

## Lesson 17: An Automatic Real-World Lens

In Lesson 15 we developed a seven-element lens with DSEARCH and then changed it into a zoom lens so we could correct at two different object conjugates. We found we needed to add an additional element with AEI to improve performance. That exercise was successful, if tedious – and it illustrates an important concept: ask for *exactly* what you want. In that case, we did not.

Since DSEARCH does not know about zoom lenses, what we got was a very good *fixed-focus* lens – and then we added the new requirement to focus at a shorter distance. So the lenses that came back from DSEARCH were not selected for that property. That’s always a risky process. Perhaps they were not well suited to the job.

Wouldn’t it be nice if the search routines could monitor the performance at two different conjugates? Then the lenses that come back would naturally tend to perform well on that score. Well, they can. We have said nothing so far about **ZSEARCH**<sup>1</sup>, which is similar to DSEARCH except it works on zoom lenses. Let us summarize the requirements for this same job by listing the input for ZSEARCH. (You should review ZSEARCH in the UM at this point, to better follow along.)

```
CORE 16
ZSEARCH 4 QUIET
SYSTEM
ID LESSON 15 ZOOM
OBB 0 20 12.7
WAVL CDF
UNI MM
END

GOALS
ZOOMS 3
GROUPS 8 0 0
ZGROUPS Z 0
GIHT 32 32
BACK 50 .01
RSTART 1000
THSTART 12
FINAL
OBA 1000 -366.5 12.7
APS 7
NPASS 50
COLOR M

FOV 0 .5 .7 1
FWT 2 1 1 1
NGRID 5
SNAP 10
ANNEAL 30 10 Q
QUICK 20 40
END

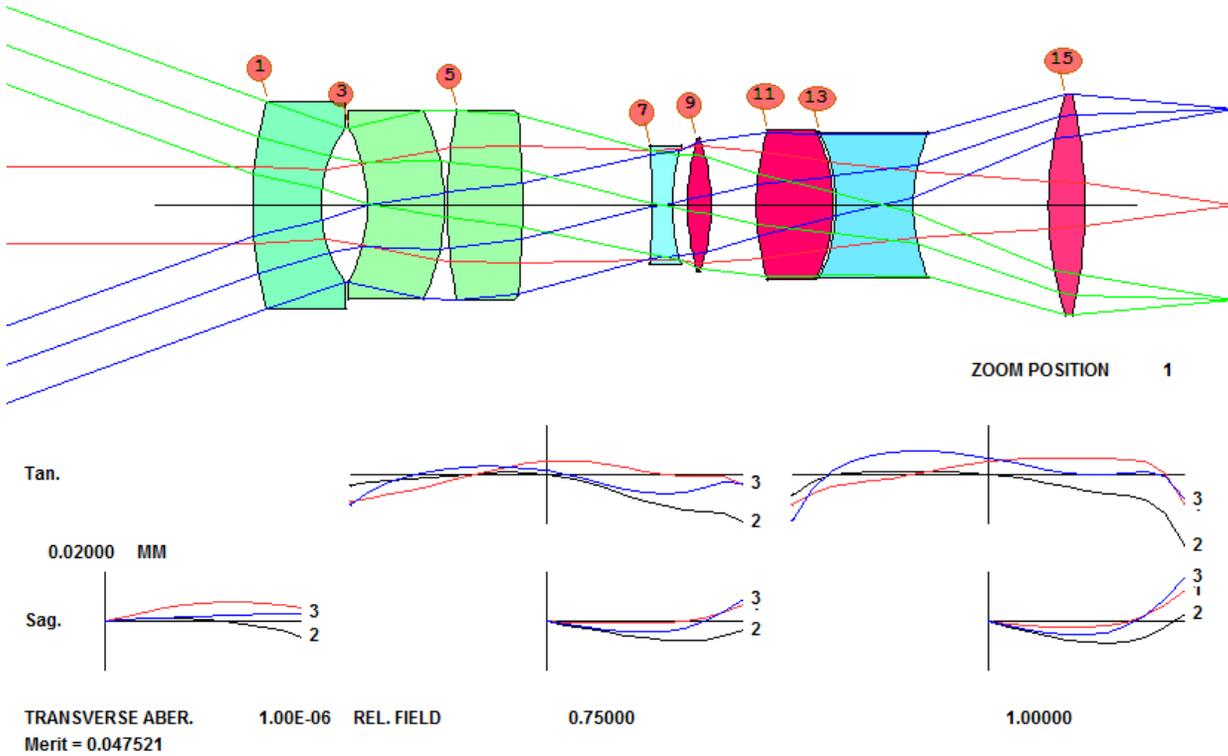
SPECIAL AANT
ADT 6 1 1
LUL 350 .1 1 A TOTL
M 32 .1 A GIHT
END

GO
```

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<sup>1</sup> ZSEARCH™ is a trademark of Optical Systems Design, Inc., a Maine, USA corporation.

With this input we declare two different object distances, infinity and 1000 mm, specify that the lens will have three zoom positions (the minimum allowed by ZSEARCH), declare a single zooming group of eight elements (the entire lens), and give a maximum allowed total length of 350 mm. We run this job, and then optimize and anneal the top lens that comes back.



Compare this to the results from Lesson 15 and you see the importance of our observation. When we ask ZSEARCH for what we *really* want, it has no trouble finding a configuration that meets those requirements. The lens looks nothing like the Lesson 15 results and works better besides. This kind of tool is a real time-saver, for sure.

But, like all tools, it has limitations. ZSEARCH does not support a curvature or thickness solve, since too many things might be zooming, and it does not support the variable YP1, which we have used before to find the best place for the stop. So we assigned the stop to surface 7 and also specified the desired GIHT in the SPECIAL AANT section of the ZSEARCH file to maintain the desired focal length. Then we put an upper limit on the total cell length.

What would happen if we assigned the stop to a different surface? Try it and see! And experiment with the value of RSTART. Every change you make sends the program up a different branch of the tree. You can quickly identify a great many promising configurations with these tools.