

Comprehensive software infrastructure for designing future CSP plants (classic tower optics with secondary)

Project SFERA, WP 13 Task 2

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DELIVERABLE R13.1 contains also the files:

SetupVersaDim.exe

VersaDim.pdf

NURBSOpticalDevices.pdf



DLR

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Deliverable R13.1:

Comprehensive infrastructure (USER SUPPLIED) for designing the future CSP (classical tower optics)

At the German Aerospace Center a generic dimensioning software application has been developed: “VersaDim”. Its design aim was to deliver a “versatile dimensioning” application that would specialize on providing the necessary numerical routines for extreme value finding and rely on separate applications to determine cost function values. VersaDim talks via one of two interfaces to these external applications: “DLL” and “Named Pipe”. Both of these interfaces are documented and example/tutorial source code how to implement them on the “external application” side is provided in C/C++, Object Pascal and FORTRAN90. Moreover, the full source code of VersaDim is provided. An [installer application](#) (see attachment) that will install VersaDim on PCs running under the Microsoft Windows operating system is included. The installer will also copy all the help and documentation files to the target folder along with the interface sample code.

VersaDim is implemented in Object Pascal and can be compiled for example with Borland Delphi or Lazarus/Free Pascal. Therefore, it can be ported also to Linux and other operating system with few modifications. It implements three generic search algorithms: gradient descent, Nelder-Mead simplex method and simulated annealing for continuous control space. In the result file, all parameter sets for which the cost function has been evaluated are listed together with the reported cost function value. For operating and progress display purposes VersaDim offers a graphical user interface (see Fig. 1). It is published under the terms of the GNU General Public License.

A copy of the [manual](#) is attached separately from the installer.

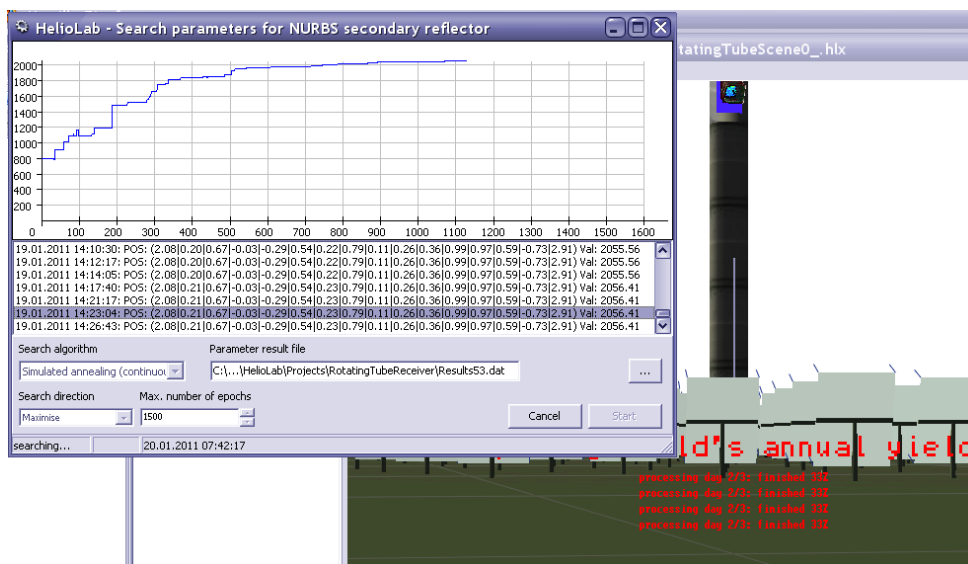


Figure 1: Screenshot of VersaDim during search run

Milestone R13.1: Report: Comprehensive analysis of a common methodology to characterize different secondary optics

The comprehensive analysis of the state of the art of applying secondary concentrators to central solar power tower plants led to the development of a novel approach for the design of secondaries based on non-uniform rational Bézier-splines (NURBS). All the equations and algorithms needed to do ray tracing calculations have been derived and implemented. A detailed description can be found in the attached file ("[NURBSOpticalDevices.pdf](#)") that is to be published in due time. By demonstration it is proved that with this methodology it is possible to fine-tune the geometry of a secondary concentrator (or any other optical device) to the needs of a given special application by varying a sufficiently small number of parameters. Using VersaDim, a NURBS-based secondary concentrator has been adapted to a receiver, trying to maximize the estimated annual yield (see Fig. 2). In this case, the receiver has been a particle receiver of a new design with the special requirement of having to be directed slightly towards the sky instead of towards the heliostats. It has been found that in this special case the new NURBS-based concentrator works better than a traditional CPC (compound parabolic concentrator).

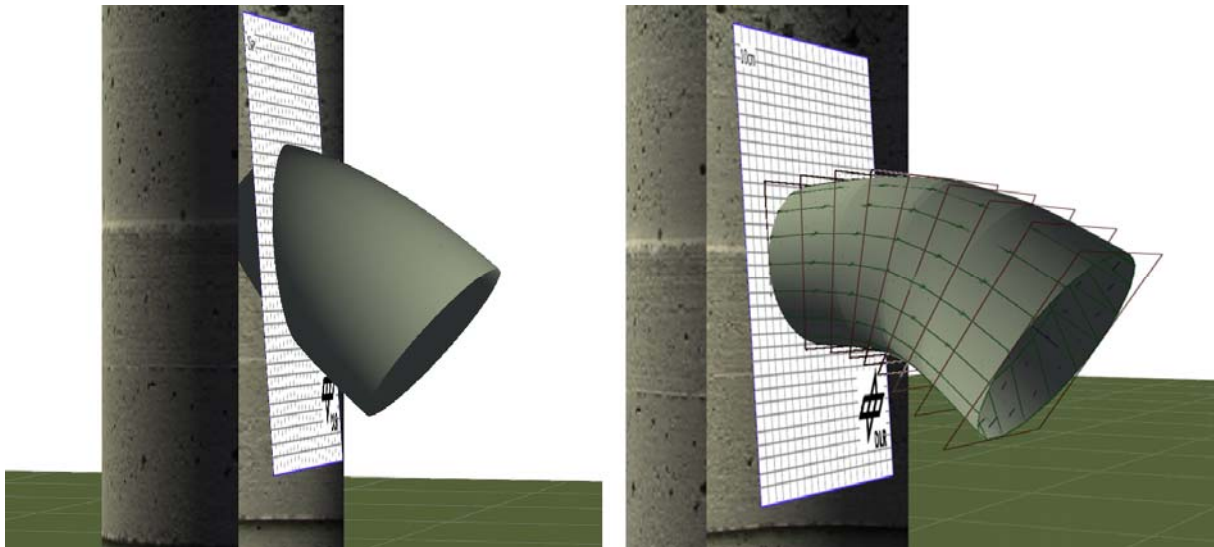


Figure 2: CPC- (left) and NURBS-based shape (right) adapted to receiver: 1580 MWh vs. 2180 MWh estimated annual yield