Analysis of the SMILES Optics Alignment

Philipp Fürholz, Axel Murk[1] , Richard Wylde[2] and Satoshi Ochiai[3]

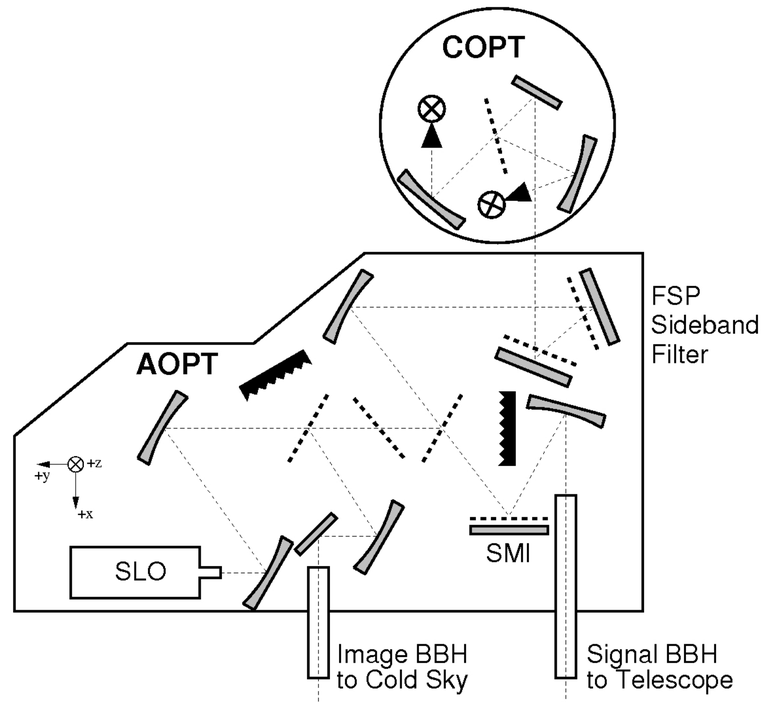
SMILES is a limb-sounder experiment which will be operated on the international space station. It's scientific goal is to measure the height distribution of several atmospheric species. This is achieved by measuring the emission spectra of the species. The height distribution is then computed by inverting radiative transfer models. Since amplitude of the expected emission spectra are small compared to the thermal radiation of the earth the antenna pattern must be well defined to make sure that only radiation from the limb is received.

Alignment Process

The alignment between the AOPT and COPT part is of great importance for ensuring a proper beam pattern of the instruments optics. Since the optical signal propagates through a overmoded corrugated waveguide already a small amount of misalignment can severely deteriorate the beam quality. The alignment of the AOPT and COPT part has been done using two-dimensional near-field beam pattern measurements. The beam pattern has been measured at the interface between the telescope and the AOPT at 35cm away from the aperture of the back-to-back horn. The measurement equipment consists of a Abmm vector network analyser and a planar scanner.

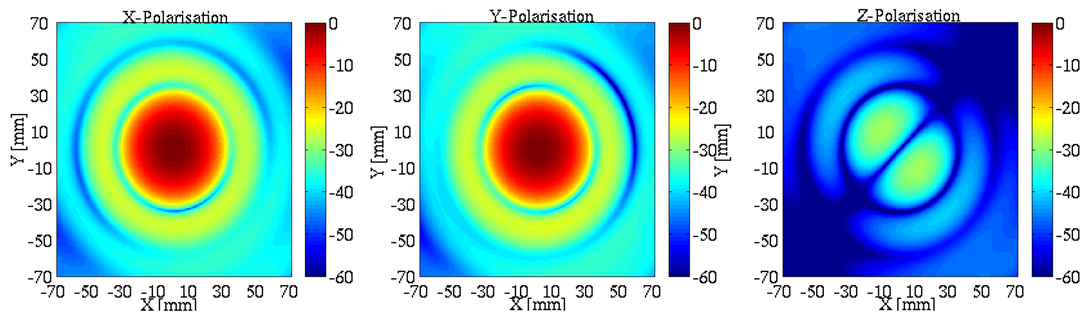
Simulation

The performance of the AOPT and COPT optics excluding the back-to-back horn has been simulated using the physical optics implementation in GRASP. The signal propagation through the back-to-back horn has been modelled using the mode-matching technique. The aim of this theoretical study was answer the question if the measured asymmetry is due to manufacturing errors or due to aberration effects at the elliptical mirrors.
The simulation results show that a lateral misalignment of 1mm in each direction causes a significant distortion of the output beam.

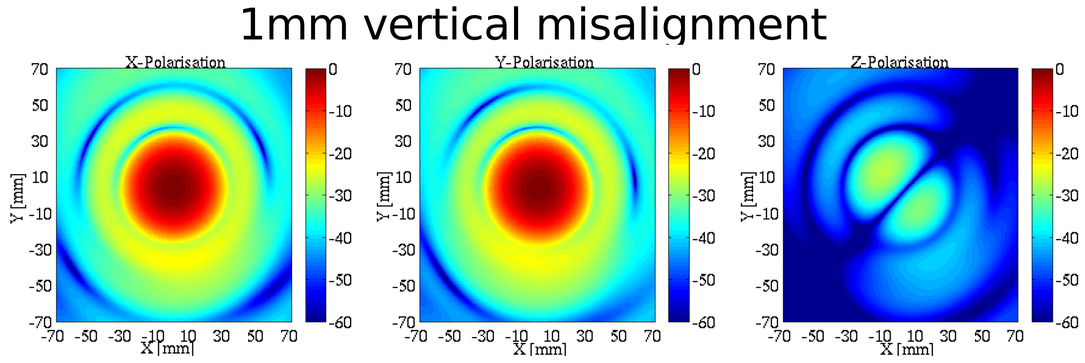


Schematic of the AOPT and COPT part of the SMILES instrument. The signal at the AOPT-Telescope interface is circular polarized because of the frequency selective polarizers.

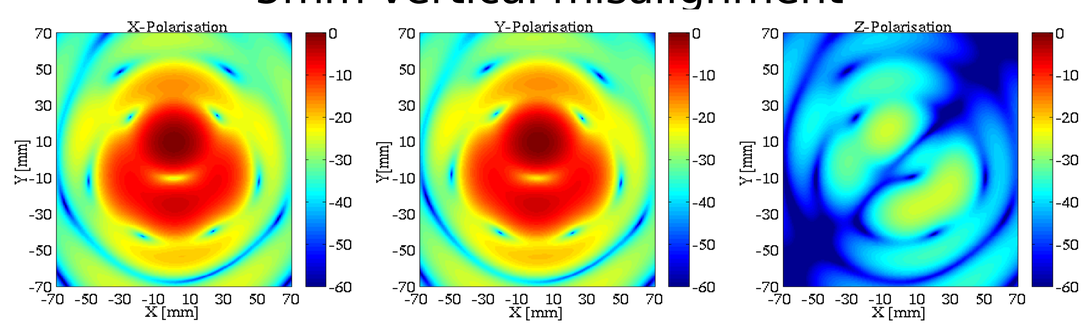
No misalignment

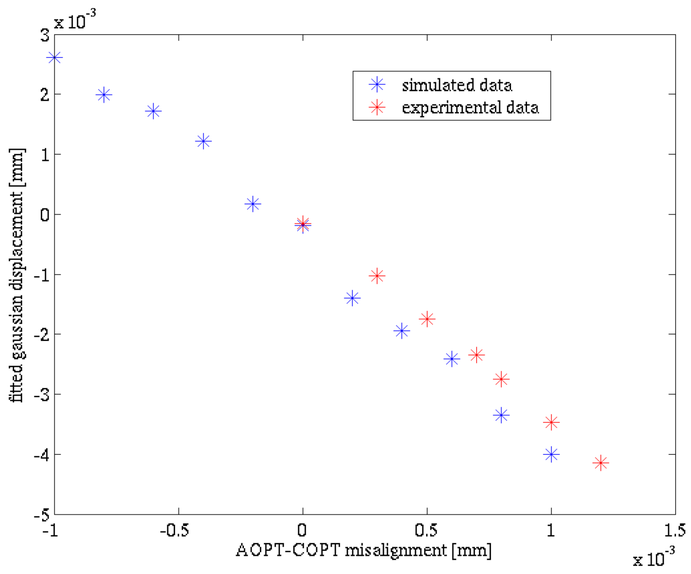


1mm vertical misalignment

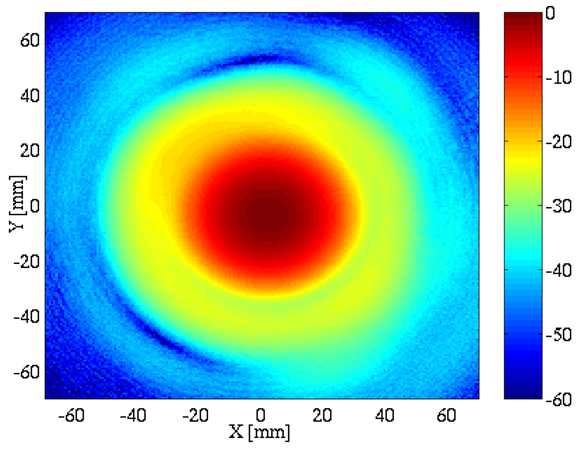


5mm vertical misalignment





relative displacement of the beam center of a gaussian beam fitted to the simulated and measured near-field data for several values of the aopt-copt misalignment



Measured beam, x-polarisation of the optimally aligned system. We observe a diagonal asymmetry which can't be reproduced entirely using the theoretical model, we therefore conclude that this asymmetry is mainly due to manufacturing tolerances.

1) Institute of applied Physics, Bern, Switzerland
2) Thomas Keating Ltd., UK
3) NICT, Japan