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Technical Specification

Interface Control Document for the Interface between the NP02 cryostat penetration purge outlet and the proximity cryogenics warm piping

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NOMENCLATURE

- PBS Product Breakdown Structure
- WBS Work Breakdown Structure
- NP Neutrino Platform

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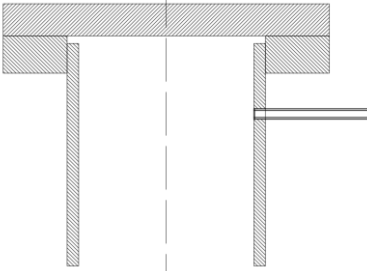
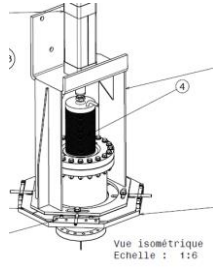
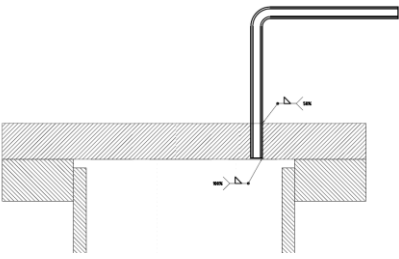
1. INTRODUCTION

The membrane cryostats for NP-02 are based in a thick passive insulation membrane. In order to fulfil the detector and proximity cryogenics functions, openings are created on top of the cryostat. Each opening creates a chimney for the warmer gas in the cryostat, which at the same time, warms the detector cables creating outgassing. The penetrations are the location where the warmer gas of the cryostat goes, but at the same time is an impurities source. For this reason, each penetration is required to have a purge port on the highest part. The proximity cryogenics subsystems can then manage and analyse the purge gas to later dump it or purify it.

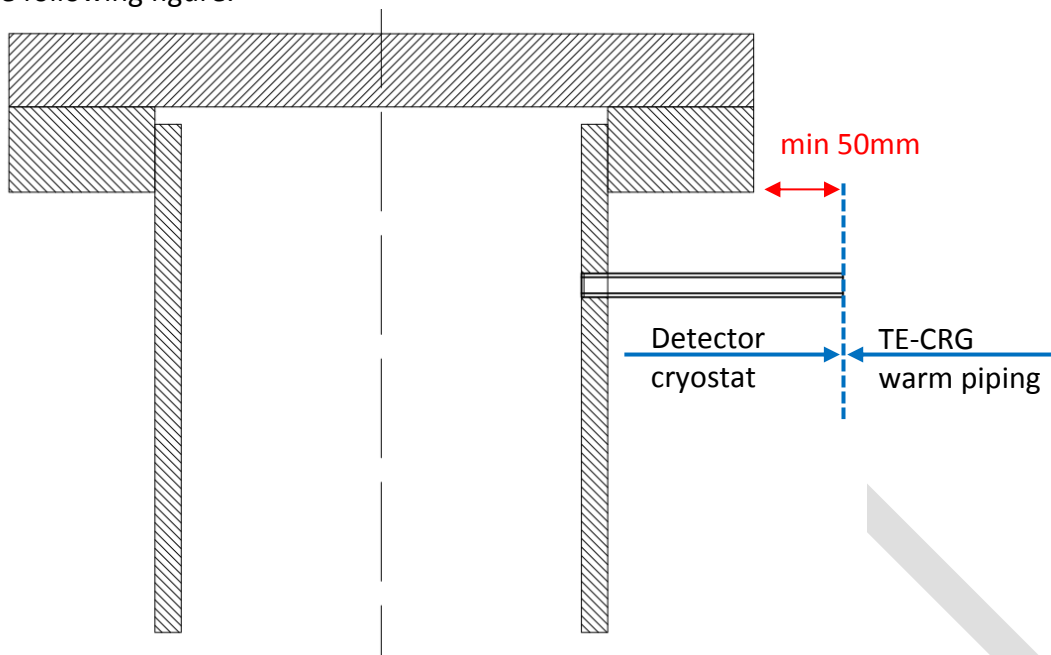
2. TECHNICAL SPECIFICATION

2.1 PURGE PORTS

Purge ports are openings placed at the top of each penetration to evacuate warm gas that has been exposed to outgassing. The typical flow value for each penetration is 0.1 g/s, accounting for a linear speed of about 0.3cm/s. Since the penetrations and the proximity cryogenics are developed by different parties, the technical details are put in common. Port type A is the basic variation for flanges that have no room on the top. Port type B is developed for the NP02 field cage positioning system that has an 80mm stroke and needs a flexible pipe. Port type C is developed to purge the penetrations with blind flanges that have available on top room.

| Name | Pipe | Stroke | Drawing | Figure |
|------|----------|--------------|------------------------|---|
| A | Ø10/12mm | No | Basic, CEN105xxSGFT |  |
| B | Ø10/12mm | Yes, 80mm | SM1- DRW00000 |  |
| C | Ø10/12mm | No | Various, |  |

To ensure quality in penetration type A, the boundary between TE-CRG and the cryostat is fixed in the following figure.



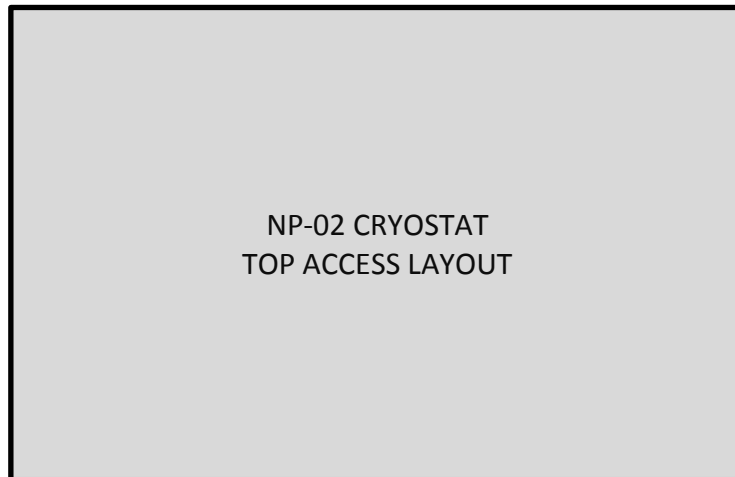
The $\varnothing 10/12$ mm pipe for penetration type A location shall be proposed according to the position and size of the flange, respecting the clearance for flange tightening bolts and extending the pipe 50mm longer than the flange.

2.2 THE PURGE VALVES

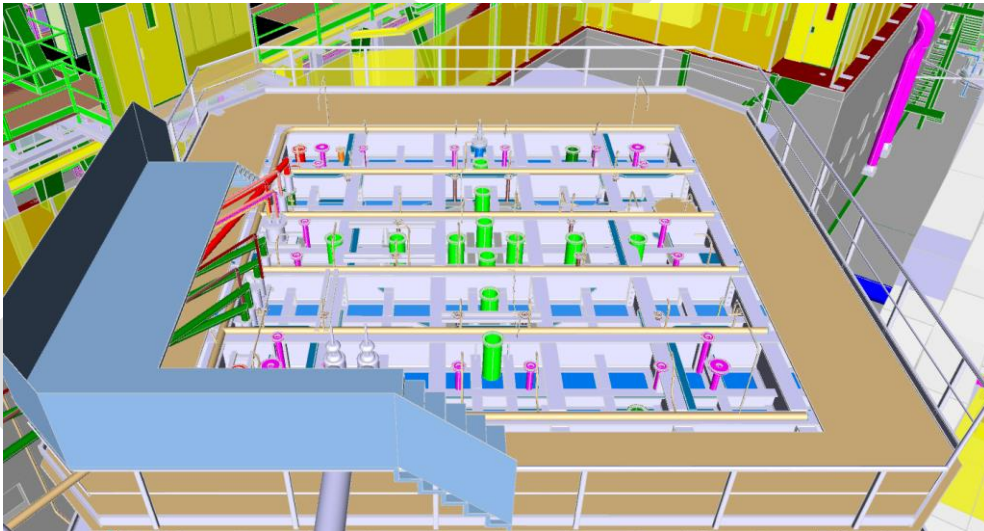
The purge valves are required to offer cryostat top penetrations isolation in all modes of operation. The device shall have a pneumatic normally closed on/off function with a single acting cylinder, offer bellows insulation and have weld-on butt weld fittings with pipe standard ISO 1127 and dimensions $\varnothing 10/12$ mm. The Kv is expected to be 0.95 m³/h. In principle the valve Kv shall be much smaller but in order to ease the welding process a larger valve is preferred. In order to equalize the flow rate of each piping branch, it is proposed to use flow restrictors at each branch runoff to create a 100mbar pressure drop for each branch in parallel. Each purge valve will be controlled with a pneumatic battery under electrical insulation. To simplify grounding and lower costs the valves will not feature position detection.

2.3 NP02 WARM PIPING

Starting from the cryostat top access specifications, transit areas are defined in order to set the warm piping routing.



The NP02 top cap warm piping is based on a manifold with 6 legs, each manifold has an \varnothing 10/12mm pipe going to each penetration purge valve.



3. INTERFACE

3.1 INTERFACE FOR NP-02 EXPERIMENT

The interface points between the detector penetrations purge points and the warm piping are covered in the table below:

| POS | Cryostat/Detector | | | Warm piping TE-CRG | | |
|------|-----------------------|----------------|-----------|--------------------|-------|----------|
| | DESCRIPTION | INTERFACE TYPE | RESP. | VALVE TAG | P bar | FLOW g/s |
| 1.1 | Field cage suspension | C | P.DUNE DP | 2PV4453 | 10 | 0.1 |
| 1.2 | Field cage suspension | C | P.DUNE DP | 2PV4454 | 10 | 0.1 |
| 1.3 | Field cage suspension | C | P.DUNE DP | 2PV4455 | 10 | 0.1 |
| 1.4 | Field cage suspension | C | P.DUNE DP | 2PV4456 | 10 | 0.1 |
| 1.5 | Field cage suspension | C | P.DUNE DP | 2PV4457 | 10 | 0.1 |
| 1.6 | Field cage suspension | C | P.DUNE DP | 2PV4458 | 10 | 0.1 |
| 1.7 | Field cage suspension | C | P.DUNE DP | 2PV4459 | 10 | 0.1 |
| 1.8 | Field cage suspension | C | P.DUNE DP | 2PV4460 | 10 | 0.1 |
| 1.9 | Field cage suspension | C | P.DUNE DP | 2PV4461 | 10 | 0.1 |
| 1.10 | Field cage suspension | C | P.DUNE DP | 2PV4462 | 10 | 0.1 |
| 1.11 | Field cage suspension | C | P.DUNE DP | 2PV4463 | 10 | 0.1 |
| 1.12 | Field cage suspension | C | P.DUNE DP | 2PV4464 | 10 | 0.1 |
| 1.13 | Field cage suspension | C | P.DUNE DP | 2PV4465 | 10 | 0.1 |
| 1.14 | Field cage suspension | C | P.DUNE DP | 2PV4466 | 10 | 0.1 |
| 1.15 | Field cage suspension | C | P.DUNE DP | 2PV4467 | 10 | 0.1 |
| 1.16 | Field cage suspension | C | P.DUNE DP | 2PV4468 | 10 | 0.1 |
| 2.1 | Slow control chimneys | C | P.DUNE DP | 2PV4469 | 10 | 0.1 |
| 2.2 | Slow control chimneys | C | P.DUNE DP | 2PV4470 | 10 | 0.1 |
| 2.3 | Slow control chimneys | C | P.DUNE DP | 2PV4471 | 10 | 0.1 |
| 2.4 | Slow control chimneys | C | P.DUNE DP | 2PV4472 | 10 | 0.1 |
| 3.1 | Signal chimneys FTS | A | P.DUNE DP | 2PV4473 | 10 | 0.1 |
| 3.2 | Signal chimneys FTS | A | P.DUNE DP | 2PV4474 | 10 | 0.1 |
| 3.3 | Signal chimneys FTS | A | P.DUNE DP | 2PV4475 | 10 | 0.1 |
| 3.4 | Signal chimneys FTS | A | P.DUNE DP | 2PV4476 | 10 | 0.1 |
| 3.5 | Signal chimneys FTS | A | P.DUNE DP | 2PV4477 | 10 | 0.1 |
| 3.6 | Signal chimneys FTS | A | P.DUNE DP | 2PV4478 | 10 | 0.1 |
| 3.7 | Signal chimneys FTS | A | P.DUNE DP | 2PV4479 | 10 | 0.1 |
| 3.8 | Signal chimneys FTS | A | P.DUNE DP | 2PV4480 | 10 | 0.1 |
| 3.9 | Signal chimneys FTS | A | P.DUNE DP | 2PV4481 | 10 | 0.1 |
| 3.10 | Signal chimneys FTS | A | P.DUNE DP | 2PV4482 | 10 | 0.1 |
| 3.11 | Signal chimneys FTS | A | P.DUNE DP | 2PV4483 | 10 | 0.1 |
| 3.12 | Signal chimneys FTS | A | P.DUNE DP | 2PV4484 | 10 | 0.1 |

| Cryostat/Detector | | | | Warm piping TE-CRG | | |
|-------------------|--------------------------|----------------|-----------|--------------------|-------|----------|
| POS | DESCRIPTION | INTERFACE TYPE | RESP | VALVE TAG | P bar | FLOW g/s |
| 4.1 | Anode suspensions FTS | B | P.DUNE DP | 2PV4485 | 10 | 0.1 |
| 4.2 | Anode suspensions FTS | B | P.DUNE DP | 2PV4486 | 10 | 0.1 |
| 4.3 | Anode suspensions FTS | B | P.DUNE DP | 2PV4487 | 10 | 0.1 |
| 4.4 | Anode suspensions FTS | B | P.DUNE DP | 2PV4488 | 10 | 0.1 |
| 4.5 | Anode suspensions FTS | B | P.DUNE DP | 2PV4489 | 10 | 0.1 |
| 4.6 | Anode suspensions FTS | B | P.DUNE DP | 2PV4490 | 10 | 0.1 |
| 4.7 | Anode suspensions FTS | B | P.DUNE DP | 2PV4491 | 10 | 0.1 |
| 4.8 | Anode suspensions FTS | B | P.DUNE DP | 2PV4492 | 10 | 0.1 |
| 4.9 | Anode suspensions FTS | B | P.DUNE DP | 2PV4493 | 10 | 0.1 |
| 4.10 | Anode suspensions FTS | B | P.DUNE DP | 2PV4494 | 10 | 0.1 |
| 4.11 | Anode suspensions FTS | B | P.DUNE DP | 2PV4495 | 10 | 0.1 |
| 4.12 | Anode suspensions FTS | B | P.DUNE DP | 2PV4496 | 10 | 0.1 |
| 5 | High Voltage Feedthrough | nd | P.DUNE DP | nd | nd | nd |
| 6 | Manhole | A | P.DUNE DP | 2PV4497 | 10 | 0.1 |
| 9.1 | Tank instrumentation | C | P.DUNE DP | 2PV4498 | 10 | 0.1 |
| 9.2 | Tank instrumentation | C | P.DUNE DP | 2PV4499 | 10 | 0.1 |

3.2 INTERFACE FOR NP-02 INTERNAL CRYOGENICS

The interface points between the internal cryogenics purge points and the warm piping are covered in the table below:

| Cryostat/Internal Cryogenics | | | | Warm piping TE-CRG | | |
|------------------------------|---------------------------|----------------|-------------|--------------------|-------|-------|
| POS | DESCRIPTION | INTERFACE TYPE | RESP | VALVE TAG | P bar | m g/s |
| 10.1 | Gar Combo | A | CA 6680914 | 2PV4497 | 10 | 0.1 |
| 11.1 | LAr Cooldown | A | CA 6680914 | 2PV4498 | 10 | 0.1 |
| 11.2 | LAr Distribution | A | CA 6680914 | 2PV4499 | 10 | 0.1 |
| 11.3 | Spare | A | D.MONTANARI | 2PV4501 | 10 | 0.1 |
| 11.4 | LAr Cooldown to condenser | A | CA 6680914 | 2PV4502 | 10 | 0.1 |
| 11.5 | Gar Boiloff | A | D.MONTANARI | 2PV4552 | 10 | 0.1 |
| 12.1 | Spare | A | D.MONTANARI | 2PV4504 | 10 | 0.1 |
| 12.2 | Spare | A | D.MONTANARI | 2PV4506 | 10 | 0.1 |
| 12.3 | Backup PSV/VSV | A | D.MONTANARI | 2PV4507 | 10 | 0.1 |
| 12.4 | Spare | A | D.MONTANARI | 2PV4508 | 10 | 0.1 |
| 13.1 | Instrumentation | A | D.MONTANARI | 2PV4509 | 10 | 0.1 |
| 14.1 | Spare & Instrumentation | A | D.MONTANARI | 2PV4511 | 10 | 0.1 |
| 14.2 | Spare & Instrumentation | A | D.MONTANARI | 2PV4512 | 10 | 0.1 |
| 14.3 | Main PSV/VSV | A | CA 6680914 | 2PV4513 | 10 | 0.1 |
| 15 | LAr Pump | nd | nd | nd | nd | nd |

3.3 INTERFACE DRAWINGS

Drawings of the location of penetrations in the cryostat by EP-DI, ProtoDUNE Single Phase and ProtoDUNE Dual Phase:

| CRYOSTAT PENETRATIONS | | | |
|------------------------------|----------------------------------|-----------|-----------------------------------|
| PBS | Document | File type | Title |
| NP-02-00-00 | CEN105CR0247 | .pdf | NP02 cryostat penetrations layout |
| NP-02-00-00 | SM1-DRW00000/ CEN105xxCRPSPFT | .pdf | Suspension feedthrough assembly |
| NP-02-00-00 | CEN105xxFSCPFT | .pdf | Field cage suspension |
| NP-02-00-00 | CEN105xxCRP-INS | .pdf | CRP Instrumentation |
| NP-02-00-00 | CEN105xxSGFT | .pdf | Signal FT |
| NP-02-00-00 | CEN105xxHVFT | .pdf | High voltage FT |
| NP-02-00-00 | CEN105xxTANK-INS | .pdf | Tank instrumentation |

P&ID drawings of the warm valves tag number according to penetration number by TE-CRG:

| P&ID DRAWING | | | |
|-------------------------|--------------|-----------|--------------------------------|
| PBS | Document | File type | Title |
| 2PV4453-2PV4496 | CEN105CG0148 | .pdf | NP02 P&ID SVs and penetrations |

Tender documents of the internal cryogenics for NP-02:

| INTERNAL CRYOGENICS | | | |
|----------------------------|---|-------------|----------------------------------|
| PBS | Document | File type | Title |
| NP-00-00-00 | NP 00 00 00 - CETS – 00703/ EDMS 1725394 | .docx/.pdf | PE supply of internal cryogenics |
| NP-02-00-00 | CEN105CG0134 | .pdf | NP02 Internal cryogenics layout |
| NP-02-00-00 | EDMS 1730764 | .xlsx /.pdf | NP02 Internal cryogenics ICD |
| NP-02-00-00 | EDMS | .pdf | CA 6680914 docs |

Drawings of the warm piping drawings made by TE-CRG according to cryostat penetration location:

| WARM PIPING DRAWINGS | | | |
|-----------------------------|----------|-----------|-------|
| PBS | Document | File type | Title |

4. SAFETY REGULATION

Some of the regulation applicable include:

- Pipe geometry according to ISO 1127
- PED European Directive 2014/68/EU

- Leak testing according to EN 1779

5. QUALITY ASSURANCE

Design:

- Inspection of routing according to access layout
- Evaluation of pipe volume and pressure according to pressure equipment standards
- Revision of drawings and material lists

Manufacturing:

- Leak testing of pipe welds according to EN 1779
- Pressure testing of pipes with closed valves with 10 bar pressure
- As built inspection according to construction layout and process P&ID

6. INSTALLATION ACTIVITIES AND SCHEDULE

The transformation of cryostat penetration flanges to purge ports type A shall be performed before the flanges are welded on the cryostat. The warm piping installation activities performed by TE-CRG for NP02 are going to take place when all the components are in place, the earliest January 2018.

7. PARTS AND RESPONSIBILITY LIST

The parts and responsibility list include:

| PBS | Description of product | Responsible |
|-------------|---|--------------|
| NP-02-00-00 | Cryostat penetrations purge ports type A | Cryostat |
| NP-02-00-00 | Internal cryogenics purge ports type A | Cryostat |
| NP-02-00-00 | Physics Instrumentation and spare flanges | ProtoDune DP |
| NP-02-00-00 | Cryogenics spare flanges | D. Montanari |
| NP-02-00-00 | Warm piping and valves installation | TE-CRG |