Energy management, storage and quality at ESRF using fly-wheel systems

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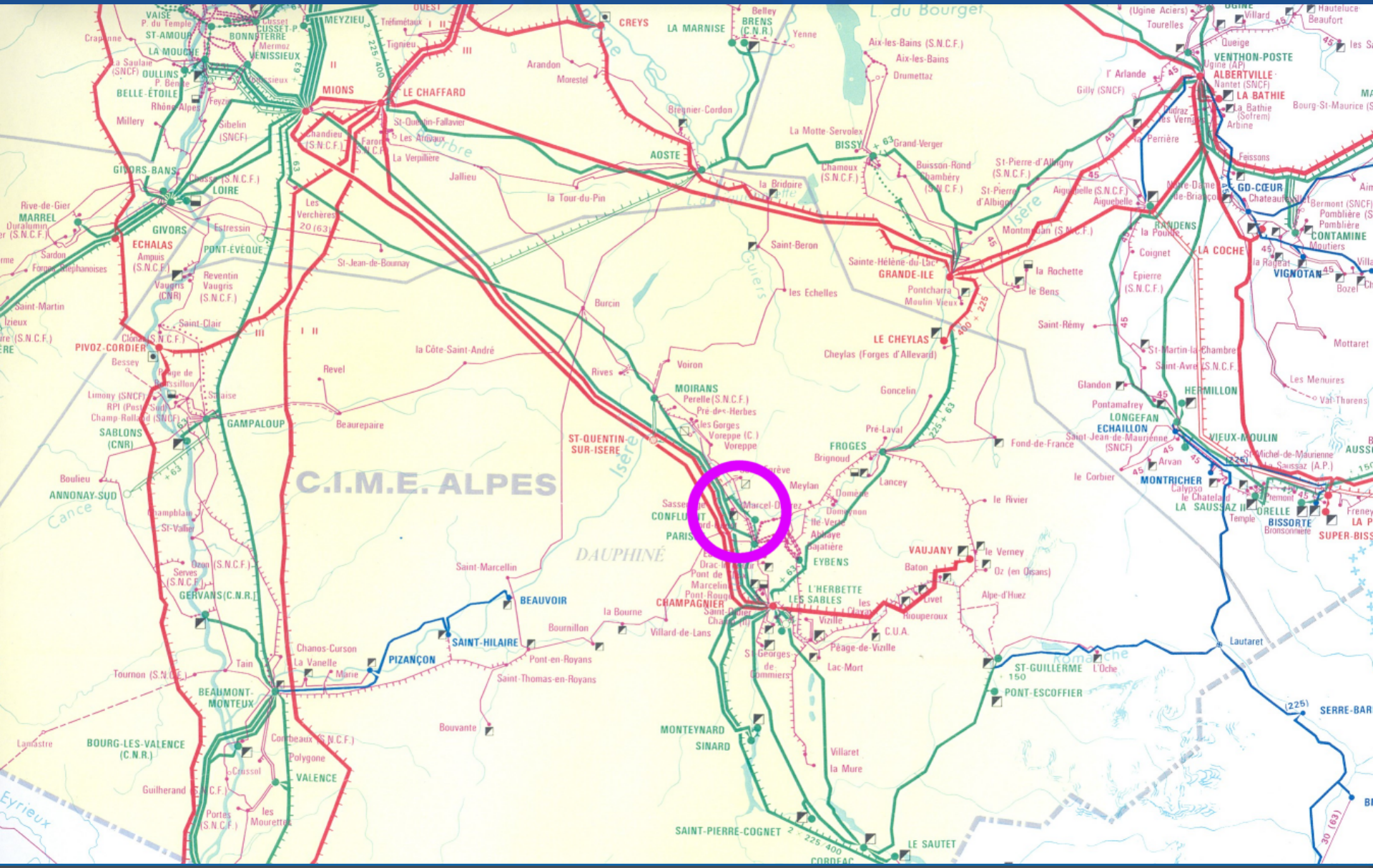
Power quality

- The first year of beam commissioning (1992) showed that the quality of electricity is vital for the ESRF.

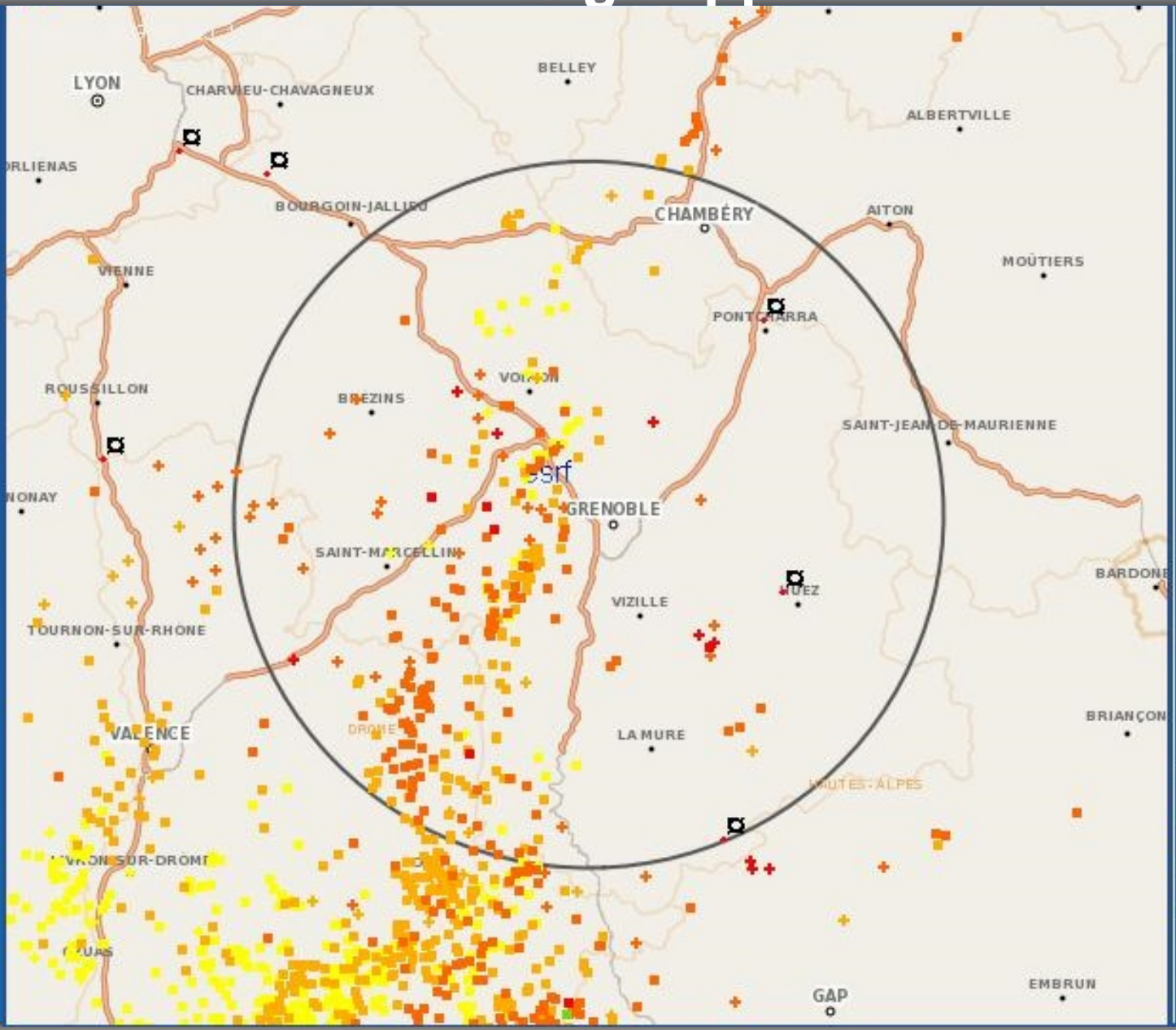
- The facility is surrounded by 3 mountain chains and is hit more than average by thunderstorms .

Hot summer Grenoble 2003

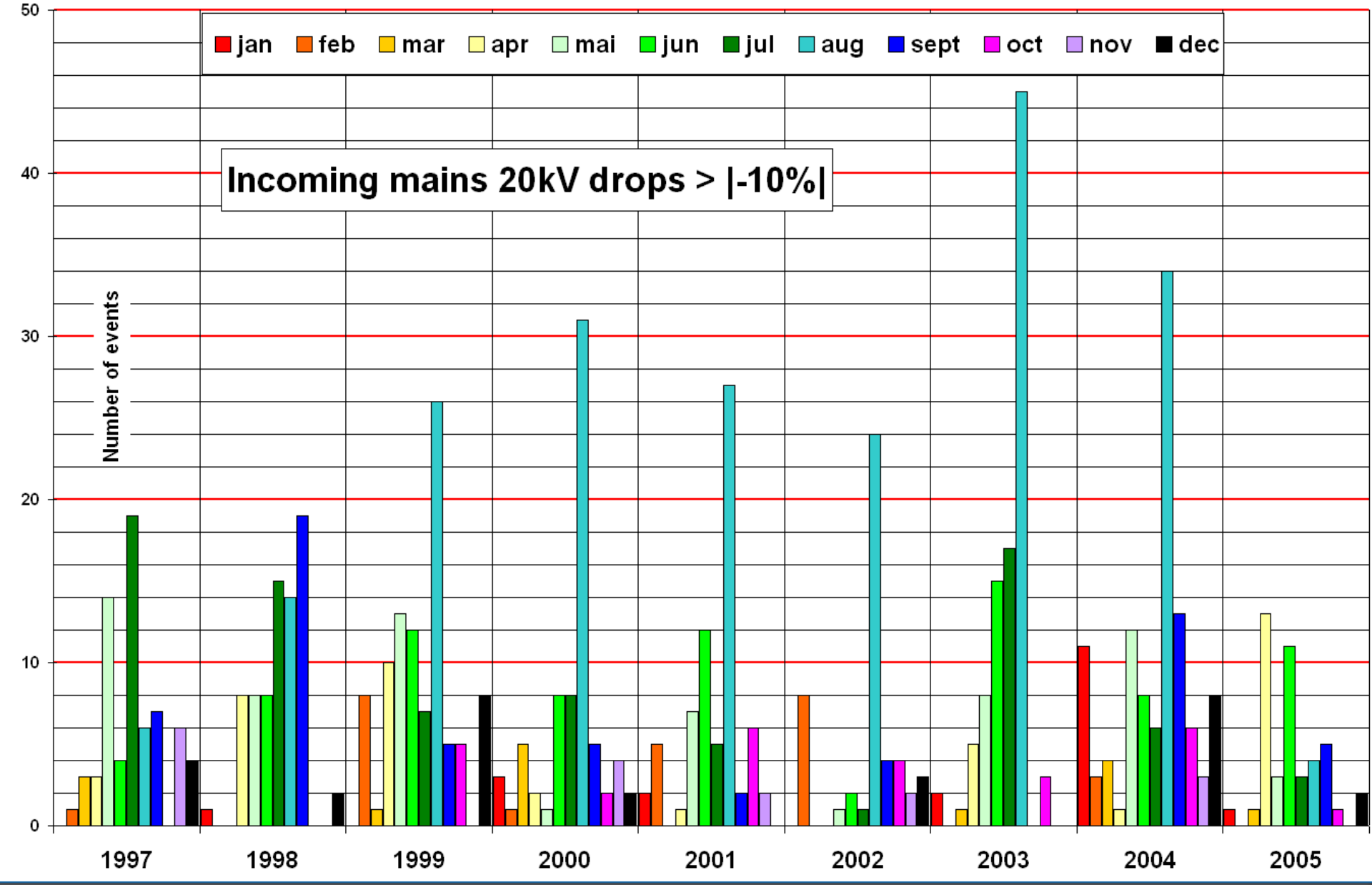
Electric distribution network



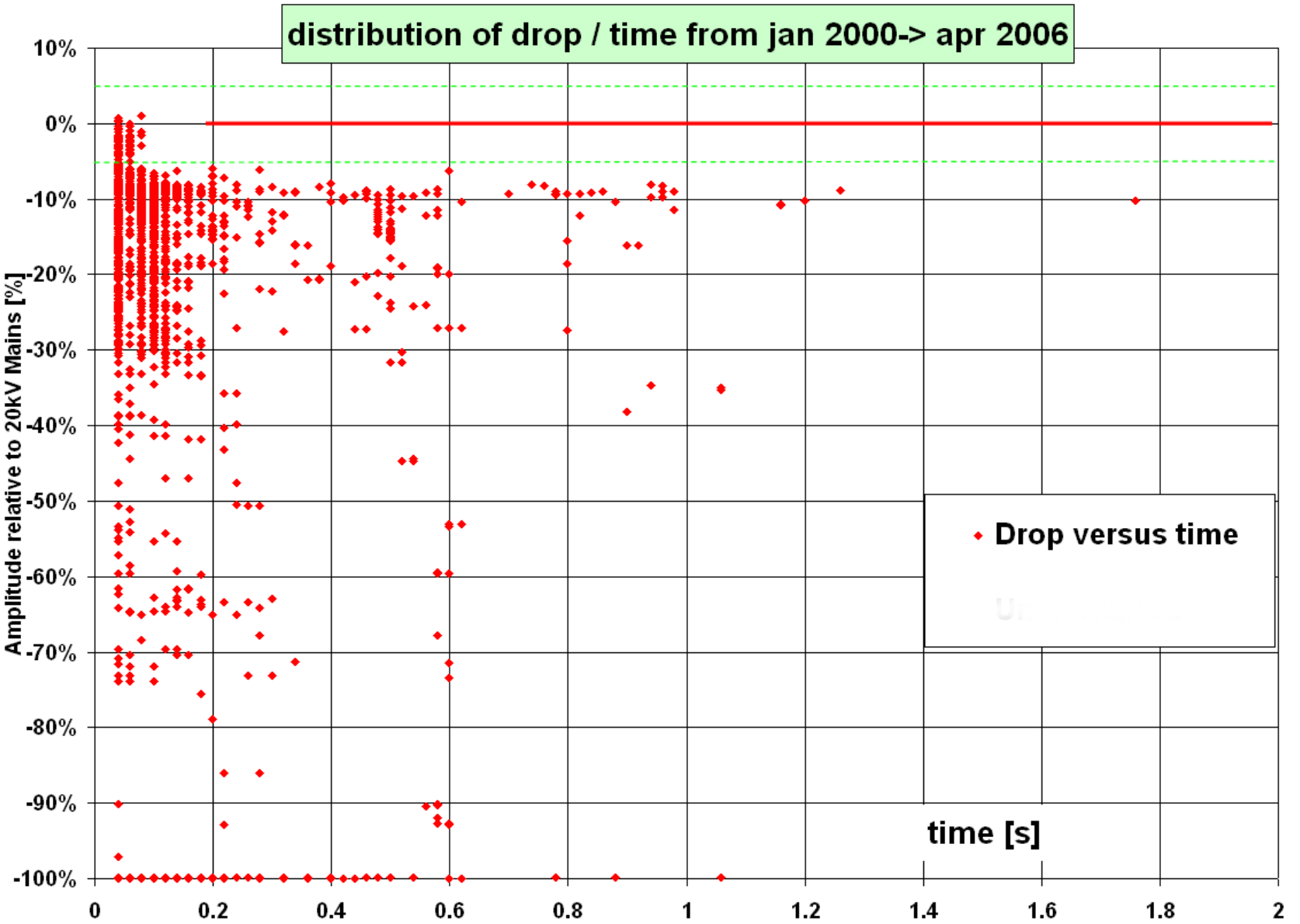
Meteorage application



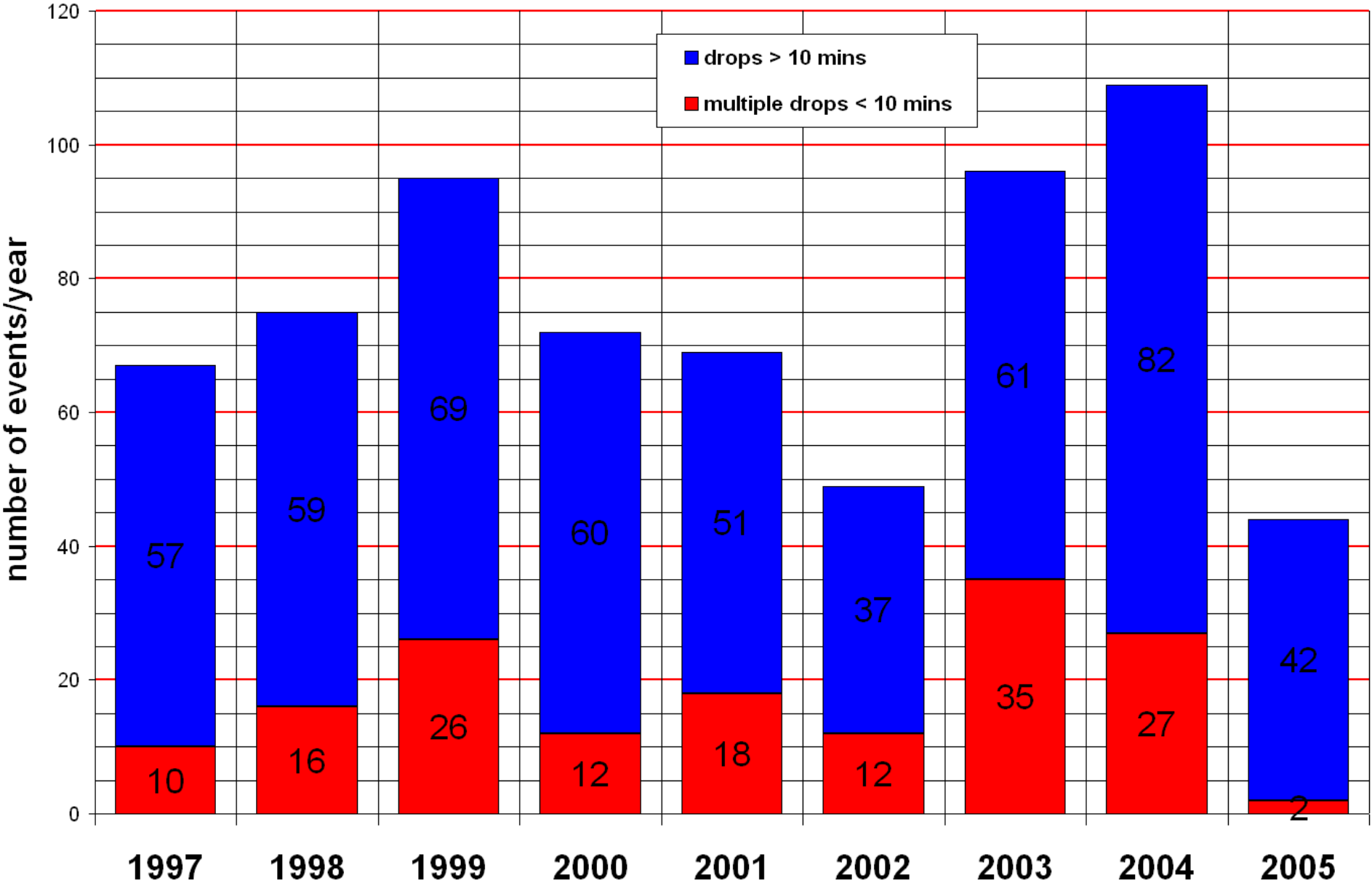
Monthly distribution of mains drops



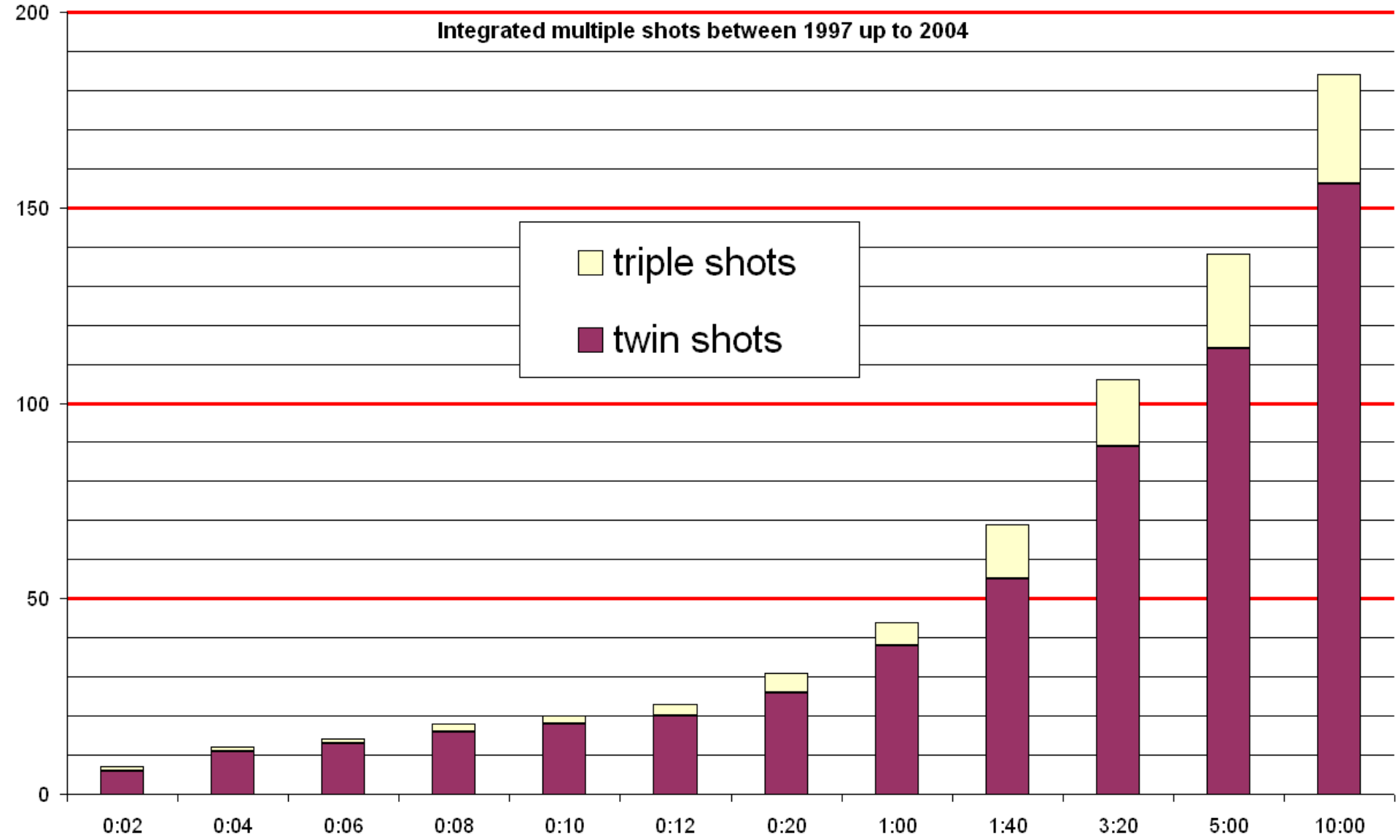
Time-depth relation



Single-multiple shots



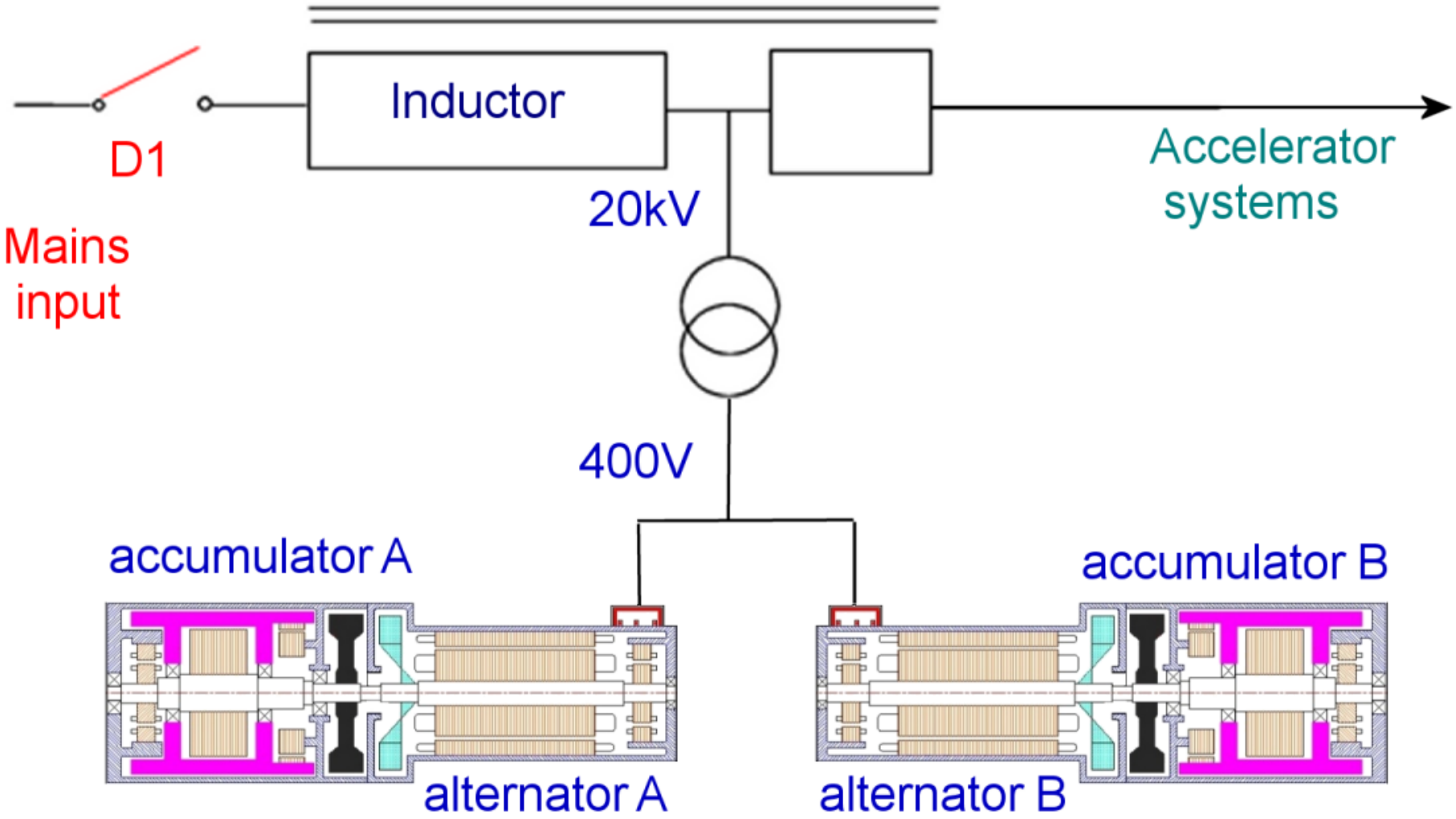
How often?


Integrated multiple shots between 1997 up to 2004
triple shots
twin shots
200
150
100
50
0
0:02
0:04
0:06
0:08
0:10
0:12
0:20
1:00
1:40
3:20
5:00
10:00

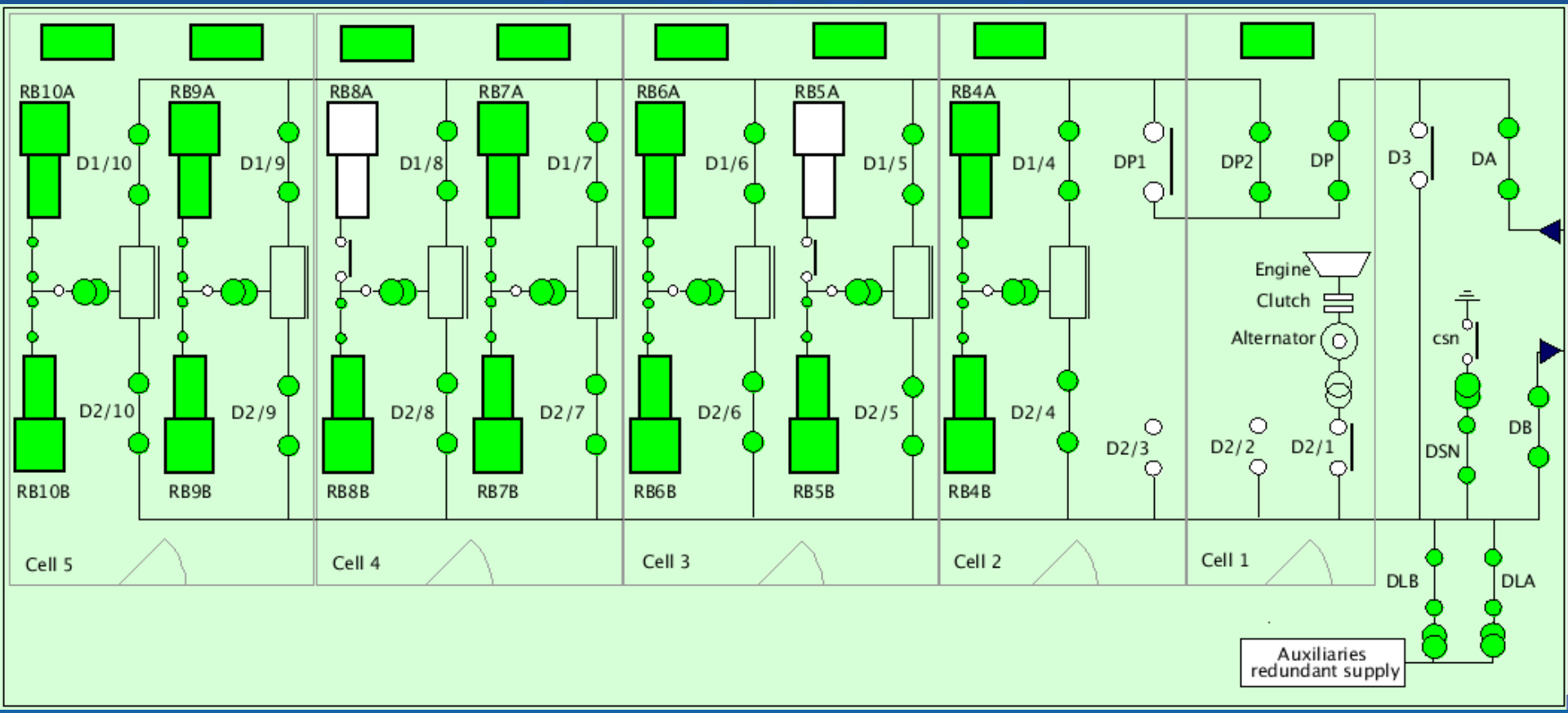
How to be protected?

- After an in depth analysis of several parameters we have specified a new system, custom designed, according to the local requirements together with very demanding caracteristics.
- +/- 5% output voltage +/- 0.5Hz frequency excursion,
- 12 sec autonomy full power, modular system,(100MJ)
- Efficiency at full power > 95%, half power > 90%.

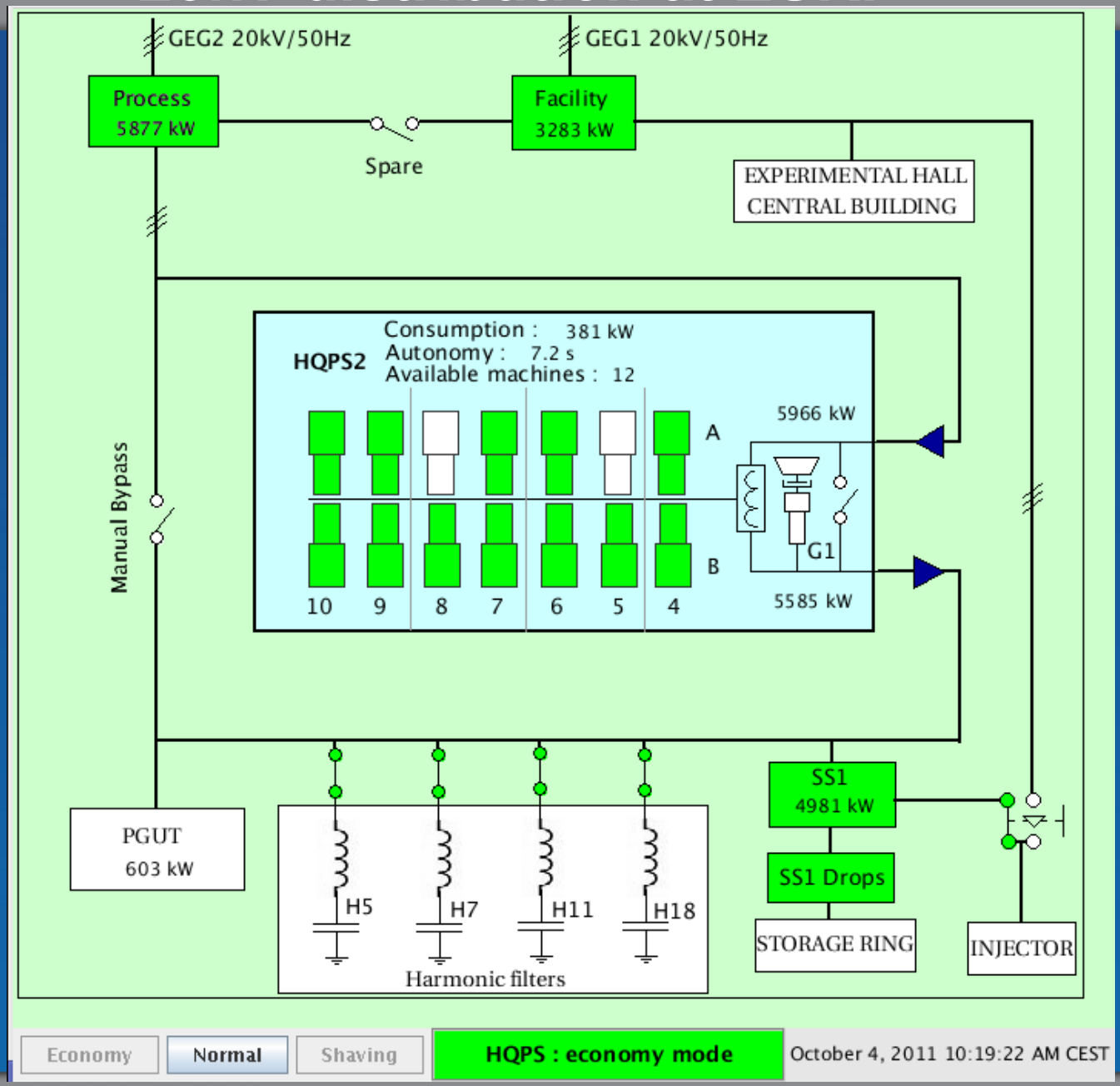
Flywheel system



The HQPS2 synopsis



20kV distribution at ESRF



4 unit arrangement in one Cell

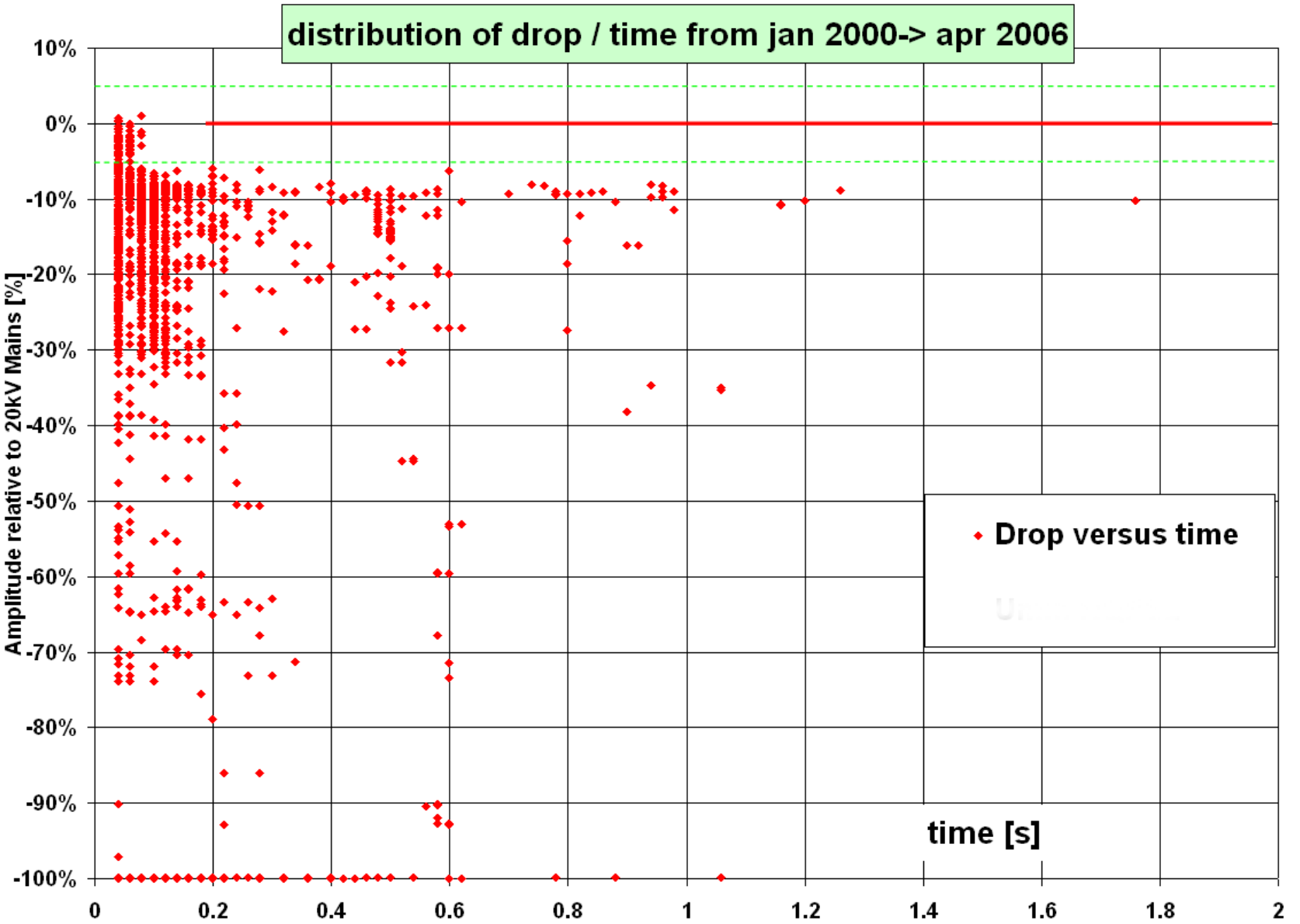
Energy management

- This configuration enables several key figures:
  - Quality of the energy supply much better than the public mains.
  - Critical and vital equipment is powered as long as the fuel is available.
  - Peak shaving capacity of 1MW to smooth over electrical demand.
  - Blackout start when the system is stopped and one event is happenning.
  - Room for installing a cogeneration system to increase energy efficiency.
- Price to pay:
  - Investment of 3M€ (building excluded)
  - Yearly running cost of 3.2GWh (= 220k€), maintenance and standby duty = 50k€

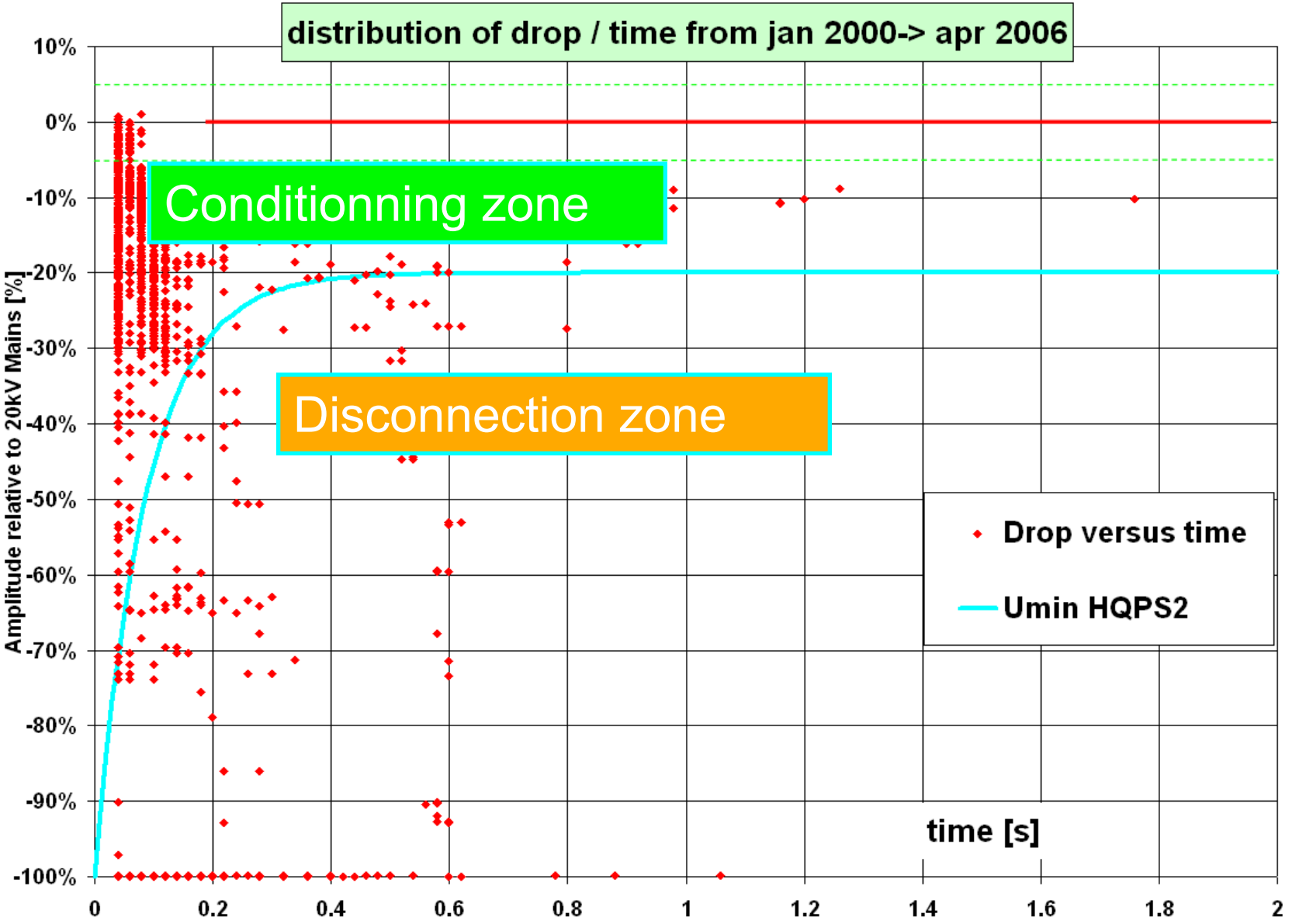
Quality of the 20kV internal network

- The system smoothes over the mains on a permanent basis.
  - Within the conditionning zone the alternators compensate for the poor quality.

Time-depth relation



Time-deep zones



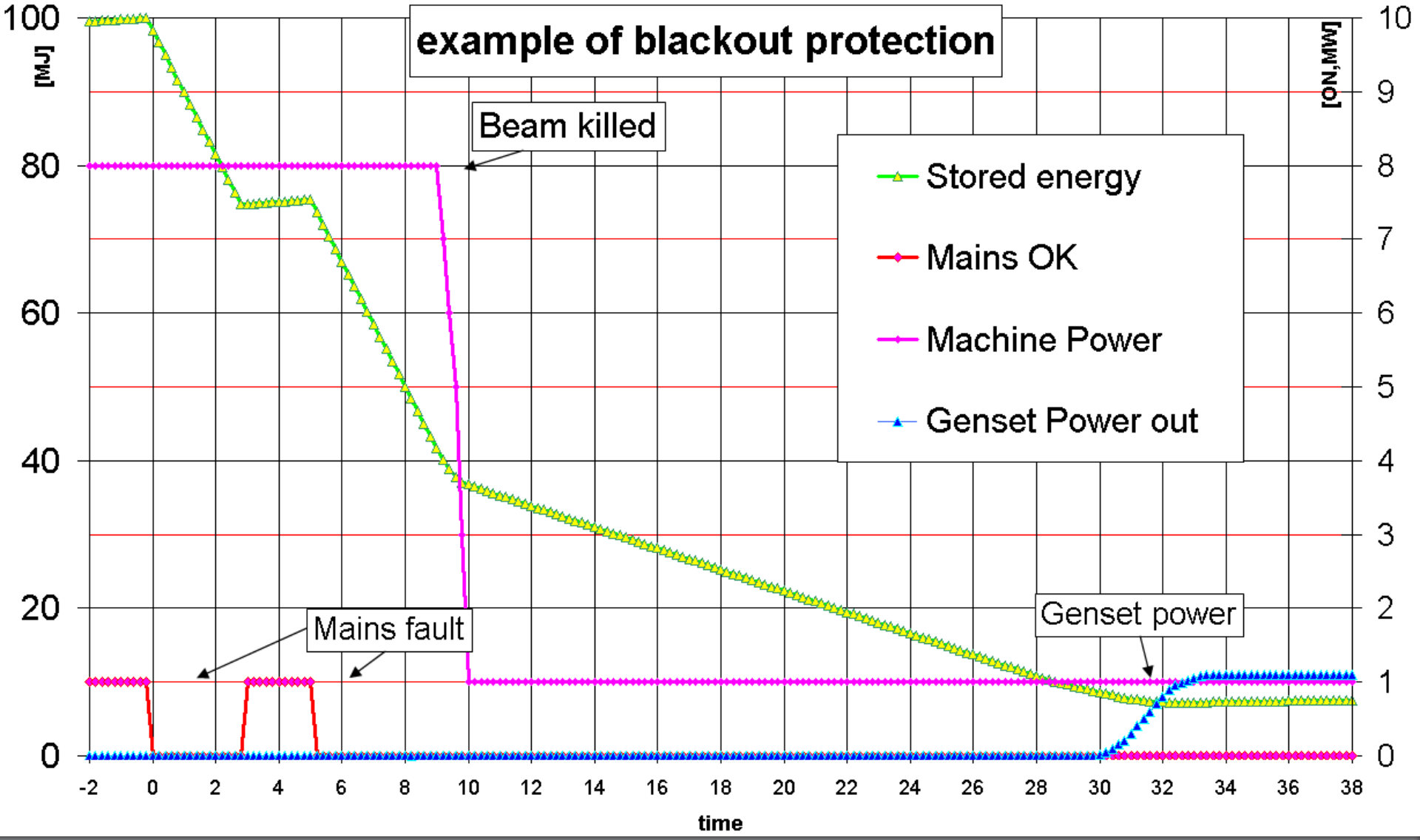
Quality of the 20kV internal network

- The system smoothes over the mains on a permanent basis.
  - Within the conditioning zone the alternators compensate for the poor quality.
    - Below the light blue line the system isolates the incoming power and compensates for the drop.
    - When the mains is back with the required quality, the public line is reconnected.

Energy management

- The energy stored (100MJ) is used when the drop is severe, less than 3 sec 100% missing power.
- Over this time this is considered as a major cut and can not be compensated for while requiring human intervention
- Only the critical loads are fed in cases where there is a longer than 3 sec cut.
- The diesel genset is started and used for those cases.

Smooth transition



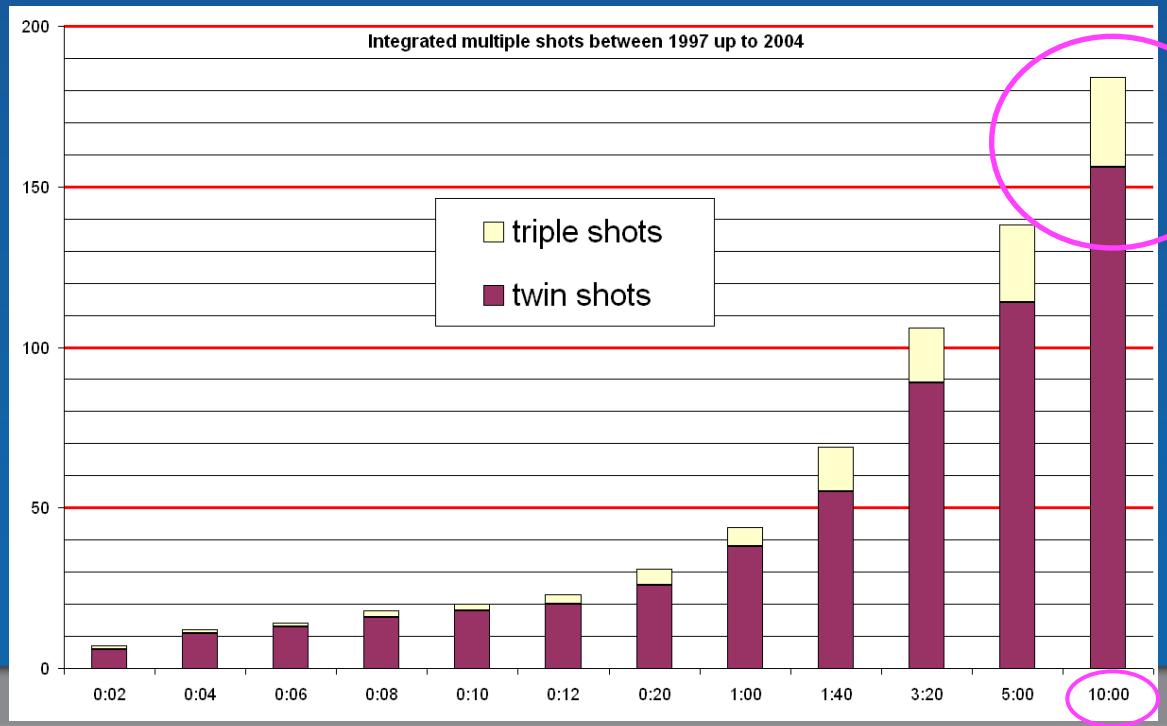
Critical power

- Some equipment is considered as critical: the time to restart is such that we have chosen to maintain the electric power to avoid a long restart of:
  - Computer network
  - Vacuum analysis and control equipment
  - Water cooling pumps
- This critical power is fed by a diesel genset of 1MW.
- This allows a quick restart of the e^- beam within 30 minutes. (otherwise usual restart time is 6 to 12 hours)
- The reduction of the load power enables a smooth transition to the genset power production (20 sec to start).

Peak shaving

- The genset power is also used to avoid peak power demand, reducing the requested power by 1MW, so avoiding or reducing penalties.
- This is also a good means of testing the emergency power which is rarely used.
  - Only used when full cut lasting more than 3 sec.
  - Or when more than 2 consecutive drops are detected within 10 minutes.

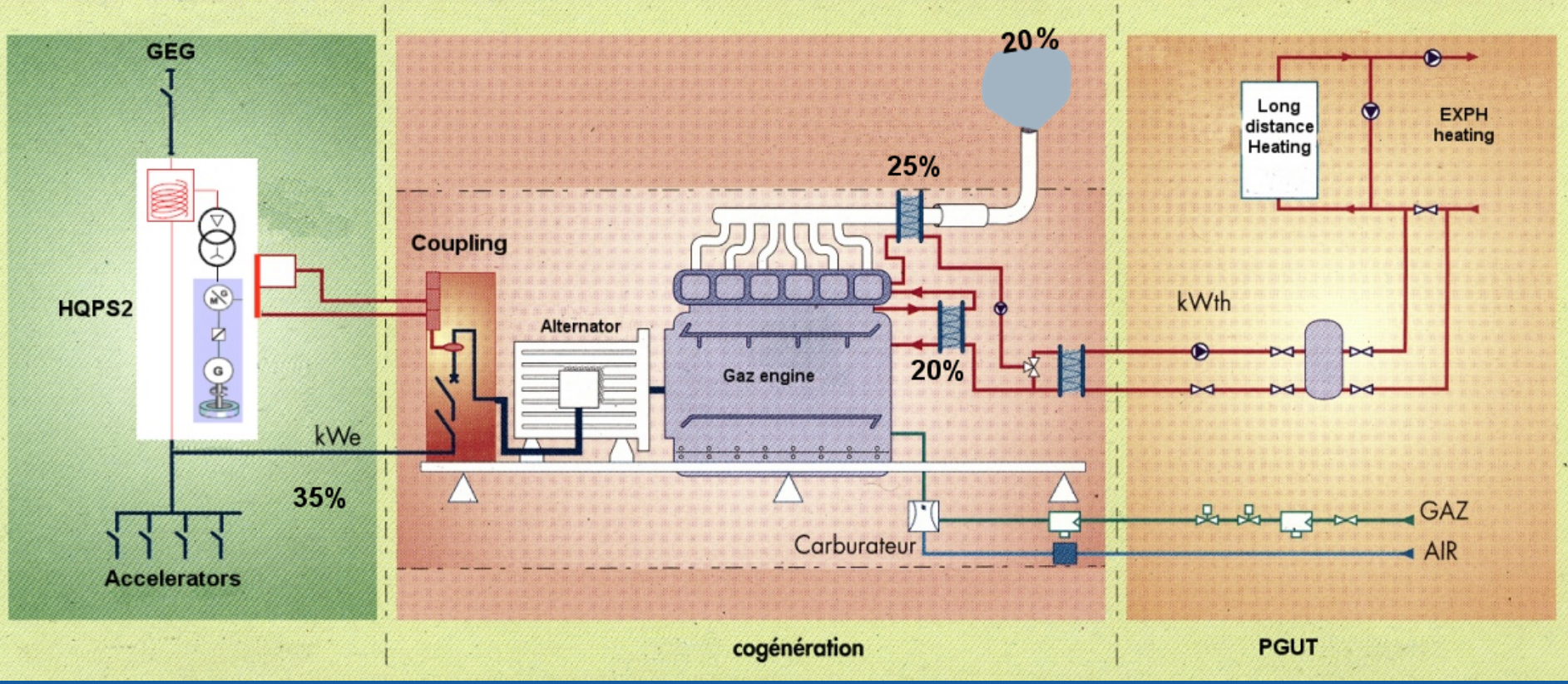
- In 2009 this peakshaving capacity reduced the penalties by 10 k€



26 events in 8 years

Peak shaving enhancement

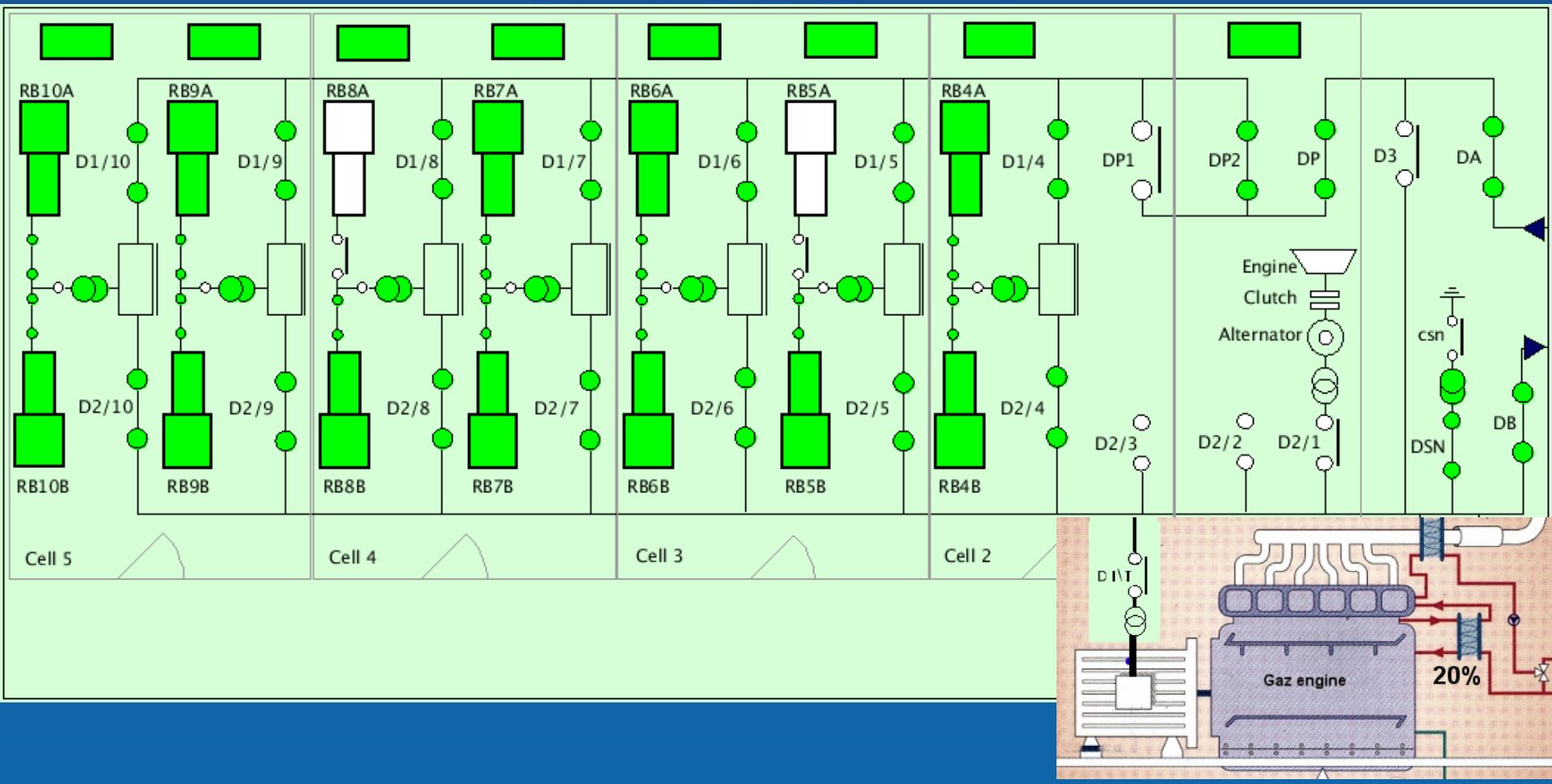
- This capacity could even be enhanced and coupled to a cogeneration system.
- Especially in winter when electricity is costly, the solution to power the injector will be carefully studied to benefit from the heat generated by the combustion engine.
- Special contracts are accessible to shave the power at the request of the RTE(french electrical transport company)



- This is the first view of a more efficient system covering the long term cuts >3 seconds

- This is the view of a system, permanently running to cover the long term cuts >3 seconds, enabling peak shaving and high efficiency power generation (>85%)

The HQPS2 synopsis with cogeneration engine



Global efficiency increased

- Several actions are underway to enhance the efficiency:
  - Adapting the stored energy to the actual power load,
  - Reducing the losses in the bearings
  - Reducing the stored energy if the combustion engine (diesel or gaz cogeneration) is/ are running. This is to take advantage of the shorter latency to get the power available.
- This is our vision of Energy management
- Any questions are welcome.
- Thank you