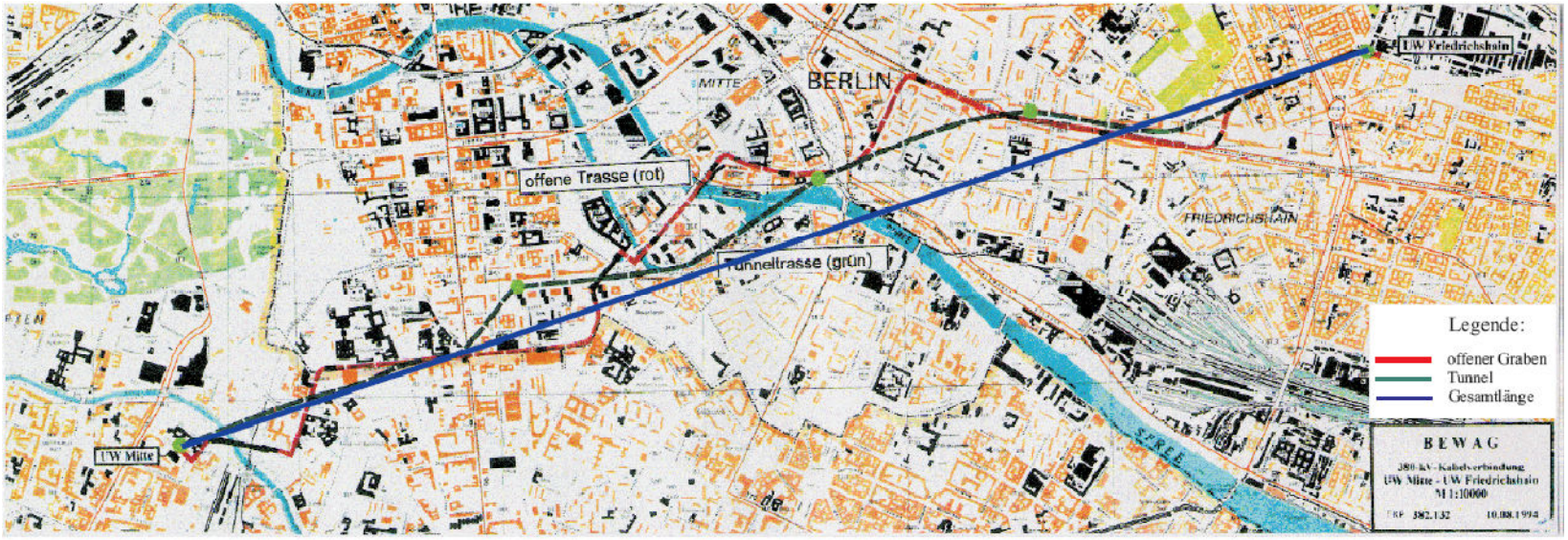
# Outline

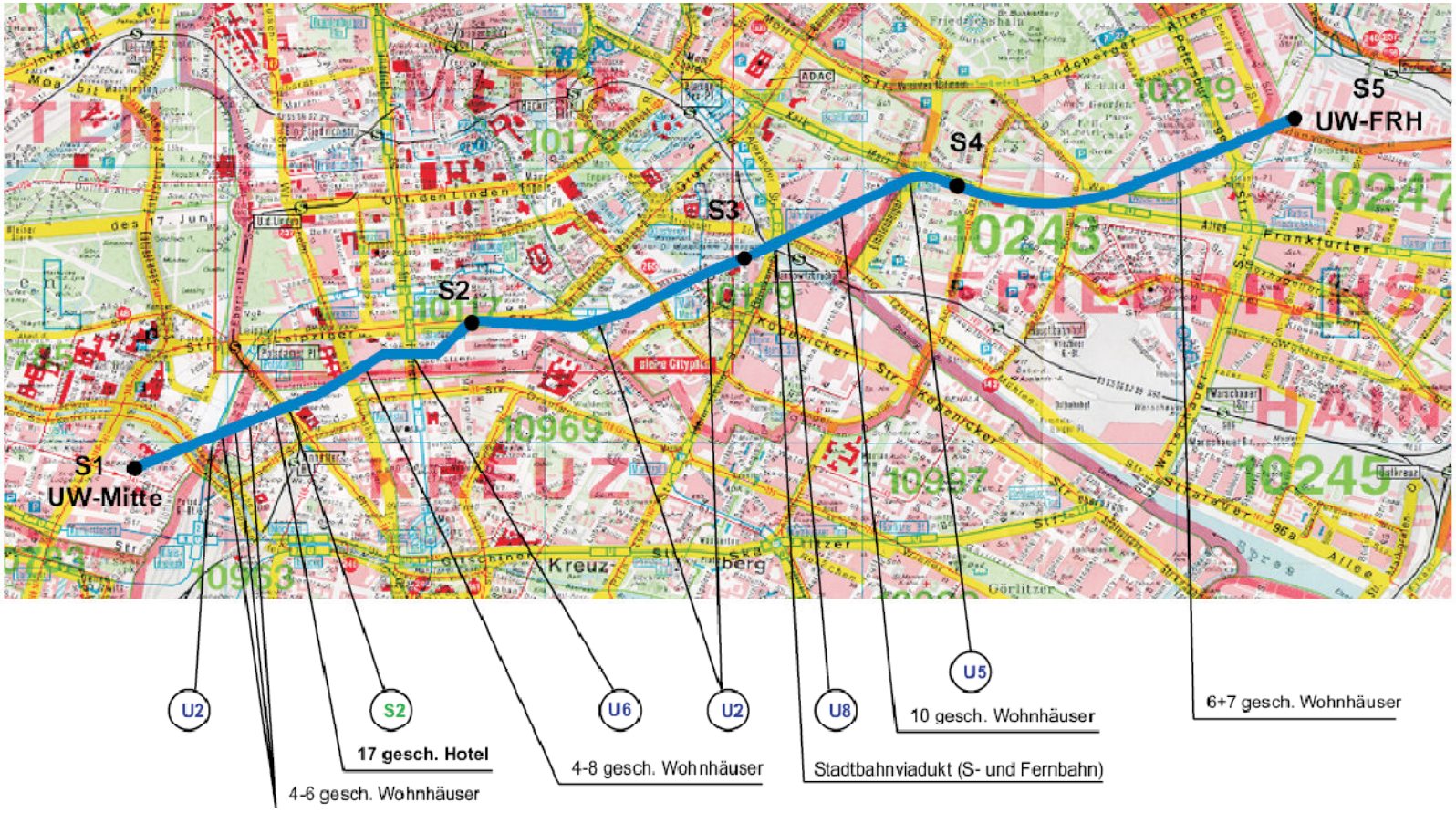
- Experience with Tunnelling in Berlin (Geology)
- To get a good price:
  - Tendering Methods
  - Design Methods

# Challenge: To Minimize Project Costs



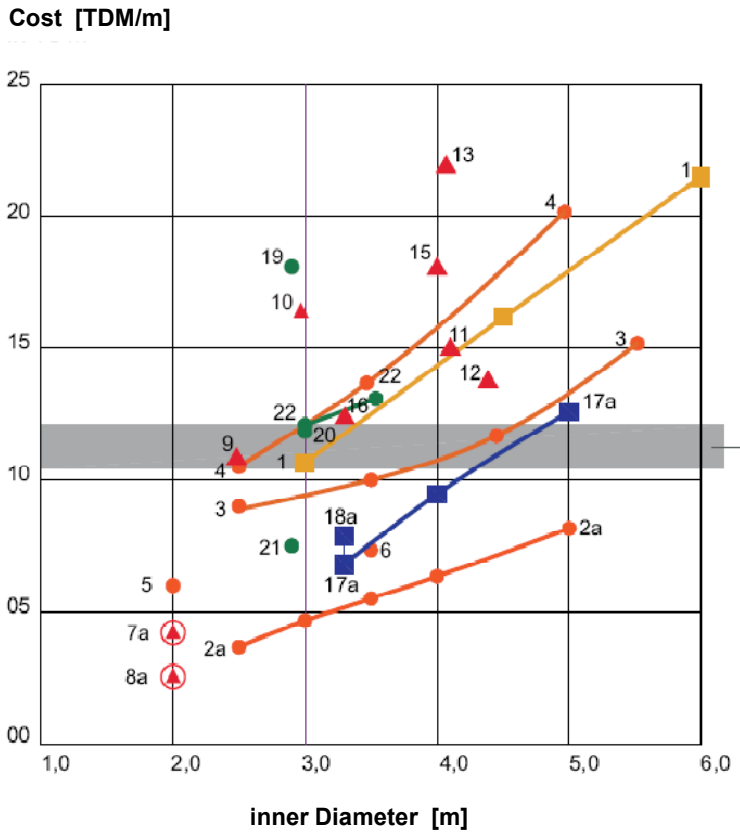

| Direct Distance: | Tunnel: | Open trench: |
|---|---|---|
| 6172 m | 6364 m | 7482 m |
| 100 % | 103 % | 121 % |

# Difficulties and Risks



# Cost Comparison: Open Trench vs. Tunnel

## Cost Estimation and Feasibility Study




STUVA

| | |
|---|---|
| 1 | Tunnelbaukosten aus Literatur (Hrsg. STUVA) |
| 2a) -6 | Firmenangaben |
| 7a) -8 a) | Kabeltunnel London |
| 7-16 | ausgeführte Bauwerke: |
| 9 | Mischwasser-Transportsammler Bremen |
| 10 | Rheintunnel Köln |
| 11 | Heizwasserleitung Berlin |
| 12 | Fernwärmeleitung München |
| 13 | Versorgungstunnel Kieler Förde |
| --- | --- |
| 15 | Tiefduker Dradenau |
| 16 | Rheintunnel Düsseldorf (1958/59) |

EAB Studie

| | |
|---|---|
| 17 a) | Variante gerader Tunnel |
| 18 a) | Variante kurviger Tunnel |

Firmenanfragen Bewag

| | |
|---|---|
| 19 | Firma a |
| 20 | Firma b |
| 21 | Firma c |
| 22 | Firma d |

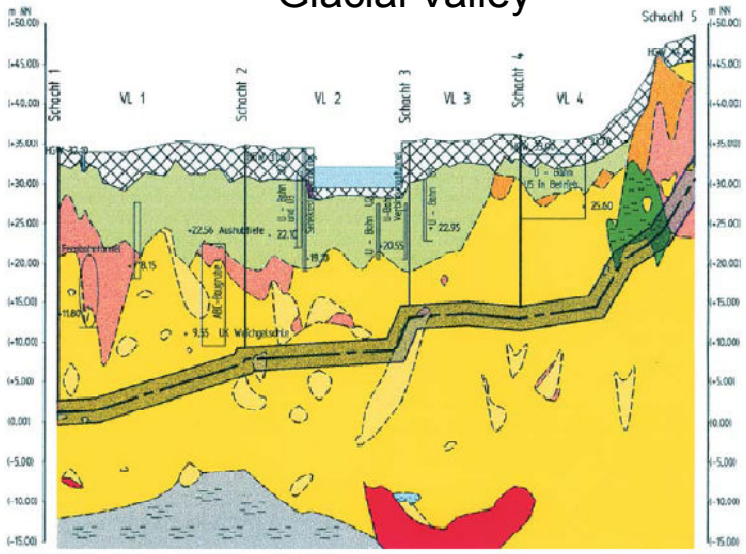
Open Trench Method

(from former projects)

a) ausländische Anfragen

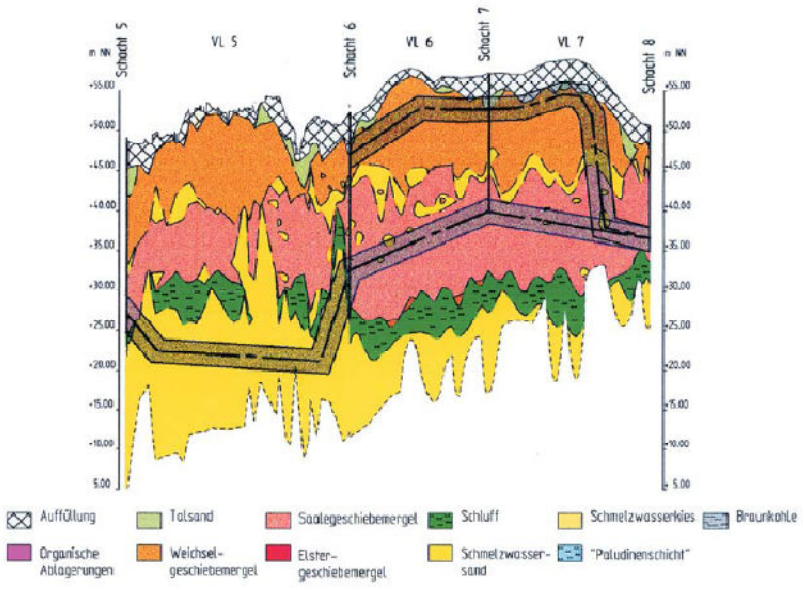
# Glacial Geology in Berlin

Lot 1
Glacial Valley




mainly sandy soils

Lot 2
Glacial Moraine




mainly loam and marl

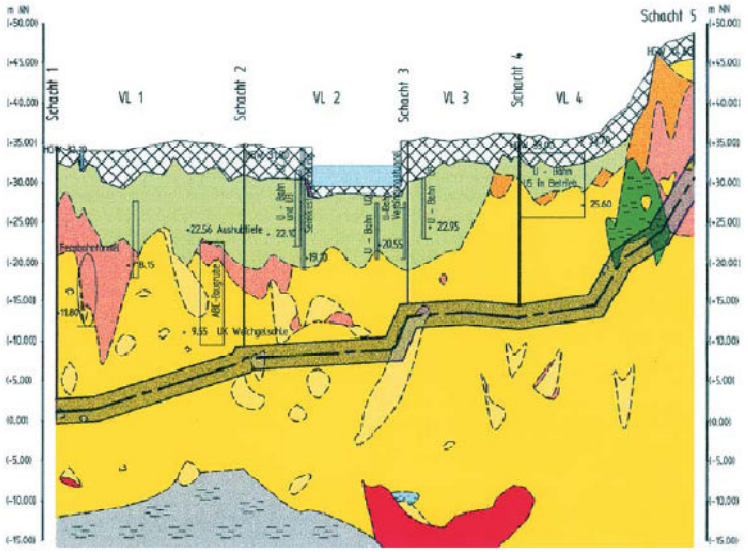
# Glacial Geology in Berlin

**Glacial Valley**

Down to a depth of more than 100 m BSL, the relevant subsoil of Berlin is composed of loose sediment from Tertiary and Quaternary.

Melt water sand gravel of Berlin-Warsaw glacial valley fro the Elster, Saale and Weichsel glacial epochs are prevalent in the Berlin inner city subsoil, while most of the remaining ground moraine plate consisting of boulder clay has been eroded.

Some remains of the eroded boulder clay may be found in the form of gravel layers with boulders of varying thickness which may cover vast areas.



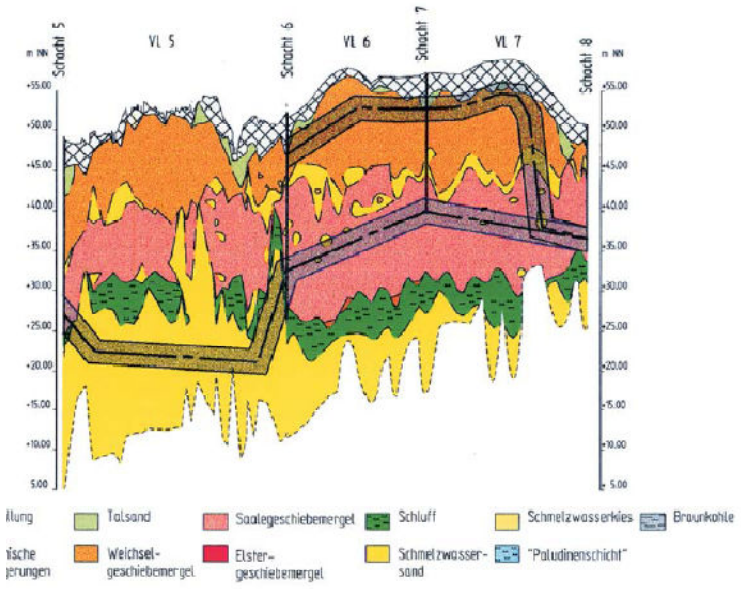
# Glacial Geology in Berlin

**Glacial Moraine**

Cohesive sediments of ground moraines are found in north eastern Berlin in the area of Barnim plateau to a depth of 40 m below ground level.

The route first dips down again into the sand-gravel melt water layers below the cohesive ground moraines.

The route continues for the remaining 2.9 km at a depth of 15 to 20 m below ground level through the cohesive ground moraine of the Saale epoche (boulder clay with intermediate sand lenses).



# Problems in Lot 2

# Problems in Lot 2

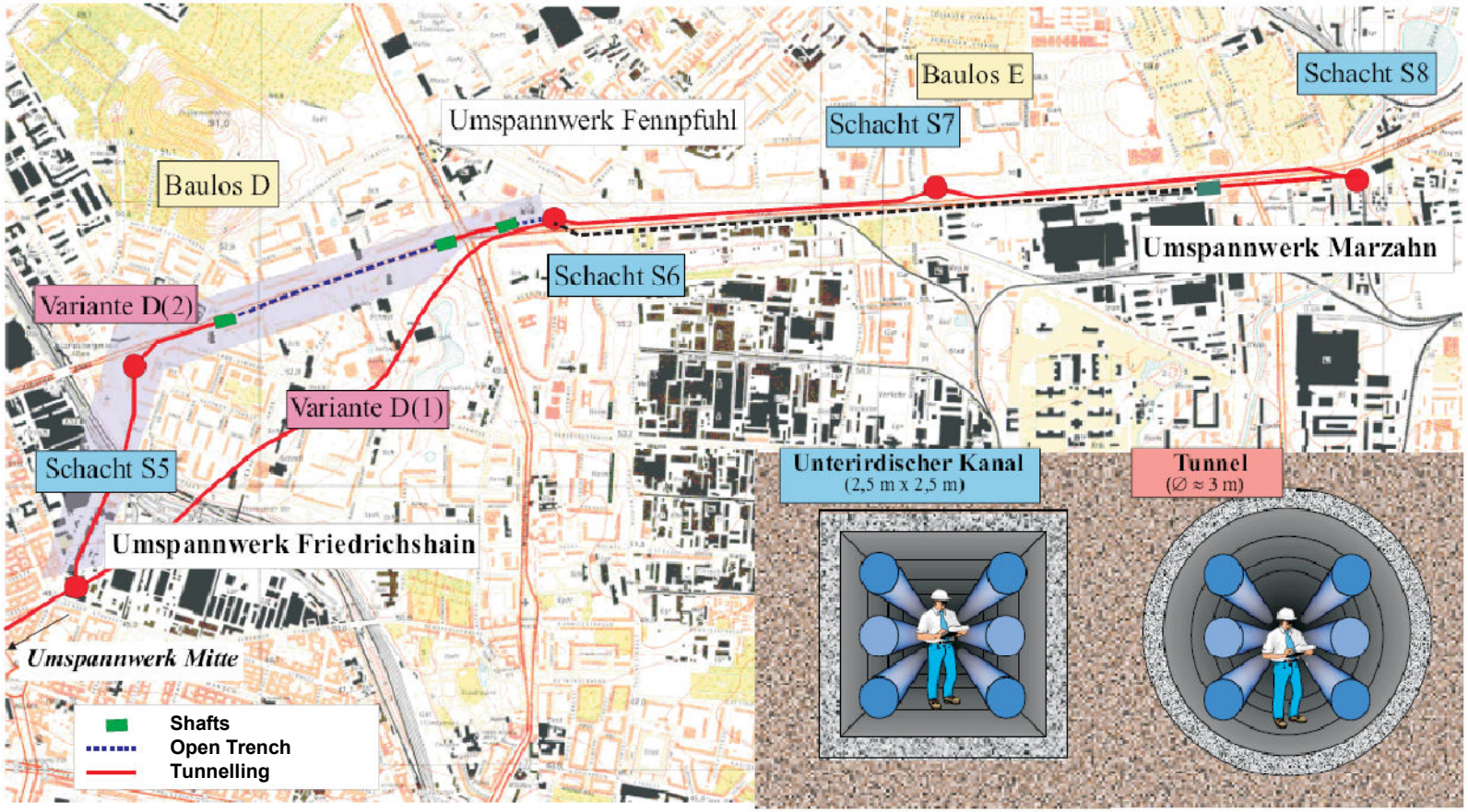
# Tendering Methods

**Tendering package only contained key functions of the project and main requirements**

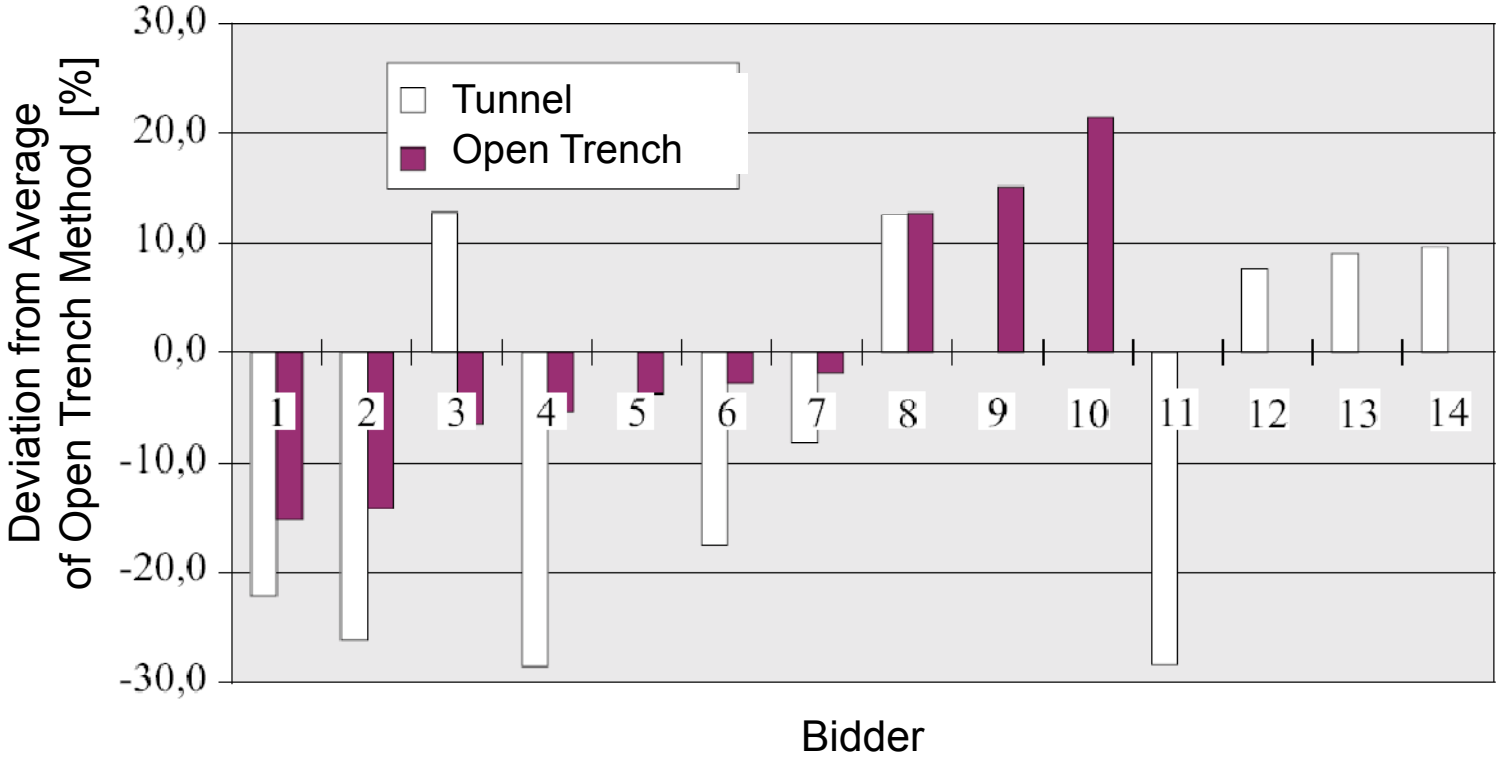
- Tunnelling: Possibility of tubbing (precast concrete units) or pipe jacking
- Shafts: interlocking bored piles, diaphragm walls, caissons

- Design alternatives (only in the second lot): open trench method vs. tunnelling

# Design Alternatives



# Results of Tendering Procedure



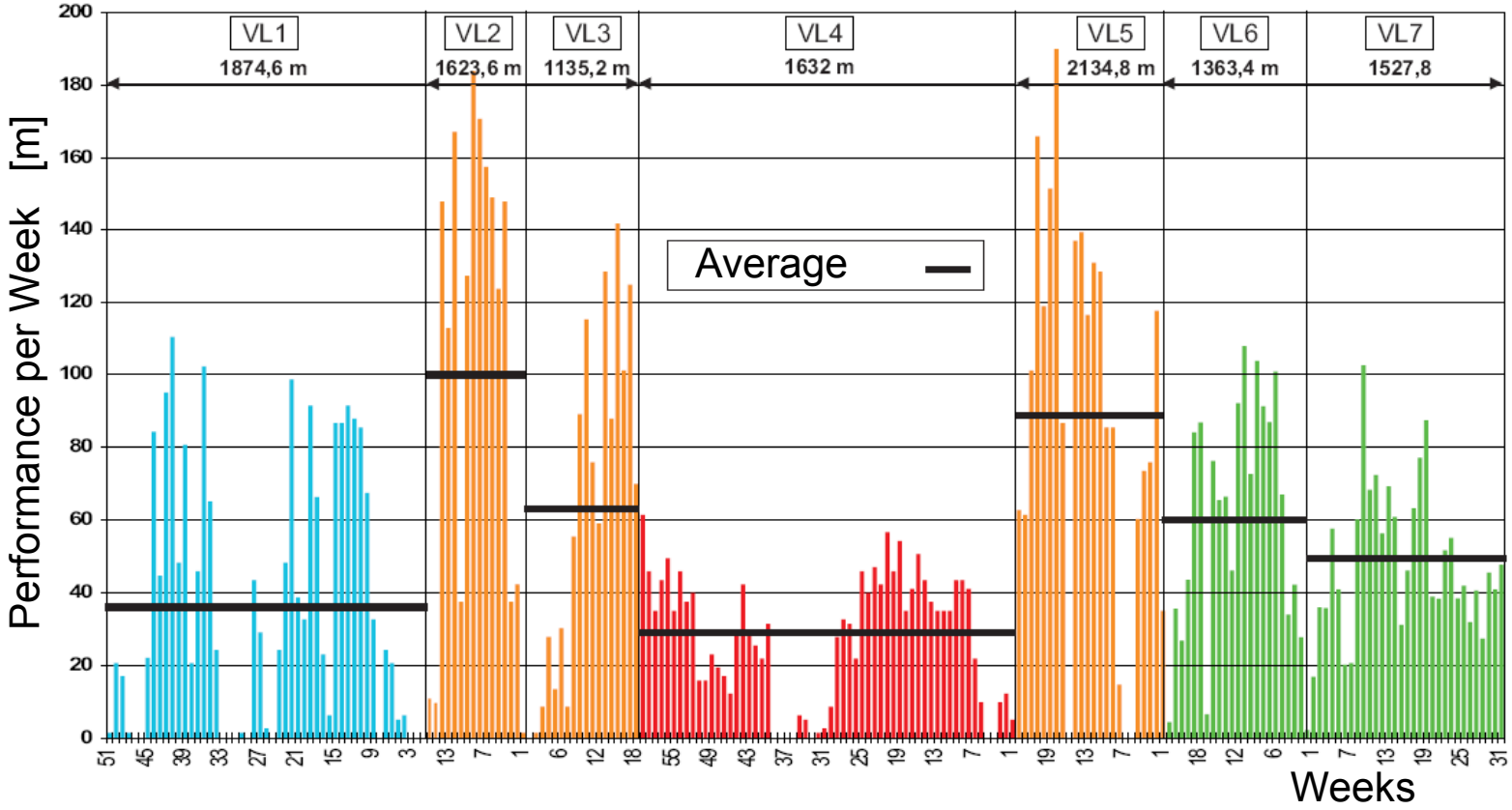
# Equipment of TBM

Experience with different TBM layouts in Lot 1

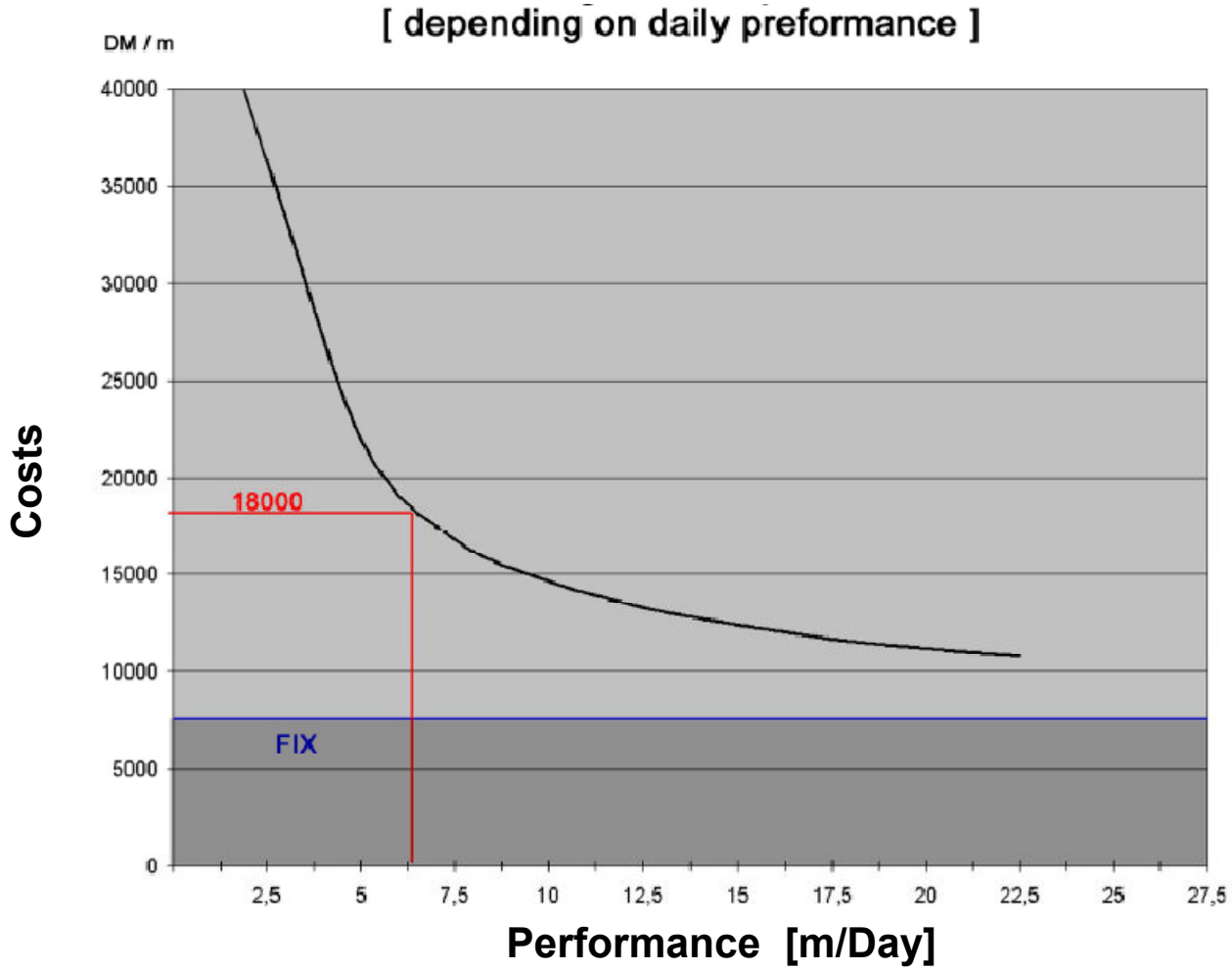
Type 1

Type 2

# Tunnelling Performance

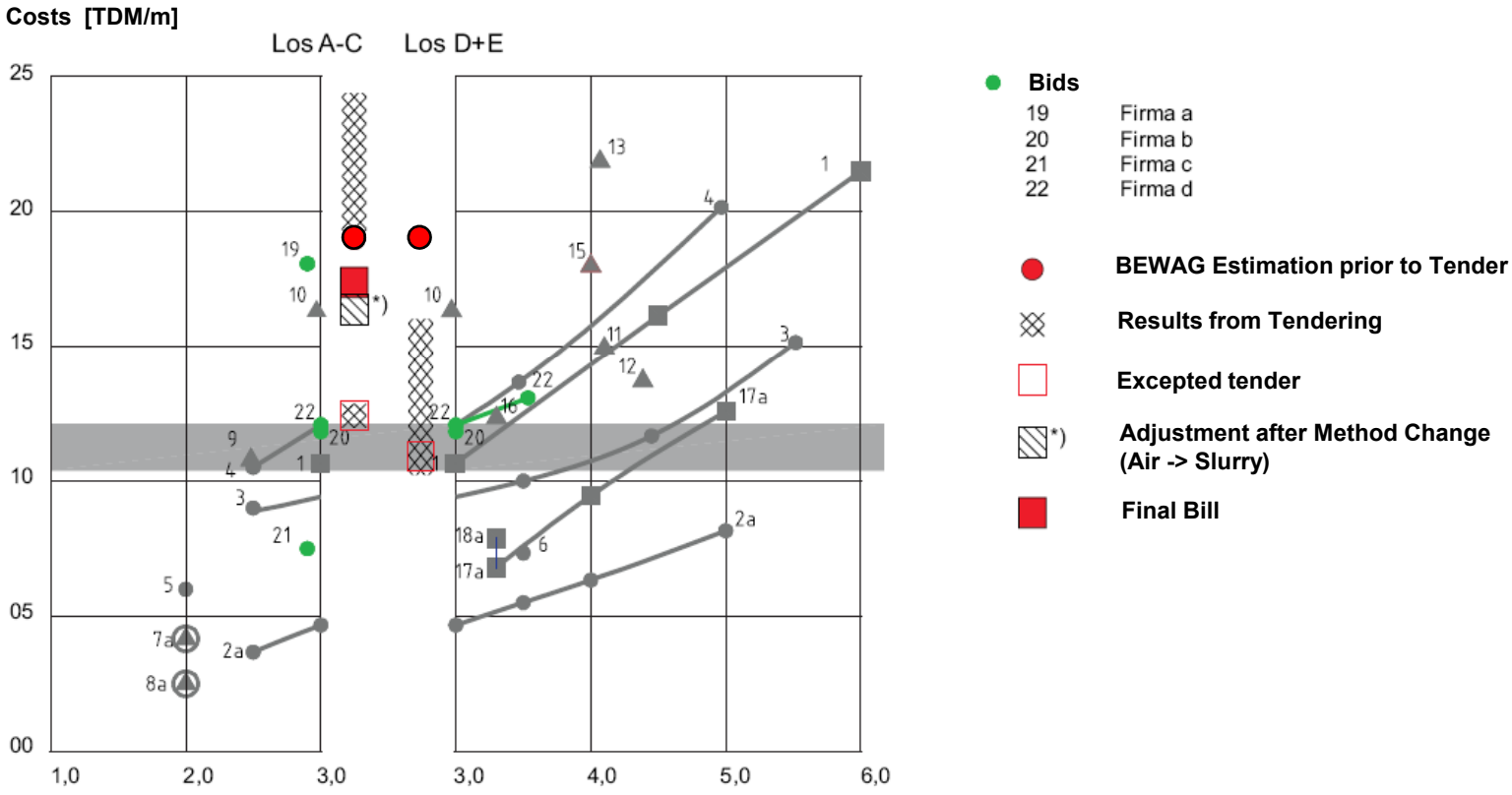


# Tunnelling Costs per Meter

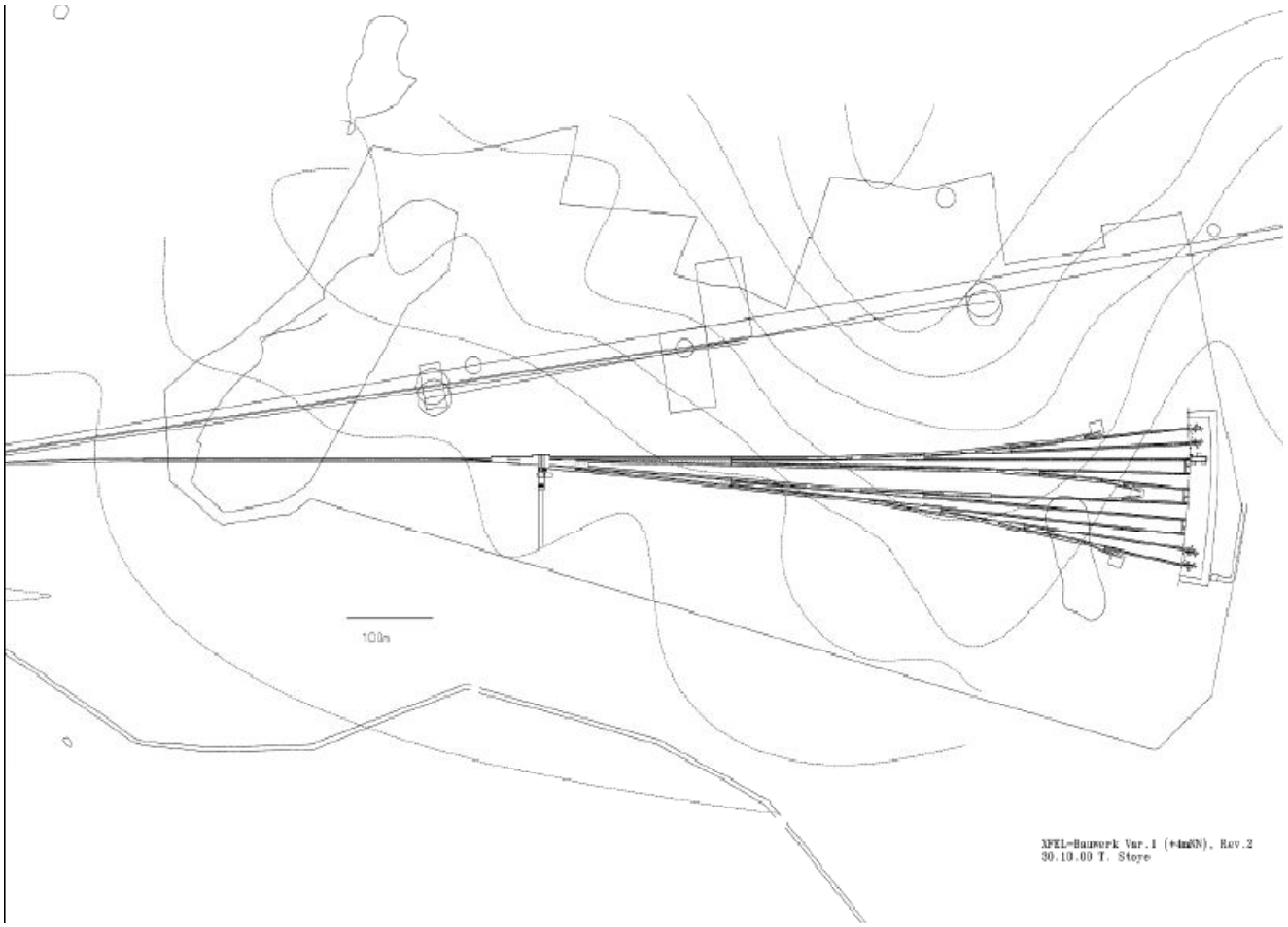



| | | | |
|---|---|---|---|
| Input | - Costs of TBM / separation equipment | : | 10 Mio. DM ( one per 8 km ) |
| | - Tunnel Lining (Tubbings ) | : | 6 Mio. DM / km |
| | - Operation ( 3 schifts per day, 5 days a Week - construction site ) | : | 60.000 DM / Day |
| | - additional costs | : | ech 20 % |

# Result in Total Costs



# Alternative Design at TESLA - XFEL



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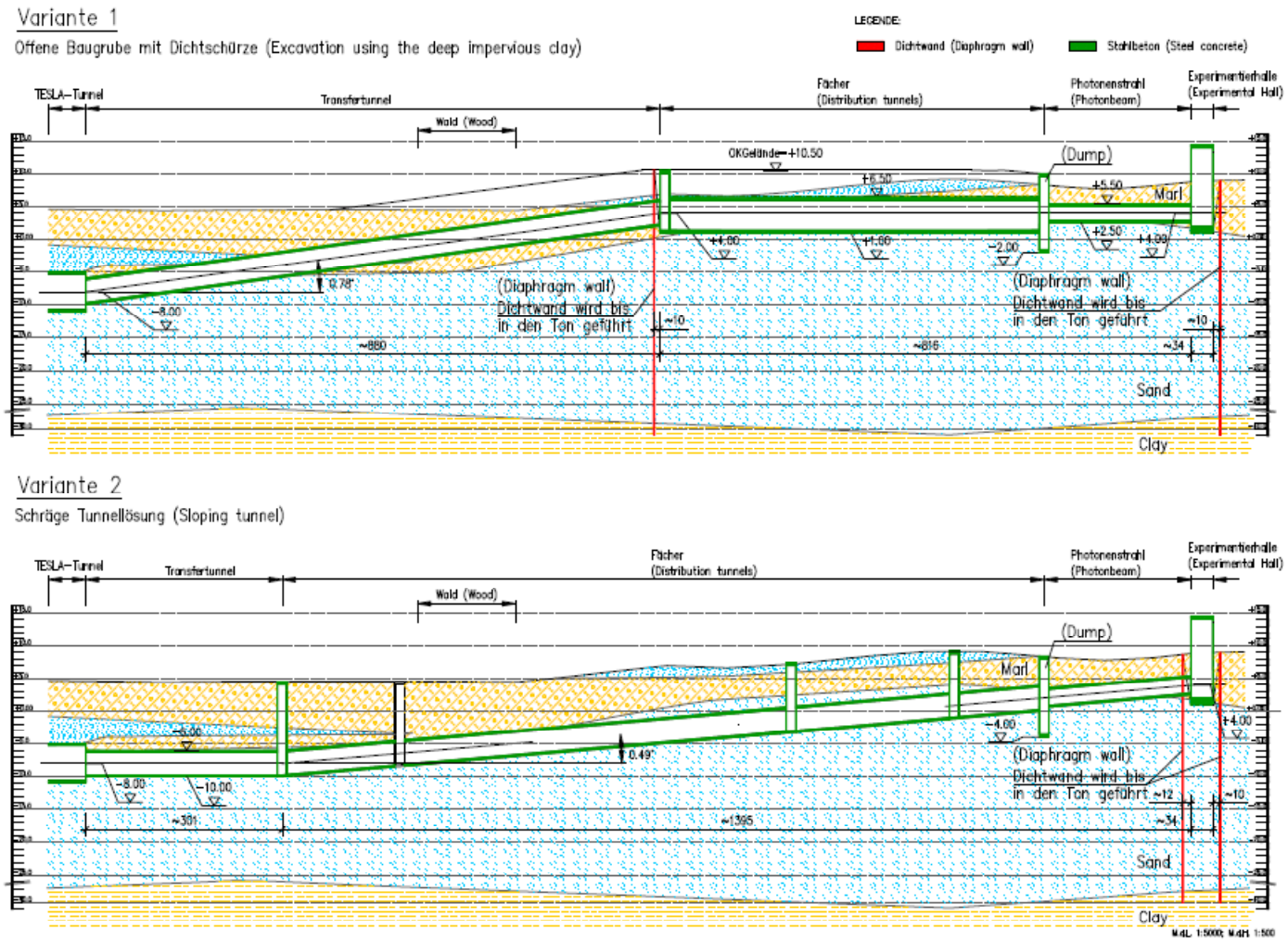
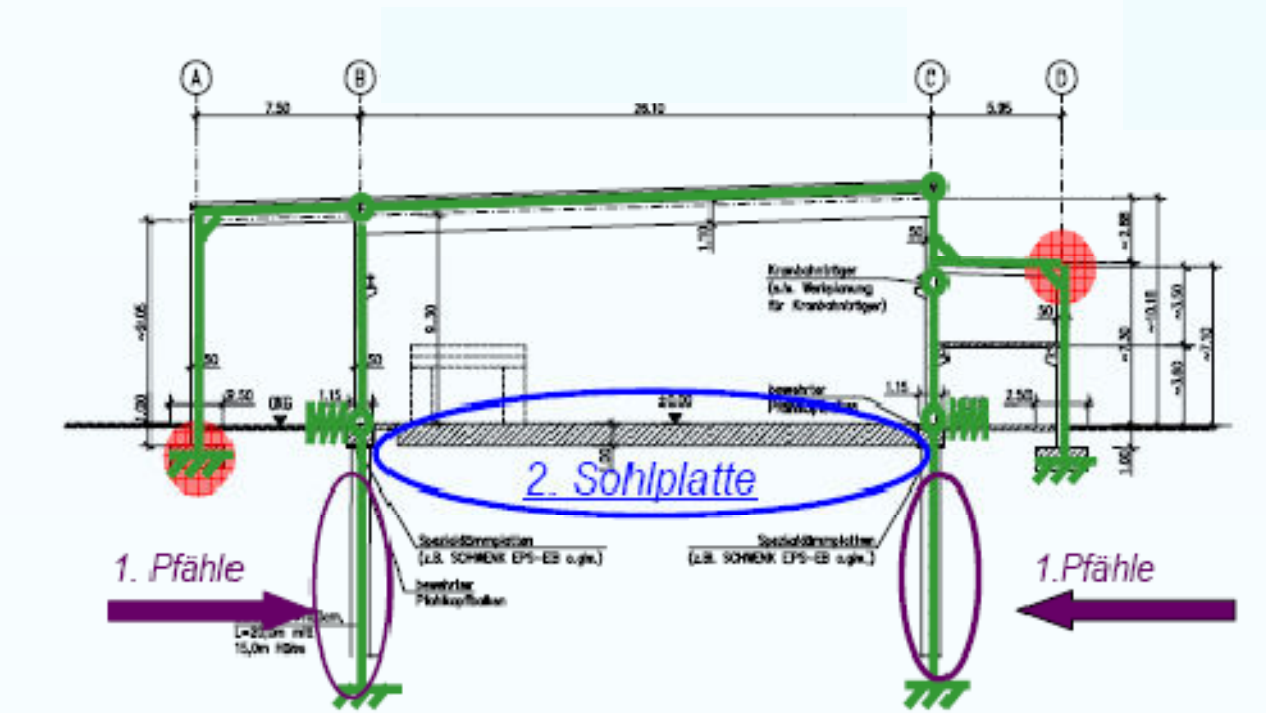



shallow solution

deep solution

# PETRA III: Results of Alternatives

**Functional description of frame construction**




**Exactly defined requirements for slab and piles**

# Results of Tendering Process

- Bidder 1 26,844 Mio€ (concrete)
- Bidder 2 27,327 Mio€ (steel)*
- Bidder 3 27,992 Mio€ (concrete)
- Bidder 4 30,849 Mio€ (concrete)

* to get the same fire protection as concrete you have to add 0.4 Mio€

# PETRA III Concrete Frame

# TESLA – XFEL: Results of Calculation

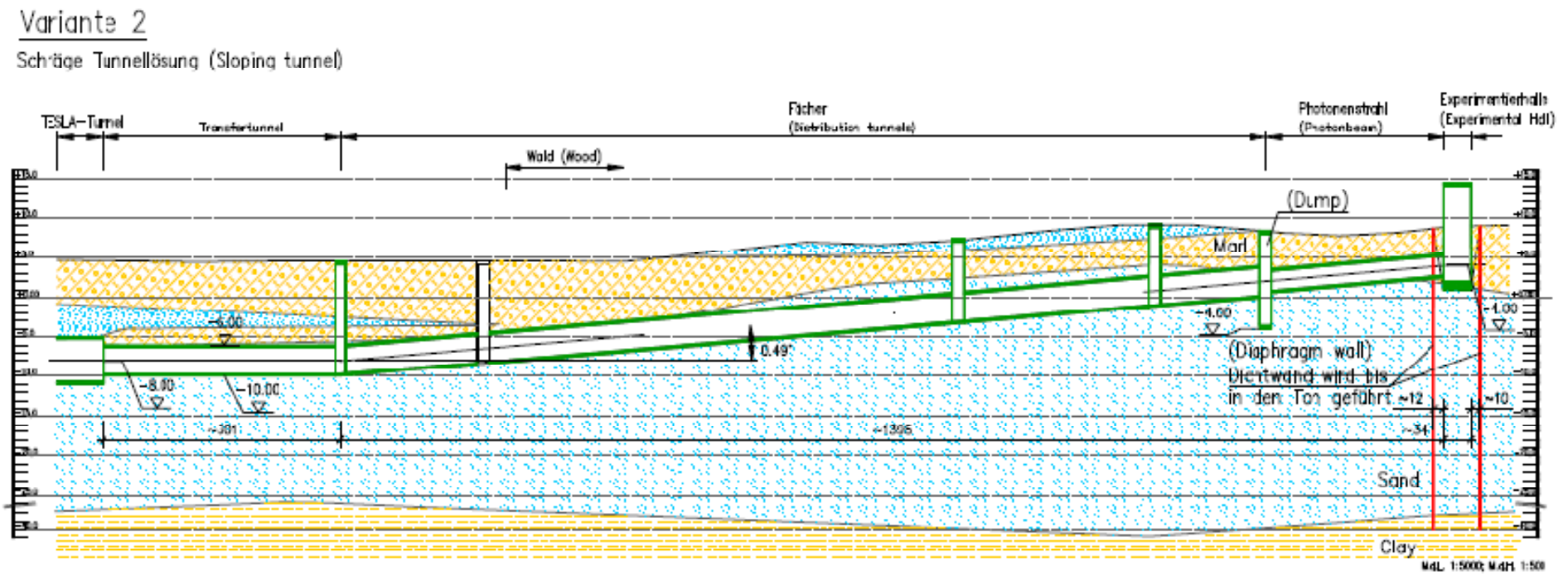
**Preisspanne:**

Nach Bewertung der Hauptpositionen mit minimalen und maximalen Kalkulationspreisen ergeben sich bei den beiden Varianten die in der nachfolgenden Tabelle 4.2 dargestellten Preisspannen.

**Tabelle 4.2:** Preisspannen (in Mio. DM) und prozentuale Abweichungen von den kalkulierten mittleren Kosten

| | kalkulierte Kosten | min. Kosten | max. Kosten |
|---|---|---|---|
| Variante 1 | 158,5 | 131,1 (-17 %) | 199,4 (+26 %) |
| Variante 2 | 163,5 | 121,3 (-26 %) | 209,5 (+28 %) |

# Alternative Design at TESLA - XFEL



# Alternative Design at TESLA - XFEL