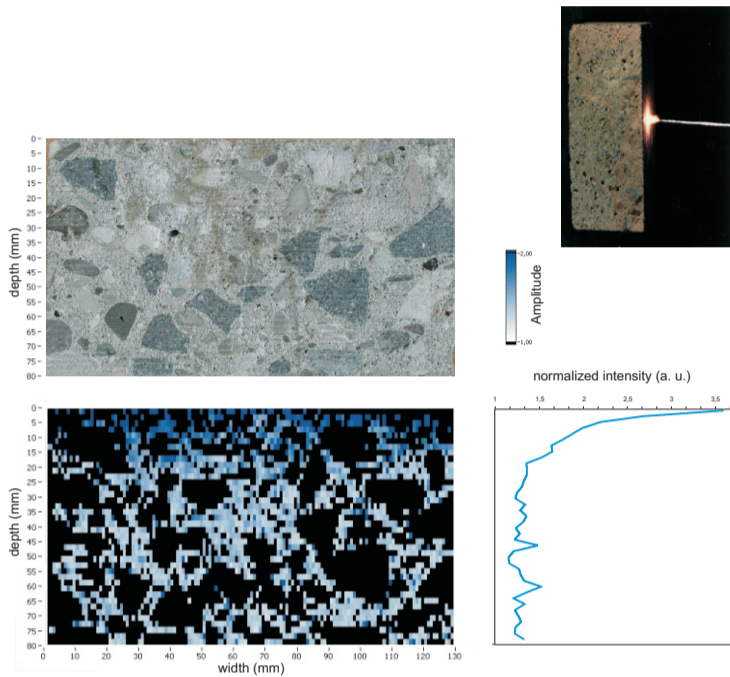


Project

- ▶ Photo of the cross section of a concrete core (130 mm x 75 mm)
- ▶ Element distribution (laboratory setup) (40 lines at a distance of 2 mm; 1 measurement / millimetre); black areas are measurements on coarse aggregates - not considered in the depth profile.
- ▶ Depth profile of ion ingress (signal/background value of sodium spectral line at 819 nm versus depth) ingress up to a depth of 20 mm



Motivation:

- ▶ Concrete is the biggest amount of artificial material produced by mankind in terms of mass and volume
- ▶ Every year a lot of effort has to be spent on the restoration of damaged structures
- ▶ For prediction of the service lifetime of infrastructure buildings (highways or bridges) it is necessary to quantify the ingress of harmful ions into the concrete

Cooperation:

- ▶ BAM - Federal Institute for Materials Research and Testing (application of NDT methods for civil engineering)
- ▶ Secopta GmbH - supplier of laser based sensor systems
- ▶ Specht, Kalleja + Partner GmbH - civil engineering company

Application:

- ▶ On-site quality assurance during the reconstruction (concrete removal) of large parking garages (CI).
- ▶ Evaluation of the potential for alkali-silica reaction (Na, K)
- ▶ Evaluation of concrete degeneration due to sewage water (S)

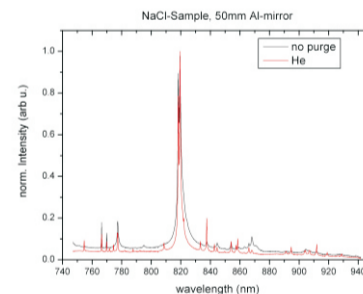
Set-up



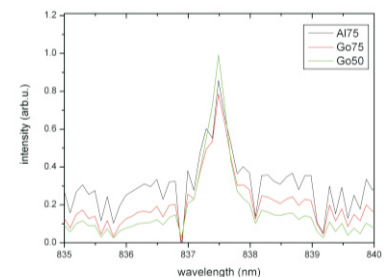
Set-up of the mobile LIBS device:

- ▶ fiber laser ($E = 3 \text{ mJ}$, $t_p < 2 \text{ ns}$, $M^2 < 1.7$, $f = 100 \text{ Hz}$, maintenance free pulses $\geq 2 \cdot 10^9$)
- ▶ detector head (weight $\leq 1 \text{ kg}$, cable length 5 m)
- ▶ spectrometer and mirrors adapted for high efficiency for Cl-detection at 837.6 nm
- ▶ A scanner in combination with chemometrics allows to investigate the natural heterogeneity of concrete

Test



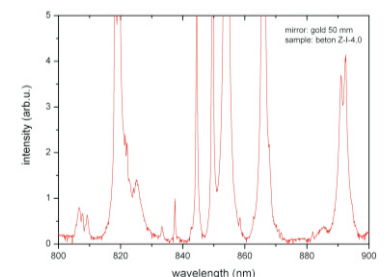
Effect of purging on the intensity of the chlorine line at 837.6 nm.



Effect of different coatings (Al, Au) and different focal lengths of the mirror optics on the chlorine line.



A typical measurement at a concrete core. The volume around the plasma is purged with Helium.



Spectrum measured at a sample of hardened cement paste containing 4.0 % Cl. The chlorine line is clearly visible.