Example of TLA optimization

- This example compares two methods to place transmission line surge arresters
  - Taking into consideration only tower footing resistance and three arresters per structure
  - Taking into consideration tower footing resistance, historical lightning incidence data along the circuit, and placement of 1, 2, or 3 arresters per structure

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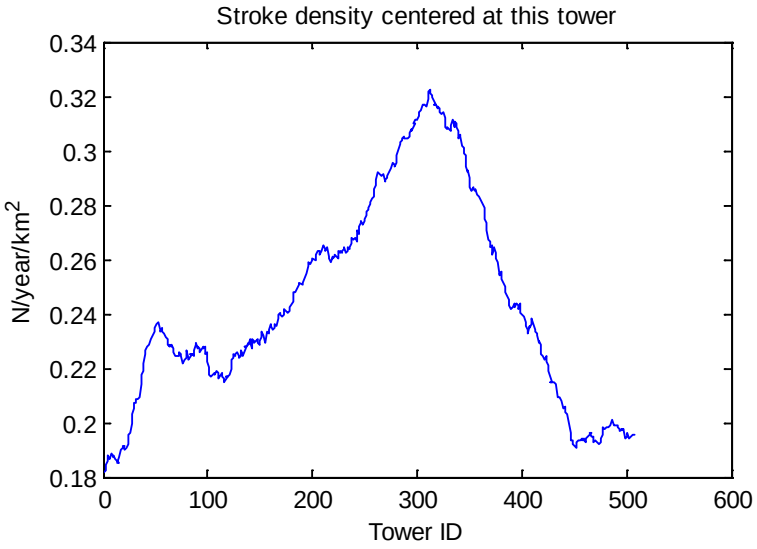
Considerations

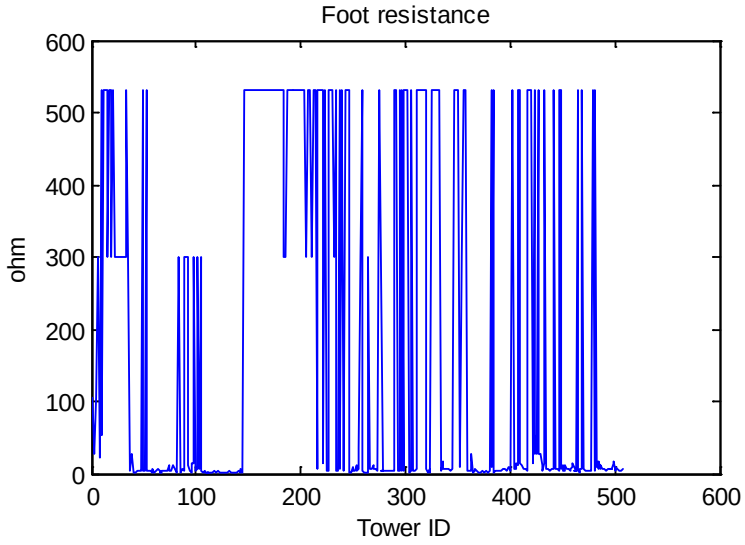
- Moderately long 115 kV circuit with a combination of lattice and wood structures.
- Stroke data from the Canadian LDN from 1994 to 2002
- Unit cost estimates are a placeholder and do not reflect actual costs
- Placement of 1, 2, or 3 arresters per structure is based on the methodology described in CEAT report T023700-3102 "*HV line arresters: Selection based on grounding impedance of towers and position*", October 2004.

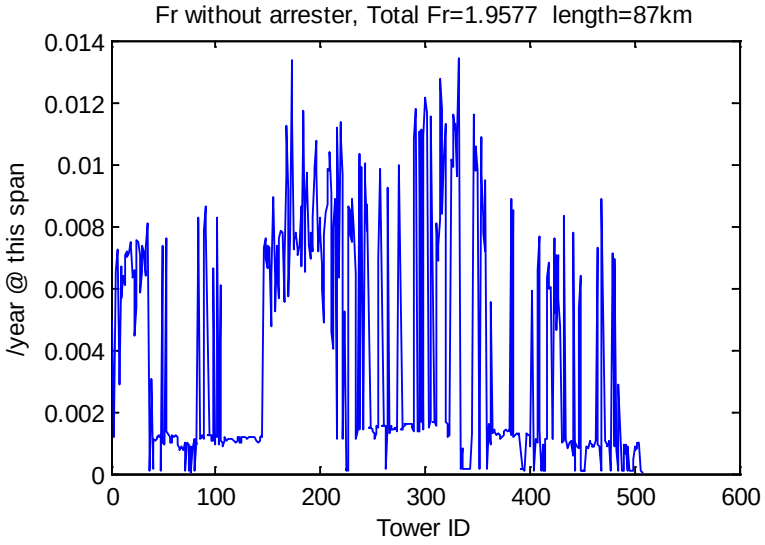
Considerations (cont.)

- Historical lightning varies by a factor of two in parts of the circuit.
- Eight years of data is a modest sample space.
- This is a high resistivity region.

Fig. 1 Tower (pole) data before installing TLAs







(Predicted interruption rate 1.96/year, length = 87km)
Reported interruption rate = 3.22
Confirmed interruption rate = 1.56

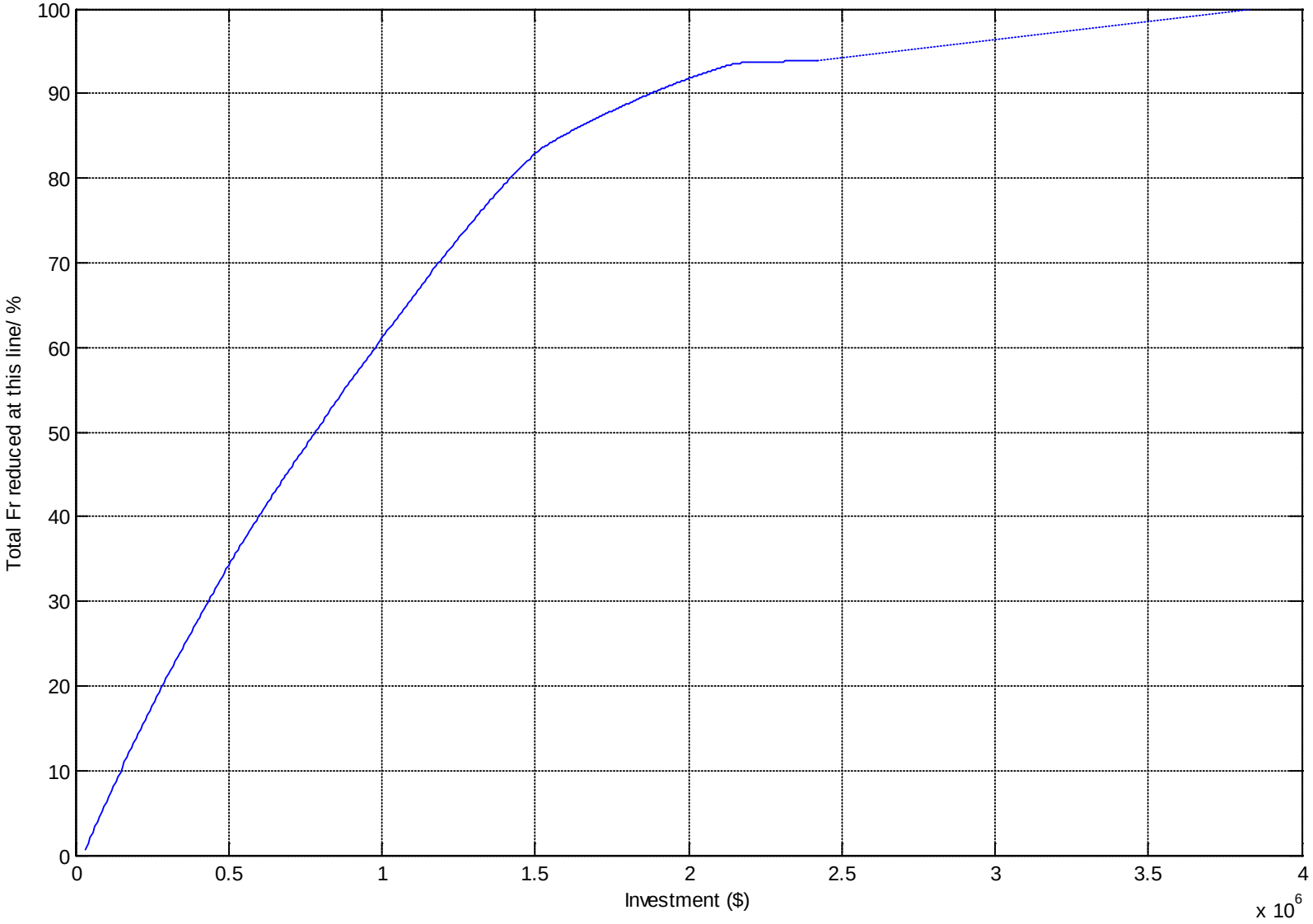


Fig.2 Flashover rate reduction vs. investment (considering factors of foot resistance, tower/pole structure and lightning density, $2500/arrester and $300/km for Rg measurement, up to 958 arresters needed for solid line, 1521 for dashed line)

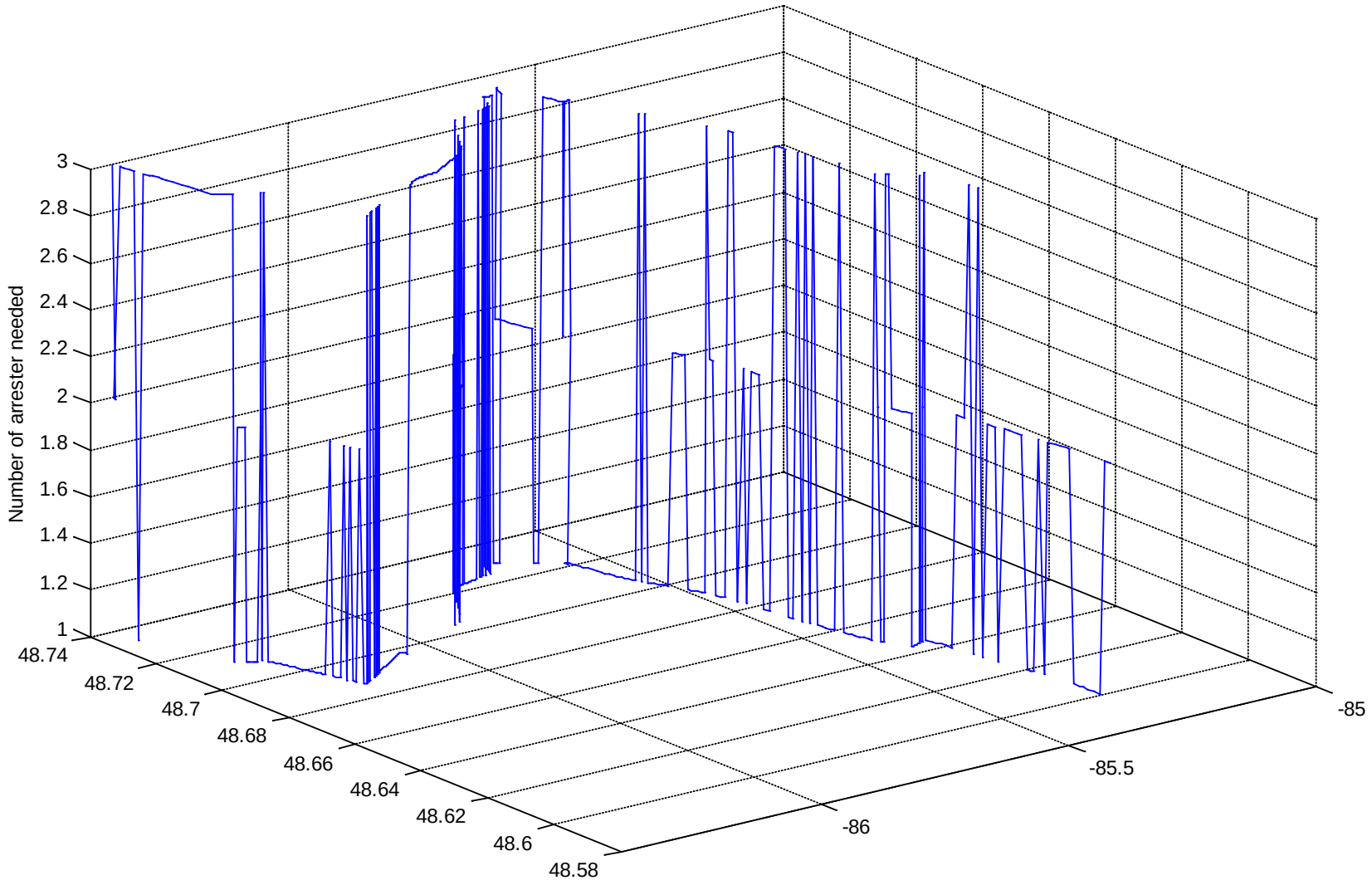


Fig.3 Number of arresters needed for each tower (correspond to Fig.2, 958 arresters altogether)

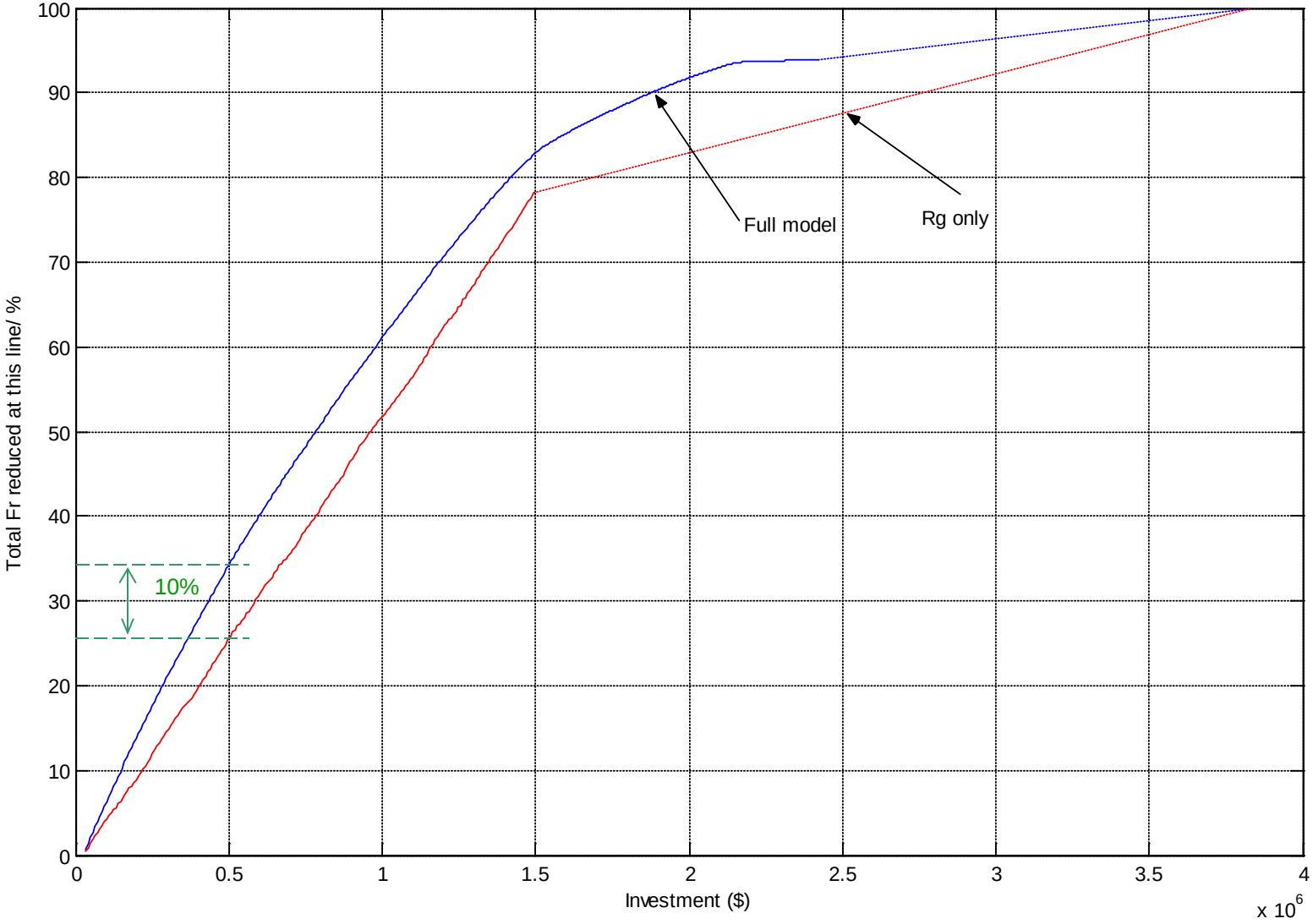
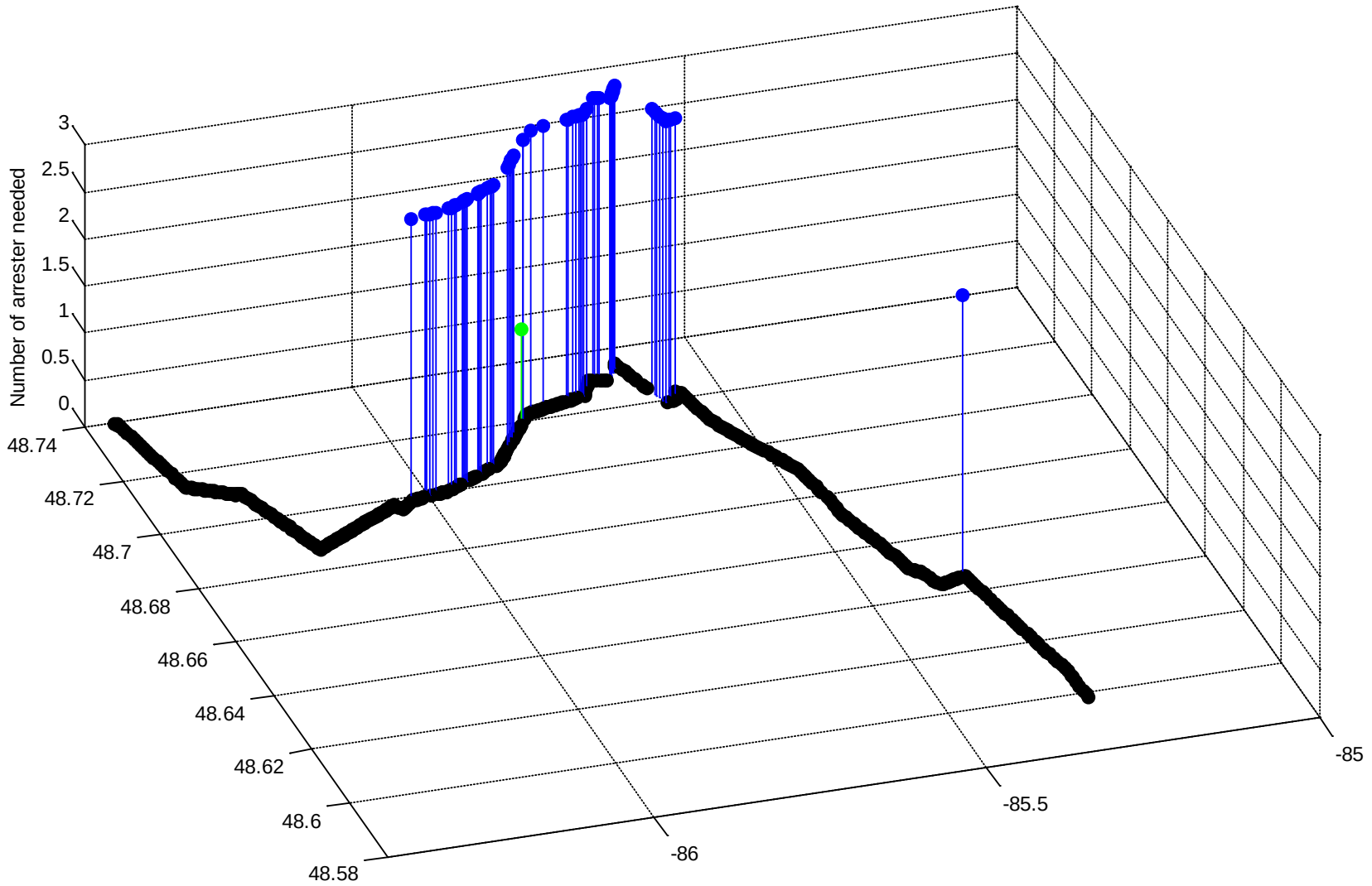
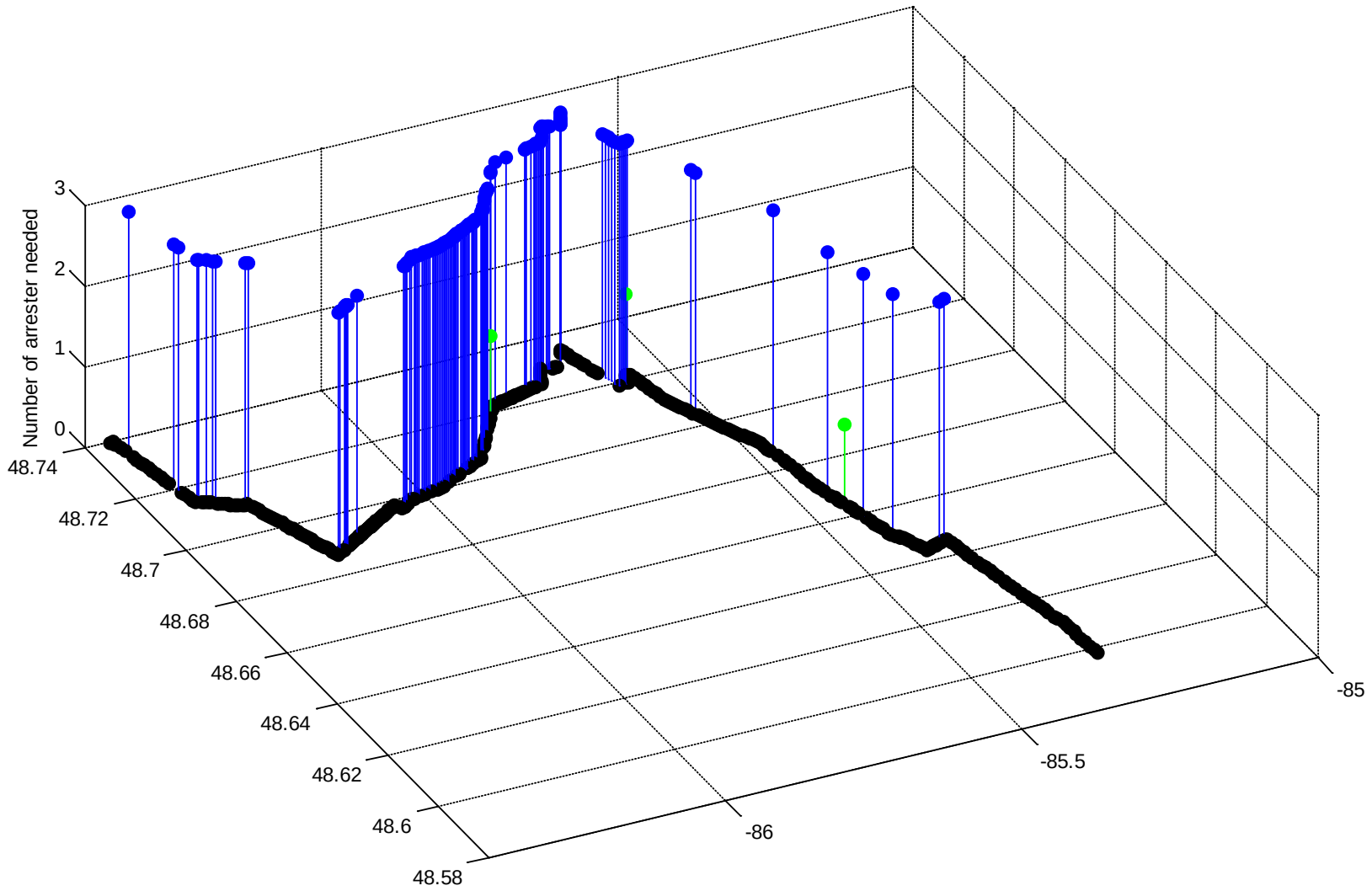


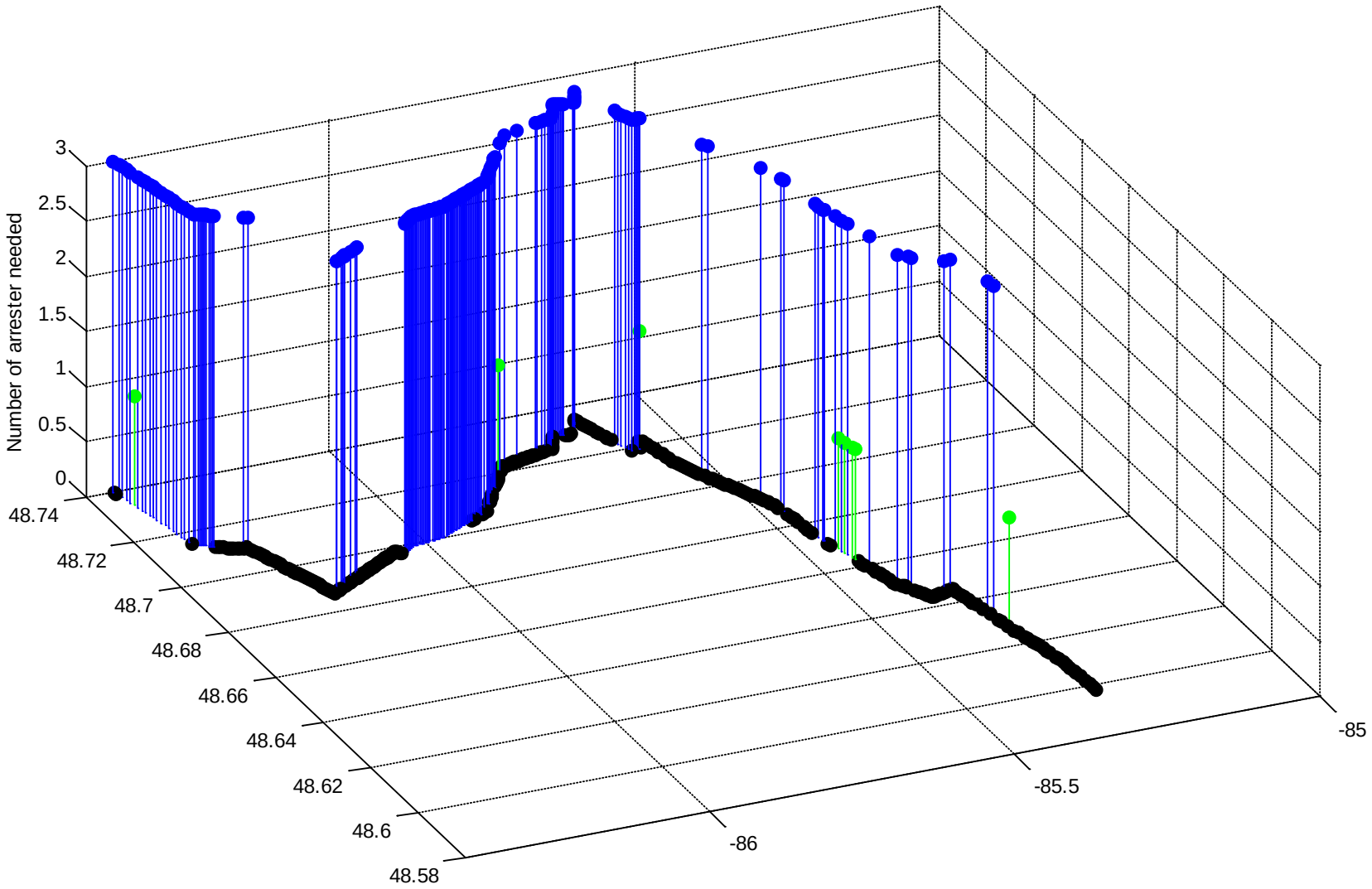
Fig.4 Backflashover reduction in % vs. cost when only footing resistance is considered. 3 arresters if Rg>50ohm. Fr=2.0295 without arresters, Fr=1.5873 with 588 arresters



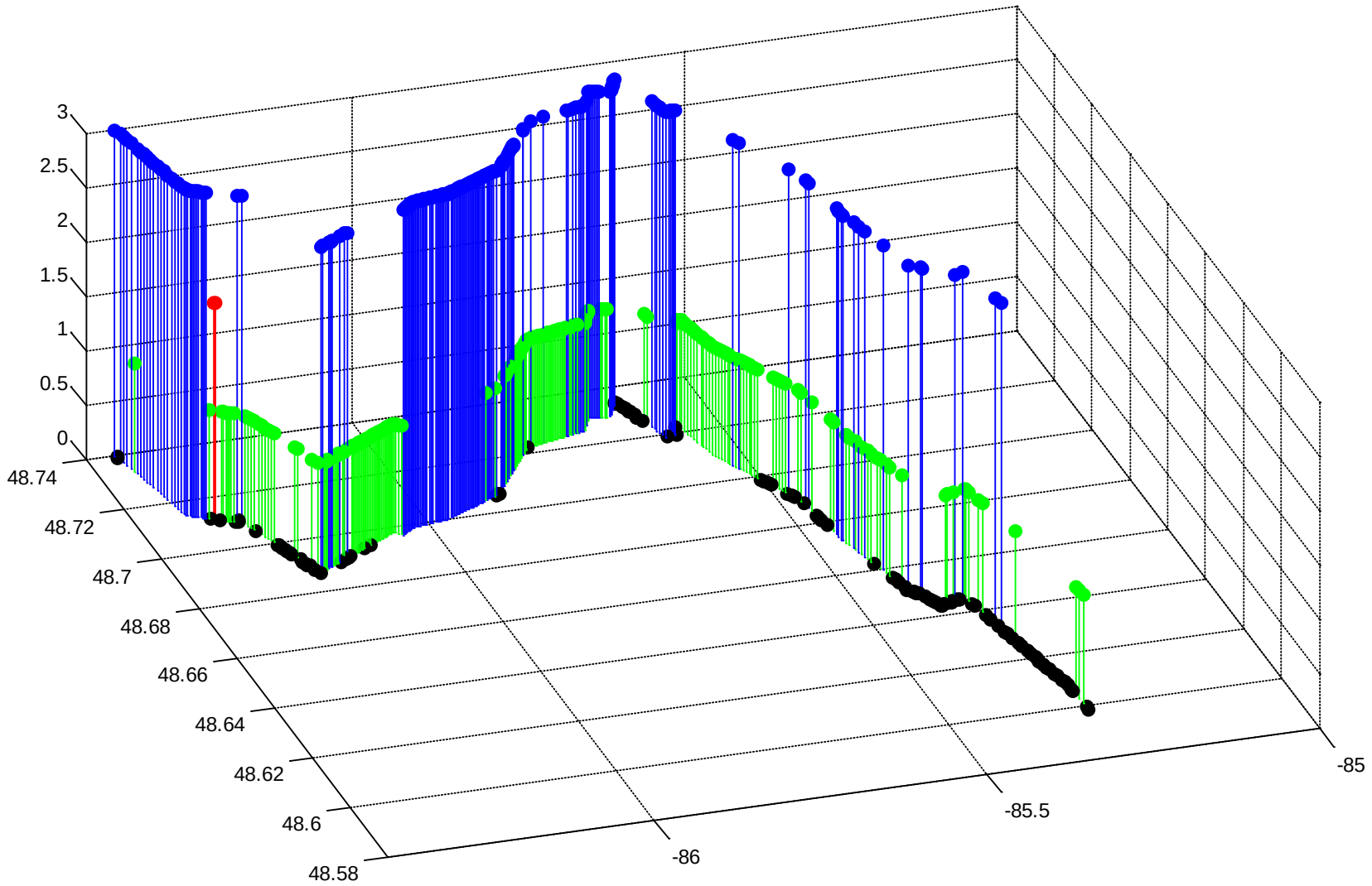
Consider all factors, $0.5M, 190 arresters, Fr 34.2% reduction



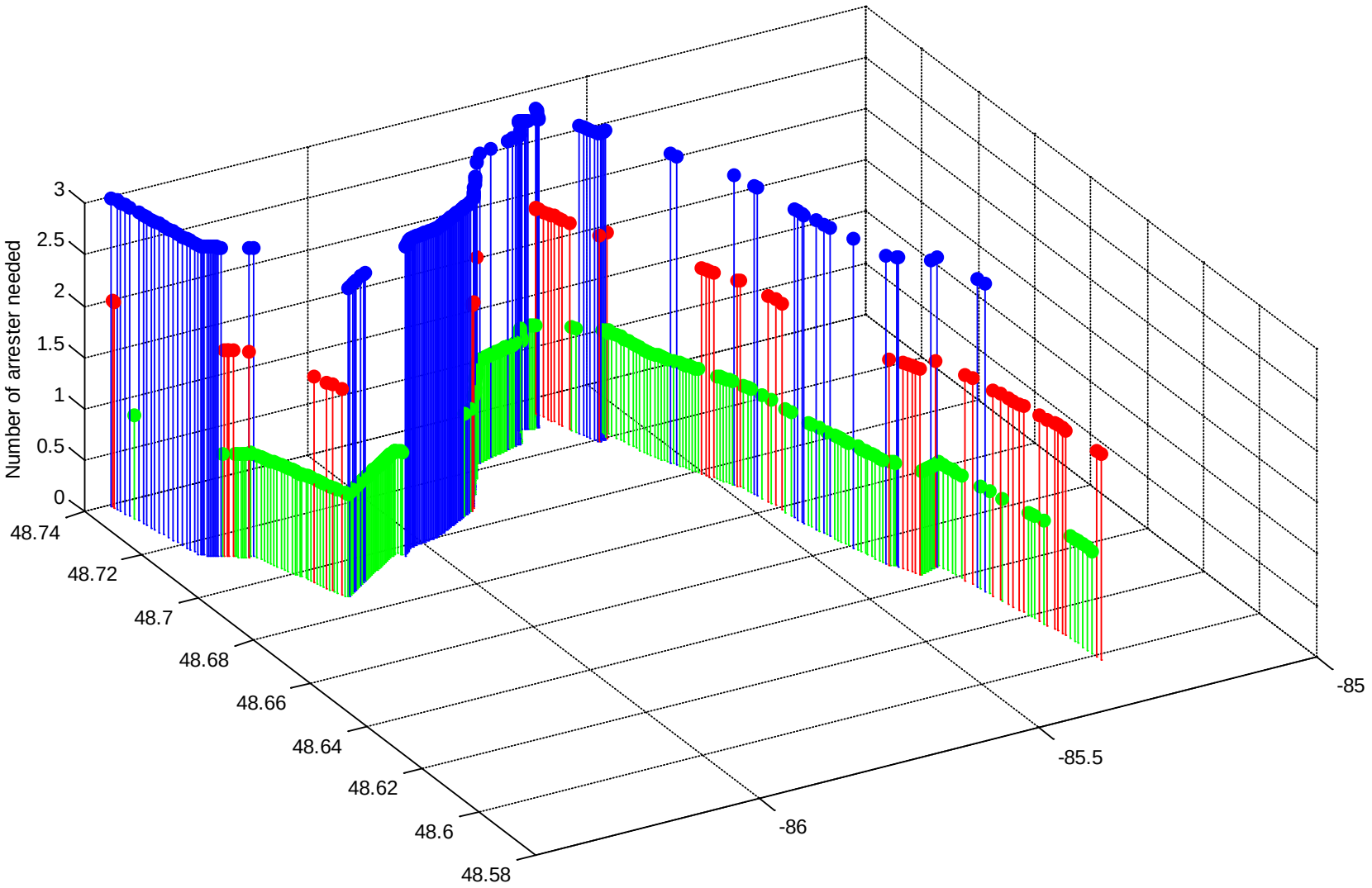
Consider all factors, $1.0M, 390 arresters, Fr 61% reduction



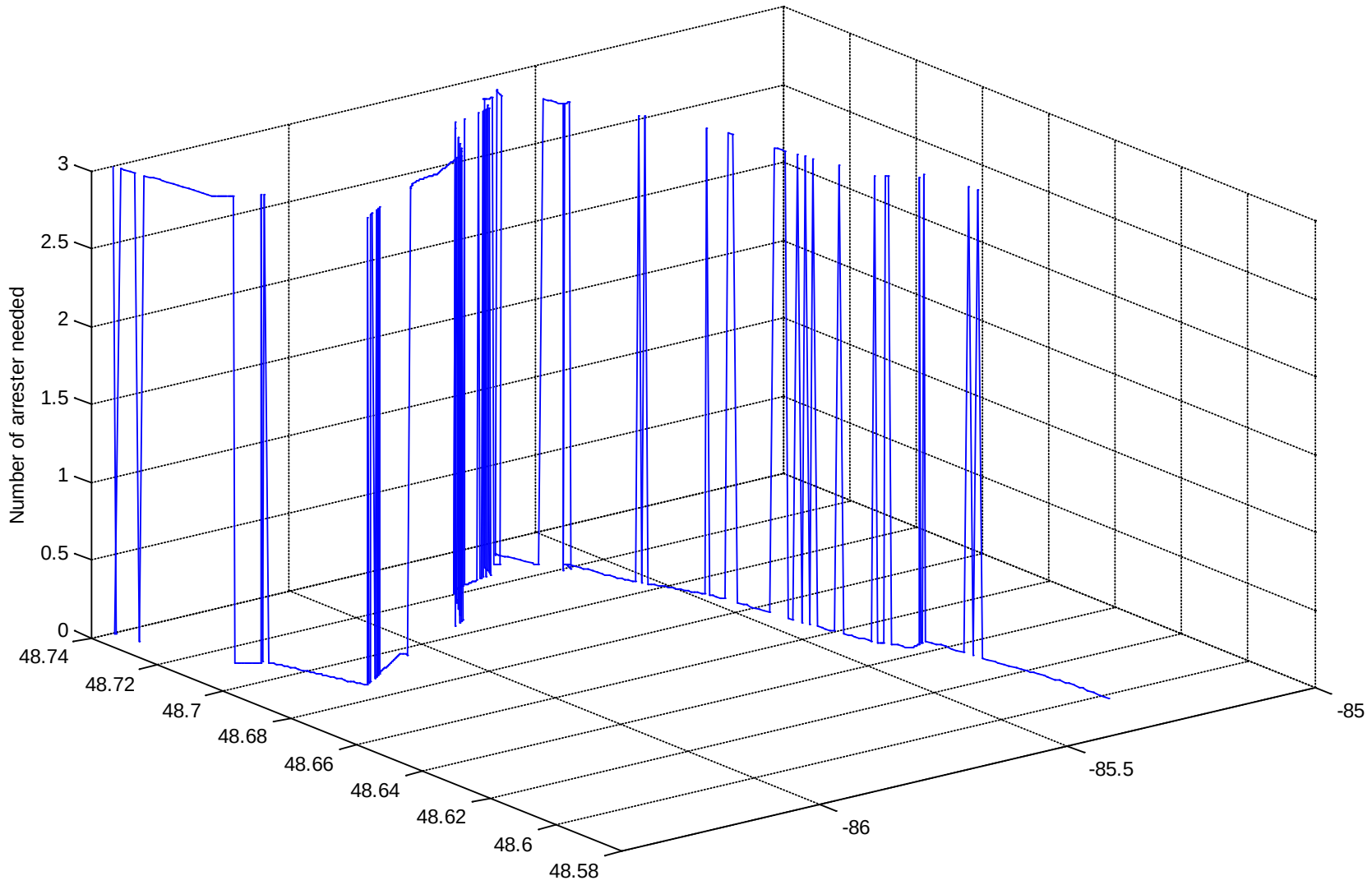
Consider all factors, $1.5M, 590 arresters, Fr 82.8% reduction



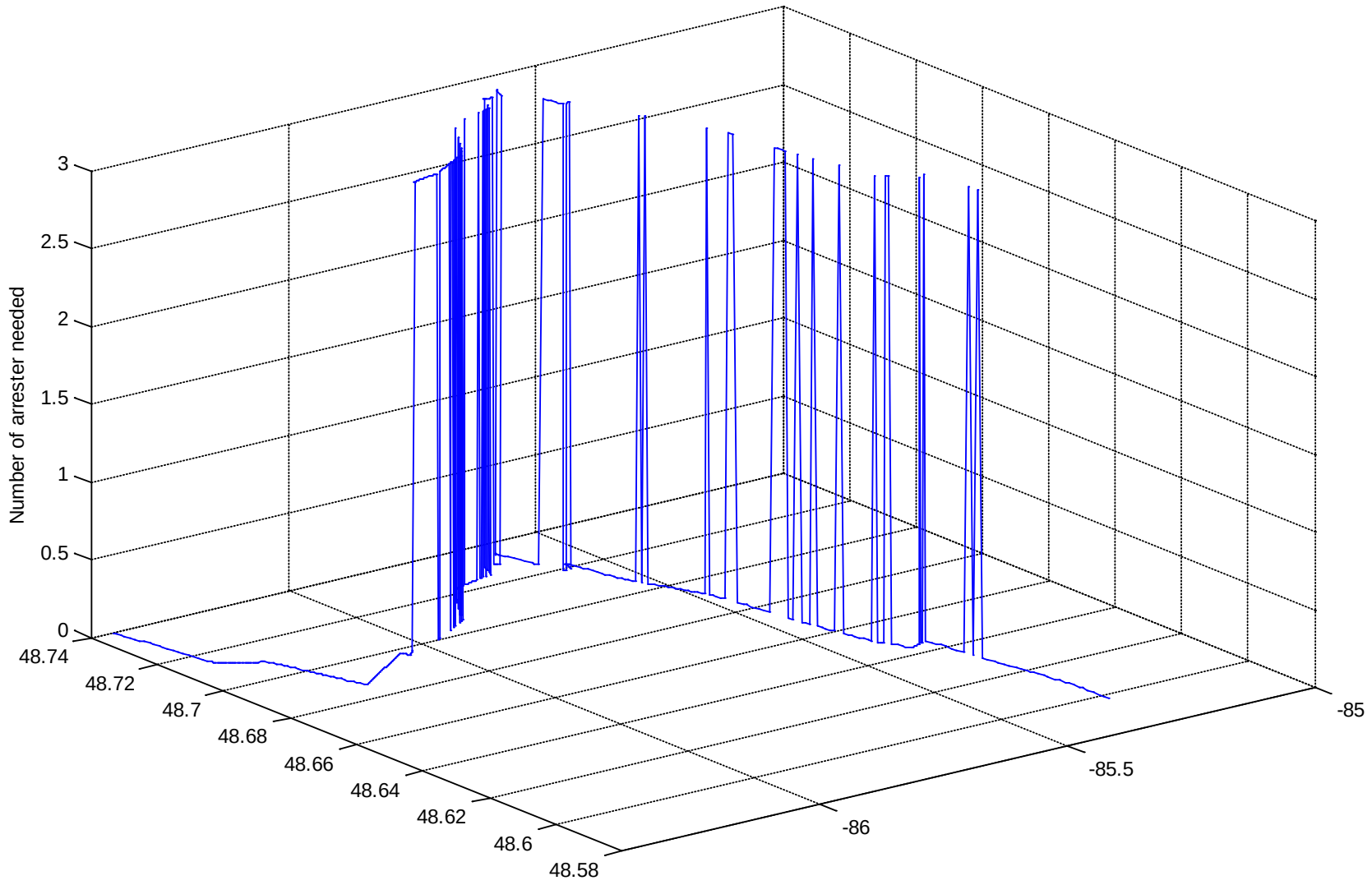
Consider all factors, $2M, 790 arresters, Fr 91.7% reduction



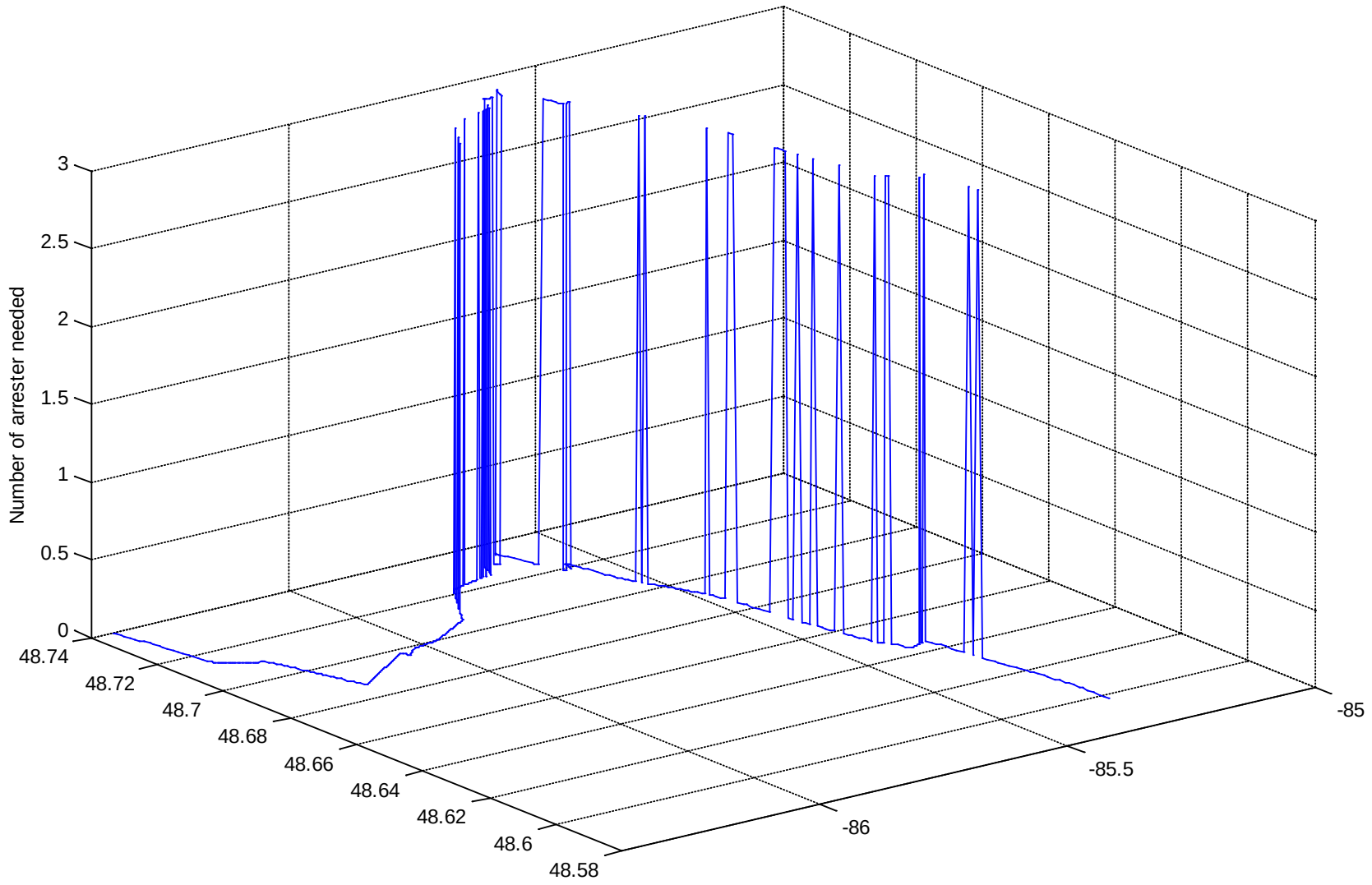
Consider all factors, $2.42M, 958 arresters, Fr 93.9% reduction



If consider Rg only, investment $1.5M, 588 arresters, Fr reduction 78.2%



If consider Rg only, $1M, 390 arresters, Fr reduction 51.7%



If consider Rg only, $0.5M, 192 arresters, Fr reduction 25.5%

Observations

- Using fewer than 3 arresters per structure is a factor when trying to achieve performance improvements above 80%
- The simplified TLA placement criterion of 3 arresters/structure if Rg > 50 Ω is surprisingly close to the more elaborate method using different numbers of arresters and local lightning density for performance improvements under 80%.
- In all instances it is critical to have a footing resistance survey