Electrical Power Quality

High Quality Power Supply (HQPS) experience at ESRF

POCPA Workshop 19-21th May 2008

Trieste Elletra

Presentation plan

1 – Quality of the electrical network 50Hz mains:
    statistics
    example of April 10th 2008

2 – Solutions to improve the performances

3 – the HQPS1 from 1995 to 2002

4 – the Damage

5 – the HQPS2 from 2008 onwards

1- Electrical quality of the 50Hz mains

Among all the Mean Time Between Failure source of contribution, one is widely spread and lies on the power input quality.

Even if you request a 5 years guaranty, one of the exclusion will apply: The incoming electrical network is out of specifications.

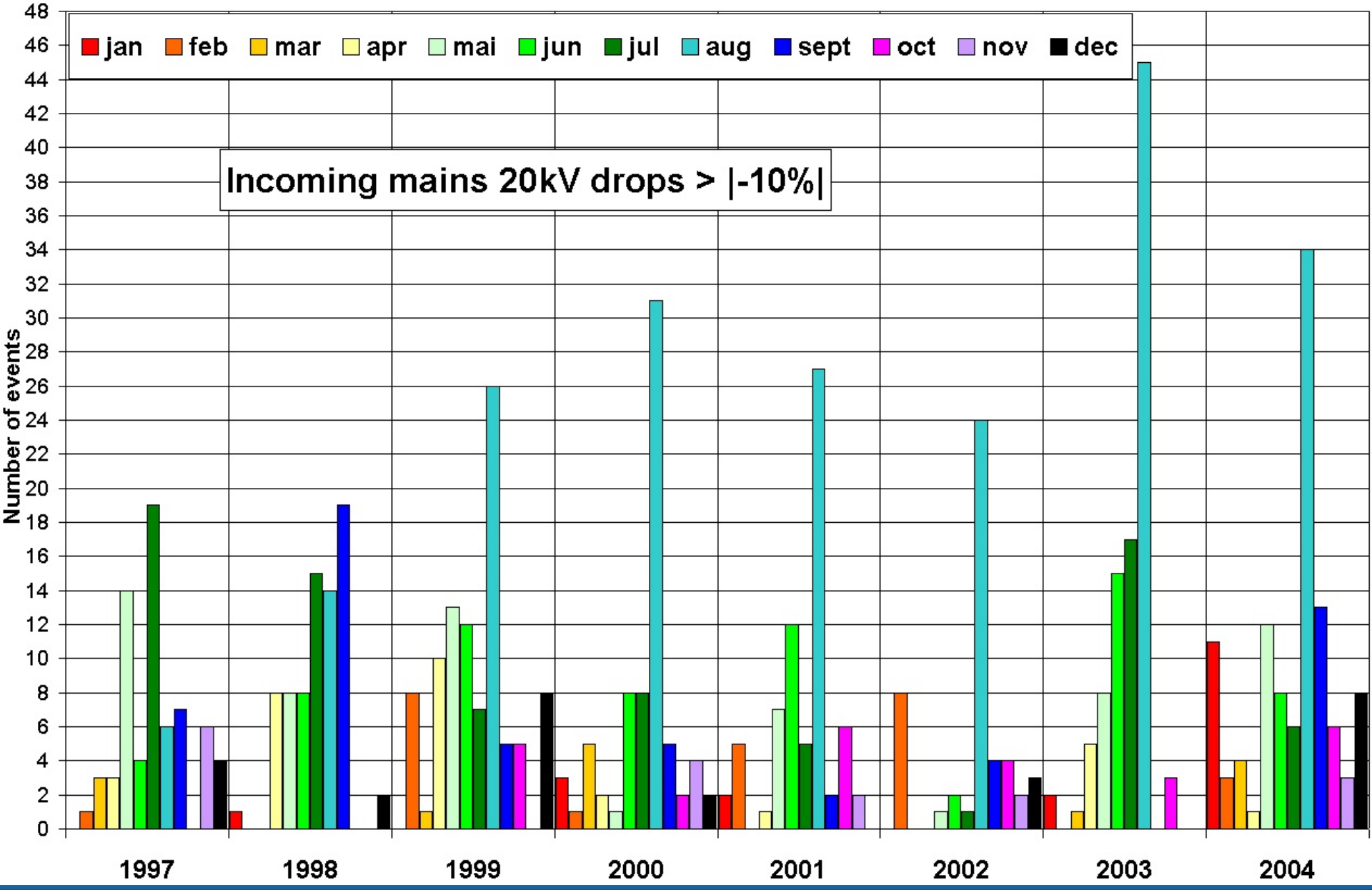
Several parameters can be observed and analyzed to qualify the power quality:

Amplitude, frequency stability, harmonic pollution, flicker, transient behaviors of parameters.

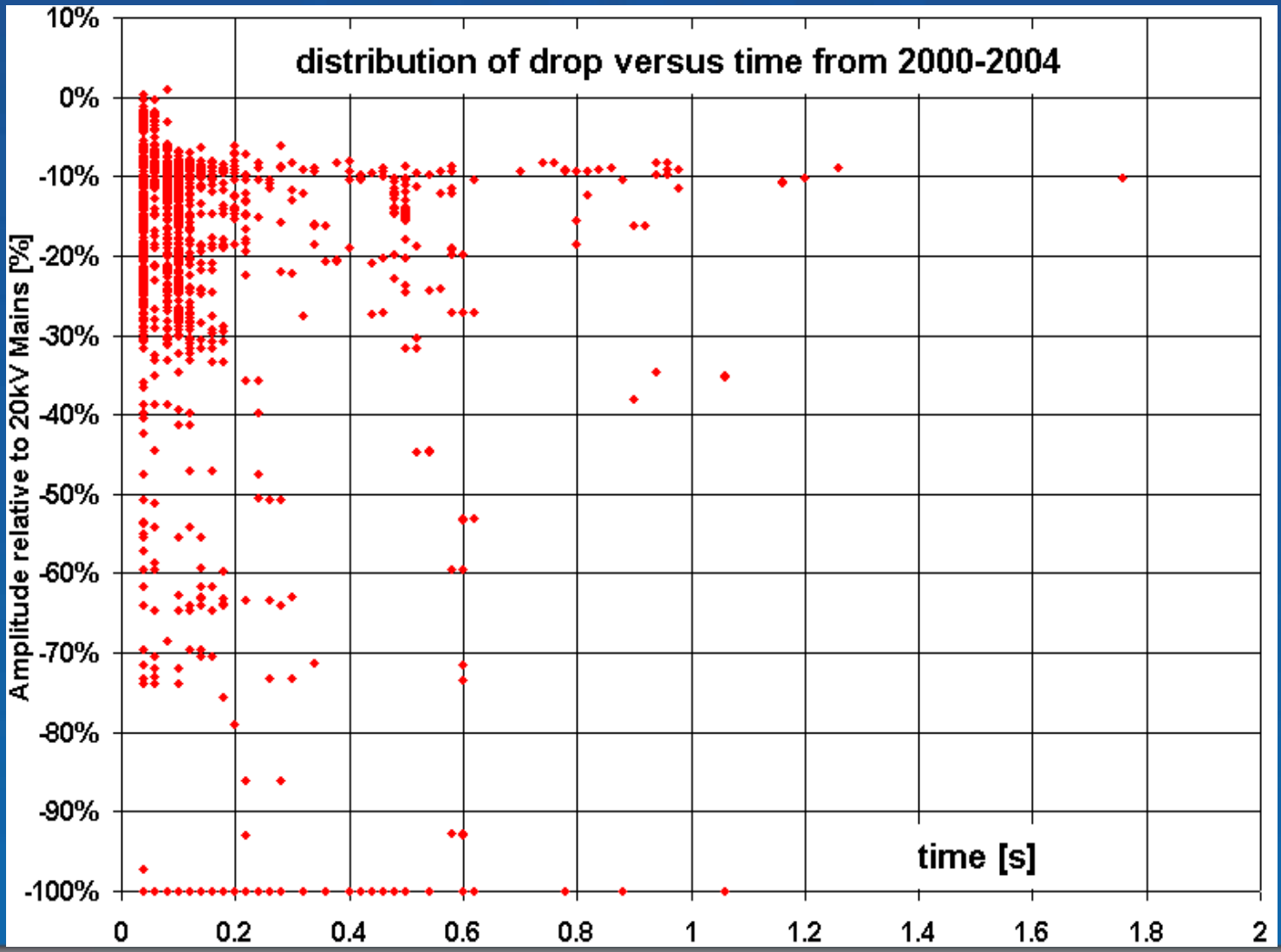
Statistics of the amplitude transient variations of the 50Hz mains.
These statistics are on the 20kV level at site entrance.

The given example is one of the representative event observed at ESRF.

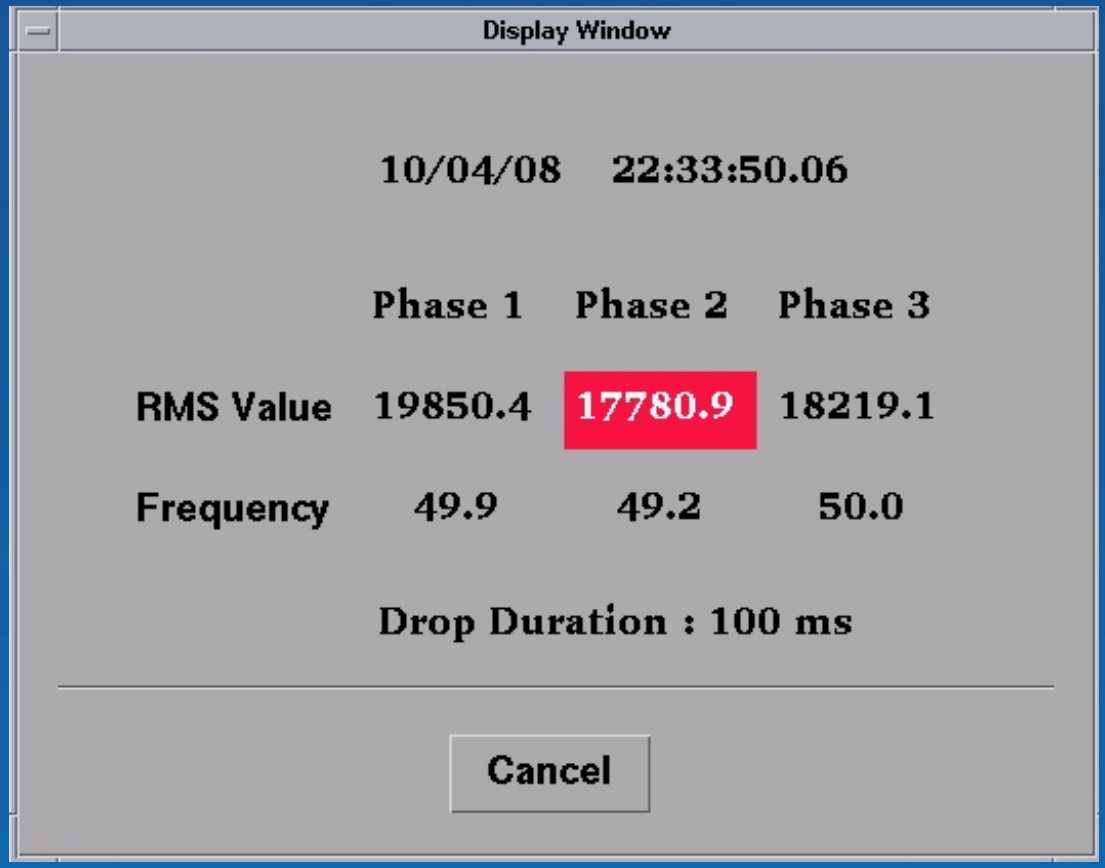
Statistics over the years



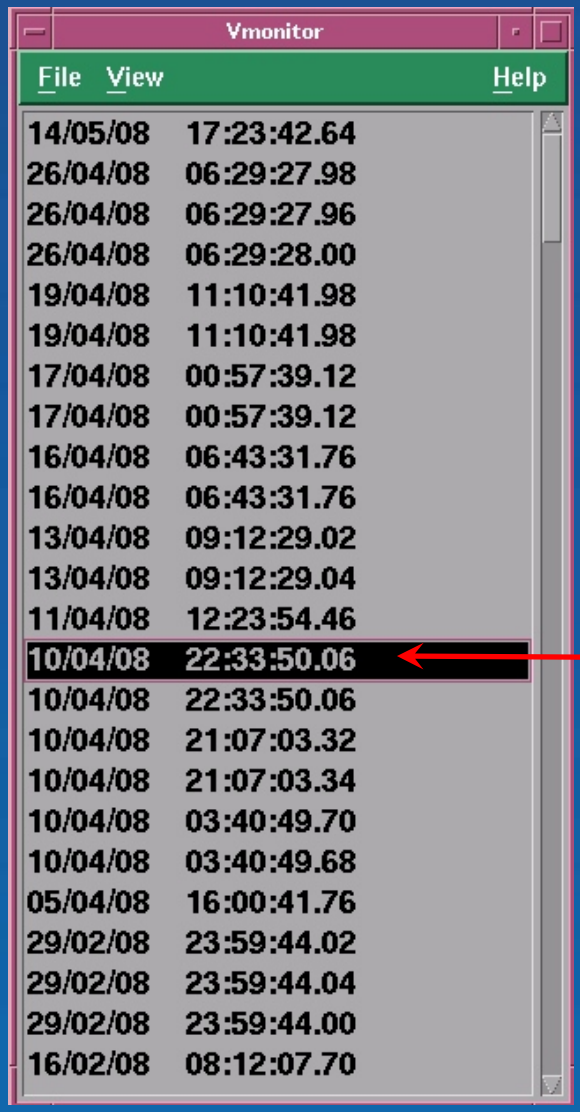
Only 6 long cuts > 3sec over 10 years

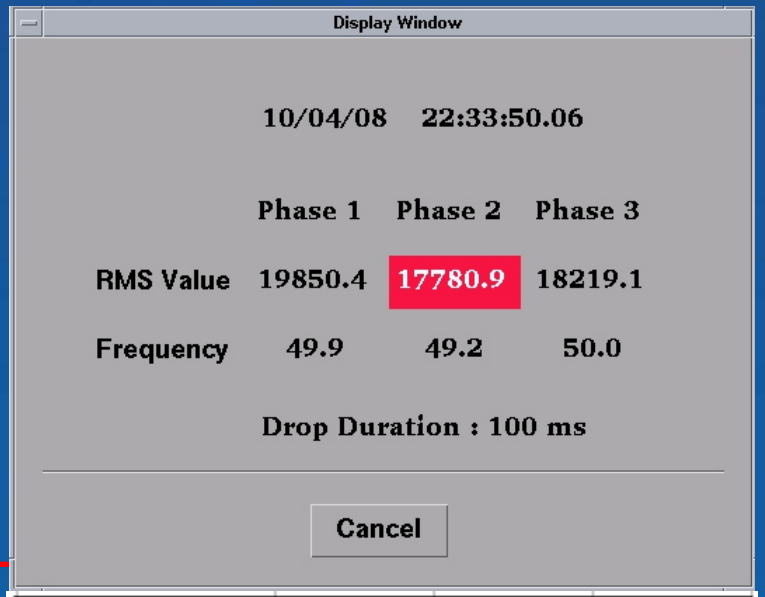


One representative example :
April 10th 2008 22:33:50 2 phases voltage sag



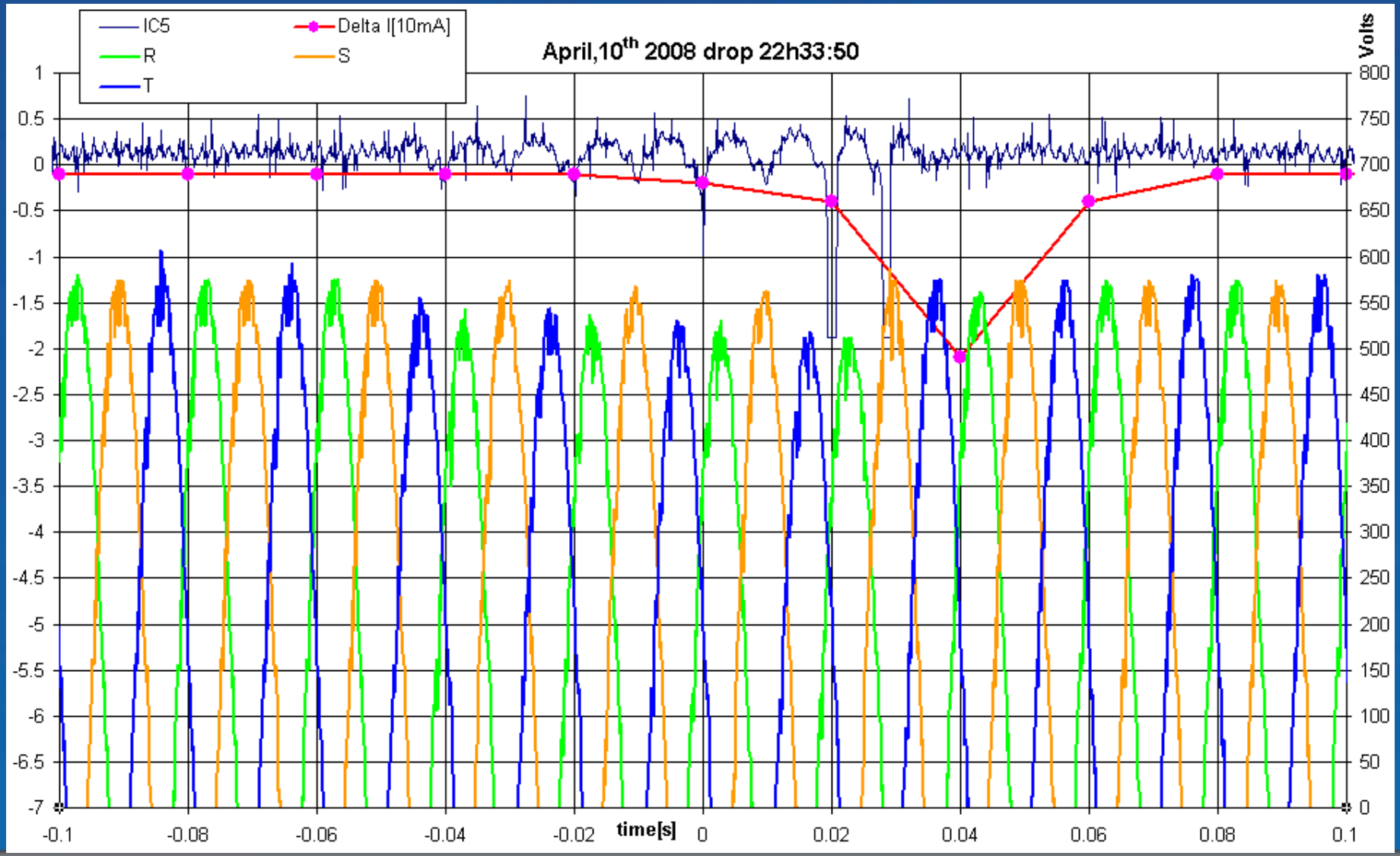
One case as an example on the statistic





20kV level	V1	V2	V3
read	19850	17780	18219
nominal	20350	20250	20360
Drop level [20kV]	-2.5%	-12.2%	-10.5%
400Vlevel	S[orange]	R[green]	T[blue]
read	562	512	518.8
nominal	575	575	581
drop	-2.3%	-11.0%	-10.7%

The effect on the QD6 Thyristor rectifier



2 – solutions to enhance the power quality

The first solution adopted by ESRF is to install a system able to compensate for all the cases.

ESRF has installed, specially designed for the 20kV, a system based on kinetic storage accumulators coupled to diesel engines.

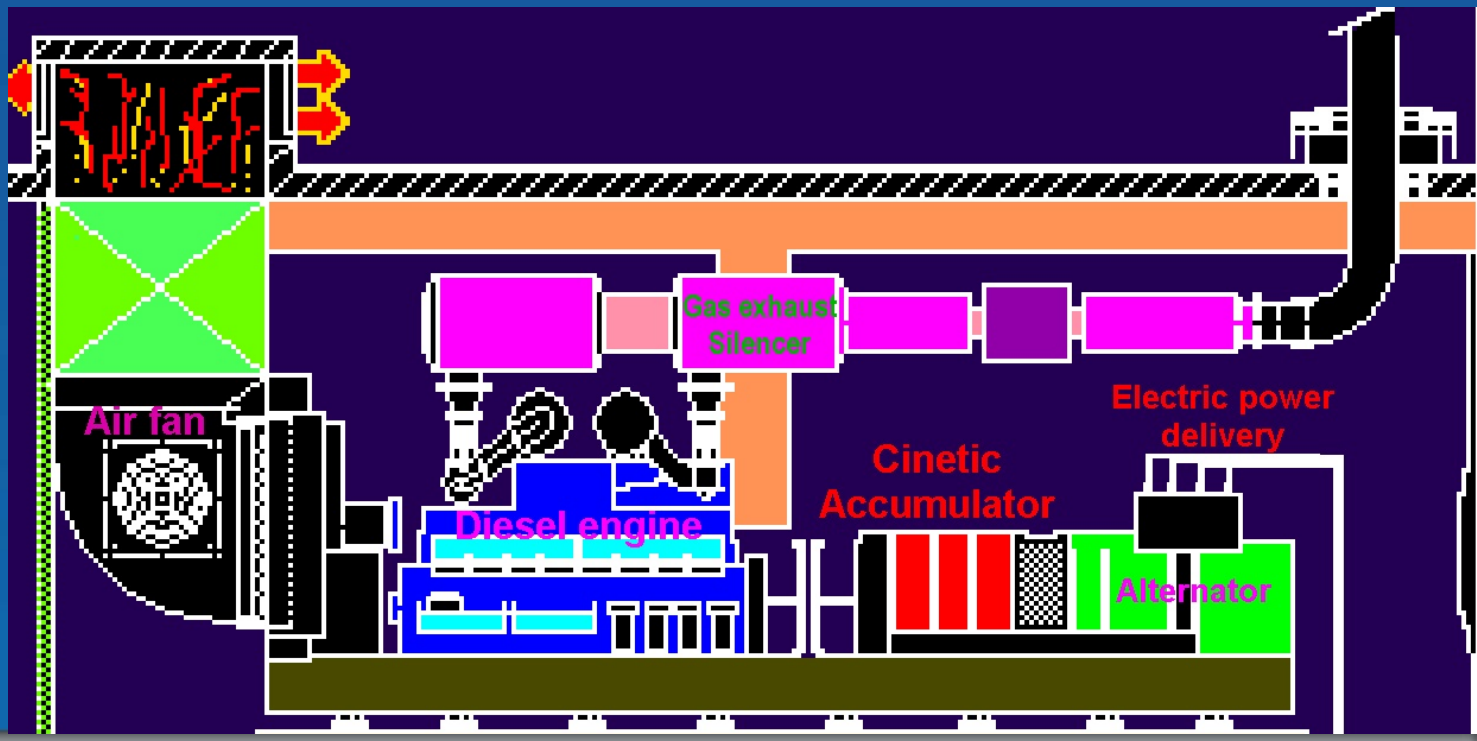
The High Quality Power Supply version 1 (HQPS1) has been used from 1995 up to 2002.

10 units of 1MVA

Redundant

(8MW peak)

10MVA 20kV

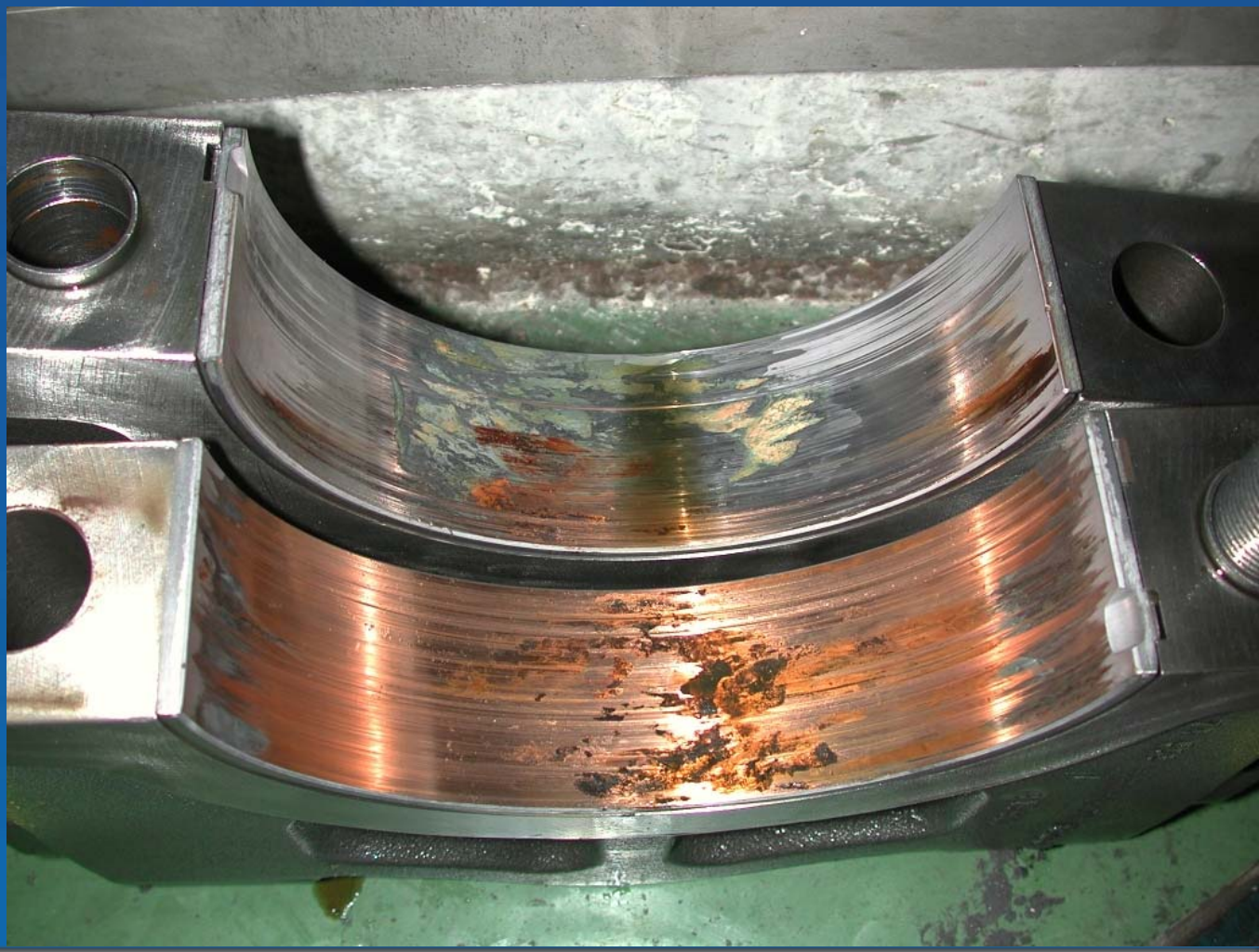


Damages after 7 years of operation

Bearings damaged
On all crankshafts
Of the 10 diesel
Engines.

Causes under legal
Considerations:
Oil quality, vibrations of
accumulators and
magnetic field induced
by remote clutch

After 4 years of
Procedure no evidence:
Decision to change
the system



Endless legal situation

The system was repaired each year before the stormy season. (~ ready in April each year)

Lot of effort has been financially engaged. (~ 2 millions Euros)

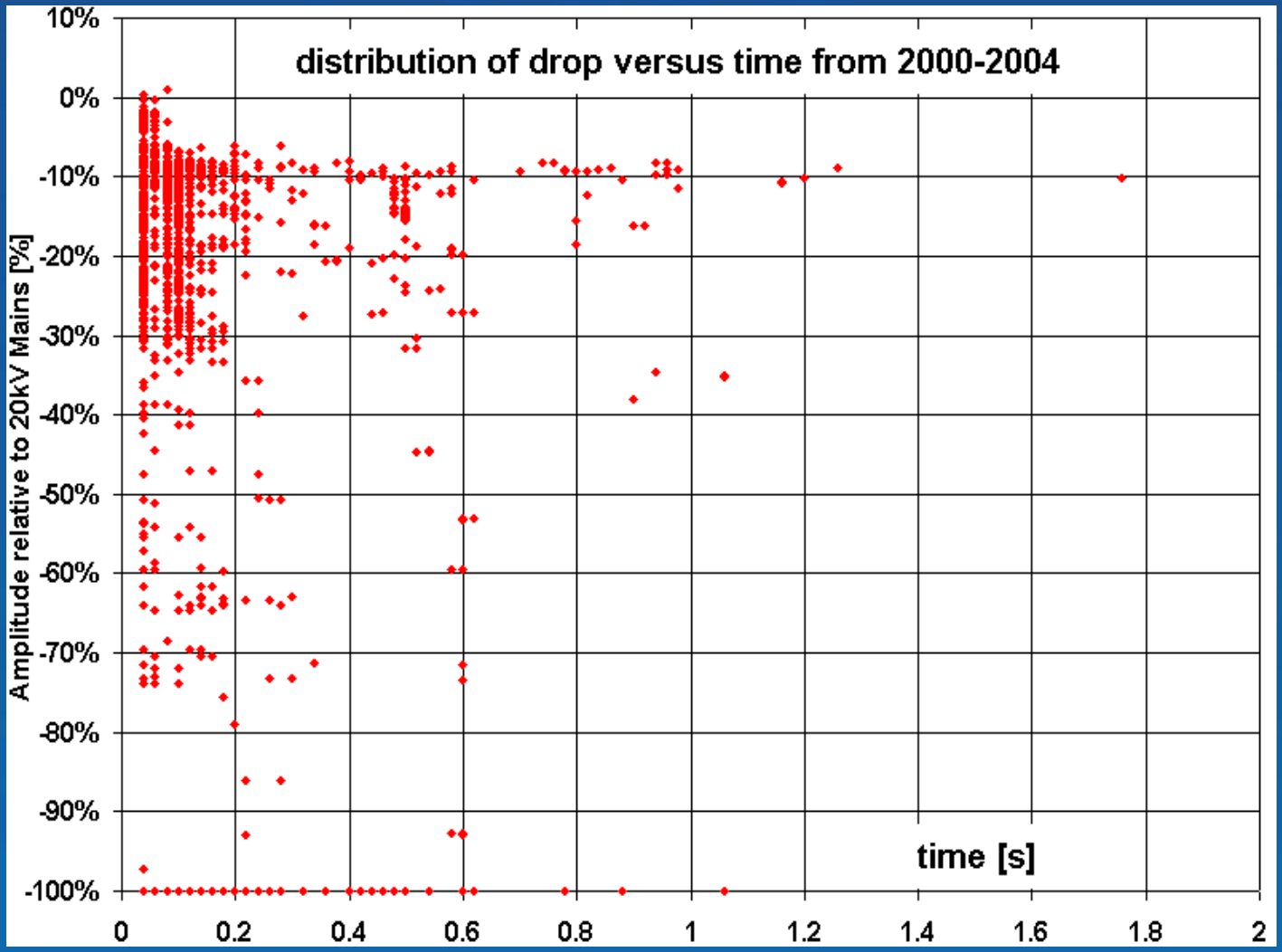
No collaboration from the manufacturer put the ESRF in a situation to invest into a new system.

The technical consequences on accelerator equipment are such that premature aging of all electrical converters, made the MTBF and repair too heavy to sustain healthy and durable operation of the facility.

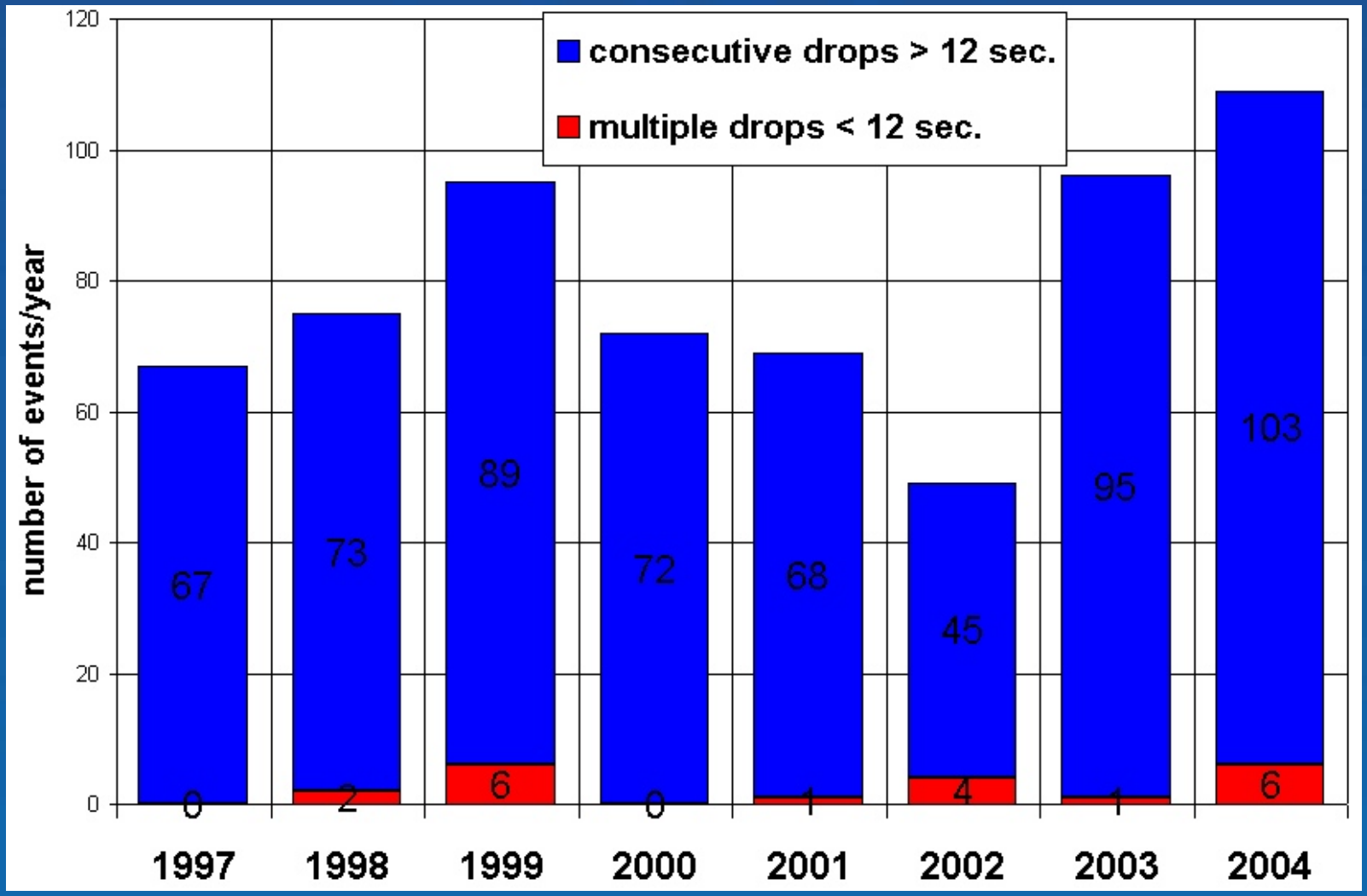
During 4 winter seasons more than 60 beam dumps where attributed to the quality of the mains, resulting in more than 116 hours lost. The ESRF User Service Mode is quoted ~14.5k€ per hour –→ 1.6M€ indirect cost due to unavailability of HQPS

No physical link between the diesel engine normally stopped and the electrical machines permanently running, has been chosen for the specification of the new system. The full power, permanent production is abandoned.

Above 3 sec of full cut , human intervention…



12 seconds of stored energy will rarely be used



Reduction of the coverage

A solution taking advantage of the experience led to avoid the long time protection

- Only the cuts below 3 seconds are fully compensated for.
- The multiple consecutives drops are taken by this new system.
- When the system is out of energy, beam dump is initiated , stop of big consumers and critical loads are powered by a separated diesel engine (single).

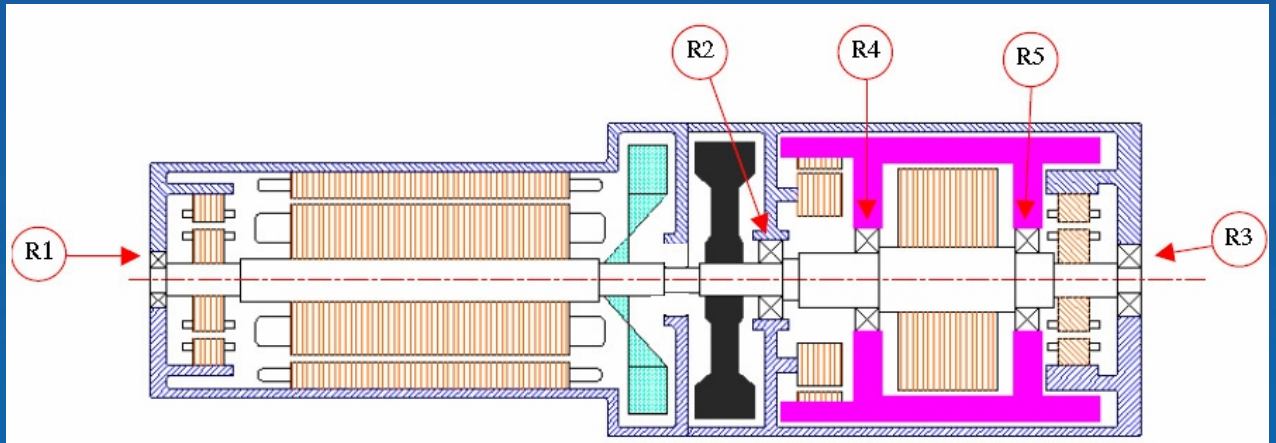
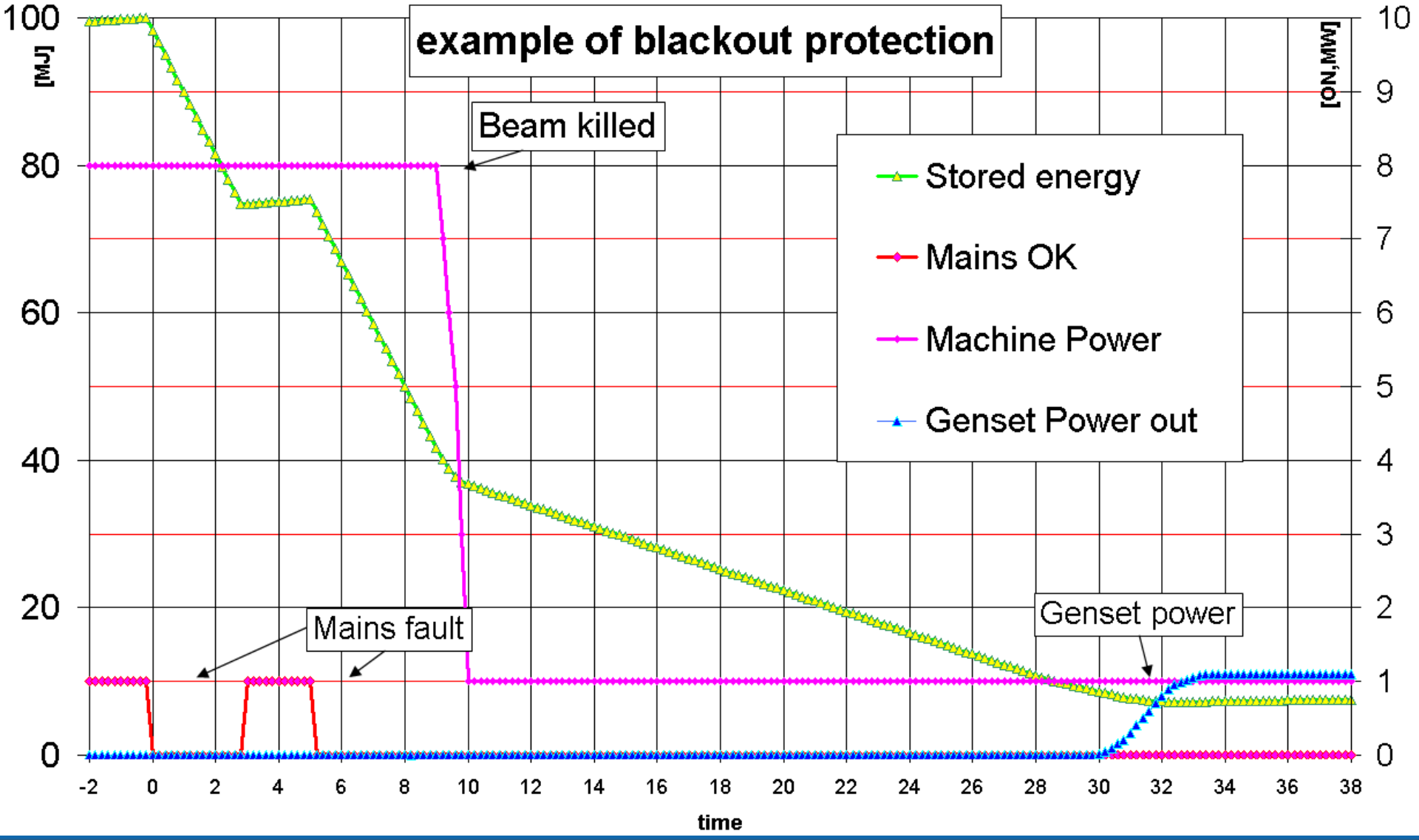


Fig. 10 - Bearings designation

How to feed the critical loads?



Key figures of the new system

9.3MW, 12 sec coverage, 14 units of 800kVA in parallel, at 20kV
~10 minutes to recharge the accumulators

The system will be in operation next month (June 2008).

- More than 100 MJ of energy can be recuperated to cover all the cases except one or 2 cases per year. (Long cut above 3 sec)
- ESRF will again be protected and the time lost due to the consequences of the voltage drops and sags will rapidly disappear.

- In addition the curative maintenance of direct and indirect destruction of equipment should again be at a reasonable level as it was with the previous installation.

- This protection is vital for the ESRF especially in summer. We suffer from more than 80 fatal lightning strikes on 10 HV aerial lines (225kV and 400kV) per year.
- It is impossible to get more than 1day overall MTBF of the accelerators without this protection

During installation

Thank you for your attention !

Any question is welcome.