ET WG1
STATUS AND FUTURE

Jo van den Brand

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Progress overview of WG1

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  - Vacuum system, cryogenics, safety systems
  - Costing

Future

Site studies

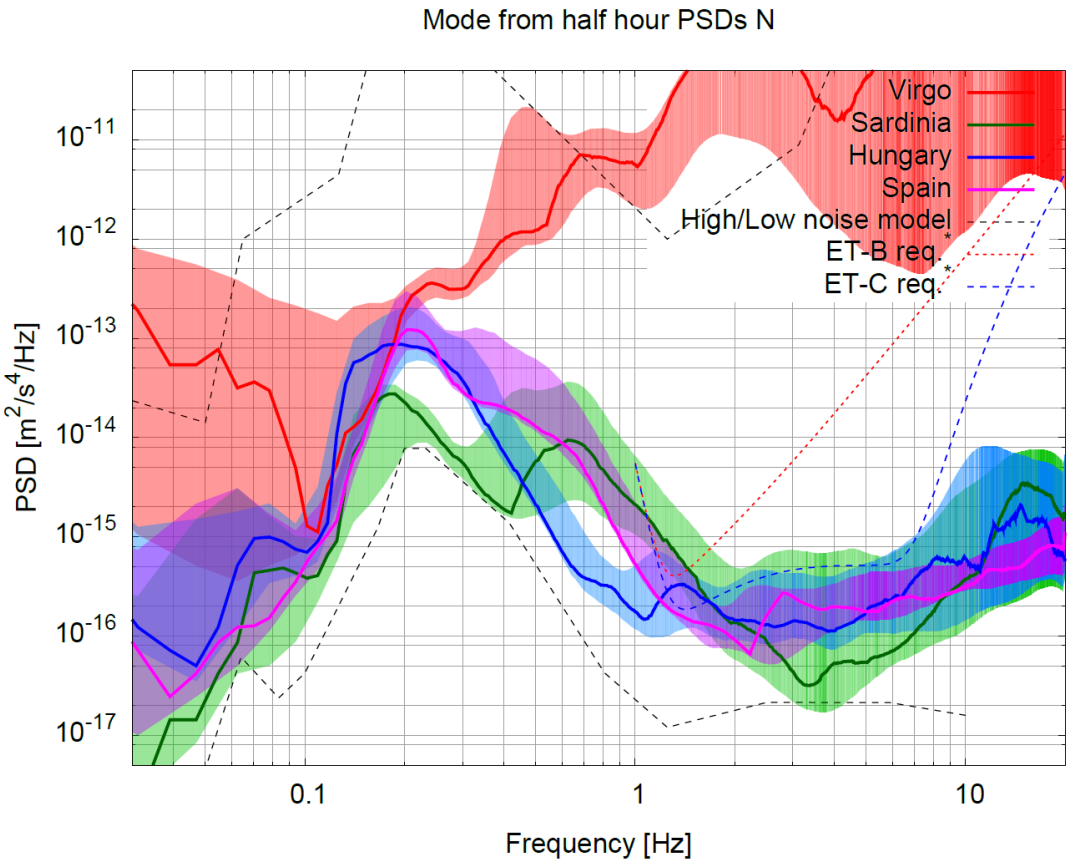
- Seismic studies
  - Typically 1 – 2 weeks of data
  - Worldwide effort
    - Europe
    - LCGT, Japan
    - Homestake, USA

Mark Beker, David Rabeling Nikhef
LCGT, Homestake, INFN, Hungary

Site studies

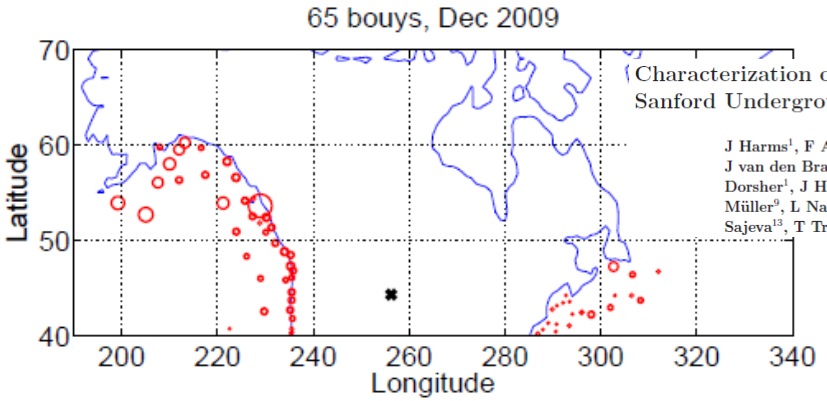
Mark Beker, David Rabeling
Nikhef with INFN, Hungary

- Seismic studies
  - Typically 1 – 2 weeks of data
  - Worldwide effort
    - Europe
    - LCGT, Japan
    - Homestake, USA
- Conclusions
  - Significant reduction in PSD compared to Virgo site
  - Complies with ET seismic requirements
  - All are underground sites
    - Several 100 m
  - No GGN subtraction techniques applied yet



Geophysical issues

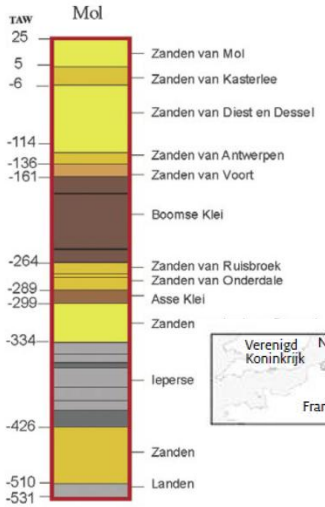
- Hardrock
  - Homestake, USA
  - LCGT, Japan
  - Europe
    - Frejus
    - Canfranc
- Salt
  - Slanic Salt Mine, Romenia
  - Realmonte, Sicily
- Clay
  - Mol, Belgium
    - Studies scheduled for 2010
- Conclusions
  - Lowest seismic noise in hardrock
  - Salt mine data too noisy
  - Other issues: cost, GGN

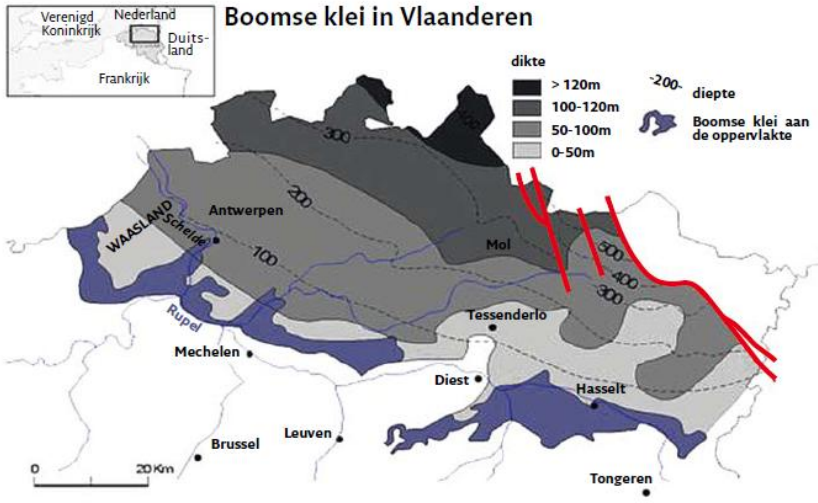


Characterization of the seismic environment at the Sanford Underground Laboratory, South Dakota

J Harms[1], F Acernese[2,3], F Barone[2,3], I Bartos[4], M Beker[5], J F J van den Brand[5], N Christensen[6], M Coughlin[6], R DeSalvo[7], S Dorsher[1], J Heise[8], S Kandhasamy[1], V Mandic[1], S Márka[4], G Müller[9], L Naticchioni[10,11], T O'Keefe[12], D S Rabeling[5], A Sajeva[13], T Trancynger[8] and V Wand[14]

Class. Quantum Grav. 27 (2010) 225011.
LIGO-P1000052





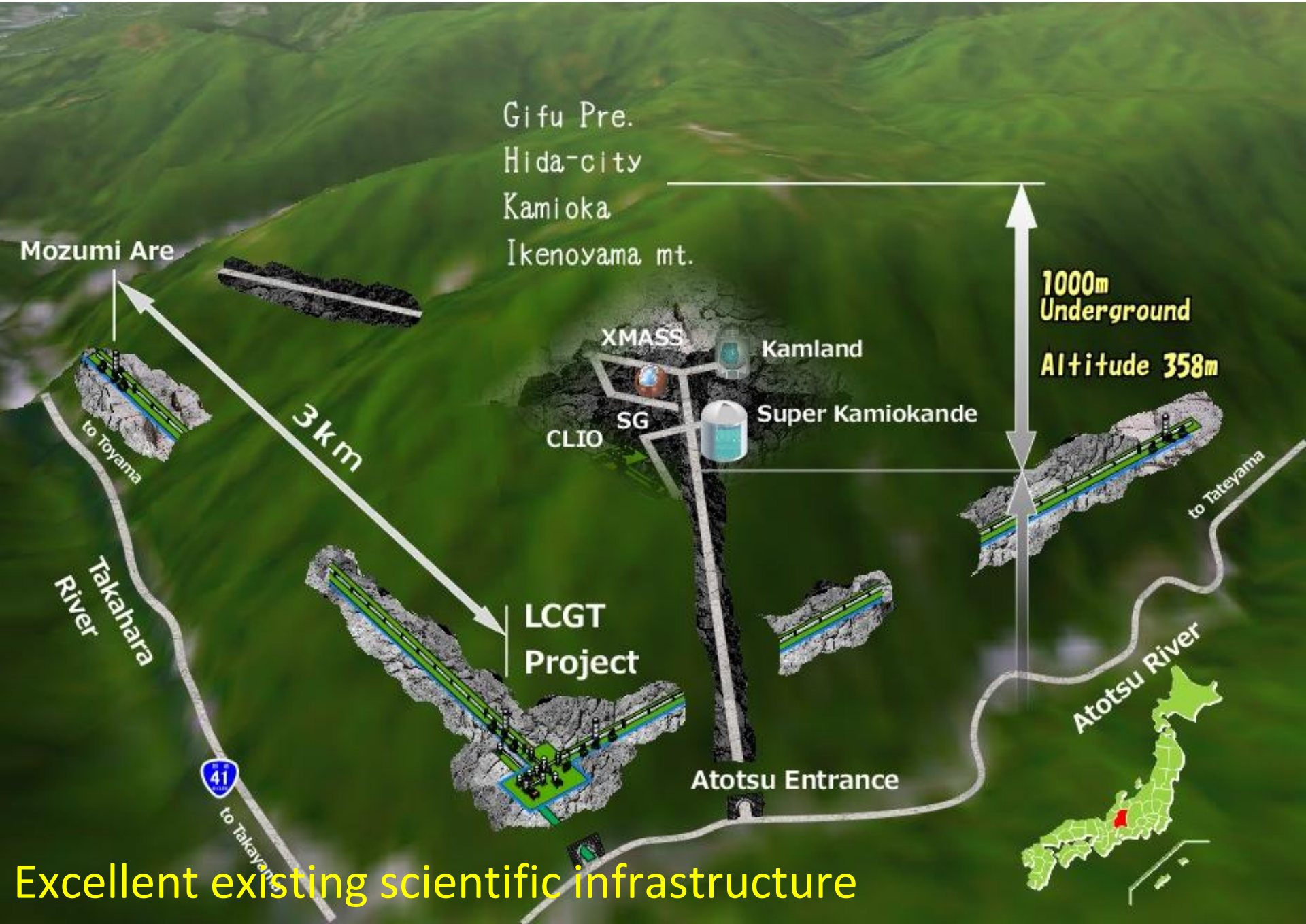
Available infrastructure

Homestake - USA

Safety issues: training, guides (by appointment)

Elevators: access (operators)

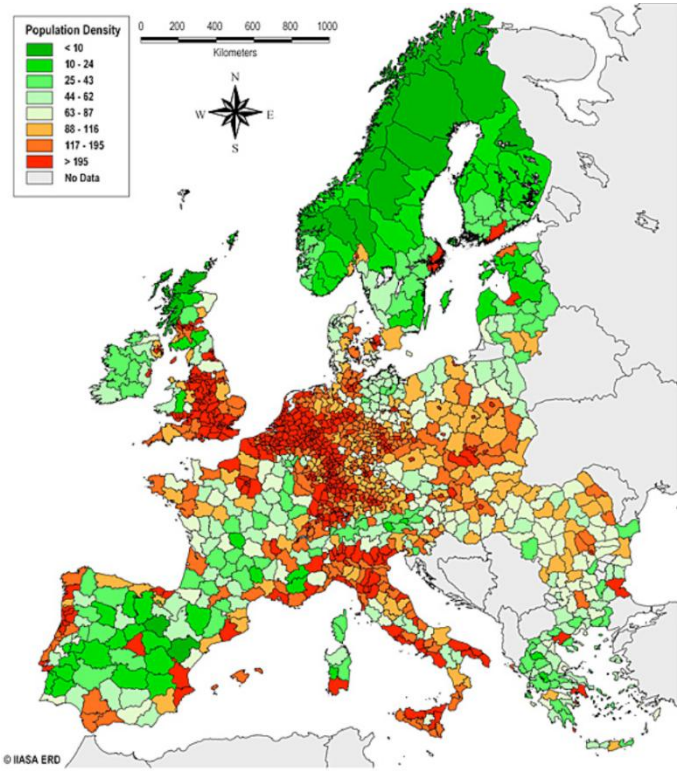
Schematic view of Kamioka Research Facility (Kuroda)



Excellent existing scientific infrastructure

Available infrastructure

- Site studies
  - Europe
    - Frejus
    - Gran Sasso
    - Canfranc
    - Hungary
    - Sardinia
- Access
  - Horizontal
    - Traffic tunnels: escort needed
    - Train tunnels
  - Vertical: Homestake
- Nearby universities or institutes
  - Commute: airport, train, highway
  - Library, lecture halls, hotels
  - Local labor force, …



GGN ANALYTICAL STUDIES

- Analytical studies
  - Giancarlo Cella
  - Jan Harms
- Conclusions
  - Reduction is a challenge at low frequency
  - Low seismic velocity is beneficial
  - Studies for homogeneous medium
  - Subtraction schemes

Improving the sensitivity of future GW observatories in the 1 – 10Hz band: Newtonian and seismic noise

M. G. Beker · G. Cella · R. DeSalvo · M. Doets · H. Grote · J. Harms · E. Hennes · V. Mandic · D. S. Rabeling · J. F. J. van den Brand · C. M. van Leeuwen

the date of receipt and acceptance should be inserted later

Keywords Gravitational waves, Noises

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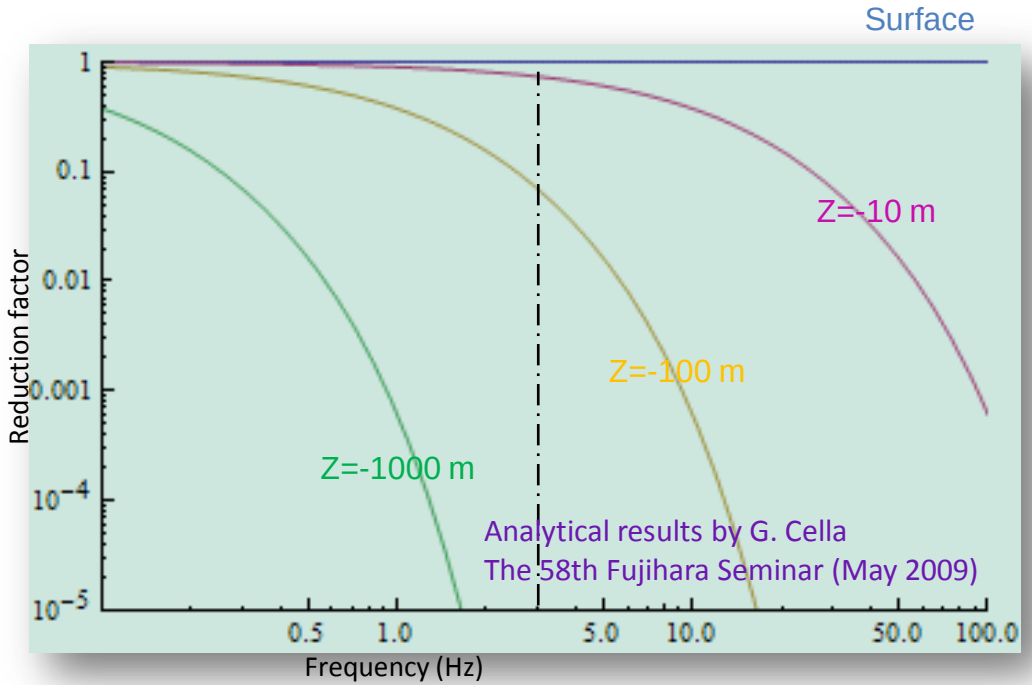
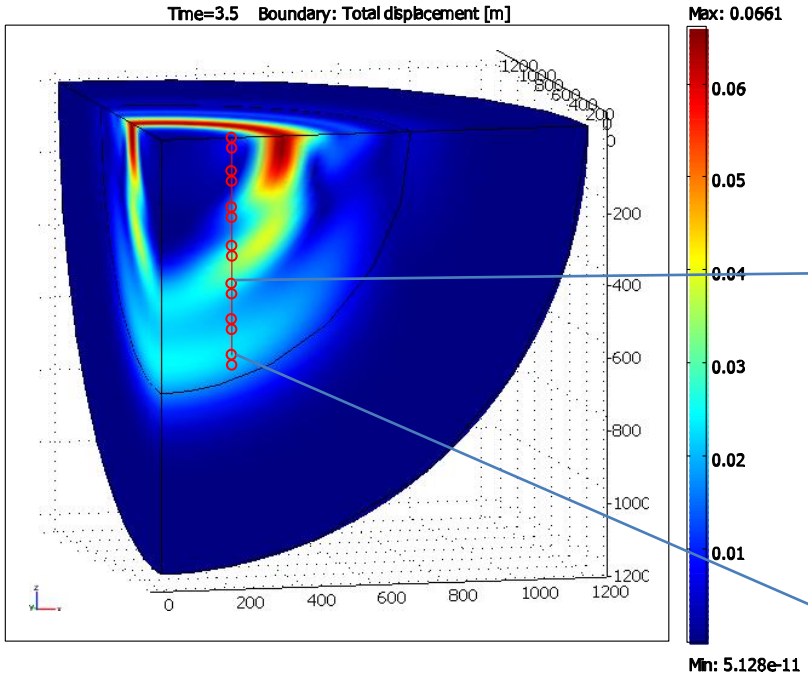
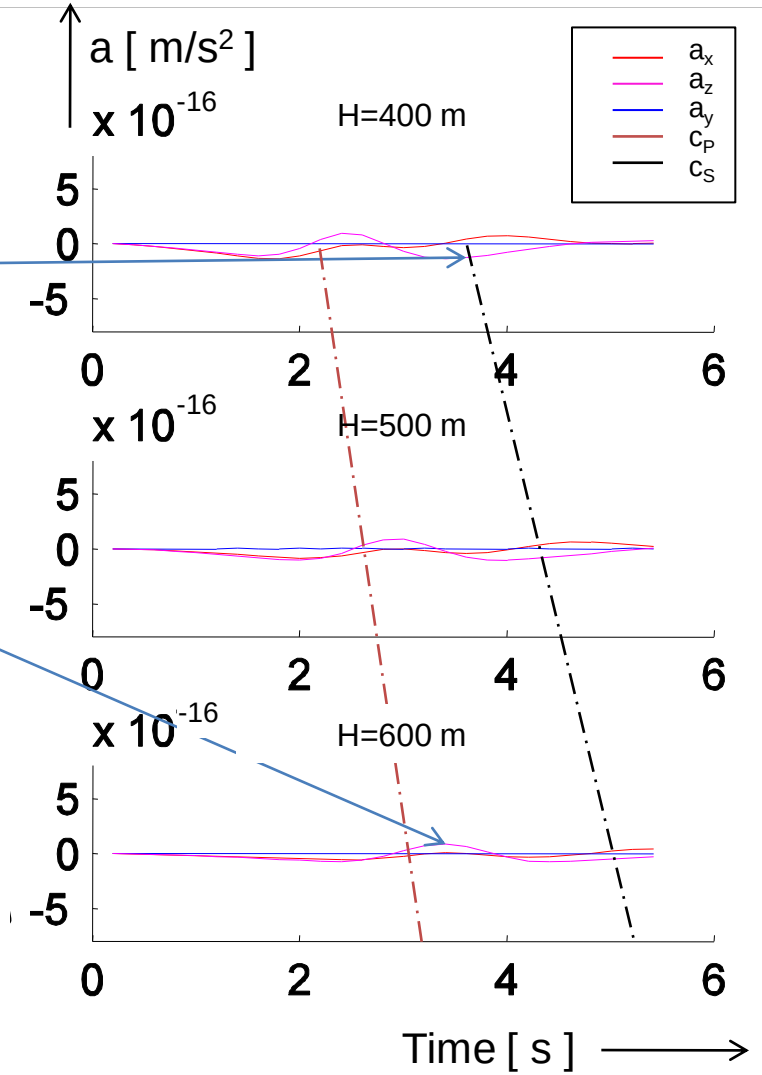
May 7, 2010



GGN studies with FEA

Mark Beker, David Rabeling
Nikhef



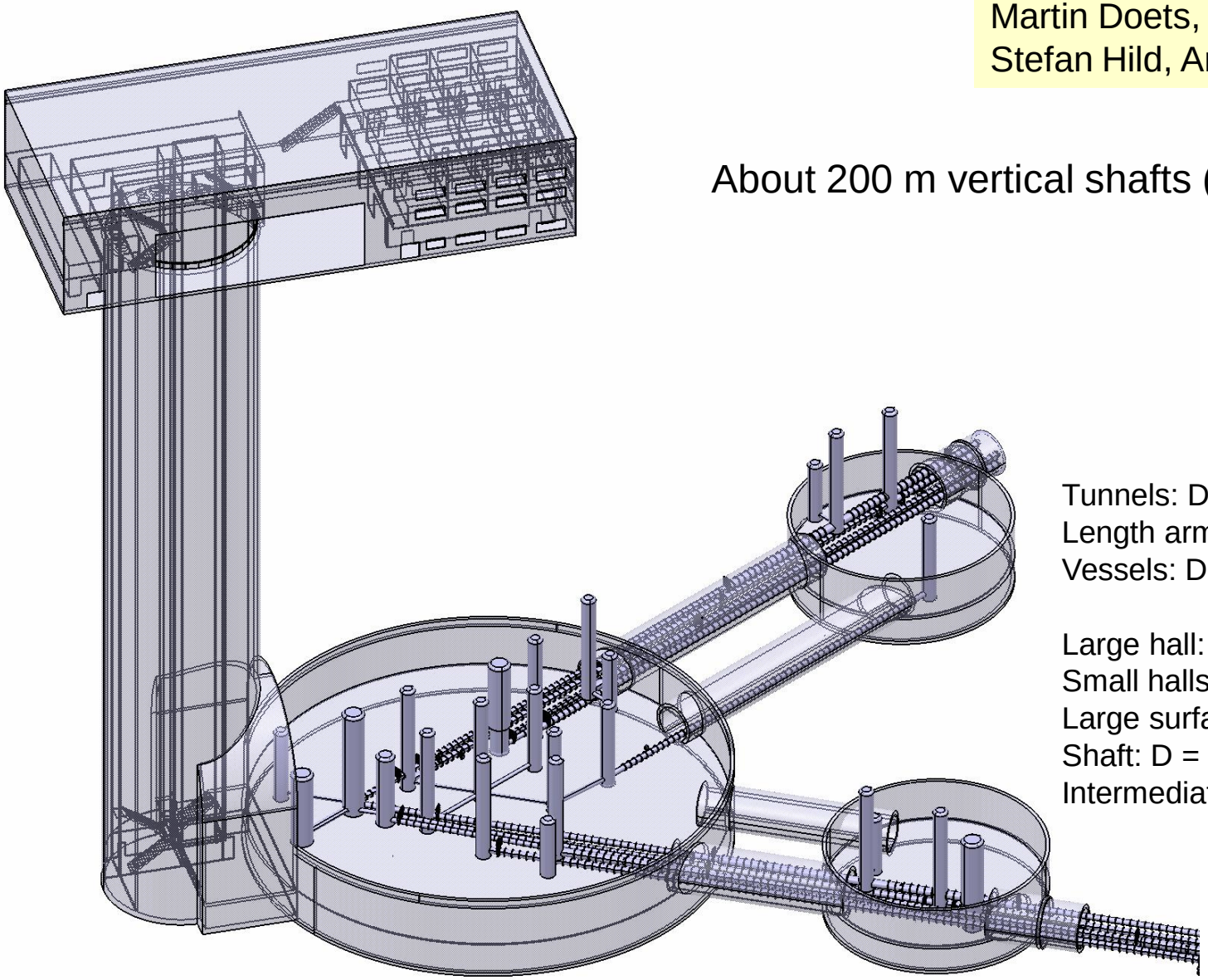


- FEA model and impulse response
  - All wave types included
  - GGN drops less than order of magnitude
  - Little geometric suppression
  - Employ subtraction (data filtering)

Infrastructure: underground

Martin Doets, David Rabeling
Stefan Hild, Andreas Freise

About 200 m vertical shafts (18 m diameter)

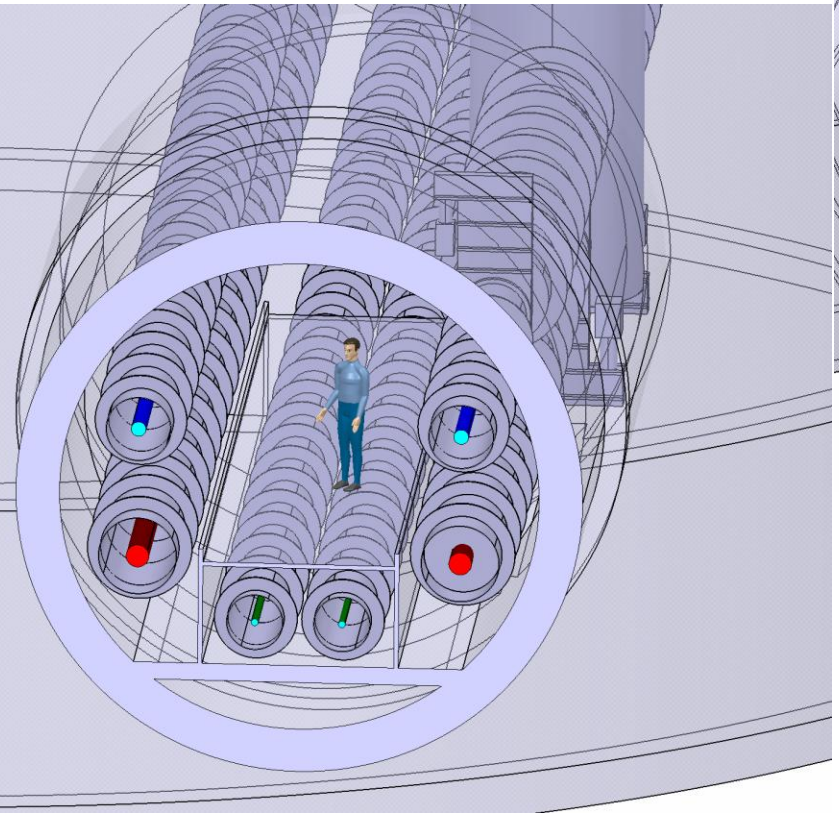


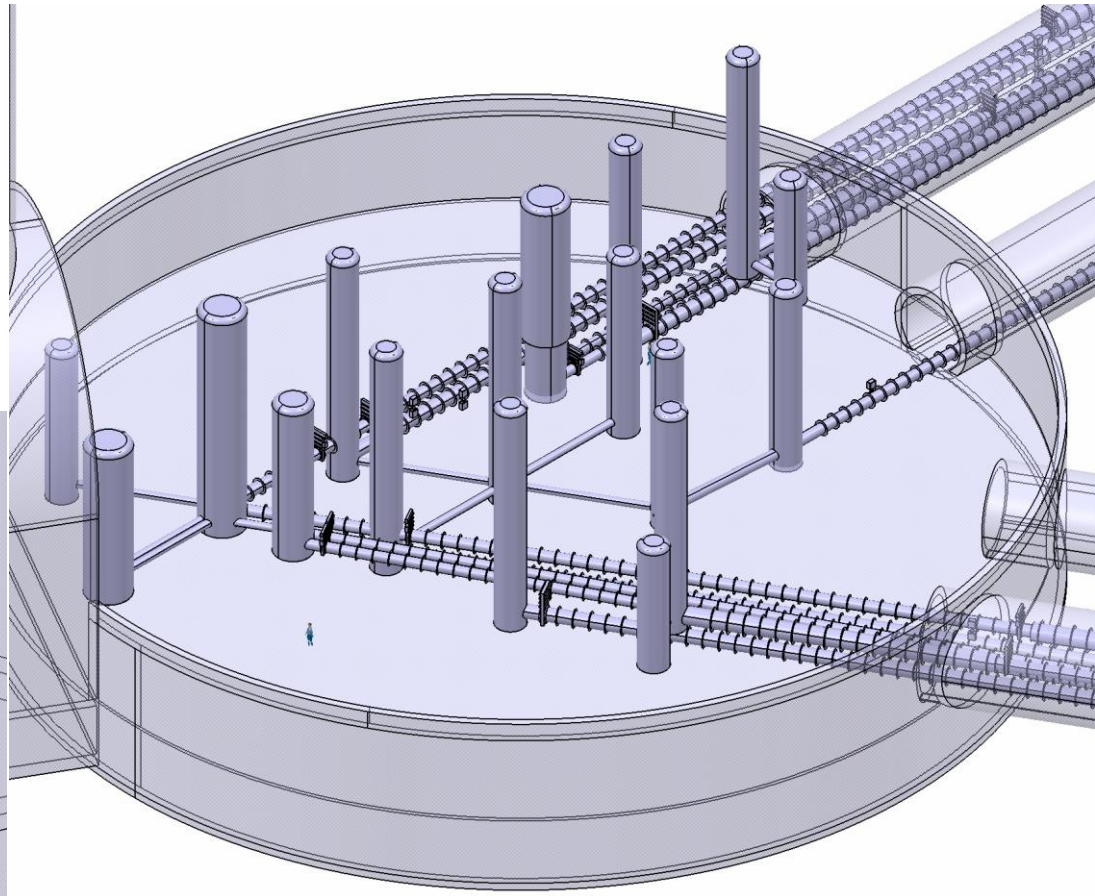
Tunnels: Din = 5.5 m
Length arms: 10 km + 2 x 700 m
Vessels: D = 0.9 m and D = 0.75 m

Large hall: D = 65 m, H = 30 m
Small halls: D = 30 m, H = 30 m
Large surface building, lift
Shaft: D = 18 m
Intermediate shaft: D = 10 m

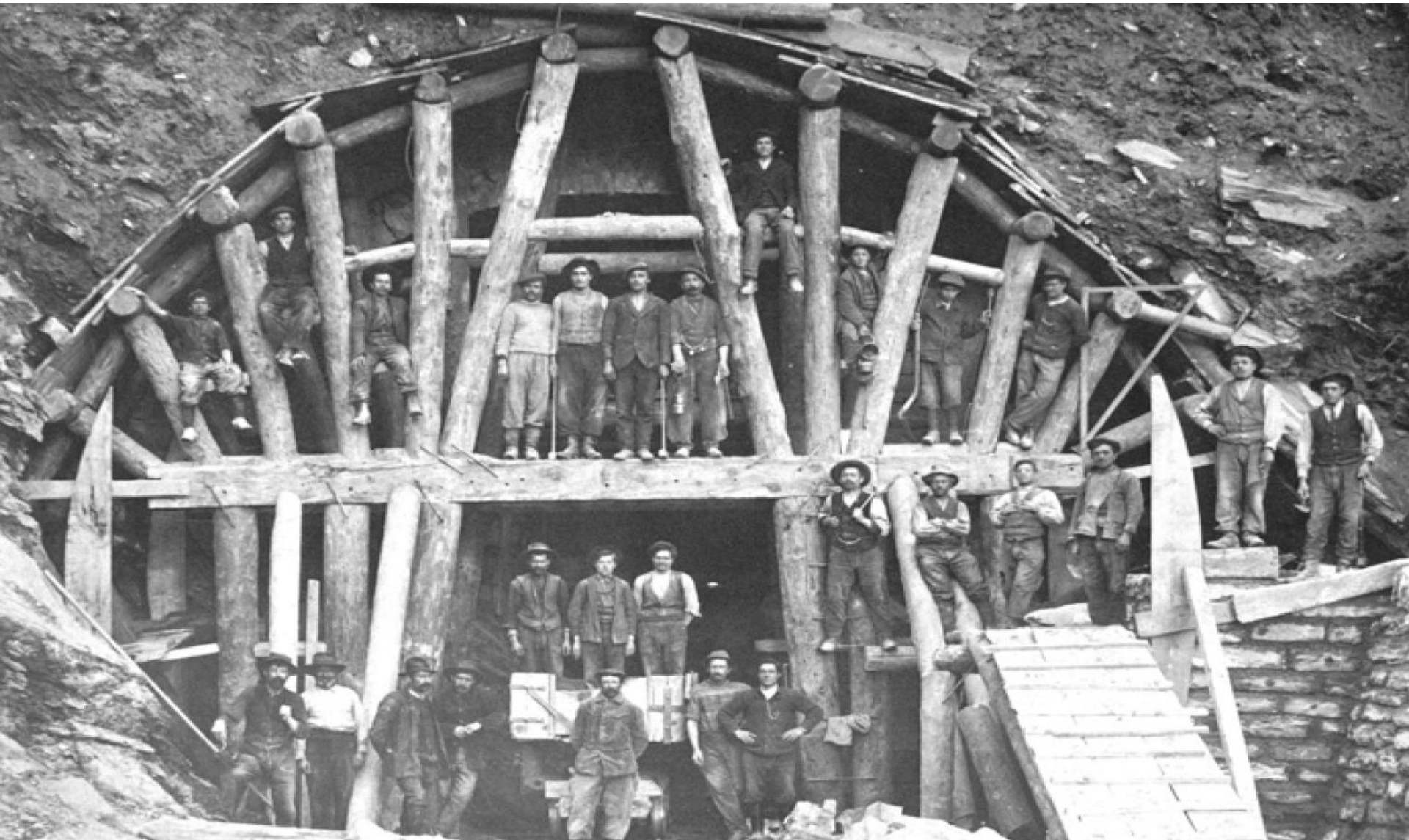
Infrastructure: underground

- Optimization studies
  - Hall infrastructure
    - Tower positions
  - Vacuum system
    - Valves

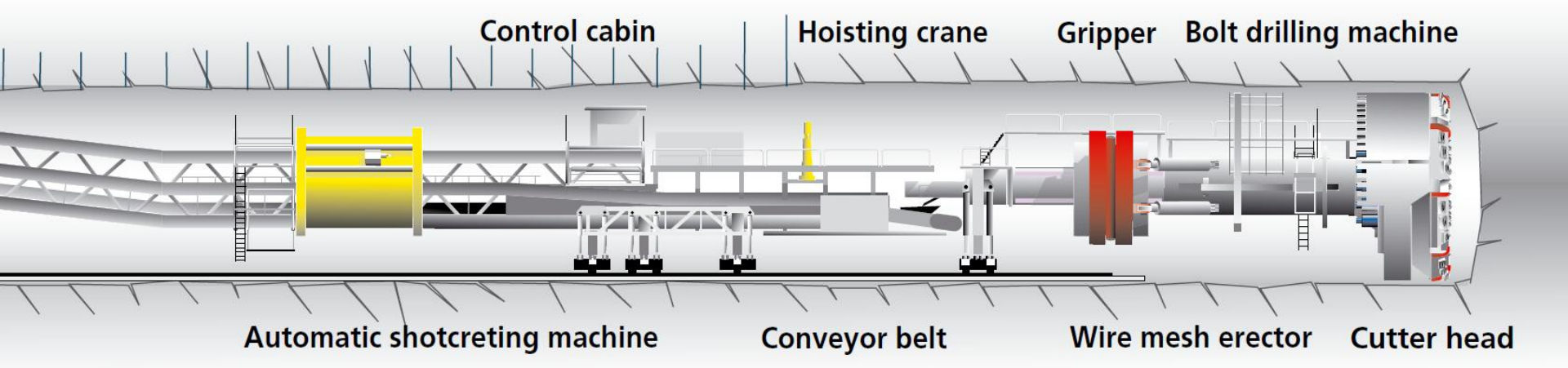




How to construct ET facility?



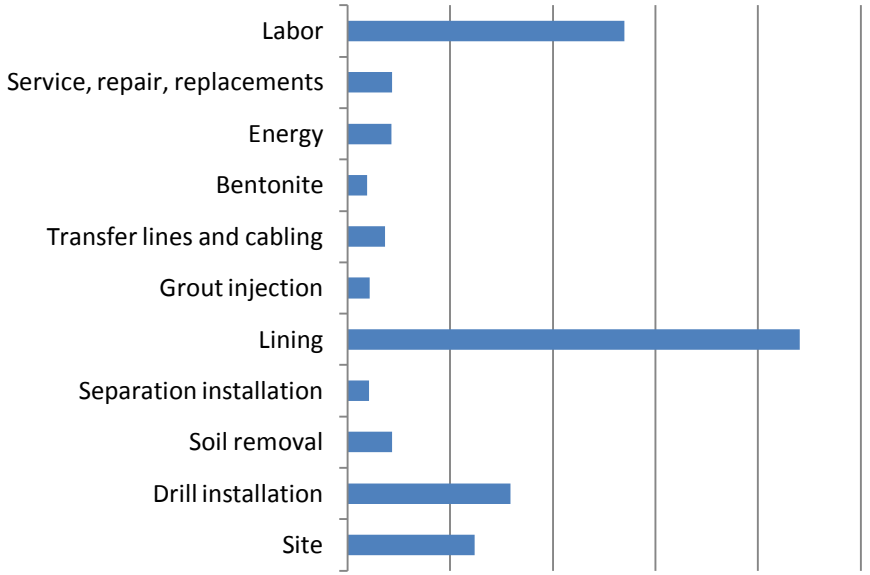
Tunnel Boring Machines

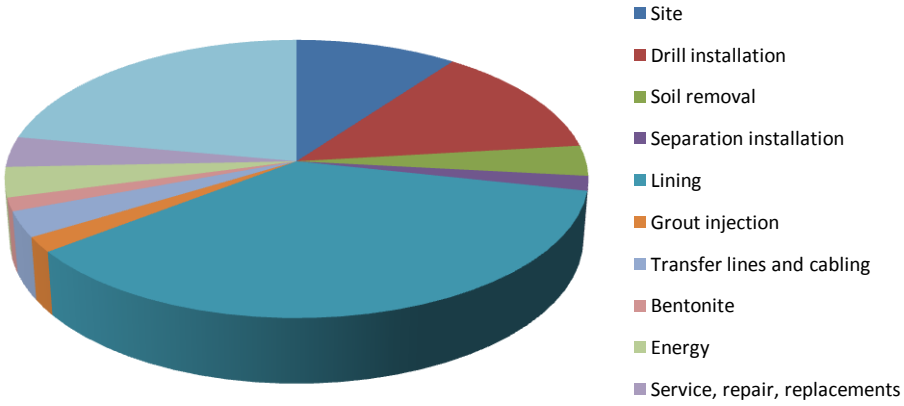


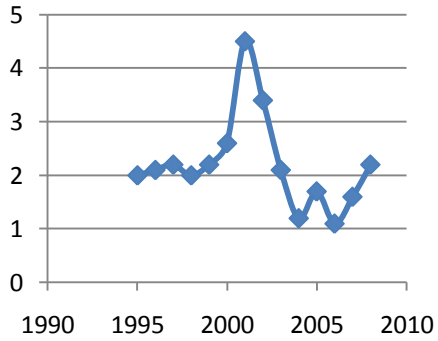
COB – Construction cost for a single 6m tube

MEuro for 5 km tunnel

Site	€ 6,174.14
Drill installation	€ 7,933.00
Soil removal	€ 2,149.03
Separation installation	€ 1,033.48
Lining	€ 22,037.46
Grout injection	€ 1,076.04
Transfer lines and cabling	€ 1,823.79
Bentonite	€ 945.33
Energy	€ 2,124.72
Service, repair, replacements	€ 2,149.03
Labor	€ 13,480.85
Total	€ 60,926.86
Profit and risk add-on	20%
Cost raw structure	€ 73,112.23



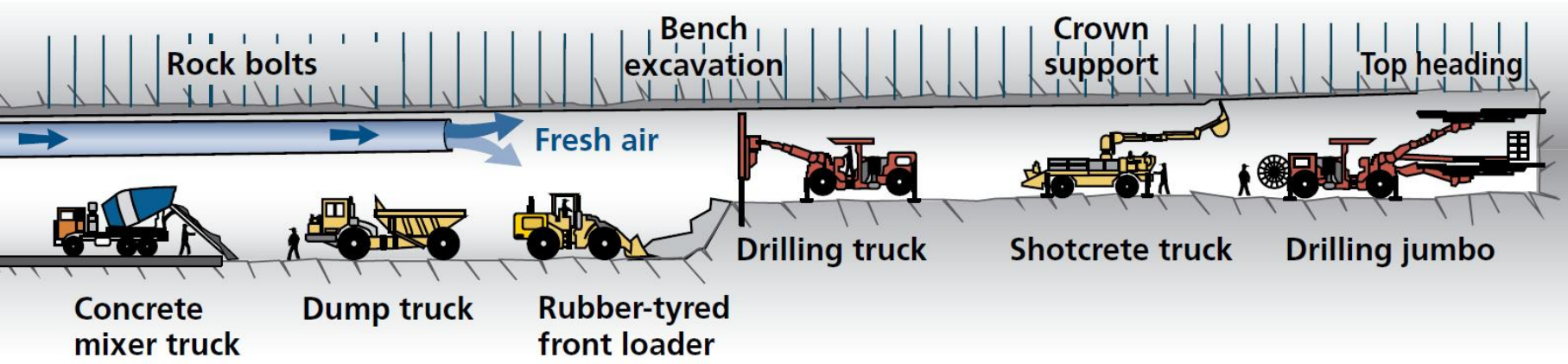




Price per m tunnel tube	€ 14,622.56
Price per m3	€ 517.18

Vertical drilling: additional cost factor (×2)

Drill & Blast


Rock bolts
Bench excavation
Crown support
Top heading
Fresh air
Drilling truck
Shotcrete truck
Drilling jumbo
Concrete mixer truck
Dump truck
Rubber-tyred front loader


Hydropower station

LHC project: CMS cavern

LHC project: CMS cavern

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LHC project: Atlas cavern

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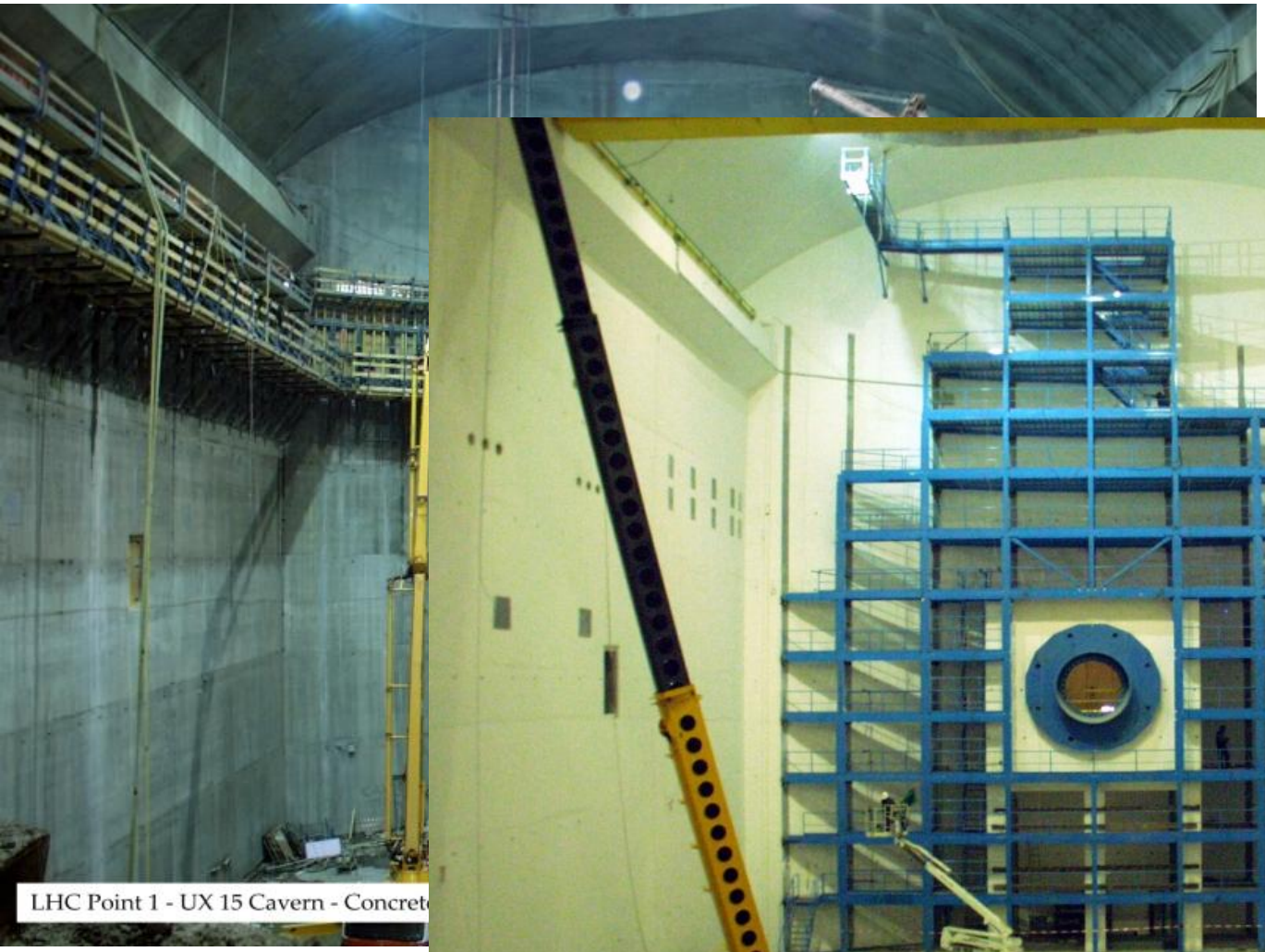

LHC project: CMS shaft

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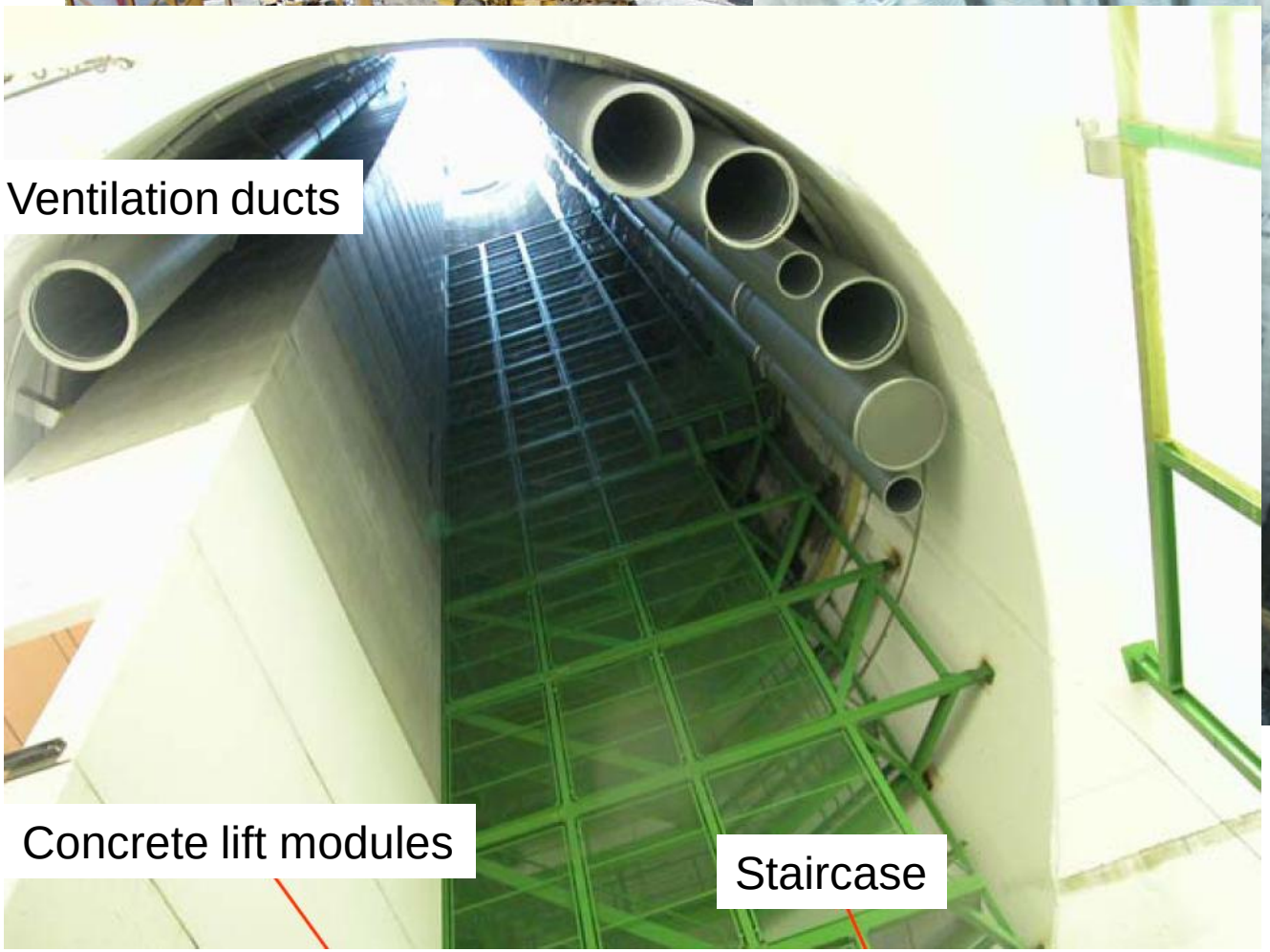
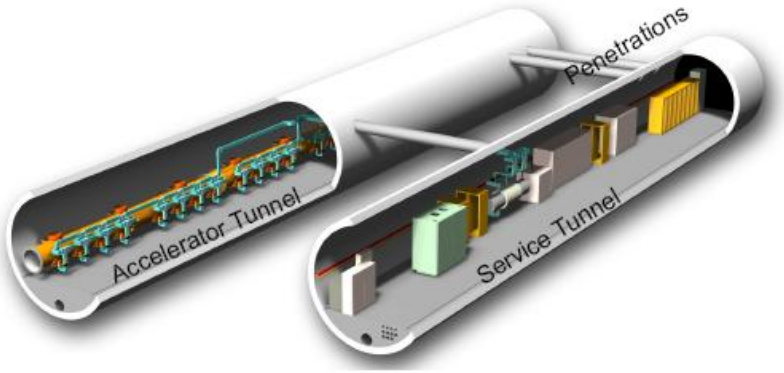


ILC cost

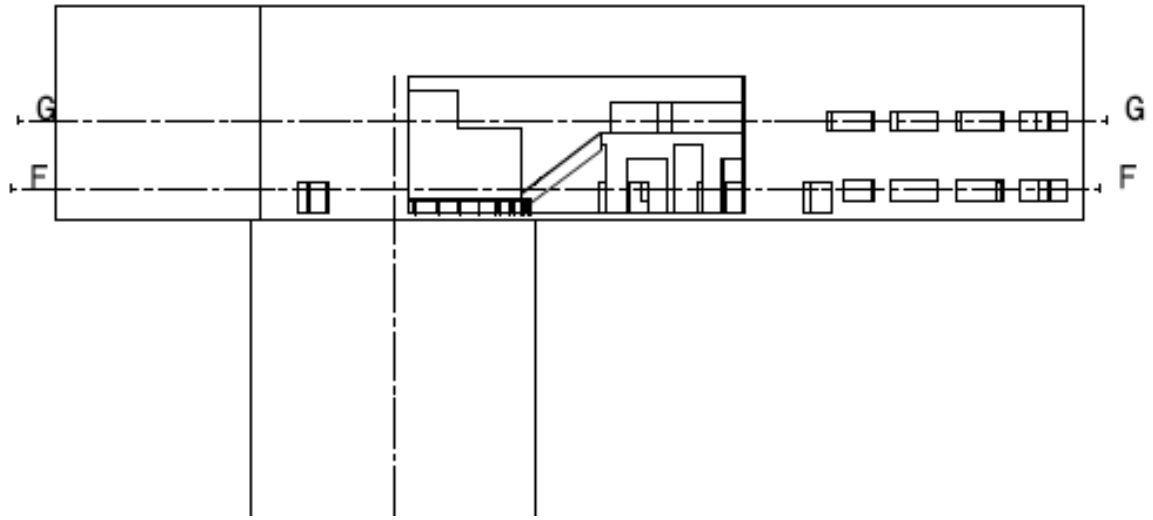
- Tunnels
  - 72 km length
  - Diameter: 4.5 m
  - Volume: 1 145 076 m3
  - Depth 100 m
  - Geology: dry rock

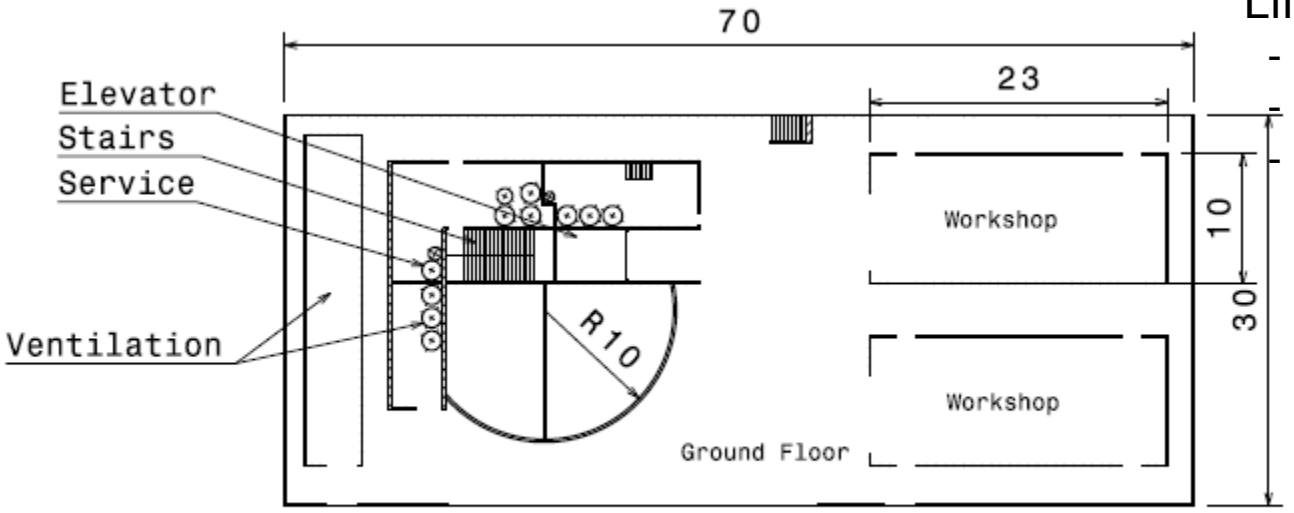


Cost: 1209 Euro/m3

- Caverns
  - Volume: 111,436 m3
- Standard TBMs
  - 9 TBMs
  - 1 year shaft construction (Φ: 4×9 m, 4×14 m, 4×1.5 m)
  - 3 months setup
  - 25 m/day boring speed (Note: 30,000/25 = 1200 days)

Surface buildings





Section view F-F
Scale: 1:500

Ground floor

- L = 70 m, W = 30 m
- 2 workshops (23 m x 10 m)
  - o vacuum tubes
  - o cleanrooms later?
- Large entrance doors
- Ventilation system (outside?)
- Cryocoolers?
- Services

Lifting facility

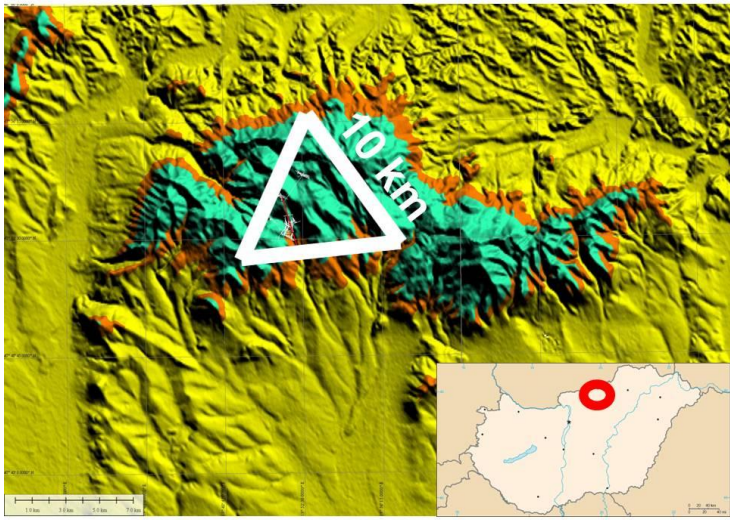
- D = 20 m
- Excavation entrance (TBMs?)
- Stairs, Elevator

Safety systems

- Fire safety
  - Egress to surface (at shafts)
  - Emergency egress points
  - Smoke detectors, manual alarms (buttons), alarm bell
  - Smoke exhaust fan
  - Emergency lighting, exit signs, direction signs
  - Portable chemical powder fire extinguishers
  - Large size fire extinguishing equipment
  - No sprinklers, hydrants and water curtains to avoid water damage
- Safety for Helium and LN2
  - From nearby campus? Include in cost estimate?
    - Offices, meeting and seminar rooms
    - Guest houses, restaurants
    - Administrative facilities
    - Computing facilities

Future

Dedicated studies of candidate sites



- Site studies
  - Collect long term seismic data
  - Active involvement of teams of local scientists
  - Local geology studies, GGN
- Consolidation of knowledge
  - Advanced detectors, LCGT, GEO-HF
  - LCGT: tunneling, cryogenics, vacuum, safety, commissioning
  - Infrastructure costing: large cost drivers (LHC, Dusel, ILC)
- Coordination of site studies and assessment
  - Site assessment process: define required studies
  - Set-up database: consolidate geo-physical and technical information
  - Ranking scheme
    - Separate technical validation from political selection criteria
  - Regular workshops