

LCGT Vacuum System

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Required Pressure: 2×10^{-7} Pa, or lower

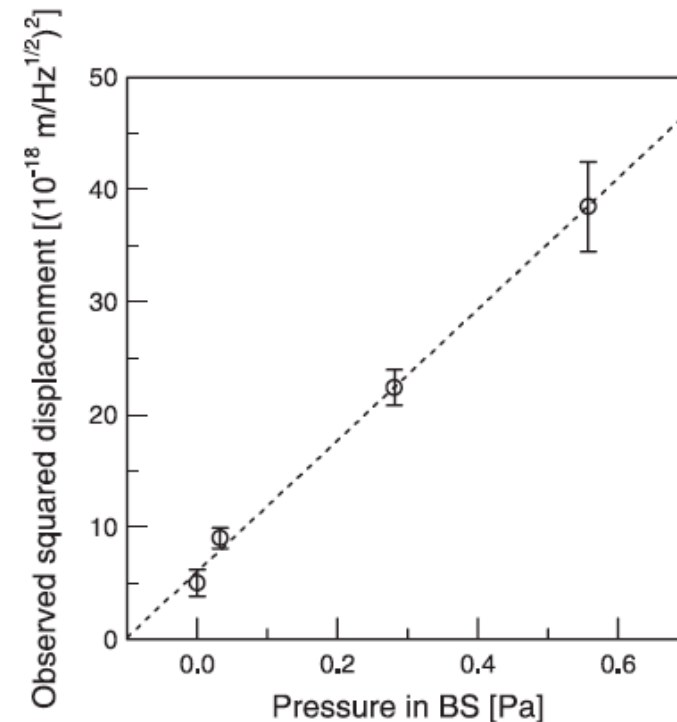
** The sensitivity h of $4 \times 10^{-24} \text{ / (Hz)}^{1/2}$ @100Hz, can be reached when the horizontal displacement noise is $1 \times 10^{-20} \text{ m / (Hz)}^{1/2}$, or lower.

** Based on the results observed in TAMA300, the scattering noise caused by residual gas molecules (mainly water) at the pressure of 2×10^{-7} Pa, is estimated as $1 \times 10^{-21} \text{ m / (Hz)}^{1/2}$, which is one-order lower than the expected horizontal displacement noise of $1 \times 10^{-20} \text{ m / (Hz)}^{1/2}$.

Direct measurement of residual gas effect on the sensitivity in TAMA300

** Xe gas pressure of 3×10^{-2} Pa induces an increase in the mirror displacement noise of $3 \times 10^{-18} \text{ m / (Hz)}^{1/2}$ @1 kHz.

Takahashi et. al., J. Vac. Sci. Technol., A20 (2002) 1237

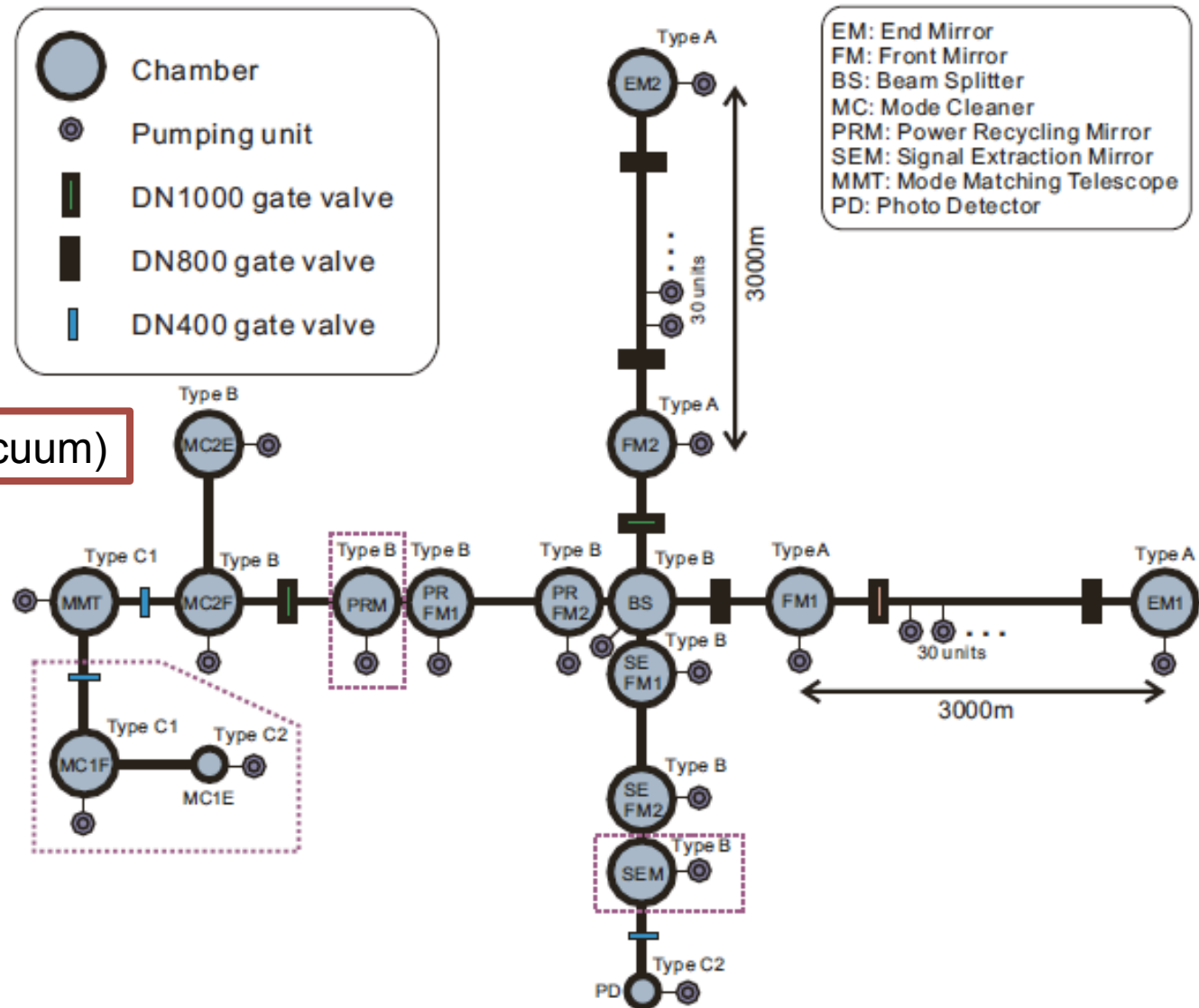


LCGT Vacuum System

** for reducing noise due to a residual gas effect

** for maintenance minimizing

UHV (ultra high vacuum)



LCGT Vacuum System

UHV (ultra high vacuum)

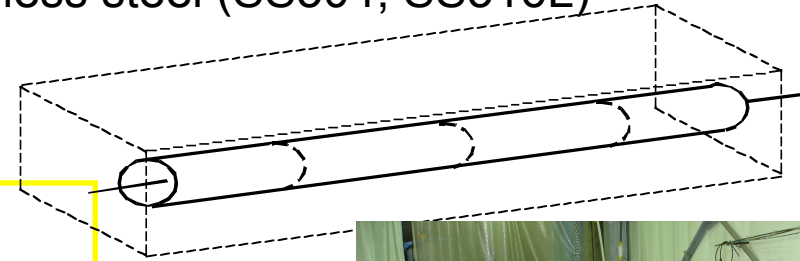
- beam tube (500 of 12-m long and 0.8 m in diameter each)
 - ** “*surface passivation*” of stainless steel prior to tunnel installation is required, so as to have an “*outgassing rate*” (per unit area for 50 hrs pumping) of the order of 10^{-8} Pa m³ m⁻² s⁻¹, or lower.
 - ** vacuum group have only one year to install all of the tubes!
“*flange connection*” for tube installation is chosen.
- optical baffle (diamond-like-carbon/DLC coated)
 - ** based on the tube vibrating test in TAMA300, 500 of optical baffles are planned to place at “*every 12 meters*” along tubes, for phase noise reduction
 - ** measured outgassing rate of DLC is 4×10^{-9} Pa m³ m⁻² s⁻¹,
- chamber (4 of 13 chambers are equipped with a cryogenic system)
 - ** installed materials, having low outgassing rate, should be chosen.
careful investigation for *elastomer* and *plastomer* (generally large outgassing)
 - ** the amount of the adsorbed molecules on the “*cool-downed mirror*” is to be discussed and investigated, concerning

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** for removing surface degraded layer of stainless steel (SS304, SS316L)

* **electro polishing (EP)**

a commonly used method
electrolyte reservoir and electrode necessary
suitable for tubes, having a large aspect ratio



EP



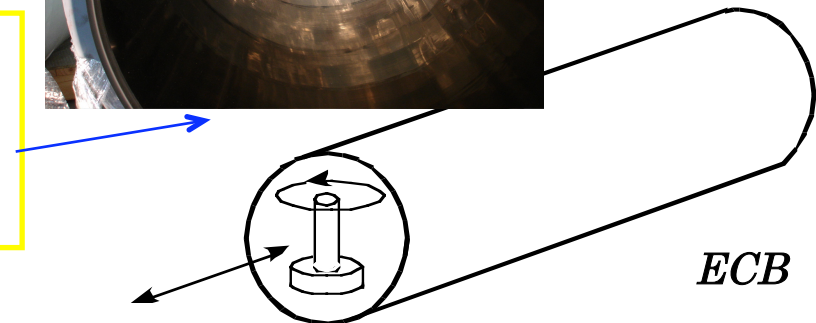
* **chemical polishing (CP)**

a commonly used method
electric field not necessary
suitable for bellows



* **electrochemical buffing (ECB)**

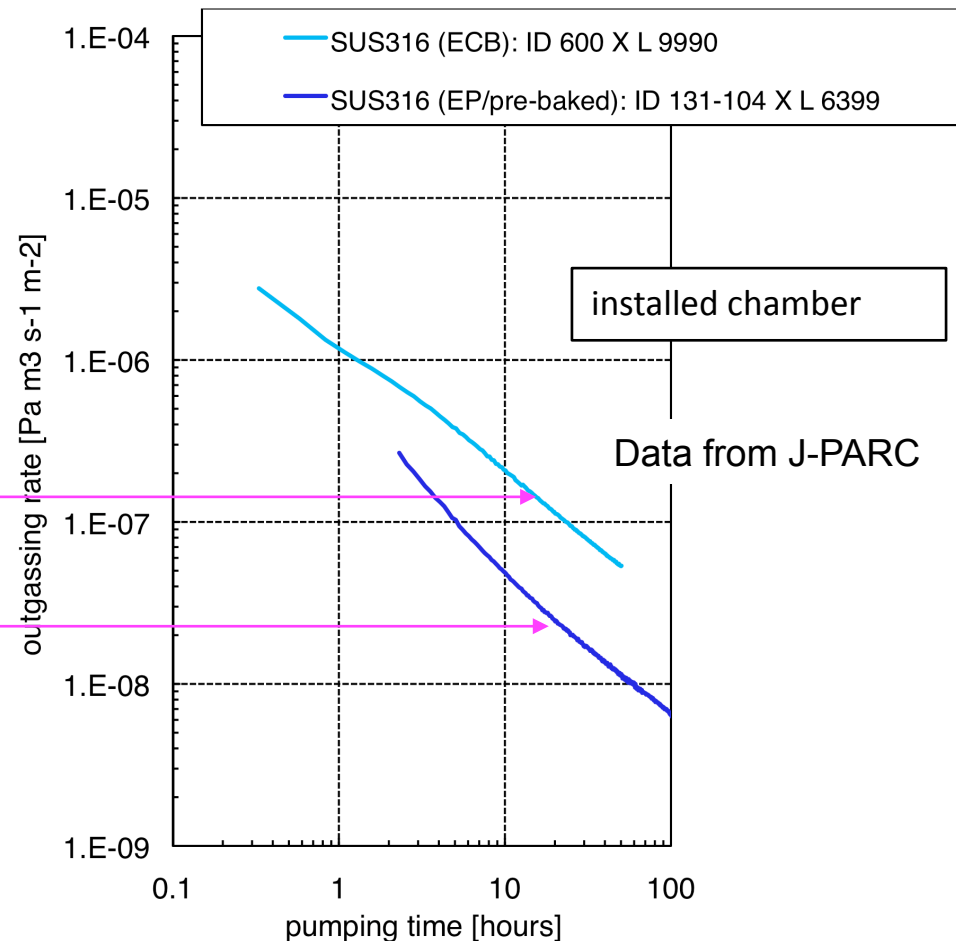
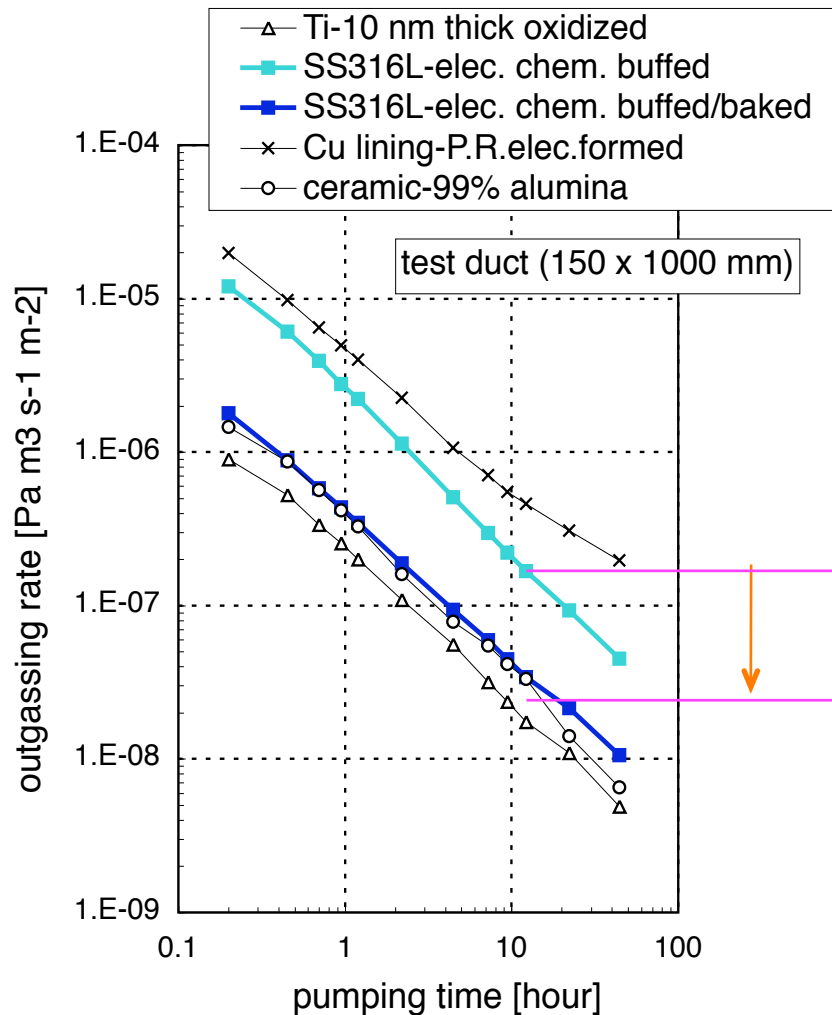
a work head with abrasive, and voltage applied.
not necessary to prepare electrolyte reservoir
suitable for tubes having a large diameter



ECB

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- ** finish processes do not always passivate the surface against water.
- ** pre-baking (215C, 23h) is effective for passivation.
(*memory effect* after air exposure)
- oxide layer after polishing is probably changed in more stable structure



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** manufacturing process of 12-m long tube

hot roll → austenitic process (A&P) → surface grinding → tubing (press and weld)

