FCC-he
Civil Engineering

FCC Week
Rome, 2016

O. Bruning, C. Cook, M. Klein, J. Osborne, D. Schulte
1. LHeC potential solutions

2. FCC-he potential solutions

3. LHeC/FCC-he potential solutions

Geology, positioning and civil engineering challenges for each
‘Intersecting’ vs. ‘Non-intersecting’ FCC Position

Jura geological interpretation (GADZ)

FCC - Intersecting

Coupe géologique interprétative Puits L - Sergy

Annexe 2

GEOTECHNIQUE APPLIQUEE DERRAZ SA

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Thurs 14th April 2016
‘Intersecting’ vs. ‘Non-intersecting’ FCC Position

Lake Geneva Bathymetry (GADZ)

140m shaft depth
‘Intersecting’ vs. ‘Non-intersecting’ FCC Position

Voirons - Faucigny geological interpretation (GADZ)
'Intersecting' vs. 'Non-intersecting' FCC Position

Prealps geological interpretation (GADZ)
‘Intersecting’ vs. ‘Non-intersecting’ FCC Position

Mandallaz geological interpretation (GADZ)
'Intersecting' vs. 'Non-intersecting' FCC Position

Vuache geological interpretation (GADZ)

FCC 100 km - Secteur Vuache
Coupe géologique présumée

ECH 1:10000
Annexe 3
FCC-he Civil Engineering

LHeC and FCC-he

LHeC Machine

Independent FCC-he Point L, F, H or B

LHeC / FCC-he LHC P8 & FCC PB

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Independent FCC-he
Point B, L, F or H
(FCC straight sections)
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FCC-he

- Connection to FCC straight section at point B, F, H, or L
- 1070m ERLs - 400m BDS – 979m radius arcs - 400m beam transfer
- 9091m total length, \( \frac{1}{11} \) of FCC
FCC-he Civil Engineering

FCC-he Point L

FCC Long Straight Section L

Tunnel Geology
- Molasse rock (sandstone)
- High risk of hitting (hazardous) Jura limestone

Construction
- Tunnel Boring Machine (TBM) in straight sections
- Roadheader in arcs

Civil Engineering challenges
- High geological risk of travelling through karstic limestone
- Not feasibility issue but special probing measures could be required (increase costs)
FCC-he Civil Engineering

FCC-he Point B

FCC Long Straight Section B

Tunnel Geology
- Molasse rock (sandstone)

Construction
- Tunnel Boring Machine (TBM) in straight sections
- Roadheader in arcs

Civil Engineering challenges
- Biggest challenge is avoiding interaction with main FCC tunnel(s) (junction caverns, sloped FCC-he)
- Geological hazards are low if in molasse
FCC-he Civil Engineering

FCC-he Point F

FCC Long Straight Section F

Tunnel Geology
• Molasse rock (sandstone)

Construction
• Tunnel Boring Machine (TBM) in straight sections
• Roadheader in arcs

Civil Engineering challenges
• Geological hazards are low based on current interpretation of geology
• High geological uncertainty in this region
• Very high risk of entering Prealps limestone if moved to the outside of the FCC
FCC-he Civil Engineering

FCC-he Point H

FCC Long Straight Section H

Tunnel Geology
- Molasse rock (sandstone)

Construction
- Tunnel Boring Machine (TBM) in straight sections
- Roadheader in arcs

Civil Engineering challenges
- Low geological risk
- Interaction with main FCC tunnel(s)

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• LHeC/FCC-he machine with experiments on both the LHC and FCC ring

• Connection at LHC P8 and FCC PB – only feasible location

• 170m vertical distance

• Traverse vertical with arcs
• LINACS at different levels (160 mASL FCC and 330 mASL LHC)

• 550m radius arcs sloped at 15.6% to traverse the 170m vertical and 2km horizontal

• Drift sections added to reach 0.5LHC total length. Added to west of P8 to avoid Lake Geneva

• 1070m LINACS - 400m BDS – 555m radius arcs - ~7000m drift (total)

• 13.35km total length... $\frac{1}{2}$ of LHC
LHC Point 8 & FCC Long Straight Section L

**Tunnel Geology**
- Molasse rock (sandstone)
- Limestone in west at FCC level
- Risk of travelling through (water bearing) moraines near the Lake

**Construction**
- Tunnel Boring Machine (TBM) in straight sections
- Roadheader in arcs

**Civil Engineering challenges**
- Risk of moraines requires study
- Risk of Limestone
- Specialised (more expensive) shielded TBM may be required

**Other challenges**
- Slope limit for transport (usually <6%)
- Large crossing angle at IPs
- Arc radius too small (1000m in CDR)
Further Study

- Study new concepts with:
  - ~900m-1000m radius arcs
  - Much smaller crossing angles and P8 and PB
  - Smaller gradients to traverse 170m vertical
LHeC/FCC-he Civil Engineering

LHC Point 8 & FCC Long Straight Section L
Further Study

TO BE STUDIED
Future Steps

• Continue civil engineering study into feasibility of FCC-he options and LHeC/FCC-he option:
  • Geological profiles for options
  • Interaction of FCC-he tunnel & LHC/FCC main tunnels
  • Optimising LHeC/FCC-he design

• Drawings
  • 3D
  • Layout sketches

• Project cost estimates
  • Scale from previous estimates (AMBERG CDR)