

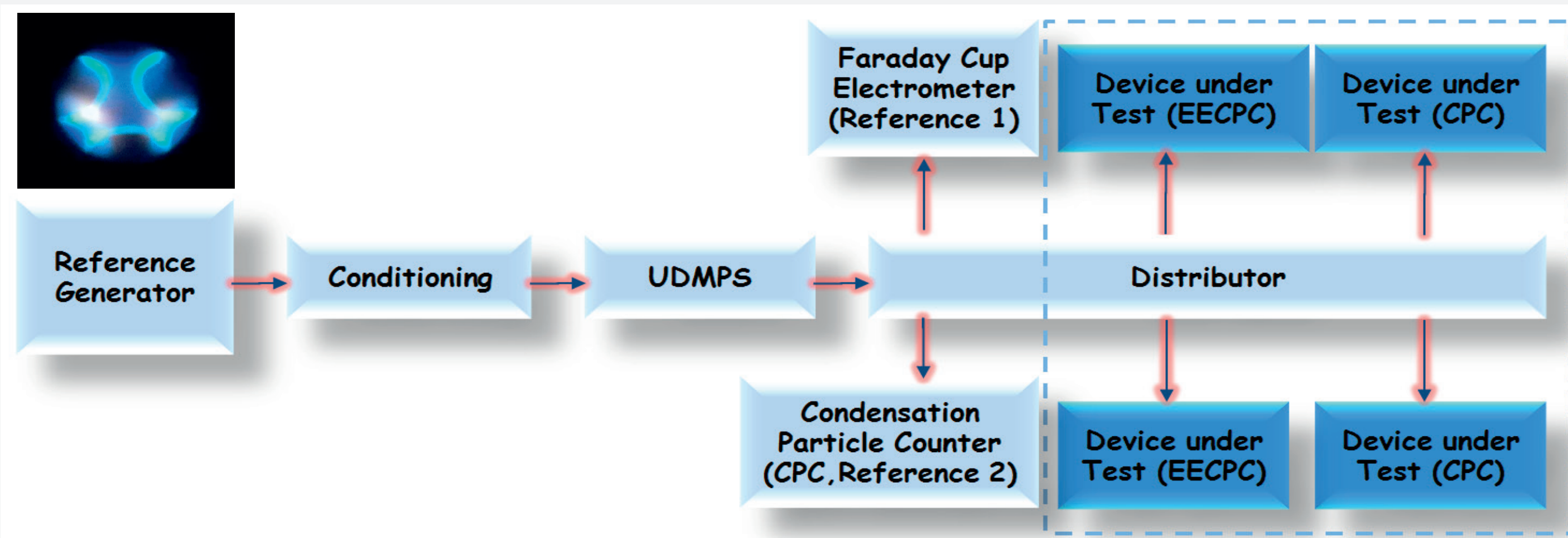
# Characterization of a PTB-standard for particle number concentration of soot particles

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## Introduction

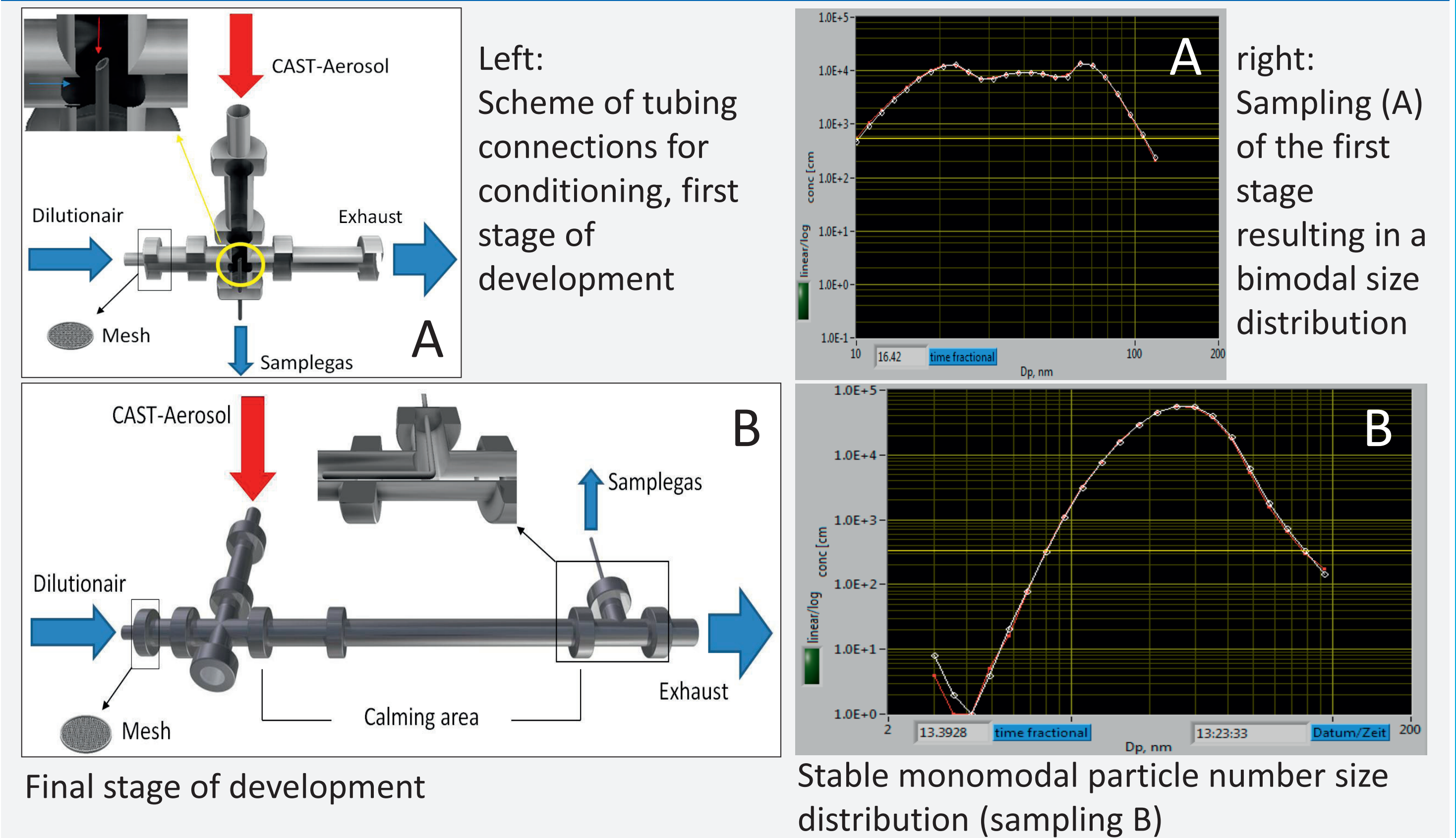
Modern engines with high-pressure fuel injection which are equipped with exhaust after-treatment systems emit significantly smaller soot particles and higher number concentration with less mass concentration. In order to control automotive emissions the European Community adopted the Euro 5b and 6 standards to introduce for the first time a number-based limit. A basic requirement to ensure those limits is a system for particle number measurements. Therefore engine exhaust condensation particle counter (EECPC) were implemented in PMP conform devices to measure the particle number concentration during the type approval of Euro 5b/6 engines [1]. Currently only commercial instrument manufacturers are providing calibration services for such EECPCs. An independent validation and calibration service without commercial interest is missing. The ISO/dis 27891 provides a calibration routine for particle number concentration and counting efficiency for CPCs taking into account the UN-ECE regulation R49 and R83. [2-3] At PTB the German National Metrology Institute a set-up for EECPC-calibration is established following the ISO recommendations.

## Experimental setup

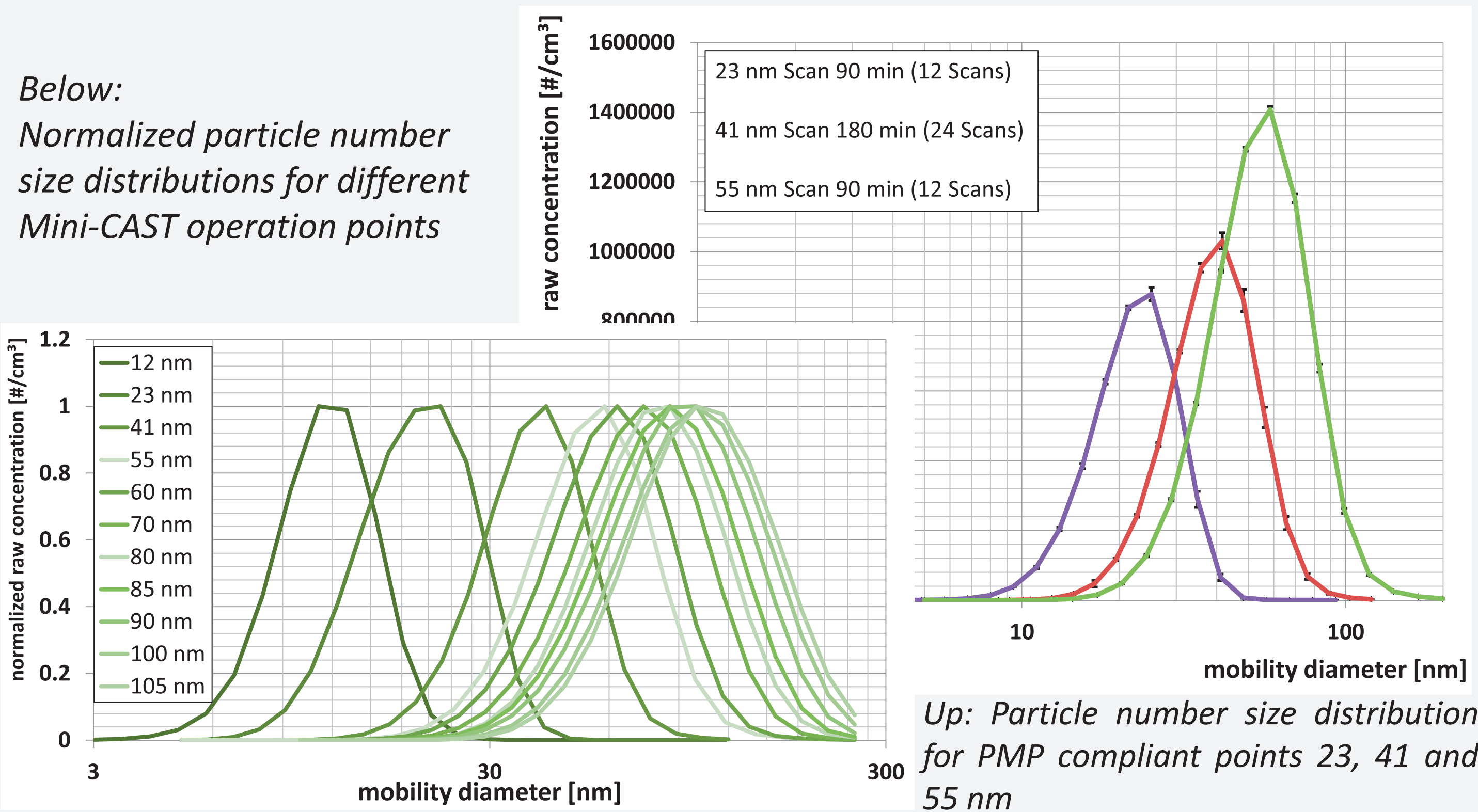


- The PTB soot standard generates aerosols with monodisperse particle number concentrations from  $10^1$  to  $10^6 \text{ cm}^{-3}$  and a mean particle number size distribution from 12 to 105 nm with mean width of 1.3 to 1.5
- Ultrafine differential mobility particle sizer for selecting of monodisperse particles (non commercial)
- Electrometer as traceable reference system (TSI 3068 FCAE)
- Condensation particle counter as secondary standard (TSI 3772 CPC)
- Engine exhaust condensation particle counter (TSI 3790 EECPC)

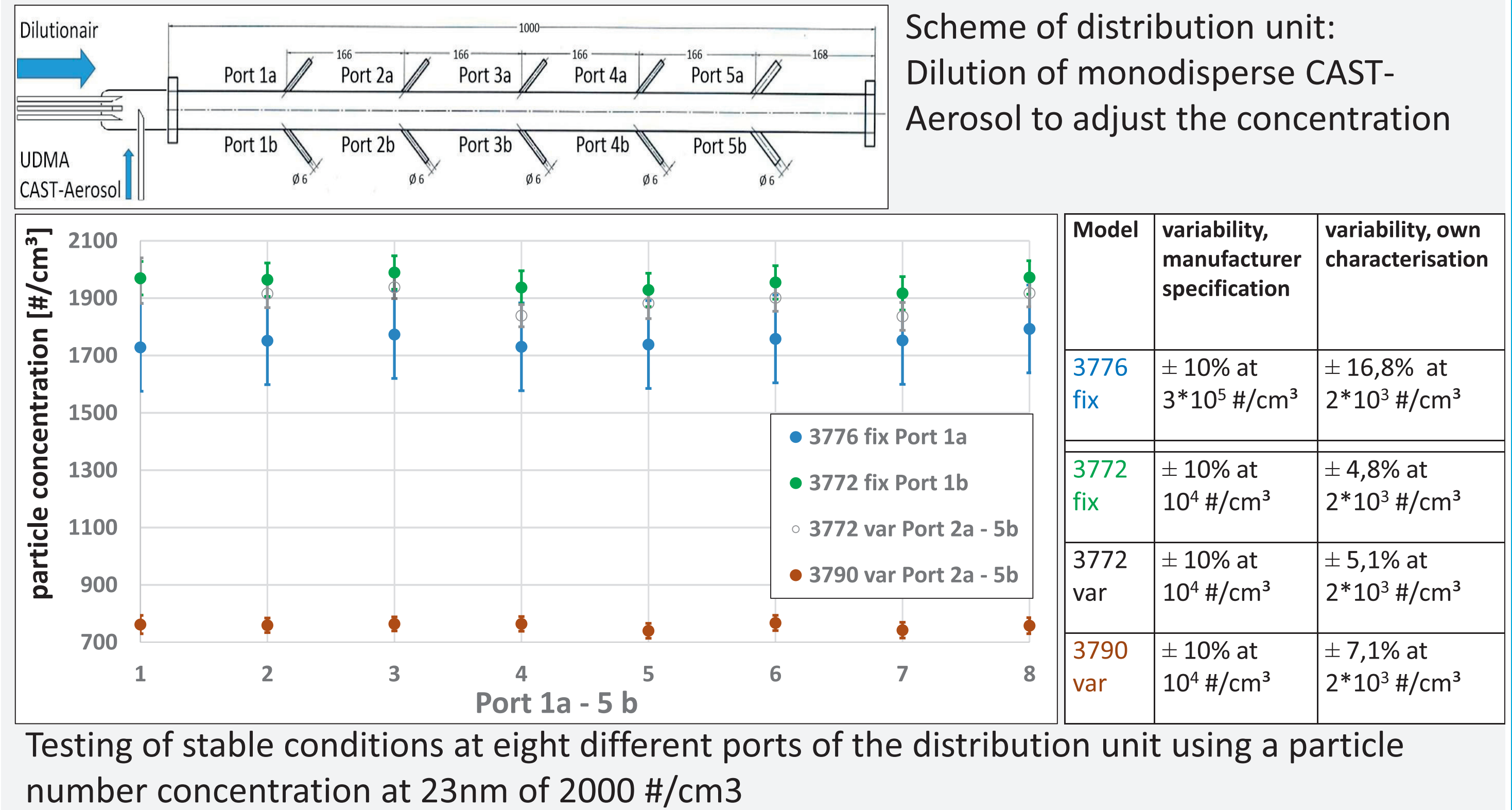
## Development of soot aerosol conditioning



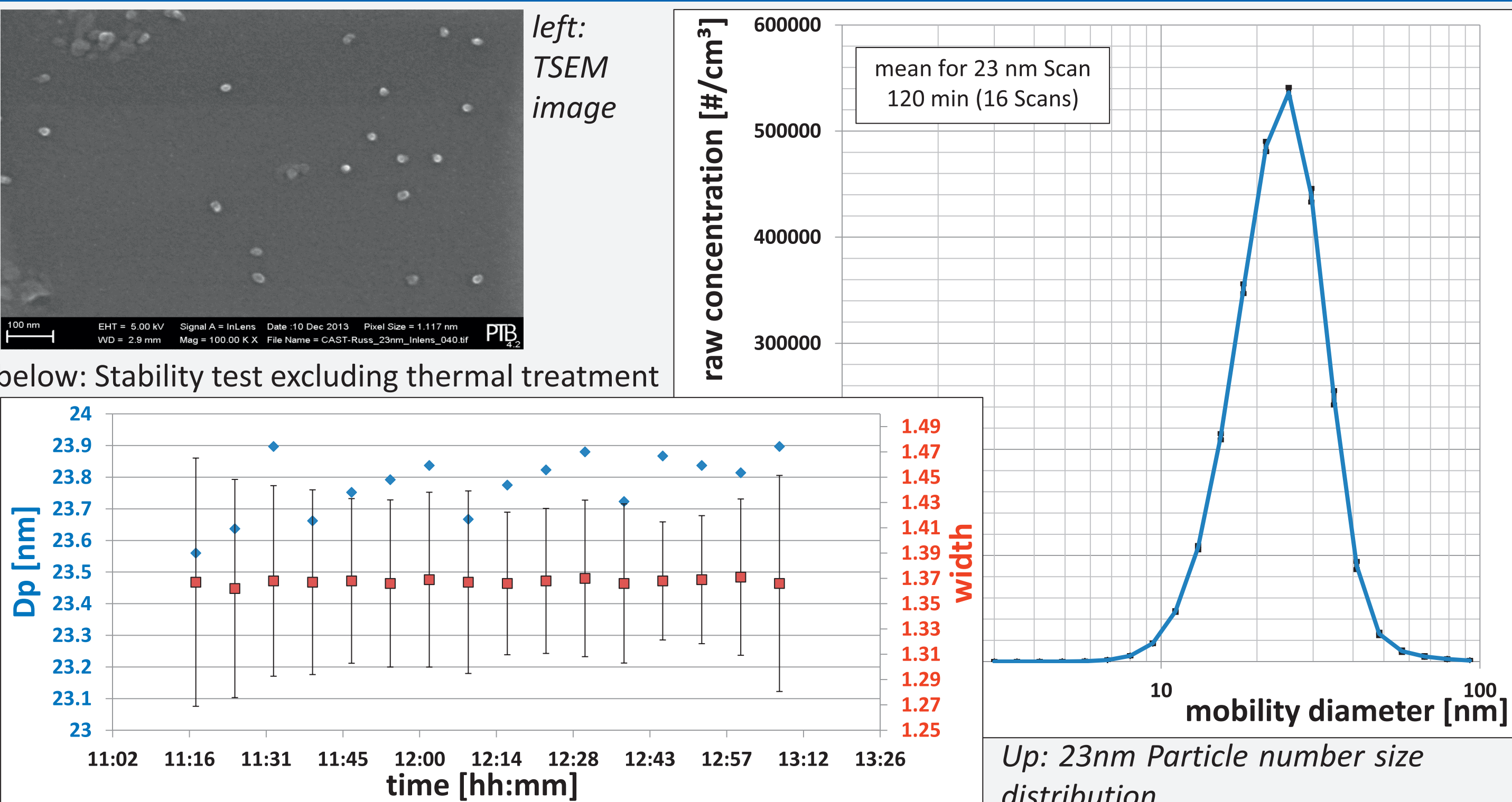
## Burner-characterization: Longterm stability



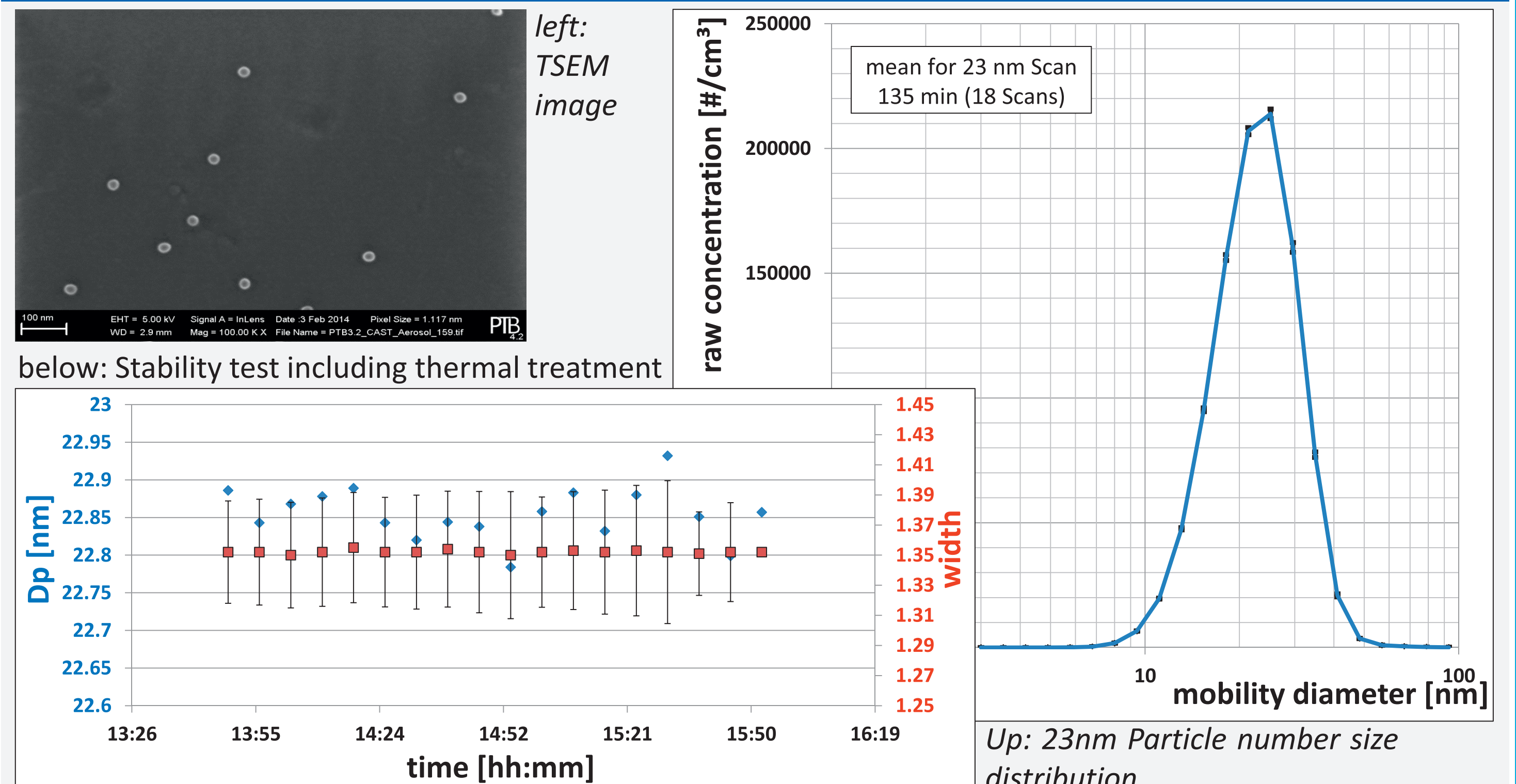
## Distribution unit



## 23 nm CAST-aerosol without thermal treatment



## 23 nm CAST-aerosol with thermal treatment



## Conclusion and outlook

- The PTB infrastructure is based on a miniCAST soot aerosol generator running on propane, which is able to generate soot well defined and stable with diffusion flames.
- The infrastructure at PTB is intended to ensure a highly stable, accurately characterized soot aerosol generator that allows well defined particle parameter variations.
- Calibration and standardization procedures are developed to allow valid comparisons between different types of particle counters, and to reliably determine uncertainties.
- The final step will be transferring the current soot aerosol generator into a soot aerosol standard in terms of uncertainty budget for particle number concentration.

[1] Commission Regulation (EC) No 692/2008 of 18 July 2008 implementing and amending Regulation (EC) No 715/2007 of the European Parliament and of the Council on type-approval of motor vehicles with respect to emissions from light passenger and commercial vehicles (Euro 5 and Euro 6) and on access to vehicle repair and maintenance information.  
[2] UNECE 2013 Regulation No 49, Offic. J. Eur. Union L:171, 1 (2013).  
[3] UNECE 2012 Regulation No 83, Offic. J. Eur. Union L:42, 1 (2012).