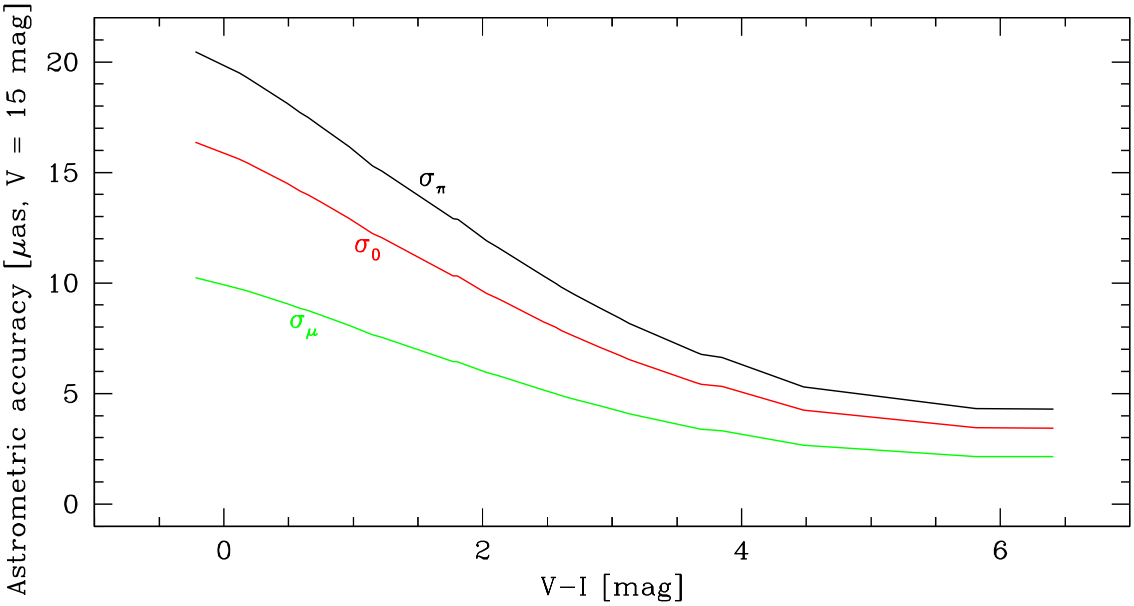

Results from the GAAT astrometric accuracy tool: predicted sky-averaged end-of-life astrometric accuracies, at V = 15 mag and as a function of V−I colour index (black: parallaxes π in μas; red: positions in μas; green: proper motions μ in μas yr^{-1}).

Gaia's scientific mission objectives can be summarized as the "observation of all 1 billion stars brighter than 20-th magnitude with end-of-life astrometric accuracies of 20 − 25 μas at V = 15 mag". Roughly speaking, Gaia's astrometric capabilities are a function of the satellite's operational strategy (mainly scanning law and mission lifetime) and the properties of its optical and detector system (e.g. CCD TDI integration). The present detailed design of the satellite is such that all mission objectives are met.

Gaia's scanning law is a central element in the data acquisition strategy during the 5-year operational lifetime of the satellite and the end-of-mission astrometric accuracies depend on its properties. Given technical boundary conditions, the scanning law has been defined in such a way that the precession speed of the spin axis on the sky is minimised and the uniformity of the end-of-mission sky coverage is maximised. In spite of this, the characteristics of this uniform revolving scanning law imply that astrometric accuracies vary with direction on the sky. Moreover, for any given direction, there is a significant difference between attainable position, proper-motion, and parallax accuracy. Generally, end-of-life (random) position and proper-motion errors will be, respectively, 25% and 50% smaller than end-of-life (random) parallax errors.

The properties of Gaia's optical and detector system are such that for stars brighter than $\sim$ 12 mag photon noise is negligible. The end-of-mission astrometric accuracies for these stars will amount to a few μas, the so-called accuracy noise floor. For magnitudes between 12 and 20, photon noise determines the line-spread-function centroiding accuracies, and the expected end-of-life astrometric accuracies are 20 − 25 μas at 15-th magnitude and a few hundred μas at 20-th magnitude. At fainter magnitudes star-detection statistics enter and astrometric accuracies reach milli-arcsecond levels.

At a given magnitude (e.g. V = 15 mag), astrometric accuracy also depends on apparent star colour − i.e. intrinsic star colour combined with interstellar reddening − through, for example, the wavelength-dependent properties of the modulation transfer function ("image quality") and quantum efficiency of the CCDs and the transmission of the optics. Generally, redder stars have smaller astrometric errors (see figure above).

A detailed astrometric accuracy tool (called GAAT) taking into account, among other things, all effects mentioned above, has been developed in the Gaia Project Scientist Support Team (see the information sheet on "Astrometric Accuracy Assessment"). Results of this tool give confidence that the present design of the satellite is viable and that the scientific mission objectives will be met.