



# Fundamental power coupler substitution on ESS cryomodule

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# Background

- After delivery and storage at ESS, the cavity string of CM02 was leaking and the leak was on the ceramic of coupler position 4 in the cryomodule.
- Inspection with an boroscope => crack on ceramic
- ESS and CEA want to preserve the cryomodule from pollution : no transport and exchange of the ceramic +antenna at ESS
- Beam line was vented with dry N2 gas with mass flow controller and the particle free vacuum group
- Never done so far on ESS cryomodule (Valve exchange done on XFEL cryomodule, electrode on a vacuum gauge) :
  - Define an environnement to reach ISO4-5 around the ceramic
  - Develop a tool

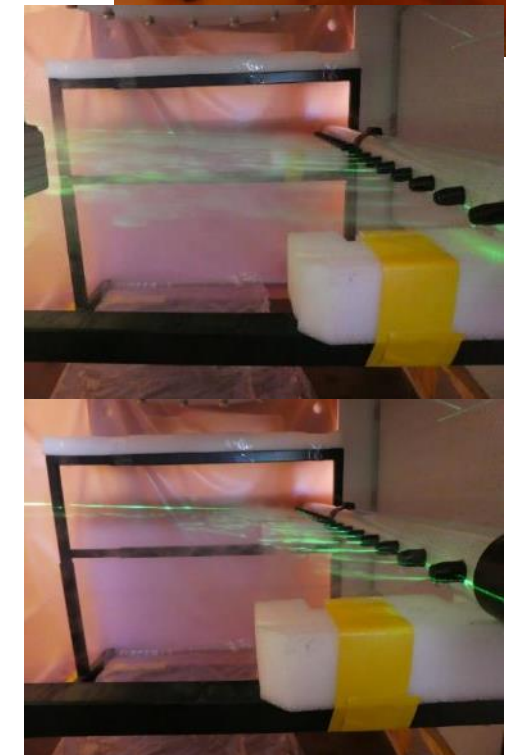
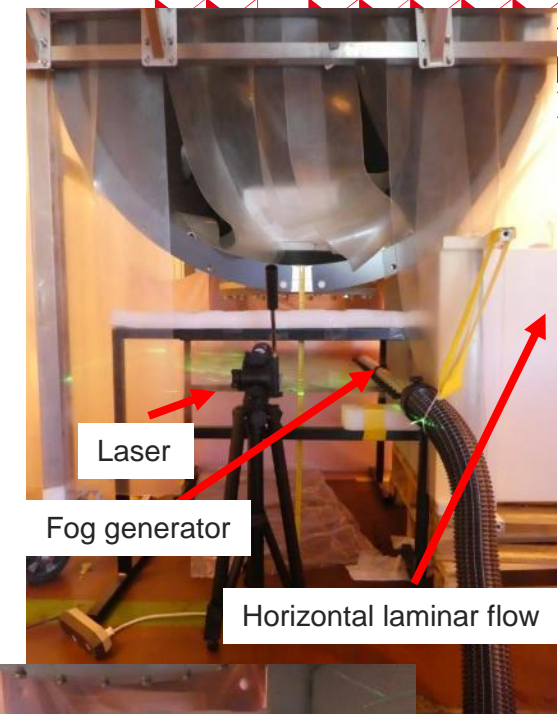
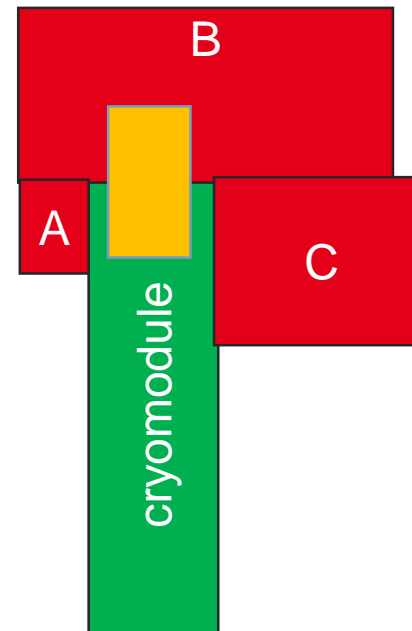
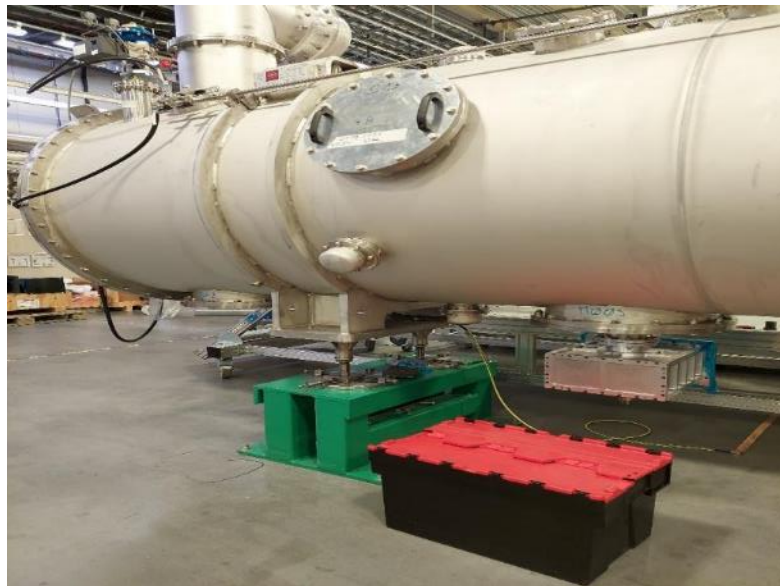


# Define an environnement to reach ISO4-5 around the ceramic

CM02 in a hall => not clean environment

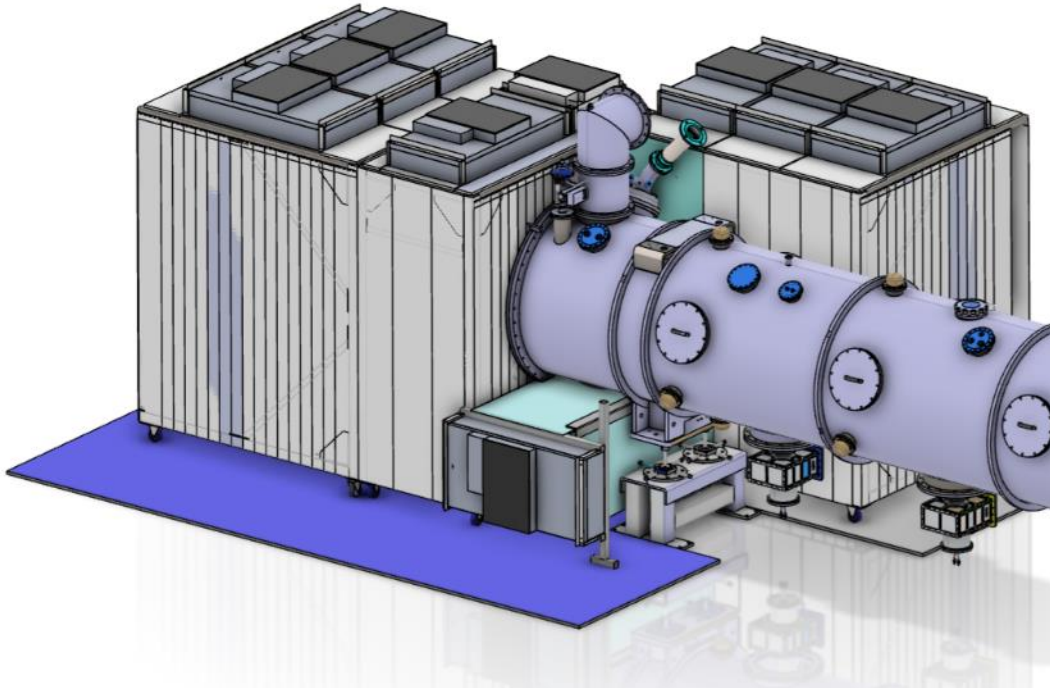
Laminar flows configuration set to host broken ceramic, new ceramic, 3 operators, tooling, vacuum group

Tests at CEA to optimise laminar flow configuration and air speed





# Environment at ESS

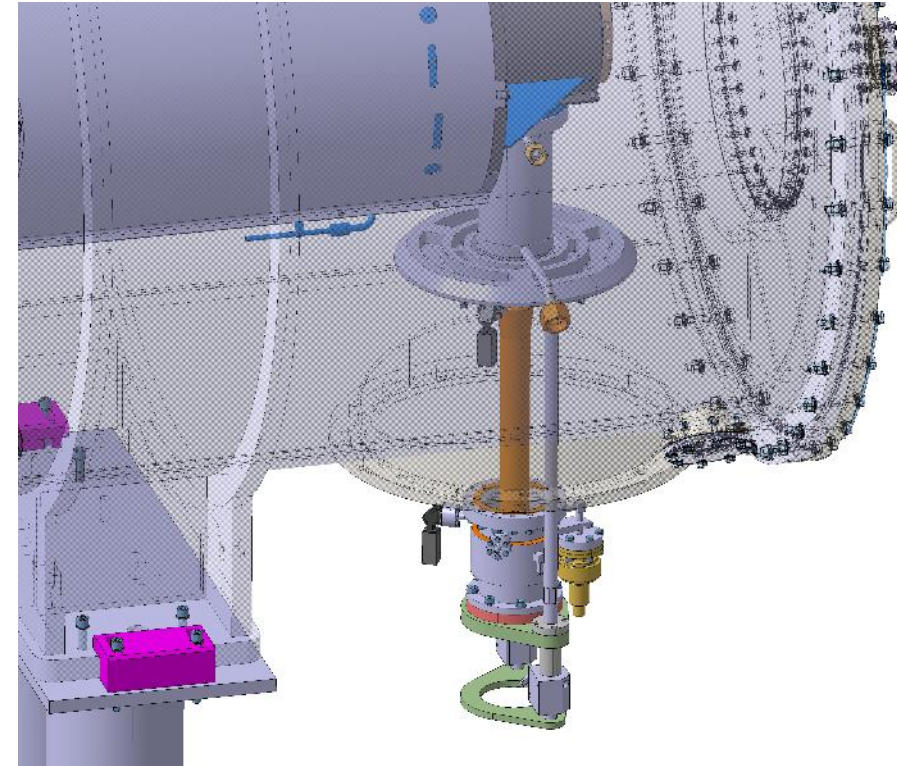


# Tool development

Goals :

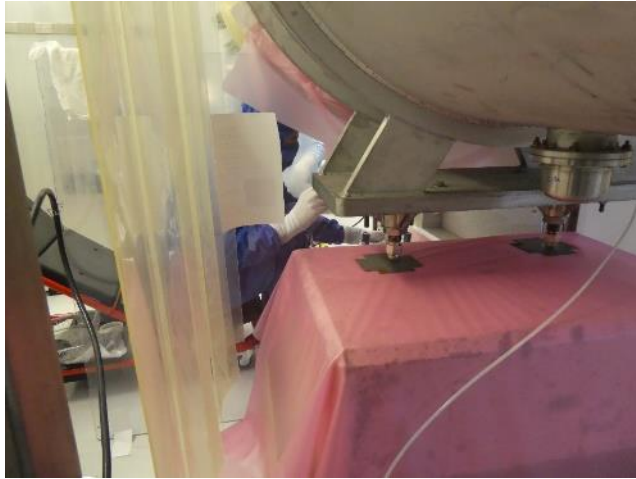
- Keep alignment between the two flanges
- No contact between wall and antenna
- Limit particle generation in presence of studs in flange
- Maintain the 8.5kg of the coupler from sliding down
- Sliding when needed

=> Igus drylin® to slide the ceramic and tooling on the two rods





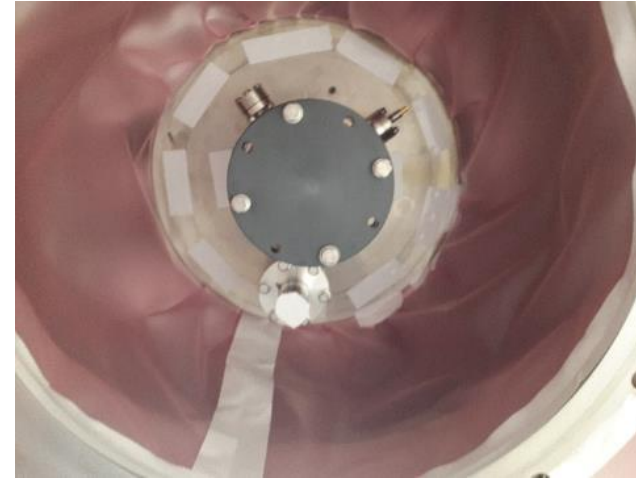
# Training



Operator sliding back and forth from « C » laminar flow to under the module. Plastic sheets of the laminar flow are taped to the module to open an operator gate.



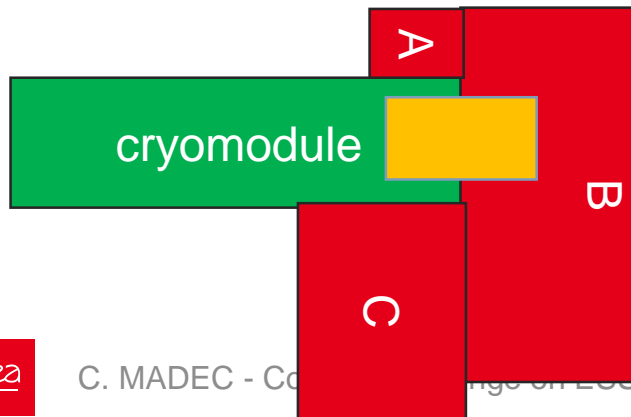
Plastic wrapping of the lower part of the module .



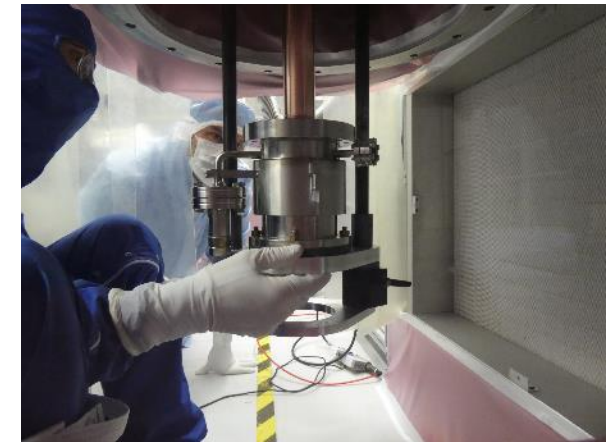
Plastic wrapping to protect ceramic from pollution



Particle counting



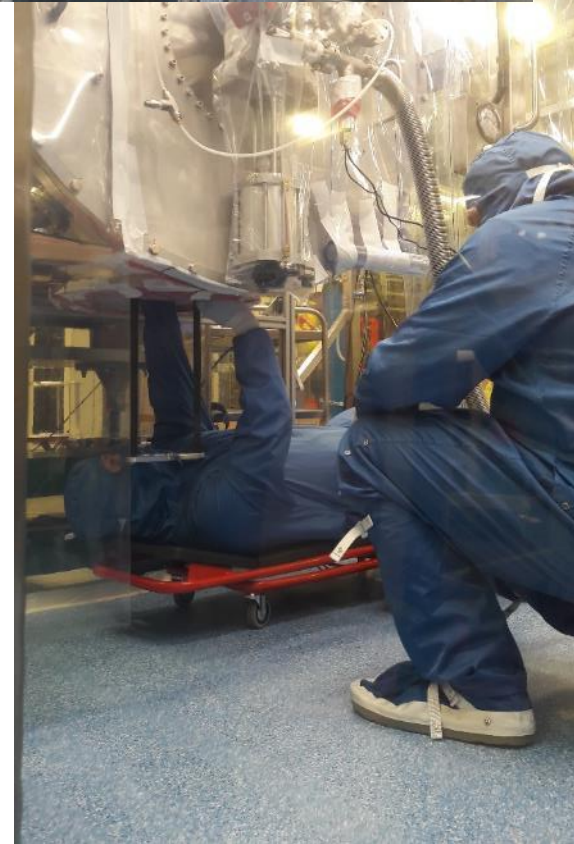
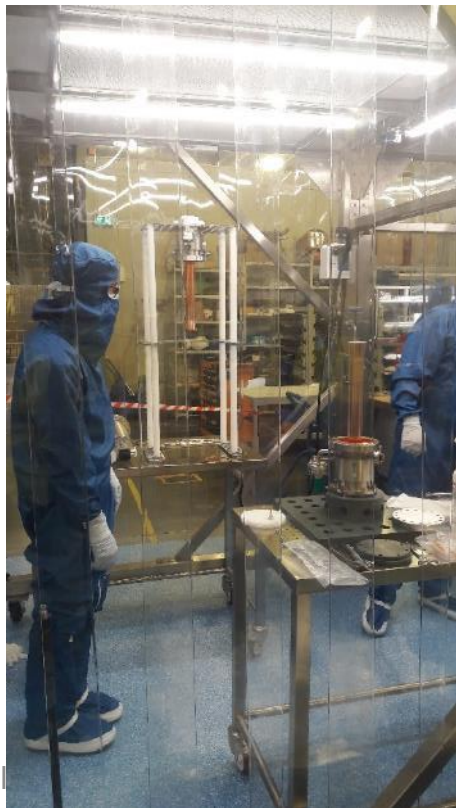
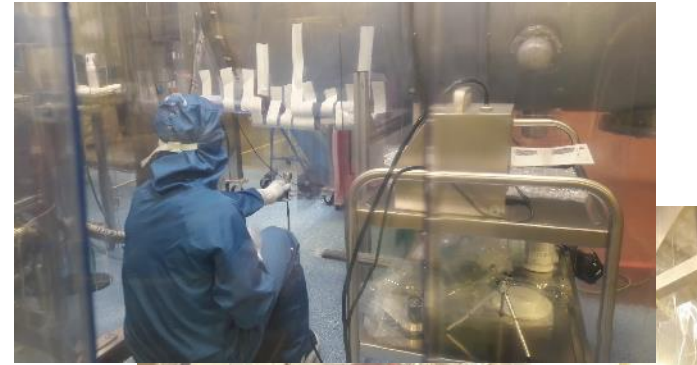
Broken ceramic removal



New ceramic



# D-day





# Tests results

- ✓ CM02 was tested at ESS and results are on specifications (FE)
- ✓ Warm and cold coupler conditioning as others
- ✓ Radiation within specs

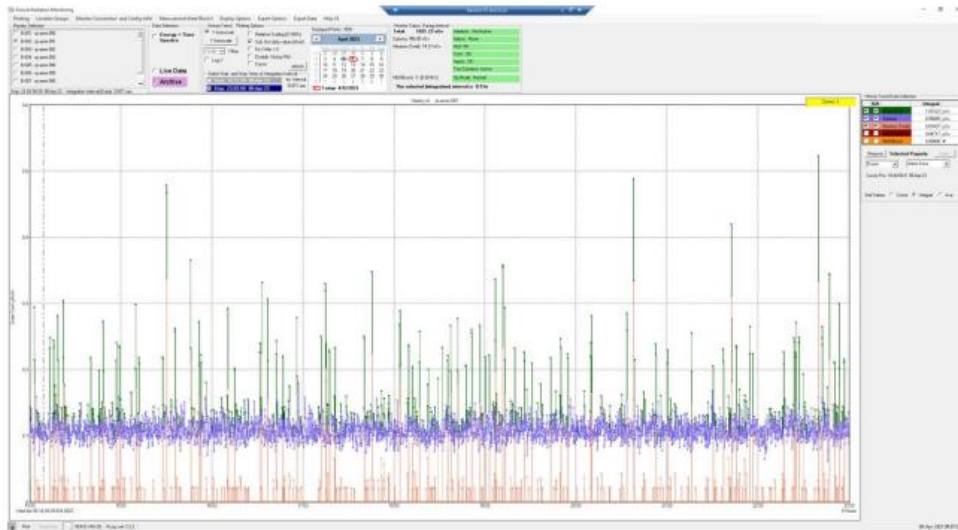
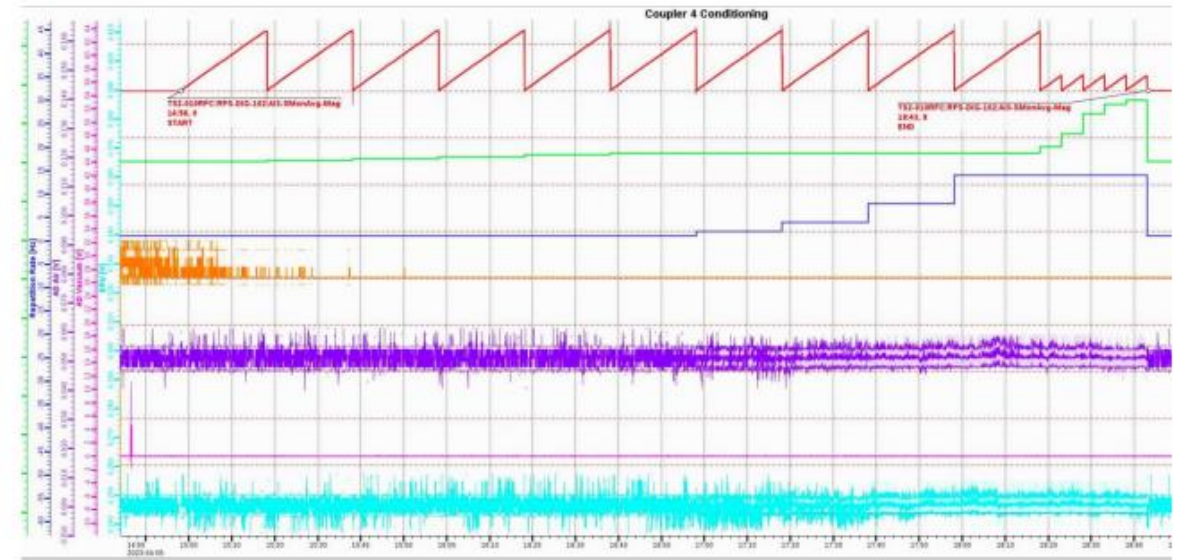


Figure 7 Data (RP Pandora system) taken on Apr 5<sup>th</sup> day time (coupler 4 conditioning). Nothing above background detected



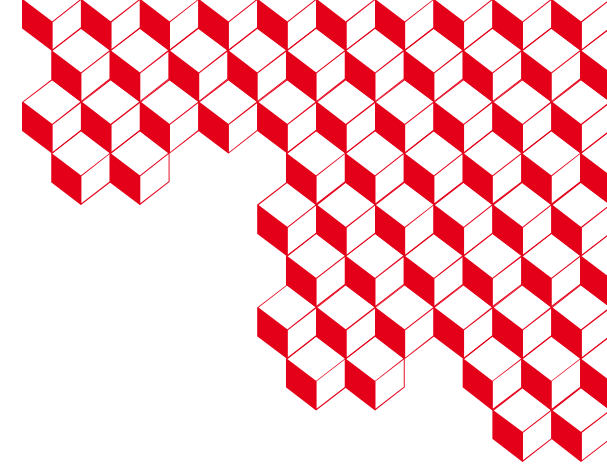
Coupler #4 conditioning

CM02_1	Energy Rad 1 (MeV)	Energy Rad 2 (MeV)	max counts/sec @ Eacc	max counts/sec @ Eacc	Max Power (kW)	Dose rate (uSv)
CAV1 2023 04 21 <sup>st</sup>	< 8	< 8	200	200	17	Integral (3h): 9.93 Gamma: 9.90 Neutrons: 0.03 Peak: 25 uSv/h
CAV2 2023 04 24 <sup>th</sup>	< 8	< 8	1600	1800	16	Integral (h): NA Gamma: NA Neutrons: NA Peak: 200 uSv/h
CAV3 2023 04 24 <sup>th</sup>	< 8	< 8	1800	400	>18	Integral (h): NA Gamma: NA Neutrons: NA Peak: 180 uSv/h
CAV4 2023 04 20 <sup>th</sup>	< 8	< 8	500	1500	19	Integral (2.6 h): 859.55 Gamma: 259.49 Neutrons: 0.06 Peak: 1.4 mSv/h
All four cavities in open loop 2023-04-26	<8	<8	NA	NA	Average (over the four cavities) nominal E <sub>acc</sub> (16.7 MV/m)	Integral (6h): 310 Gamma: 310.7 Neutrons: 0.05 Peak: 140

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# **Thank you for your attention**

## **Questions?**

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**CEA SACLAY**

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**BACK-UP SLIDES**



# Tooling

