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NMR safeguarding plan in case of major flooding of the Seine river



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1 – Introduction

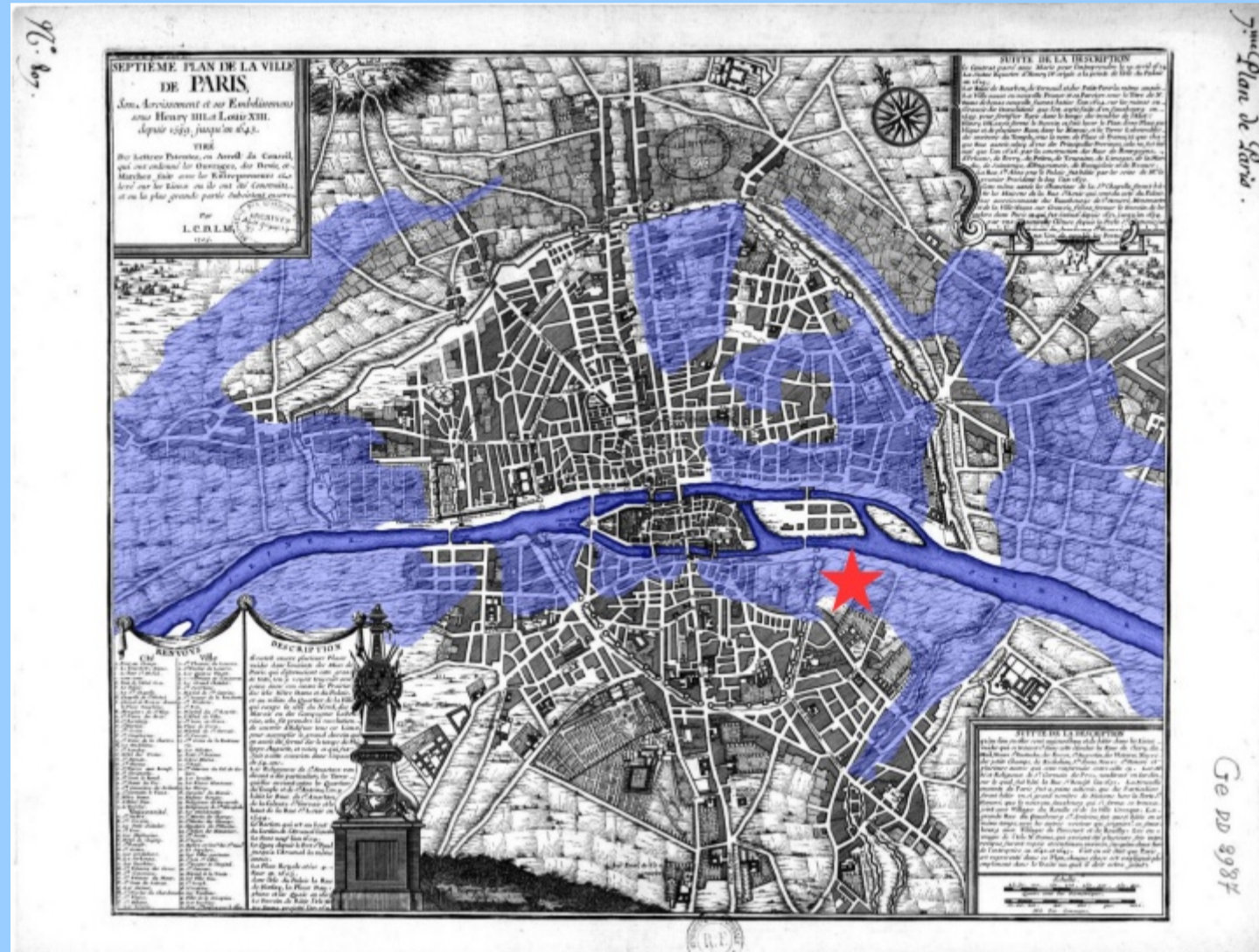


- Jussieu site is located in Paris on the banks of the Seine river.
- 14 NMR spectrometers are ranging from 300 MHz to 700 MHz.
- 9 NMR are on the ground floor, 5 NMR are on higher floors.
- Their total cost is 7 M€.
- A quench will cost 40 k€ per spectrometer.
- Flooding of electronics is estimated to 200 k€ per spectrometer.

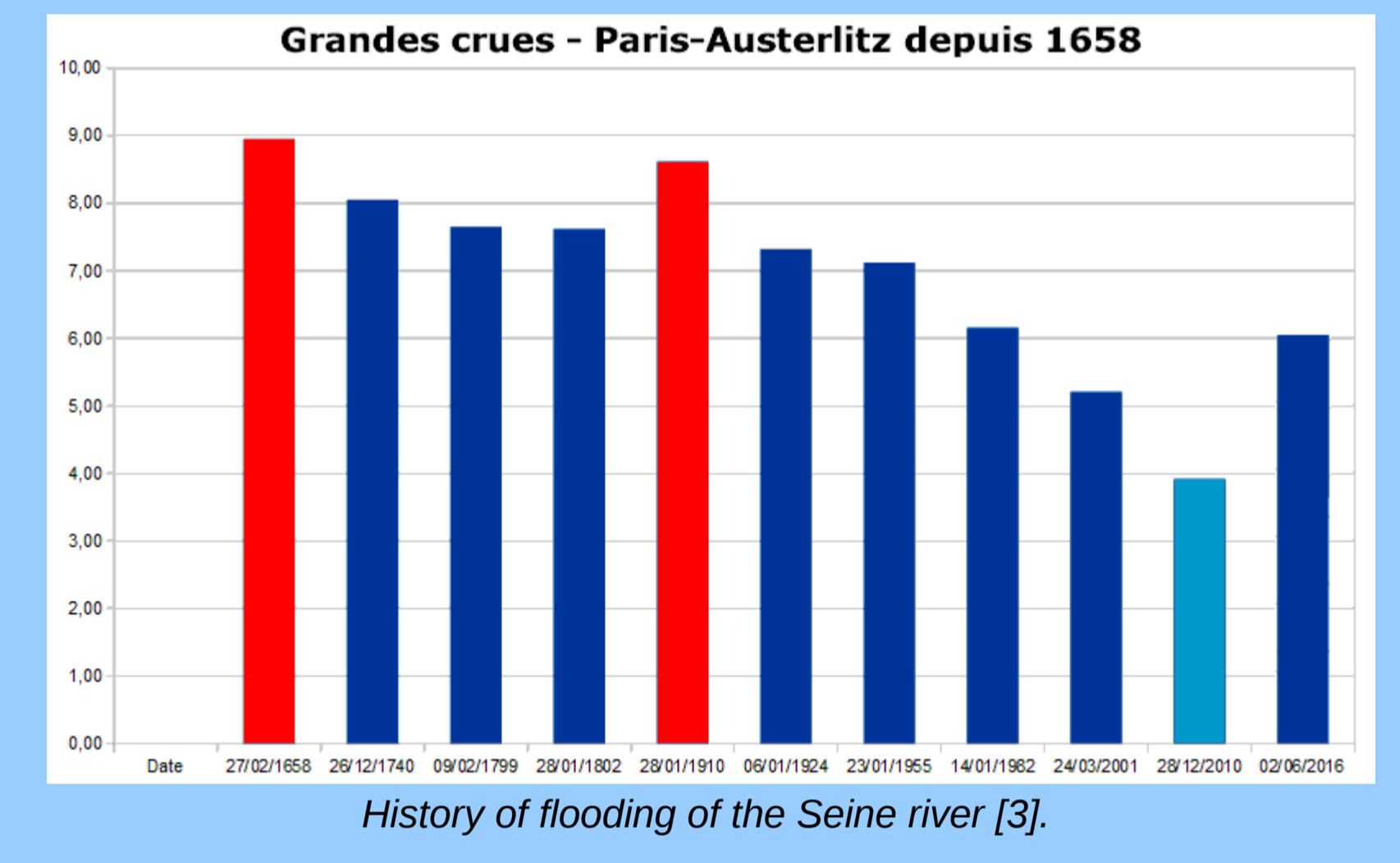
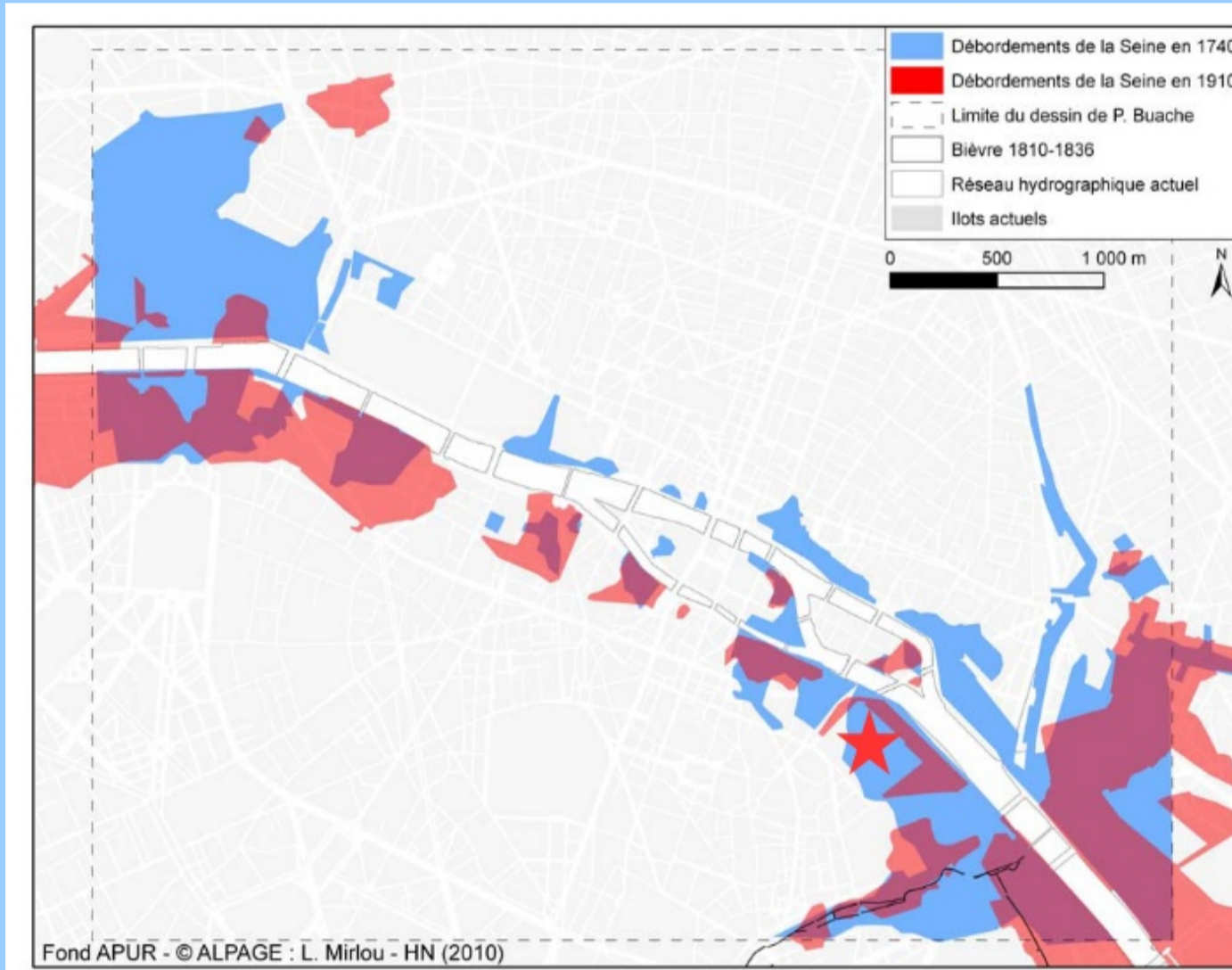
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2 – History



Flooding of the Seine river in 1658 (left) [1], 1740 (right, in blue) and 1910 (right, in pink) [2]. The red stars correspond to Jussieu.

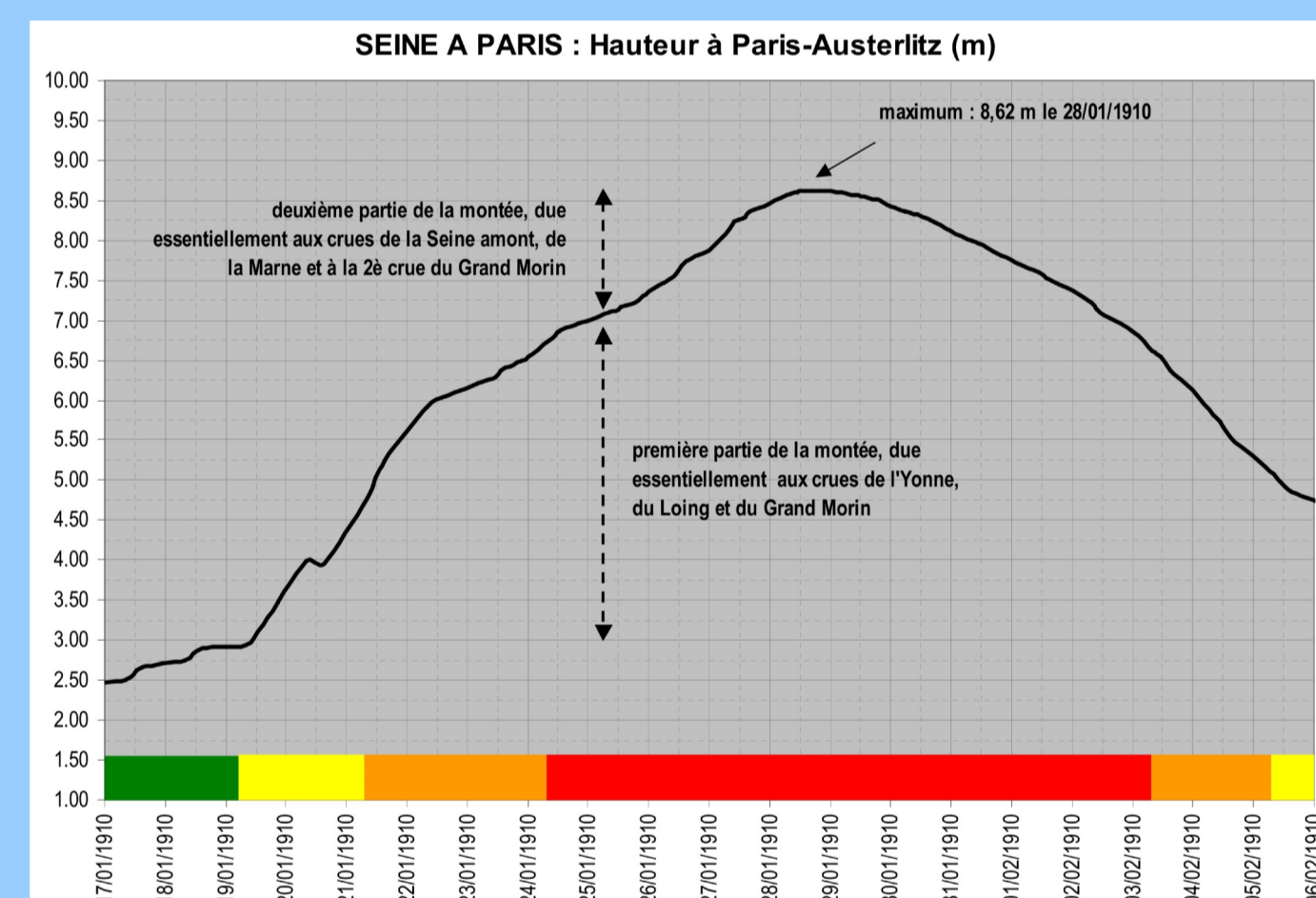


In 2016 the regional train lines were perturbed.

3 – Measurements

Alerte et prévention	CRUES	conséquences
Seuil 4 État de crise 8,62 m	1954 1954 1954 1954 1954	7,30 m 7,30 m 6,10 m 6,00 m
Seuil 3 État de préinondation 7,43 m	2001 2001	5,50 m 4,30 m
Seuil 2 État d'alerte 6,10 m		3,20 m 3,45 m
Seuil 1 État de vigilance 3,20 m		
Situation normale 0,82 m		

Seine river flood warning levels and their consequences, measured on the Zouave of the Alma Bridge [4].



Evolution of the Seine river level in 1910, Measured at the Austerlitz station [5].

- The Seine river level is difficult to measure and forecast:
- The Zouave of the Alma bridge has been lowered by 30-40 cm in 1970 [6],
- Automatic probes can give incorrect results [7],
- Predictive models reach their limit [8].
- The Seine retention lakes can only partly compensate [9].
- Basements will be flooded above 5.50 m.
- Transports will be affected above 6.00 m.
- Roads and transports in the entire region will be strongly degraded during 10 days above 6.75 m.
- There could be 80 cm of water in the NMR rooms during 6 days.

4 – Triggers and actions

Green level

- No action is required.

Yellow level

- Check *vigicrues* reports twice a day.

Orange level

- Preventively fill up all the spectrometers with liquid He.
- Fill up all the 3000 L-tanks on campus with liquid N₂.
- Daily fill up all the spectrometers with liquid N₂, as long as possible.
- Check the presence of water in freight elevator shafts.

6.50 m

- Stop and caulk the uninterruptible power supply and the air compressor on the basement floor.
- Stop and disconnect the electronic cabinets of the NMR on the ground floor.
- Evacuate the electronic cabinets and the shims coils tubes to a higher floor.
- Fill up all the 100 L-dewars available with liquid N₂ and store them near the NMR rooms on higher floors.

Red level

- Avoid floating objects in the NMR rooms.
- Wait and see.

Recovery

- Fill up all the magnets, starting with the smallest ones.
- Clean the NMR rooms and restart the spectrometers.



5 – Conclusion

- Major flooding of the Seine river is a highly probable risk.
- The NMR platform could be strongly affected.
- The electronic cabinets need to be evacuated to higher floors.
- A good coordination is needed between NMR technical staff, campus cryogenics staff and campus technical staff.
- NMR staff comings and goings will get considerably more complicated.

Acknowledgements

- NMR technical staff
- Campus cryogenics staff
- Campus technical staff