Networks of local minima for EUV mirror systems

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Introduction

Local minima situated in a multidimensional merit function space are connected via links that contain saddle points and form a network[1].

Network detection

1) start from a local minimum
2) detect all saddle points connected with the local minimum
3) local optimization downwards on both sides of each saddle point -> new local minima
4) perform 2) and 3) for all new local minima
5) select the best solutions

Application

The best systems (represented in blue in **Fig.1** and **Fig.2**) remain in the network even when the number of constraints is changed.

Conditions: **variables:** 6 curvatures
constraints: paraxial telecentricity

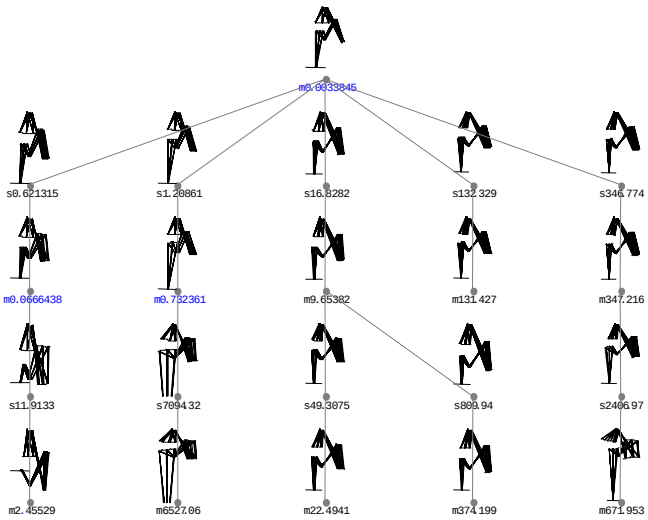

Fig.1 Network structure of a six-mirror system search, situated in a five-dimensional merit function space. S represents the saddle points. M represents the minima. The value of the merit function is also shown.

Conditions: **variables:** 6 curvatures
constraints: paraxial telecentricity
magnification

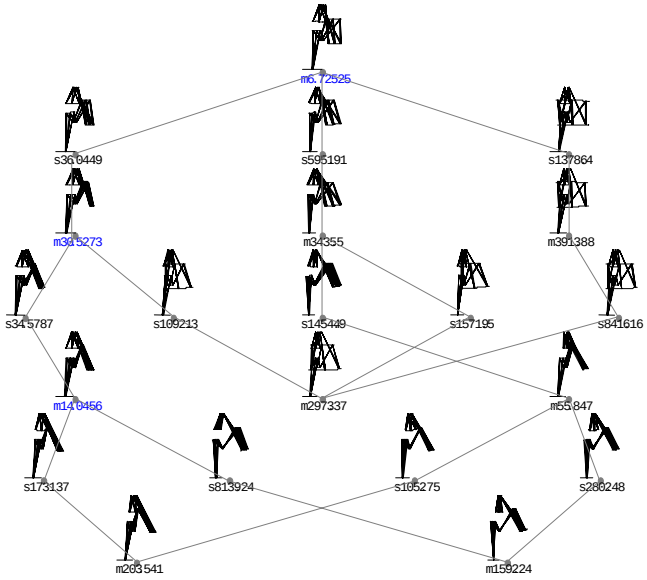

Fig.2 Network structure of a six-mirror system search, situated in a four-dimensional merit function space.

The best local minimum is then reoptimized with all variables and all constraints (**Fig. 3**).

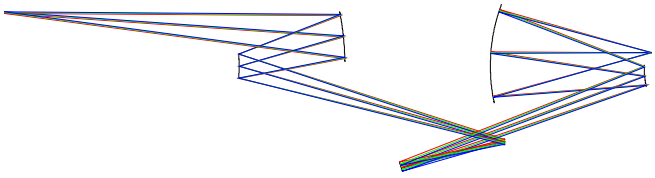

Fig.3. Six-mirror microlithographic projection system with object heights between 114 and 118 mm, a numerical aperture of 0.25, a magnification of 0.25, distortion below 1 nm and all incidence angles on the surfaces below 15˚.

The network method provides insight in the topography of the merit function space.

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Reference

1. F. Bociort, E.van Driel, A. Serebriakov, "*Networks of local minima in optical system optimization*", Optics Letters **29**, 189-191 (2004)