CERN Seismic Network Proposal

Michael Guinchard – CERN

Morgane Cabon, Cedric Charrondiere, Kevin Develle,

with contributions from many people from integration, civil engineering team,…

CERN – 30th June 2016

Motivations

- Several reasons to install the seismic network at CERN:
  - Continuous LHC monitoring;
  - HL-LHC Civil engineering activities:

    Monitor our installation to anticipate some risks on the beam stability generated by civil engineering activities.
  - Geneva Program “Géothermie 2020”:

    Evaluate effects of the micro-seismicity induced by the geo-thermal exploitation on our installation.

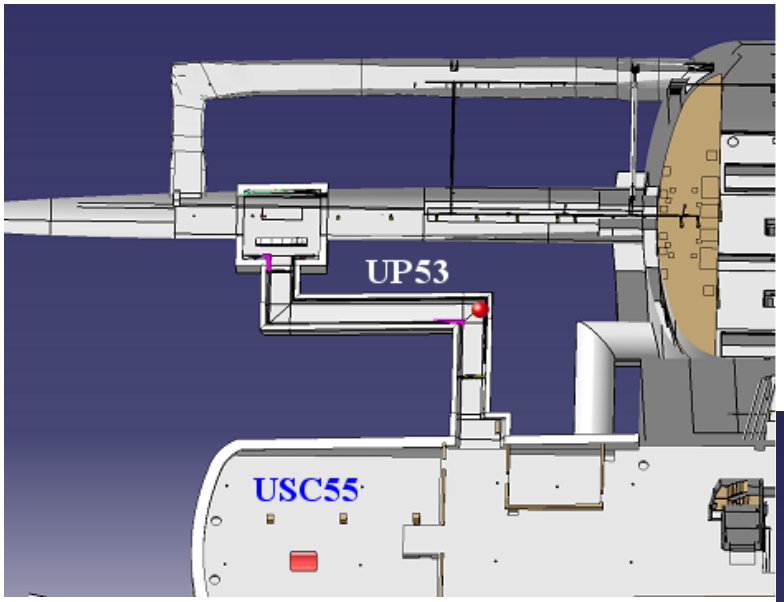
The minutes of the 213th LMC meeting were approved.

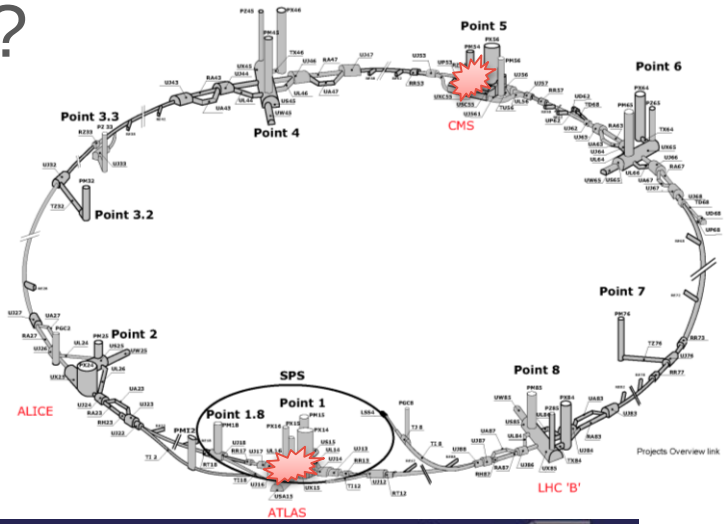
P. Collier reviewed the actions and decisions from the 213th meeting:

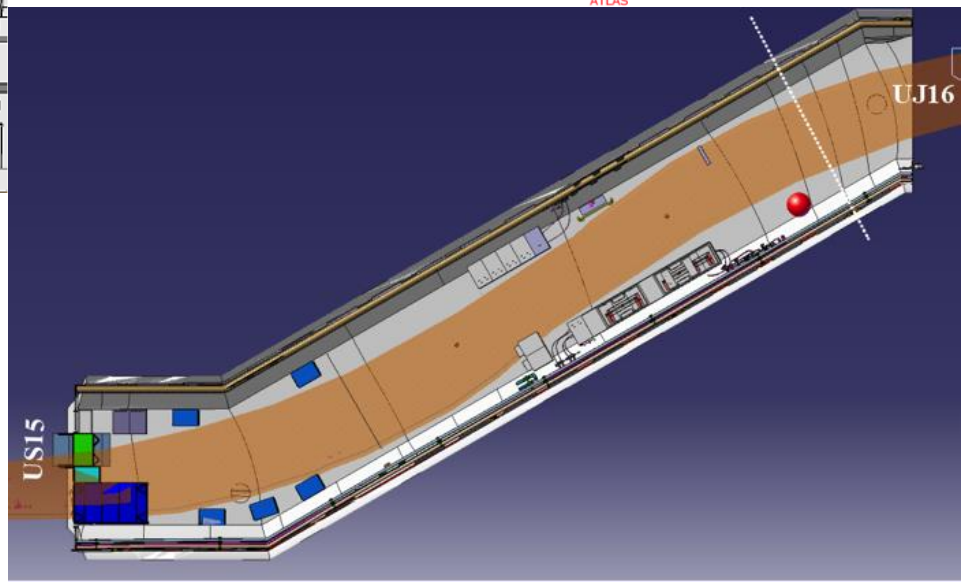
- *ACTION (EN-MEF-SU and EN-MME): propose a plan to install accelerometers or other measuring devices to record the ground oscillations in the LHC.* **D. Missiaen** proposed that the lead in the implementation of the action is taken EN-MME. **P. Collier** agreed. **D. Perini** for EN-MME agreed.

Proposal

- Where to install the stations ?







Proposal

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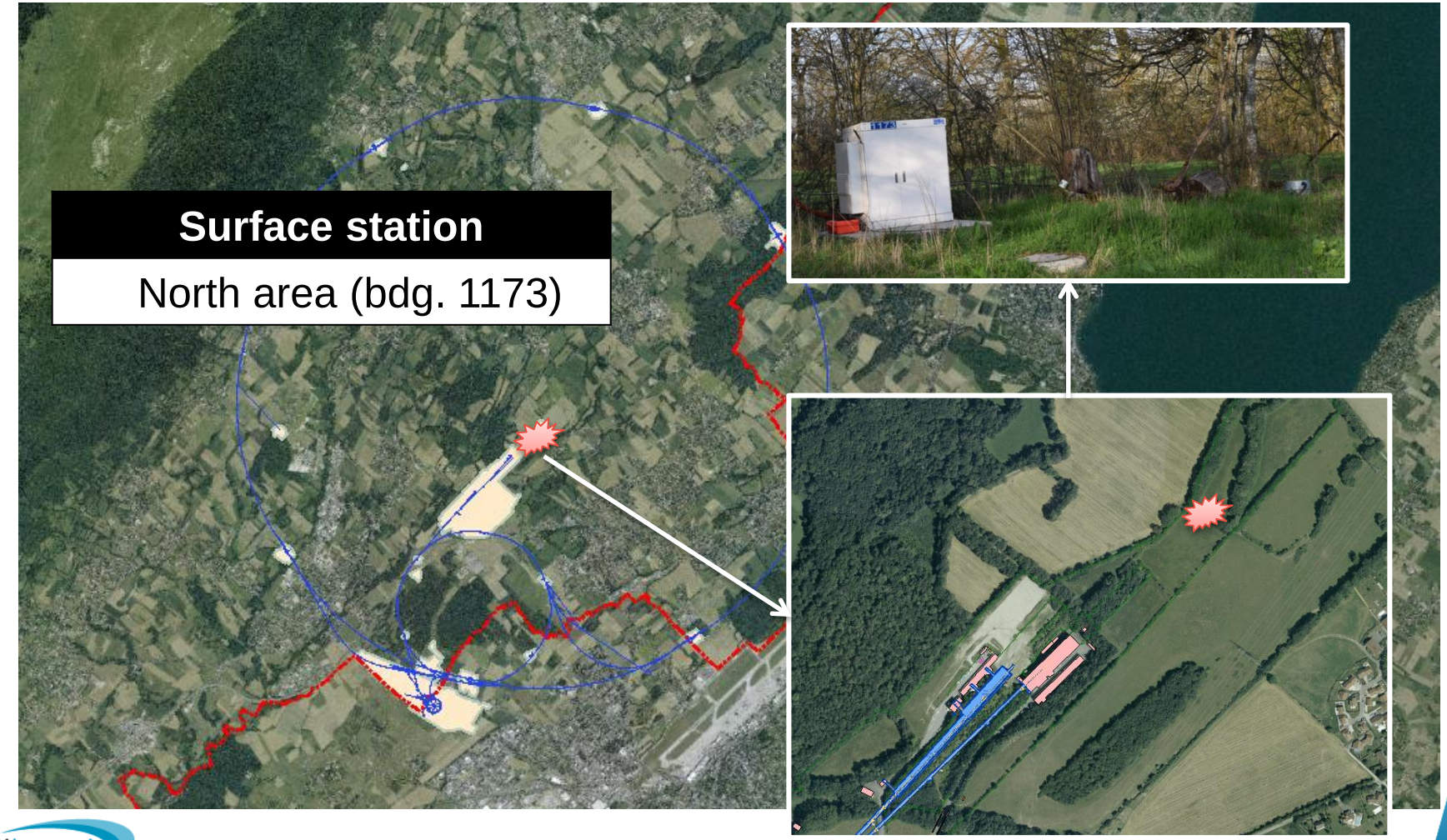


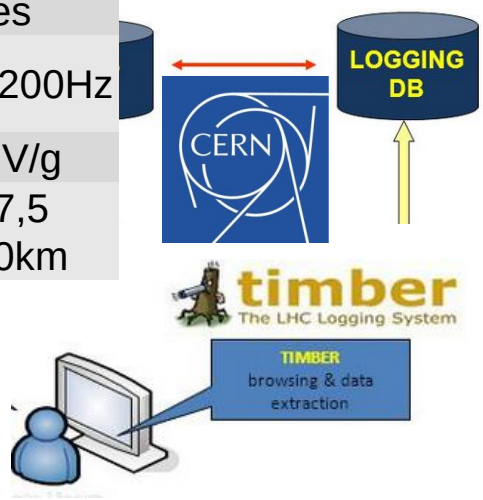
Proposal

- Technical proposal : structure

Model	Guralp 40T	Kinemetrics EpiSensor ES-T
Output	Ground velocity	Ground acceleration
Triaxial	Yes	Yes
Frequency range	60s to 100Hz	DC to 200Hz
Sensitivity	800 V/(m/s)	2,5 V/g
Threshold level for earthquake detection	≈ M3,5 @10km	M 7,5 @10km

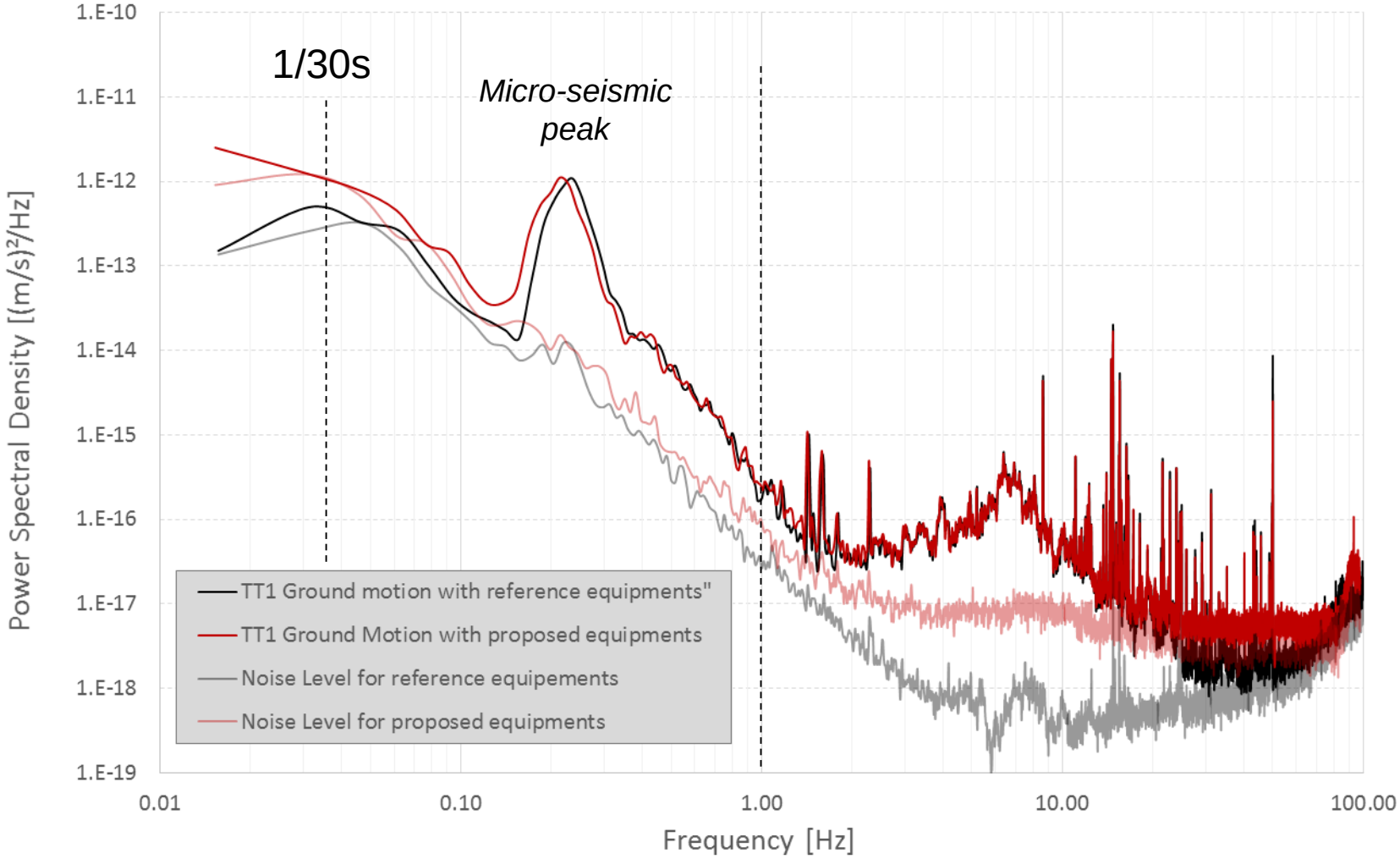
and transfer

Schweizerischer Erdbebendienst
Service Sismologique Suisse
Servizio Sismico Svizzero
Swiss Seismological Service



Preliminary results

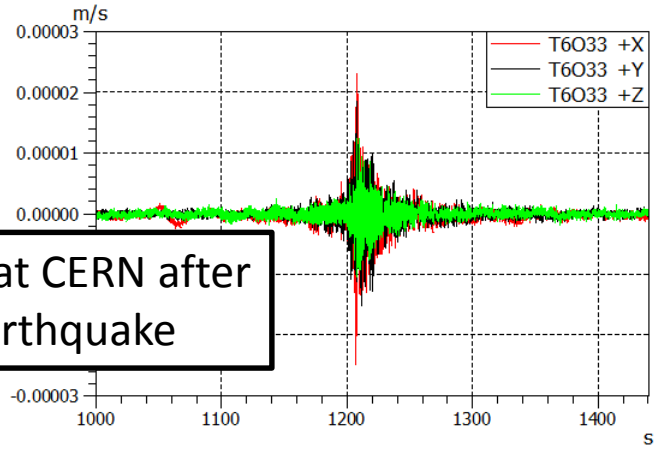
- Ground motion measurements at TT1



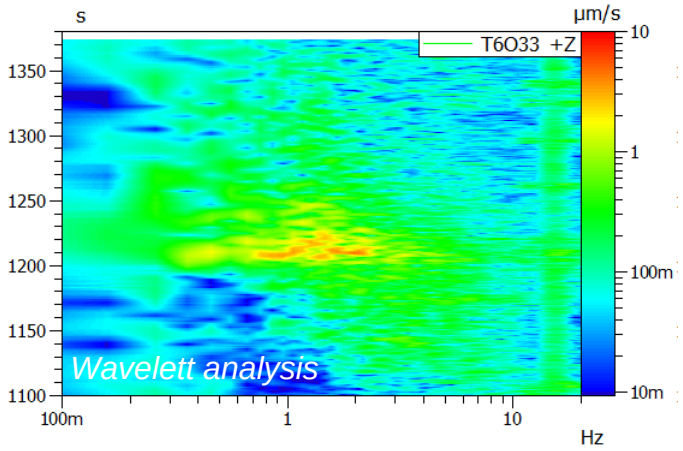
Preliminary results

- Earthquake detection at TT1

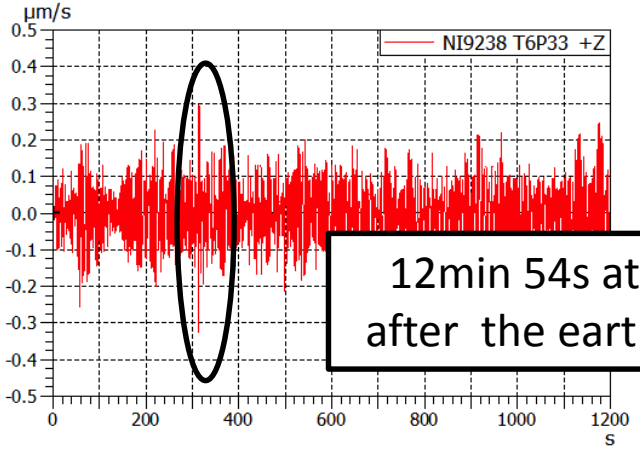
- Magnitude **ML 5.0**
- Region **FRANCE**
- Date time **2016-04-28 06:46:50.4 UTC**
- Location **46.06 N ; 1.11 W**
- Depth **10 km**



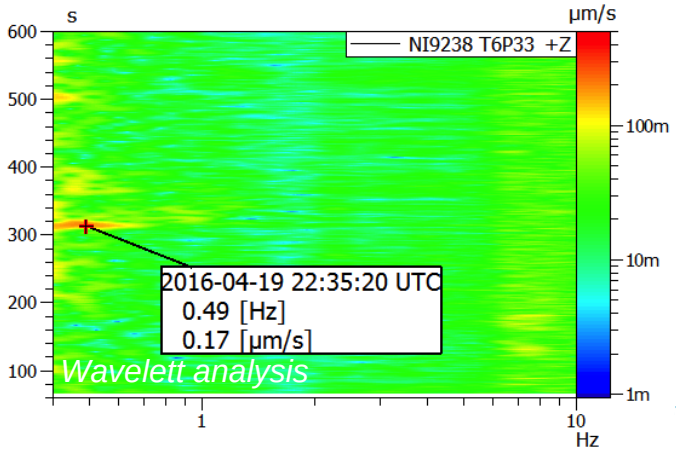
2min 10s at CERN after the earthquake



- Magnitude **Mw 5.7**
- Region **NEAR COAST OF ECUADOR**
- Date time **2016-04-19 22:22:26.7 UTC**
- Location **0.56 N ; 80.03 W**
- Depth **20 km**



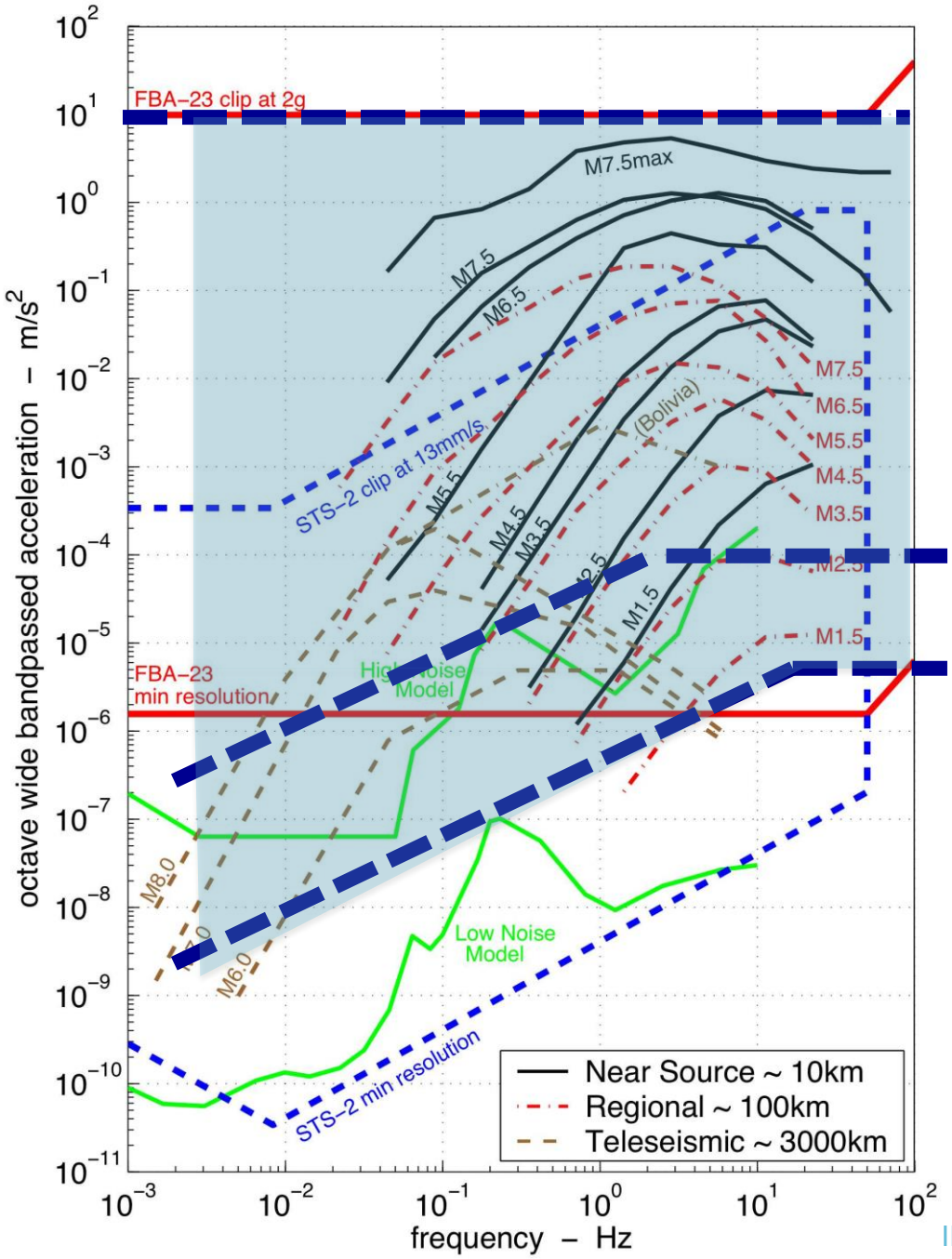
12min 54s at CERN after the earthquake



Conclusion and next steps

- Validation tests were performed with a station installed at TT1 :
  - Ground motion and eathquakes are measured;
  - Data transfert to SED is validated by SED & CERN.
- Overall budget for installation : 115 kCHF;
- Budget for maintenance : 20 kCHF/Year;
- Installation planned during EYETS 2016 if proposal accepted and financed (discussion in progress);
- Installation under discussion with the coordination team - ICL (EN-ACE).

Conclusion



CERN free field ~ - 90dB
- M2.5 at 10km only
- M3.5 at 100km only

CERN tunnel ~ -120dB
- M2.5 @ 100km only

Thank you!

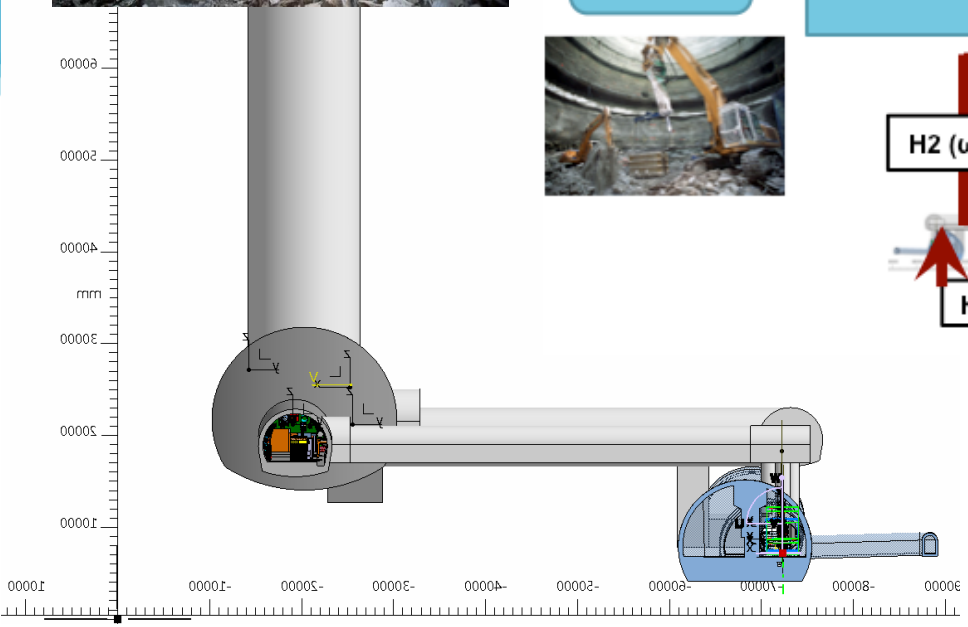
Questions

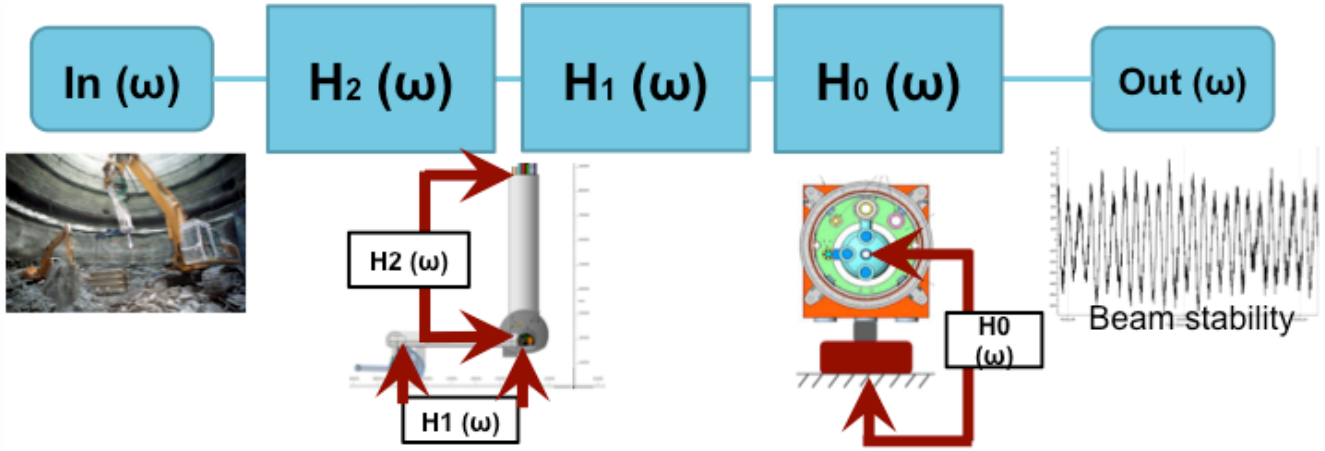
HiLumi
HL-LHC PROJECT

And more…

Motivations

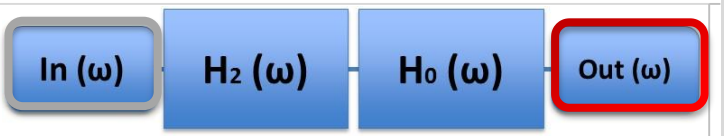
- HL-LHC Civil engineering activities:

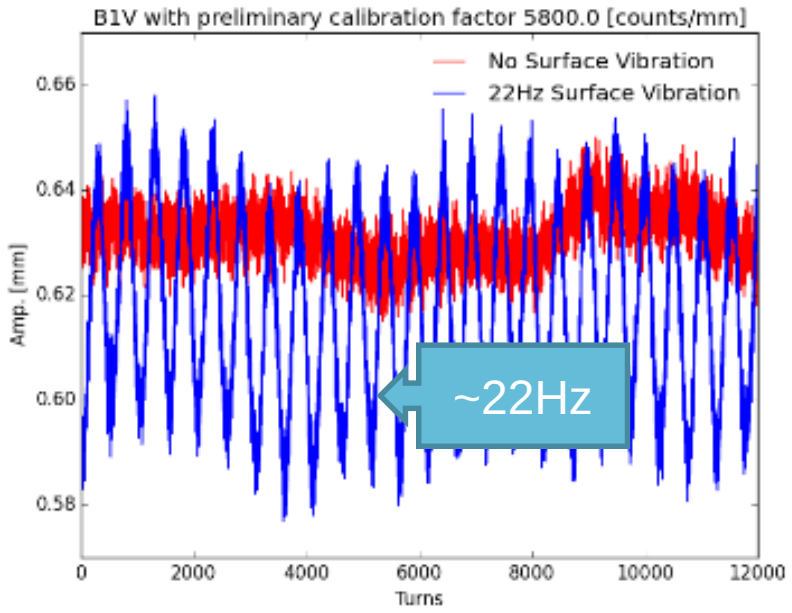




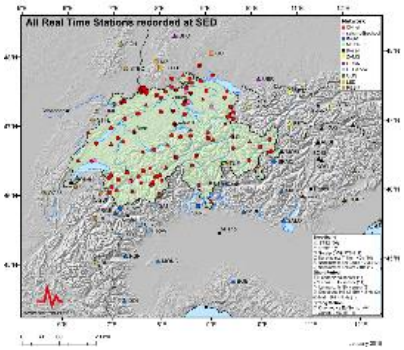
Motivations

- HL-LHC Civil engineering activities:





Motivations

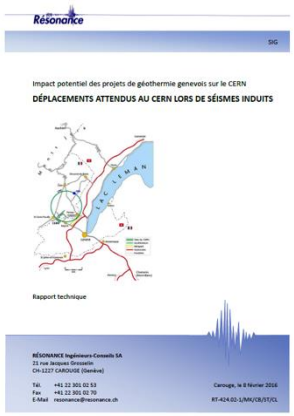


- Geneva Program “Géothermie 2020”:
  - Prospection phase to identify suitable locations ;
  - Exploitation of geothermal energy may induce seismic activity (high pressure water) ;
  - Low seismic activity around Geneva➔ Low density of monitoring stations (from the Swiss side)
  - CERN is associated to the study since the seismic activity may have effects on LHC operation

    (CERN Contact : M. Poehler) ;
  - A report on the possible impact of earthquakes on the CERN installation was recently published by the engineering company Resonance SA (mandated by SIG).

Motivations

- Geneva Program “Géothermie 2020”:
  - The expected earthquake magnitudes may reach up to ~3, but most earthquakes are expected to be limited to magnitude ~2.
  - The cold mass movements are predicted to reach ~1-10 µm for magnitude 2 earthquakes (a factor 10 more for magnitude 3).


Résonance

SIG

Impact potentiel des projets de géothermie genevois sur le CERN

DÉPLACEMENTS ATTENDUS AU CERN LORS DE SÉISMES INDUITS

Rapport technique

RÉSONANCE Ingénieurs-Conseils SA
21 rue Jacques-Grosselin
CH-1227 CAROUGE (Genève)

Tél. +41 22 301 02 53
Fax +41 22 301 02 70
E-Mail resonance@resonance.ch

Carouge, le 6 février 2016

RT-424.02-1/MR/GB/ST/CL

Motivations

- Geneva Program “Géothermie 2020”:

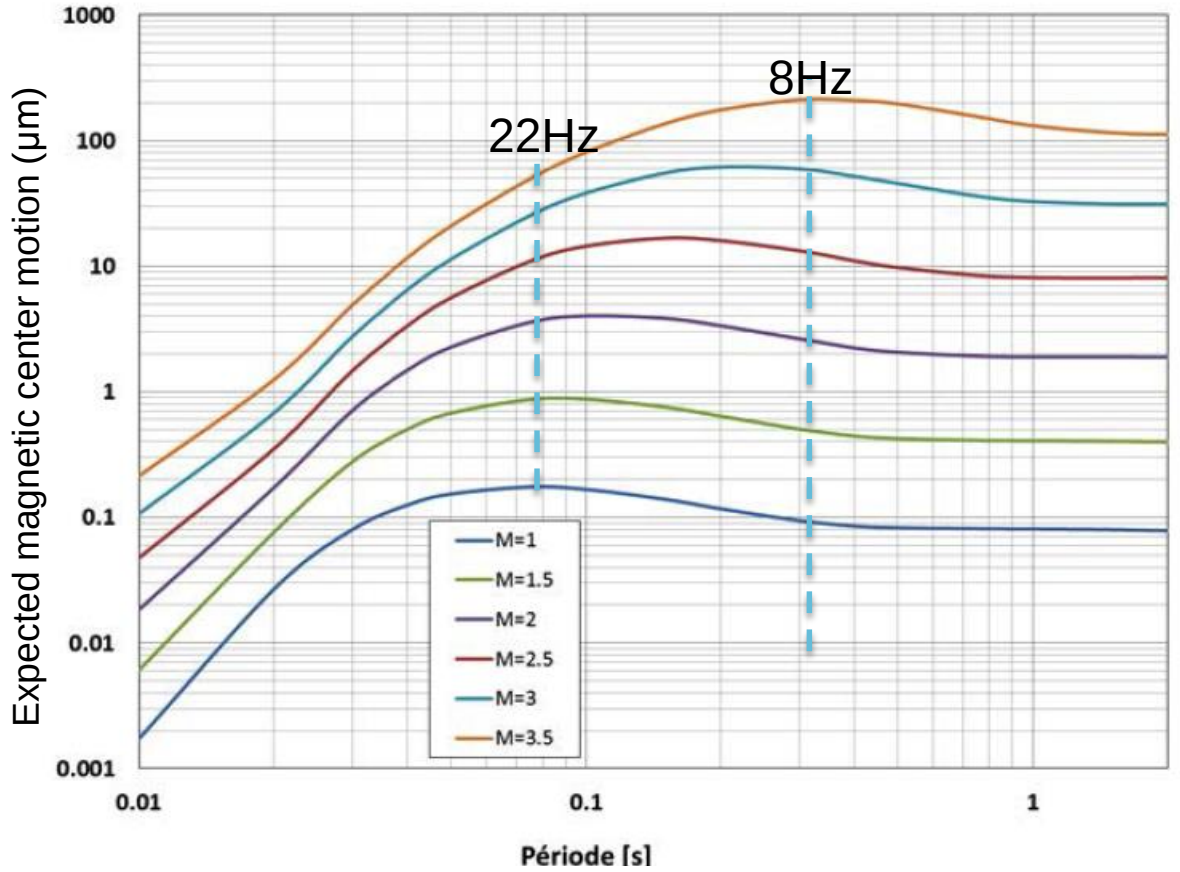
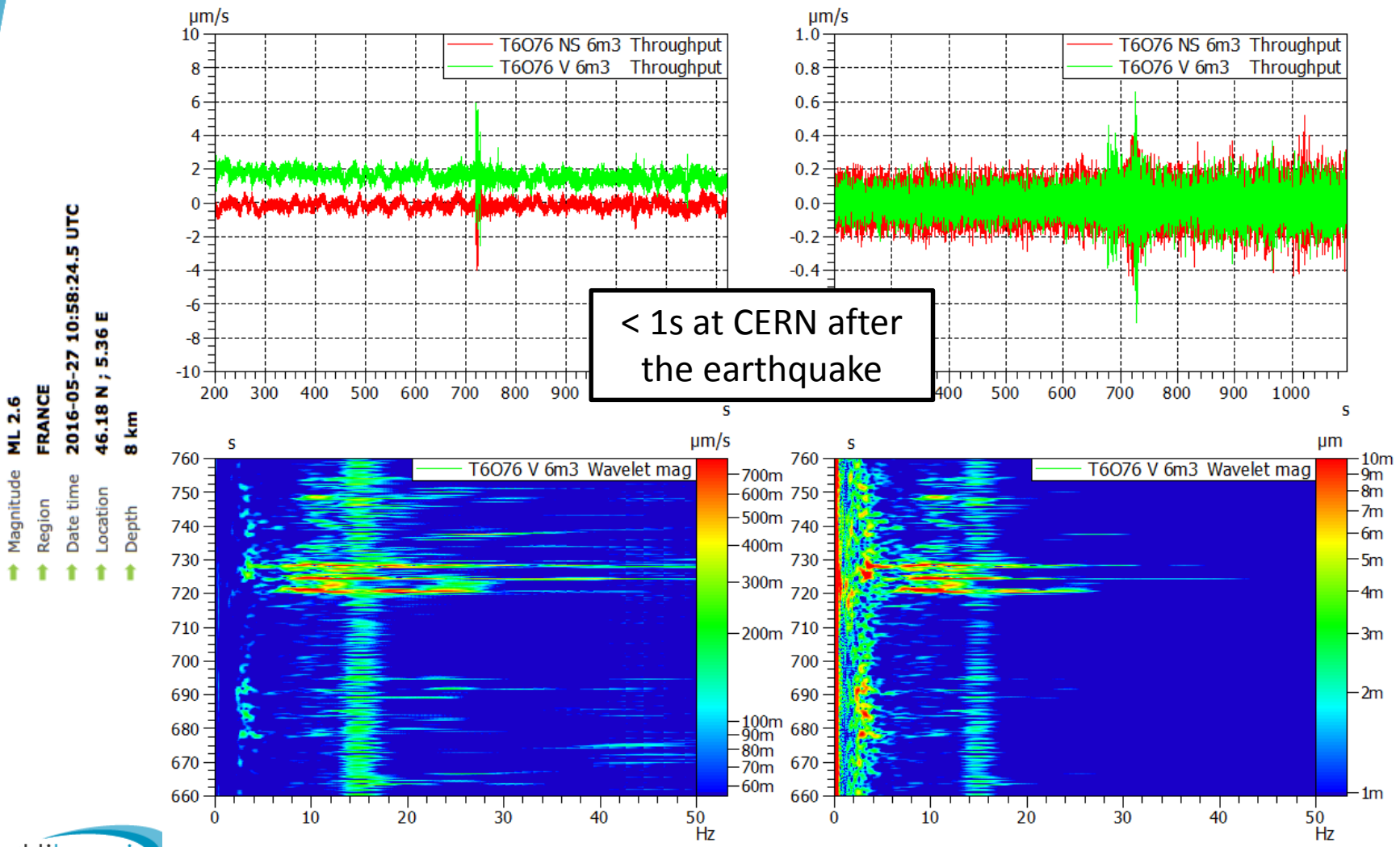


Figure 4.4 : *Déplacements spectraux en fonction de la période propre pour différentes magnitudes, pour une distance épicentrale de 5 km et une profondeur du foyer de 3 km, obtenus par SMSIM pour $\Delta\sigma$ = 10 bar, Q = 600 et κ = 0.02 s et un amortissement de 1 %.*

Preliminary results

- Earthquake detection at TT1 (M2.6 – 61km Geneva)

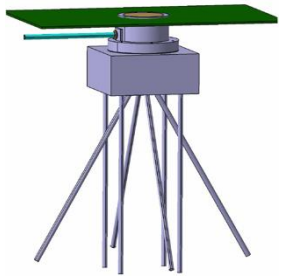


Cost estimation

- Equipments for underground stations :

Cost estimation per station			
	Model	Type	Price
Sensor for LHC ground motion	Guralp Geophone	6T	4 620 CHF
Sensor for strong motion	Kinemetrics accelerometer	EpiSensor ES-T	3 850 CHF
DAQ Frame	NI CompactRIO	9035	3 025 CHF
DAQ Card for ground motion	National Instruments	9239	935 CHF
DAQ Card for strong motion	National Instruments	9239	935 CHF
Thermal and Mechanical Protection	EN-MME	–	550 CHF
Cabling	EN-EL	–	550 CHF
	TOTAL		14 465 CHF

- Equipments for surface station :

Cost estimation per station			
	Model	Type	Price
Underground installation			***14 465 CHF***
Vault			1 300 CHF
Anchors			300 CHF
Baseplate			500 CHF
Construction Work (ext)			5 000 CHF
Electrician (ext)			2 000 CHF
Building Permit			500 CHF
	TOTAL		24 065 CHF

Cost estimation

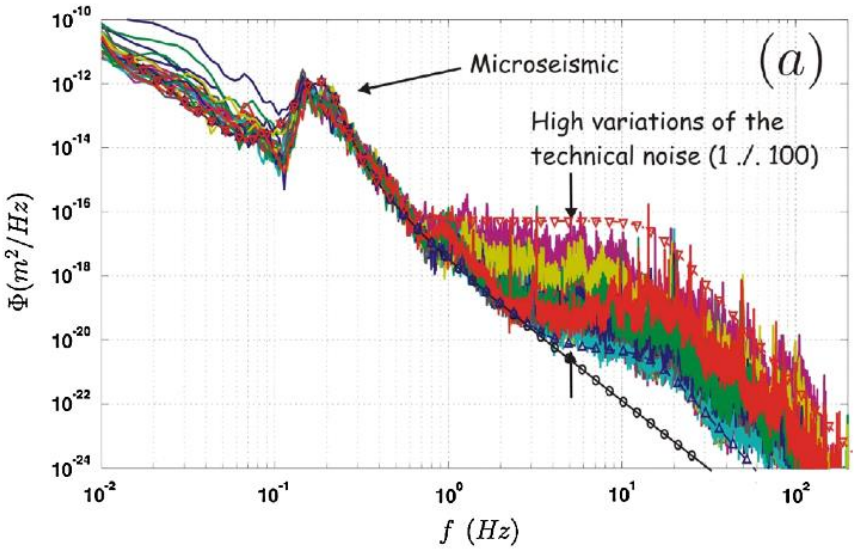
- Price equipments overview:

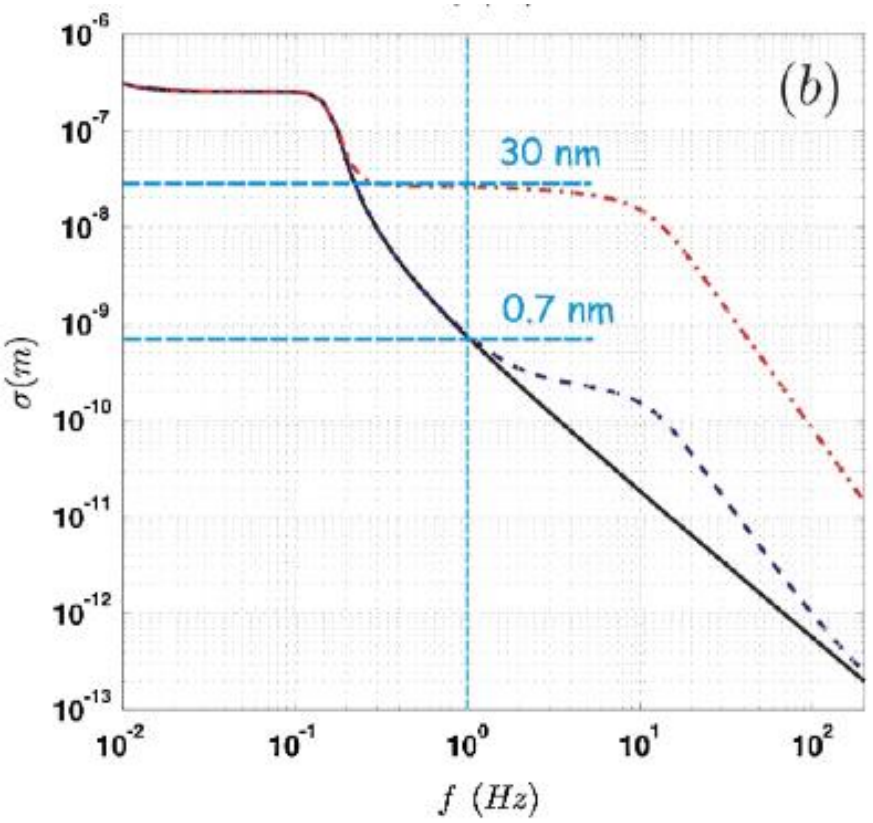
Underground stations		
Minimum	Pt 1, Pt 5	≈ 30kCHF
Intermediate	Pt 1, Pt 5 + Pt 2, Pt 8	≈ 60kCHF
Maximum	8 LHC infrastructure	≈ 120kCHF
Surface station		
North area (bdg. 1173)		≈ 25kCHF

- Manpower:
  - EN-STI (Software development): 24kCHF
  - EN-MME (Study, tests, installation, etc): 36kCHF

Requirements

- CERN Seismic network should be able to :
  - Measure the standard ground motion level underground :





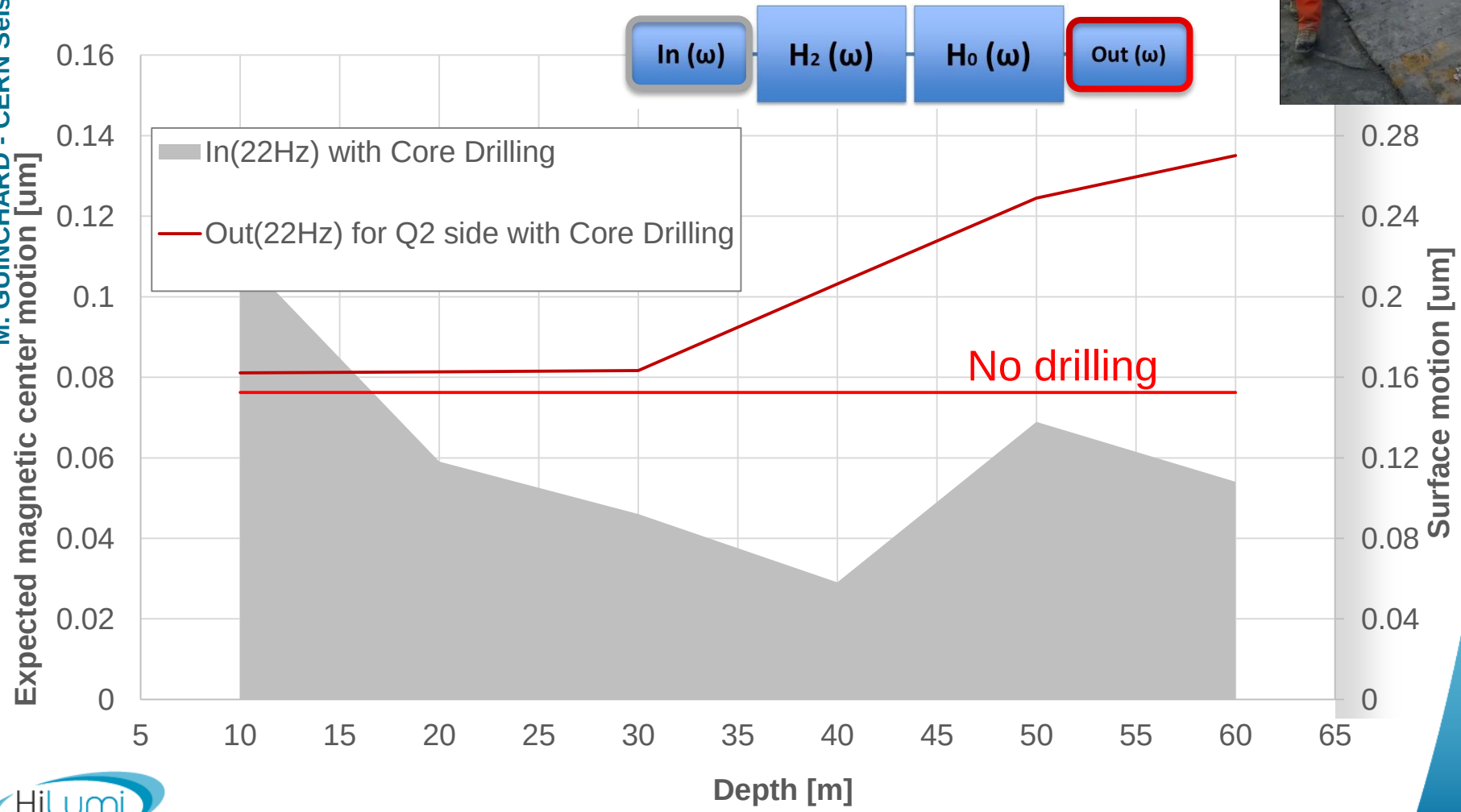
PHYSICAL REVIEW SPECIAL TOPICS - ACCELERATORS AND BEAMS 13, 072801 (2010)

Seismic response of linear accelerators

C. Collette, K. Artoos, M. Guinchard, and C. Hauviller

Core drilling → triplet predictions

- The expected motion of the triplet magnetic center vs depth remains at level of ≈ 0.1-0.2 μm – acceptable.



Time constraints