# MERIT Collaboration Meeting
# Cryogenics

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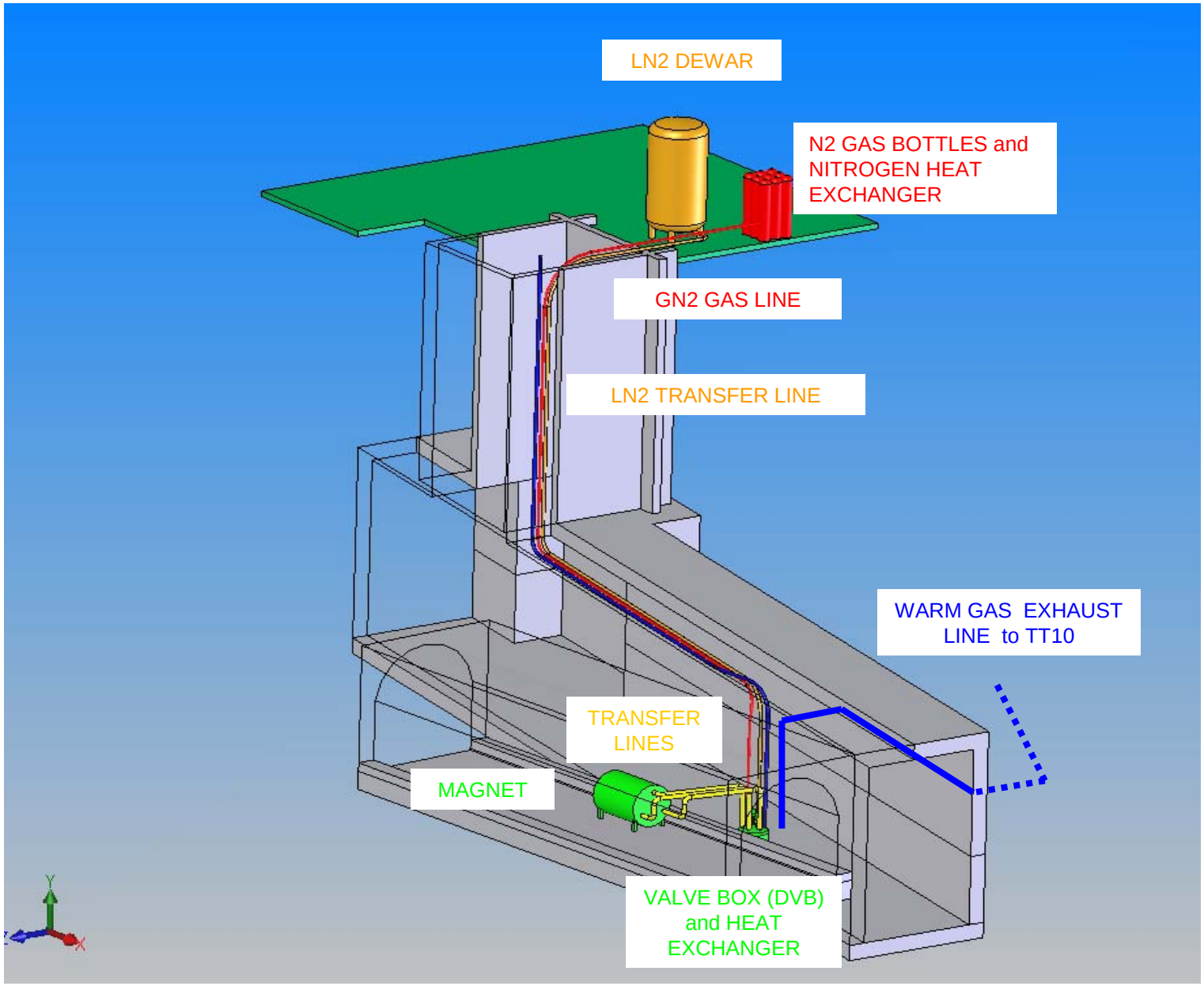
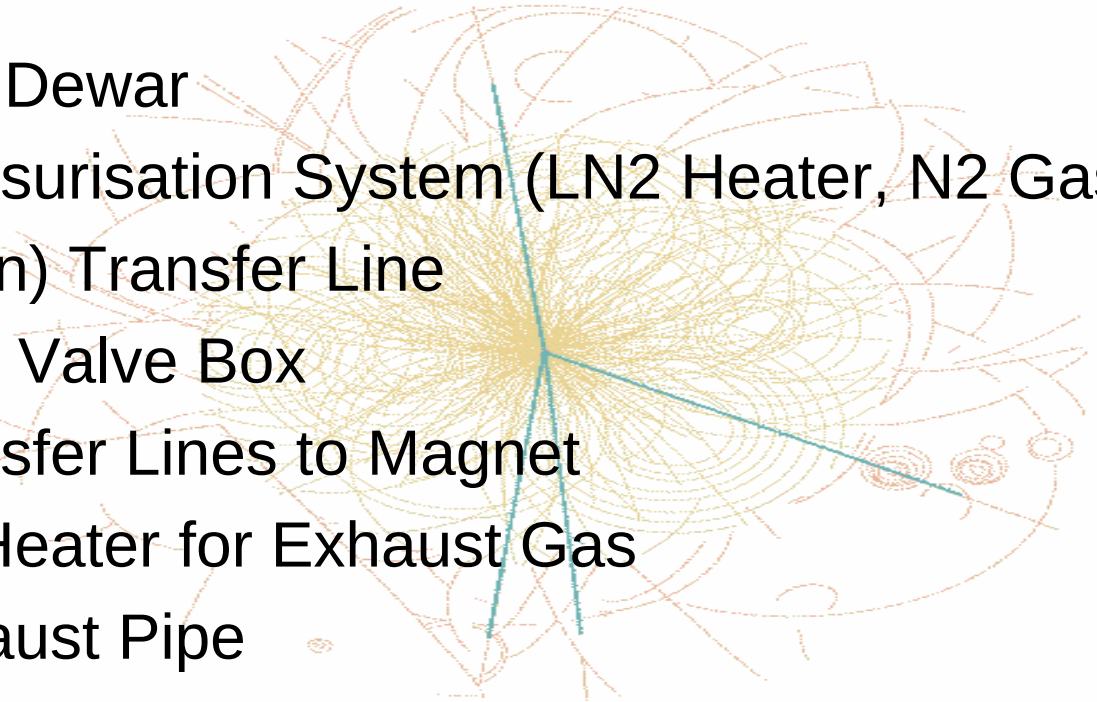
# Overview of Presentation

1. Lay-out at n-TOF area
2. Equipment
3. Flow Scheme, Functionality
4. Safety; Radiation Hard Instrumentation ?
5. DVB Valve Box; new location proposal at TT2a
6. Routing GN2 Exhaust Line (proposal)
7. Safety; LN2 or GN2 related potential ODH
8. Situation on Project

# 1. Lay-Out at n-TOF Area (Principle)



# 2. Equipment



- LN2 Dewar
- Pressurisation System (LN2 Heater, N2 Gas Bottles)
- (Main) Transfer Line
- DVB Valve Box
- Transfer Lines to Magnet
- N2 Heater for Exhaust Gas
- Exhaust Pipe
- Instrumentation
- Process Control System
- Safety Equipment

# LN2 Dewar for MERIT and proposed location of surface test of Cryogenic Equipment at Hall 180

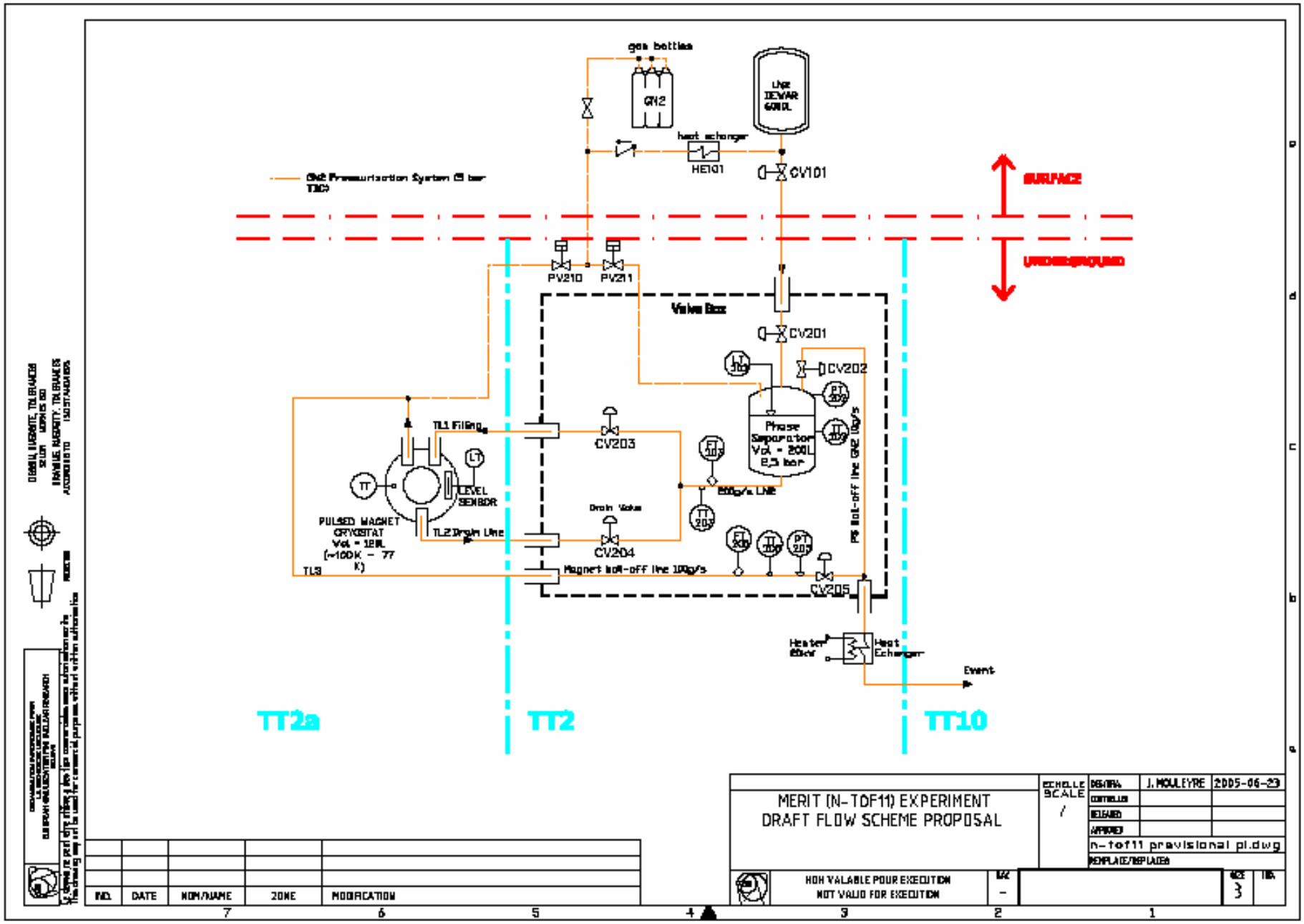
6000 litre dewar currently used at ATLAS hall 180 test facility.

Principly similar type could be used for MERIT. Check on renting/availability !

Adaptations required in any case.

Test area at hall 180 would be ideal as infrastructure available including control room. Floor space to be negotiated with ATLAS technical coordination.

# 3. FLOW SCHEME (P&I), FUNCTIONALITY



# Functionality (simplified)

1. Magnet at 77 K, submerged in LN2
2. Empty Magnet by Pressurisation, Liquid to Phase Separator in DVB (quantity 100 l)
3. Firing of Magnet
4. Re-cooling (stored LN2 quantity in phase seperator and LN2 surplus supplied  from surface dewar)
5. Fill cryostat
6. Restart at 1.)

# 4. Safety; Radiation Hard Instrumentation ?

- Why may we need it ?
- What to do ?
- Lessons from LHC machine and detector cryogenics
- Other solutions ?

# Cryogenic Instrumentation exposed to Radiation at LHC

Radiation Effects on Cryogenic Components

Radiation background during LHC operation has been identified to be of risk to instrumentation components required to measure and control the process parameters.

Effects of radiation: Aging of material, modification of properties, perturbation of electronics,

**RISKS for the instrumenation components… entail risks for the cryogenic process and consequently for equipment and, potentially for personnel**

Cryogenic Equipment potentially sensitive to radiation identified are *control valves, pressure transducers, level transducers, temperature sensors, vacuum gauges, pumps, etc.* i.e. basically ALL of the industriel type of instrumentation commonly used for cryogenic processes.

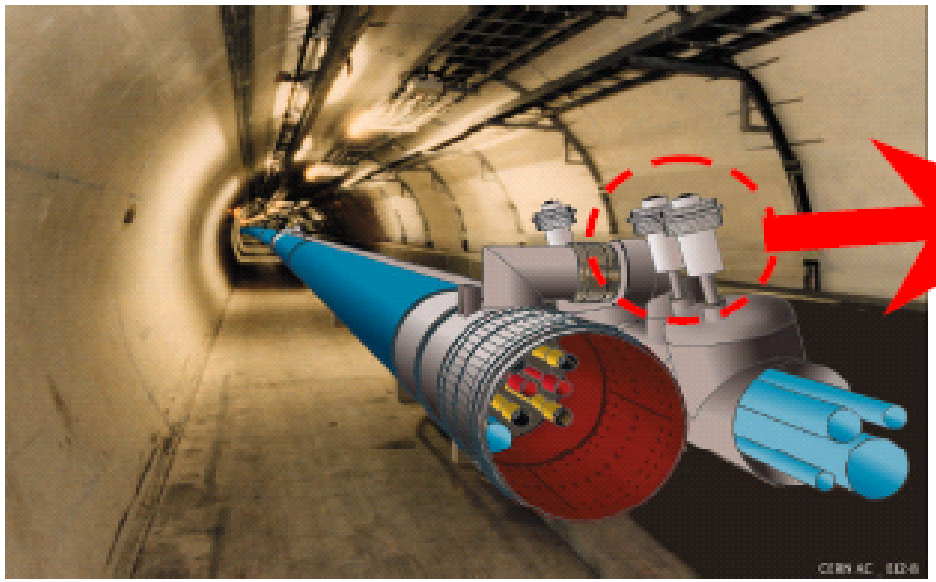
Radiation:

- Particles producing TID (Total Ionising Dose) (photons) Unit: Gray/time
- Particles producing SEE (Single Event Effect) ex. high energy neutrons Unit: hadron/cm2
  ***Single Event : a single high energetic particle can deposit energy at a critical node on a chip. Single events are proportional to particle flux***

# Cryogenic Instrumentation exposed to Radiation
(example control valves with positioners)

## Placement of positioners in LHC

Typical cryogenic control valve for LHC.
Control of cryogenic flow in local cooling loops.



# Instrumentation exposed to Radiation at LHC

APPROACH:

-Radiation Working Group(s) established at CERN

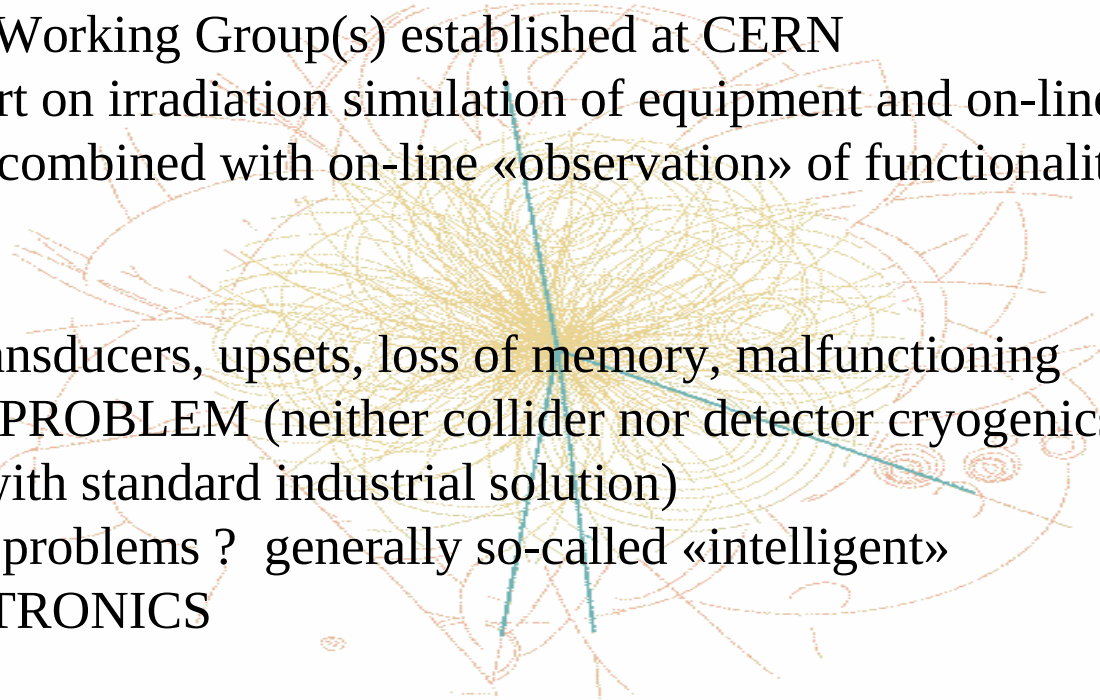
-Large effort on irradiation simulation of equipment and on-line data taking combined with on-line «observation» of functionality

RESULTS:

Drifts of transducers, upsets, loss of memory, malfunctioning

= BIG PROBLEM (neither collider nor detector cryogenics could work with standard industrial solution)

what poses problems ? generally so-called «intelligent» ELECTRONICS



SOLUTIONS:

-Split, i.e. take sensitive electronics out and place at distance

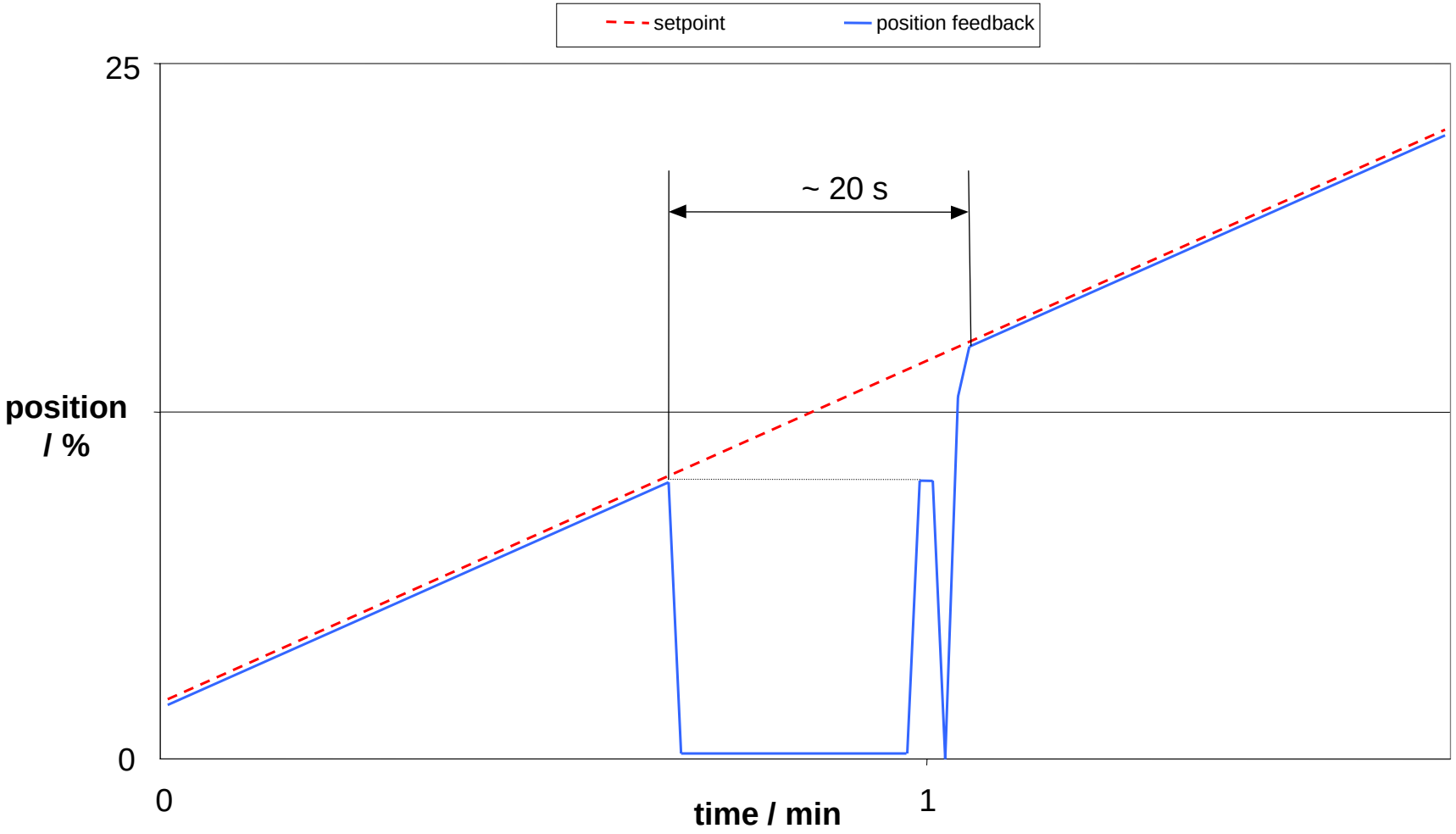
-Converters of transducers at distance

-For pressure transducers use «old fashioned type» with strain gauges

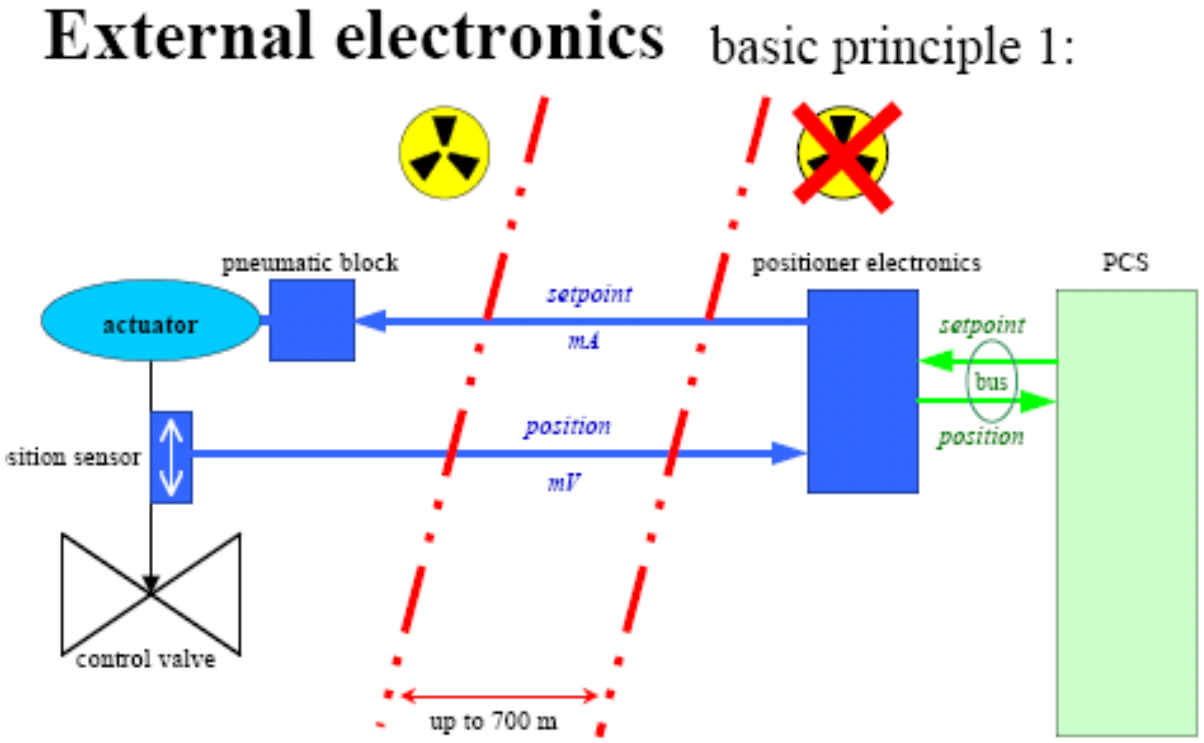
# Failure Examples; Dropouts

(graph courtesy W. Hees, AT-ACR)

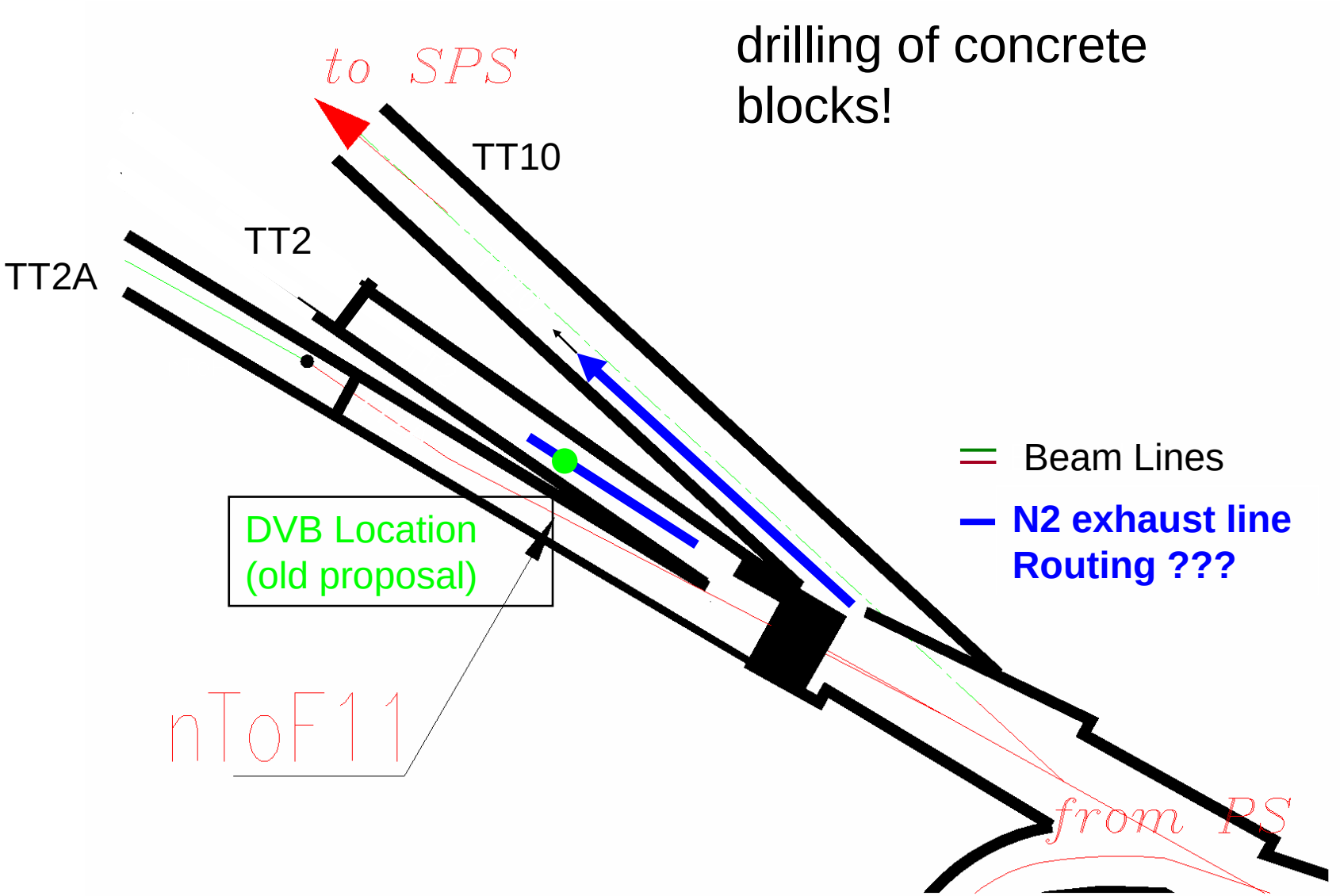
Typical dropout of positioner while electronics are being irradiated



# Split Solution of Instrumentation exposed to Radiation (example valve positioner) = **O.K.**



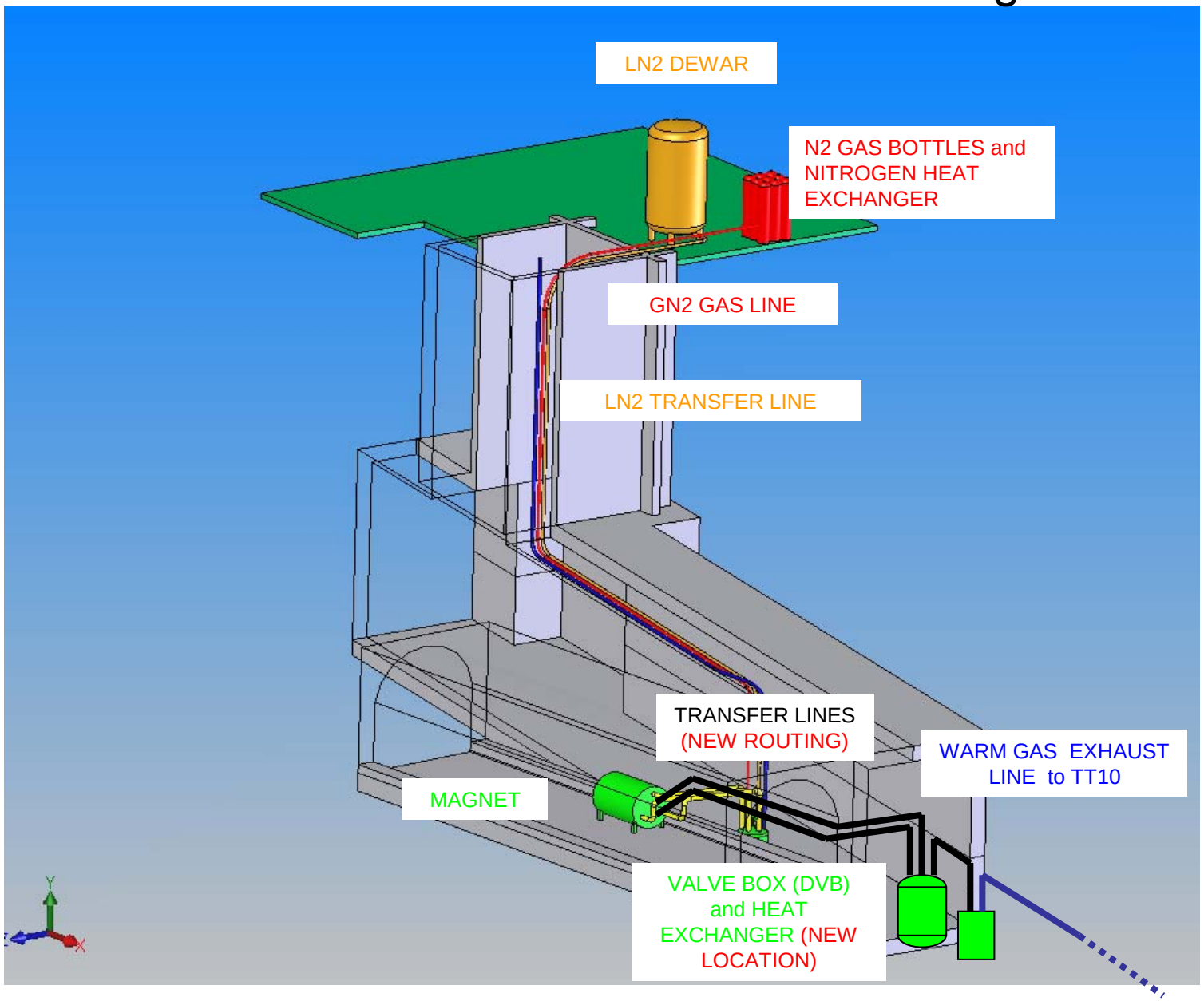
# DVB Location and GN2 Exhaust Line Routing (Old Proposal)



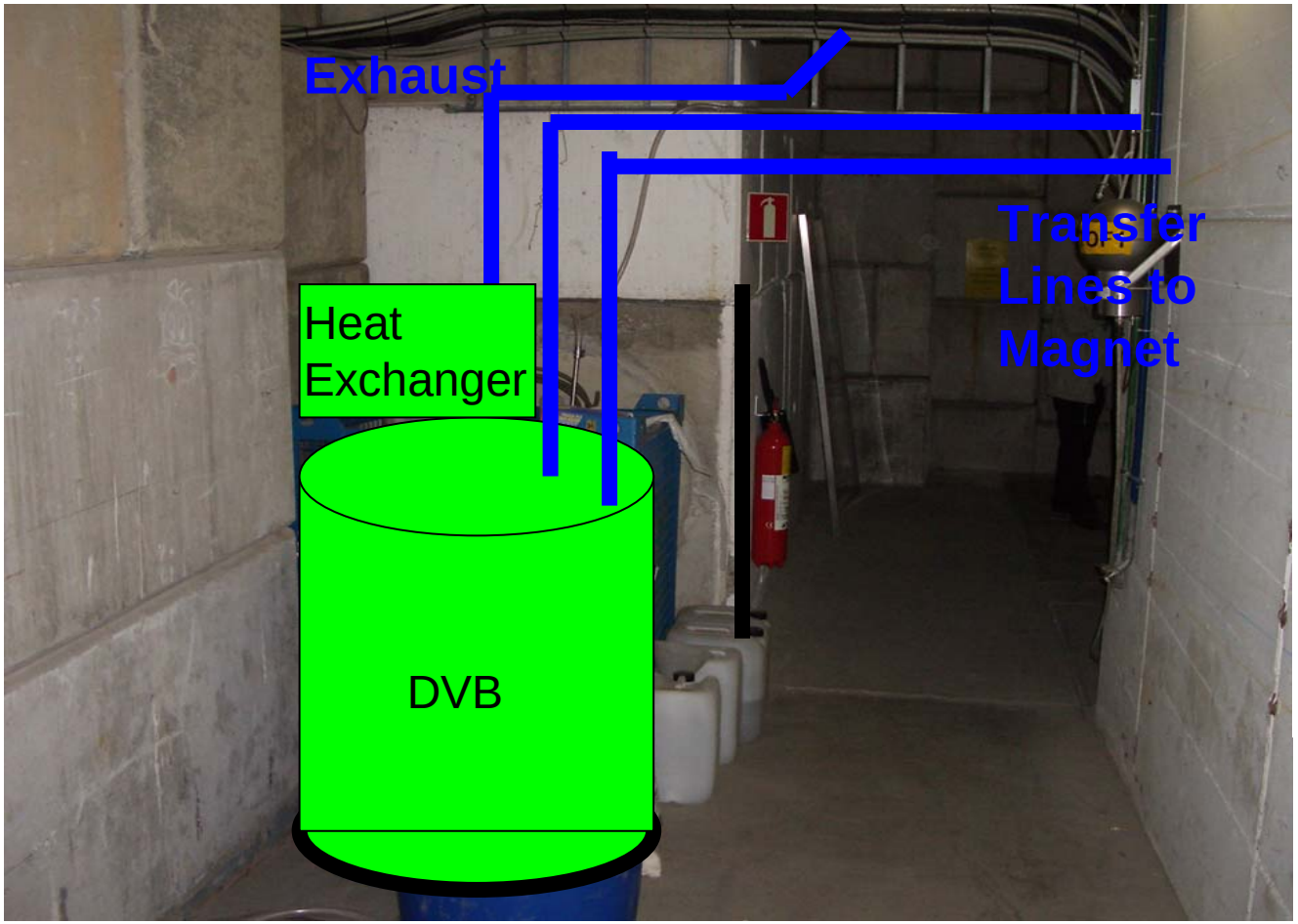
# View down “n-TOF” at TT2A


Ceyling is “vault” type, i.e. round. Drilling of  hole for transfer lines passages between DVB valve box and Magnet may become difficult.

# 5. Proposed New Location of Valve Box (DVB) and Routing of Transfer Lines between DVB and Magnet



# Proposed Location of DVB and Heat Exchanger




View “down” TT2

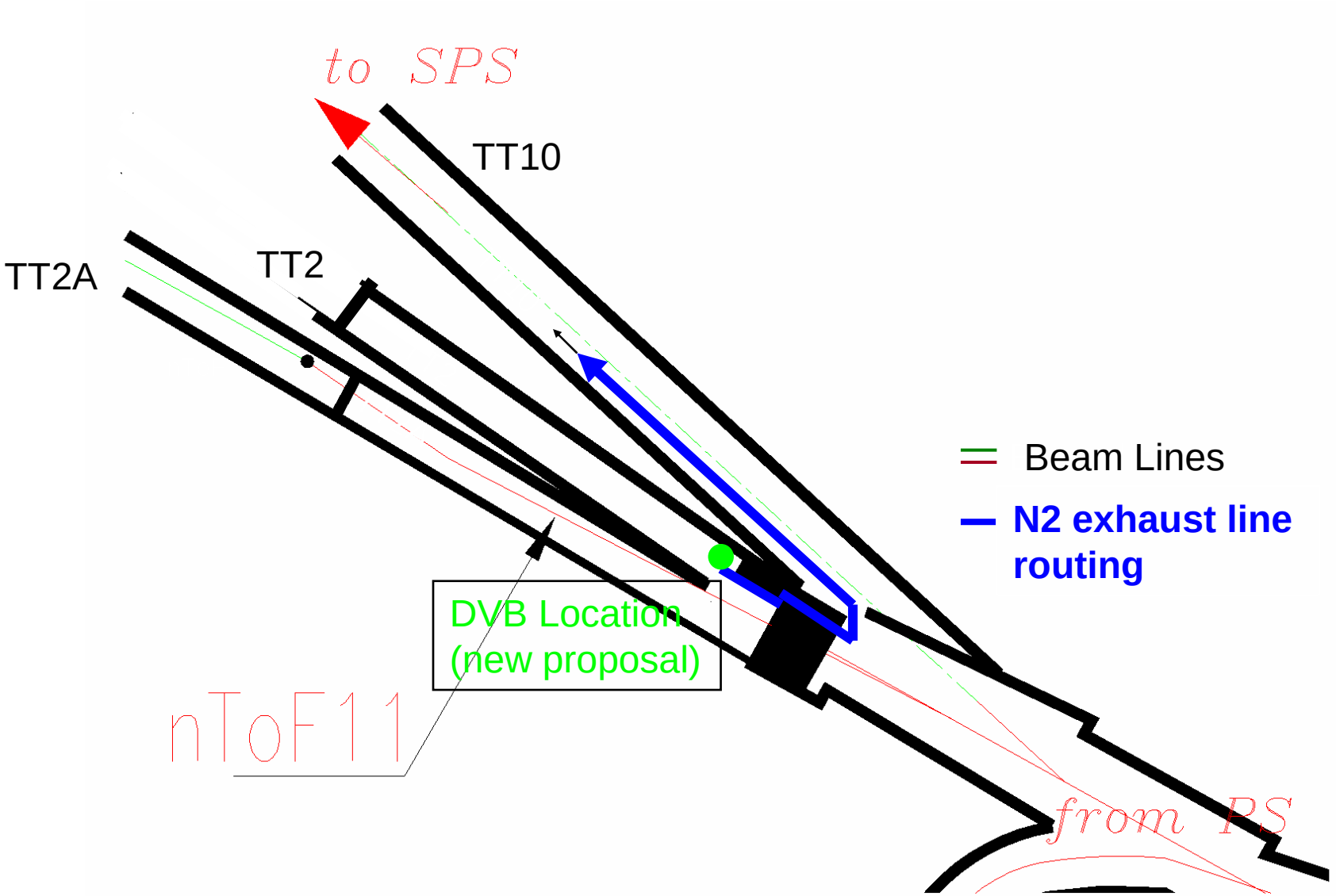
# N2 Exhaust Line Routing Proposal

View of concrete shielding blocks with horizontal “passages”

Passage in concrete block which may be used to pass the N2 Exhaust Line.

Advantage: No concrete drilling necessary.

# DVB Location and GN2 Exhaust Line Routing (New Proposal)



# 7. Safety; LN2 or GN2 related potential ODH

Hazard to people at underground (TT2a and TT2) due to potential accidental spills of LN2 and loss of GN2

Risks of Asphyxiation, Cold Burns, Hypothermia !

“Cryogenic Systems Built-in” Safety Measures in Cryogenics:

1) Adequate design
   -choice of material and quality assurance, -reliable interconnection bayonets, -choice of instrumentation
2) Reliable control and supervision system permitting alarms in case of necessity
3) Fully automised process control
   a) to try to avoid hazardous situations like pressure build-up in vessels
   b) to minimize required access of personnel
4) Safety Valves “blowing” to TT10

# Safety; LN2 or GN2 related potential ODH

- Risk assesment in collaboration with the Safety Commission (+ Spill Tests ?)
- Technical Solution for ODH Detection with Technical Service Dep.
- ODH must be an automised detection system with links to TCR (Technical Control Room) and SCR (Safety Control Room) via “CSAM” (CERN Safety Alarm Monitoring)
- Procedures (Access control, Training)

# Safety Systems (example ATLAS)

Collective Safety systems

-Passive safety measures (discharge)

-ODH Detection and Warning

-Emergency ventilation and extraction

- »Red phones» to Safety control room

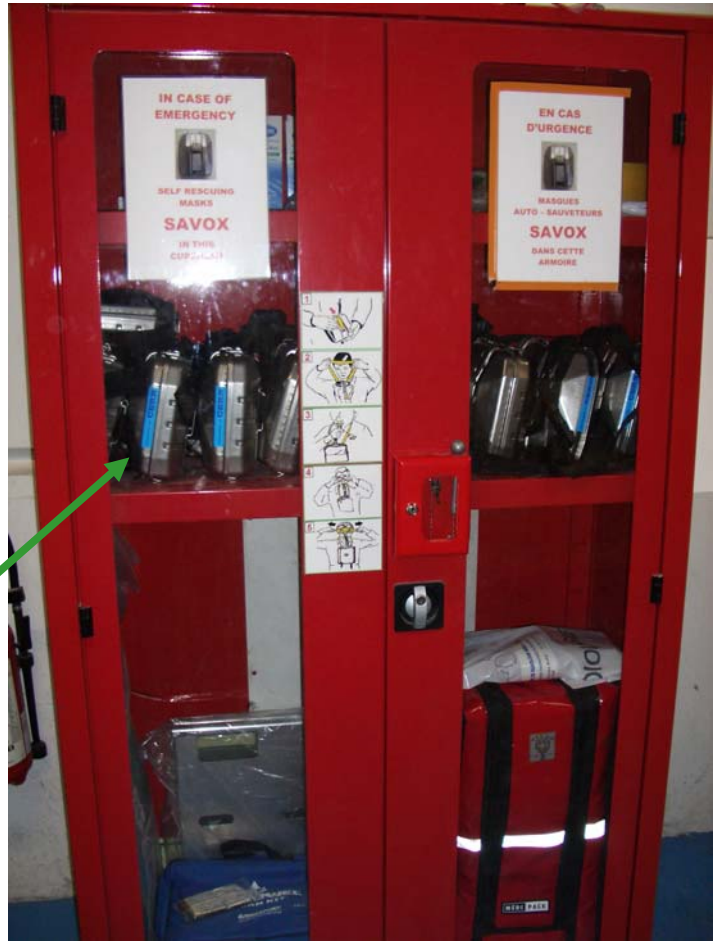
-personnel rescue by fire brigade

Individual Safety Systems

-mobile telephone,

-portable ODH detector

-breathing apparatus



# ODH Detector System (example ATLAS)


A typical **ODH transducer** (mounted on skid for ODH detection at floor level).
= Radiation Hard.
Principle: membrane, penetration of gases, sensing with electrochemical reaction.


**Control equipment**

To be located in protected area.

# ODH Detector Warnings


**-Warning sign**

**-Visible warning (Flashing light) + TCR information**

**At below 19 %**

**-Audible warning (Sirene) + SCR information, = Alarm 3 (CERN jargon)**

**At below 18 %**

# ODH Installations in collaboration with TS dep.

***E-mail of a colleague at work…***

Hi Friedrich,

We already have infrastructure which is connected to the technical network (alarms) located at the entrance of the ISR building 375. We can connect up to 64 detection points to this system. Rough price for 4 detection points plus safety infrastructure and interlocks X CHF

If we have to install an additional control panel + infrastructure locally then the price could escalate up to XXX CHF as long as all the usual technical networks etc. are available locally. We do have a spare control panel (only 1 yr old) that we could install to reduce the price ( XX CHF).

Hope this info helps.

CU

David.

***= latest info before leaving CERN. Check when back…***

# 8. Situation on Project

**Proximity equipment**

1) DVB valve box (“distribution valve box”)

-Process defined and flow scheme (P&I) terminated with MERIT collaboration

-Preliminary Technical Specification made by CERN-ECR and handed over to RAL (Aug. 2005)

-RAL adapts document for tendering according to their rules

-Tendering has started (***RAL***)…

-RAL has obtained one preliminary quote (AS Scientific)…based on preliminary information

Proposal: Do tendering to get meaningful quotes. A large number of European firms are capable to fabricate the supply item.

| | |
|---|---|
| 2) Transfer lines to magnet | *RAL* |
| 3) DVB Instrumentation | *no news on details (ECR)* |
| 4) vacuum pump for insulation vacua | *exists (ECR)* |
| 5) el. heater system | *design proposal (ECR)* |

# 8. Situation on Project

**Intermediate Infra**

1) (Main) transfer line for cooling and filling — *no news* (ECR)
2) exhaust for warm nitrogen gas (to TT10)

= *dimensioned, ECR has similar installation currently for ATLAS*

**External Infra**

1) LN2 reservoir — *under investigation (ECR)*
2) Concrete Platform — *CERN site manager informed*

**Instrumentation of Infra** — *for later (ECR)*

**Process Control**

-hardware — *pending (ECR)*

-process detailed description — *for later (ECR)*

-software *(engineer for programming/commissioning can be made available at ECR, however, "reservation commitment" shall be made soon)*

**Safety: Radiation Hard Instrumenation** (or not?) — *clarification pending*

**Safety: ODH**

ODH and warningsystems — *started (ECR)*

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