

Fiber Port Cluster 2 – 6

**Fiber port cluster with two
input channel:
Investigation of principle
and adjustability**

by

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1 Introduction

A 6-port fiber port cluster has to be fed with two input channels of almost same wavelengths. The alignability of the system and the adjustability of the splitting ratio is investigated.

2 Setup

The fiber port cluster 1 - 6 by Schäfter+Kirchhoff has an unused input port in principle. By this port a second source IN 2 can be coupled into the system (see Fig. 1). An assembly symmetric to input channel 1 consists of a polarizer, a beam splitter 98/1, and a photo diode for monitoring purposes.

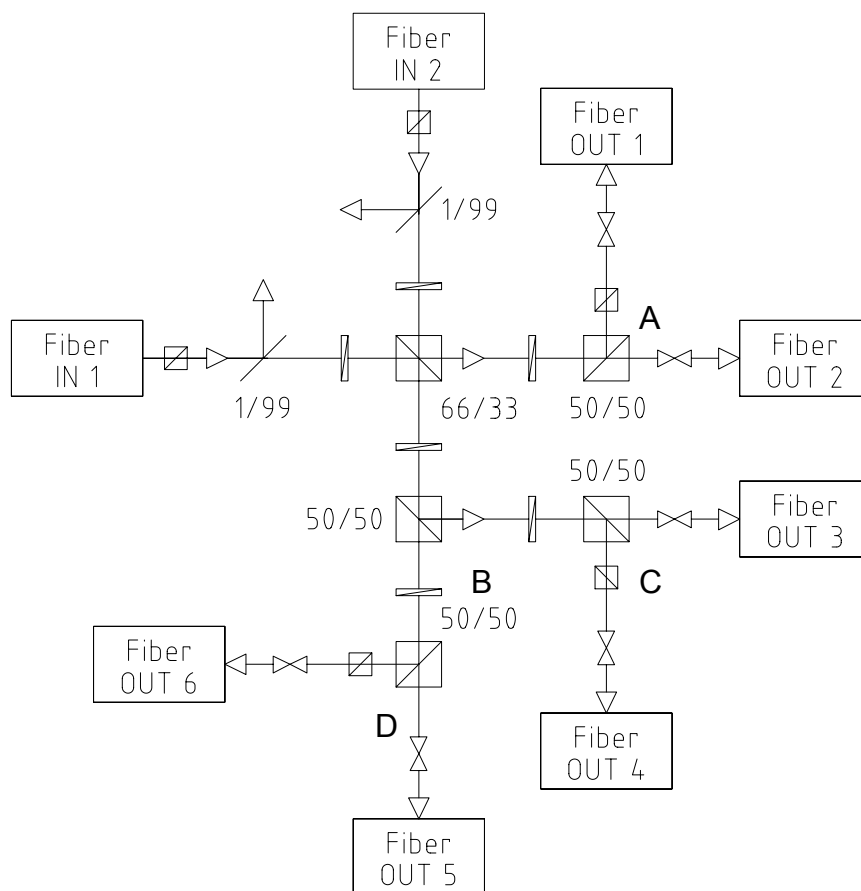


Fig. 1: Fiber port cluster 2-6

3 Operation principle

The operation principle of power splitting by use of a wave plate and a polarization beam splitter is shown in the vector diagram, see Fig. 2.

3.1 Phasing

The diagram in Fig. 2 shows the phasing of the two input channels at output: At port 2 to port 4 the radiation is phase-shifted by π , the others are inphase.

Despite the phase shift, after a quarter-wave plate the orientation of circular polarization is identical for both sources. When the two input channels have the same coherent source they interfere and generate a beat signal – depending on frequency shift.

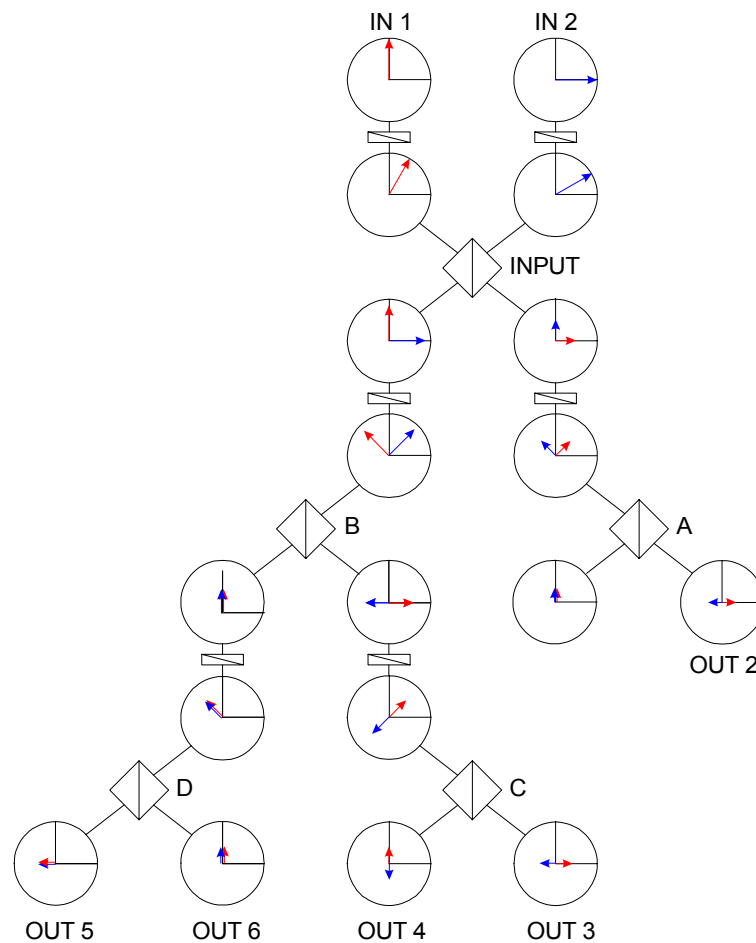


Fig. 2: Diagram of states of polarization and phasing inside the fiber port cluster.

4 Alignment

The alignment of polarization beam splitters and half-wave plates inside the cluster already is defined by the demands on splitting one input source only. As additional freedom of alignment there is the laser beam coupler at the second input only. Besides the tilt adjustment (lateral translation of the focused spot at fiber end face) a lateral adjustment (alignment of coupling axis to fiber axis) has to be given.

5 Splitting ratio

Since polarization beam splitters do not work ideally, but reflect approx. 5 % of p-polarized radiation together with approx. 100 % of s-polarized radiation, a balanced power splitting simultaneously for two input channels is not achievable necessarily (Fig. 3). The possibilities of alignment will be investigated in a simple model:

Consider a fiber port cluster with two input channels (sources). The wave plates are adjusted to their nominal position.

Fig. 4 shows the power splitting at the individual output ports. The powers vary between 9.5% und 17.5%.

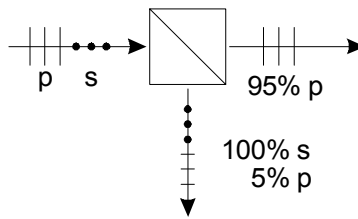


Fig. 3: A polarization beam splitter has in reflection a limited extinction of about 20:1.

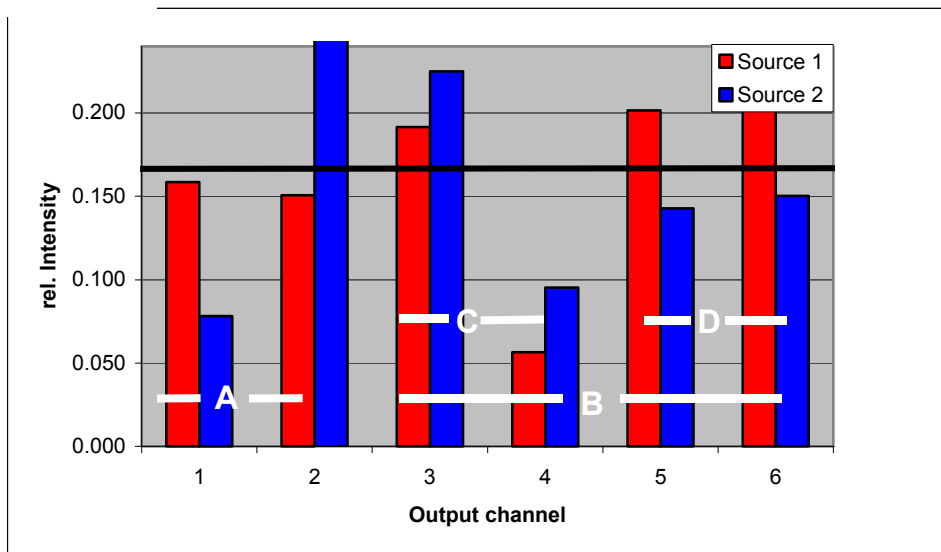


Fig. 4: Distribution of two input channels to the 6 output channels at nominal position of wave plates (5 % reflection of p-polarization).

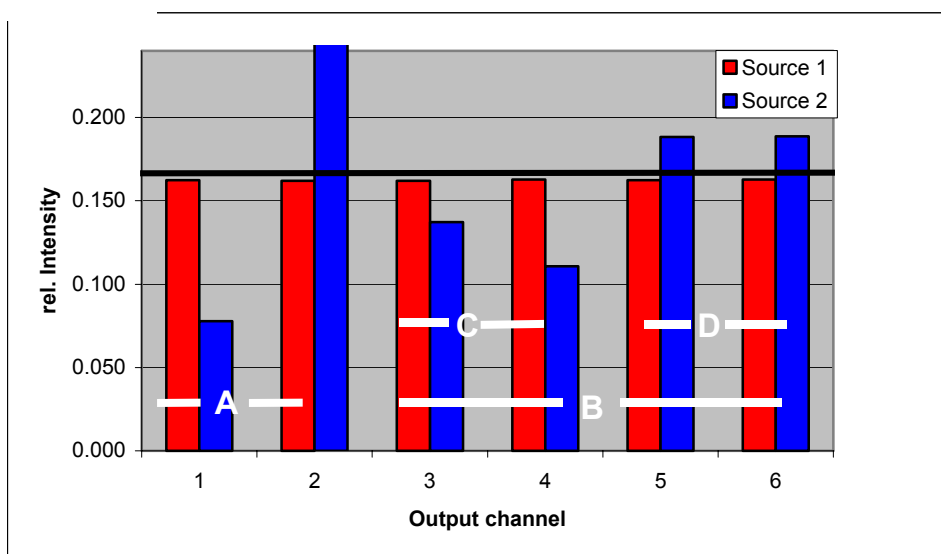


Fig. 5: Distribution of two input channels to the 6 output channels at optimum position of wave plates for one input channel (input 1).

In case of a real alignment, the power levels will be more equalized, since the power variation can be adjusted for by minor rotating the wave plates.

Fig. 5 and Fig. 6 show the same fiber port cluster, adjusted for a balanced output for one input channel, respectively.

The variation of powers of the other source, respectively is approx. 7% to 25%.

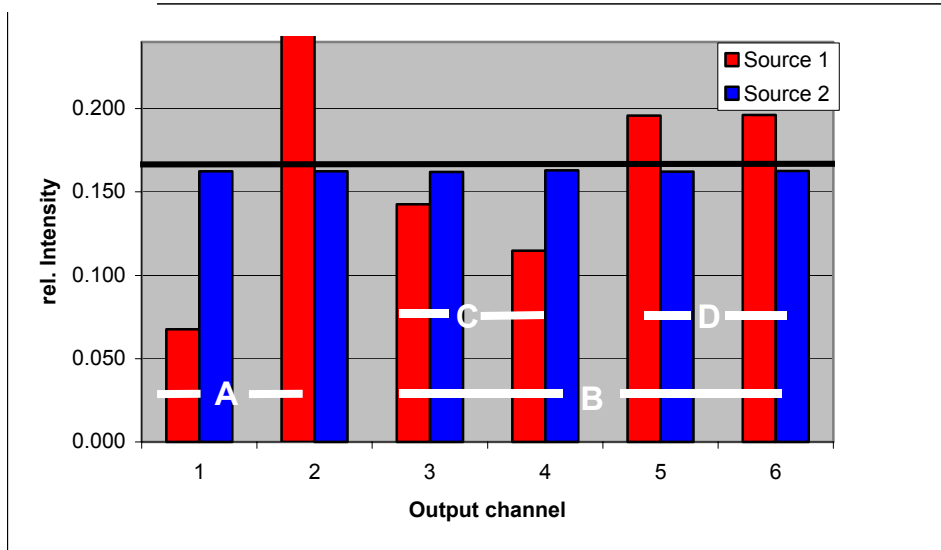


Fig. 6: Distribution of two input channels to the output channels at optimum position of wave plates for the other input channel (input 2).

For the adjustment of the cluster shown in Fig. 7, the orientation of the wave plates are the center positions of the alignments of Fig. 5 and Fig. 6.

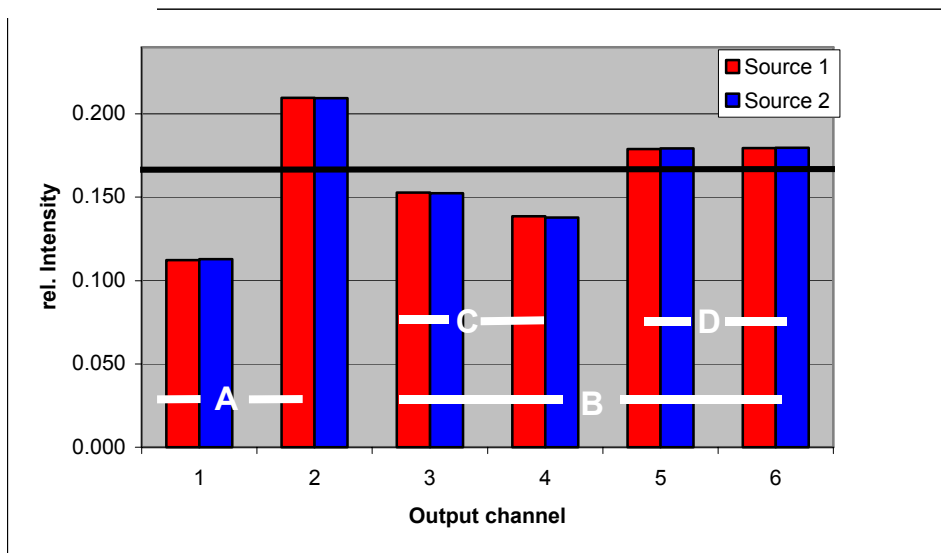


Fig. 7: Wave plates in center position of the two extrema in Fig. 5 and Fig. 6.

The power levels of the different output channels are still different and vary in between 11% and 21%, however the power levels of the different sources are the same for each output port.

By attenuators at the six output channels of the fiber port cluster, the power levels can be dimmed to a common level, see Fig. 8.

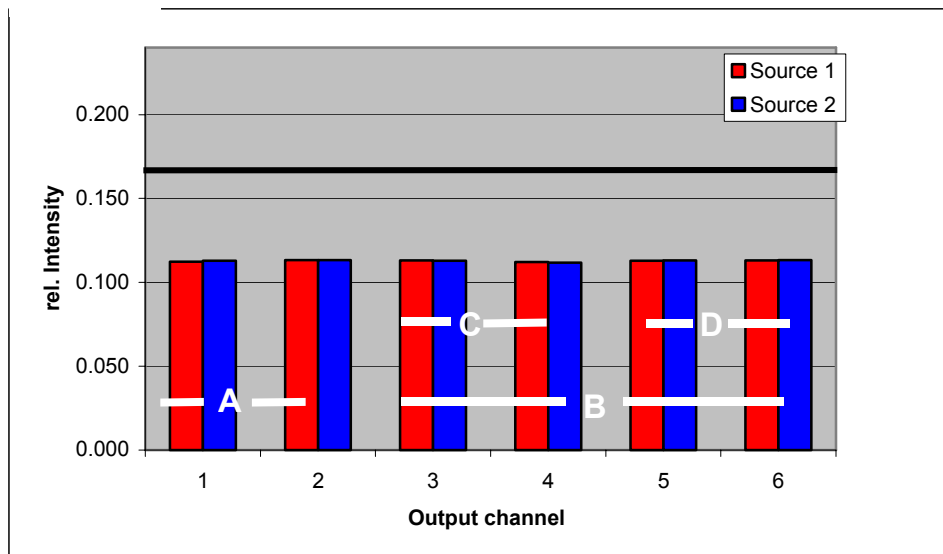


Fig. 8: Adjustment of Fig. 7 with dimming of power levels by use of attenuators at the output ports.

The losses compared to a system with ideal polarization beam splitters are 33%. By further optimization of the adjustment a balanced power splitting with approx. 77.5% efficiency compared to an ideal fiber port cluster can be reached.

When there is need for equal power levels by pairs only, an different optimization of the system is possible, see Fig. 9. In this case the efficiency is 95% compared to an ideal system.

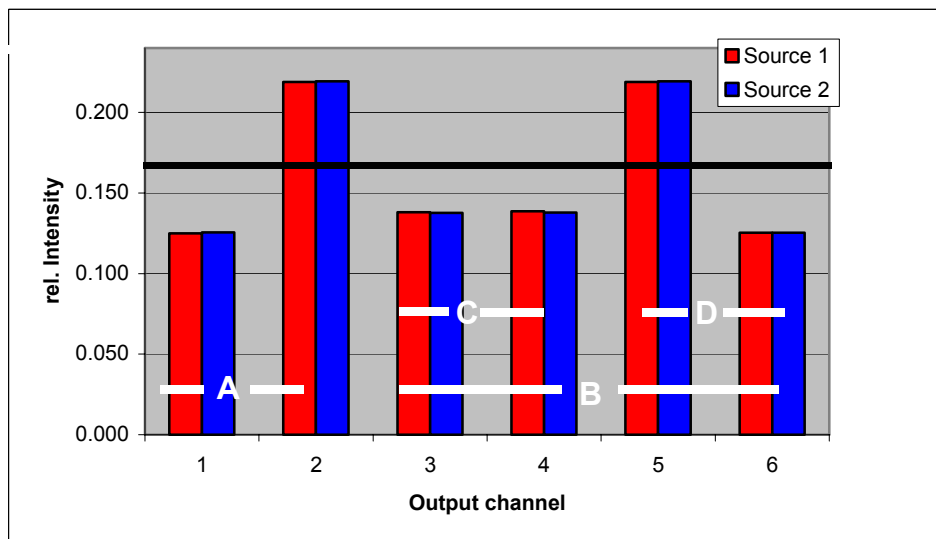


Fig. 9: Adjustment of Fig. 7 with equalized power levels by pairs (with attenuators).

6 Conclusion

A fiber port cluster 1-6 can be upgraded by a second input source of (almost) same wavelength. For that the second input port of the first polarization beam splitter.

In principle this fiber port cluster with two input channels has to be balanced. An adjustment for intended unequal power levels at each output port is not possible.

A limitation is given by the fact, that a real polarization beam splitter has in reflection a limited extinction of about 20:1 only.

In a fiber port cluster with one input only, the power splitting can be adjusted for by minor rotating of the wave plate. The overall transmission of the system is reduced.

In case of a fiber port cluster with two input channels the variation in power levels can not be adjusted for by rotating the wave plates. At each output port an attenuator is placed with which a balanced power splitting is possible. But the overall transmission of the system is reduced to about 77% compared to the transmission of an ideal fiber port cluster.

Is the splitting adjusted for balanced output levels in pairs only, the efficiency is about 95% compared to the transmission of an ideal fiber port cluster.

In part of the output channels both sources are phase-shifted to each other. Due to their same state of polarization they are transformed equally to a circular state of polarization by a quarter-wave plate. In case of coherence of the two sources, beating has to be expected.