



Large Scale He Hydrodynamic CERN Facilities

2000-2001 : GReC Experiment in hall SM18

200?-200? : He Pipe Experiment in hall 180



Large Scale He Hydrodynamic CERN Facilities

PART 1

GReC Experiment in hall SM18

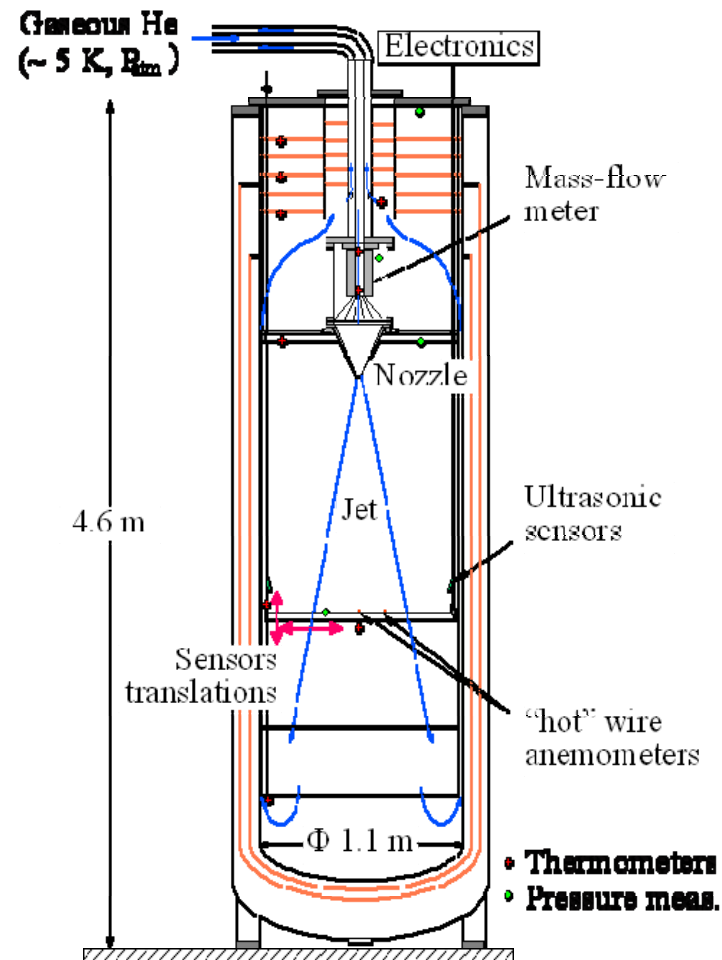
Collaboration :

CERN (GENEVA, SWITZERLAND),
CRTBT (GRENOBLE-FRANCE)
LEGI (GRENOBLE-FRANCE)
ENSL (LYON - FRANCE)



GReC Experiment

Large axisymmetric turbulent jet





GReC Experiment

Cryogenic requirements

- ◆ Gaseous He flow as cold as possible ($\sim 4.5-5$ K)
- ◆ No liquid droplet allowed at all (single phase)
- ◆ Flow rate as high as possible
- ◆ As stable as possible steady-state conditions during the measurement period (a few hours)



GReC Experiment

Cryogenic facility available and compatible :

6kW @ 4.2 K LINDE cryoplant in SM18

- ◆ 300 g/s LHe @ 4.2K , atm. pressure
⇒ $Re \sim 10^7$, $R\lambda \sim 6000$
- ◆ Availability of a distribution valve box with removable transfer lines



SM18 Hall Largest cryogenic test facility at CERN

Cryogenic
test area for
the big LHC
magnets
and RF
cavities



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SM18 Helium Cryogenic infrastructure SUMMARY

He cryogenic equipments connected to hall SM18 :

- ◆ P18 : 18 kW @ 4.5K, atm. p. AL refrigerator (~770 g/s LHe), feeding a 25 000 liter LHe dewar
- ◆ Network of LHe distribution and recuperation transfer lines
- ◆ Large pumping unit 400W @ 1.8 K (10 mbar)
- ◆ 2 x 100 000 liters LHe storage vessels



SM18 Helium Cryogenic infrastructure SUMMARY (2)

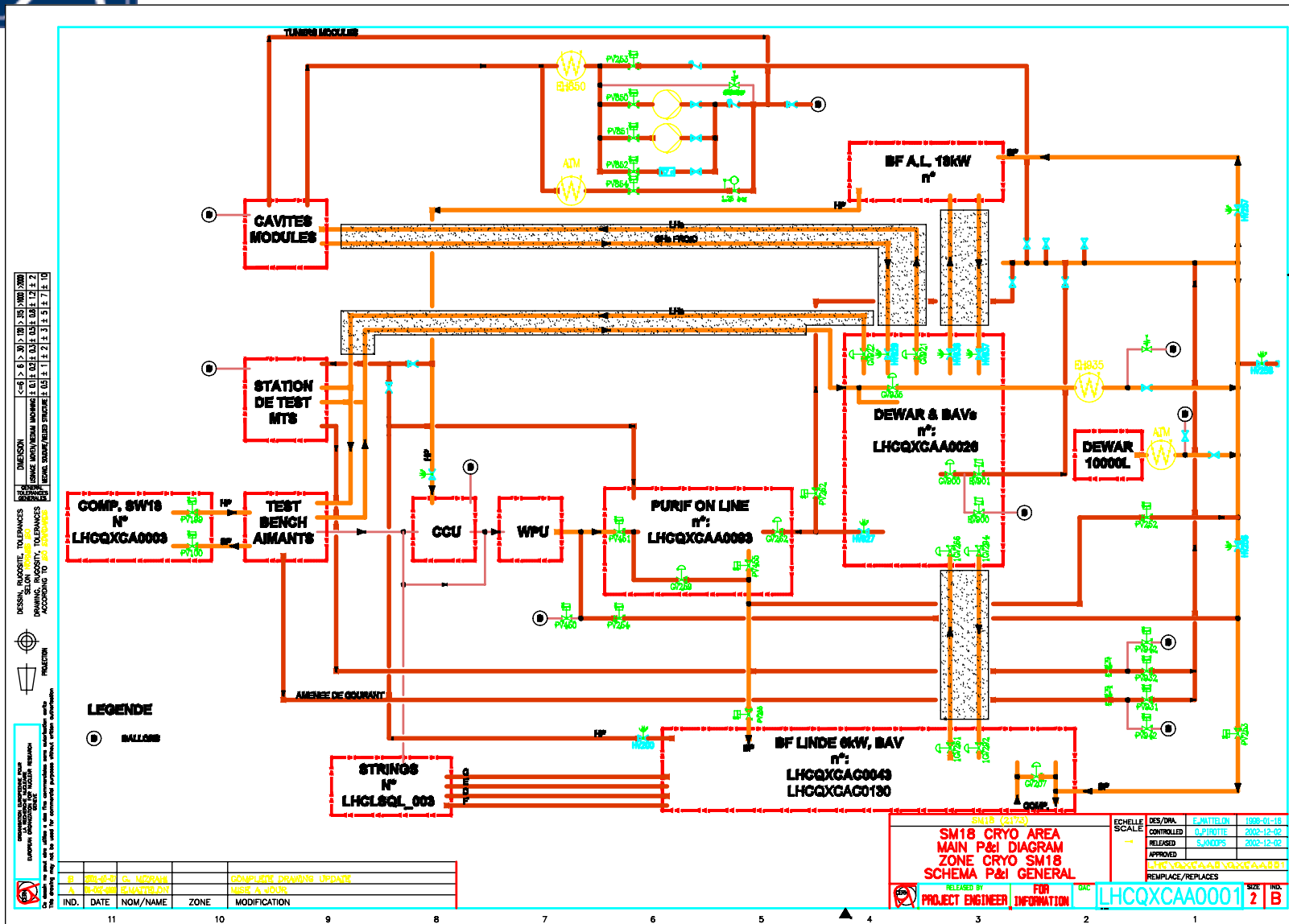
He cryogenic equipments available in hall SM18 :

6 kW @ 4.2 K LINDE cryoplant

- ◆ 300 g/s LHe @ 4.2 K , atmospheric pressure
- ◆ Additional separate LN2 precooler
- ◆ Feeds the 25 000 liter LHe buffer dewar (backup for the 18 kW during LHC magnets tests)
- ◆ Distribution Valve Box : TLs to Dewar (fixed) + string (removable)



SM18 Helium Cryogenic Infrastructure General Flow Scheme



DESIGN: IN ACCORD TO SERVICES
 DRAWING: IN ACCORD TO SERVICES
 DIMENSION: IN ACCORD TO SERVICES
 TOLERANCES: IN ACCORD TO SERVICES
 PROJECTION: IN ACCORD TO SERVICES

REVISIONS

| IND. | DATE | NOM/NAME | ZONE | MODIFICATION |
|------|------------|-------------|------|-------------------------|
| B | 2002-12-02 | G. MIZRAN | | COMPLETE DRAWING UPDATE |
| A | 2002-12-02 | S. WATTELIN | | TEST A 0010 |

| IND. | DATE | NOM/NAME | ZONE | MODIFICATION |
|------|------------|-------------|------|-------------------------|
| B | 2002-12-02 | G. MIZRAN | | COMPLETE DRAWING UPDATE |
| A | 2002-12-02 | S. WATTELIN | | TEST A 0010 |

SM18 (21723)
**SM18 CRYO AREA
 MAIN P&I DIAGRAM
 ZONE CRYO SM18
 SCHEMA P&I GENERAL**

| | | |
|------------------|--------------|------------|
| DES/DWA | E. WATTELIN | 1998-01-16 |
| CONTROLLED | D. PIOTTE | 2002-12-02 |
| RELEASED | S. WATTELIN | 2002-12-02 |
| APPROVED | | |
| REPLACE/REPLACES | LHCQXGAA0001 | |

RELEASED BY: PROJECT ENGINEER
 FOR INFORMATION: LHCQXCA0001



SM18 SC Magnets Test Benches



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SM18 Magnets + Cavities Test Stations



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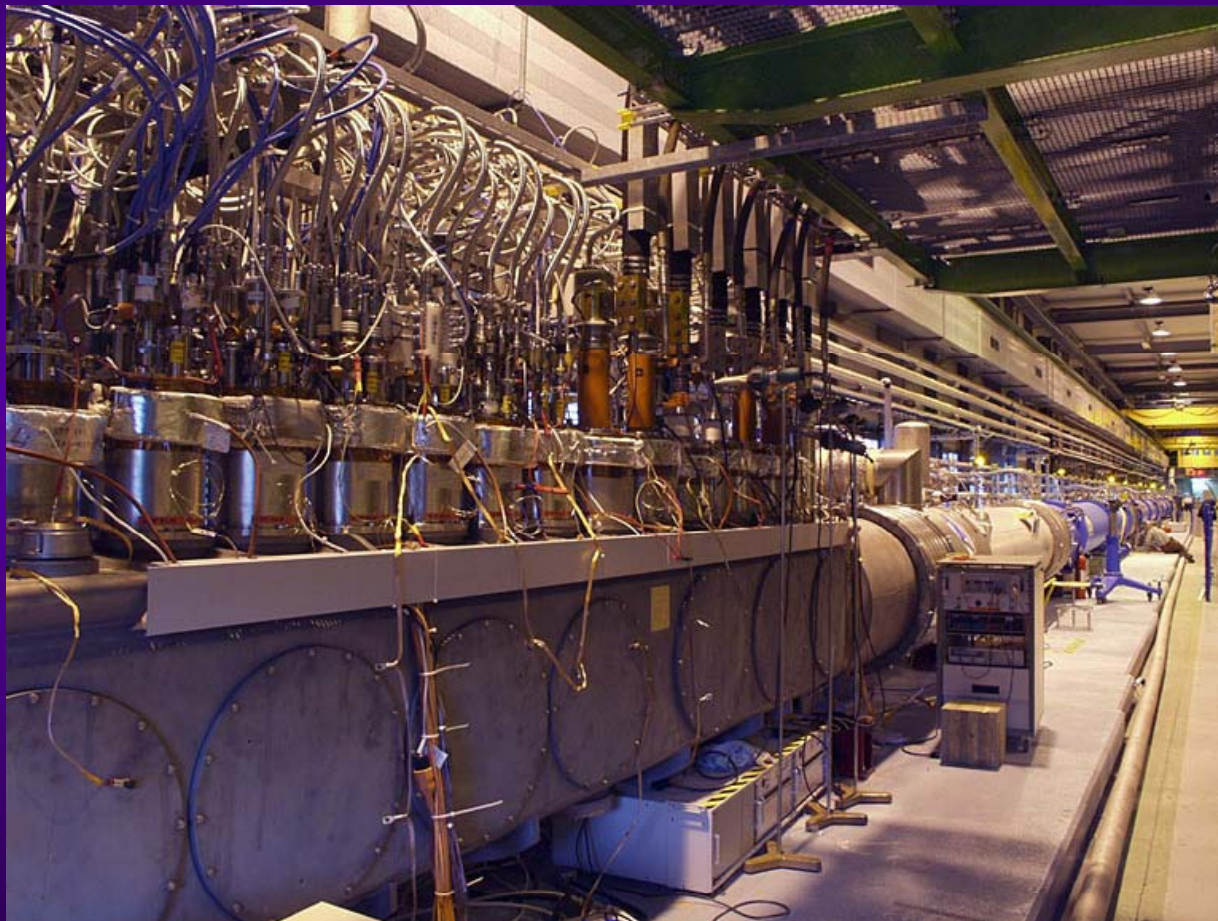


SM18 Magnets Test Benches



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6kW LINDE Cryoplant: recuperated from LEP and re-installed in SM18 for the LHC magnet string (Proto of a full cell of the LHC magnets lattice)



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6kW LINDE Cryoplant: recuperated from LEP and re-installed in SM18 for the LHC magnet string



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GReC Experiment

Solutions for the cryogenic requirements

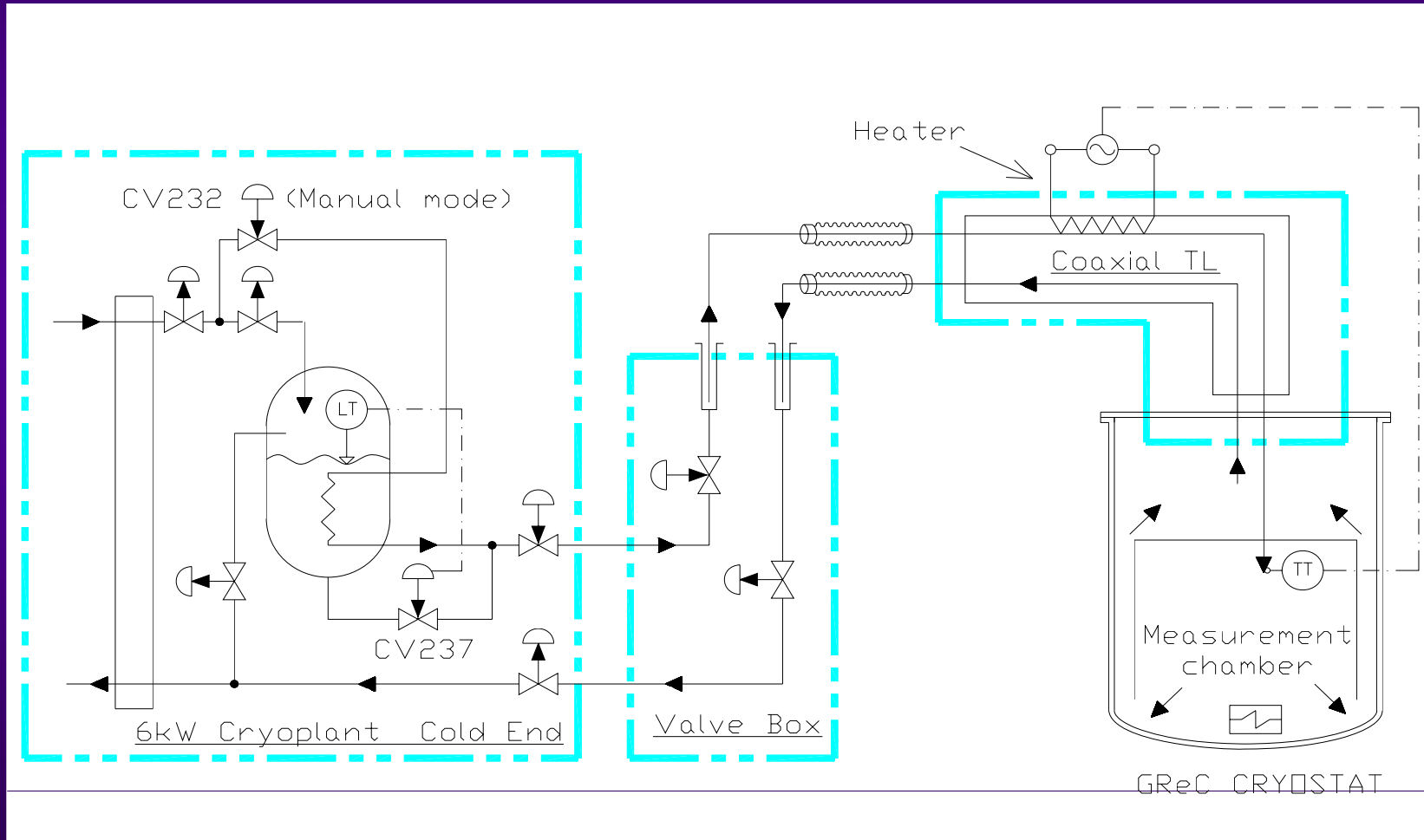


Recycling of a cryostat used for the tests of LEP cavities

Development of a special removable interconnecting transfert line



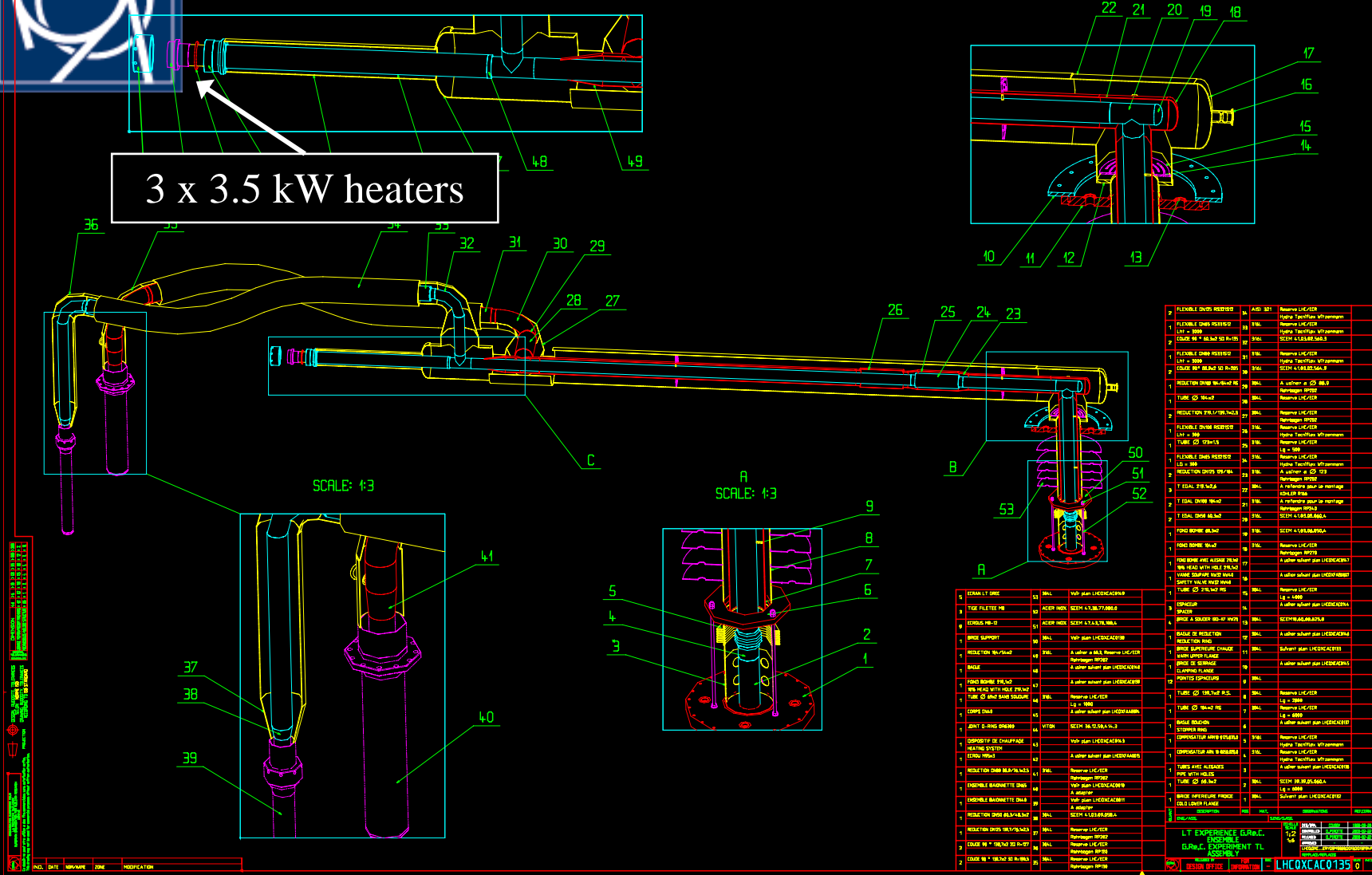
GReC Experiment Simplified Test Set-up Flow Scheme





GReC Experiment : special coaxial interconnecting transfer line

3 x 3.5 kW heaters



| REF | DESCRIPTION | QTY | UNIT | REF | DESCRIPTION | QTY | UNIT |
|-----|------------------------------|-----|-------|-----|--------------------------|-----|-------|
| 1 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 14 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 2 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 15 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 3 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 16 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 4 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 17 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 5 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 18 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 6 | REDUCTION DRIVE RESISTOR | 1 | SMALL | 19 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 7 | TUBE Ø 1/2INCH | 1 | SMALL | 20 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 8 | REDUCTION DRIVE RESISTOR | 1 | SMALL | 21 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 9 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 22 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 10 | TUBE Ø 1/2INCH | 1 | SMALL | 23 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 11 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 24 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 12 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 25 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 13 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 26 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 14 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 27 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 15 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 28 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 16 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 29 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 17 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 30 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 18 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 31 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 19 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 32 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 20 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 33 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 21 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 34 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 22 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 35 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 23 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 36 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 24 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 37 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 25 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 38 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 26 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 39 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 27 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 40 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 28 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 41 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 29 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 42 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 30 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 43 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 31 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 44 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 32 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 45 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 33 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 46 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 34 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 47 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 35 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 48 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 36 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 49 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 37 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 50 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 38 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 51 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 39 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | 52 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 40 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | 53 | REDUCTION DRIVE RESISTOR | 1 | SMALL |
| 41 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | | | | |
| 42 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | | | | |
| 43 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | | | | |
| 44 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | | | | |
| 45 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | | | | |
| 46 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | | | | |
| 47 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | | | | |
| 48 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | | | | |
| 49 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | | | | |
| 50 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | | | | |
| 51 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | | | | |
| 52 | COULDE 90° 1/2INCH 30 IN-107 | 1 | SMALL | | | | |
| 53 | FLEXIBLE DRIVE RESISTOR | 1 | SMALL | | | | |



GReC Experiment

Head of the
special coaxial
interconnecting
transfer line



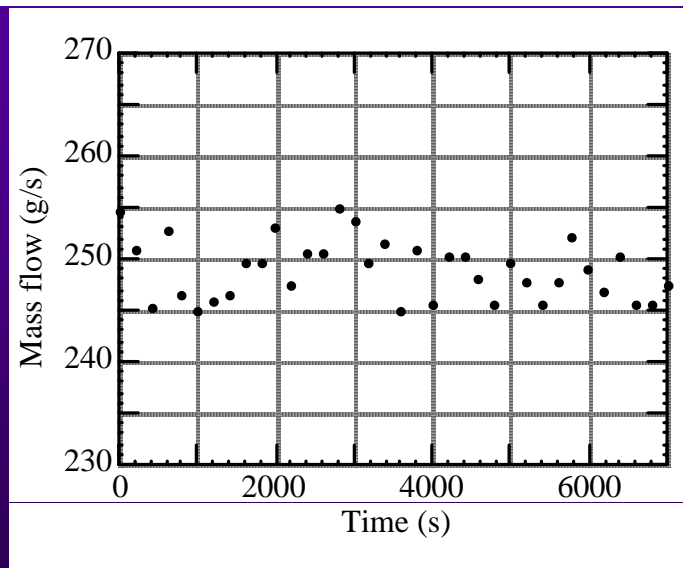


GReC Experiment Results & Stability

| Mass flow (g/s) | U_{nozzle} (m/s) | U_{average} (m/s) | u' (m/s) | Re_{nozzle} (10^7) | R_λ |
|--------------------|------------------------------|-------------------------------|---------------|------------------------------------|-------------|
| 20 | 2.5 | 0.3 | 0.08 | 0.077 | 1750 |
| 80 | 9.8 | 1.2 | 0.42 | 0.31 | 3500 |
| 260 | 32.3 | 3.9 | 1.5 | 1.01 | 6100 |

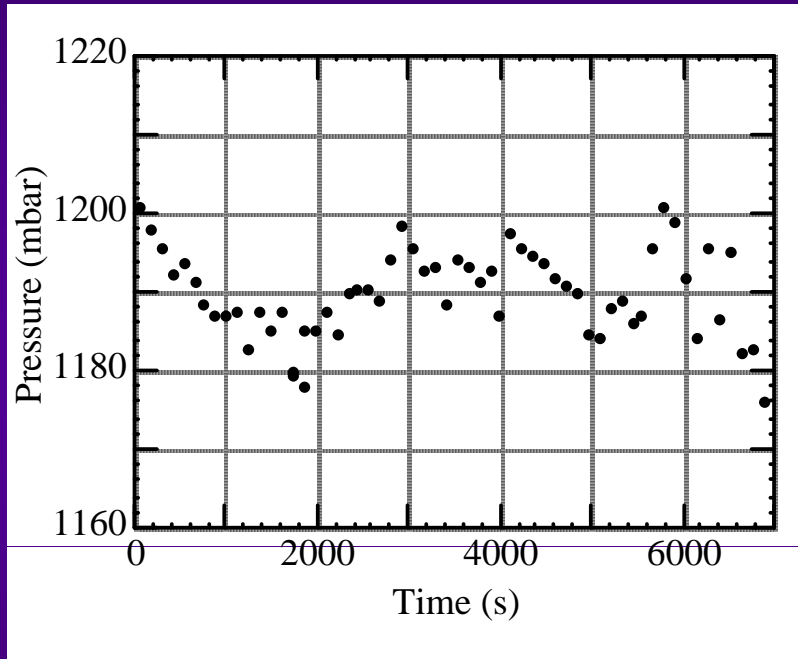
Mass flow
stability < 2%

250 ± 5 g/s



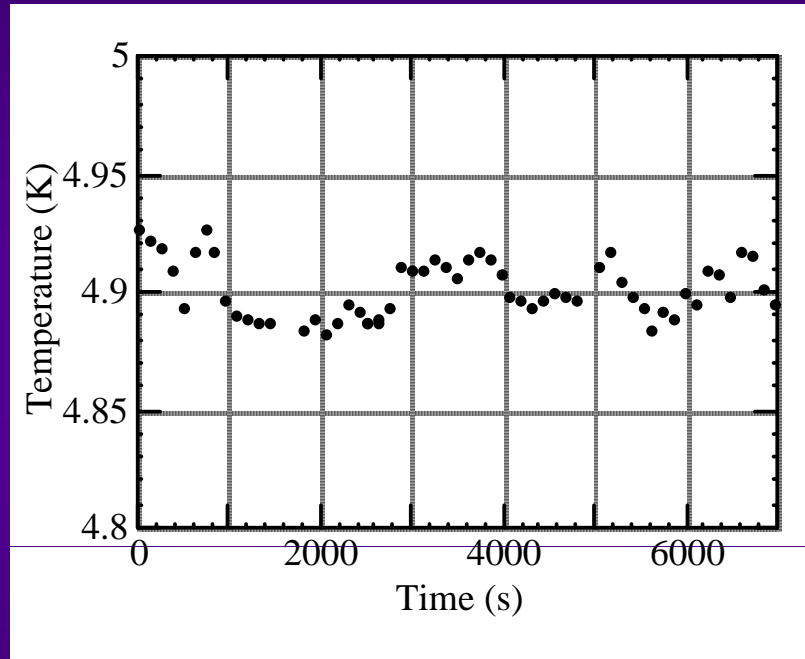


GReC Experiment Results & Stability



Pressure stability

1190 ± 12 mbar



Temperature stability

4.90 ± 0.03 K



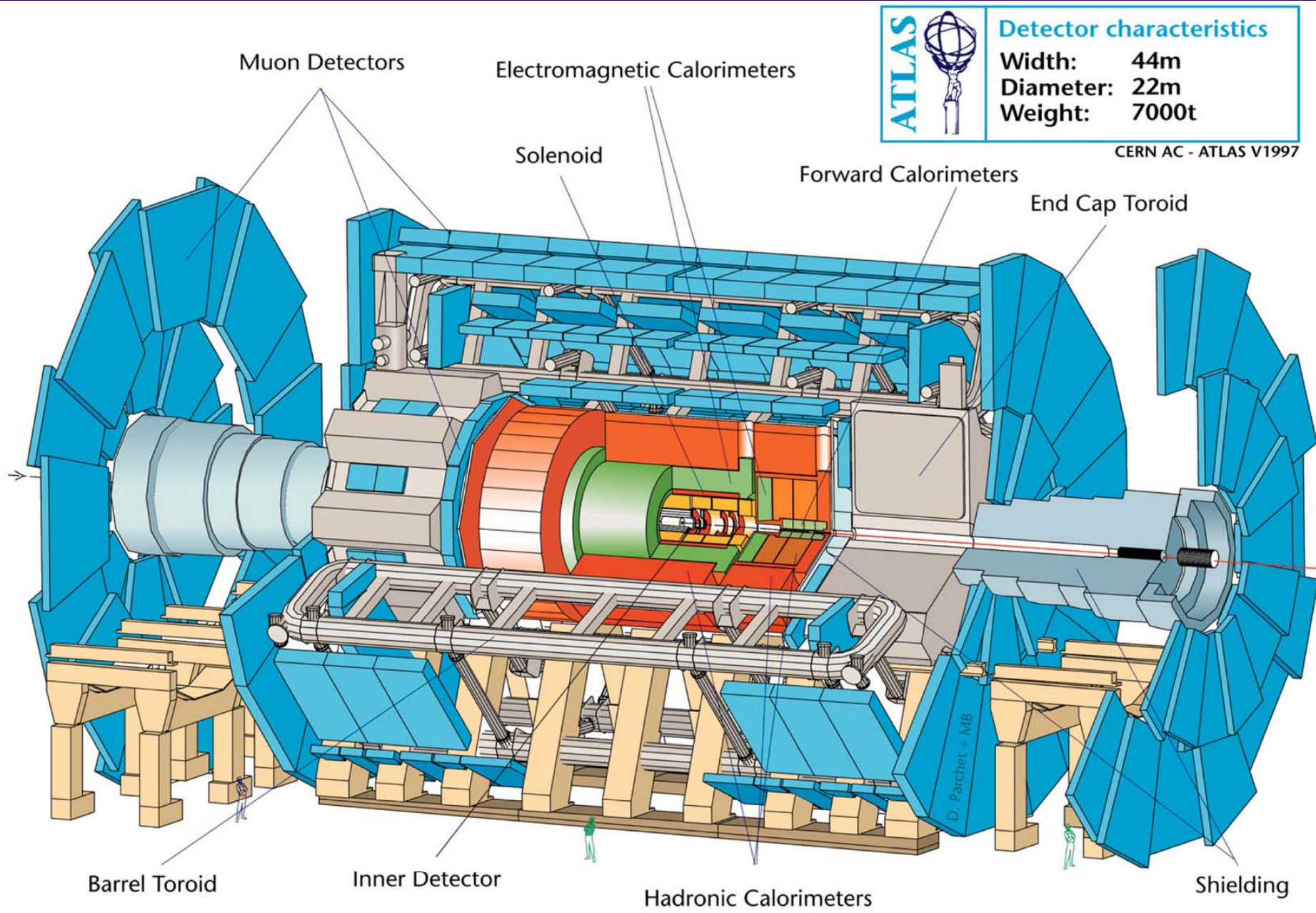
Large Scale He Hydrodynamic CERN Facilities

PART 2

He Pipe Experiment in hall 180

Collaboration :

CERN (GENEVA, SWITZERLAND),
NEEL (GRENOBLE-FRANCE)
LEGI (GRENOBLE-FRANCE)
ENSL (LYON - FRANCE)





Halls 180+191 : ATLAS assembly and cryogenic test area for huge parts of the detector : SC magnets + LAr calorimeters



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Helium Cryogenic infrastructure based on a 1.2 kW @ 4.5K Linde cryoplant

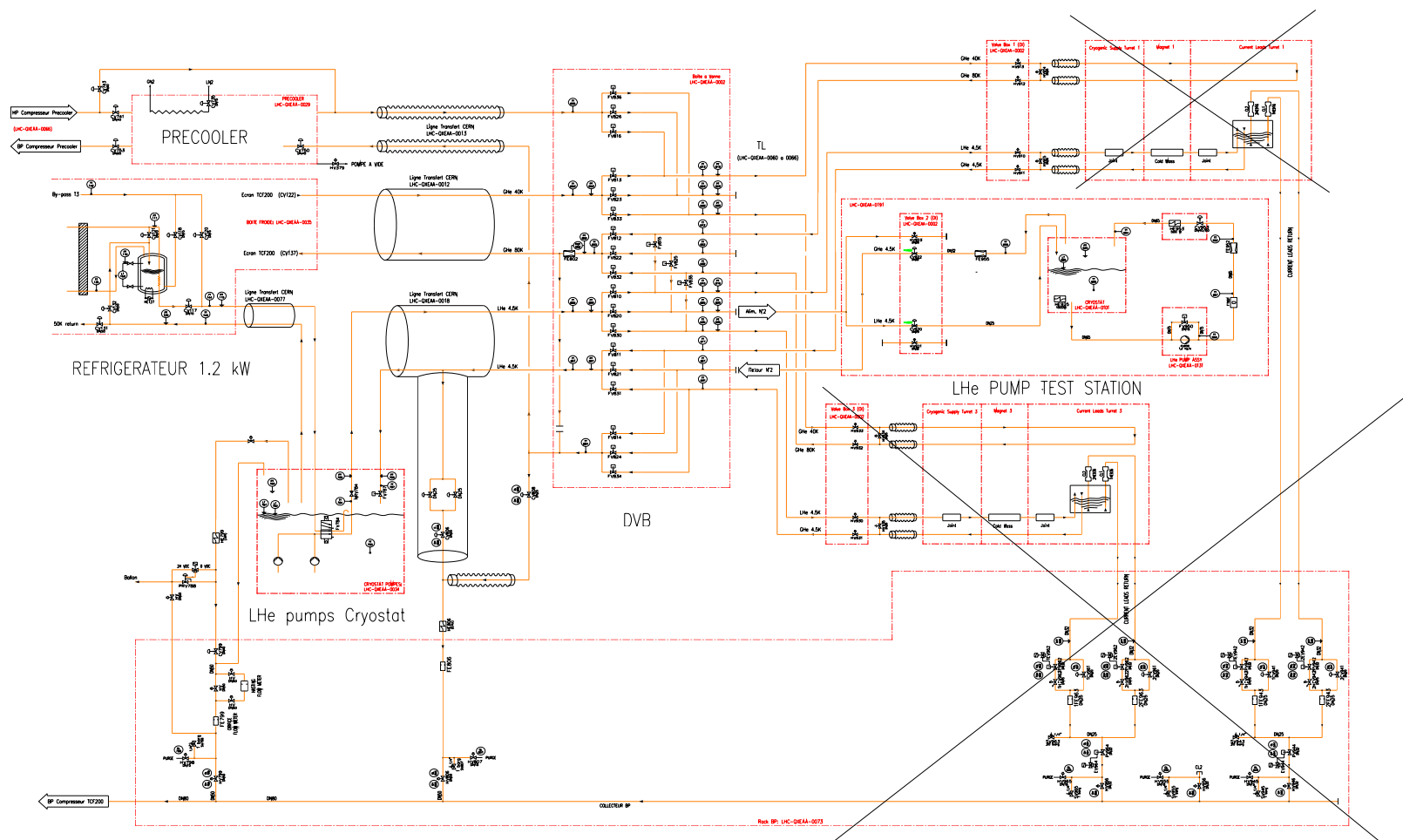
He cryogenic equipments available in hall 180 :

1.2 kW @ 4.5 K TCF200 LINDE cryoplant

- ◆ 60 g/s LHe @ 4.5K , atmospheric pressure
- ◆ Refrigerator can be boosted with LN2
- ◆ Additional separate LN2 precooler
- ◆ Availability of 2 x 100 g/s LHe immersed centrifugal pumps
- ◆ DVB with 3 shielded distribution lines
- ◆ Modular TF with an up to 1.5 kg/s LHe centrifugal pump
⇒ *Insertion of the He pipe experiment (module)*



Helium Cryogenic infrastructure based on a 1.2 kW @ 4.5K Linde cryoplant





He Pipe Experiment

Profit of

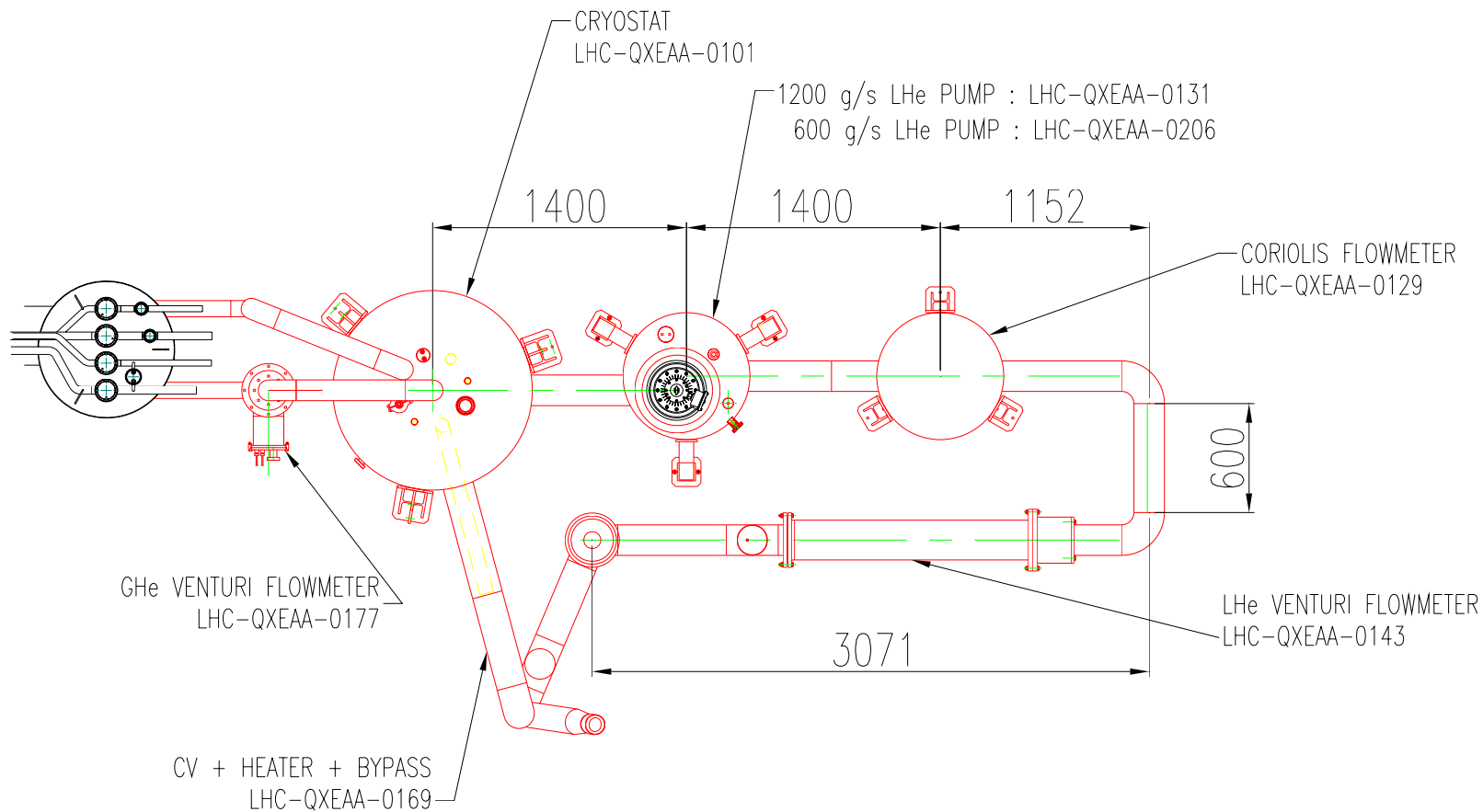
- ◆ the availability of the largest LHe forced flow at 4.5K : centrifugal pump of 1.5 kg/s, $\Delta P=400$ mbar
- ◆ the modularity of the installation

⇒ *He Pipe Experiment to study confined and wall-bounded turbulence for*

$$Re \geq 10^7$$

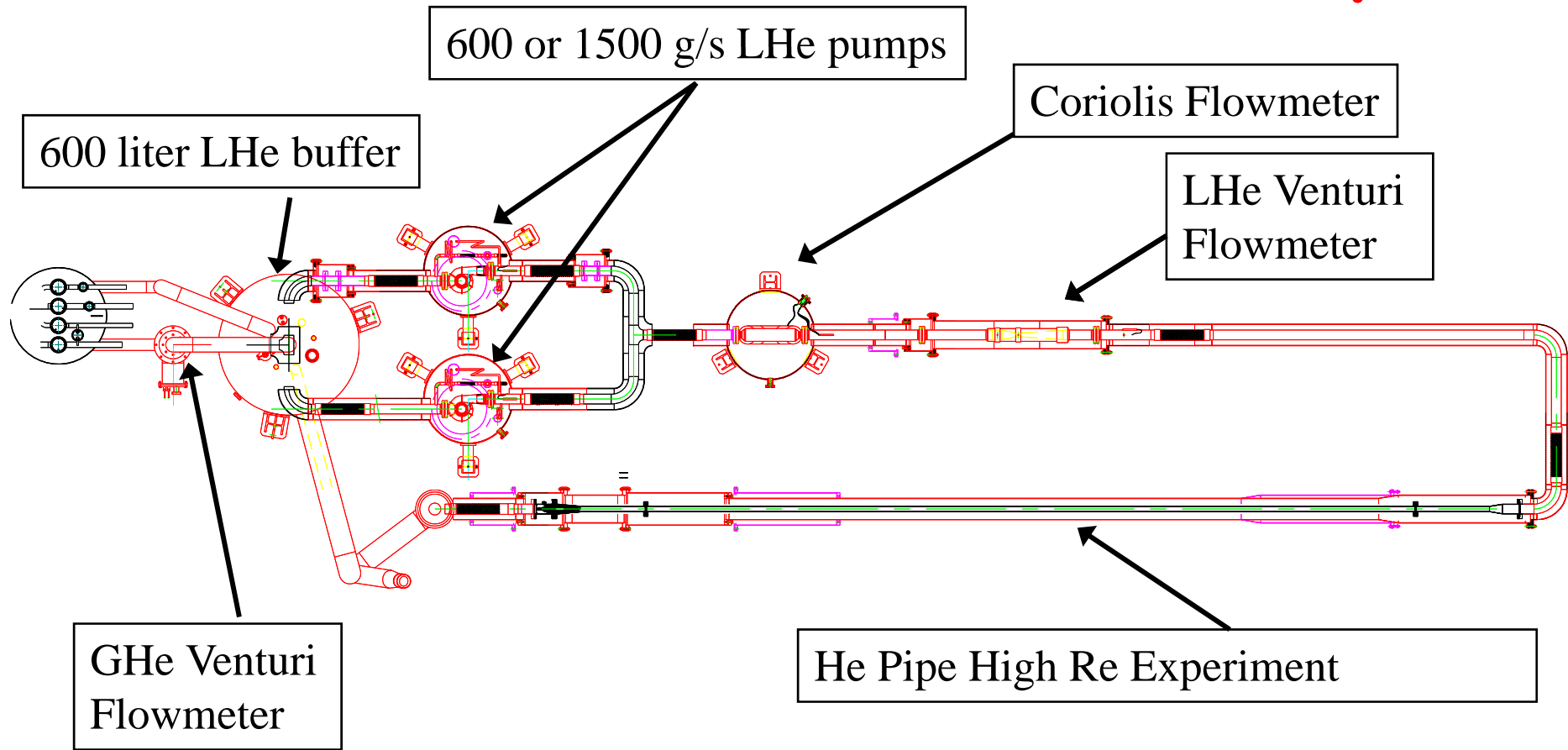


ACTUAL 1.2 kg/s LHe Pump TEST SET-UP



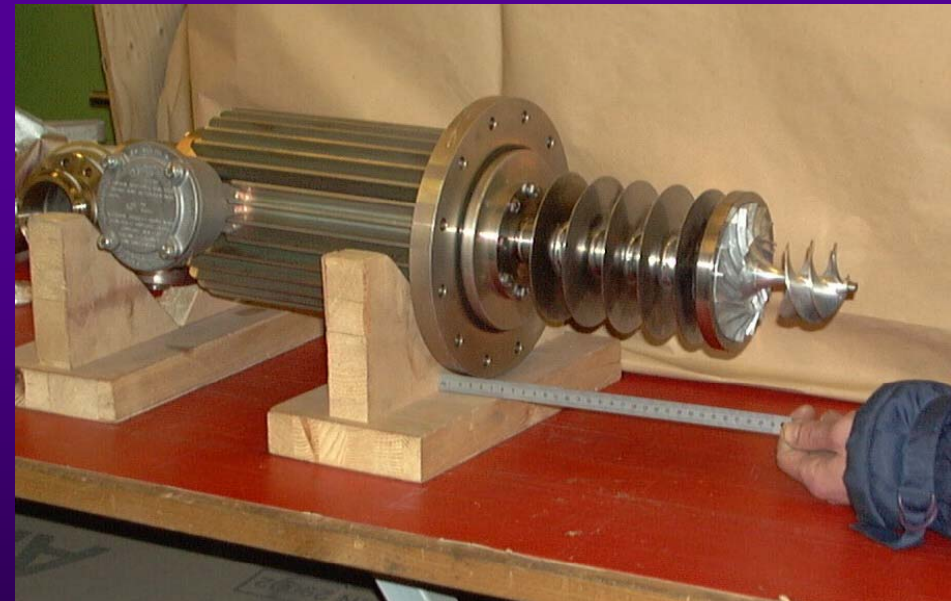


PROJECT OF MODIFIED TEST SET-UP FOR He Pipe





1.2 kg/s LHe Pump Test Facility



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ATLAS Hall180 : BT Cryo Test Facility



Precooler, DVB + TLs

TCF200 + Pump Cryostat



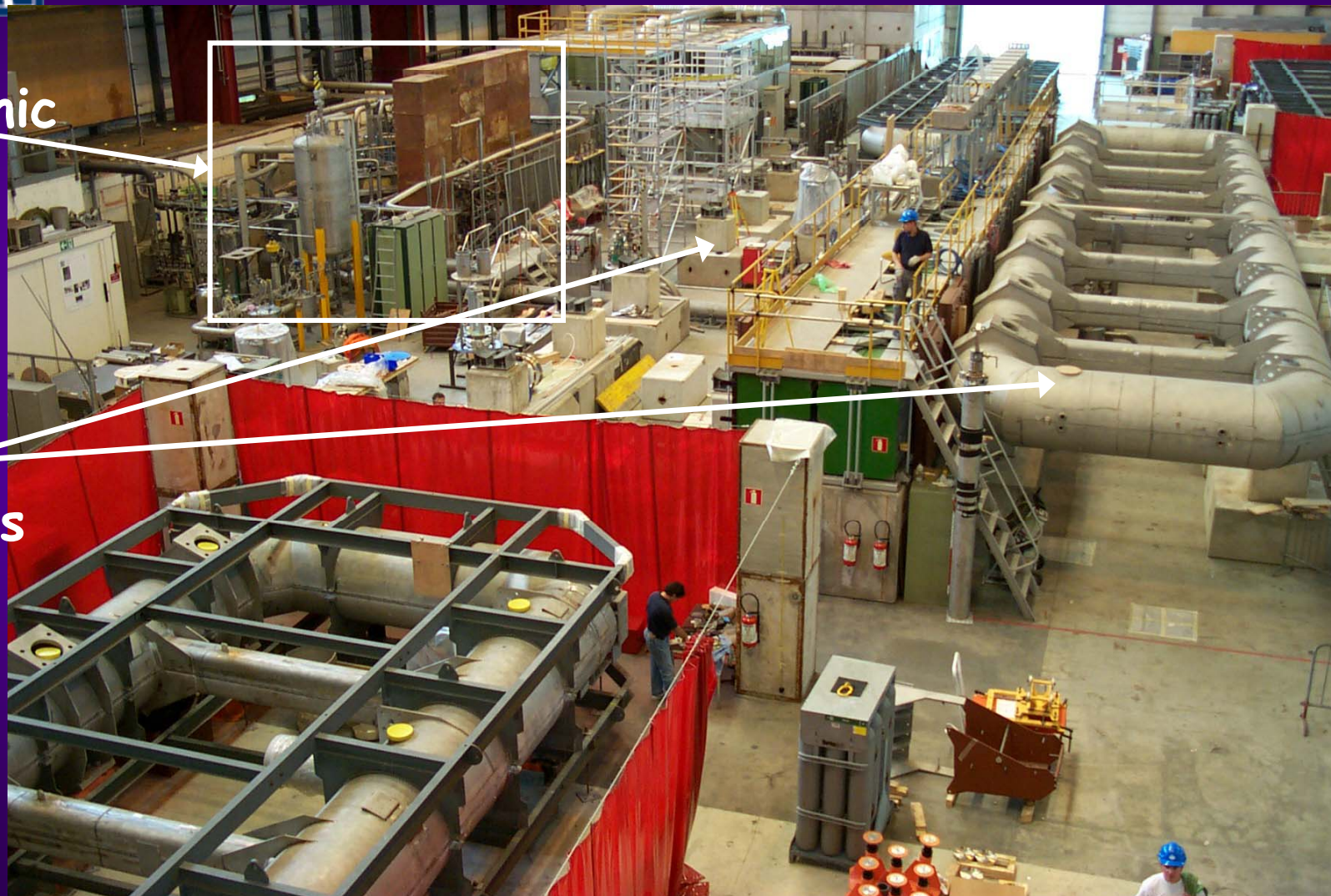
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2 BT magnet test benches + 1.2 kg/s LHe pump Test Facility

Cryogenic
Area

BT
Test
Benches



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Large Scale He Hydrodynamic CERN Facilities : conclusion

Two High Re Experiments
Large cryogenic facilities
Hall 180 SM18



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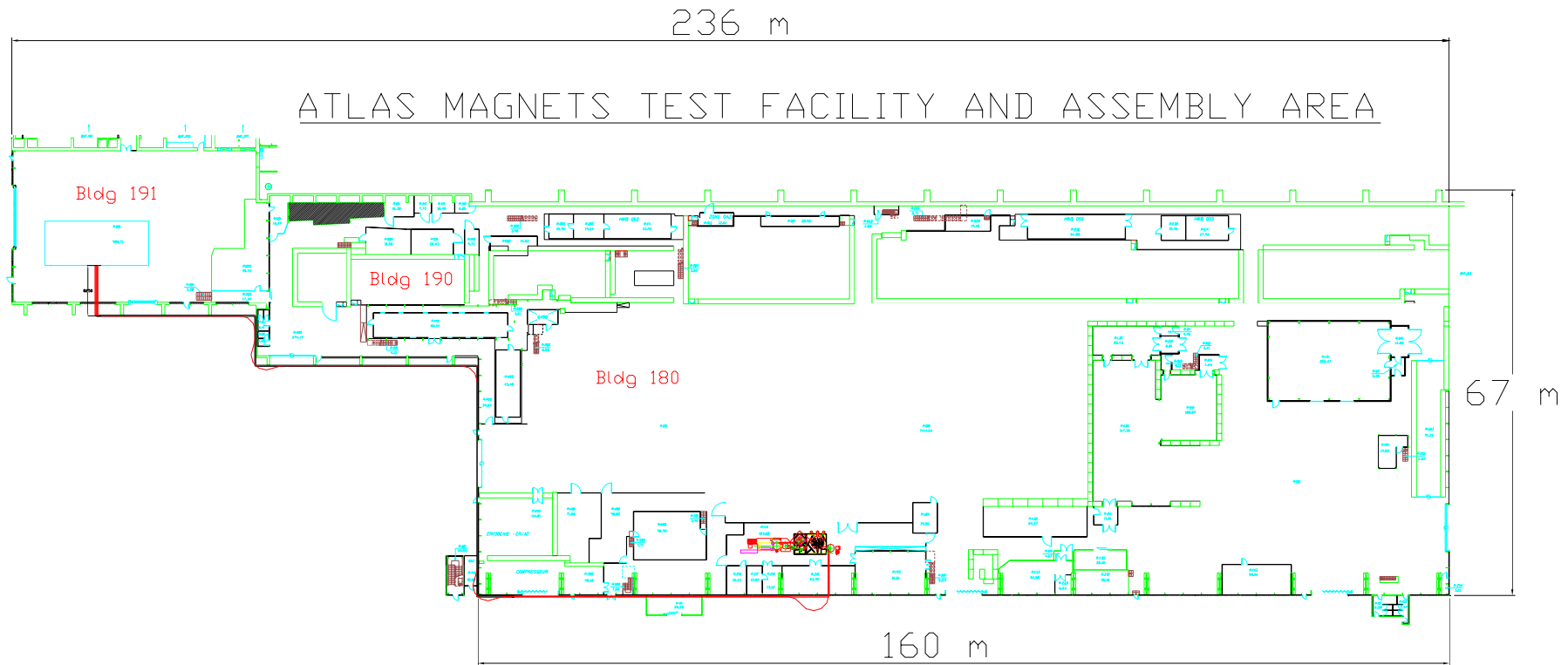
Large Scale He Hydrodynamic CERN Facilities : conclusion



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HALL 180



ATLAS Hall180 : BT Cryo Test Facility



BT Integration2 Wed Mar 28 16:16:20 2007

Precooler, OI VB + TLs

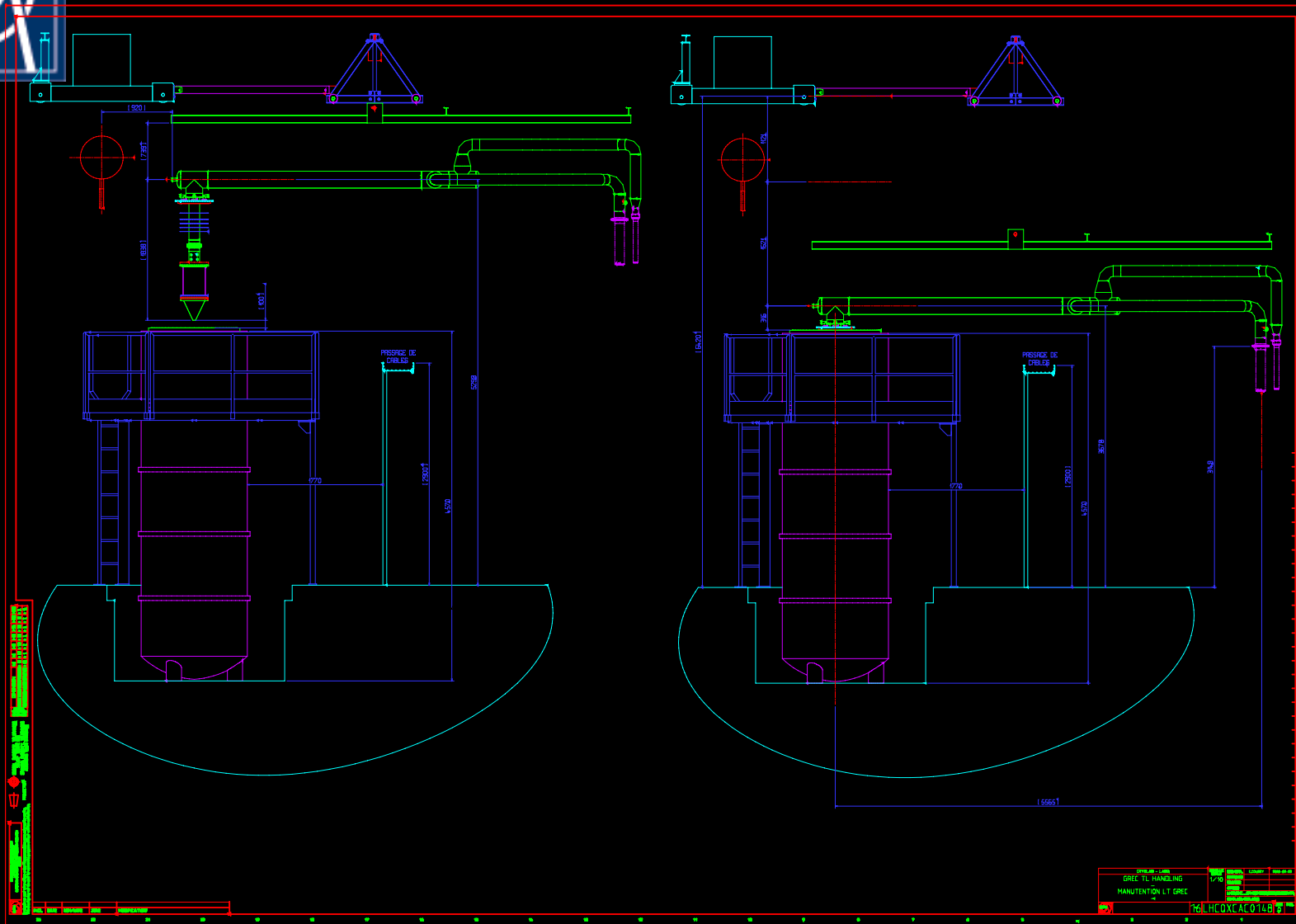
TCF200 + Pump Cryostat



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GReC Experiment : handling tool for the transfer line



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