ATC-ABOC Days 2007

Session 1: Major Events in 2006

Session 1: Major Events

Chairman: Frederick BORDRY (AB/PO)
Scientific Secretary: Peter SOLLANDER (AB/OP)

1 **Statistics of Operational Events and Consequences**
by Bettina MIKULEC (AB/OP)

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by Jose GASCON (TS/EL)

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by Karsten KAHLE (TS/EL)

5 **PS MAIN POWER SYSTEM: What has been done from June 2006? What will be the situation in 2007?**
by Jean-Paul BURNET (AB/PO)

Machines – A Difficult Year

… after an 18 month shutdown for many machines

… and rebuilding ¼ of the PS main magnets

… in a brand new control room

… with new applications software (SPS)

… with often a reduced level of availability from the equipment groups due to LHC commitments

… needing new procedures for access and safety

… having a large number of new personnel in the OP group

… and having an impressive series of major breakdowns

…again a slide 'stolen' from Paul…

Major Breakdowns

- Breakdown of the SPS main compensator on May 8th delays startup (1 month)
- PS rotating machine: damage of the rotor discovered on May 15th; after rotor exchange back to normal operational conditions on June 22nd (no more spare!)
- Several major power cuts:
  - Short on the 400 kV line on May 15th → limited to power consumption of 63MVA (machines down for 2.5 days); in addition 130 kV failure on May 16th
  - Major power cut on July 27th (3 days down): explosion of an 18 kV circuit breaker → diesel backup groups started, but could not take the load → complete electricity breakdown after UPS batteries were empty; even telecom failure, security installations affected…
- PS septum SHM42 failure August 1st (sparks)
- F61S.BHZ01 - the never-ending story: south branch of East Hall badly affected all over the run and out of action from 28th of Sept!
- …, tank 3 of LINAC2, PS inflector zone, ISOLDE, AD, SPS water leaks, CNGS, …

- Equipment failures have potential to increase machine down-times: age of machines and ever more demanding running conditions…
- Old systems often a bottleneck due to decreasing support (sometimes even loss of experience!). Could in some cases better documentation help?
- Identify critical system, orphan equipments and equipment with only one specialist (holiday or illness problem)
- Flawed beam instrumentation usually doesn't lead to machine down-time, but adequate and well working diagnostics can significantly improve beam quality and therefore physics outcome.
- Piquet/expert service should be re-evaluated per domain for the LHC era and should be harmonized. (see Session 2)
- Changes to E-Logbook allowing to obtain easier more precise statistics.

Subject mentioned but not discussed:

- Demineralised water in PS complex and air conditioning
- PS inflector zone: could it be put back rapidly in place in a safe manner ?

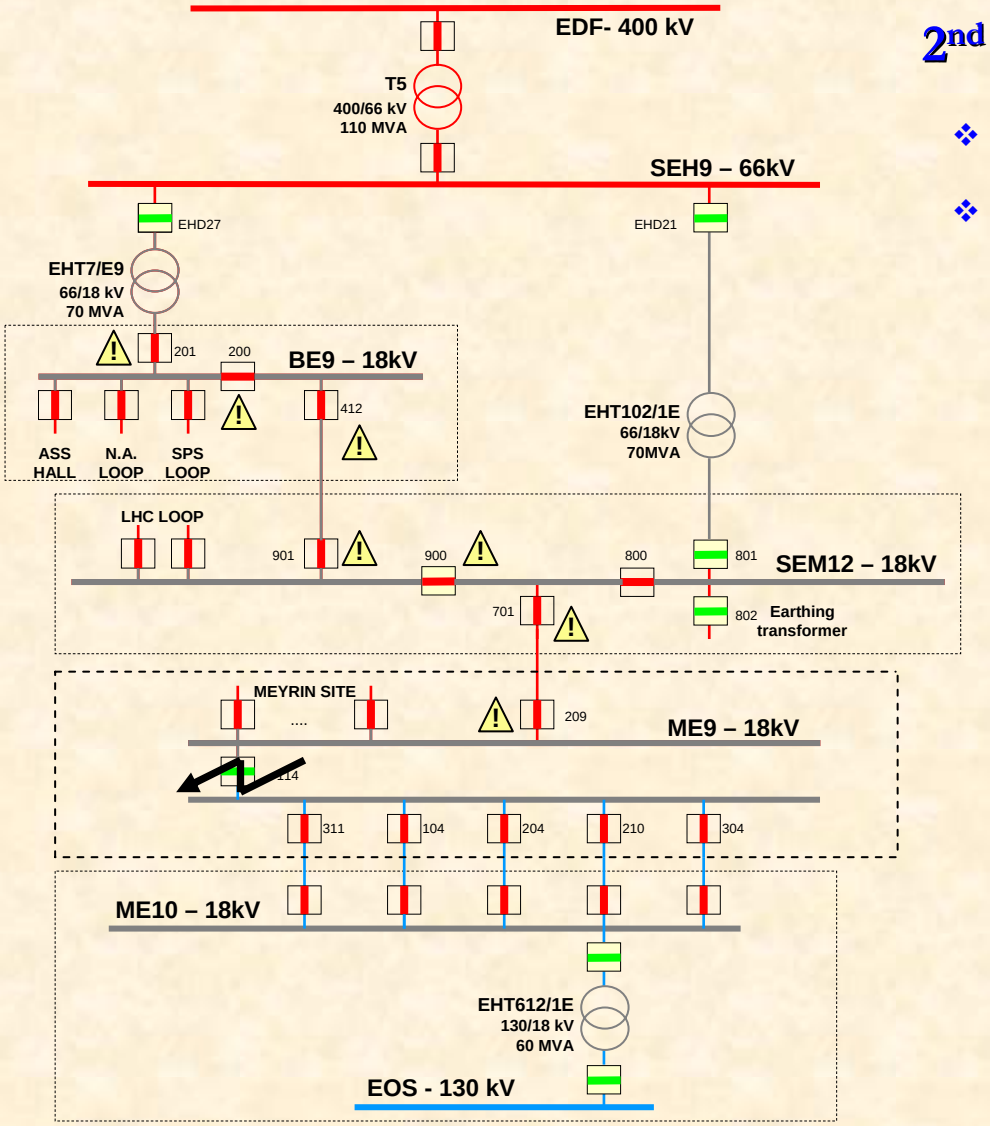
Electrical network: selectivity and protection plan

by Jose GASCON (TS/EL)

⇨ CERN HV Electrical Network

- Voltage levels: 400kV, 130kV, 66kV, 20kV, 18kV and 3,3kV
- 94 HV substations: 38 LHC, 26 SPS and 30 Meyrin
- 4 sources: EDF (400kV & 20kV), EOS and Diesel Generators
- 3 different interconnected networks by site:
  - LHC: Machine, General Services and Safety (Assured)
  - SPS: Pulsed, Stable and Safety (Assured)
  - Meyrin: Pulsed, General Services and Safety (Assured)
- Sites interconnected by 18kV links
- Power flow direction depending on the configuration
- About 1,000 protective relays and switchgears
- Compensators and harmonic filters
- Diversity of loads: pumps, converters, dipoles, transformers, compressors

29th July 2006 (II)

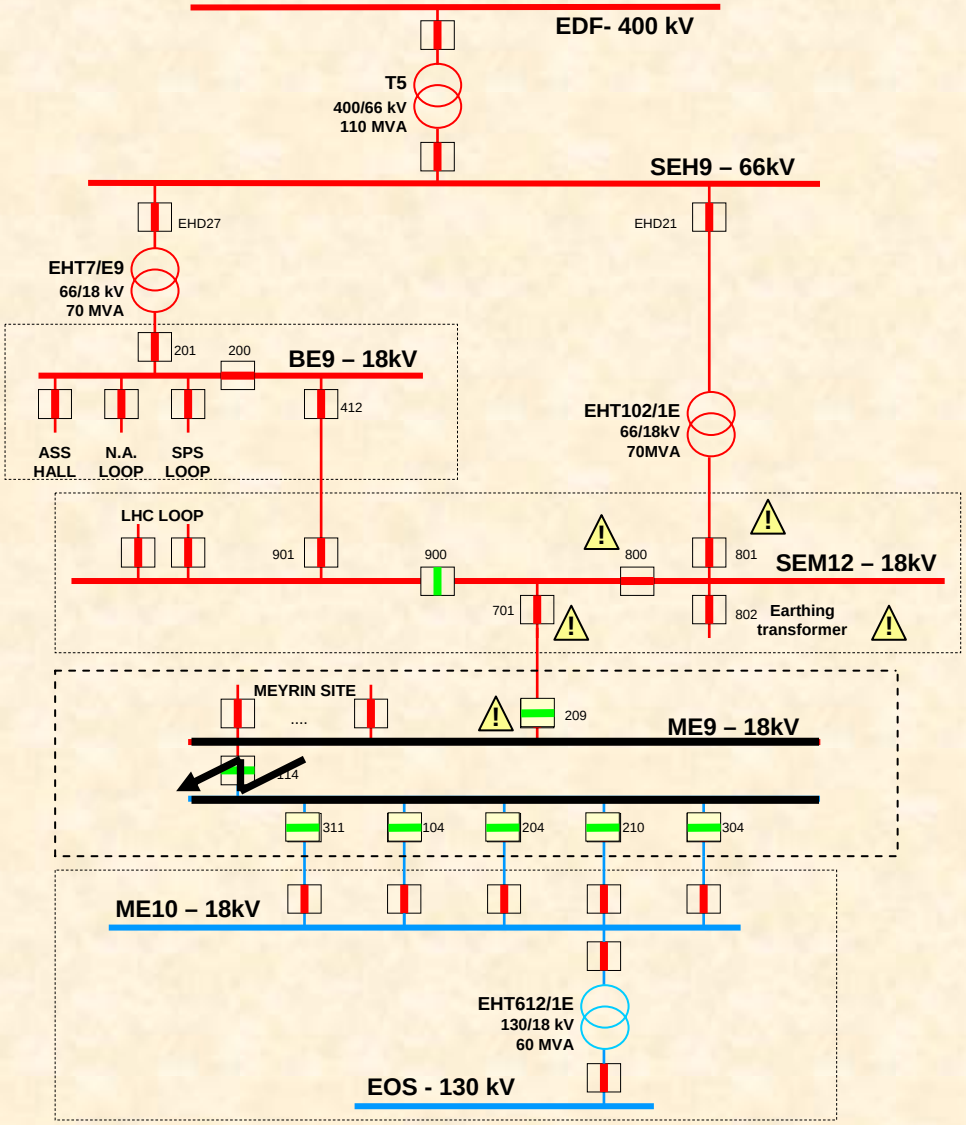


2nd fault after "autotransfer system"

- 3 ph. detected by all prot. but blocked
- Protection trips at 66kV source

Black Saturday

29th July 2006: selective



CERN HV Electrical Network

⇨ Protection system

- Switchgears from all ages: specific clearing time for each generation
- Different technologies in protective relays

  40% digital, 40% electronics and 20% electromechanical

Plan for the selectivity

- Database of the selectivity settings (HV protection) is completed to 60%
- Short circuit calculation completed and under approval (TS/EL)
- **Should be completed by April 2007**.
- No presently simulation of the complex CERN network
- Need change of hardware (40% digital, 40% electronics and 20% electromechanical) to implement selectivity between 66kV and 18kV levels.

Schedule:

- **April 2007:** proposals for selectivity for 18kV network. Implementation of new settings if time discrimination is OK but anyway auto-transfer system (BE9, SEM12 and ME9 substations), north area, *west area*, LHC-1 and LHC-5 will continue to provoke trip at 66kV level
- **January 2008 :** implementation of solutions for the previous areas and for the main substations
- **By end of 2008 :** selectivity for all CERN HV network

Recommendations:

- To complete the survey of the settings allowing to check the level of selectivity and to produce a proposal for implementation.
  (April 2007: proposal presentation at ATC)

- To implement asap the settings and change the necessary hardware

- To model the CERN network (Simulation program as EMTP or equivalent) to be able to simulate the network (selectivity, incident,…)

- Medium and Long term: review of CERN electrical network for new projects (Linac4, SPL, PS2,…) and future energy perspectives
  O. Bayard wrote :"L'alimentation en électricité du CERN 1957 à 2007" (CERN/ST/96-01; rev. Feb 1997). New vision will be necessary.

The safety electrical networks at CERN

by Anne FUNKEN (TS/EL)

Levels of availability of the electrical supply (400V distribution level)

Types of supply	See mains perturbations ?	Switched off by AUG ?	Back up by Diesel set ?	Downtime ?
 Normal **EBD**	Yes	Yes	No	Yes Mains downtime
 Assured **EAD**	Yes	Yes	Yes	Yes 30s to 90s
 Safety **ESD**	Yes	No	Yes	Yes 30s to 90s
 UPS **EOD**	No	Yes or No	Yes or No	No Battery autonomy : 10min to 2h
 48 Vdc **ECD**	No	No	Yes	No Battery autonomy : 2h to 3h

Useful for the end user to check on which network their loads are connected

The CERN assured networks

- The assured networks are composed of :
  - 14 Diesel-generator sets (6.3 kV, 3.3 kV, 400 V), stand-by mode
    total installed power : 17.5 MVA
  - 17 PLCs Normal / Safety
  - 29 main switchboards (18 kV, 3.3 kV, 400 V)
- The implementation of the assured network is different for each site :
  - Meyrin
  - SPS with North Area and CNGS
  - LHC

SPS Areas

- BA1 to BA5, CCC, BA80 :

  3.3 kV safety network supplied from the 18 kV Meyrin assured network (800 kVA, 3.3/.4 kV transformer in ME59. 4 km link), 250 kVA available on each point

- BA6, BB6 and BA7 :

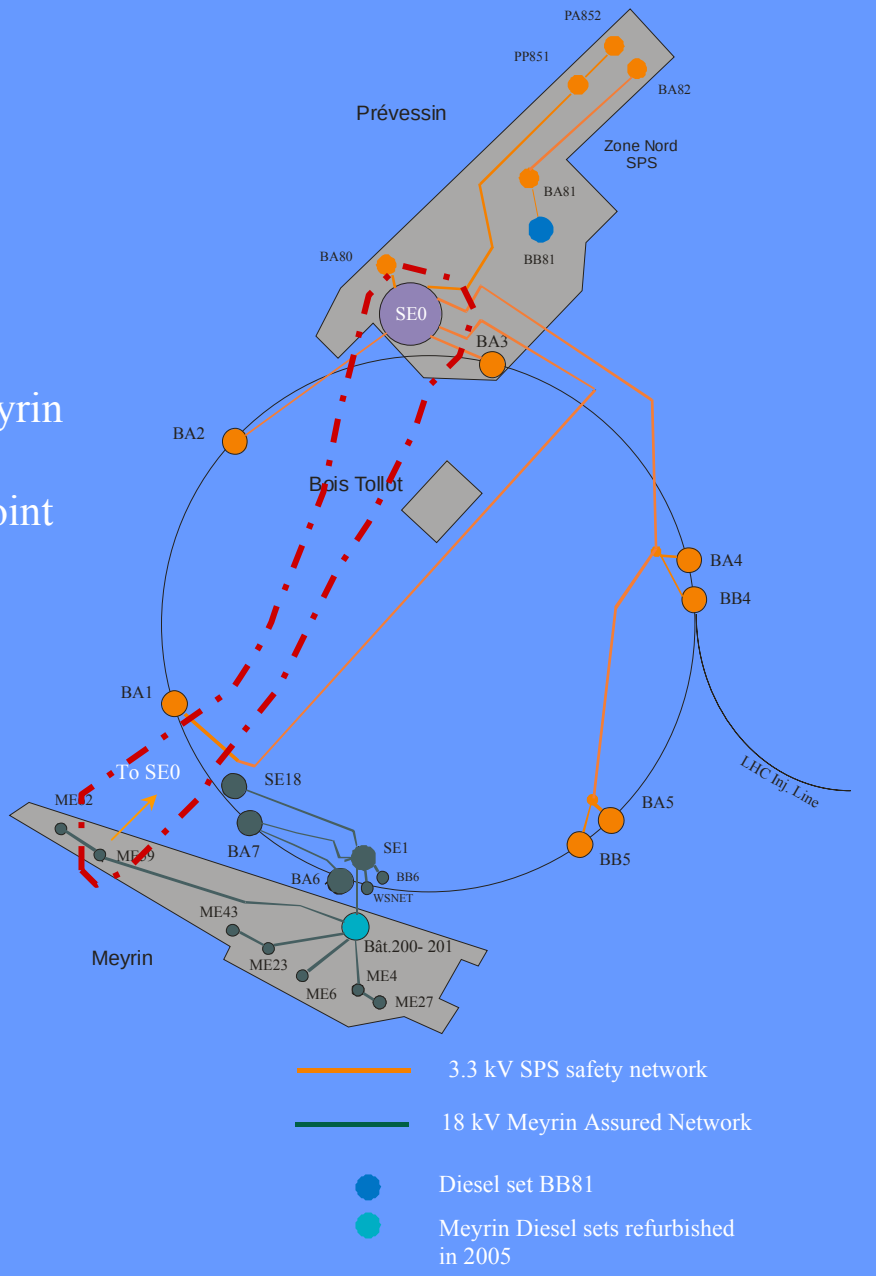
  18 kV distribution supplied from the 18 kV Meyrin assured network

- BA81, BB81, BA82 :

  3.3 kV network supplied from the dedicated 1250 kVA, 3.3 kV Diesel-generator set in BB81

- CNGS, TSG4 :

  EAD switchboard in TSG4 supplied from the normal network due to the lack of assured power in BA4, BB4



Recommendations:

- Tests AUG and Diesel should not be delayed
- Annual calendar for all the tests (AUG, diesel, 400 kV) must be defined in accordance with the machine operation schedule.
- Any changes on the safety network should be documented and approved. (who: TS/EL group leader).
- Safety network: “if you change anything on a safety system, it’s mandatory to retest the system”. Recommendation to group the modifications before the tests except if it’s really vital.
- Safety network: clear list of equipments presently on the different networks should be available and easily comprehensible by the users.
- In case of “29th July incident” type : reconnection priority list must be established and known by the different groups
- The type of electrical supply required for LHC star points and safety systems must be clarified. All star points linked to safety systems should be fed on UPS. Survey under progress by TS/EL, equipment owners and Paul Proudlock. Autonomy should be defined and approved (ICC, LTC)

Recommendations:

- LHC evacuation systems (sirens) are presently supplied by the assured network but should be on the safety network

- Diesel tests on 4th December 2006: 14/14 Diesel-generators sets did operate correctly and 16/17 PLCs Normal/Safety with correct function.
  but no feedback from users !!!!
  It would be important to know the users who should have been supplied but were not and users who should not have been supplied but were?

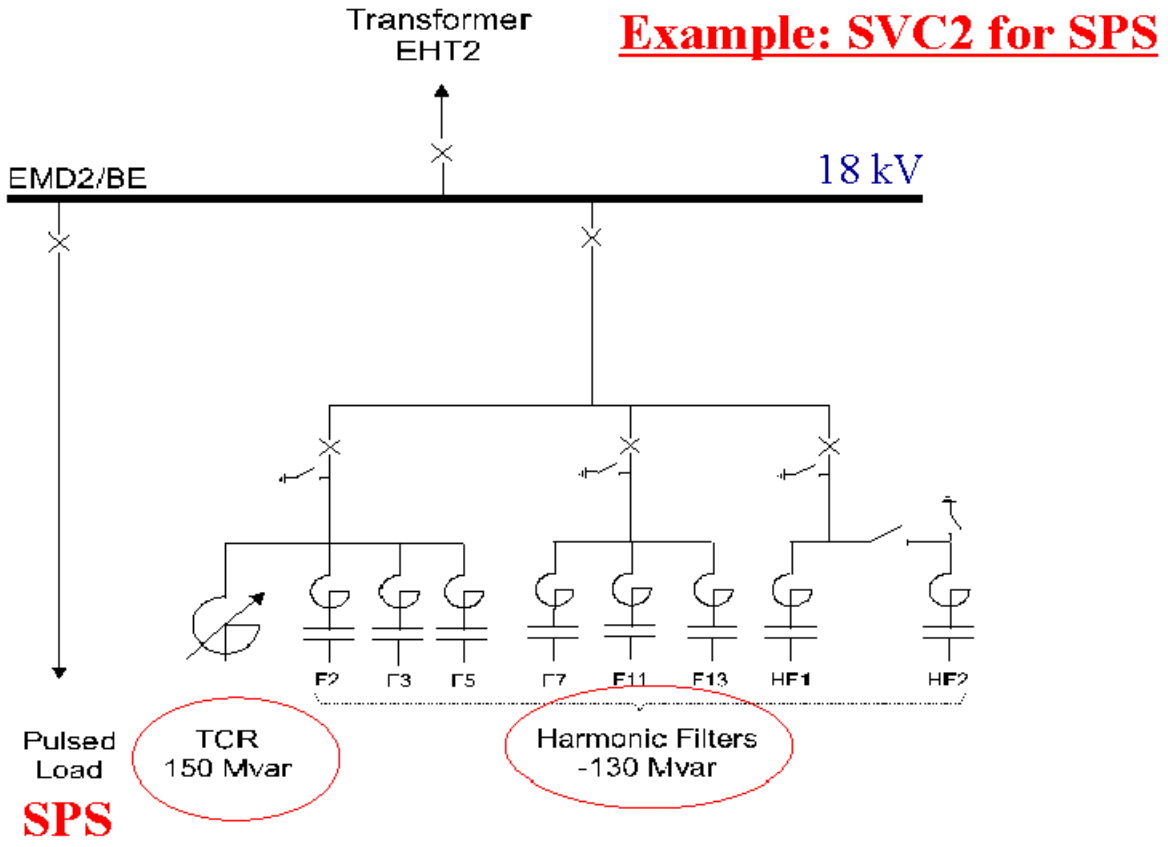
- CNGS (BA4) : transfer of the EAD switchboard in TSG4 to the assured network (presently supplied from the normal network due to the lack of assured power in BA4, BB4)

- TI2, TI8 (BA7, BA4) : transfer of the smoke extraction systems to the safety network

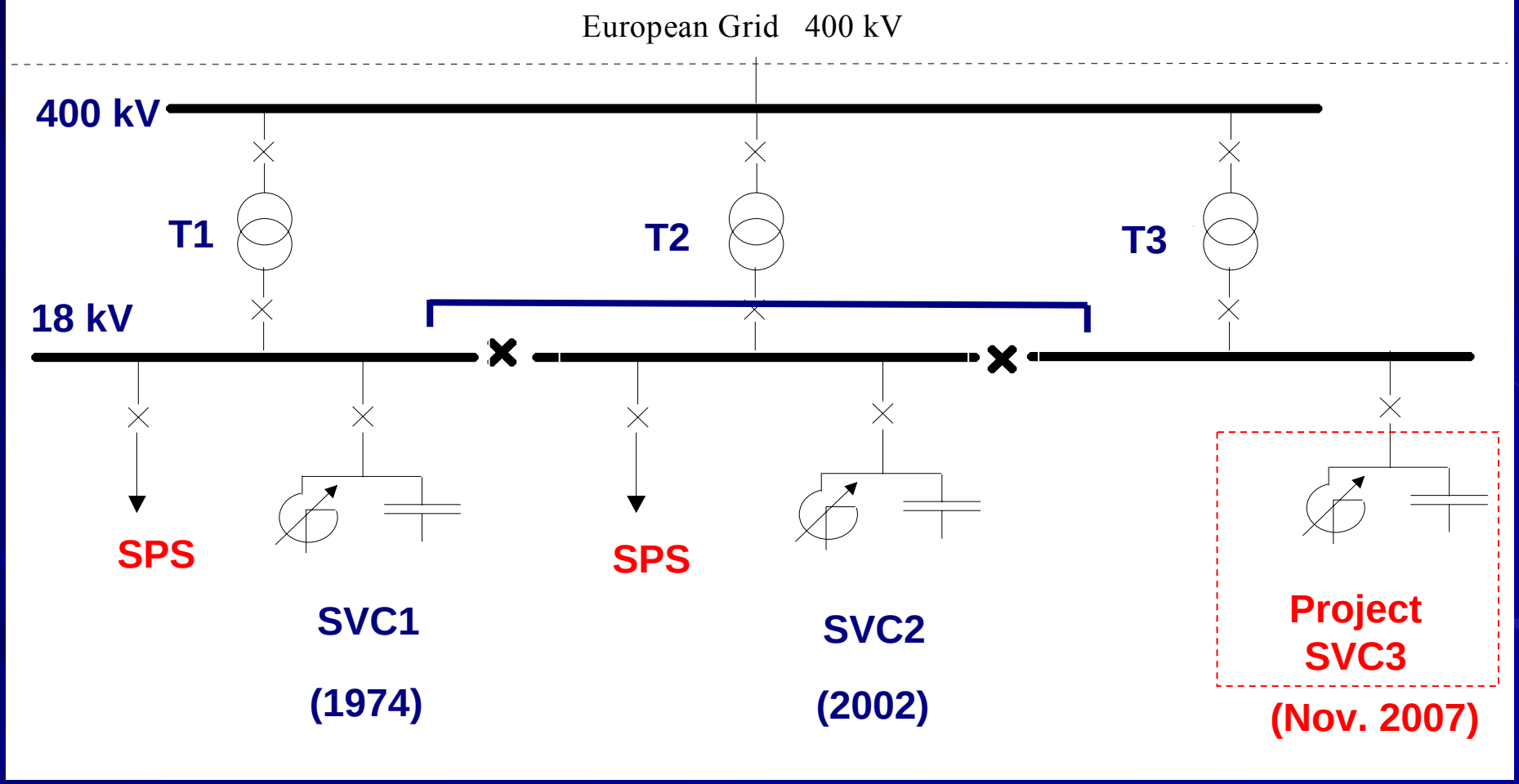
- 3.3 kV safety network of SPS: review the power balance and correct start-up of safety equipment in the worst case (i.e simultaneous starts of big consumers like smoke extraction systems when the safety network is on Meyrin diesel sets,…)
  Medium term: Meyrin strategy (centralized with redundancy) or LEP/LHC strategy (decentralized diesels per point).

The situation of the Static Var Compensators at CERN. Risk analysis, maintenance strategy and consolidation

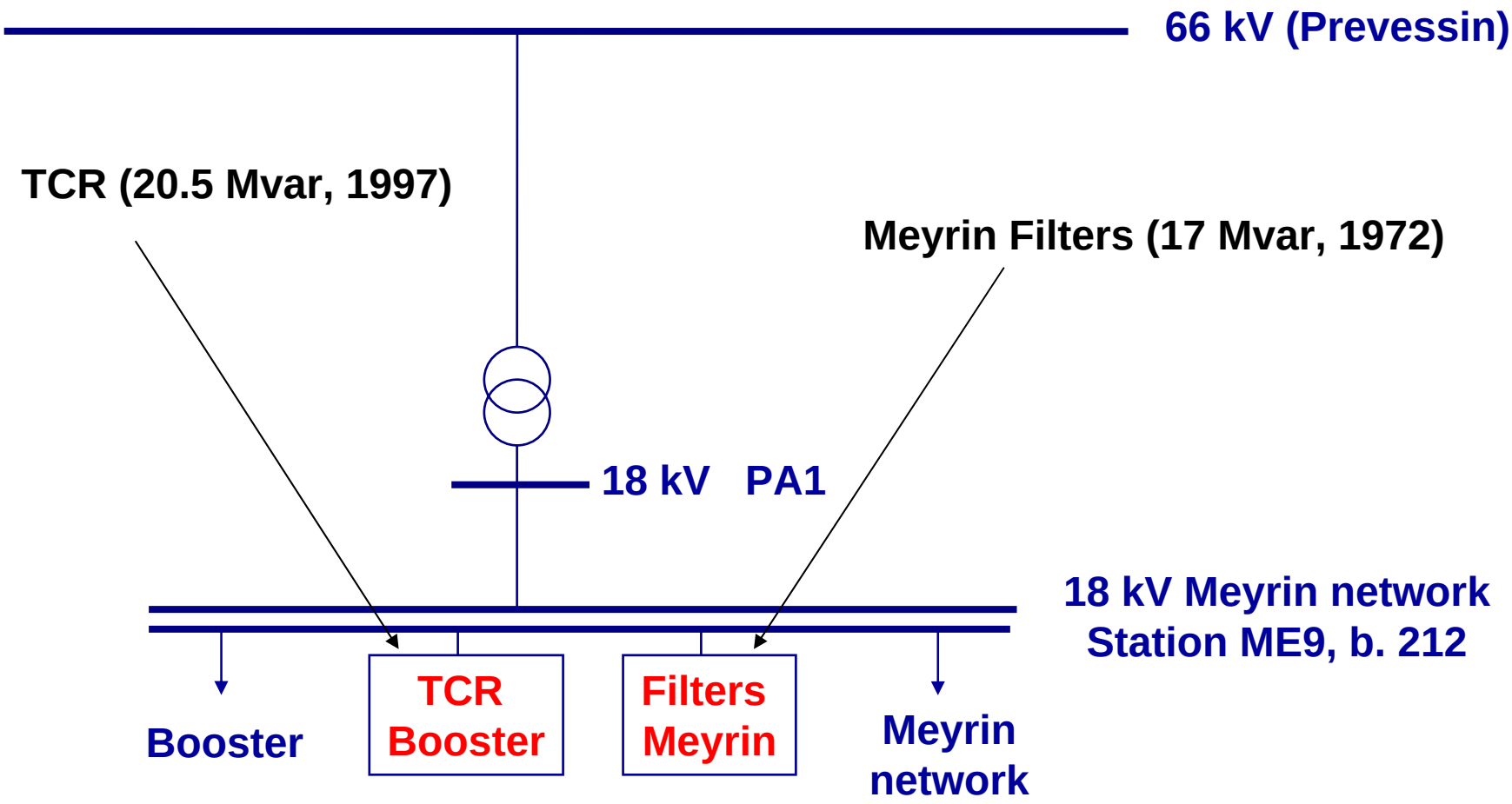
by Karsten KAHLE (TS/EL)



Introduction: SPS electrical network



Introduction: Meyrin network and Booster



Recommendations:

- Meyrin harmonic filters situation was presented as a high risk (ageing equipment, 35 years). The technical state should be clarified urgently (by April 2007) and presented to the ATC.

- *SCV3 (SPS) will be ready by Nov. 2007.*
- *No redundancy in 2007: SVC 1 + SVC2. (spare capacitors are in stock in case of the same problem as in 2006)*

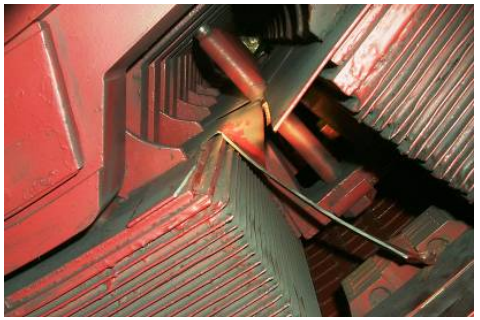
- *Saturated inductance of SVC1 presents a high risk of failure.*
- The two options (maintenance of SVC1+BB3 % complete spare parts for SVC2 and SVC3 (coils, capacitors, …) should be evaluated (MTTR and costs) before to take a decision.

- LHC SVC:
  - *Pt 2 and Pt 4 SVC will be put back in operation in 2007 (which month ?)*
  - *Pt 6 and pt 8 SVC by mid 2008 :* impact on HW commissioning and LHC start up should be clarified.

    Karsten's comment: the exact planning will depend on the availability of resources.

PS MAIN POWER SYSTEM:
What has been done from June 2006?
What will be the situation in 2007?

by Jean-Paul BURNET (AB/PO)

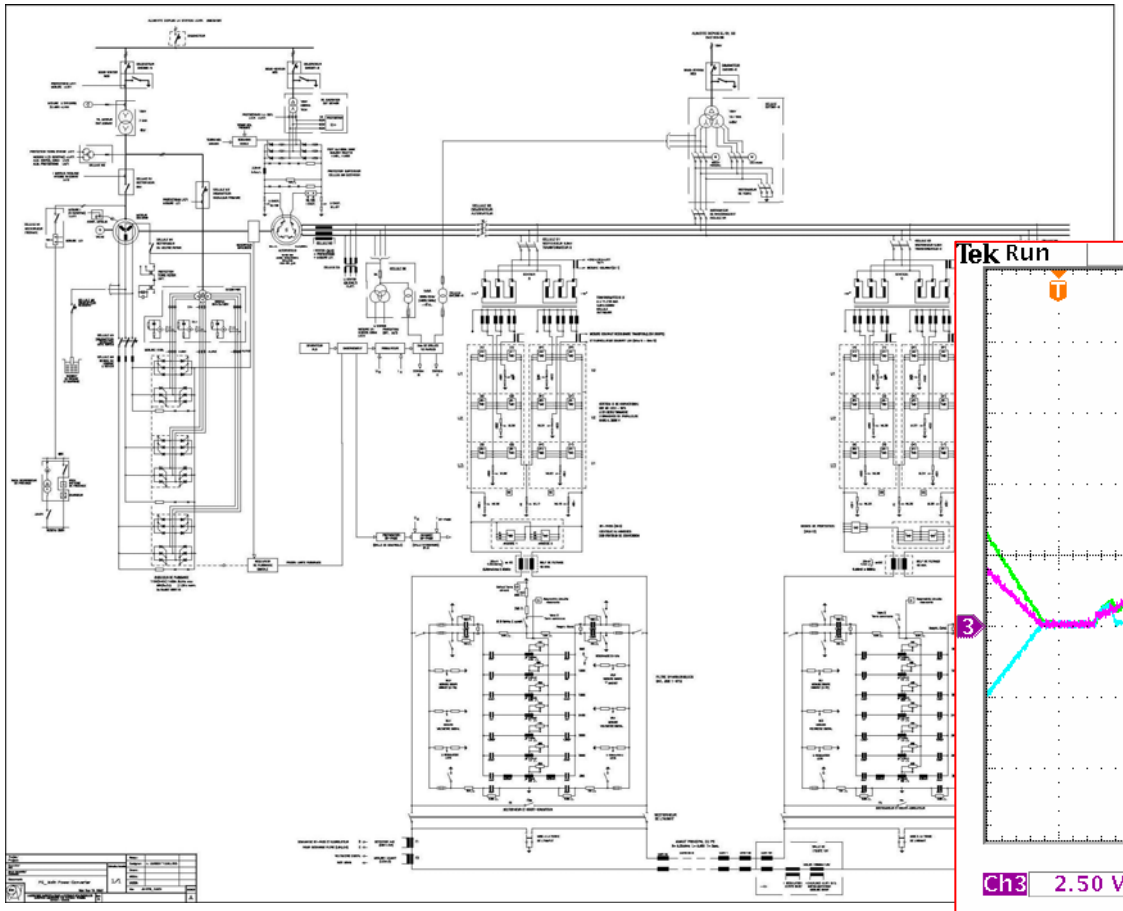


2004

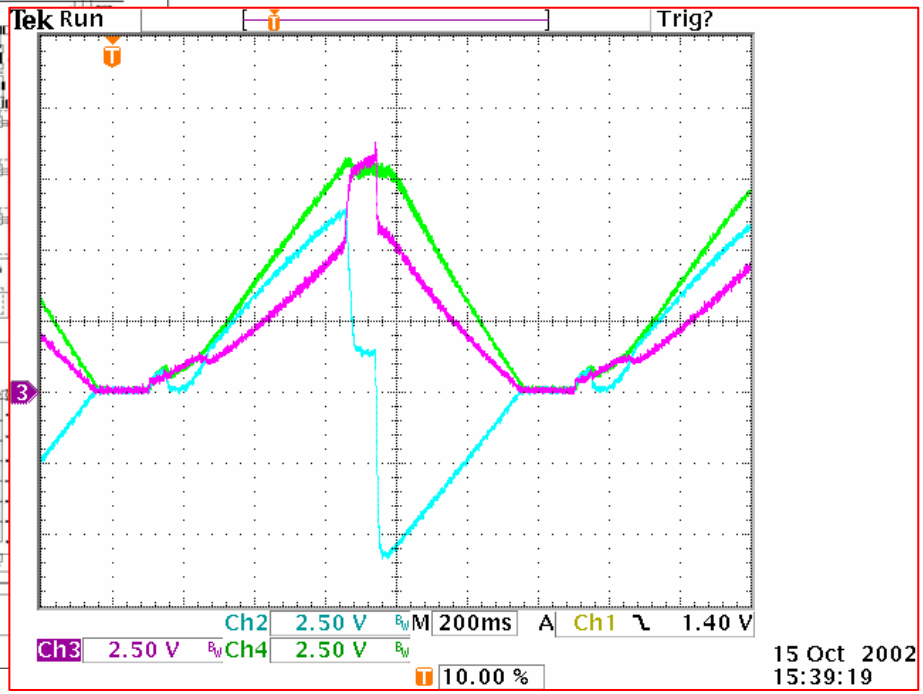
2006

History of the problems

- June 2006: Restart of the 13MVA back-up system
- 2 weeks in operation for SFTPRO cycles to fill SPS



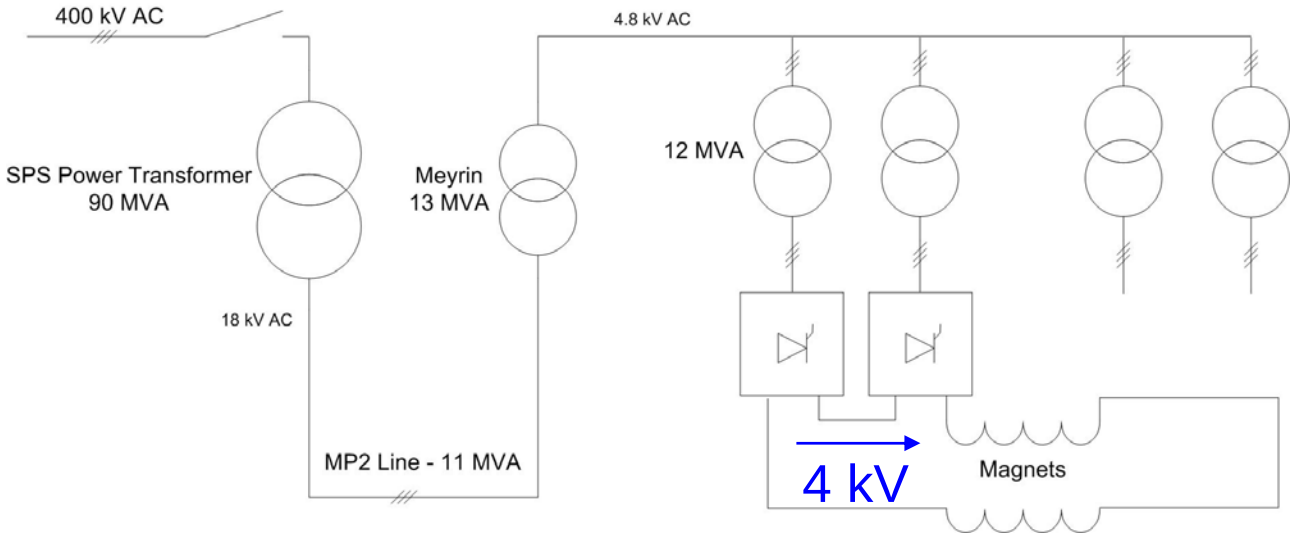
13 MVA transformer connected to SPS 18kV



26 GeV cycles

- 26 GeV cycles can not be done with two stations (9 kV)
  - The power distribution is too weak (11 MVA)
  - The overload is too high (60 MVA) for the 13MVA transformer

- Solution
  - Use only one station to supply the magnets
  - Only 4kV applied to the magnets, Bdot divided by 2.7
  - Max power divided by 2 (Reminder: Max cycle tested in 1980: 20GeV)



Conclusions

- In case of breakdown of the rotating machine, the physics program will be reduced. Here are the major scenarios:

  – **26GeV cycles alone** for LHC physics (4 per minute)

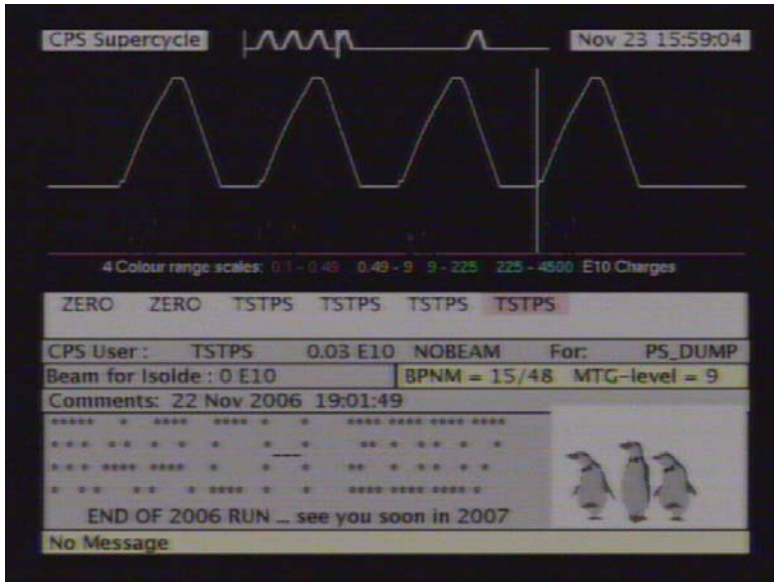
  or

  – **14GeV cycles alone** for SPS physics
    - Single injection every 14.4s (two stations mode, ~ normal Bdot)
    - Double injection every 28.8s (two stations mode, ~ normal Bdot)
    - **Double injection every 16.8s** (one station mode, **half Bdot** (like LHC cycles))

  or

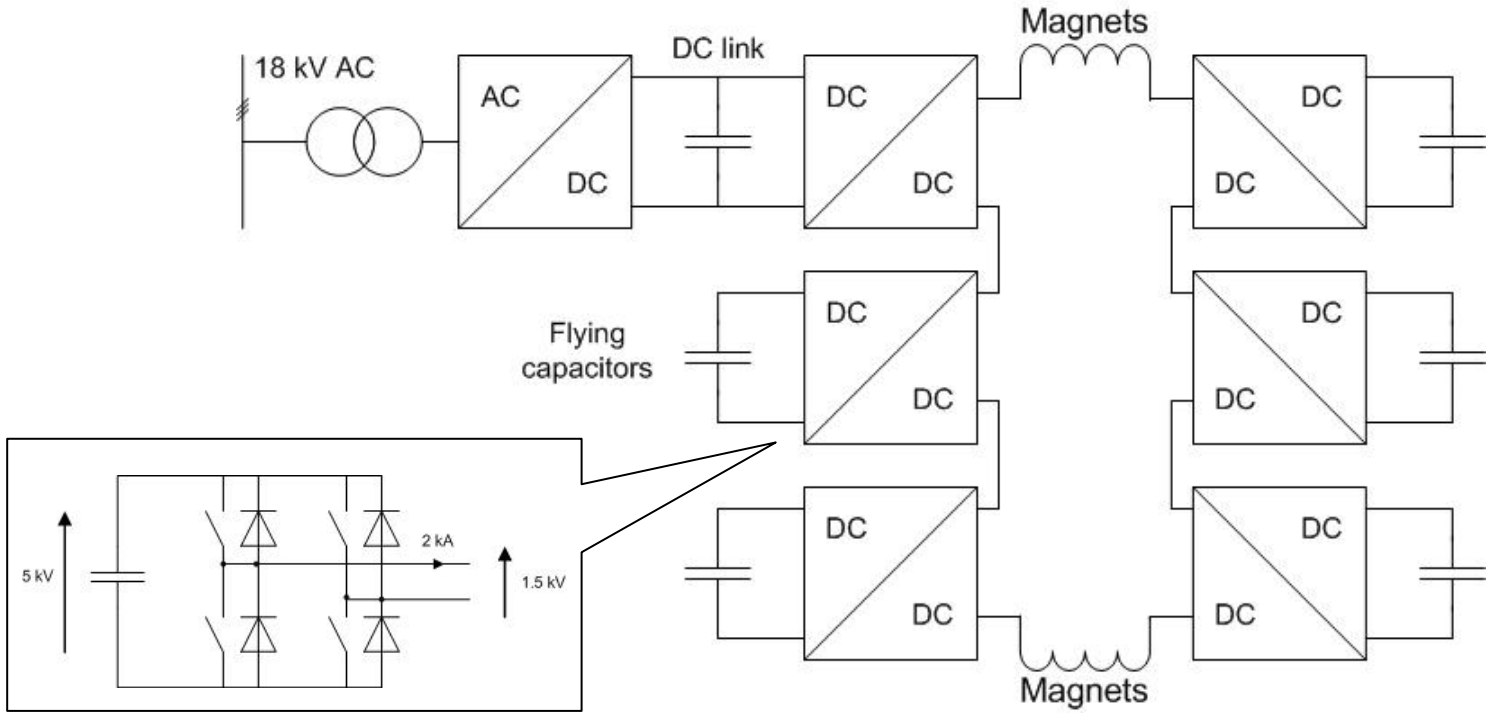
  – **Mixed cycles:** 14-20-24-26 ⇒ **one station mode**
    - 4 equivalent 26GeV cycles in a supercycle of 60s
    - Example: 2 * 14 GeV + EASTC + LHC + NTOF

- Change of mode shall be limited at one or two per day



MPS with capacitive energy storage

- Use capacitors to store energy and to exchange it with the magnets
- Directly integrated in the power converter
- Classical dry capacitors 5 kV, 1F, ~1000 caps in 6 banks (7m * 2m * 2.5m)
- New concept based on industrial products (Medium Voltage Drives)
- Outdoor containers and modular
- Turnkey system



Where are we with the new MPS?

- MS-3490/AB started 1st December 06
- Functional specification under approval
- Contract expected after FC of September

- First power test in 2008
- Installation and final power test in 2009
- Operation in 2010

ORGANISATION EUROPÉENNE POUR LA RECHERCHE NUCLÉAIRE
EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH

Laboratoire Européen pour la Physique des Particules
European Laboratory for Particle Physics

Group Code: AB-PO/JPBcc Original: English

EDMS No.: 797624

PS Consolidation Project *MS-3490/AB*

Market Survey

Technical Description
for a
60 MW power system
With capacitive energy storage

Abstract

The purpose of this market survey is to establish a list of companies with experience in the development and production of high power converters in the range of 10 to 100 MW.

This Market Survey will be followed by one Invitation to Tender during the year 2007.

Pre-series is foreseen for the year 2008 and final delivery is foreseen for the year 2009.

November 2006

CERN
CH-1211 Geneva 23
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AB
consolidation

CERN Div./Group or Supplier/Contractor Document No.
AB/PO/JPB

EDMS Document No.
xxxxx

Date: 2006-03-02

Functional Specification

NEW POWER SYSTEM
FOR THE PS MAIN MAGNETS

Abstract

This document describes the functional specification of the new main power system for the PS accelerator. This system will replace the present power system including the 90MVA rotating machine.
First, the present power system will be presented. Second, the new power system will be introduced with the major changes foreseen. The planning of the project will also be presented.

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Recommendations:

- Maintain the high level of maintenance of the existing rotating machine

- Test every year the back-up solution (13 MVA)

- Schedule an MD session 26GeV with beam in 2007 to make sure that the 13MVA is a backup solution for LHC 26 GeV cycle with beam parameter measurement in 2007 (with rotating machine and end of the year with 13 MVA transformer)

- No beam. No pulse (Don't pulse more than necessary) No "more" spare rotors

- Full speed for the new solution *(but not in operation before 2010)*
  In parallel, it would be good to test a SMES prototype with power converters for later projects (RCS machine).

Fk Bordry – Summary Session 1 ATC-ABOC days – 9th Feb 07