Towards the next frontier in high precision solar polarimetry: 10^-4

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In the last two decades, solar physics has greatly explored the 10^-3 polarimetric sensitivity level (referred to the continuum intensity). This has provided us with a quantitatively accurate picture of the photospheric magnetism for mean longitudinal fields in the range of about 5 Gauss. However, the same 10^-3 detection levels translate into a sensitivity to transverse fields of the order of 100 Gauss, which shows that our picture of the magnetic field is fundamentally biased. The Zeeman effect is perverse enough to tell us that a 5 G sensitivity in the transverse fields will only be achieved when we reach the 10^-5 sensitivity level. While the Hanle effect is already helping us to detect hidden transverse fields at the photosphere, it is also clear that it biases our results in other ways. Thus, we are left with the imperious need to progress towards increasing our polarimetric sensitivities one order of magnitude or even better. In this talk, I will present the science cases that expect us in the 10^-4 sensitivity world and the technical challenges that we must face for that.