Sub 20 nm particle inspection on EUV mask blanks

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Introduction

The Rapid Nano is a particle inspection system developed by TNO for the qualification of EUV reticle handling equipment [1]. The detection principle of this system is dark-field microscopy. The performance of the system has been improved via model-based design. Via our model of the scattering process we identified two key components to improving the inspection sensitivity [2]. The first component is to illuminate the substrate from multiple azimuth angles. This illumination mode averages out the variance in the background scattering, allowing for a lower detection threshold to be used. Two years ago, this illumination mode was implemented in our existing inspection system [3].

The second component to improve the sensitivity is to decrease the wavelength of illumination. A shorter wavelength increases the total scattering and reduces the background scattering relative to the defect signal. A new Rapid Nano inspection system will be completed in the beginning of 2016, which combines the multi-azimuth illumination with a 193 nm source. This system will have a sensitivity in-line with the ITRS roadmap for defects on EUV masks.

	PSL on Si [nm]	Al on Si [nm]
RN1: 532 nm, 1-azimuth Predicted	**59**	**35**
Measured	**59**	**35**
RN3: 532 nm, 9-azimuth Predicted	**43**	**25**
Measured	**42**	
RN4: 193 nm, 9-azimuth Predicted	**18**	**18**

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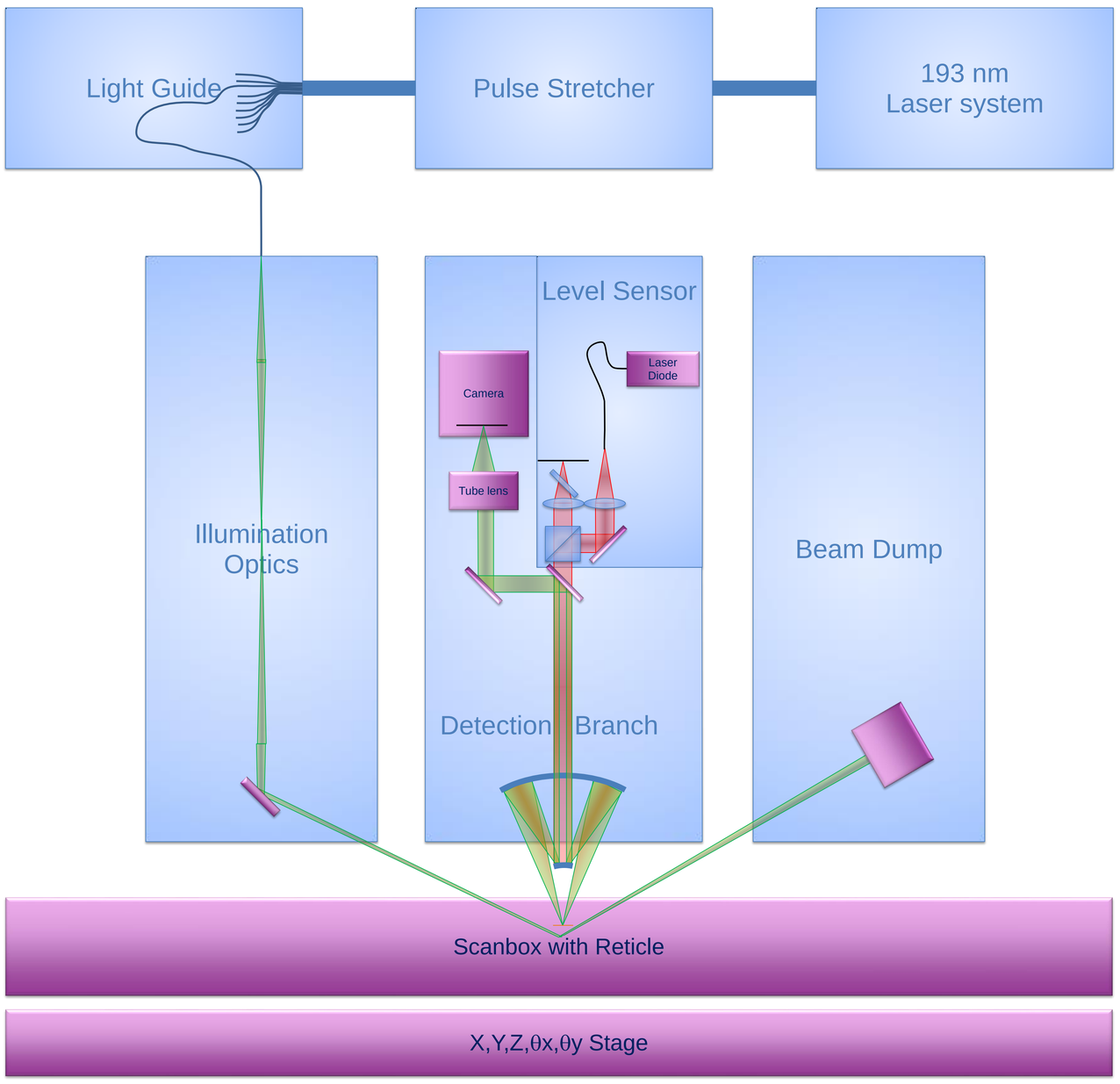

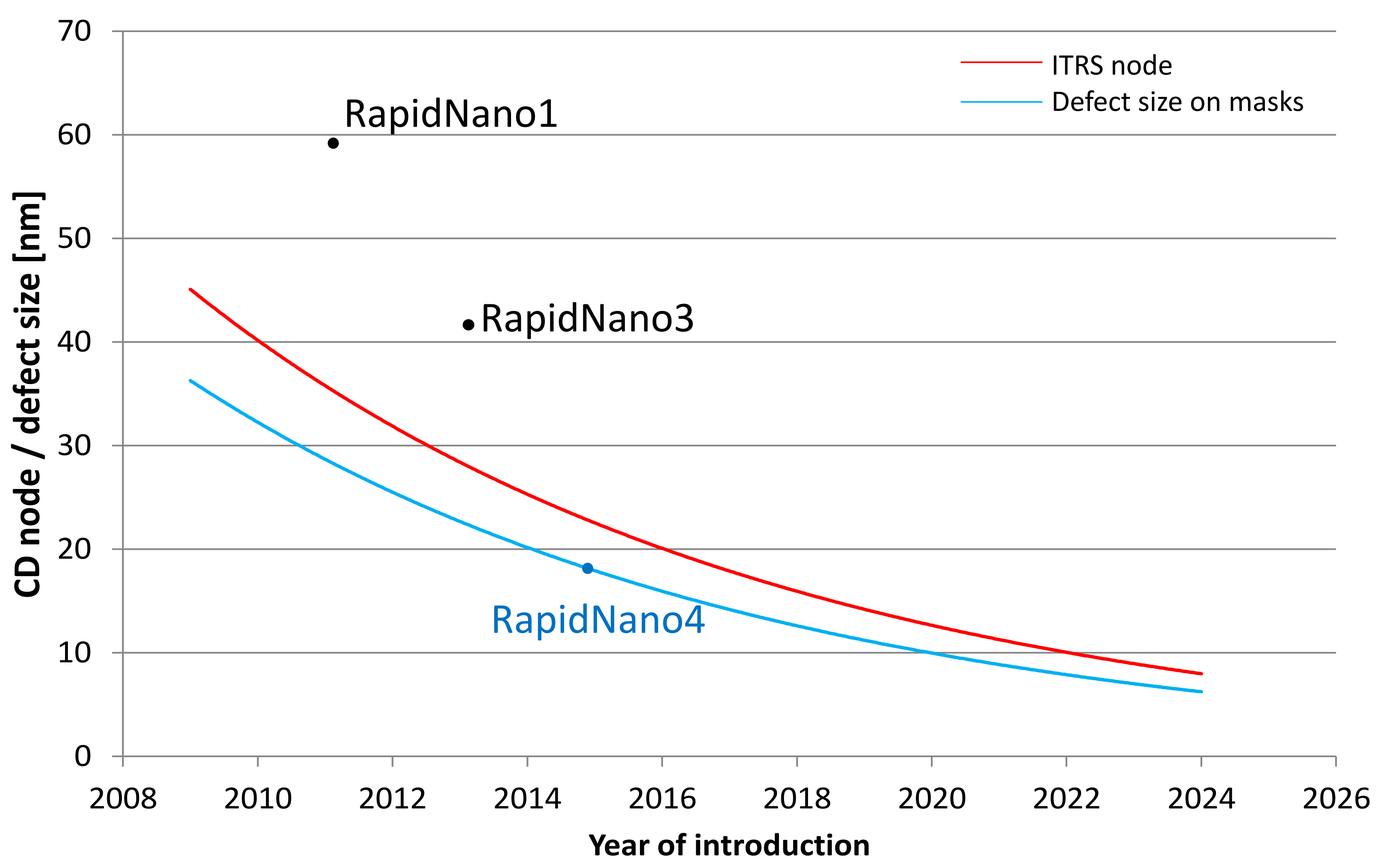

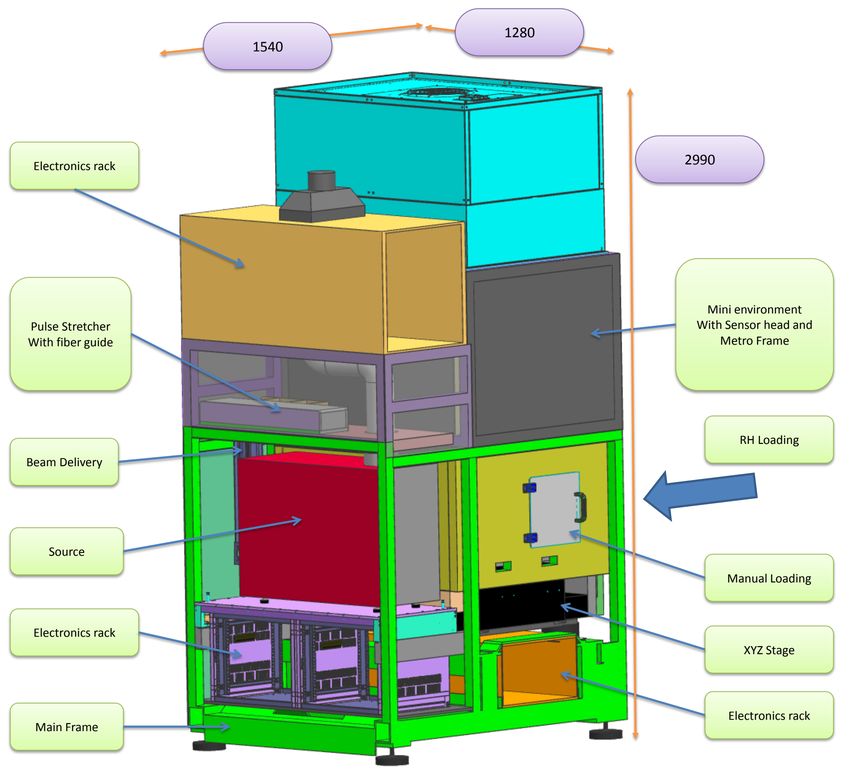

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2. Walle, P. van der, Kumar, P., Ityaksov, D., Versluis, R., Maas, D.J., Kievit, O., Janssen, J., Donck, J.C.J. van der, "Nanoparticle detection limits of TNO's Rapid Nano: modeling and experimental results", Proc. SPIE 8522, 2Q (2012).
3. Walle, P. van der, Kumar, P., Ityaksov, D., Versluis, R., Maas, D.J., Kievit, O., Janssen, J., Donck, J.C.J. van der, "Increased particle detection sensitivity by reduction of background scatter variance", Proc. SPIE 8681, 16 (2013).

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