Laser Ablation of Silicon Nanoparticles for Enhanced UV Photon Sensing via Wavelength-shifting Properties

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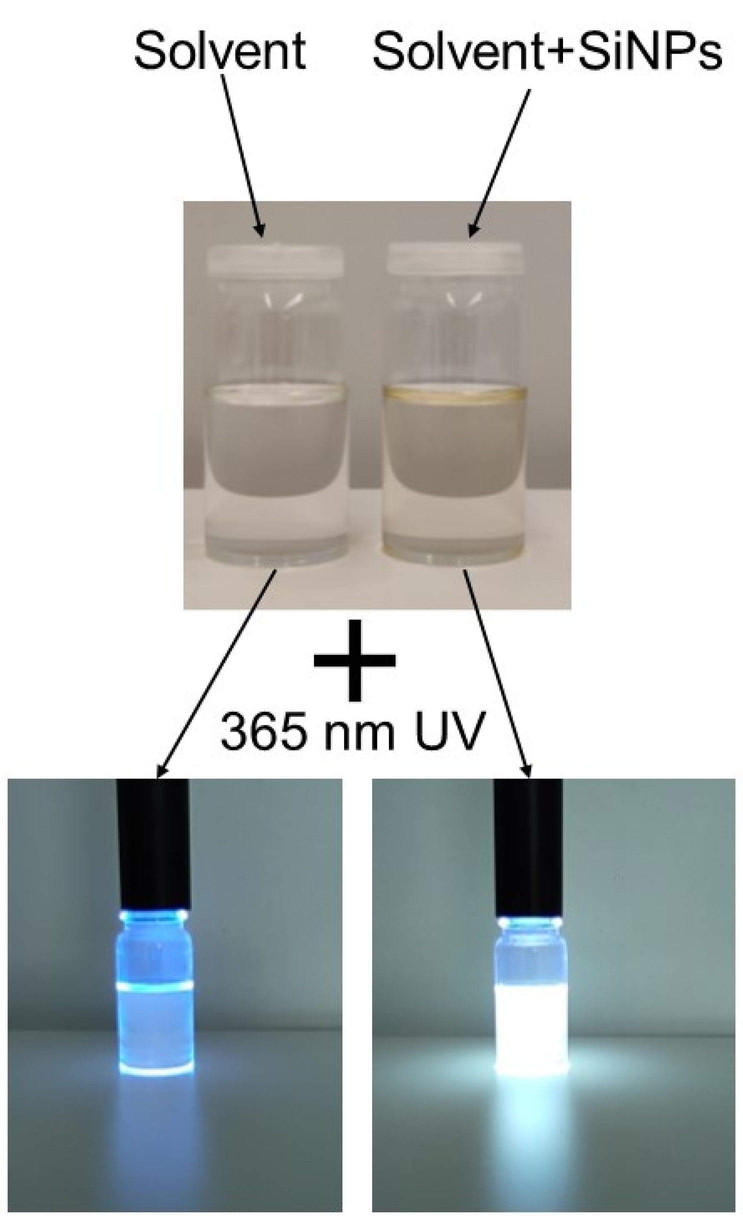
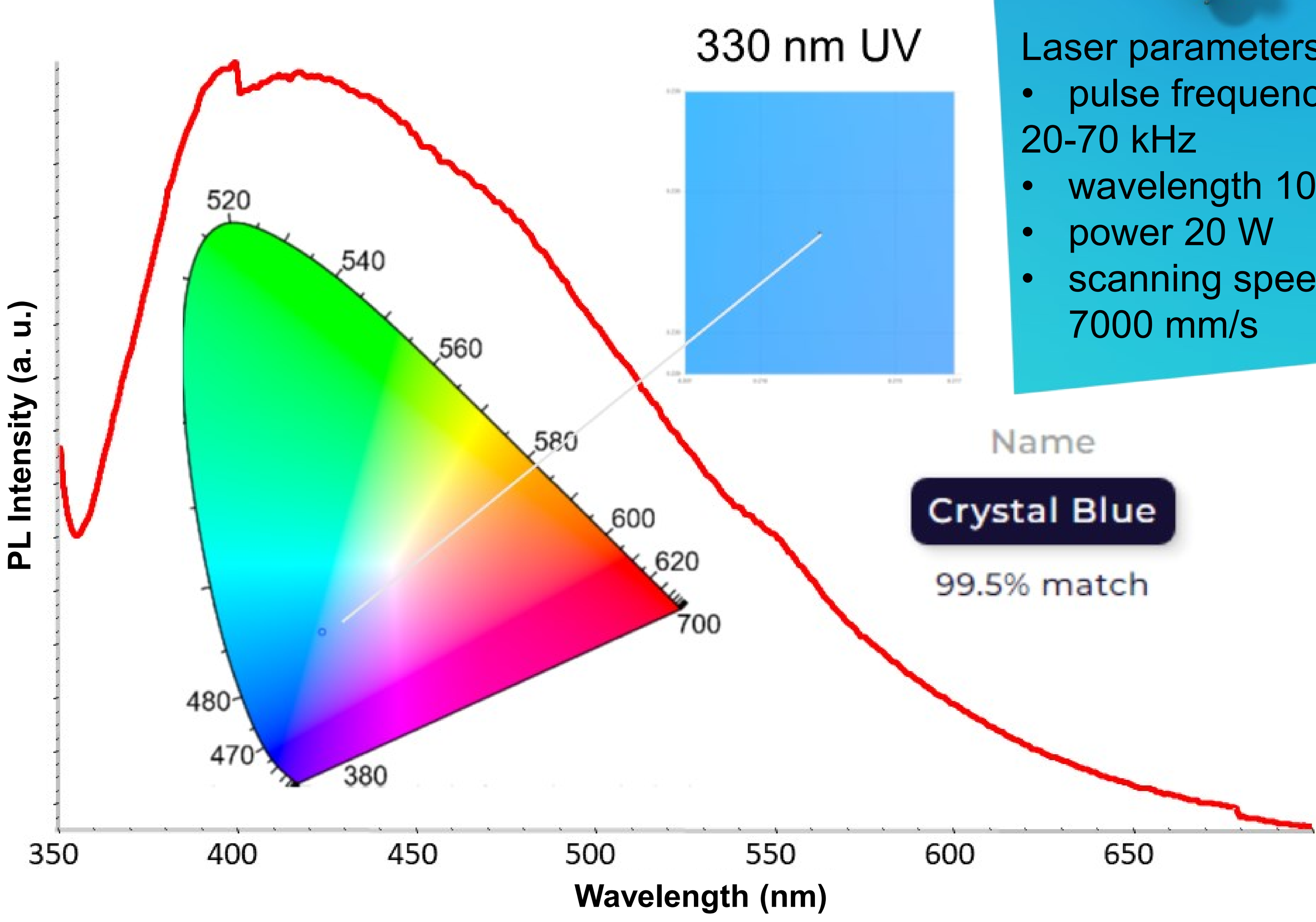
The detection of ultraviolet (UV) photons is becoming increasingly important in high-energy particle physics experiments. Sensitivity to UV photons (wavelength range < 350 nm) is essential for detecting Cherenkov radiation in crystals, as well as scintillation light in dark matter and neutrino experiments. Silicon nanoparticles (SiNPs) are sensitive to UV light. Depending on the nanoparticle size, they can absorb UV light and re-emit it at visible wavelengths (>400 nm). The size of SiNPs can vary depending on the technological parameters of laser ablation. Therefore, it is essential to effectively control the laser ablation process in order to obtain nanoparticles of the desired sizes.

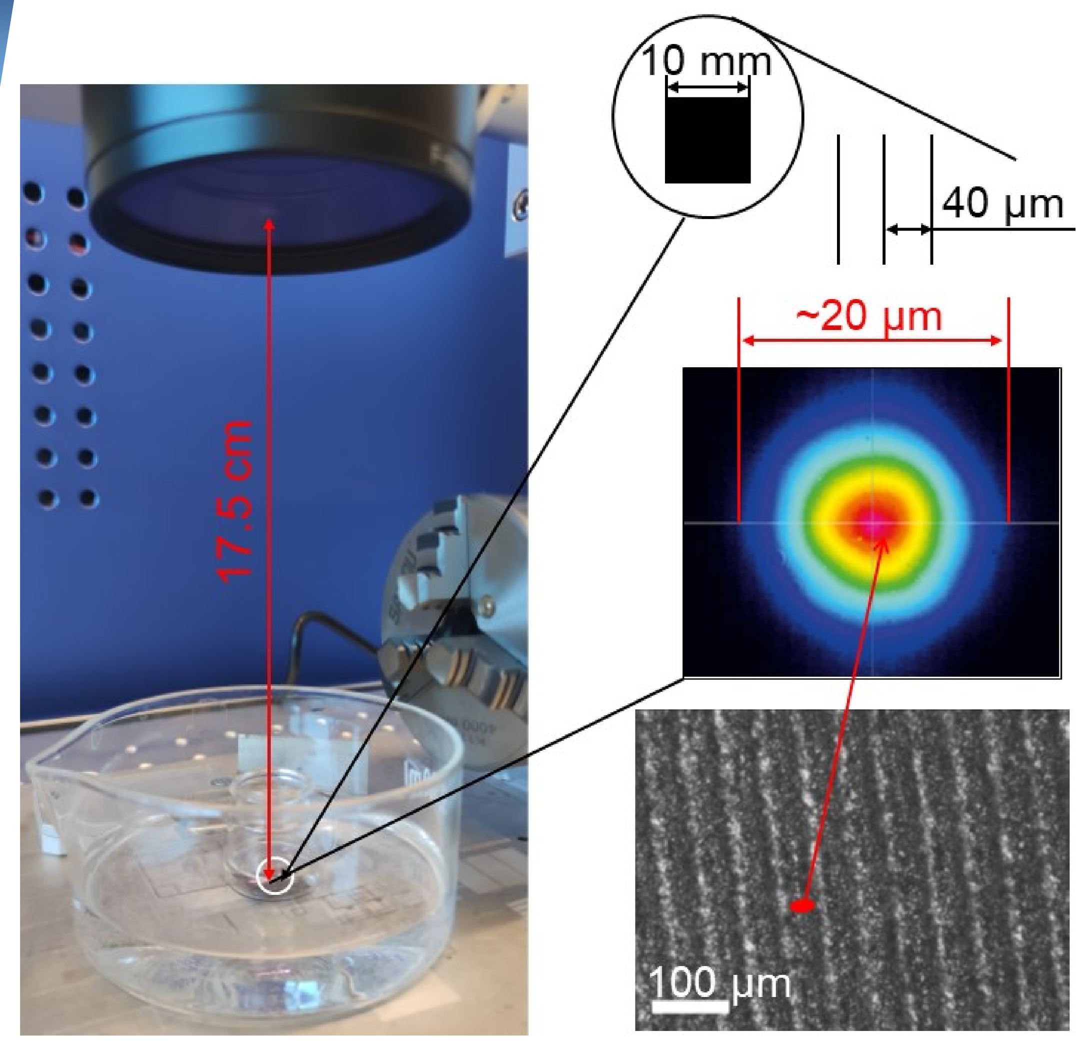
UV IRRADIATION OF THE FORMED SiNPs



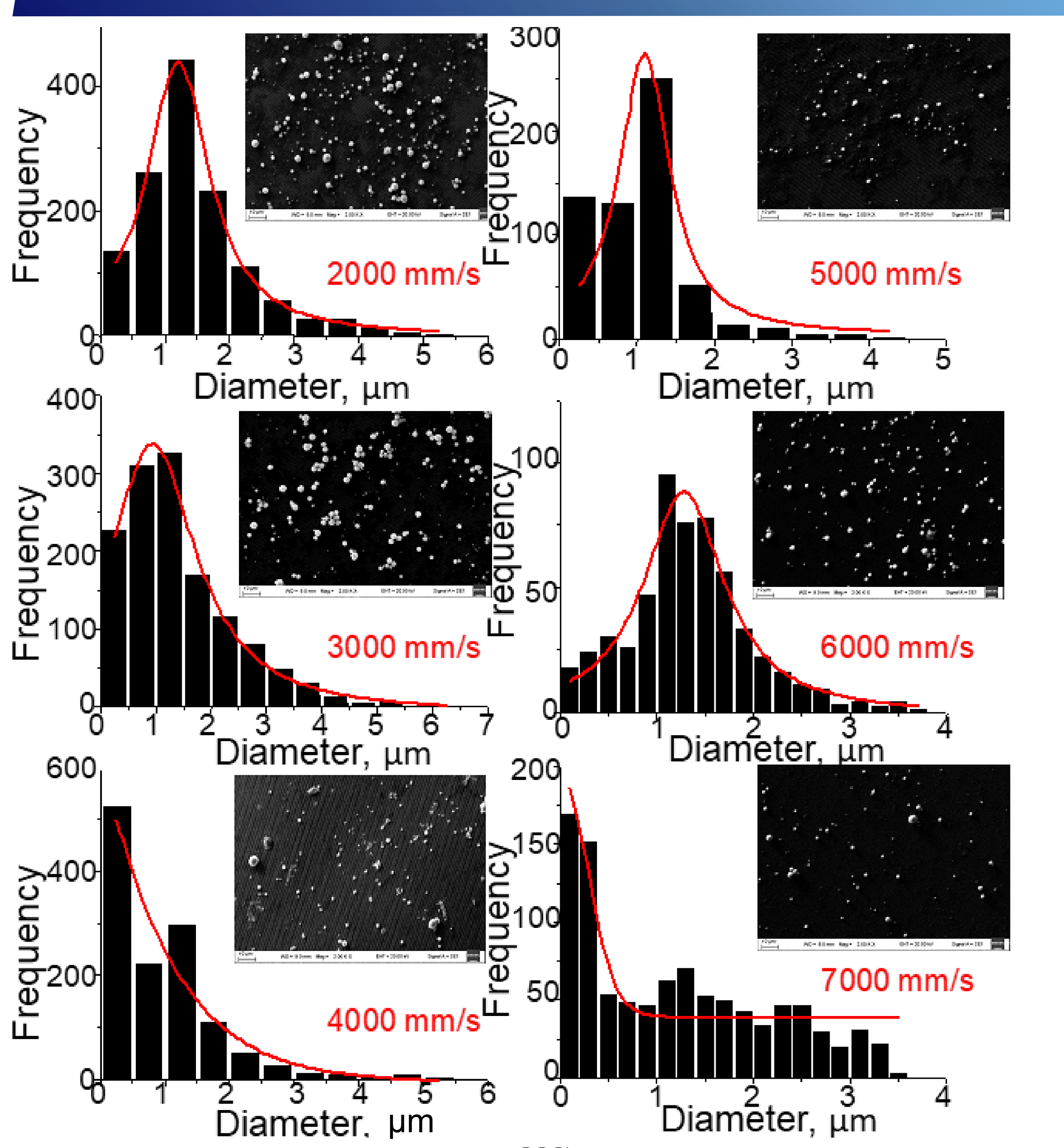


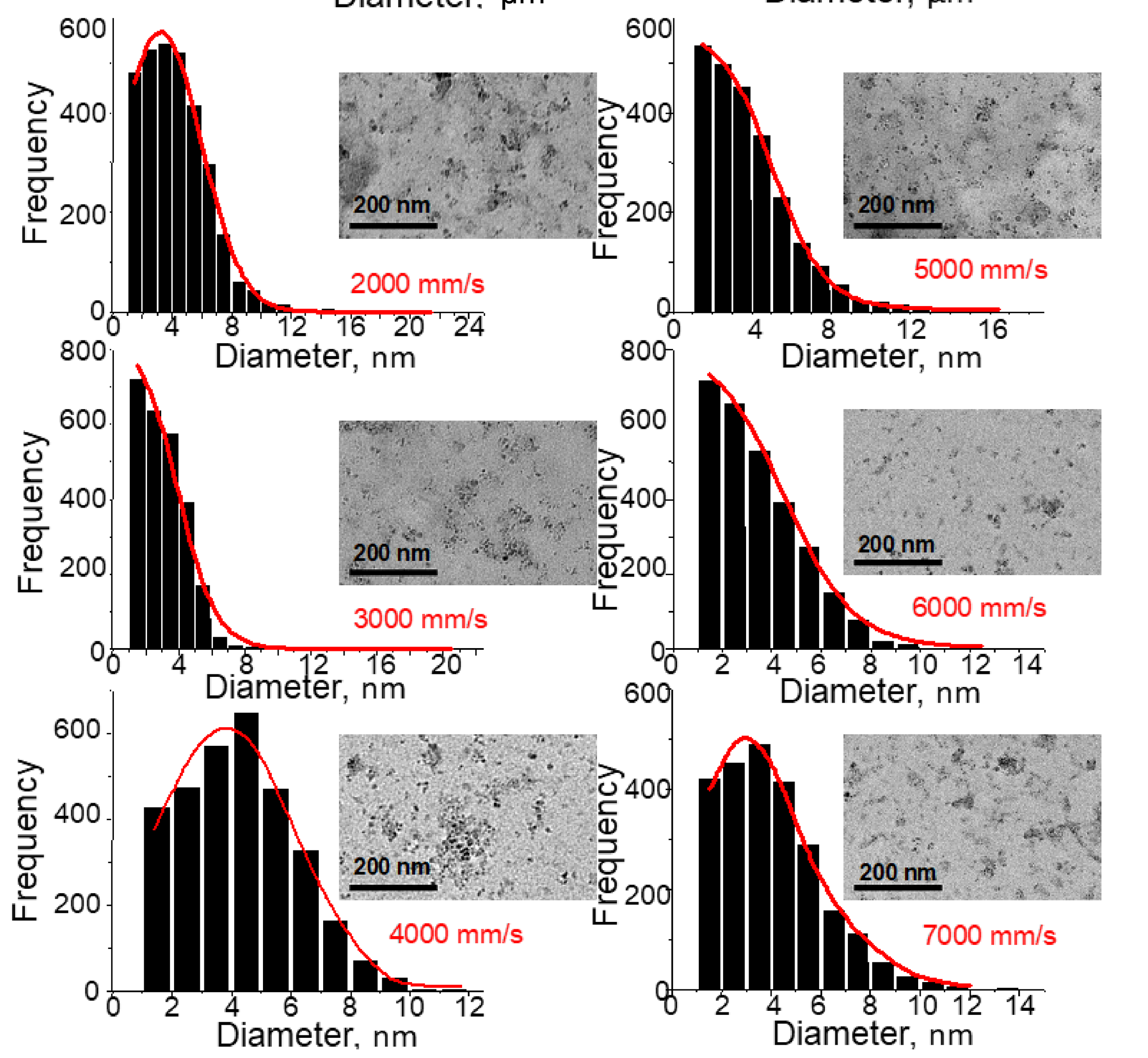
Laser parameters:
- pulse frequency 20-70 kHz
- wavelength 1064 nm
- power 20 W
- scanning speed 2000-7000 mm/s

LASER ABLATION

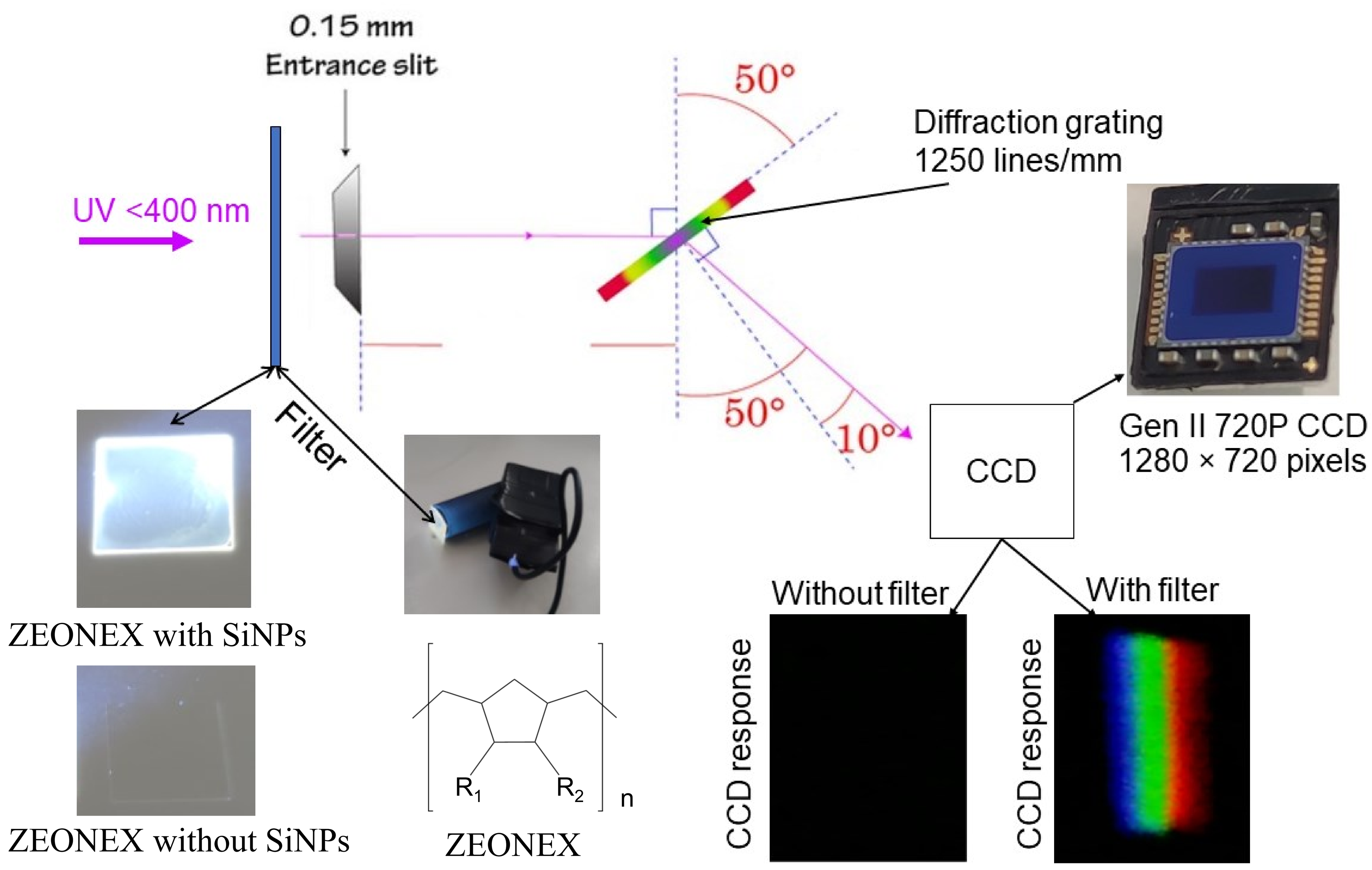


PARTICLE SIZE ANALYSIS: SEM vs TEM





PROTOTYPE TESTING



CONCLUSIONS

We employ Si target laser ablation to synthesize colloidal solutions of SiNPs exhibiting diverse size distributions. The characterization of particle dimensions was conducted through SEM and TEM analyses, revealing the presence of polydisperse nanoparticles with diameters <10 nm. Subsequently, these sub-10 nm NPs are employed as filtering components, in conjunction with a ZEONEX matrix, within a CCD-based spectrometer configuration to enhance its sensitivity to the wavelengths <400 nm.

ACKNOWLEDGMENTS

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