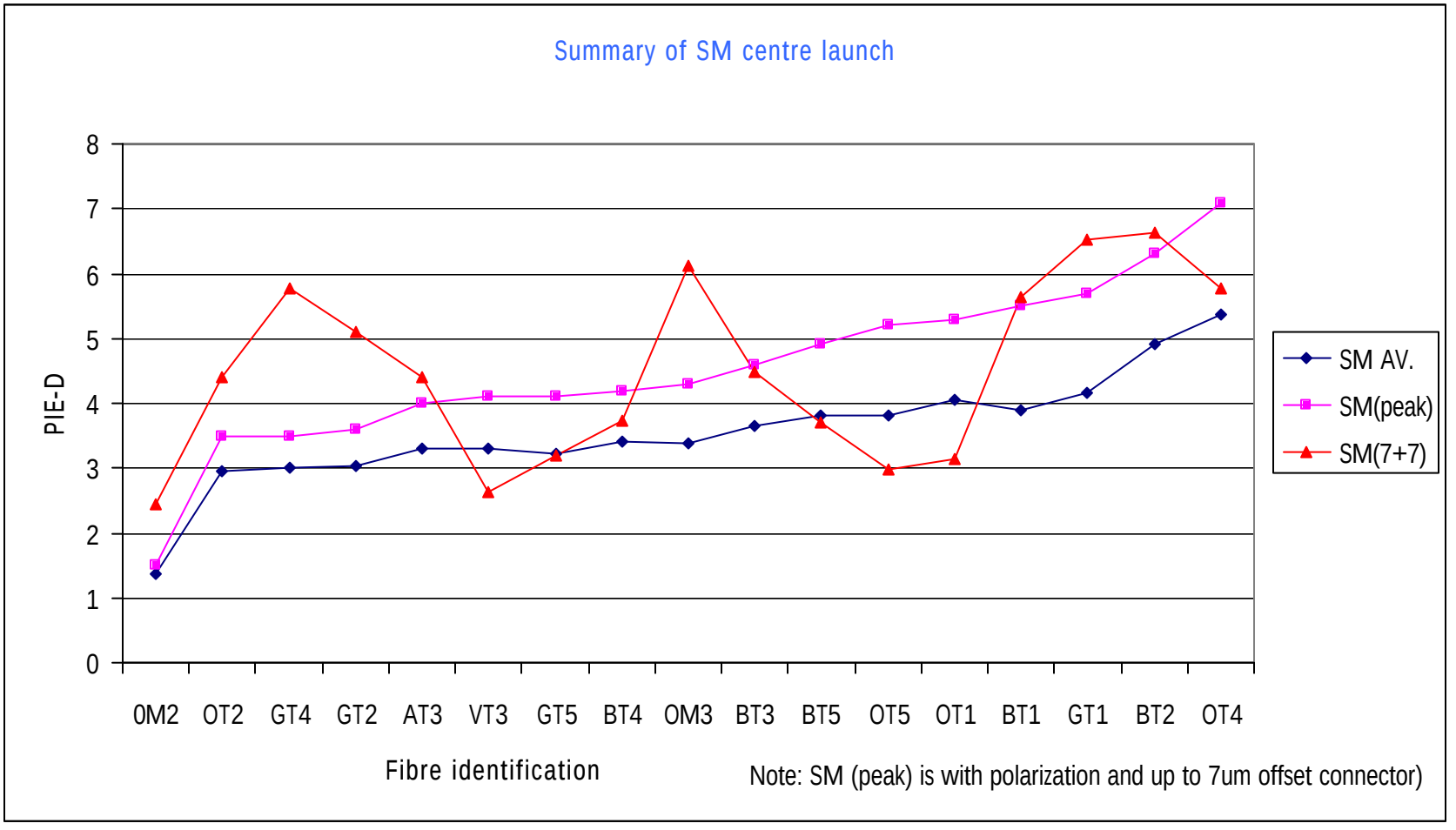
Centre launch using Single Mode fibre with two 7um connectors in line. Shaker is on.

Experimental setup: Average



Again the fibres are sorted by SM for PIE-D.

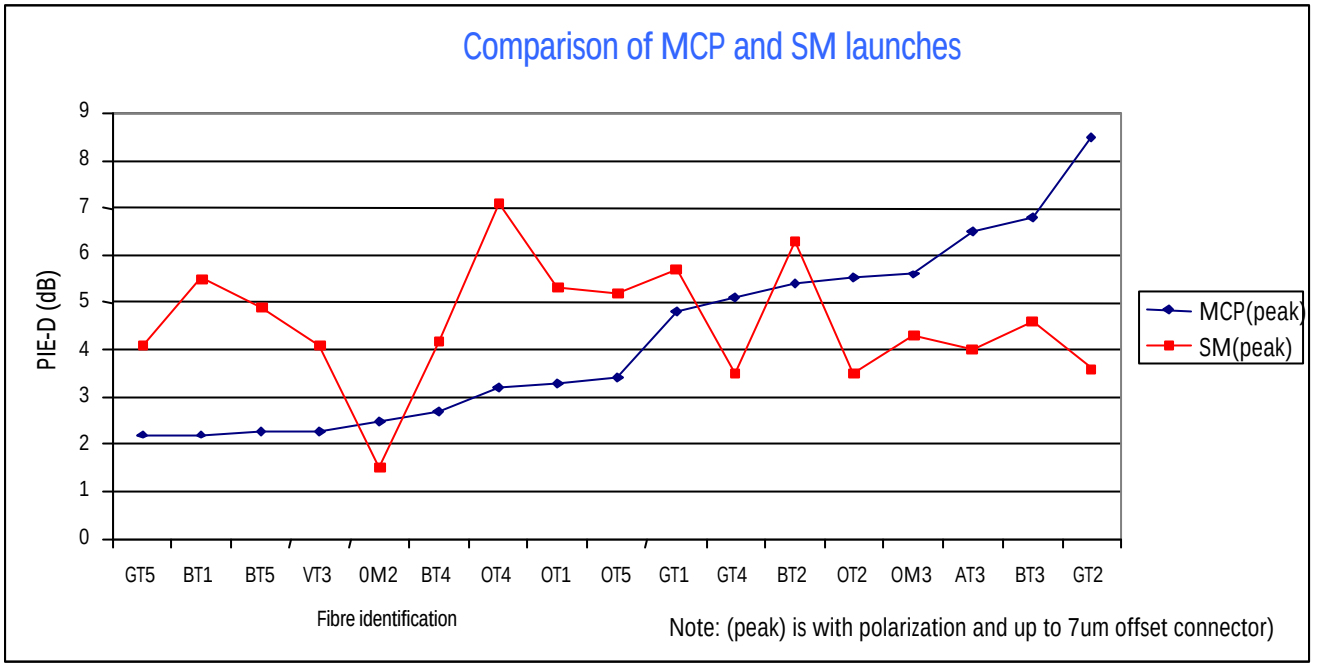
OFL BWDP worst with 7um connectors



Shows the range from SM launches. Ranges are more spread than with offset launch.

Offset and Centre launch

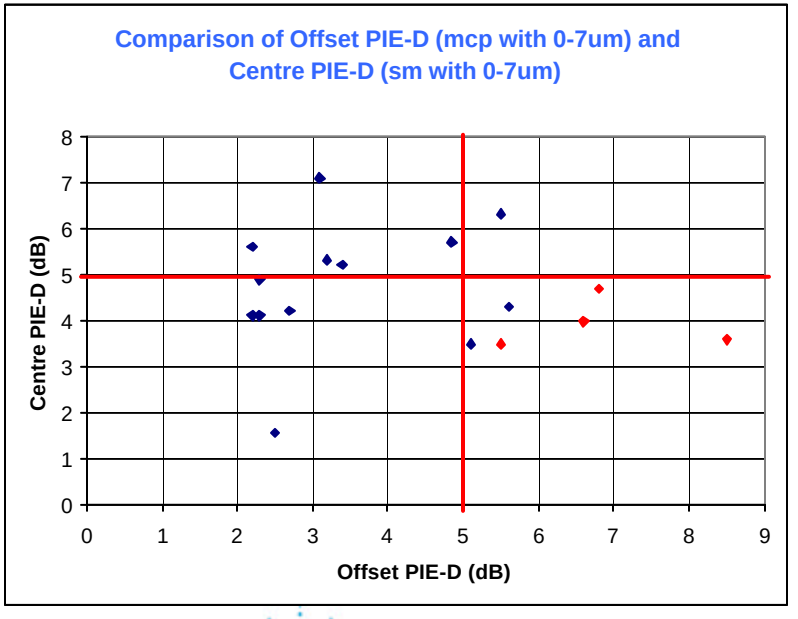
Slide		Launch
23	Comparison	Single mode fibre (Centre launch) with Mode conditioned patch-cord. Both with polarization changes and a single variable connector up to 7um offset.
24	Scatter-graph	Single mode fibre (Centre launch) with Mode conditioned patch-cord. Highest value of PIE-D obtained from either one or two 7um offset connectors for both.
25	Observations	

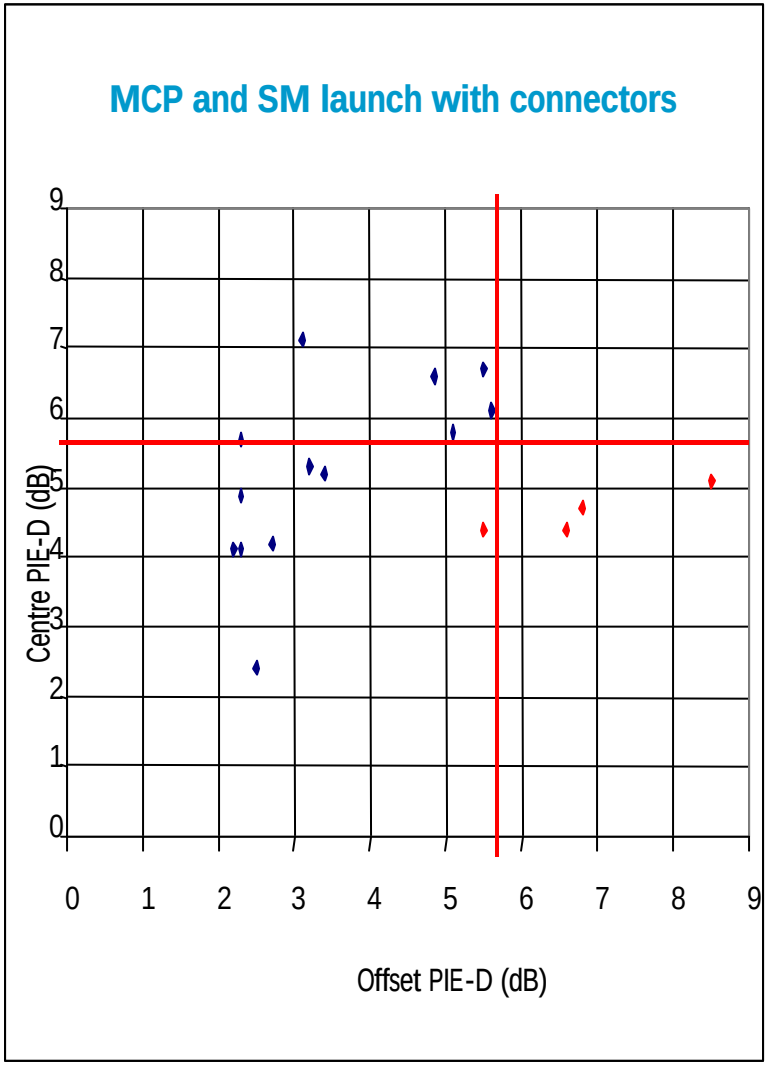


Comparison between the centre and offset launch for the single 7um connector offset

As a Scatter-graph

Those in red are the OFL BWDP fail fibres





Scatter-graph of the worst value of PIE-D for either one 7um connector with polarization or two 7um offset connectors. Those in red are the OFL BWDP fail fibres.

Variation of Waveforms in Multimode Fibre Observations:

- **Polarization and mechanical stress on fibres causes less variation in PIE-D when using an offset launch compared to central**
- **Good correlation between Bandwidth Distance Product and PIE-D for offset launch**
- **A PIE-D of about 5.5dB is needed for the TIA FO 2.2, 1996 Round Robin fibre when using both launch conditions**
- **For those fibres that fail OFL BWDP specification, central launch has a lower PIE-D value than offset**
- **Small difference between MCP with one or two 7um connectors**