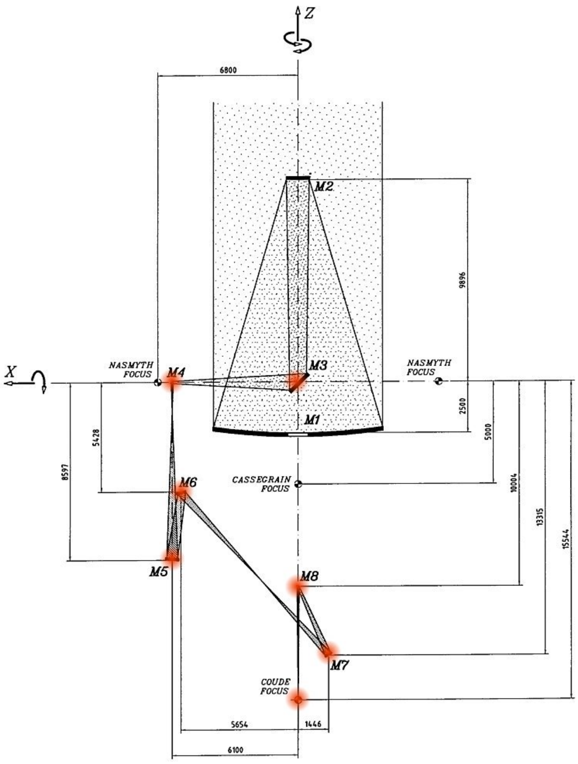
Polarization and VLTI:

the problem



AND

a solution....

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Two aspects of polarization

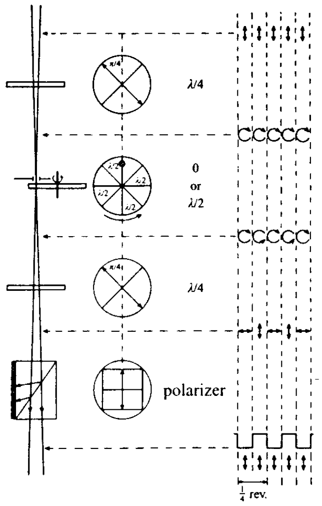
Power difference ("optical" usage)

$$I \;=\; I_0 + I_{90}$$

$$Q = \; I_0 - I_{90}$$

$$U = \; I_{45} - I_{-45}$$

$$V = \; I_{rc} - I_{lc}$$



Correlation ("radio" usage)

$$I \;=\; \overline{E_x E_x^* + E_y E_y^*}$$

$$Q = \; \overline{E_x E_x^* - E_y E_y^*}$$

$$U = \; \overline{E_x E_y^* + E_y E_x^*}$$

$$V \; = i(\overline{E_x E_y^* - E_y E_x^*})$$

Interferometer Stokes visibilities

$$\mathcal{I} \;=\; \overline{E_{1x} E_{2x}^* + E_{1y} E_{2y}^*}$$

$$\mathcal{Q} = \overline{E_{1x} E_{2x}^* - E_{1y} E_{2y}^*}$$

$$\mathcal{U} = \overline{E_{1x} E_{2y}^* + E_{1y} E_{2x}^*}$$

$$\mathcal{V} \; = i(\overline{E_{1x} E_{2y}^* - E_{1y} E_{2x}^*})$$

N.B. Correlation and polarization are to some extent interchangeable

The solution (e.g. for VLTI)

1. **Separate 2 linear polarizations (x, y) at Cassegrain, where polarization is still largely uncorrupted**

2. **(If desired, tag each beam by its own modulation frequency)**

3. **Transport to correlator as 100% linear polarization (by fiber or optical train; restore polarization to 100% linear wherever necessary); i.e. use 'radio' architecture**

4. **Combine into synthetic partially-polarized beams as follows:**

$$\begin{aligned} 1x &\Leftrightarrow 2x \\ 1x &\Leftrightarrow 2y \\ 1y &\Leftrightarrow 2x \\ 1y &\Leftrightarrow 2y \end{aligned}$$

(telescopes $1, 2$)

("complex correlations" are now expressed as "states of partial polarization" of these 4 beams)

5. **Use 1 "classical" (i.e. non-interferometric) optical (I,Q,U,V) polarimeter to determine the states of partial polarization of all the beams (4 per telescope pair), yielding the required complex correlations; i.e. a particular implementation of an optical correlator bank**

Advantages

- Yields "polarization fidelity" at optical wavelengths

- Can be constructed as a 3-telescope "polarization-optimized" phase-closure system

- a) Uses different aspects of polarization where necessary

  b) Uses optical components in their "natural" modes

- Uses only a few detectors (pixels) per beam and can be very broadband (0.3 to >1 micron)

  Applications: limiting magnitudes; STJ instruments

N.B. A "no-polarization-required" mode is a simple option

Minor problems of this architecture appear to be soluble and are discussed in a paper now in preparation: request from tinbergen@astron.nl