



# **BGC monitor Phase II: vacuum studies for LHC integration and operation**

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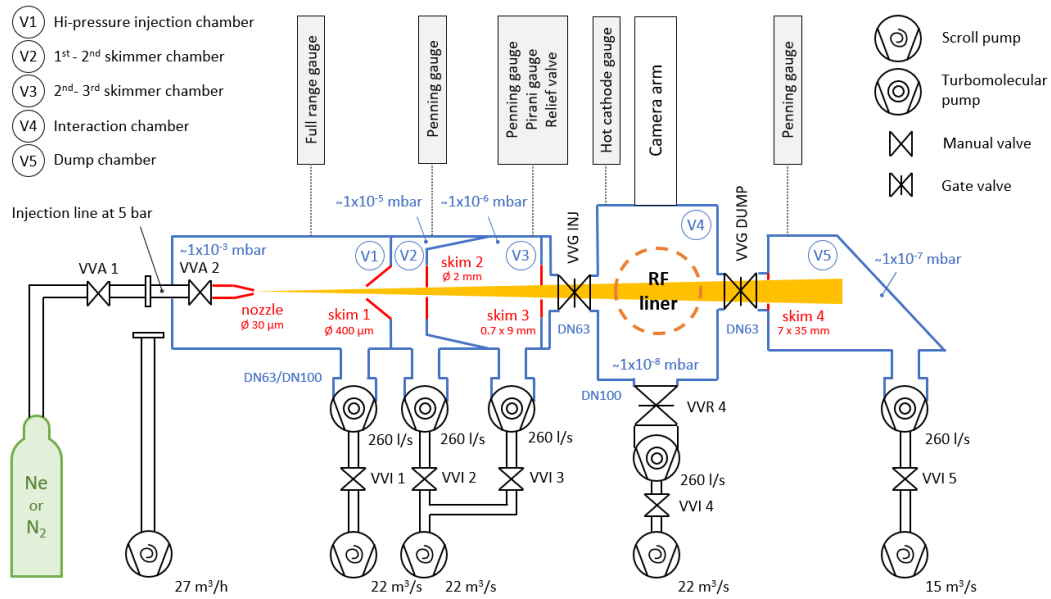
## 1. Off-line test campaign

## 2. Simulations

- H<sub>2</sub>O throughput from unbaked chambers and NEG coating saturation
- N<sub>2</sub> operation: pressure profile, gas exit ratios and NEG coating saturation
- Ne operation & distributed injections: pressure profile (sim. & measurements), gas exit ratios and deposition on cryogenic surfaces

# Off-line test campaign

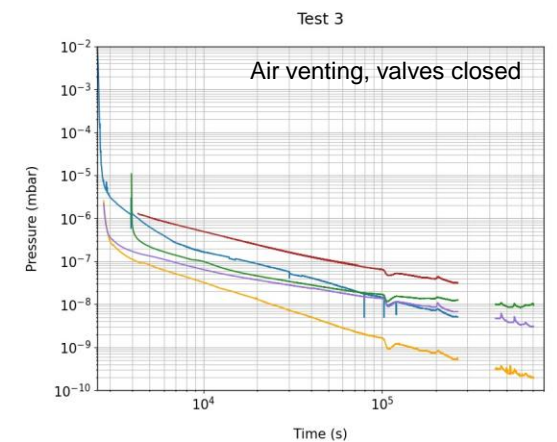
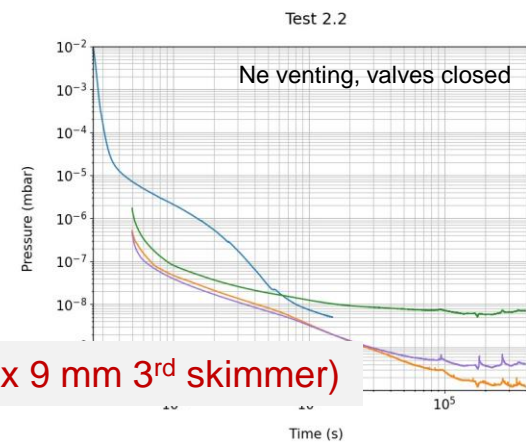
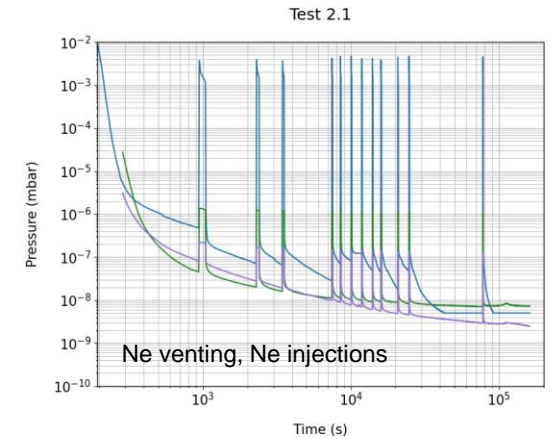
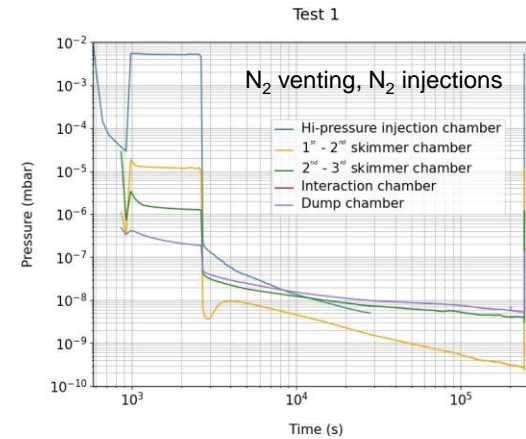
## ■ Pump down & injections



B8 BGC vacuum layout

	$\Delta$ Pressure test 1 (mbar)	$\Delta$ Pressure test 2.1 (Ne corrected)(mbar)
Hi-pressure injection chamber	$5.1 \times 10^{-3}$	$4.9 \times 10^{-3}$
1 <sup>st</sup> - 2 <sup>nd</sup> skimmer chamber	$1.2 \times 10^{-5}$	
2 <sup>nd</sup> - 3 <sup>rd</sup> skimmer chamber	$1.1 \times 10^{-6}$	
Interaction chamber	$5.2 \times 10^{-8}$	$4.7 \times 10^{-6}$
Dump chamber	$1.2 \times 10^{-7}$	$1.9 \times 10^{-7}$
		$5.4 \times 10^{-7}$

**/3.8 (0.3 x 9 mm 3<sup>rd</sup> skimmer)**



# LHC simulations

H<sub>2</sub>O from assembled unbaked chambers → NEG saturation



Injected N<sub>2</sub> → NEG saturation

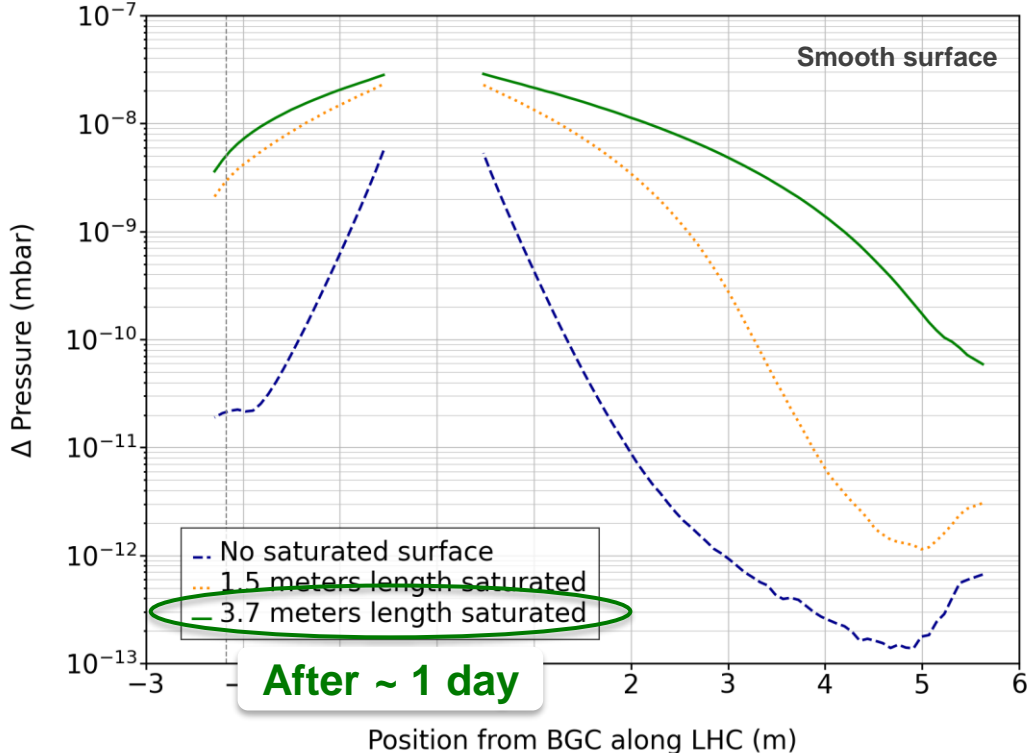
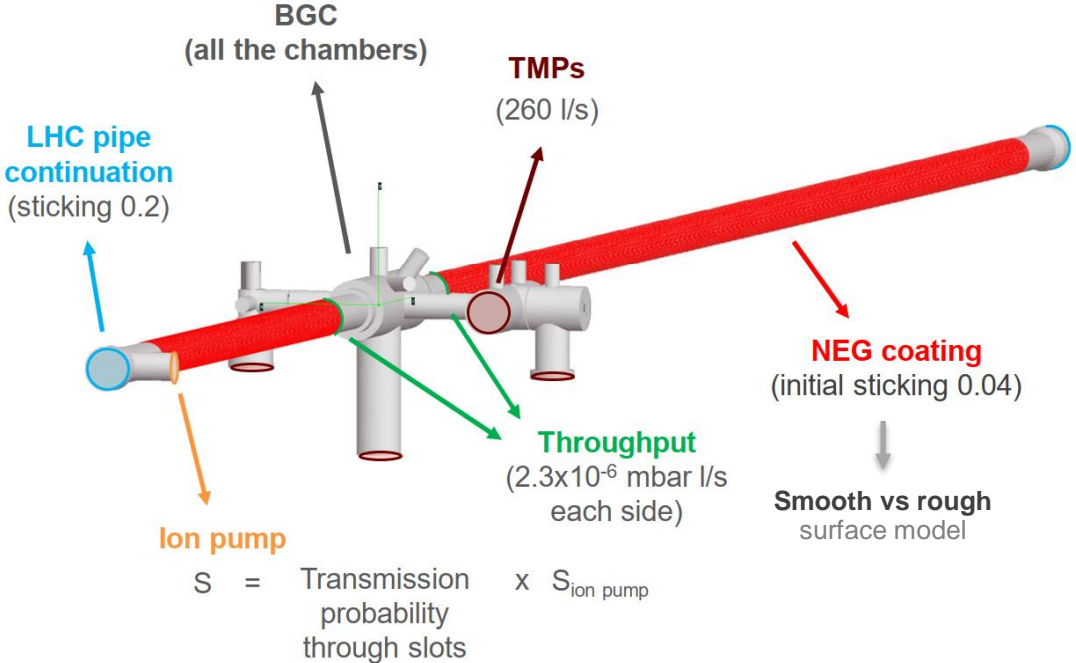


Injected Ne → Depositions on cryogenic surfaces



# LHC simulations – N<sub>2</sub>

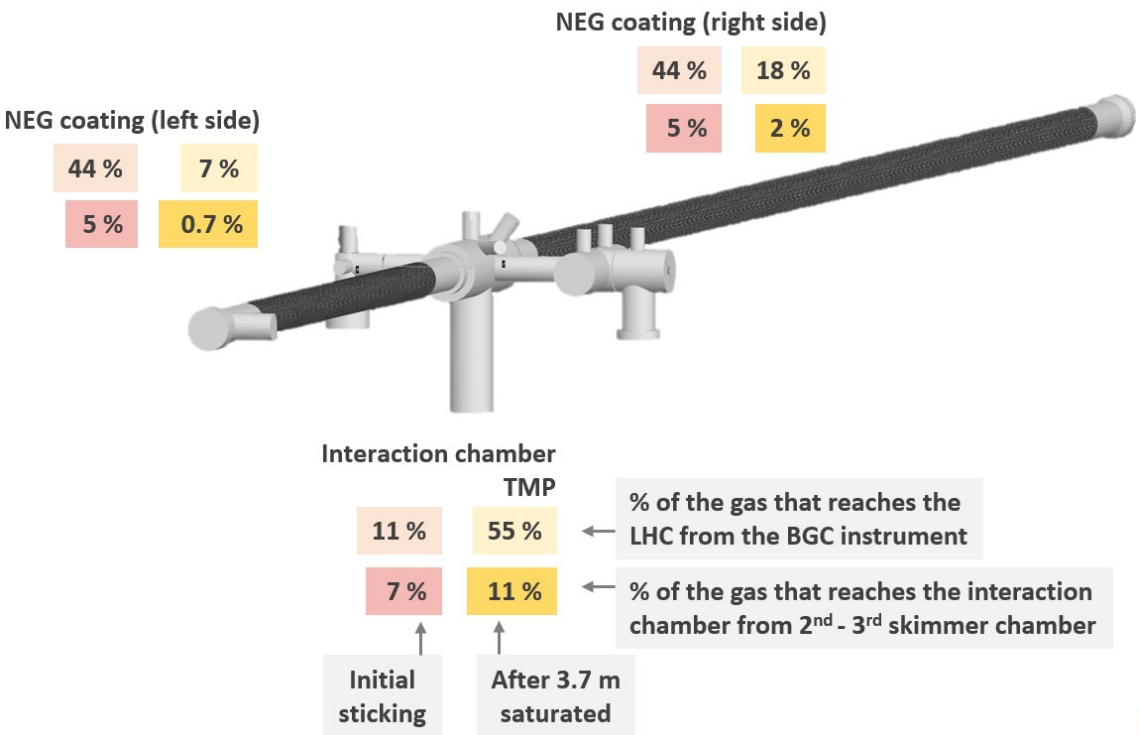
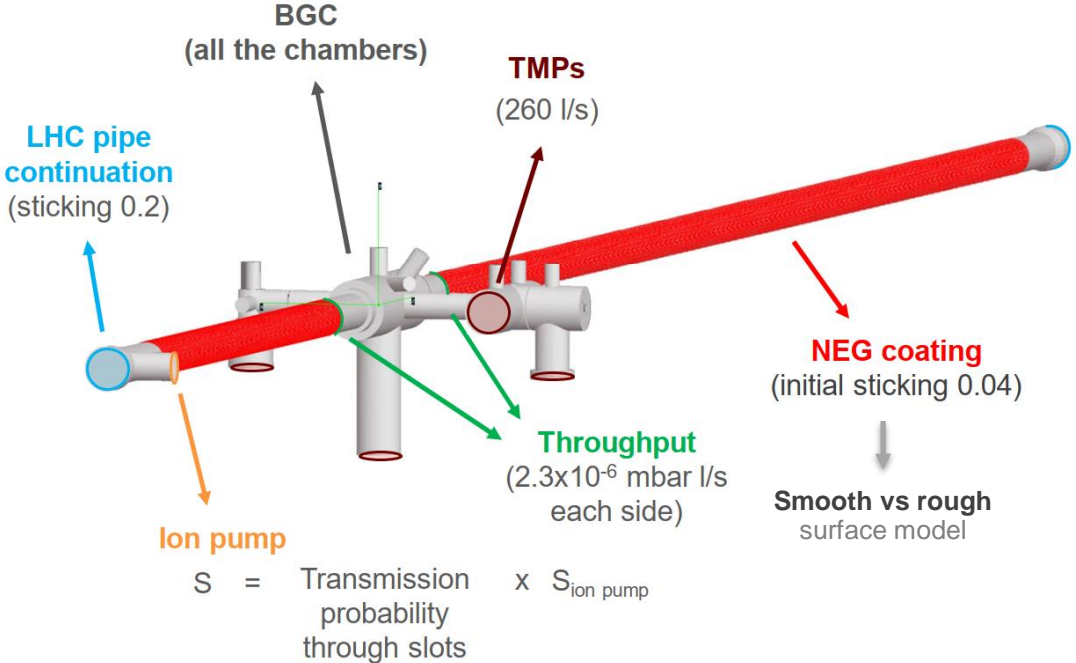
Injected N<sub>2</sub> → NEG saturation





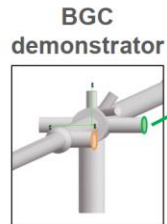
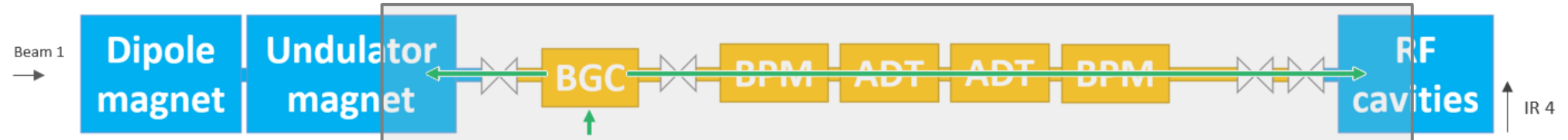
# LHC simulations – N<sub>2</sub>

Injected N<sub>2</sub> → NEG saturation



# LHC simulations – Ne

Injected Ne → Depositions on cryogenic surfaces



Throughput  
(arbitrary value)

Throughput  
( $2.1 \times 10^{-6}$  mbar l/s  
each side)

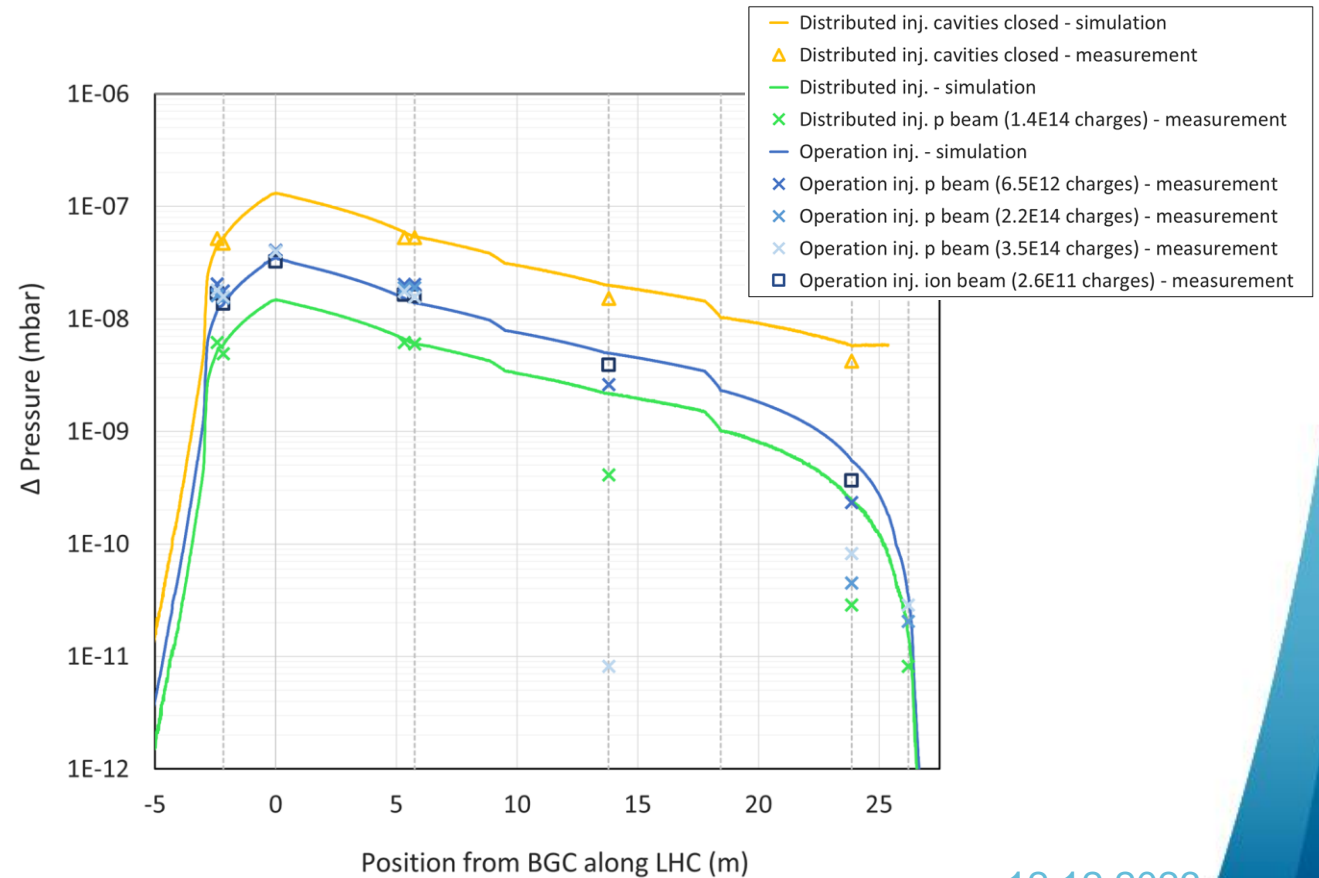
TMPs  
(260 l/s)

Cryopump: RF cavities (4.5 K)

Ion pumps

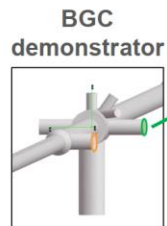
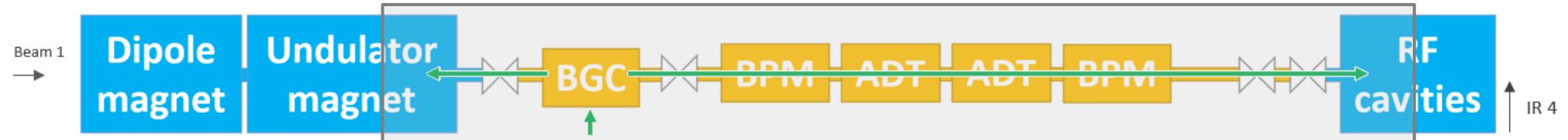
$$S = \text{Transmission probability through slots} \times S_{\text{ion pump}}$$

Cryopump: cold bore (1.9 K)  
through beam screen slots

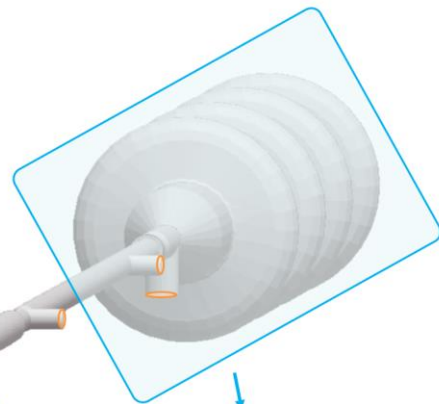
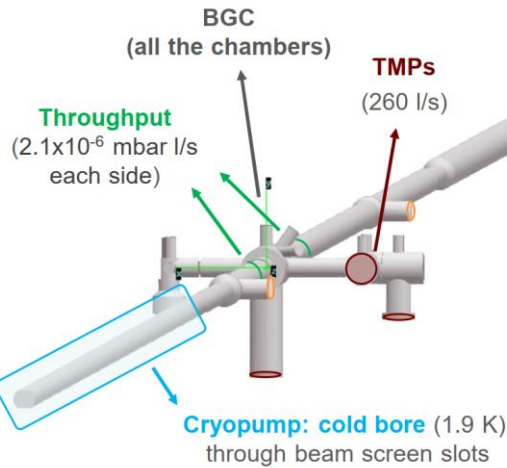


# LHC simulations – Ne

Injected Ne → Depositions on cryogenic surfaces

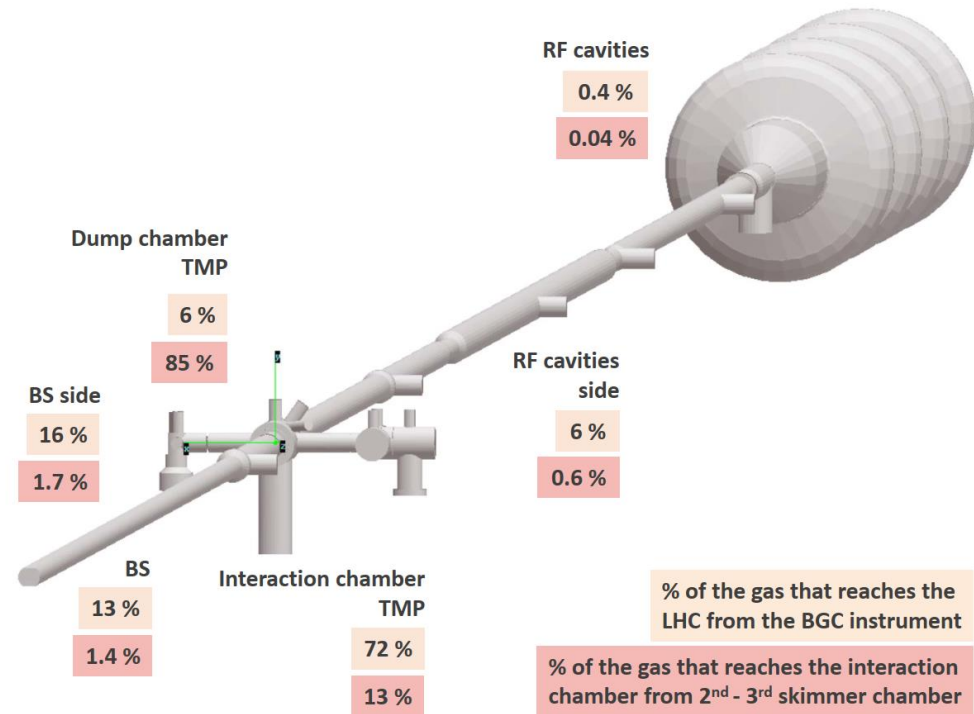


Throughput  
(arbitrary value)



Cryopump: RF cavities (4.5 K)

$$S = \text{Transmission probability through slots} \times S_{\text{ion pump}}$$



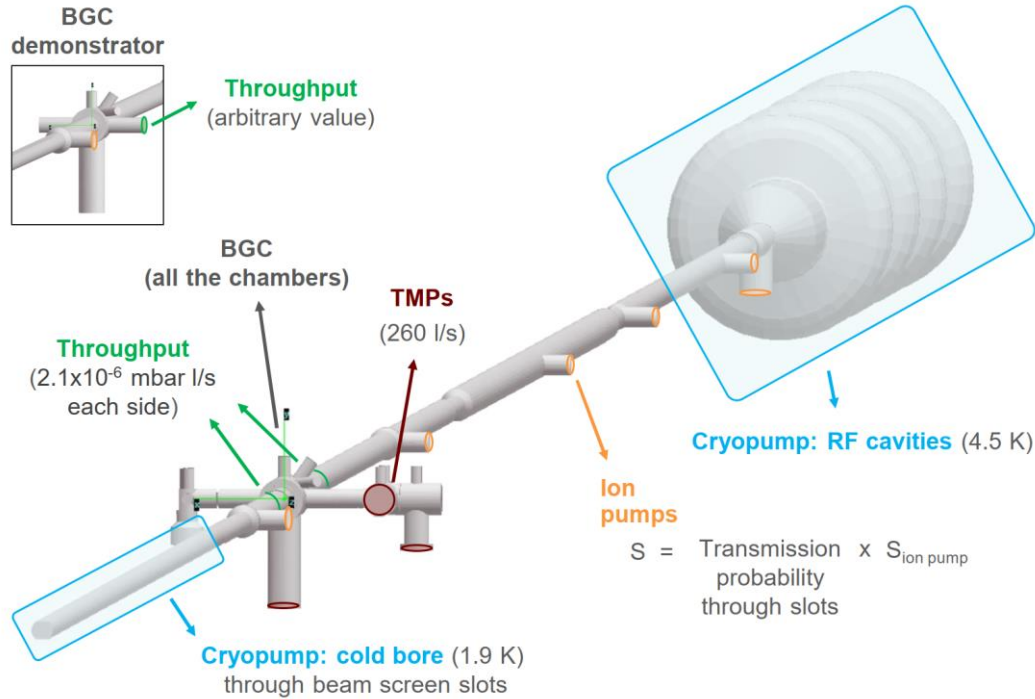
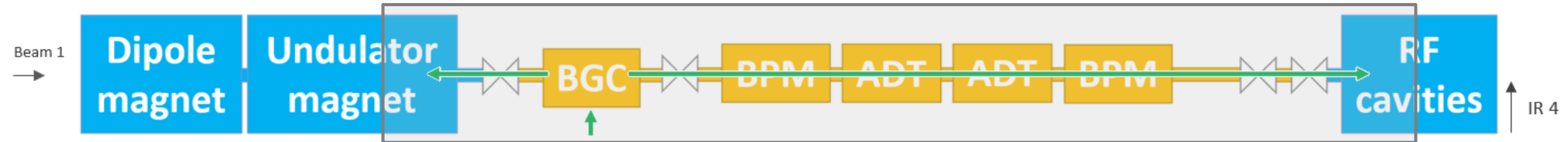
% of the gas that reaches the LHC from the BGC instrument

% of the gas that reaches the interaction chamber from 2<sup>nd</sup> - 3<sup>rd</sup> skimmer chamber

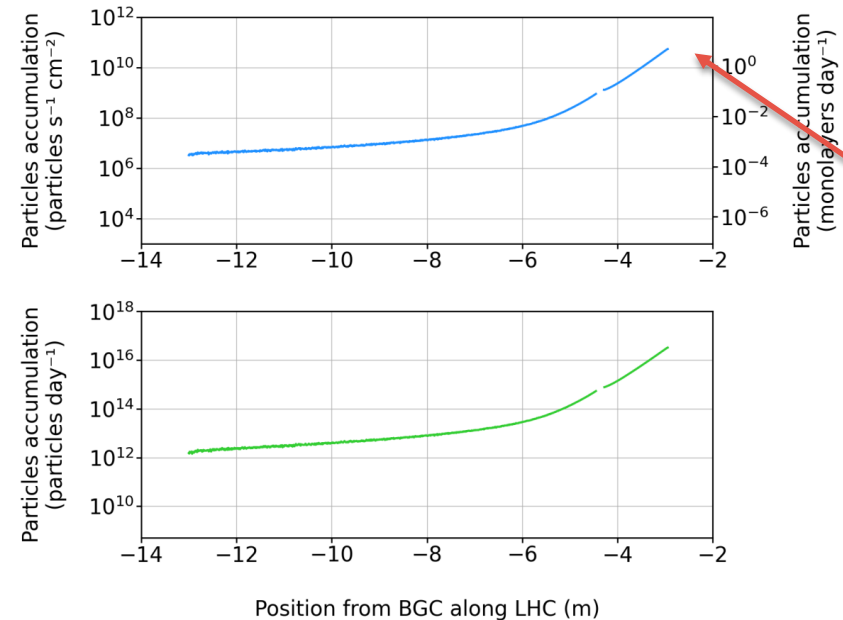


# LHC simulations – Ne

Injected Ne → Depositions on cryogenic surfaces



Particles accumulation on the cold bore

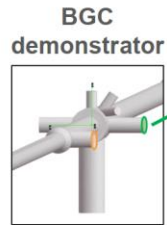
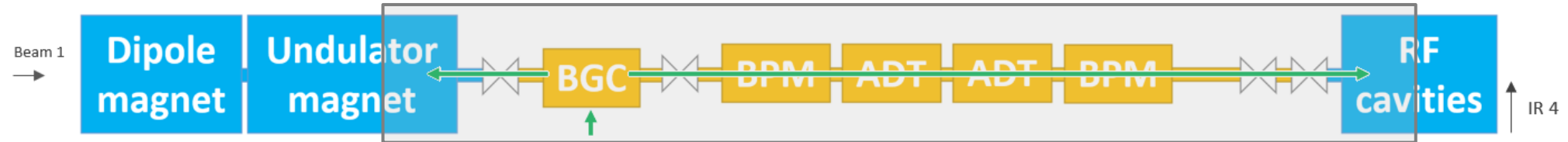


**19.6 monolayers**  
after **100 h** of  
continuous  
operation

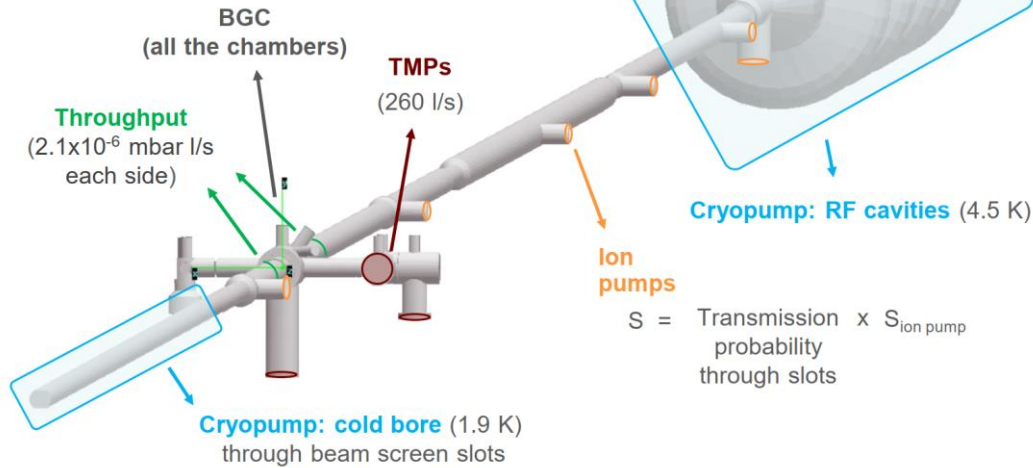
↓  
**Estimated SEY increment:**  
**0.28**

# LHC simulations – Ne

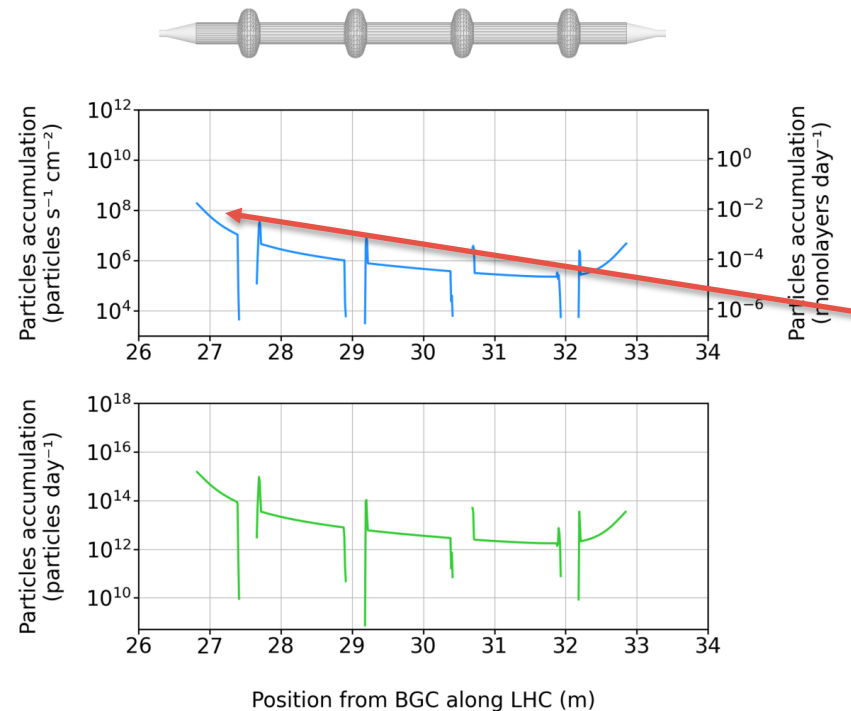
Injected Ne → Depositions on cryogenic surfaces



Throughput  
(arbitrary value)



Particles accumulation on the RF cavities

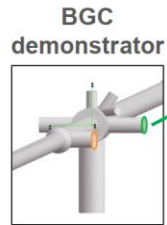
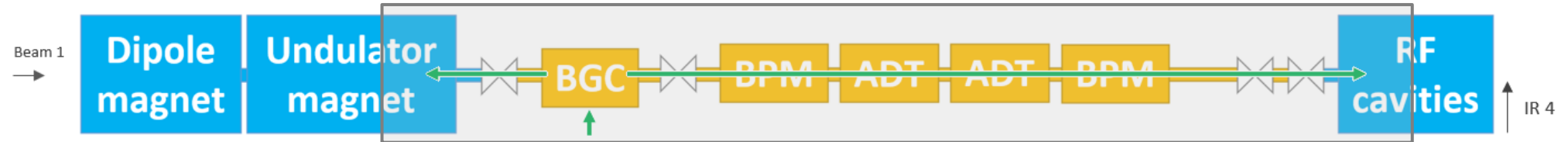


**0.07 monolayers**  
after **100 h** of  
continuous  
operation

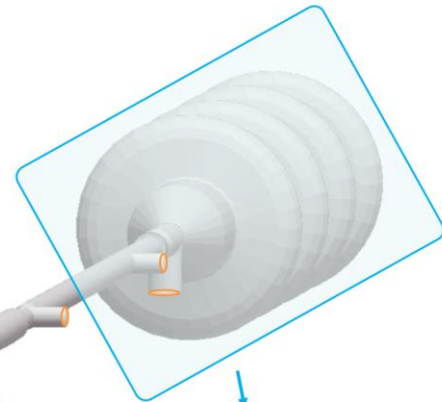
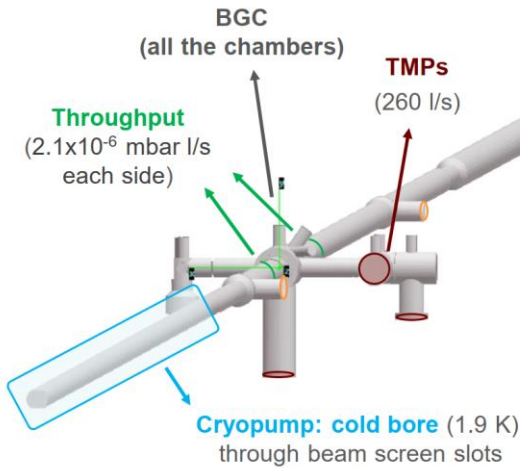
↓  
Estimated  
**SEY increment:**  
**1E-3**

# LHC simulations – Ne

Injected Ne → Depositions on cryogenic surfaces



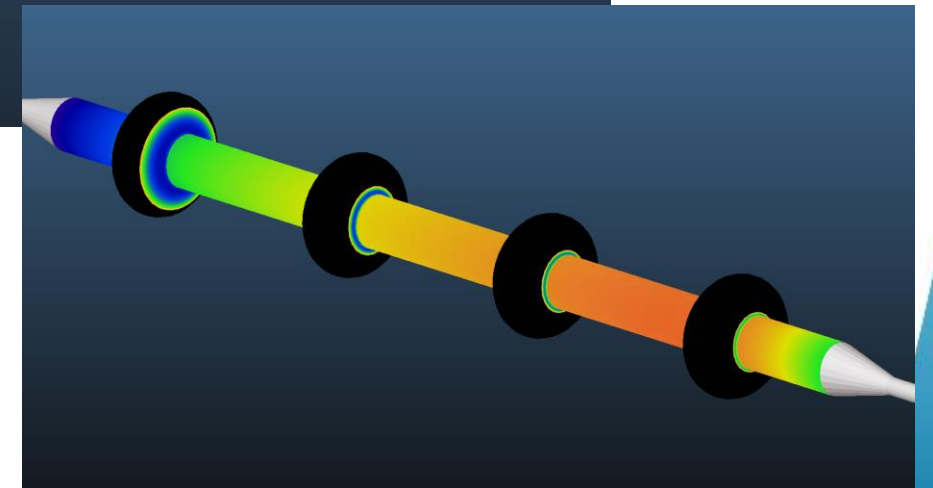
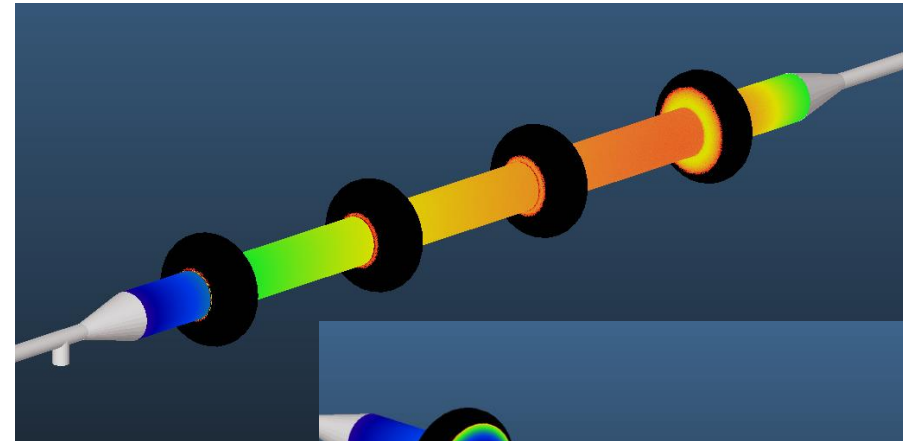
Throughput  
(arbitrary value)



Cryopump: RF cavities (4.5 K)

Ion pumps

$$S = \text{Transmission} \times \text{probability through slots} \times S_{\text{ion pump}}$$



# Conclusions

- **Pump down and injections characterized** during off-line tests, allowing to obtain **inputs** for the LHC simulations.
- **Acceptable** compromise between BGC **pump down time** and **estimated saturated length** of the beamline with **H<sub>2</sub>O** from **unbaked chambers**, **avoiding the bake-out**.
- **Significant NEG saturation** simulation results **due to N<sub>2</sub> injections**: **3.7 m both sides in 1 day** (smooth surface model -worst case-).
- **Good agreement** between **Ne pressure simulations** and **measurements without beam or at lower beam intensities**.
- **Negligible** contribution to **SEY** of Ne monolayers after 100 h of operation in **RF cavities** (**0.07 monolayers, SEY 1E-3**) while it is **not** in the **cold bore** (**19.6 monolayers, SEY 0.28**)

**Thank you for your attention**

