Connection of British and French levelling networks

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Application to UELN

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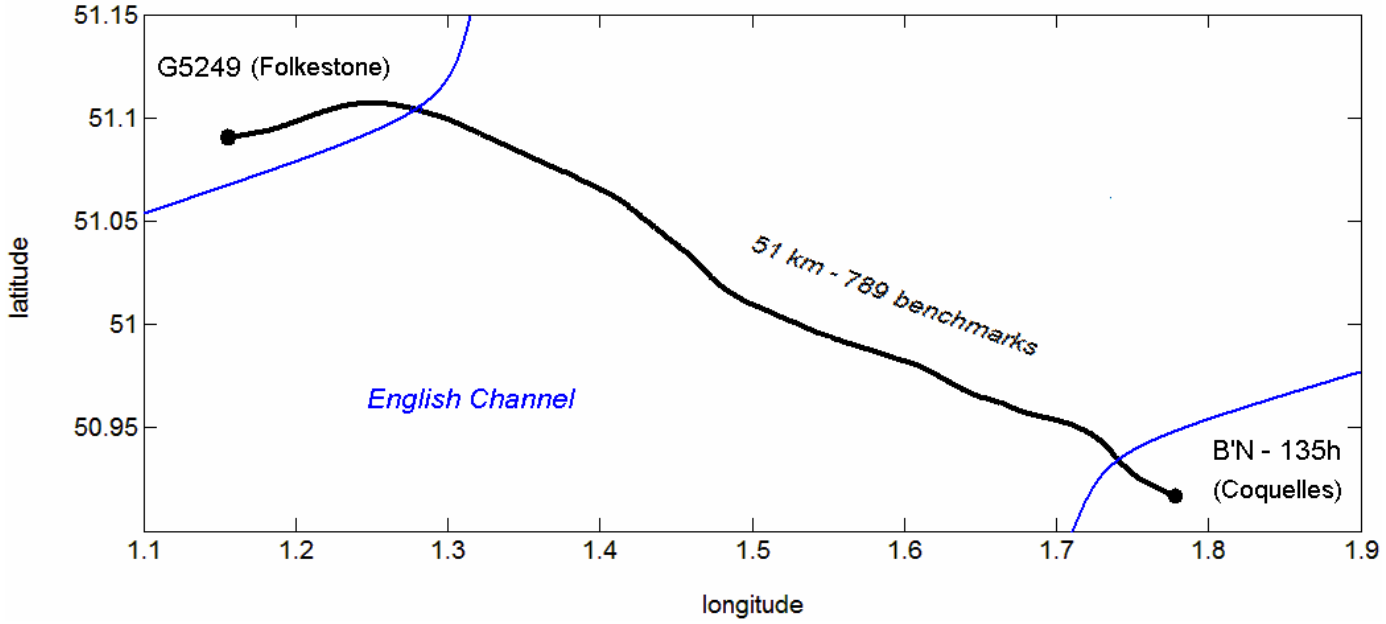
The 1994 levelling through the Channel Tunnel

- Measurement of the difference in height between a “French” and a “British” benchmark



The 1994 levelling through the Channel Tunnel

- A British team used the “SREH” technique:
  - SREH = Simultaneous Reciprocal EDM Heighting
  - SREH has demonstrated geodetic quality levelling
  - Two modified Leica theodolites (T2000 & TC2000) used
  - Leg lengths <150 m, mean of 4 VAs and 3 distances
  - Invar staff < 5 m away to transfer height to ground
  - Tidal effects removed by computation

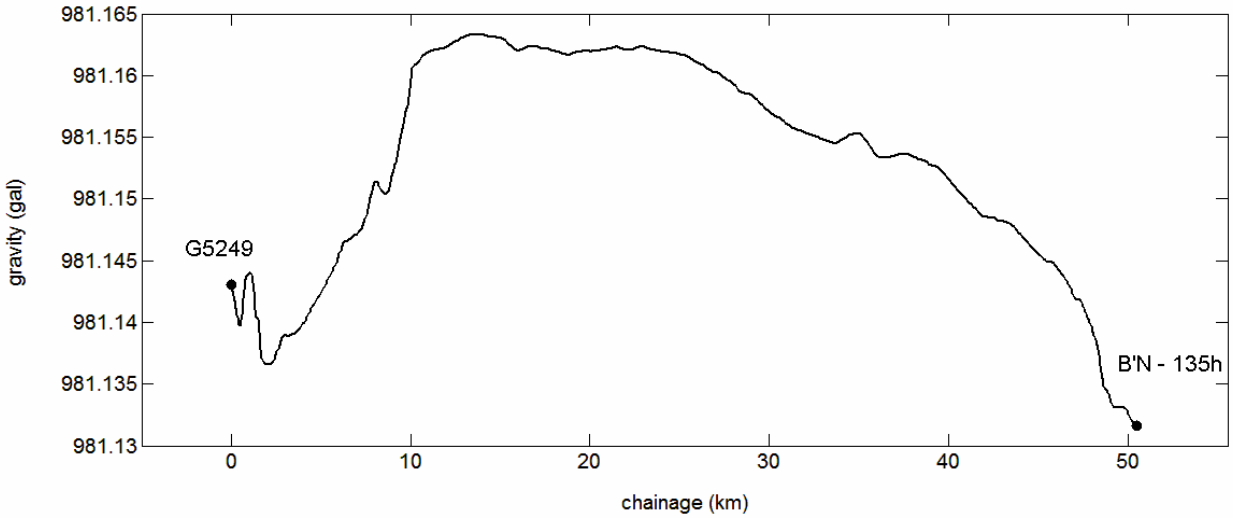
The 1994 levelling through the Channel Tunnel

- A French team used traditional levelling :
  - NA2 level with calibrated invar staves
  - ~3 km sections measured forth and back with half-turns at mid-tide time
  - Measurements were made again when

$$\left| DN^{forth} + DN^{back} \right| > 0.3\,mm$$

The 1994 levelling through the Channel Tunnel

- Gravity measurements made by Edinburgh University :
  - Readings with two Lacoste & Romberg gravimeters at 150m intervals
  - Junction with BPGN93 at Swingfield, near Dover



British and French computations

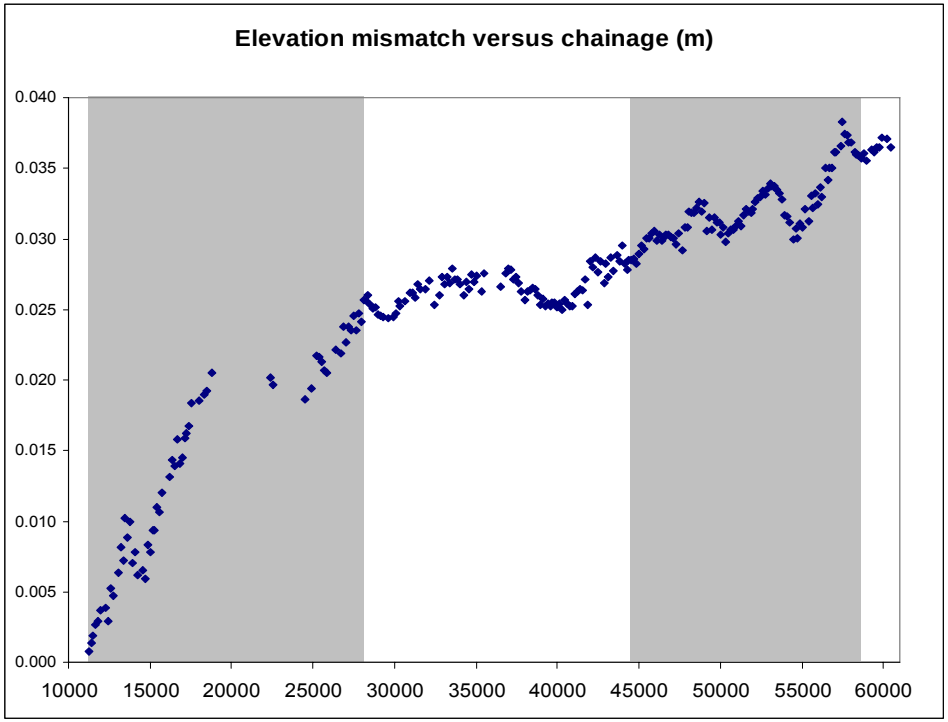
- Carl Calvert's 1994 computation
  ↳ 44,8090 m ± 6 mm geometrical difference in height

- Last IGN computation (2006)
  ↳ 44,8455 m ± 8 mm geometrical difference in height

→ 3,65 cm discrepancy, far over the estimated precision of each value !

Possible origins of this discrepancy

- Tidal loading : not detectable in IGN data
- Re-measurements handling : only a few mm difference between various IGN computations
- Influence of gravity variations : 0,4 mm along the tunnel
- Refraction issue studied by Mr. Hipkin
- Residual error of stave foot or calibration in IGN levelling: no obvious reason in observations



- Structure of mismatches was studied by Mr Hipkin
- Both levellings compared with TML engineering levelling
- No evidence of systematic error in either levelling

Adopted solution

- Meeting hold in Paris on January 31st, 2007

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- The straight mean of the two values was adopted, even if it has no scientific meaning.

	OS value	IGN value	Straight mean
Geometrical difference in height	44,8090 m	44,8455 m	44,8272 m
Geopotential difference	439,6525 m²/s²	440,0105 m²/s²	439,8315 m²/s²

Consequence : Shift ODN / IGN69

- British value : 38 cm
- French value : 42 cm

↳ Ordnance Datum Newlyn is 40 cm ± 2 cm above IGN69 datum.

Application to UELN

- Decision to connect each tunnel portal to a nearby UELN point

↳ Geopotential difference between a French UELN point and a British UELN point

  – French connection done using the NIREF data
  – British connection : to be decided and provided by OS

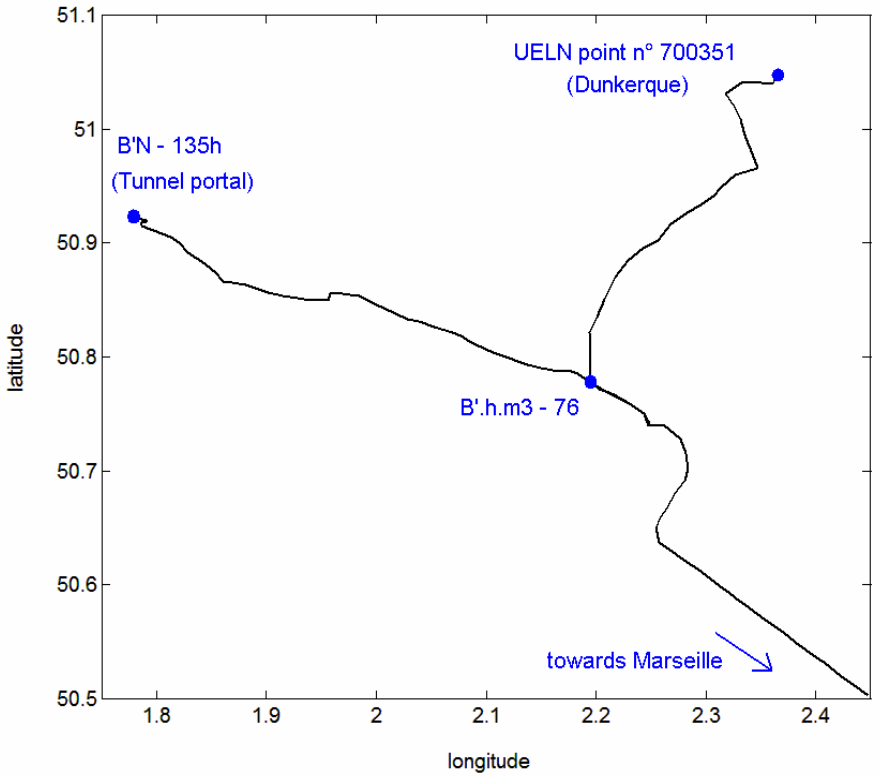
French connection with UELN

- NIREF : The French Reference Levelling Network

French connection with UELN

- Geopotential number of point n° 700351 (UELN95/98): 47,953 m²/s²
- Computed geopotential difference: 98,478 m²/s² (with interpolated gravity values)

↳ Geopotential number of point B'N–135h : 146,431 m²/s² (normal height UELN95/98: 14,9244 m)



Conclusion

- The difference between the British and French levelling networks was measured by two independent surveys through the Channel tunnel.
- A 4 cm discrepancy was recorded.
- A precise integration of the British levelling network to UELN is now feasible.