MERcury Intense Target Experiment Installation Issues

I. Efthymiopoulos

Thanks to:

A.Fabich, H.Haseroth, F.Haug, J.Lettry, and the colleagues from the service groups at CERN

MUTAC Review Meeting
FermiLab – March 16, 2006

Outline

- The experimental layout

Progress update

- Experiment sub-systems
  - Cryogenics
  - Solenoid power supply
- Safety issues
  - Solenoid and cryogenics review
  - Access and interlocks
- Transport and installation
- Budget
- Schedule

… and a short update on

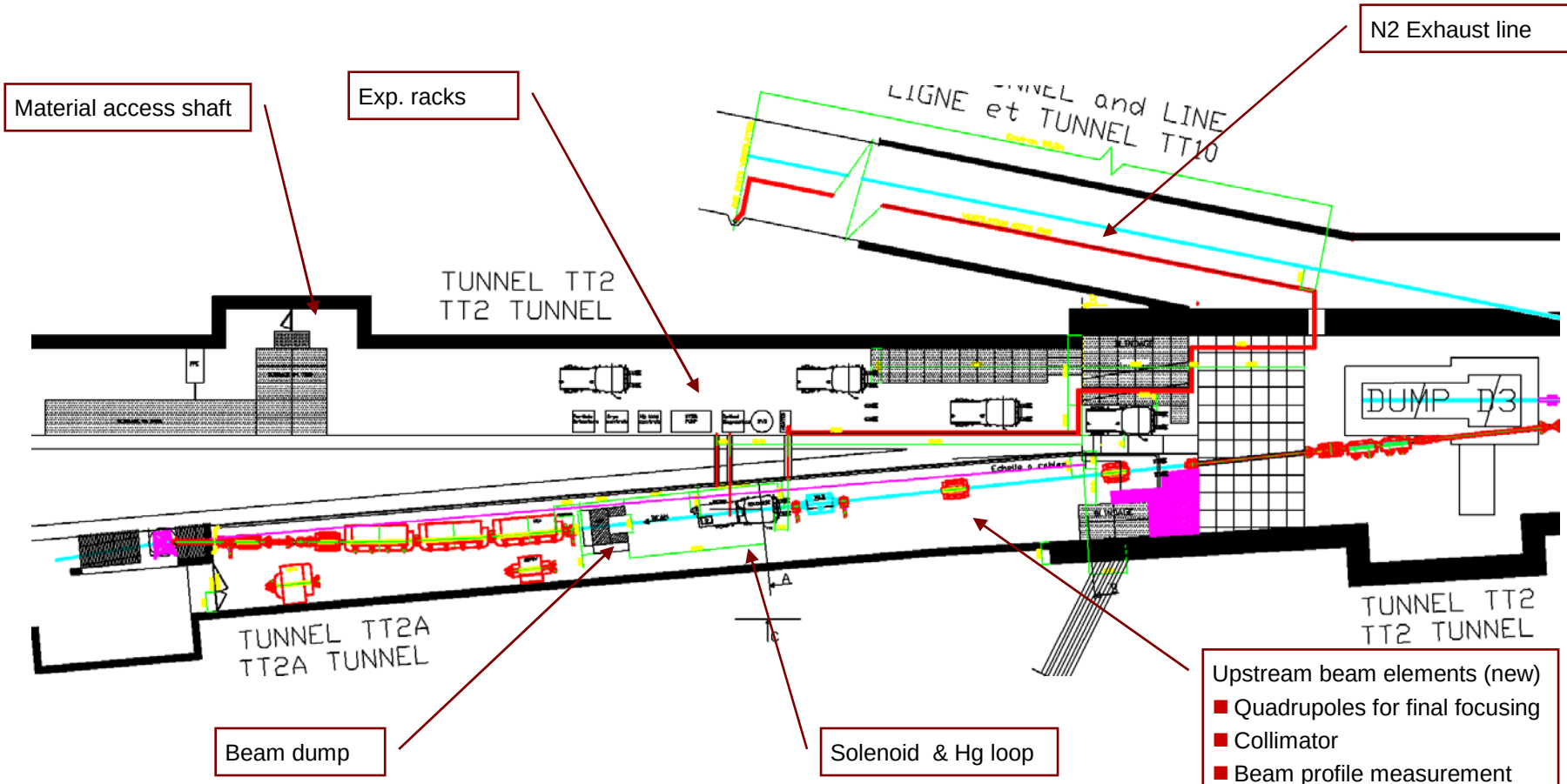
- Beam parameters – pulse list
- Beam instrumentation

The Experimental Layout

- Good progress over the last months
  - location of experiment (solenoid) and the beam line elements in the TT2A tunnel defined
  - a preliminary rack allocation of the experiment services in the TT2 tunnel is proposed

- Detailed AutoCAD drawings of the TT2 and TT2A tunnels are now available
  - Include all the shielding walls and services for the nTOF beam and target already installed in the area
  - Used already to define the passage of the cryogenics exhaust line into TT10 and the location of the cable passage holes between TT2/TT2A tunnels

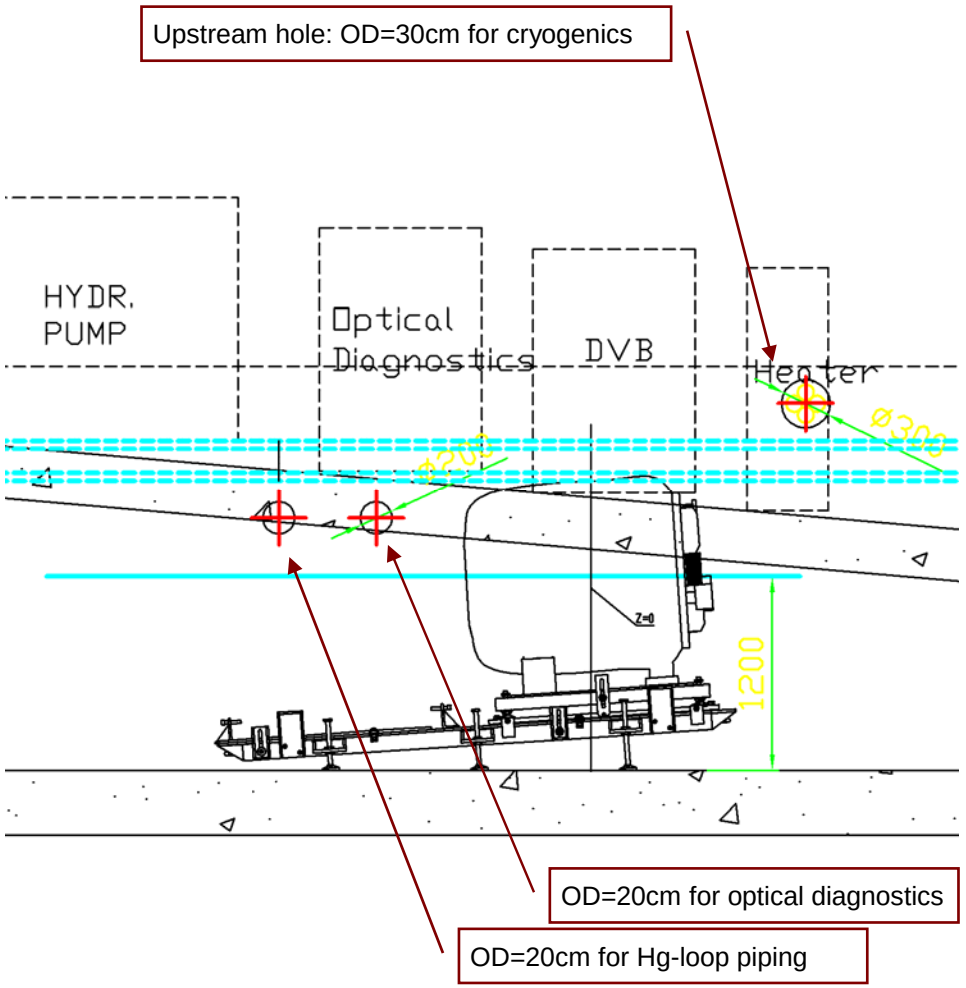
The Experimental Layout



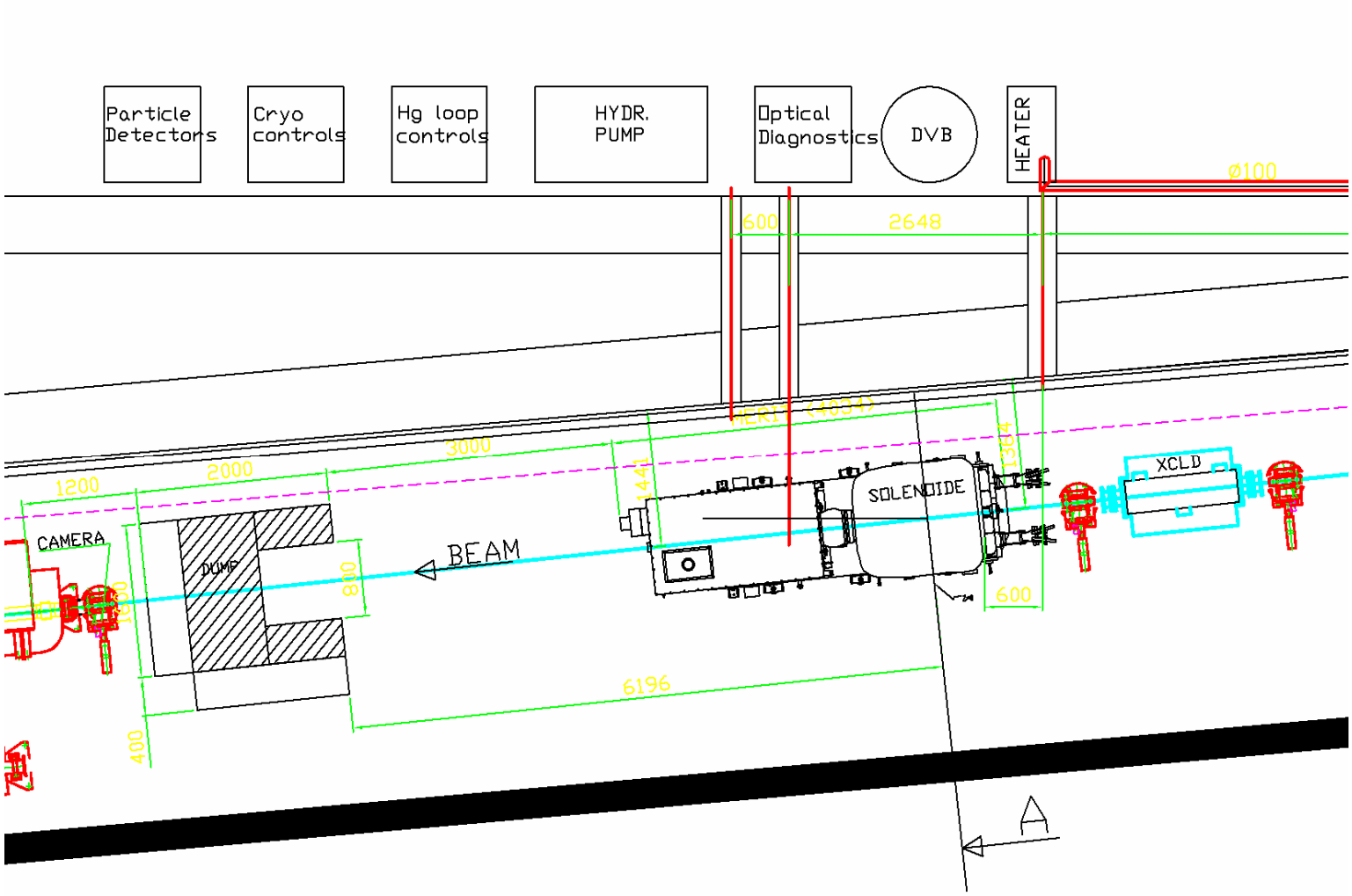
The Experimental Layout

Cable passages

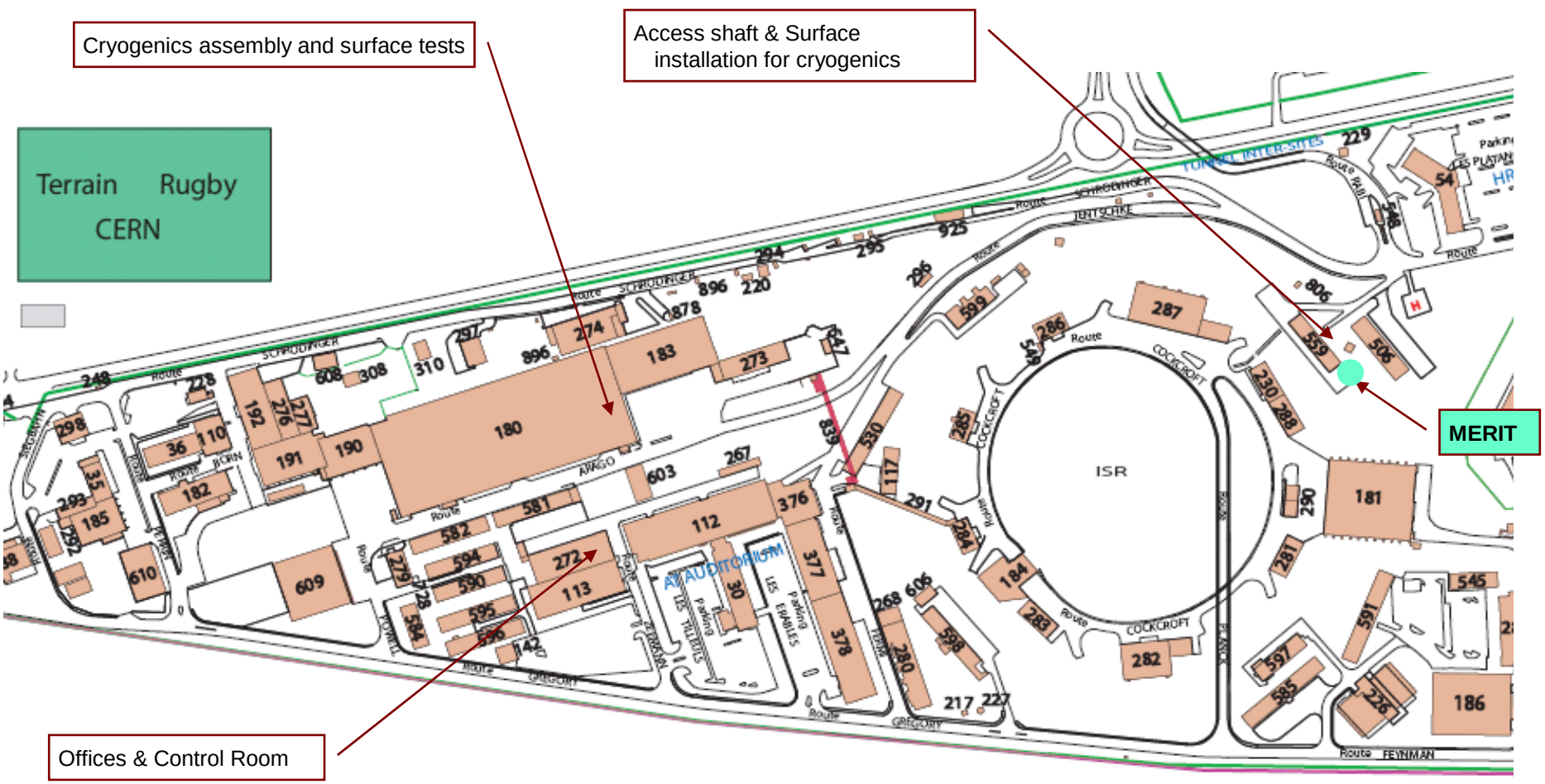
- Allow short passage for cables and services between TT2 and TT2A tunnels
  - Reduce cost and complexity
- The hole direction is optimized to minimize radiation leakage to TT2 tunnel
  - Could be filled with sandbags after the installation of the cables if radiation is an issue



The Experimental Layout



The Experimental Layout



Cryogenics

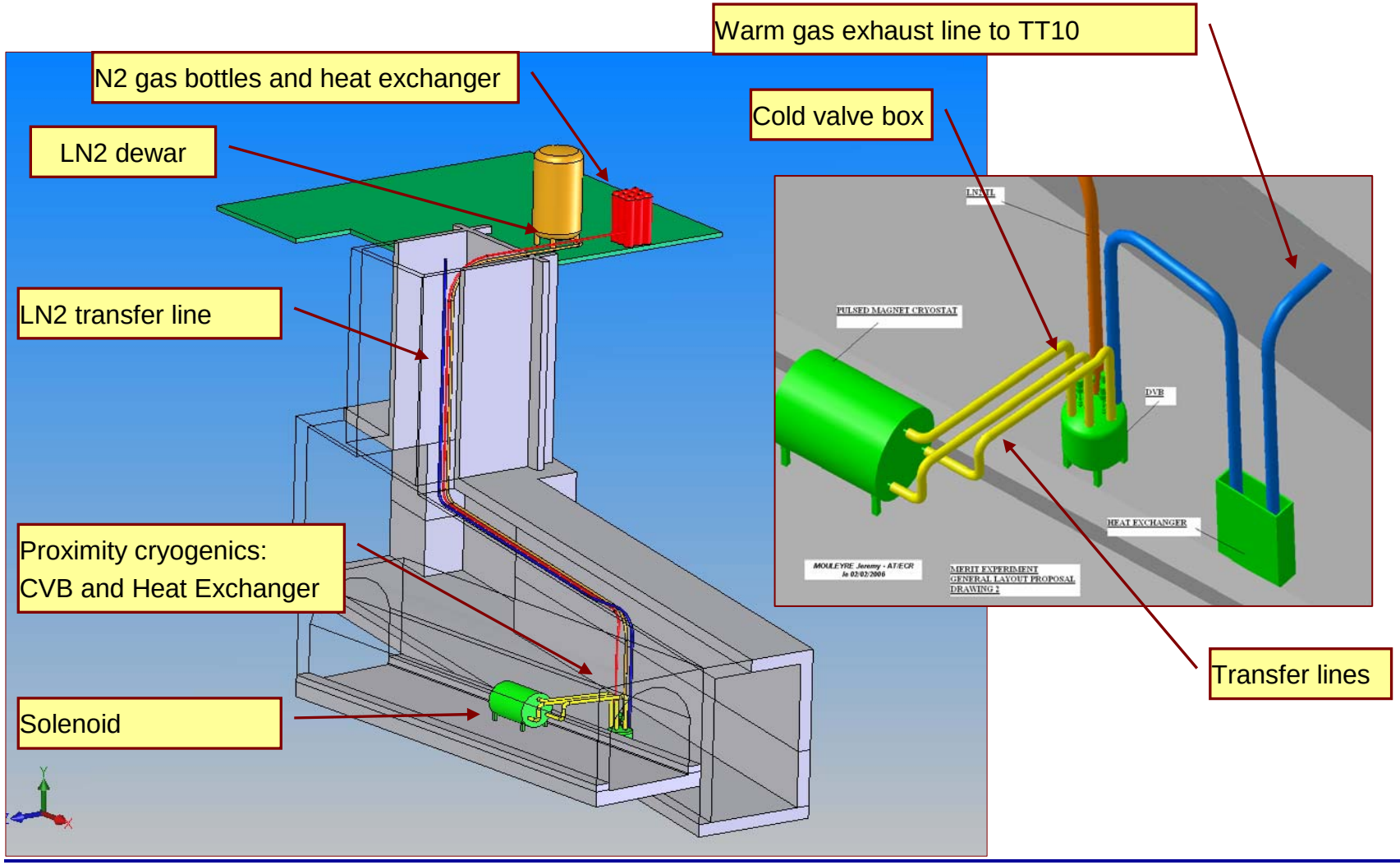
Aim:

- Provide LN2 to cool the solenoid at 80K
- Readout and control according to CERN standards
  - Guarantee safety of operations
- Collaboration between RAL & CERN
  - Project engineer: F.Haug/CERN

Status:

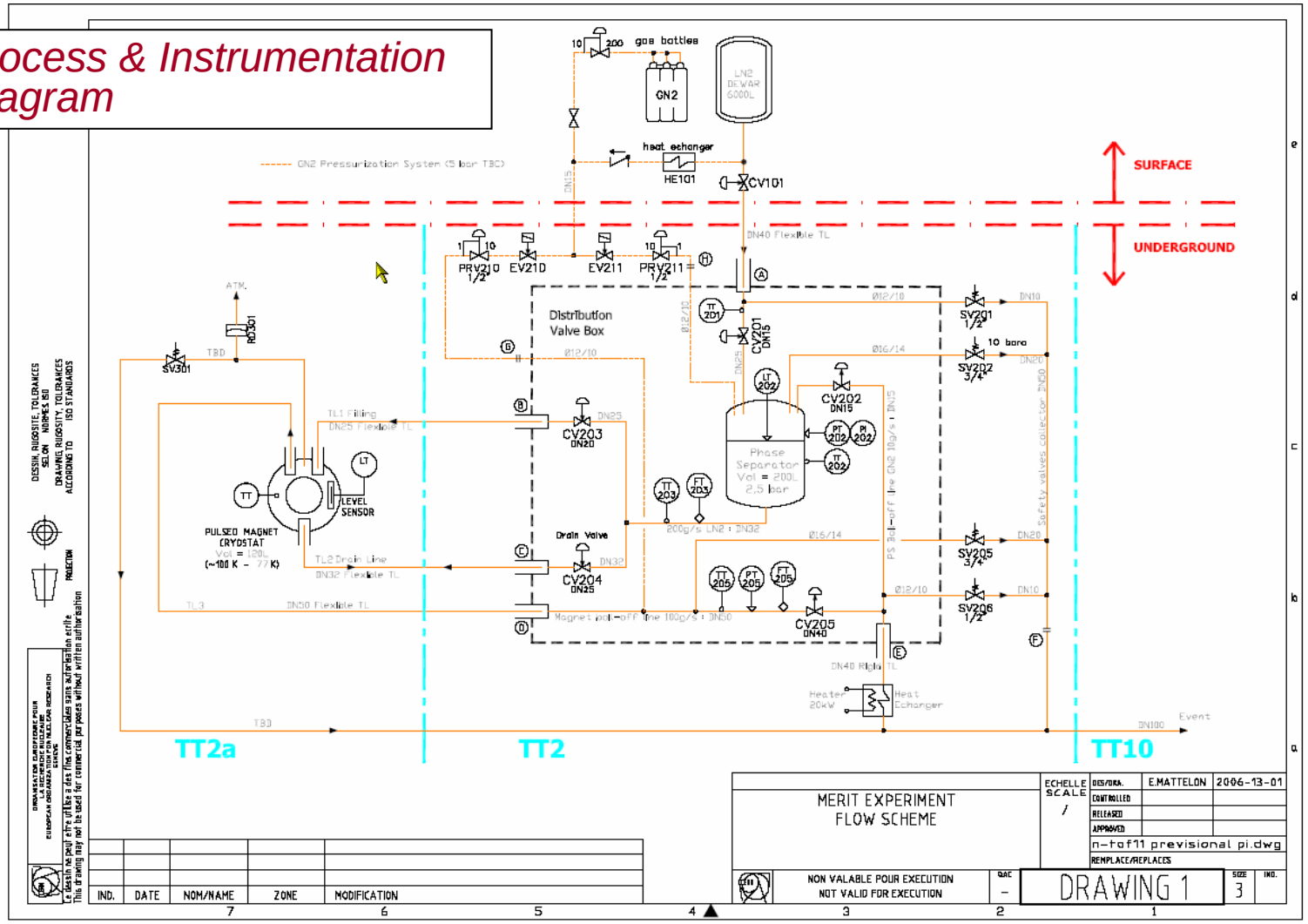
- System design completed including instrumentation and safety valves
- Gas N2 exhaust line to TT10 installed

Cryogenics


Warm gas exhaust line to TT10
N2 gas bottles and heat exchanger
Cold valve box
LN2 dewar
LN2 transfer line
Proximity cryogenics:
CVB and Heat Exchanger
Solenoid
Transfer lines
PULSED MAGNET CRYOSTAT
DVB
HEAT EXCHANGER
MERIT EXPERIMENT
GENERAL LAYOUT PROPOSAL
DRAWING 2

Cryogenics

Process & Instrumentation Diagram



F.Haug - CERN

Cryogenics

- After several iterations, the Specification document for DVB is now available
  - Tendering will be done by RAL
  - Production on the critical path
- Procurement of other components ongoing in parallel
  - Valves, control equipment

Schedule:

- System assembly at CERN
- Commissioning at surface (bat.180) in Autumn 2006
- Installation in the tunnel to follow

ORGANISATION EUROPEENNE POUR LA RECHERCHE NUCLEAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH
Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

MERIT Project *EDMS document No.: 695878*

Technical Specification for the fabrication of a Cryogenic Valve Box for liquid nitrogen distribution

Abstract

This Technical Specification concerns the design and the fabrication of a cryogenic Distribution Valve Box as part of the liquid nitrogen cooling system for the MERIT project. MERIT is a proof-of-principle experiment to test a mercury jet target as a source of pions for a Neutrino Factory or Muon Collider. A pulsed solenoid capable of producing 15 Tesla surrounds the jet in order to collect the pions produced in the interaction of the proton beam with the mercury. The solenoid is manufactured from copper and cooled by liquid nitrogen.

The liquid nitrogen that flows to and from the magnet is controlled by means of a Distribution Valve Box which is part of the overall cryogenic system.

This Distribution Valve Box (DVB) is being purchased by Rutherford Appleton Laboratory (RAL) to be used at CERN.

January 2006

Solenoid Power Supply

Aim:

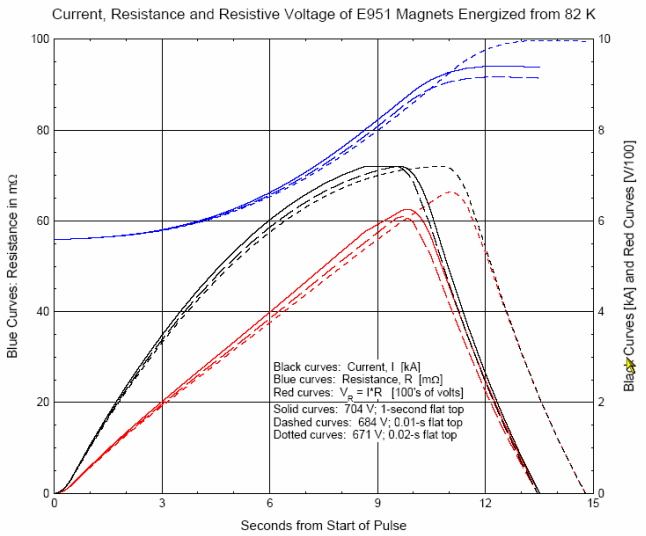
- Provide power for the solenoid in “pulsed” mode: 7kA;700V / 30 min
- Recuperate the power supply used for the SPS extraction to the West Area
  - Work done by CERN/AB-PO group

Status:

- Power supply installed in bat.193
- Refurbishment started – will be completed by October 2006
- AC transformer installed
  - Associated AC circuitry refurbishment to be done for the 18kV cell
- Cabling:
  - DC cabling {power supply – solenoid} installed
    - 6×400 mm^2 Al cables - air cooled
  - AC cabling partially done

Solenoid power supply

Power Supply in 193 building



Power Supply in 193 building

AC Transformer

G.LeGedoc – AB/PO

Safety issues

- MERIT Presentations in:
  - **AB Installation Committee (ABIC)**
    - discussed interface with PS/SPS and CERN services teams
      - → permission to work in TT2/TT2A tunnel during PS/SPS operation
  - **AB Safety Committee (ABSC)**
    - Presented safety structure of the experiment and proposal for review program of various components
- ISIEC form for the experiment
  - Define safety structure and identify safety issues
- Initiated reviews of the various systems
  - Started with the Solenoid and Cryogenics System

Safety

Initial Safety Information for Experiments at CERN - ISIEC

- CERN is informed about all safety particularities of MERIT
- MERIT Safety structure:
  - H.Kirk & K.McDonald overall responsible as spokespersons
  - A.Fabich as GLIMOS
    - General Liaison in Matters of Safety
- Information on safety issues for the experiment under CERN/EDMS structure
- Also available from the experiment web pages: http://cern.ch/merit

CERN — European Organization for Nuclear Research

I S I E C

INITIAL SAFETY INFORMATION ON EXPERIMENTS AT CERN

DATE:	January 2006	**EXPERIMENT:**	MERIT (ntof11)
INSTALLATION START:	February 2006	**AREA/BEAM:**	TT2A (FTN), TT2, TT10, ISR
SPOKESMAN:	Harold G. Kirk (BNL), Kirk McDonald (Princeton University)		
GLIMOS :	Adrian Fabich	**TEL:**	160345
FILLED IN BY:	Adrian Fabich	**TEL:**	160345

(1) TEST BEAMS : FTN line
LABS AT CERN (BLDG/ROOM): TT2A (FTN), TT2, TT10, ISR

(2) GASES, LIQUIDS, CRYOLIQUIDS
(used in detectors or kept in nearby containers)

Device Type	Fluid 1 + % Fluid 2 etc.	Volume	Abs. Press.	Max Flow
cryogenics	LN2	6000 liter	15 bar	200 g/s
Hg loop	mercury	25 liter	100 bar	1.5 l/s
hydr. fluid	Quintolubric	~200 liter	206 bar	~70 l/s
	(see EDMS 702271)			

(3) OTHER CHEMICALS
Toxic/Corrosive/Flammable metals, solvents, additives etc:

see above,
no flammable gases/liquids present

(4) ELECTRICITY

	Magnet type	Power	Field	Gap Vol.	Max.water press.
MAGNETS:	BNL solenoid	5 MW	15 T pulsed	15 cm bore, 1m	80 K cryogenic, 15 bar

High Voltage (> 1 KV)	Detector Type	Voltage	Current	Stored Energy	No of HV Channels	Remote Shut-off?
	scintillator	???	???	???		
	not yet known	???	???	???		

SHORT-CIRCUIT current > 5 mA for >50 V possible anywhere? bus bar to BNL solenoid
POWER dissipated by all electronics a) on detectors: negligible
b) off detectors: negligible
SPECIAL GROUNDING REQUIREMENTS? n.a.

1/2

Safety issues

Solenoid and Cryogens Review

- Held @CERN in February 2006
  - Review panel from CERN safety and cryogenic system experts
  - Safety officials as observers
  - Report available http://edms.cern.ch/document/710659

CERN
CH-1211 Geneva 23
Switzerland

EDMS Document No
7106259
Created:9 March 2006
Page 1 of 4

GENERAL SAFETY & HYGIENE GROUP
MECHANICAL SAFETY SECTION

MEMORANDUM

MERIT CRYOGENICS PROJECT REVIEW

To: I. Efthymiopoulos AB/ATB
A. Fabich AB/ATB

From: A. Astone SC/GS
V. Benda AT/ACR
B. Delille SC/GS
G. Lindell SC/GS
G. Perinic AT/ECR

Distribution List :
P. Cennini AB/ATB
A. Desirelli SC/GS
B.Pichler SC/GS
R. Trant SC/GS

Document(s) Received

Building(s)

1. INTRODUCTION

This memorandum concerns the MERIT magnet cryostat project review. It contains recommendations to be put in practice by the MERIT collaboration either in matter of mechanical and cryogenics aspects of the magnet and its feeding system design. The recommendations shall be fulfilled prior to the use of the MERIT cryostat magnet at CERN.

2. CRYOSTAT MECHANICAL DESIGN

In the framework of the MERIT cryostat magnet project review, SC/GS Mechanical Safety (MS) section here lists its remarks concerning design and commissioning of the magnet.
According to CERN D2 safety code an engineering file shall be provided to SC/GS/MS containing all documents and design parameters necessary for acceptance of the cryostat magnet at CERN. We expect the MERIT collaboration to provide CERN the engineering report before shippping of the cryostat magnet to CERN.
The document shall in particular contain:

1. Base material and filler material certificates
2. User's notice
3. Complete set of drawings
4. A list and all results of planned safety inspections, safety checks and quality controls

Safety issues

…Solenoid and Cryogenics Review – Major remarks

- Provide documentation for solenoid fabrication
  - Including x-ray validation of the welds
  - Proof that ASME standards are respected
    - And corresponding vessel validation is made
- Important to keep good record of the tests made and findings during the MIT tests
- Safety valves and operating pressure for solenoid to be defined
- Process flow diagram for the cryogenics operation should be defined in detail

Safety issues

Next steps:

- Reply by June to the issues addressed by the S&C Review
- Schedule reviews in the coming months for:
  - The Hg-loop system
  - Transport and installation at CERN

Safety issues

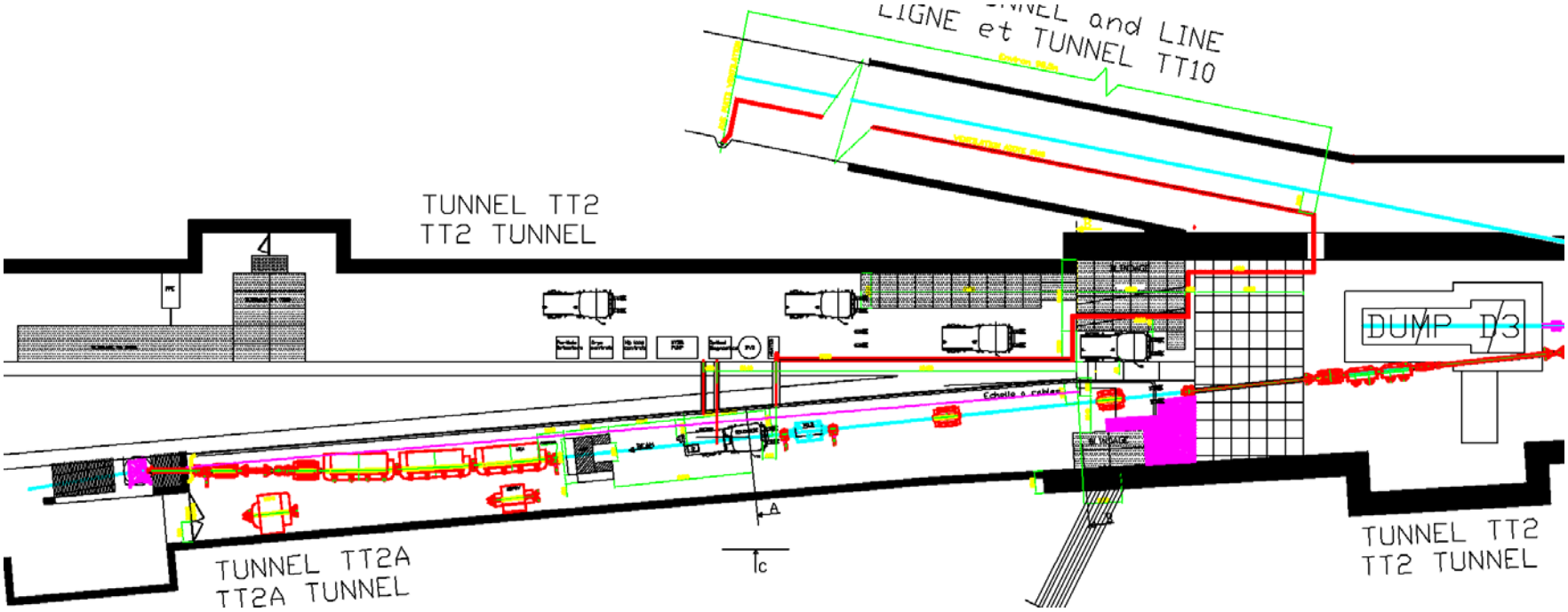
Access and interlock

- Access in TT2/TT2A tunnels possible when PS/SPS in operation
  - Limited access as in other exp. areas
    - Card reader for personnel access

- Interlock conditions defined:
  - Access interlock: no beam $\oplus$ magnet off $\oplus$ ODH detection
  - Magnet power supply interlock $\leftrightarrow$ cryogenics system

Transport & Installation

- Studies on how to transport the solenoid started
- Passage around TT2/TT2A junction always critical



Beam request – pulse list

- Based on pulse list July 2005
  - http://proj-hiptarget.web.cern.ch/proj-hiptarget/default/Documents/subsystems/ProtonBeam/pulselist.xls
  - Total dose limited to 3×10^{15} protons on target.

Beam parameters:

- Nominal momentum 24 GeV/c
- Intensity/bunch – baseline: harmonic 16 (i.e. 16 buckets in PS, Δt=125ns)
  - **2-2.5 $\times$ 10^{12} protons / bunch**
  - **total maximum ~30 $\times$ 10^{12} protons/pulse**
- Pulse length up to 20 ms possible (beyond 2 μs switch to 14 GeV/c)

Next steps:

- MD time in 2006 assigned
  - To address the most critical configurations – priorities should be defined
- Set-up time at the beginning of 2007 may be required to achieve the highest intensities

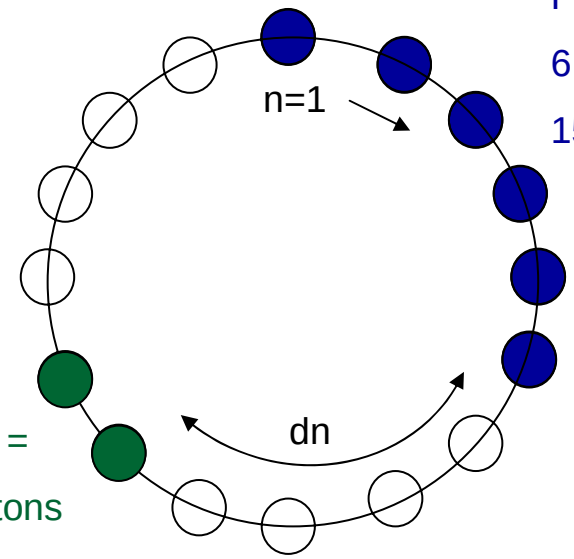
Beam setup for Cavitation Studies

- h16 beam operates in bunch pairs
  - Bunch pairs located in bucket n and n+1

PUMP:

6 bunches =

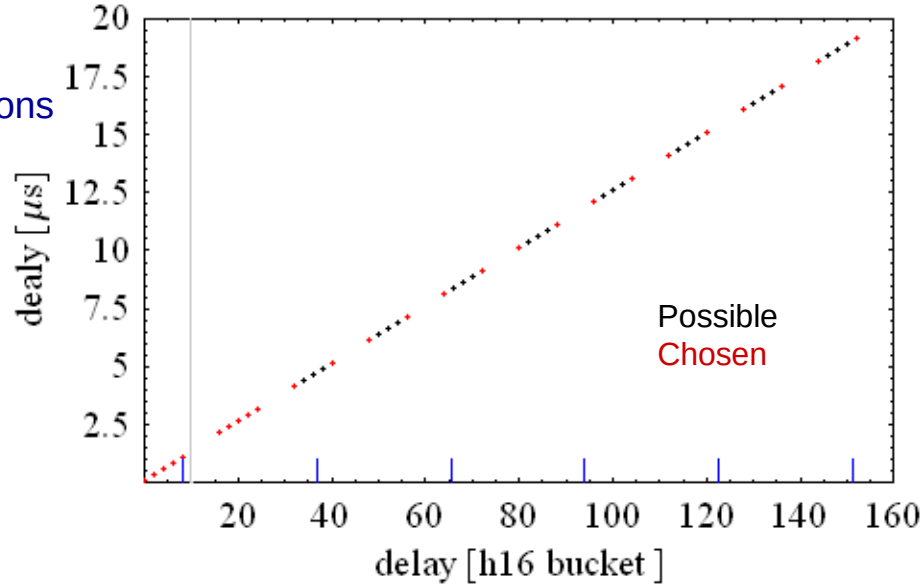
15*10^{12} protons



PROBE:

2 bunches =

5*10^{12} protons



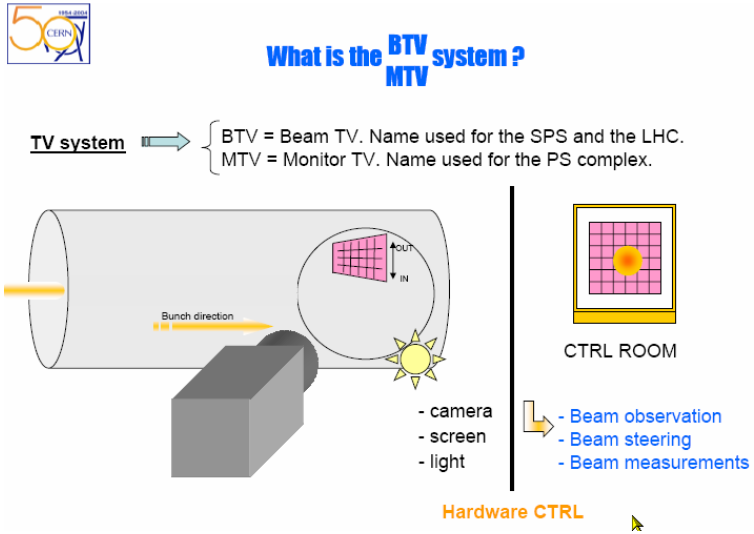
- $dn_{experiment}$ = 0,2,4,6,8, 16,18,20,22,24, 32,40, 48,56, ...
- Inhomogeneous intensity distribution causes intensity limits
  - MD dates scheduled towards the end of 2006 – profit from development of CNGS beams with similar (high) intensities

Beam profile measurement

3 Monitor types considered
Based on beam properties to be measured

- MTV screens
  - "almost" readily available
  - Minor effort
  - Minimum budget
- SEM-grid
  - None available - needs new construction
  - Costly: >50 kChF
  - Manpower these days very little at CERN
- Wire scanner
  - "Slow" measurement

Baseline: MTV screens



Transverse beam parameters

- Position & spot size → MTV screens
- Direction → 2× MTV screens & collimator
- Divergence → not a direct measurement
  - Rely on beam simulations
  - Estimate from spot size monitors

Longitudinal beam parameters

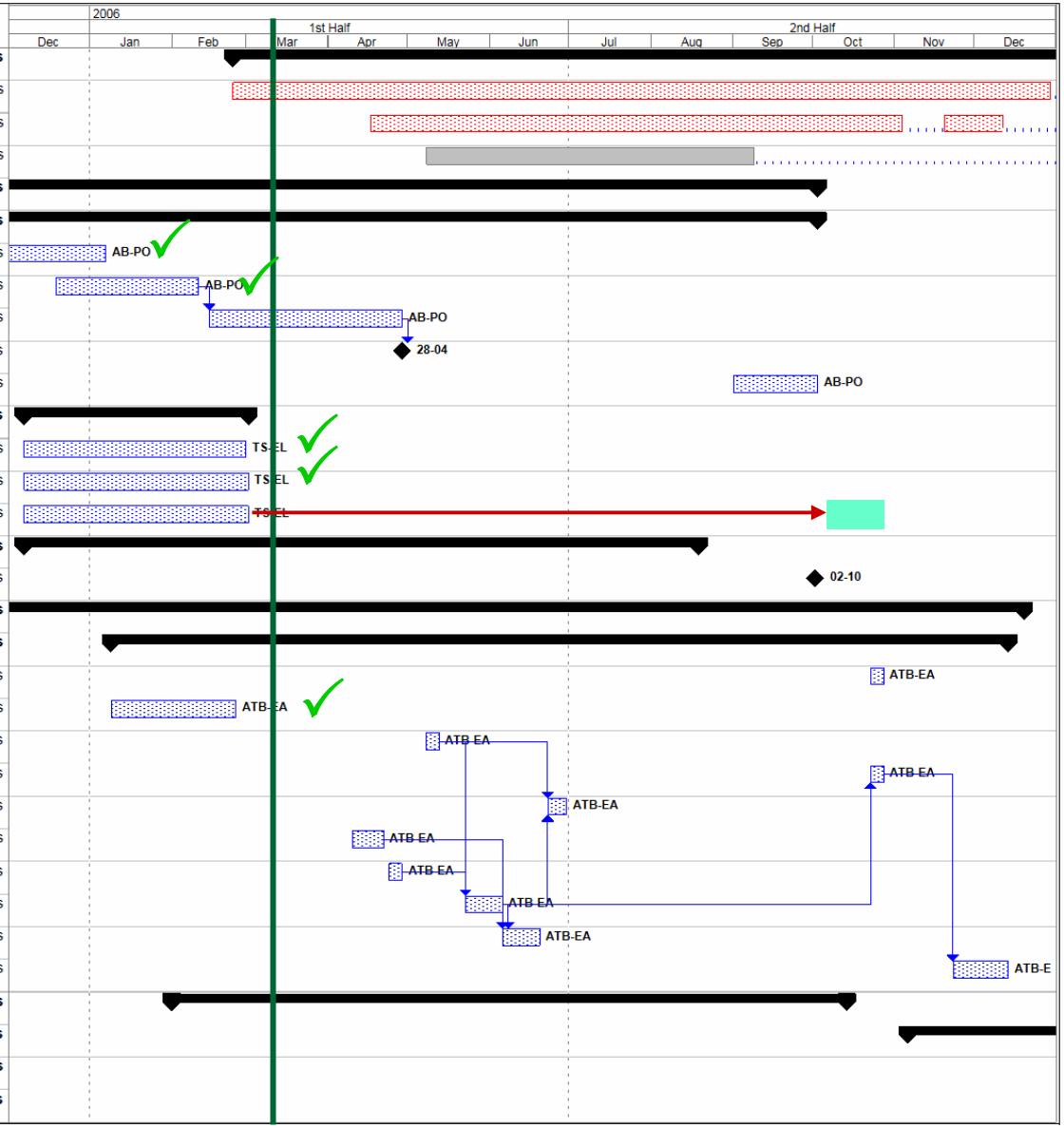
- Measured by pick-ups in the PS & TT2 line upstream of MERIT
- Log values and make available the information for the MERIT collaboration
- Parameters measured:
  - Bunch length
  - Bunch spacing
  - Pulse length
  - Intensity

Installation Schedule

- Target date: **November 2006**!
  - Ready to receive and install the solenoid and Hg-loop into the tunnel
- Infrastructure in the tunnel has to be finished beforehand
- Installation and commissioning of solenoid and Hg-loop only at the TT2A tunnel
- Working schedule available taking into account:
  - Installation delays: manpower, tendering, ordering, ...
  - Access limitations due to PS/SPS operation in 2006

Schedule at CERN

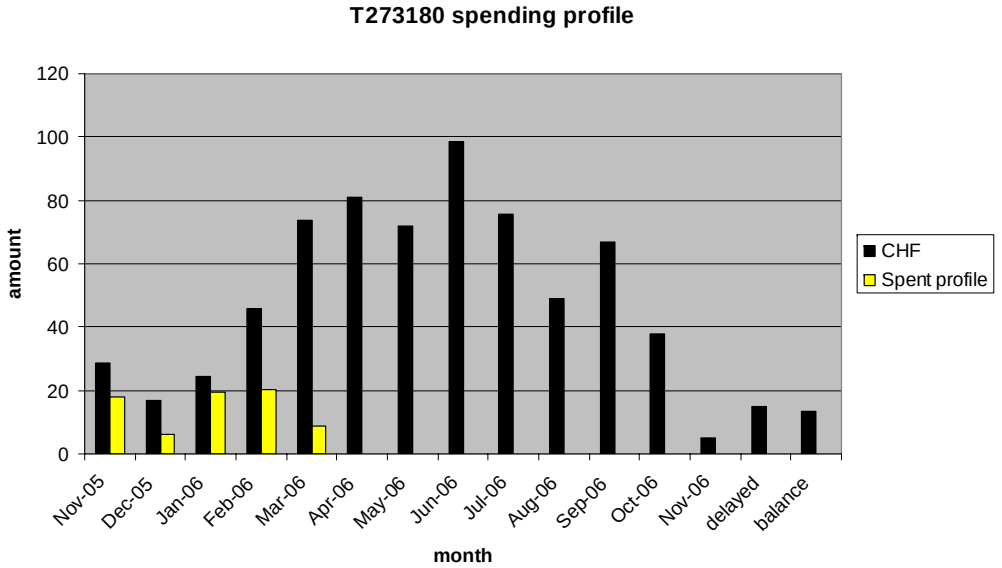
ID	Task Name	Resource Names	Start	Finish	Duration
1	**Accelerator Operation**		**24 Feb '06**	**14 Nov '08**	**711 days**
2	PS/SPS closed	PS/SPS	24 Feb '06	14 Nov '08	589 days
3	PS run	PS	17 Apr '06	31 Oct '08	446 days
4	AD run	AD	08 May '06	05 Sep '08	269 days
5	**Solenoid Power**	**AB-PO**	**07 Nov '05**	**02 Oct '06**	**236 days**
6	**DC power supply**	**AB-PO**	**07 Nov '05**	**02 Oct '06**	**236 days**
7	Preparation BA6 & AD193	AB-PO	07 Nov '05	06 Jan '06	45 days
8	Installation	AB-PO	19 Dec '05	10 Feb '06	40 days
9	Refurbishment	AB-PO	15 Feb '06	28 Apr '06	53 days
10	installation bat.193	AB-PO	28 Apr '06	28 Apr '06	0 days
11	Interlock connections	AB-PO	01 Sep '06	02 Oct '06	22 days
12	**-AC cirquitry**	**TS-EL**	**07 Dec '05**	**01 Mar '06**	**61 days**
13	Installation transformer	TS-EL	07 Dec '05	28 Feb '06	60 days
14	Installation AC cabling	TS-EL	07 Dec '05	01 Mar '06	61 days
15	AC cell	TS-EL	07 Dec '05	01 Mar '06	61 days
16	**DC Cabling**	**TS-EL**	**07 Dec '05**	**18 Aug '06**	**183 days**
19	Operational	AB-PO	02 Oct '06	02 Oct '06	0 days
20	**Cryogenics**	**AT-ECR**	**01 Aug '05**	**19 Dec '06**	**362 days**
42	**Experimental Area**	**ATB-EA**	**09 Jan '06**	**13 Dec '06**	**243 days**
43	Open shaft	ATB-EA	23 Oct '06	27 Oct '06	5 days
44	Vent line to TT10	ATB-EA	09 Jan '06	24 Feb '06	35 days
45	transport platform TT2 - TT2A	ATB-EA	08 May '06	12 May '06	5 days
46	Transport of solenoid	ATB-EA	23 Oct '06	27 Oct '06	5 days
47	Beam attenuator	ATB-EA	23 Jun '06	29 Jun '06	5 days
48	Beam layout	ATB-EA	10 Apr '06	21 Apr '06	10 days
49	Cut/removal vacuum	ATB-EA	24 Apr '06	28 Apr '06	5 days
50	Dismount nTOF line elements	ATB-EA	23 May '06	05 Jun '06	10 days
51	Drill holes TT2 - TT2A	ATB-EA	06 Jun '06	19 Jun '06	10 days
52	Installation of beam elements	ATB-EA	23 Nov '06	13 Dec '06	15 days
53	**Installation of experiment**	**ATB-EA**	**01 Feb '06**	**13 Oct '06**	**183 days**
56	**Commissioning**	**MERIT**	**06 Nov '06**	**02 Mar '07**	**85 days**
60	**Data taking**	**MERIT**	**11 May '07**	**13 Jun '08**	**286 days**
65	**Dismantling**	**ATB-EA**	**02 Jul '07**	**19 Oct '07**	**80 days**



Budget

CERN Code status – March 2006

- Total credited: 700 CHF (560 USD)
- Committed from BNL: 320 kCHF
- Spent to date: 85 kCHF
  - Pipeline : 25 kCHF



Conclusions

- Good of progress on MERIT installation issues
  - Experiment layout defined
  - Power supply, DC cabling, TT10 vent line, cable passages,
- Important progress on Safety issues
  - ISIEC form and presentation in relevant committees
  - Review of solenoid and cryogenics systems
- Integration schedule on track
  - Tendering & construction of cryogenics DVB on critical path
  - Cryogenics must proceed to schedule
- The goal remains to have beam at the startup in 2007

More slides

Proposition for Priorities

General approach

- Repeat each parameter configuration twice
- Increase intensity to moderate $1.5*10^{13}$ protons/pulse
- Do basic program, MHD first
- Each proton pulse configuration is performed at B=15 T (solenoid) and B=0 T (horn)
- Consider effort for PS operation to change settings

0. beam setup
1. MHD
2. beam position
3. Pulse structure
   a) Cavitation
   b) 50 Hz operation
4. Spot size
5. Intensity

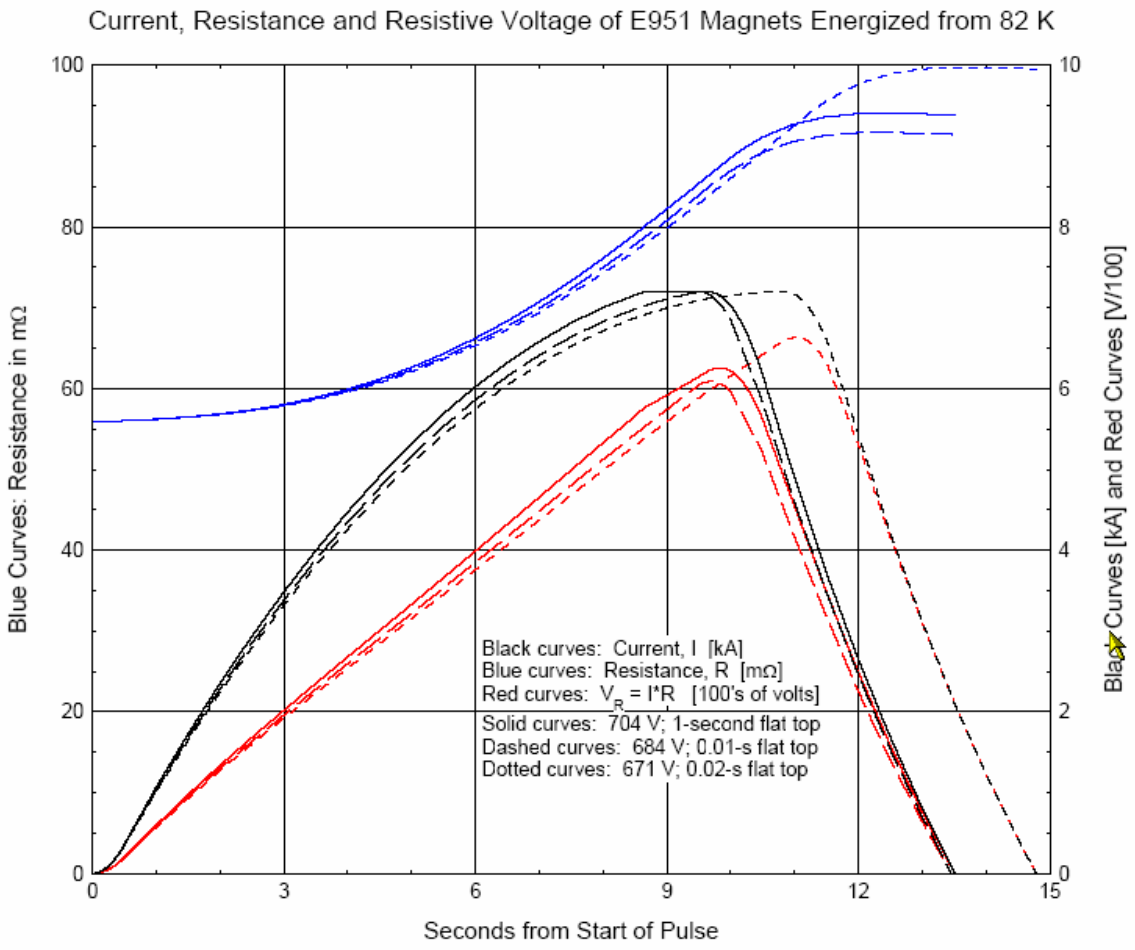
Pulse should include operation scenarios.

The Experimental Layout

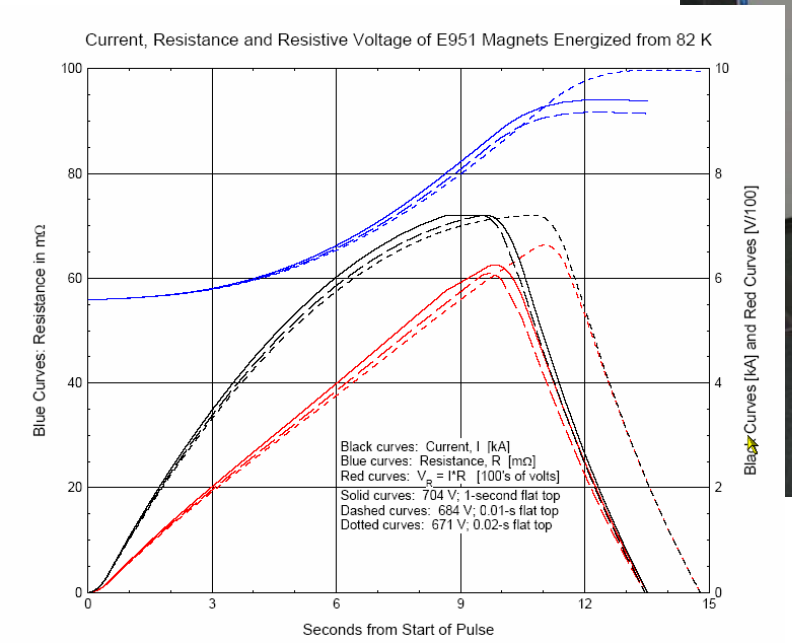
Control Room

- Location to be decided – two options:
  1. At the ISR tunnel at the exit from TT2 tunnel
     - Need to reserve the space from other users
     - Not the ideal place for a control room
  2. Use the old West Area CR in bat.272
     - Further away but at walking distance from the tunnel door
     - Next to the cryogenics lab there the surface tests will be made
- Decisive factor would be the cabling. Are cables installations required between TT2 & CR?
  - Can all communication be based on Ethernet network?
- Aim to conclude on this issue by end of April 2006

The solenoid power supply



Solenoid power supply



C. Martins – AB/PO