

## 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

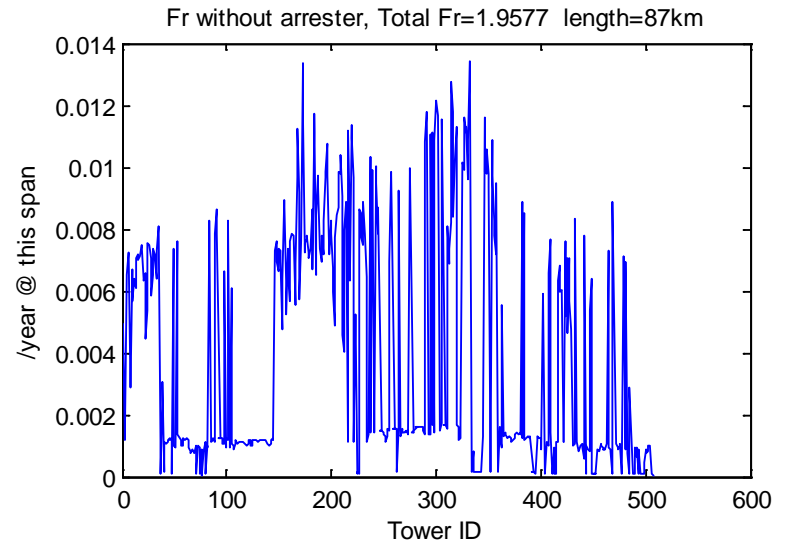
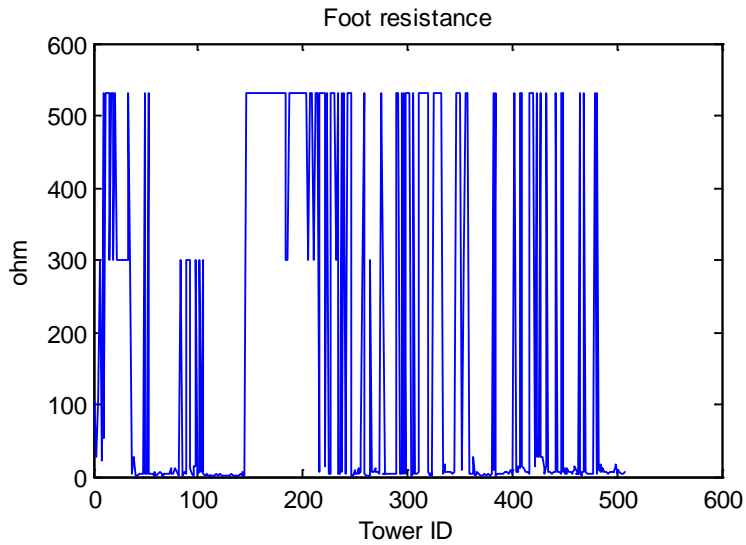
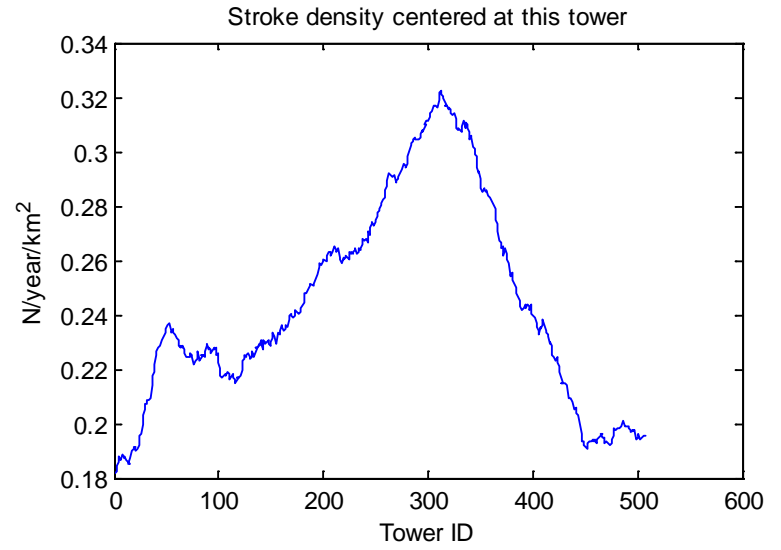
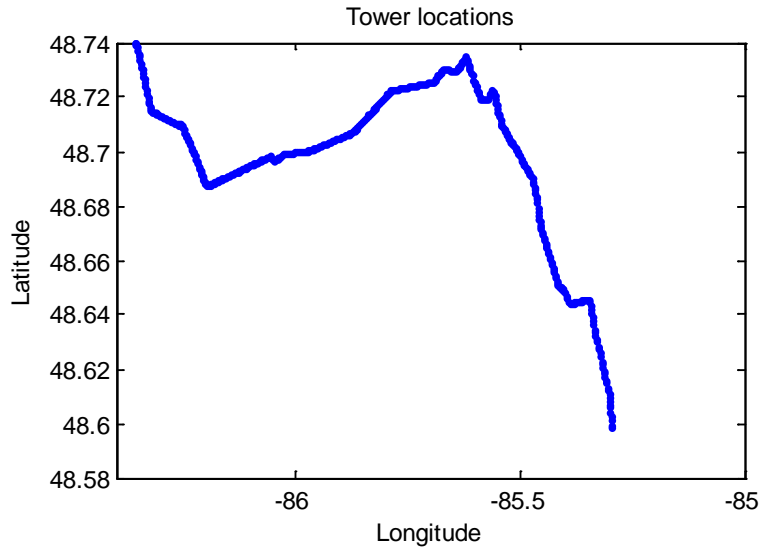
# Considerations

- 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

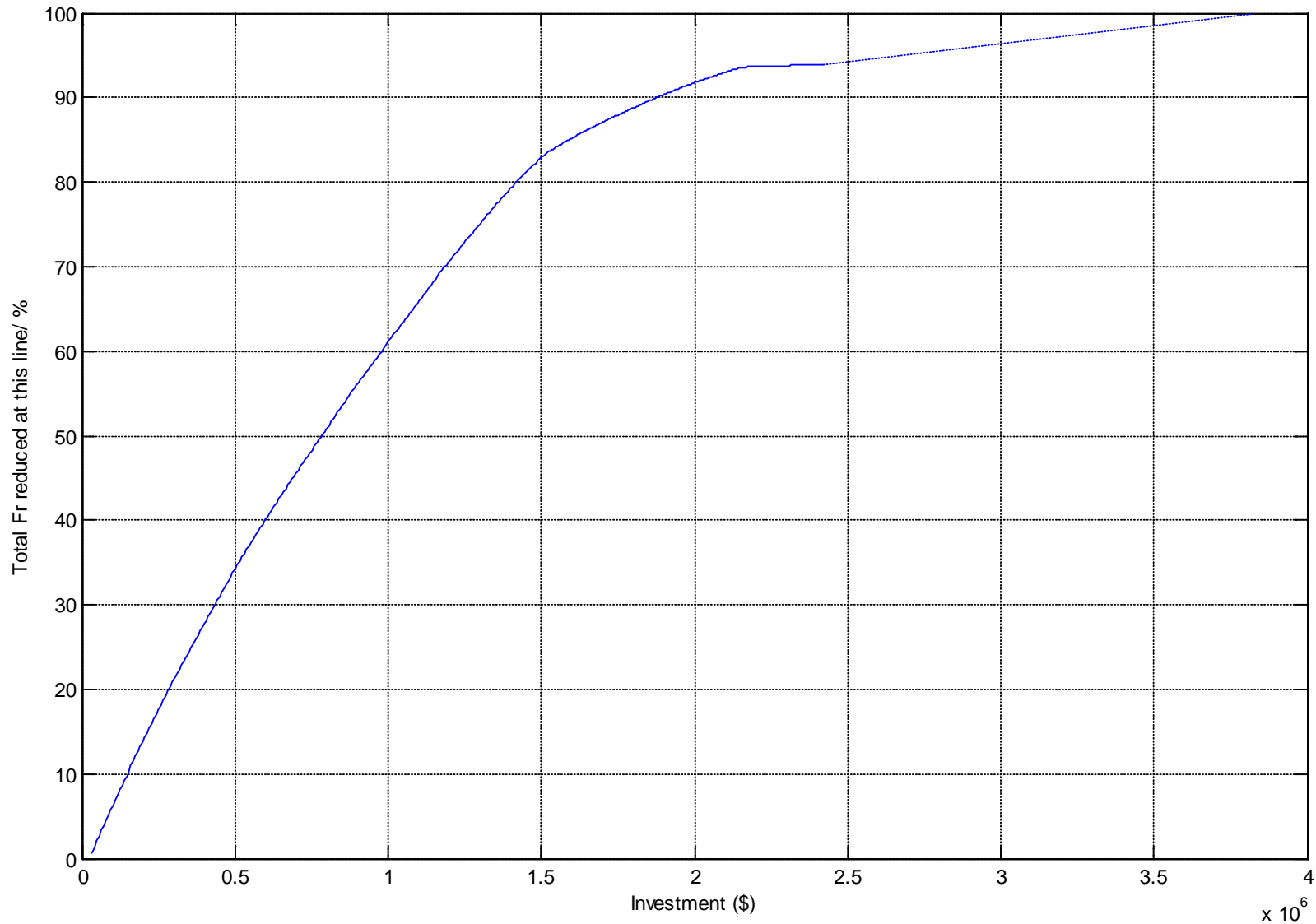
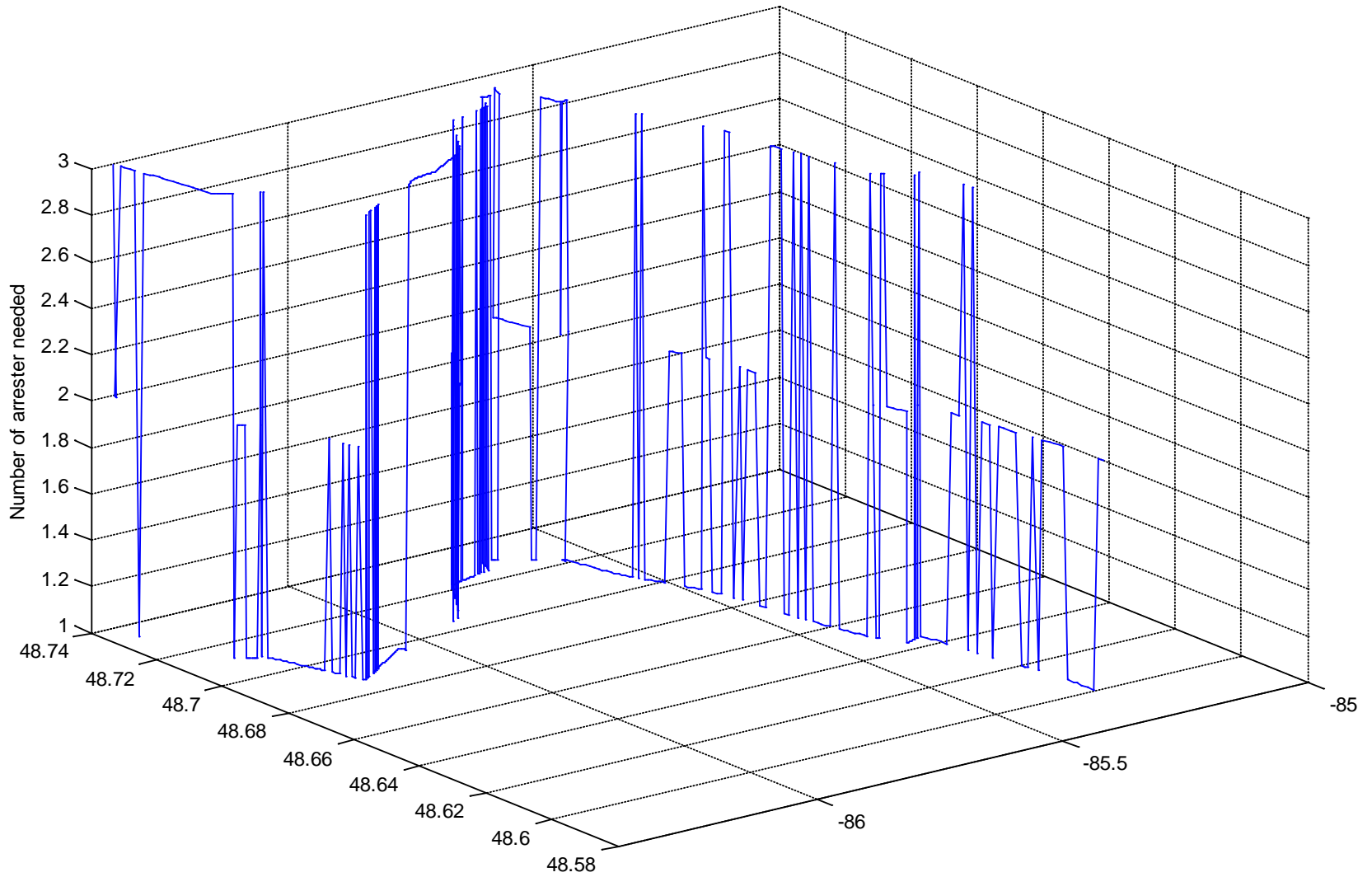


Fig.2 Flashover rate reduction vs. investment (considering factors of foot resistance, tower/pole structure and lightning density, \$2500/arrester and \$300/km for Rg measurement, up to 958 arresters needed for solid line, 1521 for dashed line )



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

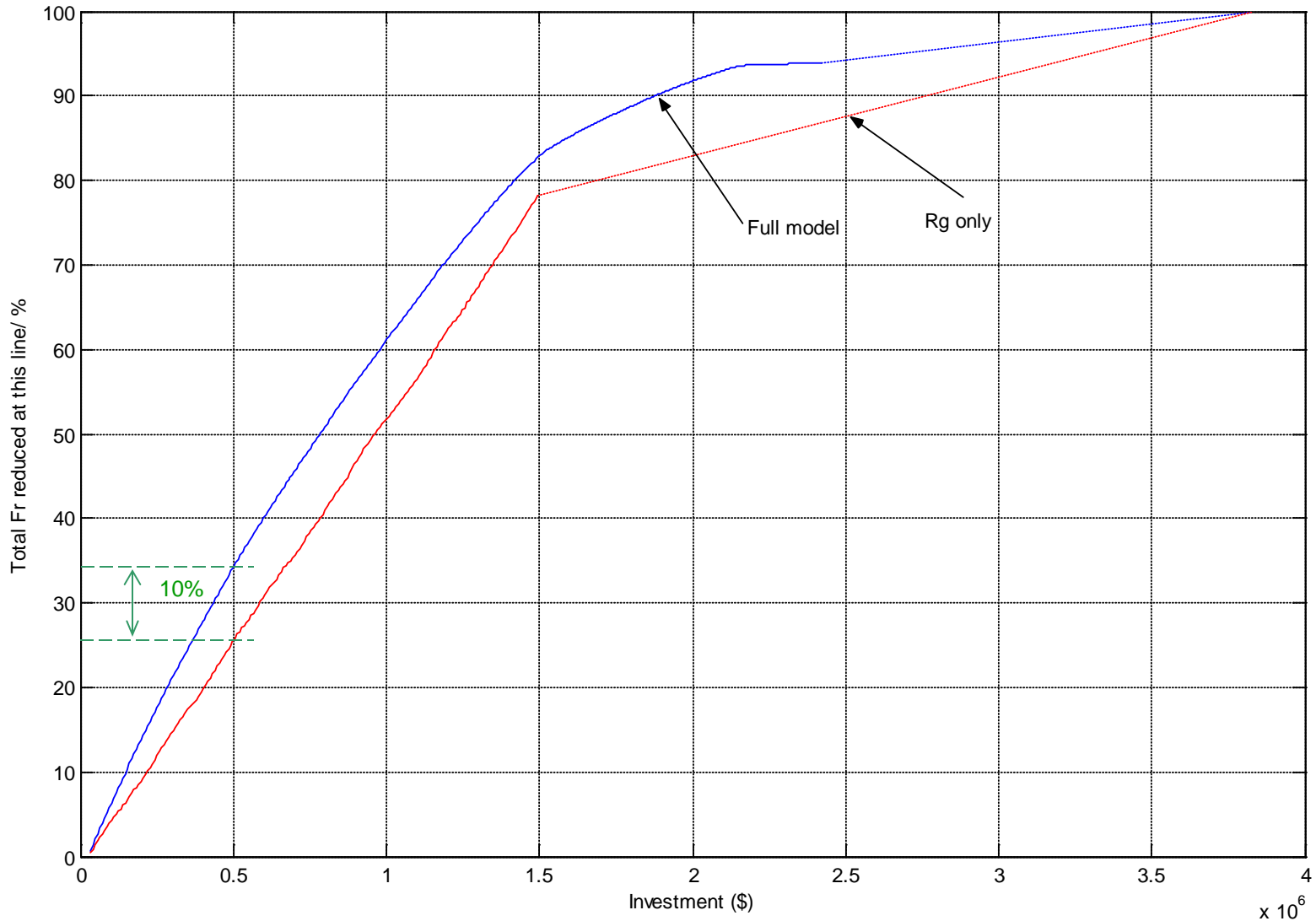
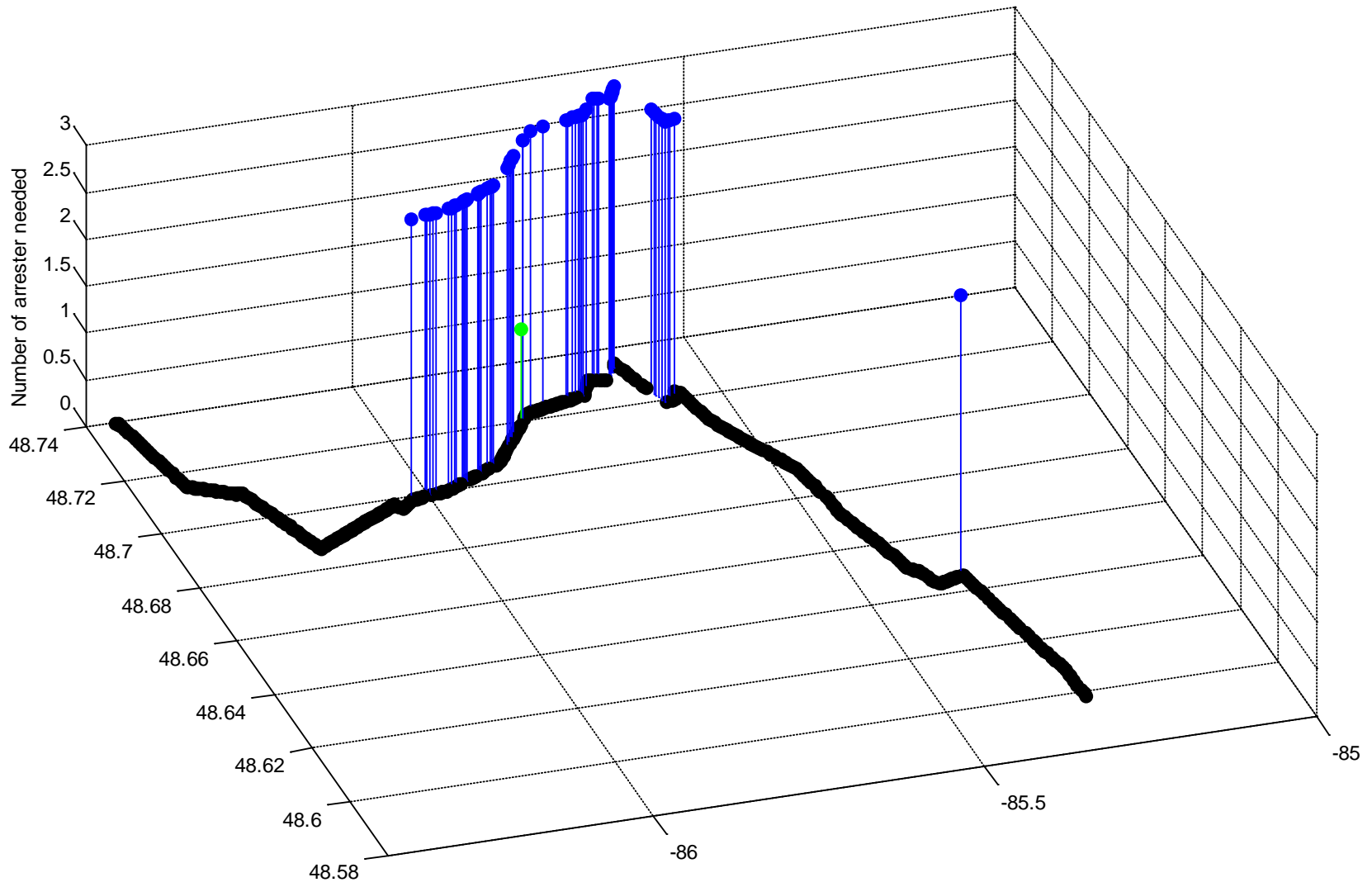
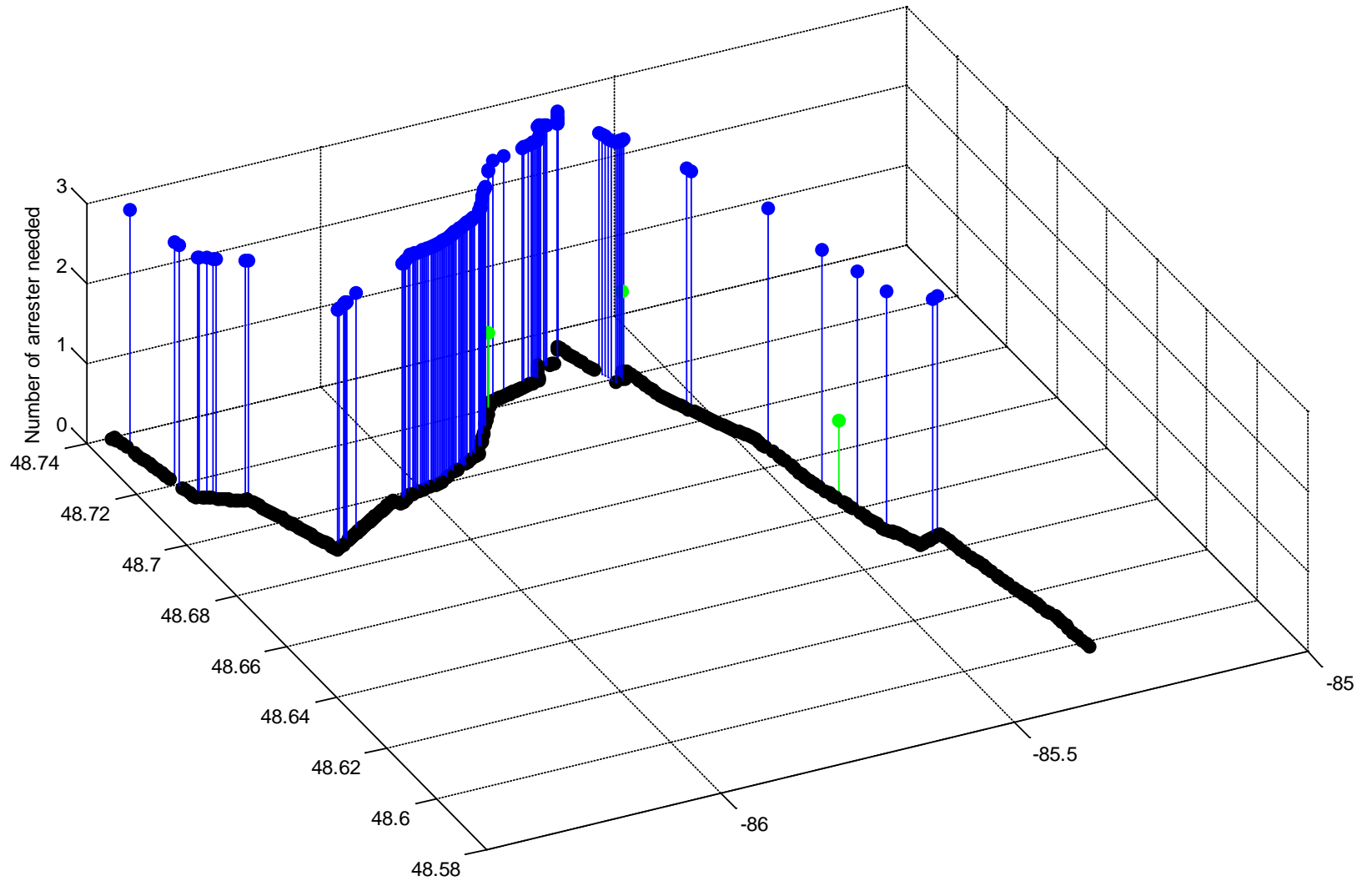


Fig.4 Backflashover reduction in % vs. cost when only footing resistance is considered. 3 arresters if  $R_g > 50\text{ohm}$ .  $Fr = 2.0295$  without arresters,  $Fr = 1.5873$  with 588 arresters

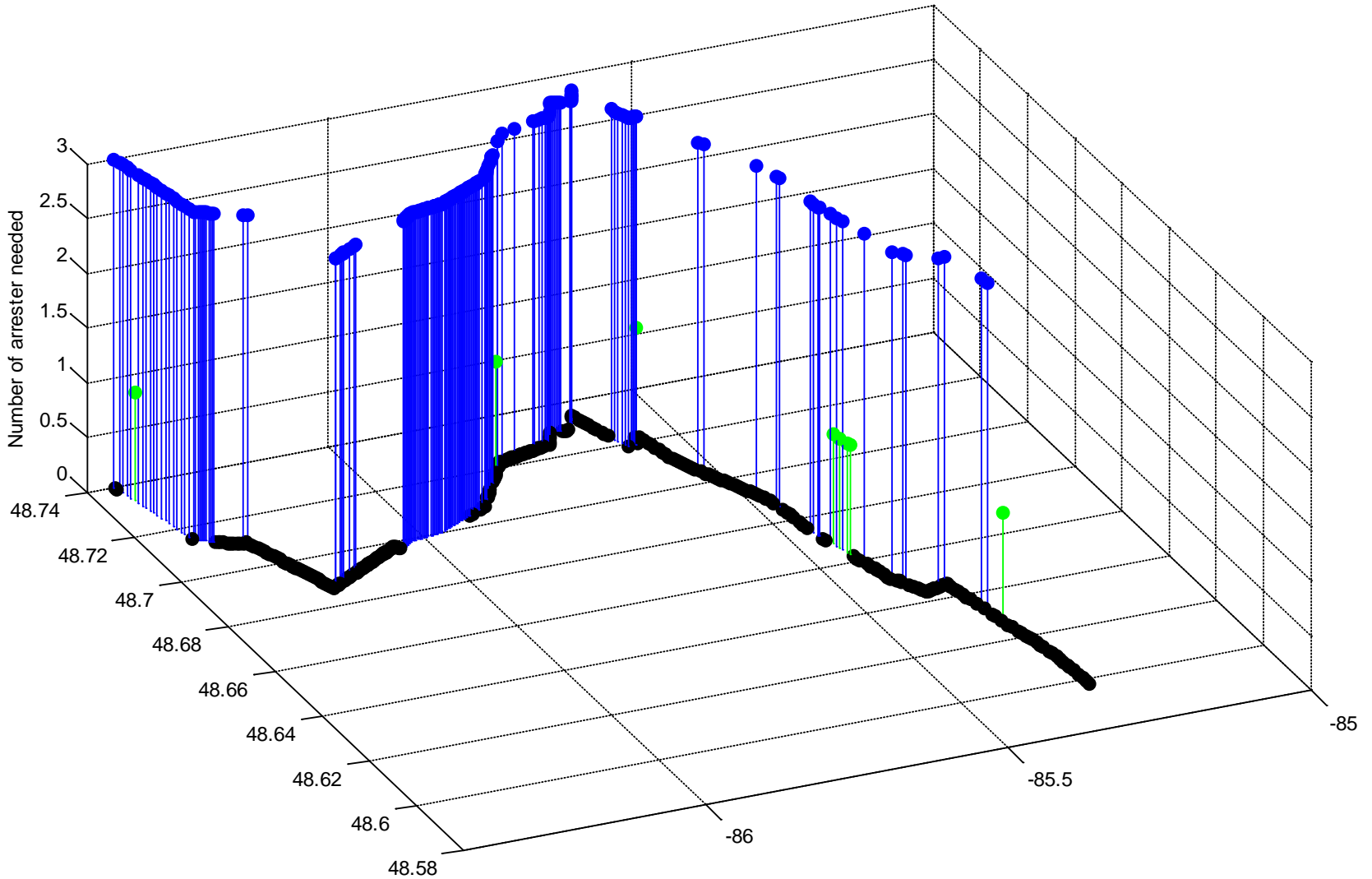


Consider all factors, \$0.5M, 190 arresters, Fr 34.2% reduction

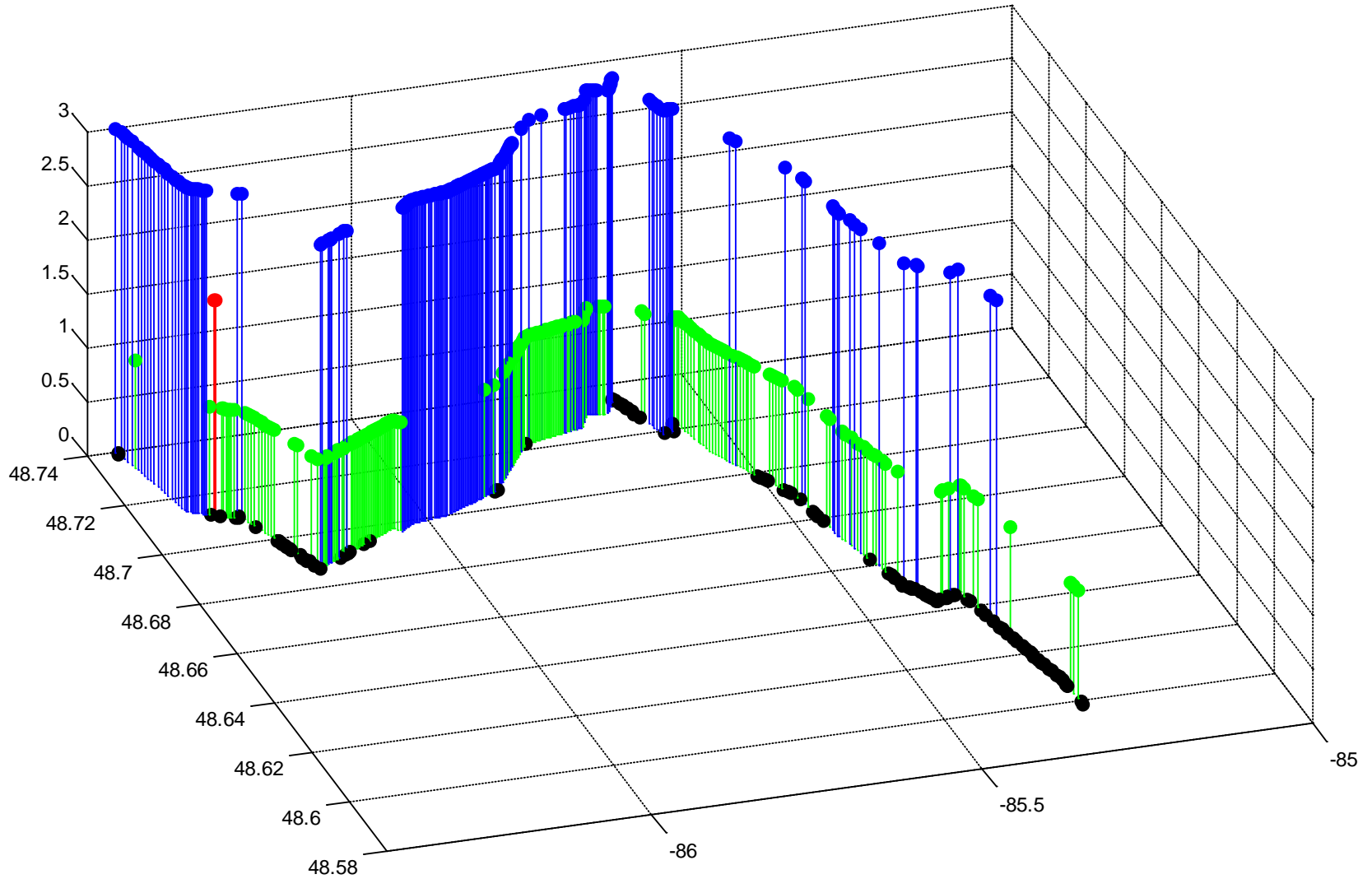




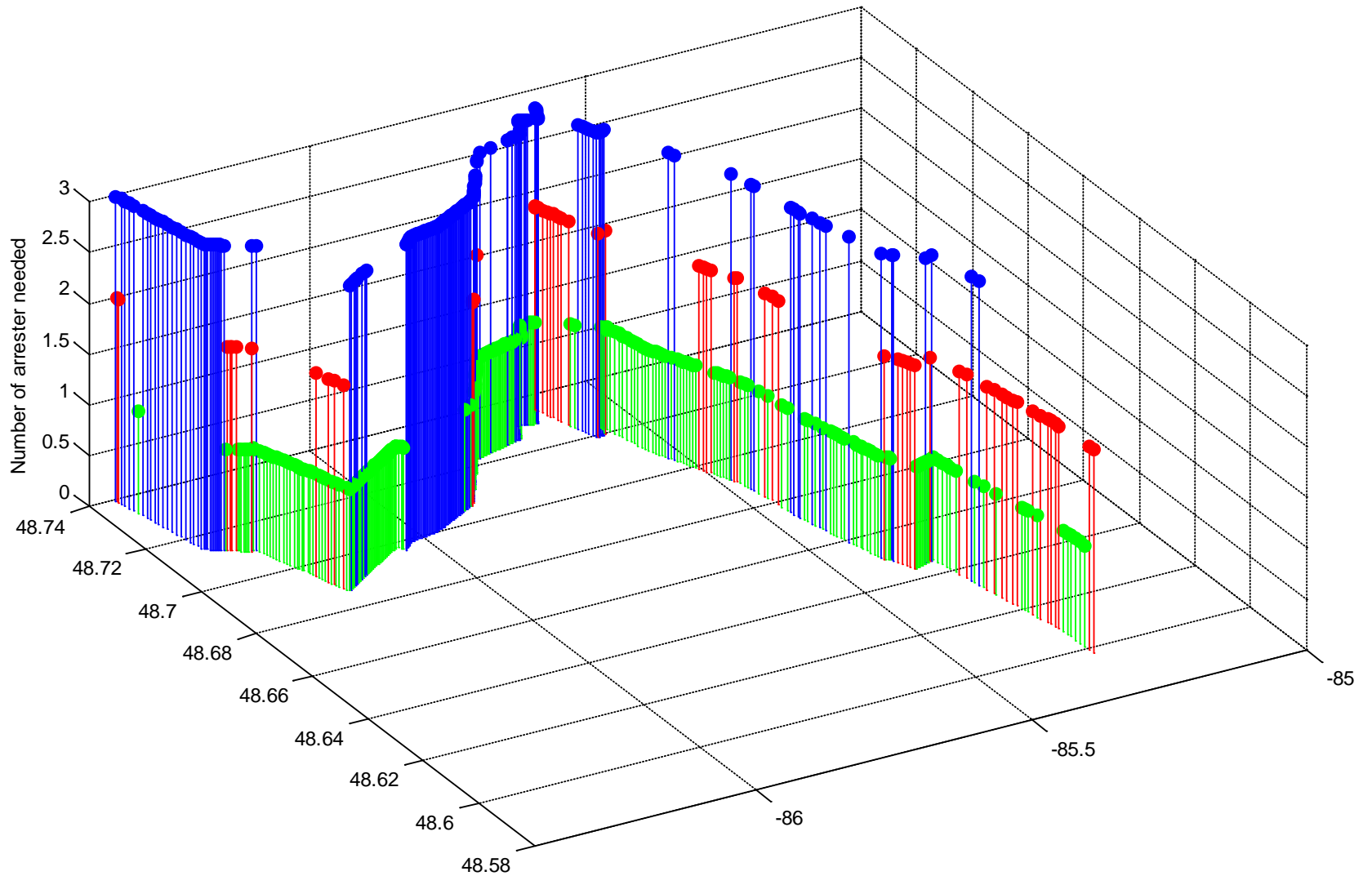
Consider all factors, \$1.0M, 390 arresters, Fr 61% reduction



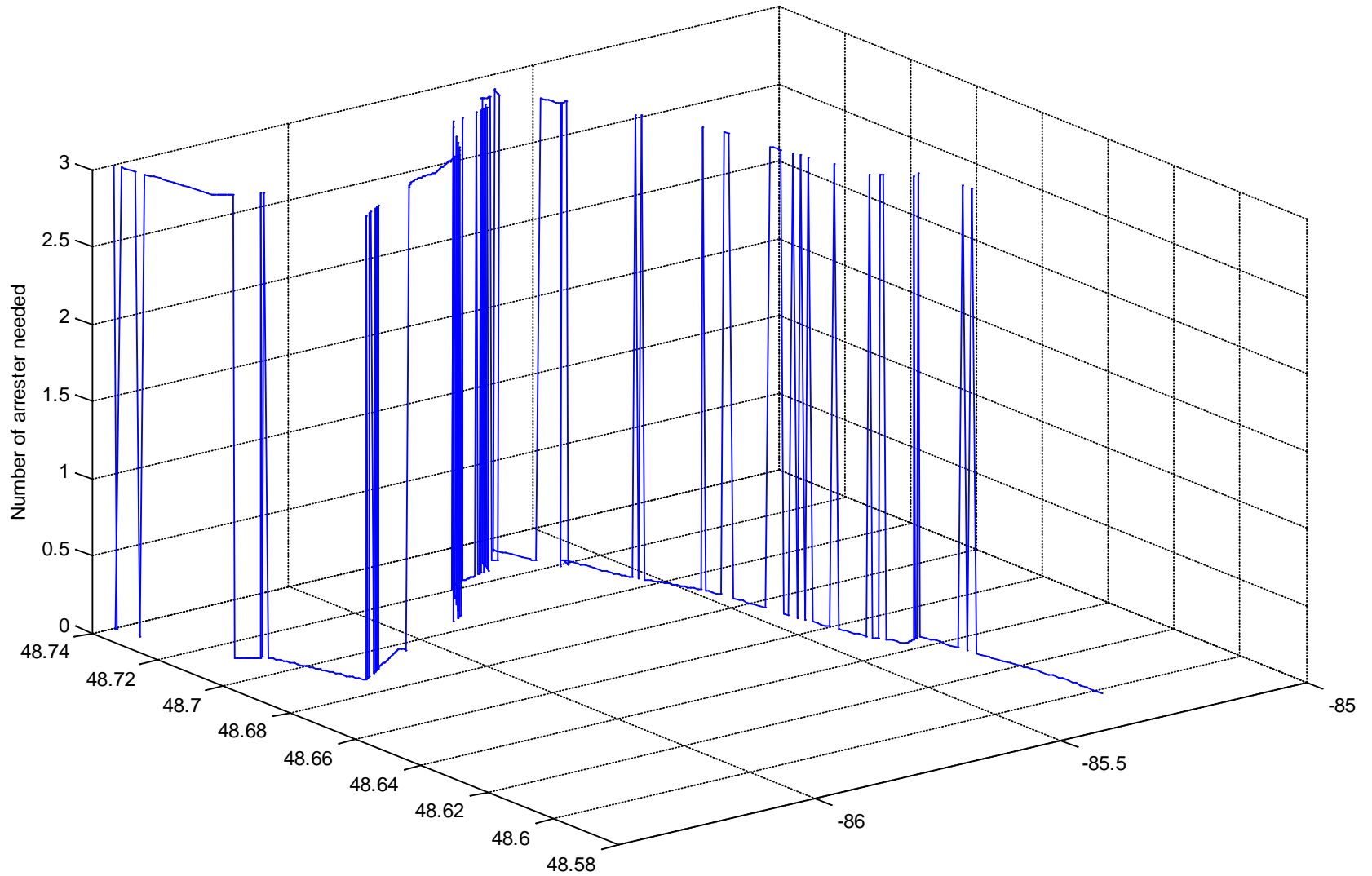
Consider all factors, \$1.5M, 590 arresters, Fr 82.8% reduction



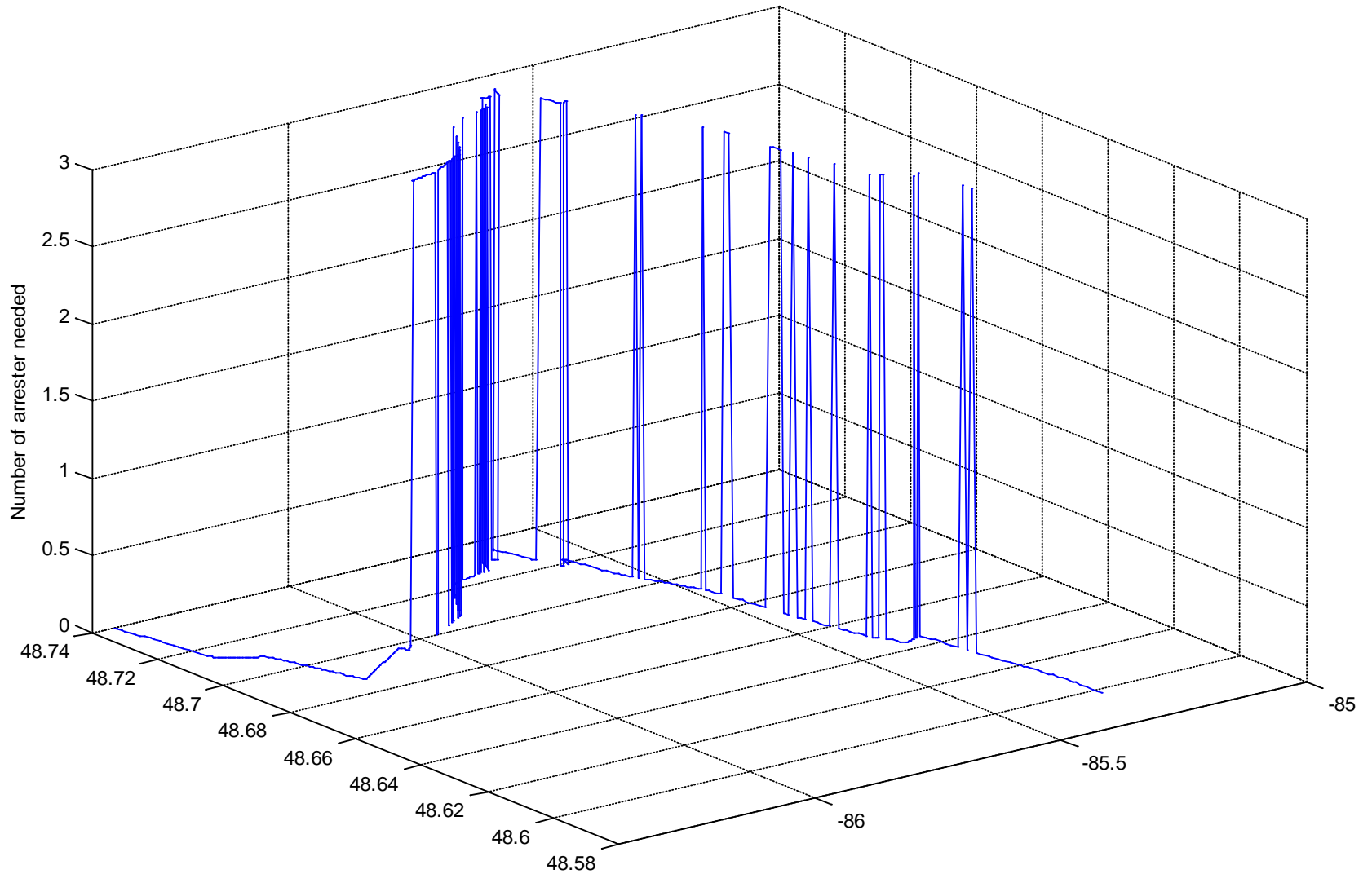
Consider all factors, \$2M, 790 arresters, Fr 91.7% reduction



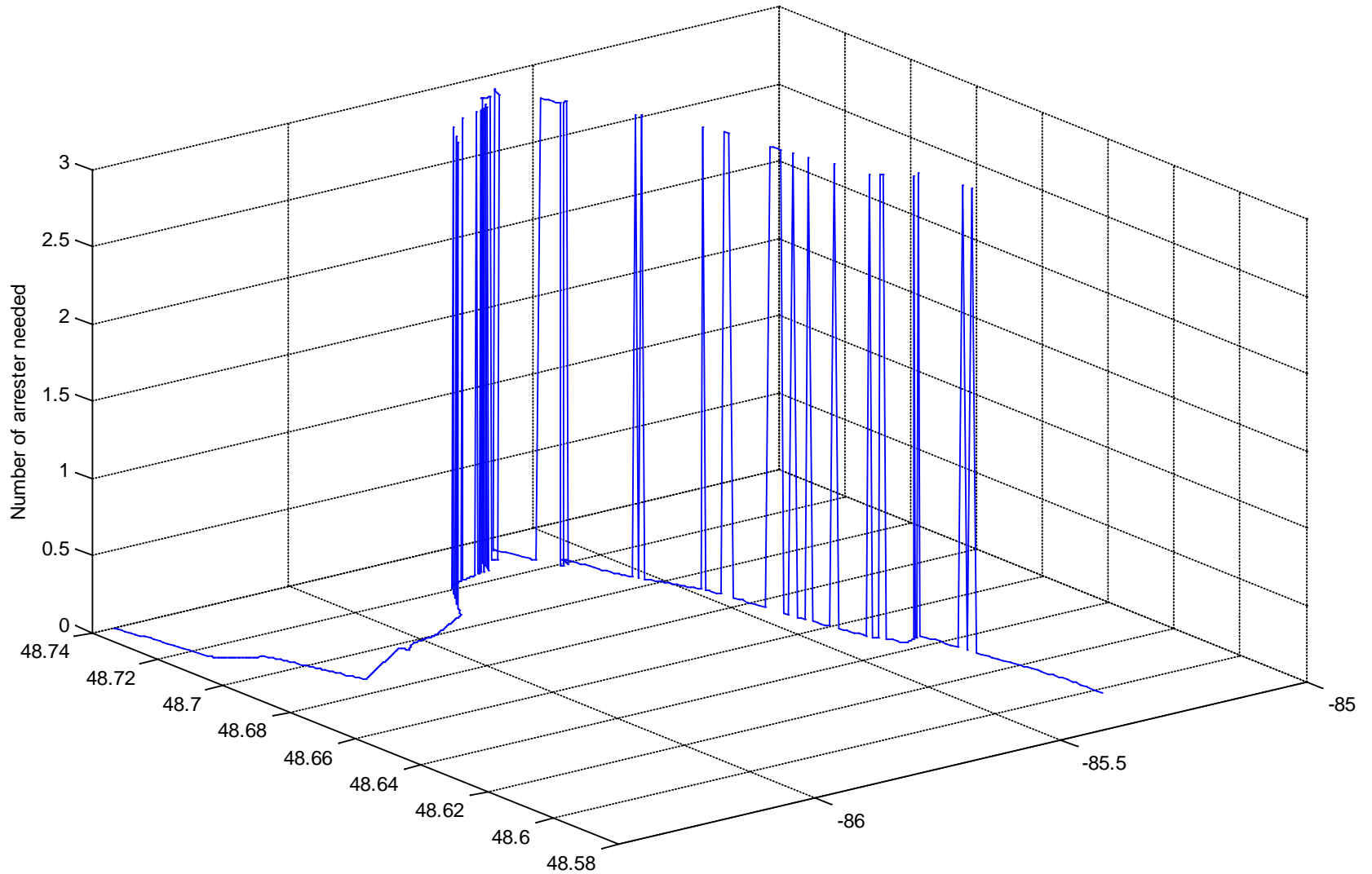
Consider all factors, \$2.42M, 958 arresters, Fr 93.9% reduction



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  $R_g > 50 \Omega$  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