

## HIGH-PERFORMANCE CERAMICS

# ELECTRICAL BREAKERS FOR CRYOGENIC SYSTEMS

### Application:

CASE STUDY: Insulators for cryogenic systems (Cryogenic Ceramic Breakers)

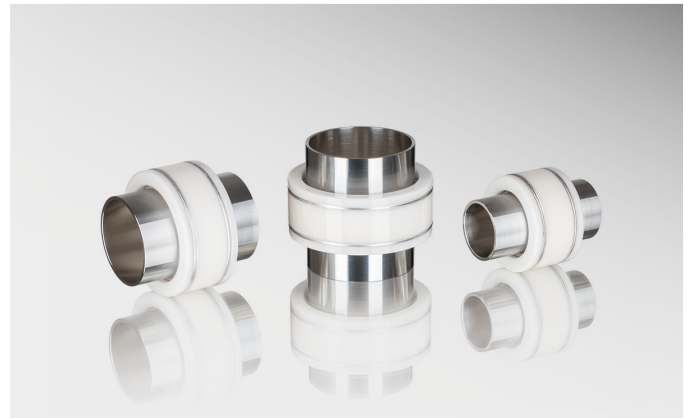
### Material:

Aluminium Oxide **F99.7**

For the cryogenic systems for four liquid argon based neutrino detectors ProtoDUNE installed at CERN (France) and the Short Baseline Far and Near Detectors installed at FERMILAB (Batavia/Chicago US), DEMACO (Netherlands) designed, manufactured and tested the cryogenic distribution system and used for this 54 electrical insulators made of **F99.7** to electrically break the cryogenic transfer lines of this system.

All the process pipes of cryogenic transfer lines with design temperature of 77 K and a design pressure of 10 bars connecting to the cryostats are electrically insulated by the mean of ceramic insulators of 10pF or less on each pipe dielectric break. These so called Electrical Breakers are ceramic pipe parts with at both side a stainless steel pipe ends which is butt welded on the process pipes.

To meet the requirements of the overall specifications of CERN and FERMILAB, DEMACO designed a distribution system and worked in close cooperation with KYOCERA to design the Electrical Breakers to fulfil the technical specifications and testing requirements.



### The main technical specifications are:

- ▶ Electrical isolation voltage: 2000 V DC
- ▶ Isolation resistance: > 1 MΩ
- ▶ Design temperature: 77 – 320 K
- ▶ Design pressure: 10 bar
- ▶ Helium leakage rate: ≤ 10<sup>-9</sup> mbar\*I/s at design pressure
- ▶ Nominal diameter: DN25 – DN50
- ▶ Cold Shock testing: Liquid nitrogen of 77 K
- ▶ Cleanliness: UHV cleaning requirements
- ▶ Pressure equipment directive: PED 2014-68-EU

- ▶ Small desorption and leakage rates
- ▶ High pressure resistance
- ▶ Best insulation properties
- ▶ Temperature resistance between -271°C and 450°C

## Competence in Advanced Ceramics Engineering for customized solutions

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