

Gradient Coils
(Syllabus for ISMRM 2014 MR Engineering Educational Session)
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The requirements of fast imaging methods and diffusion weighted sequences have driven the advances in gradient coil design as well as the accompanying techniques and technologies for eddy current shielding, heat removal, power amplifiers and noise/vibration reduction. With the increase of available gradient power and -strength, peripheral nerve stimulation (PNS) has become a major limitation for further performance increase of clinically used systems. Early 1990s MRI scanners were capable of typical gradient amplitudes and rise times of 20mT/m and 600-1000us. Clinical MR systems today drive gradients (safely) below the border of human PNS limits with typically 40mT/m amplitude and 200-400us rise time.

In this talk, we show the route of technological steps which were needed to take in order to achieve the maturity of the 2010s gradient systems. Special emphasis will be put on gradient coil design techniques including border conditions like e.g. stray field, magnetic forces, vibration and power amplifiers. At the border of latest gradient system developments, human MR research experiences with gradient amplitudes in the range of 100-300mT/m are currently made. We will give an outlook on the technologies required for this regime and possible szenarios beyond. While currently in research use with diffusion techniques on the the human brain, these ultra high gradient power systems may reveal their potential for other human body parts in the future.