Optical Tomography of the Cornea: From backscattering to forward scattering

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With OCT, in the nineties of the previous century a door was open for an optical tomographic approach of the eye with a much better resolution than with ultrasonic tomography.
The contribution of our laboratory to ex-vivo OCT was to introduce a full field en face approach (FFOCT) that allowed to get sub cellular resolution. Applying FFOCT to in vivo experiments was hard because of the eyes movements, nevertheless with the work of talented scientists (Kate Grieve, Peng Xiao, Slava Mazlin and Pedro Mece) the goal was reached.
FFOCT relies as OCT on the light that is backscattered by the eye structures; we will discuss a few points about in vivo FFOCT of the cornea but we will more focus on a relatively new approach working in transmission Full Field Optical Transmission Tomography (FFOTT) of the cornea that showed quickly spectacular results.
In the particular geometry developed by Samer Alhhadd and Slava Mazlin (that will also be discussed in the framework of the present meeting) the light that illuminates the sclera is backscattered in the direction of the cornea (red eye effect). The light that is forward scattered by the cornea structures (cells, nerves..) interferes with the light scattered by the sclera. The signal happens to be much higher than in backscattering: indeed for micron sized structures the forward scattering cross-section is about one thousand time the backscattering one.
Then we will discuss the optimization of the OTT signals in term of spatial coherence of the source and will show that under certain coherence conditions super-resolution can be achieved.