# On the design of the $\pm 90^o$ deflector for STEREO SWEA instrument

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Two alternative solutions were investigated. The first solution is to extend the standard $\pm 45^o$ deflector up to $\pm 90^o$. This deflector should be bounded by double-layer toroidal meshes. Any available particle trajectory should be perpendicular to this mesh to avoid trajectory disturbance by inter meshes potential (about 5V). The solution which has been found is shown in Figure 1.

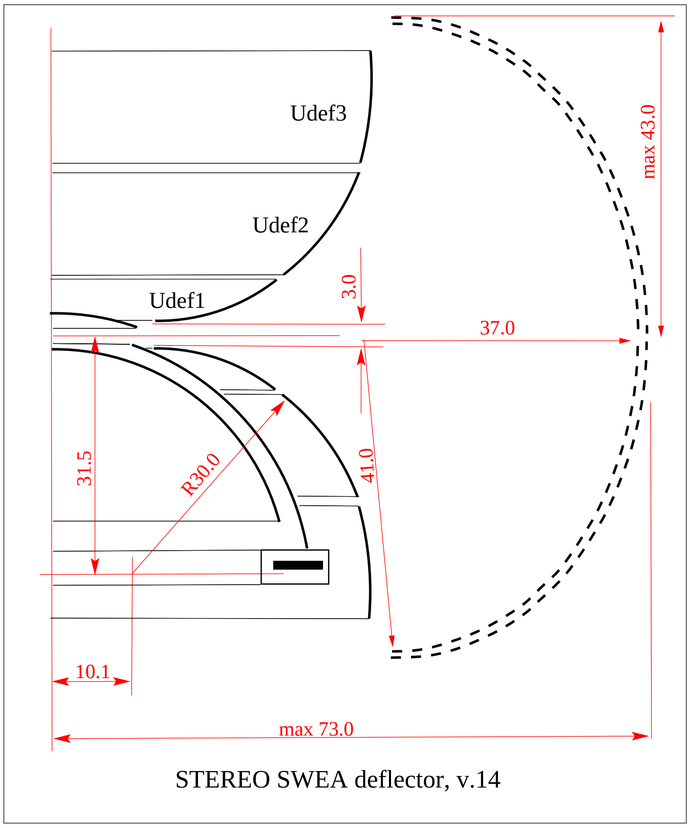


*Figure 1. The principal sketch of the extended deflector with the double toroidal mesh.*

Figure 1 shows about actual size of the sensor cross-section. Note that internal toroidal electrode is divided into 3 parts under the different voltages. These voltages are changed proportionally, so they can be powered by one source via resistive divider. The voltage of external mesh is the chassis potential and the voltage of the internal grid is $U_0$ to compensate the spacecraft potential. This voltage $U_0$ is the constant addition to all voltages in the internal part of the sensor. The ray tracing in the 3-D model of the deflector is shown in Figure 2.

One can see that all trajectories are perpendicular to the entrance mesh and that the deflection reaches $90^o$. However this solution has two significant disadvantages.

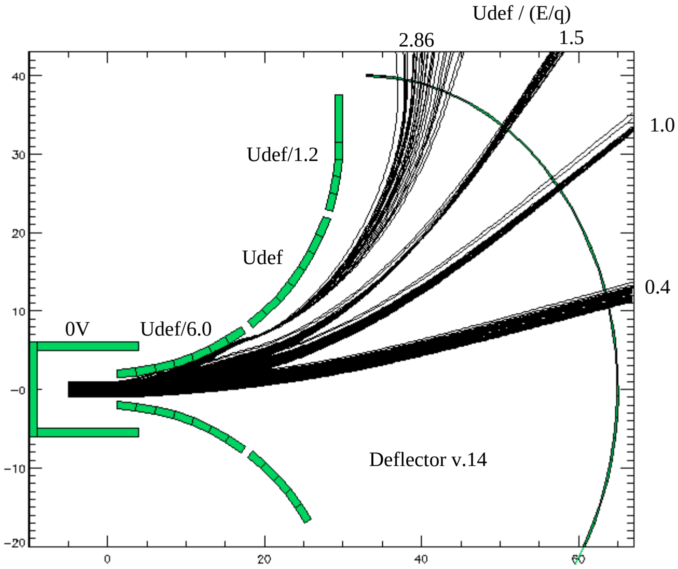


*Figure 2. The example of the ray tracing in the 3-D model of the deflector. Particles were launched from the analyzer site. The energy of each electron beam is given as the $Udef/(E/q)$ ratio. Here Udef is the voltage of the middle section of the deflector.*

- The voltage needed for $90^o$ deflection is too high. The potential of the middle section should be $2.86 \cdot \frac{E}{q}$.
- The external grid extends too far from the electrode. As a result the maximum radius of the sensor is 73mm.

There is another solution of the problem. Figure 3 shows the deflector with another type of the external electrode. This electrode looks like toroidal "steps" structure. The right insert in Figure 3 shows the cross-section of such "steps".

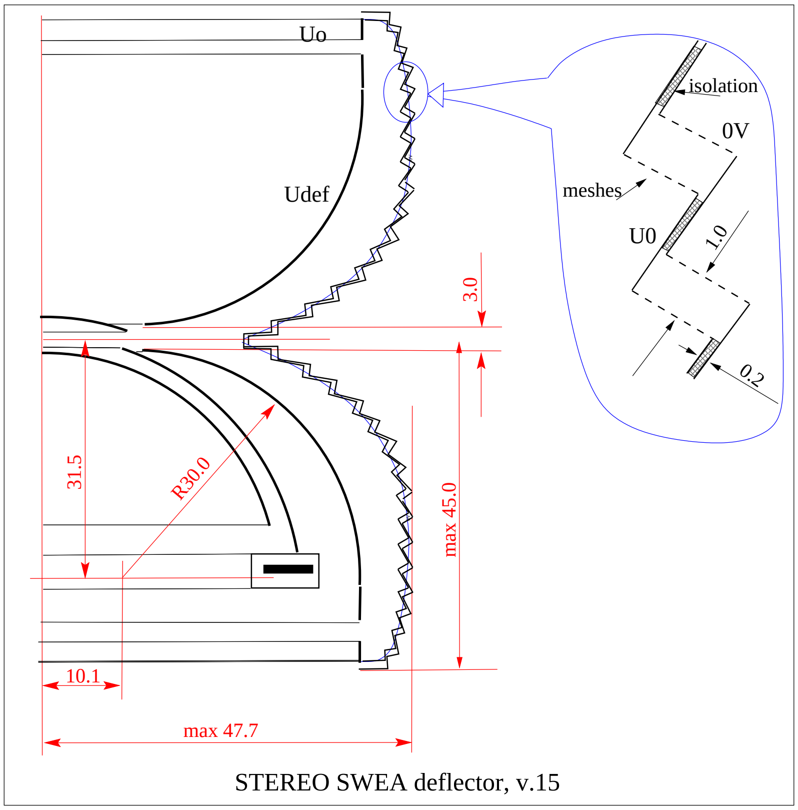


*Figure 3. The sketch of the $\pm 90^o$ deflector with structured external electrode.*

For the first view this design looks much more complicated than the previous one. But actually the proposed external electrode could be made more easily than two separated meshes in the original design. In the last case the external electrode is two shells glued together with 0.1mm isolation spacers. This gives very strong self-supported construction. The only hazard could be the non-smooth voltage-angle dependence. The external meshes in this case could be produced as the set of meridional thin stripes. The transparency of such mesh could be about 70%.

The left panel of Figure 4 shows the ray-tracing example performed in the simple model of the deflector with the smooth external electrode for simplicity. Because the size of the "steps" is much less than the internal-external electrodes gap, the general directions of the trajectories in the real deflector will be similar.

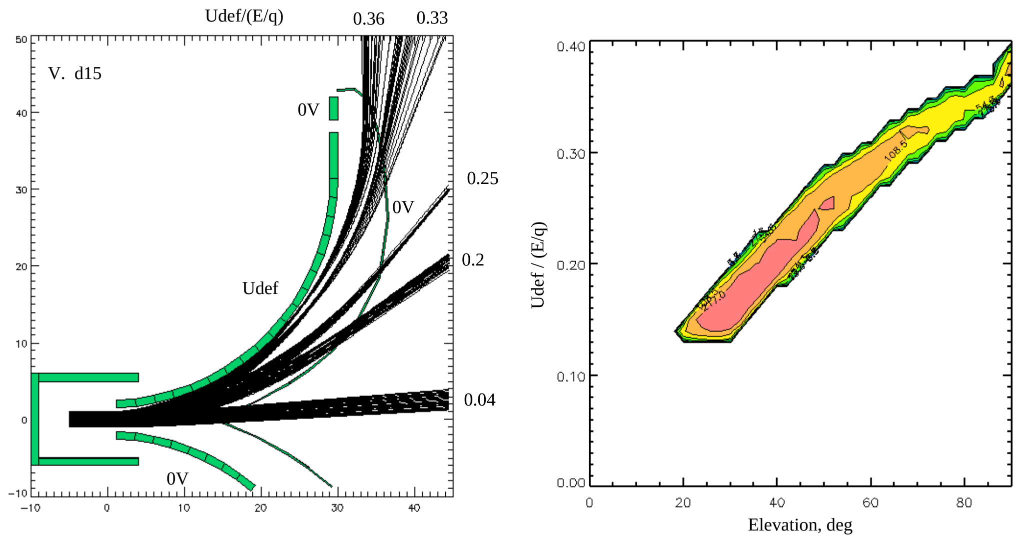


*Figure 4. Ray tracing example in the simple smooth external mesh deflector model (left panel) and Voltage - Angular response of the deflector (right panel).*

Here one can see that to reach $90^o$ deflection only $U_{def} = 0.36 \cdot \frac{E}{q}$ is needed. This gives a possibility to measure in very wide energy range. The right panel of Figure 4 shows the $U_{def} - Elevation$ response of this simple model. The contour levels increase with factor of 2 and the top red contour corresponds to the half of maximum.

To evaluate more realistic electrode configuration the numerical model combining the simple model and the part of full configuration was made. The additional part is bounded by the red rectangular in the left panel of Figure 5.

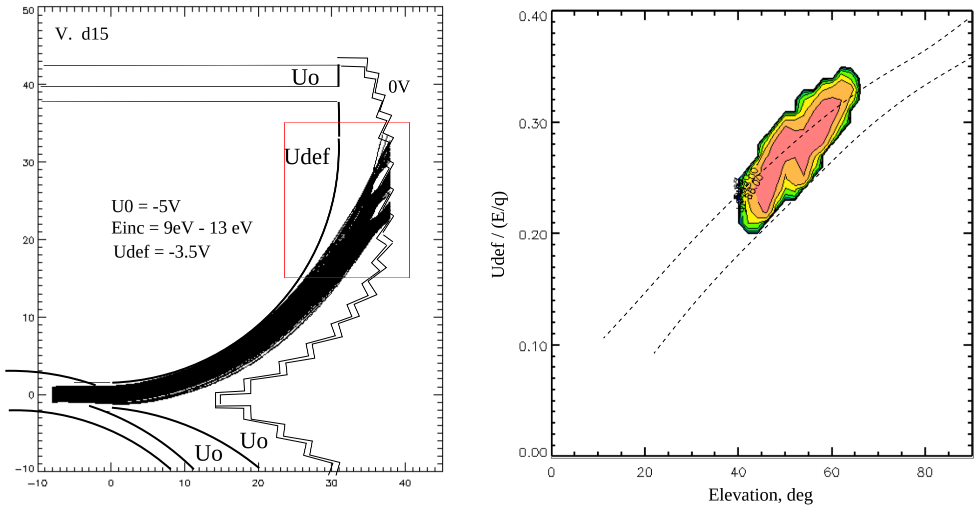


*Figure 5. Ray tracing example in the calculation model with the realistic external electrode (left panel) and Voltage - angular response of such model for worst case of measurements (right panel).*

This model was tested for the worst case of operation when the deceleration voltage U0 is about the incident particles energy. The left panel of Figure 5 shows the ray-tracing example for such extreme conditions. The transparency of the external electrodes finally is 95% of the simple model. One can see the disturbance due to the influence of the trajectory tangential to the solid parts of external electrodes. The right panel of Figure 5 shows the Voltage - Angular response of the evaluated part of the deflector for the worst case. The deviation of the response is not dramatic. The effective width of the polar angle aperture is $10^o$ which is enough for the instrument goal.

**Conclusion**

I suggest to evaluate the second design as an alternative to the original design of the deflector. Because the sizes of the instrument are changed just a little, we can make the final decision after prototype evaluation.