

Current injection on a pharmaceutical plant, measured and modeled

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Current injection on a pharmaceutical plant, measured and modeled

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University of Technology

Where innovation starts

Introduction

Experiment

- **Goal: Test lightning protection (LP) of pharmaceutical plant**
- **Method: Current injection on LP roof grid and measure induced I & V in test cables**
- **Model: FEKO skeleton of building for interpretation and extrapolation**
- **Result: Insight in effectiveness of LP**
 - Building structure
 - Induced I & V in test cables
 - Intended external downconductors

Measurements



High voltage lead

Structural Steel

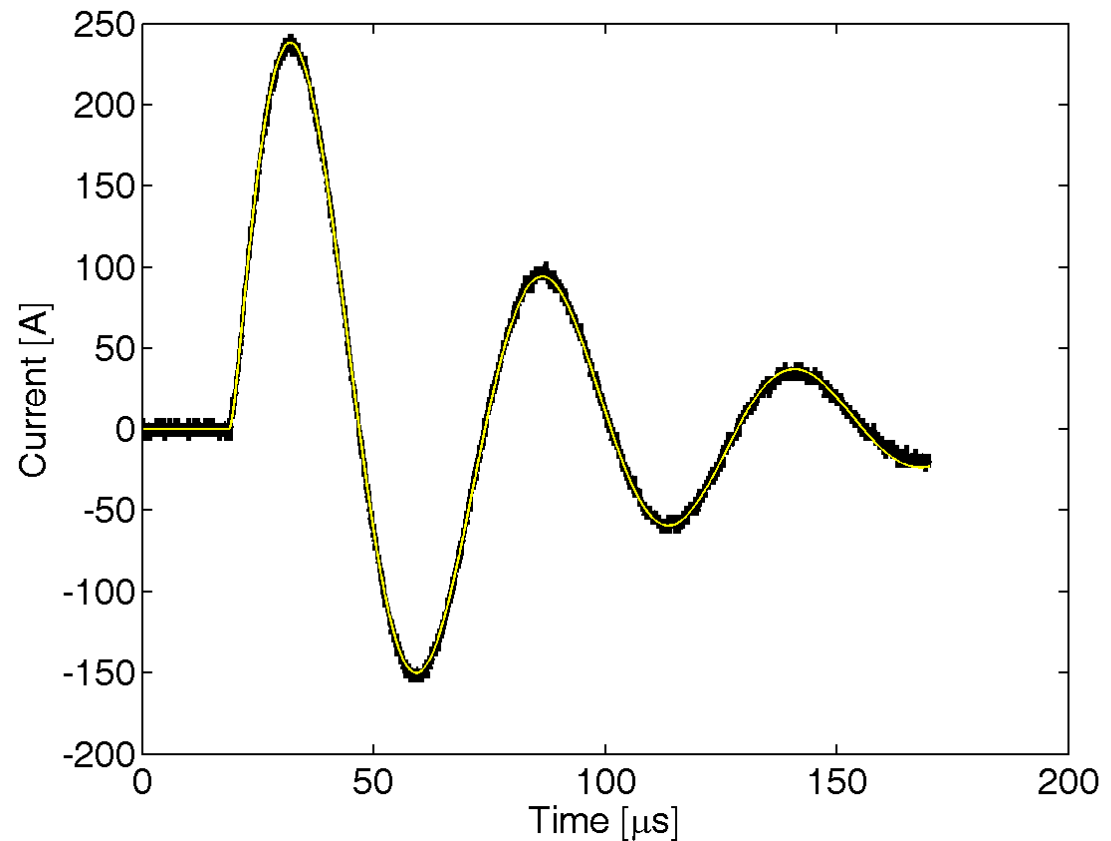
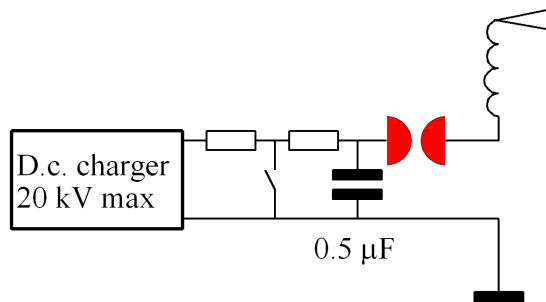
Roof grid

Container with source on roof

Measurements

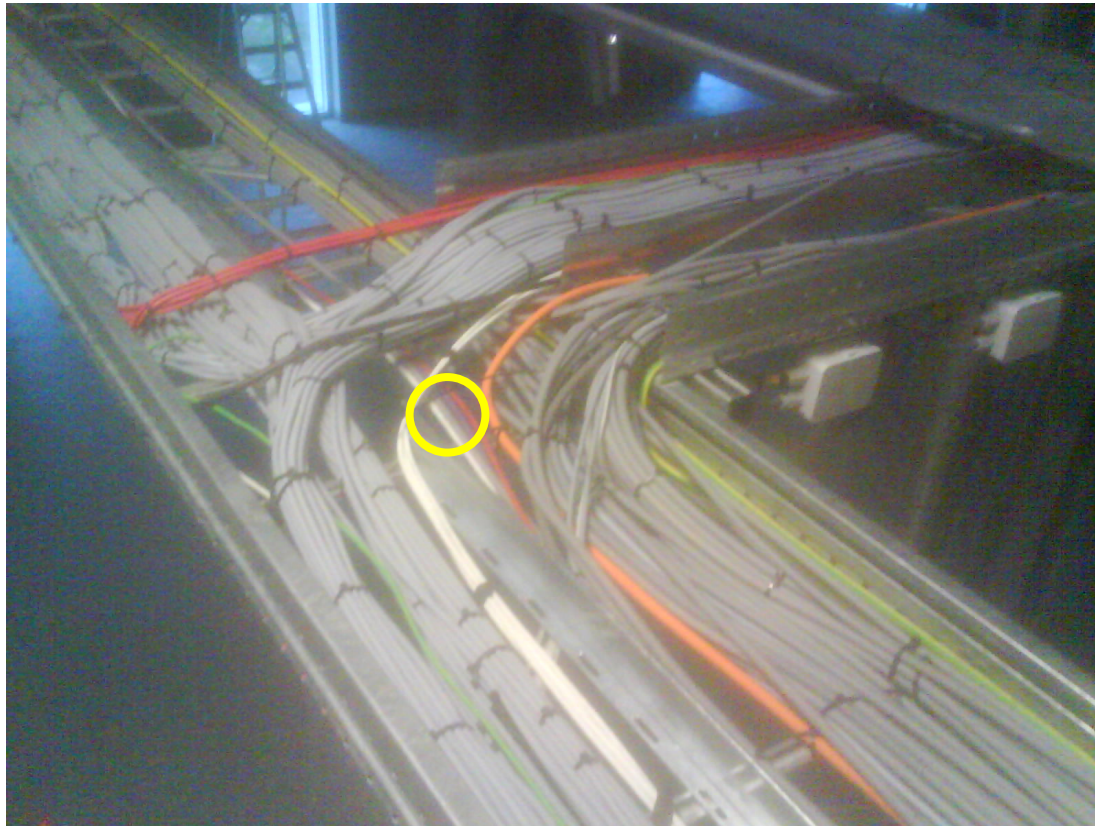
Source signal

- $I_p = 250 - 300 \text{ A}$
- $f_r = 18.4 \text{ kHz}$
- $L_c = 150 \mu\text{H}$
- $R_c = 5.1 \Omega$



Measurements

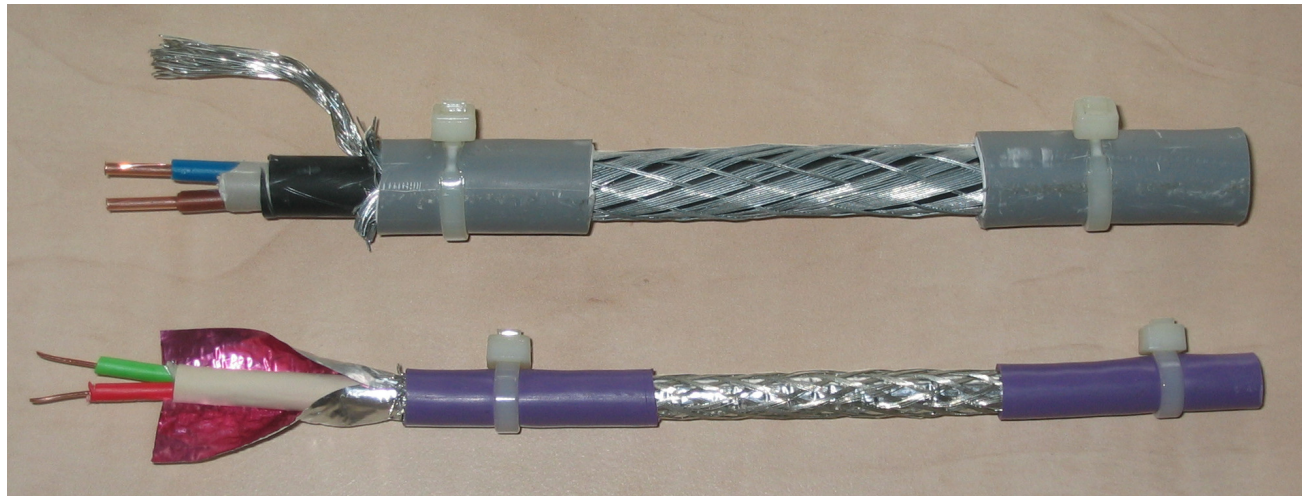
Test cables



- Trays with cables and 100 m test cables

Measurement Test cables

- a) Draka 03 HULT 3 G 2.5 mm² (0.27 μ H/m)
- b) Draka HULTO 2 x 2,5 mm² + as 2.5 mm²
- c) Siemens Simatic net profibus



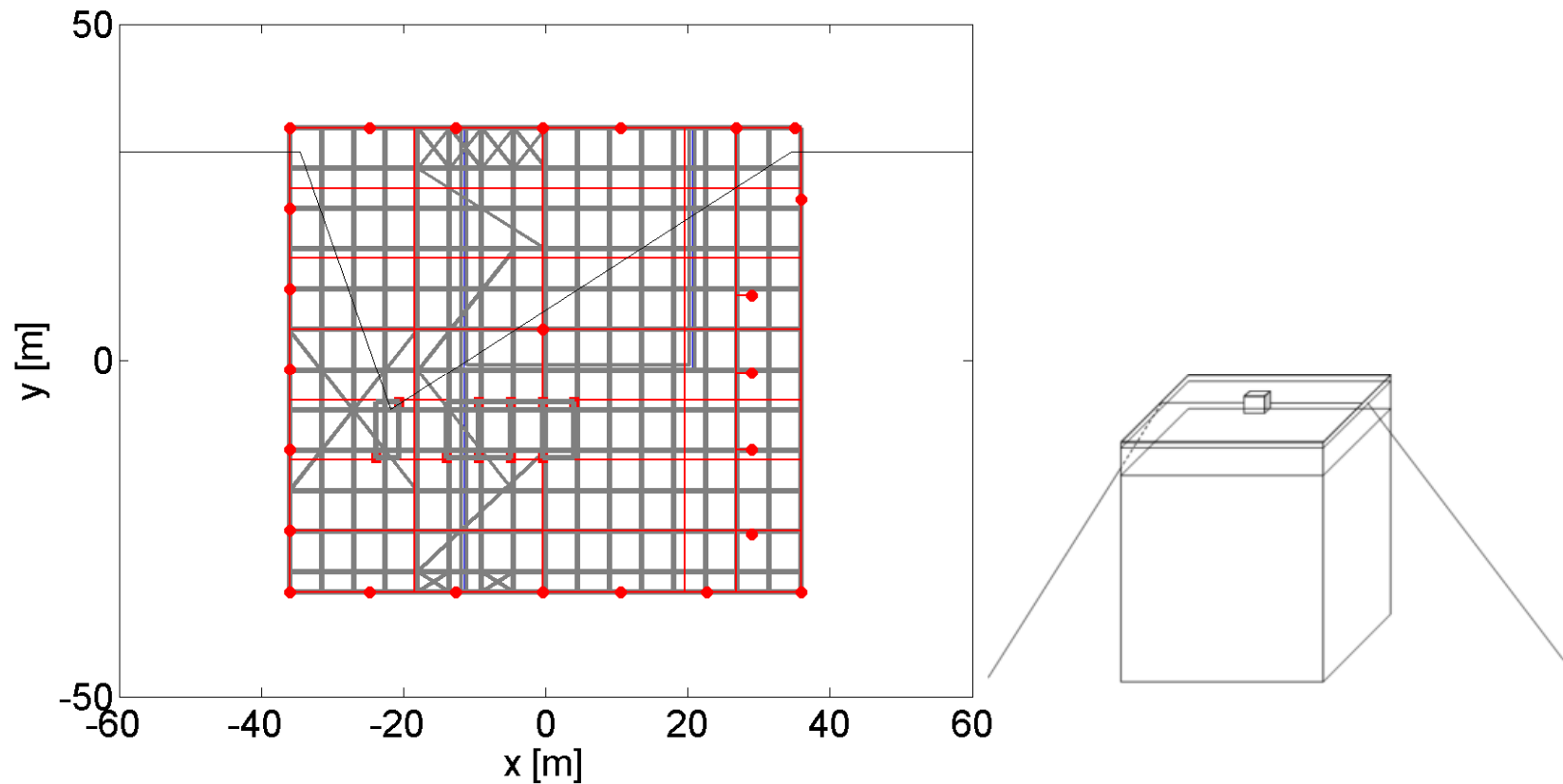
Picture of cable b and c

Modeling

- **Limited:**
 - **Includes main roof construction**
 - **Excludes piping, ducts, facade, concrete reinforcement since not welded through, other cables in tray**

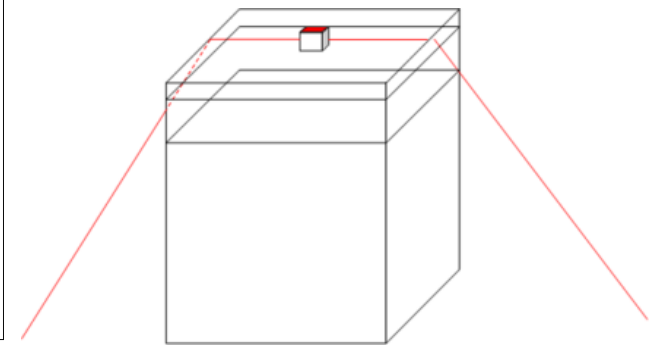
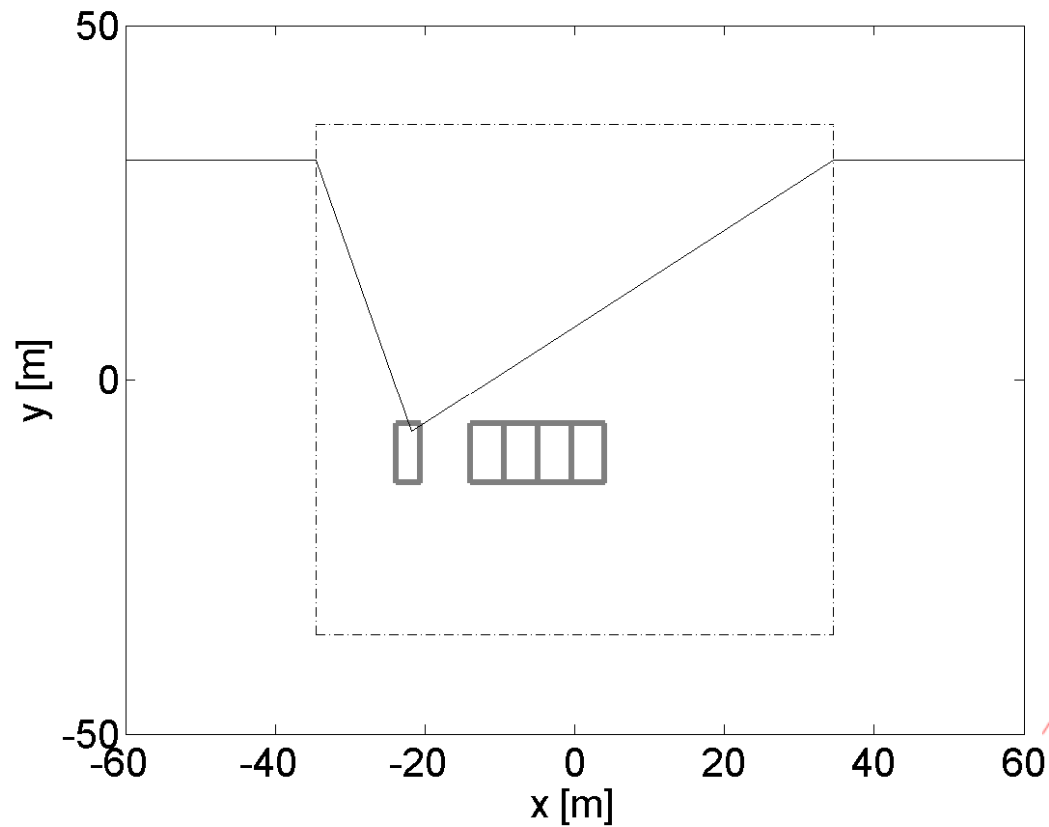


Modeling



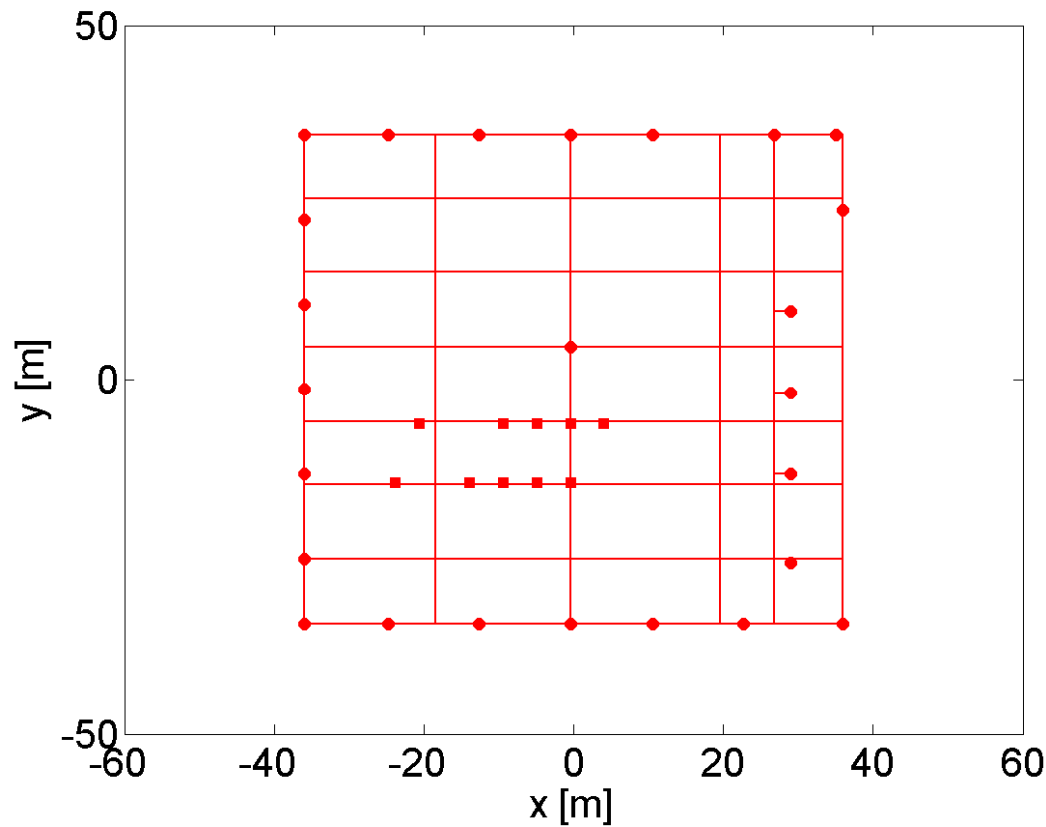
Top view projection of pharmaceutical plant

Modeling

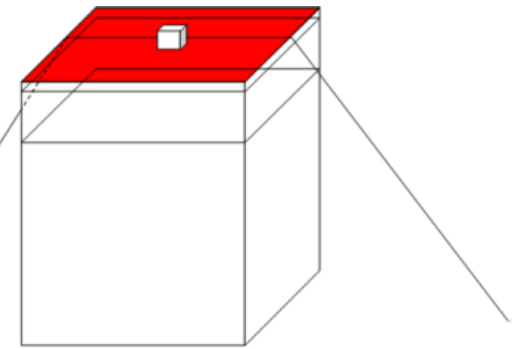


Chassis and high voltage leads

Modeling

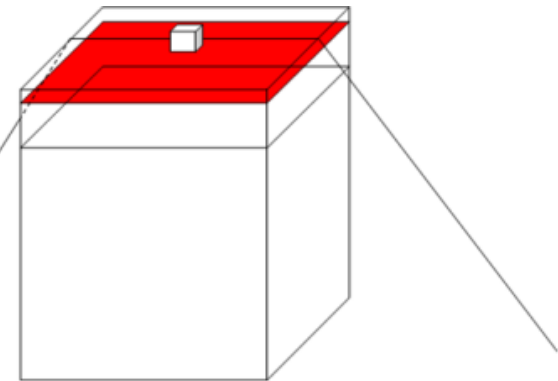
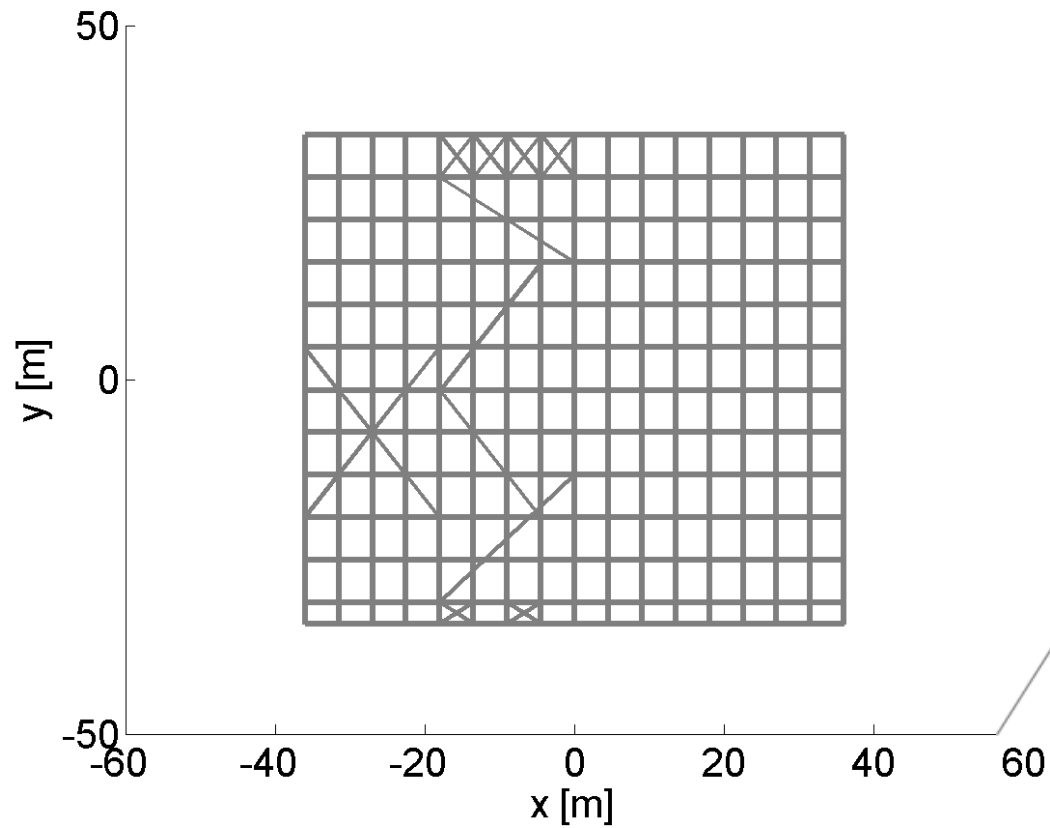


- Down conductors
- Container connection



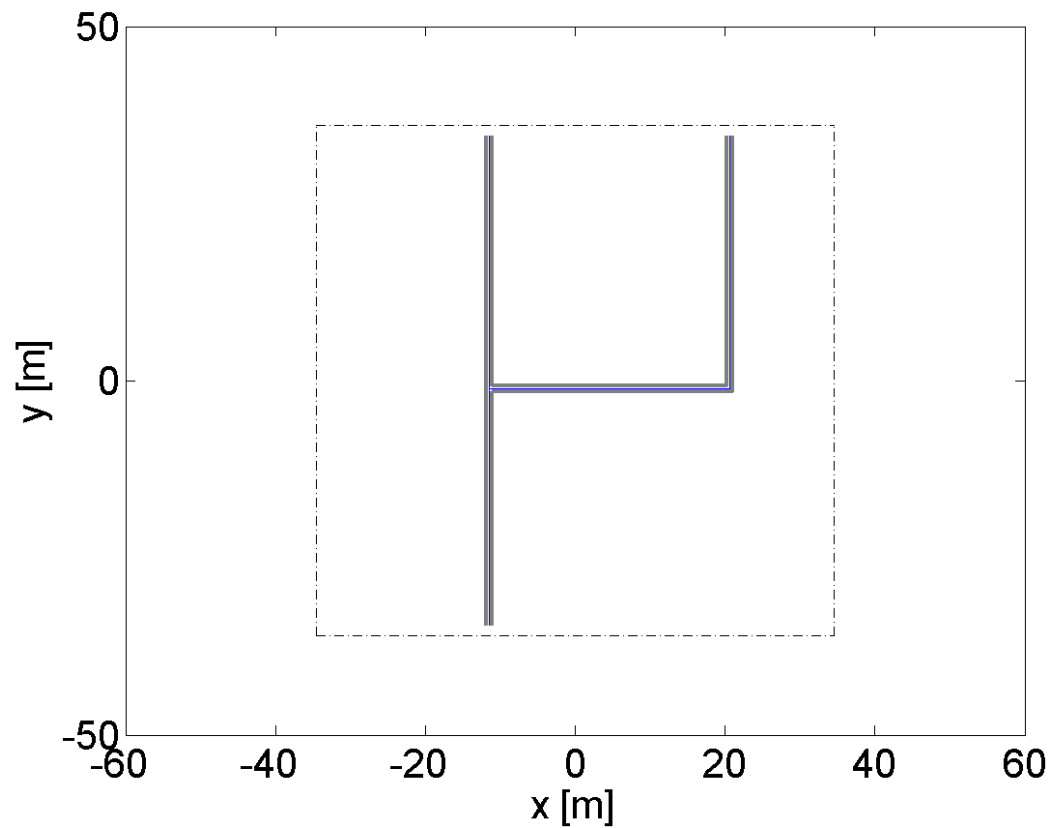
Lay-out roof-grid

Modeling

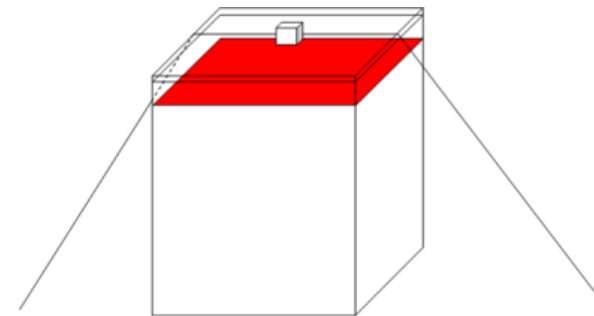
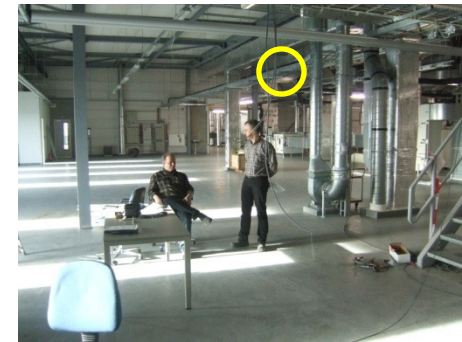


Lay-out steel construction roof

Modeling

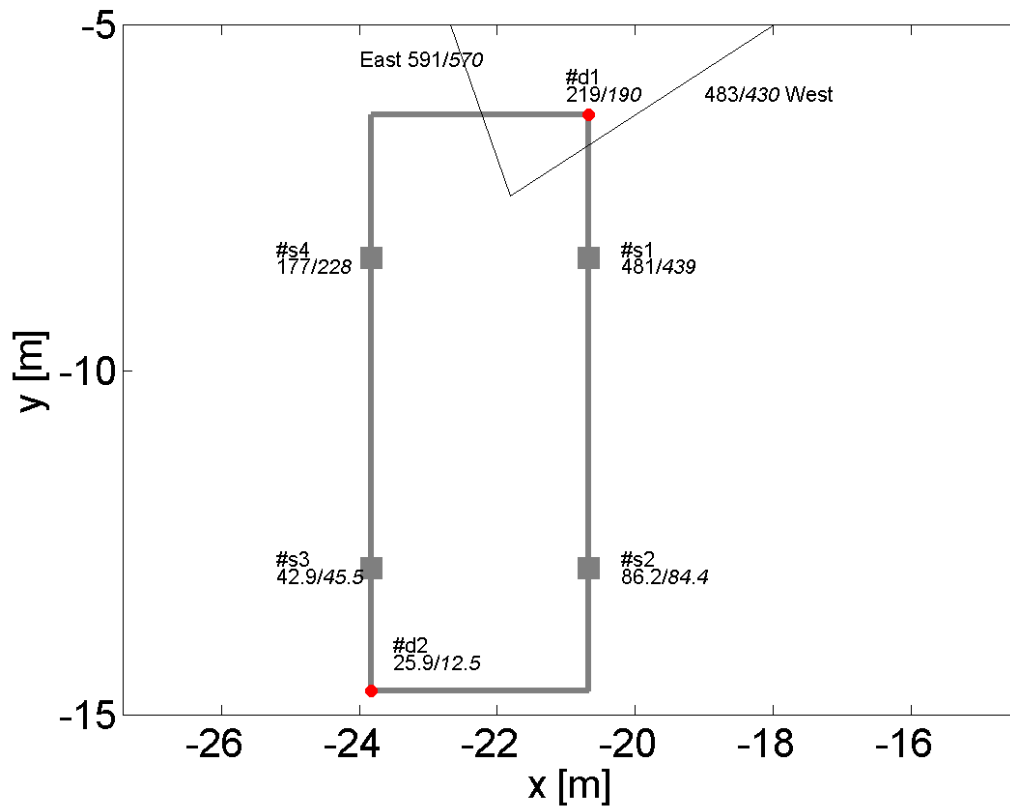


Lay-out cable tray



Modeling Results

| | Measurement | Simulation |
|-----------|-------------|------------|
| Girders | 75 % | 80% |
| Roof grid | 25 % | 20% |



Lay-out of container

Test cables

- a) Draka 03 HULT 3 G 2.5 mm² (0.27 μH/m)
- b) Draka HULTO 2 x 2,5 mm² + as 2.5 mm²
- c) Siemens Simatic net profibus

| Type | R [Ω] | Z' _t (18 kHz) [Ω] |
|------|----------|------------------------------------|
| a*) | 0.74 | 3.6 |
| b) | 0.74 | 2.1 |
| c) | 0.95 | 0.82 |

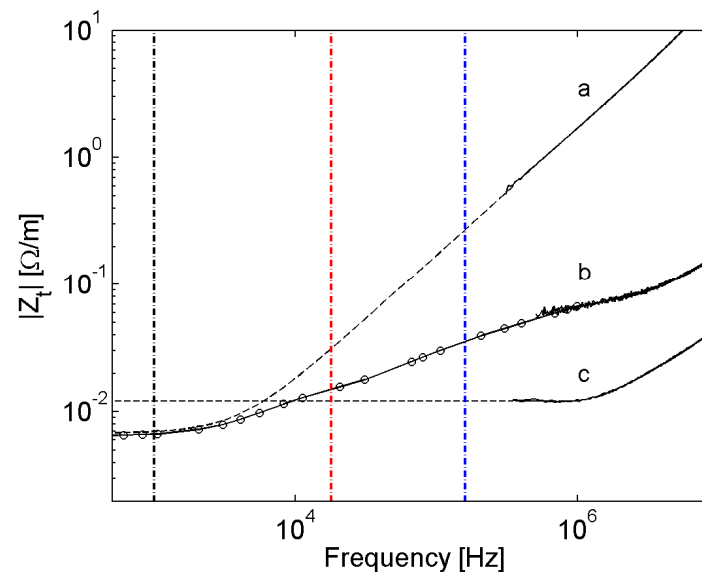
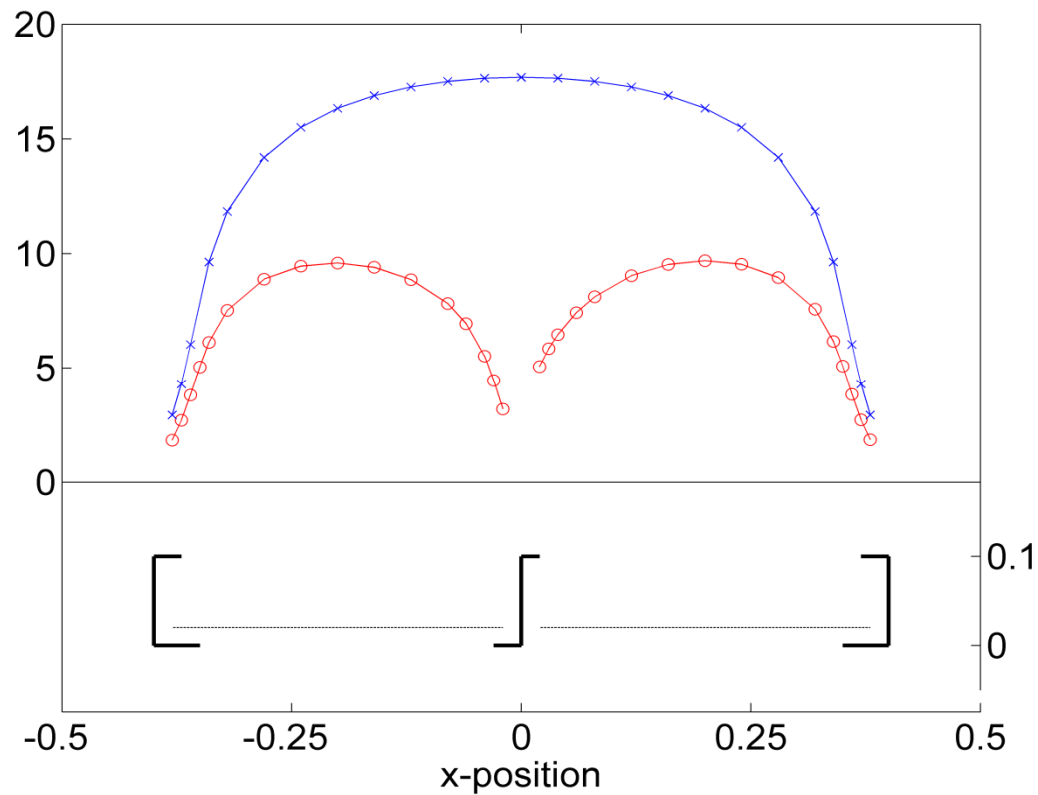


Table 1: Parameters of three 100 m test cables

* Slightly different measurement setup

- Low frequency
- Measurement frequency
- Lightning frequency

Test cables Conduit



- Cable bundle current in % versus position

Test cables

- **Extrapolated for unshielded 3 G cable**
 - 100 kA, 1 μ s lightning assumption
 - Current tray & cables 1.3 kA
 - Current cable worst case position 33 A
 - Cable a) Z_t 0.27 Ω /m, 100 m
 - Voltage shared by both ends: 0.9 kV
 - Cable b) Z_t 0.05 Ω /m 100 m
 - Voltage shared by both ends: 0.2 kV
 - Cable c) Z_t 0.01 Ω /m 100 m
 - Voltage shared by both ends: 40 V

Conclusion

- **Roof LP grid contributes less than girders**
 - **Measurements and model agree**
- **Tray current: calc./meas. = 3**
 - **Reduced model, many more current paths present**
- **Z_t of cable important for V/I ratio**
 - **V/I ratio as for lab test on cables**
 - **Shielded cables much better**

Thank you

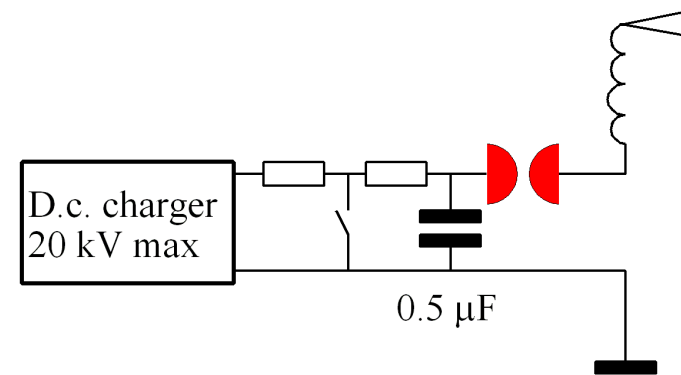


Introduction

Background

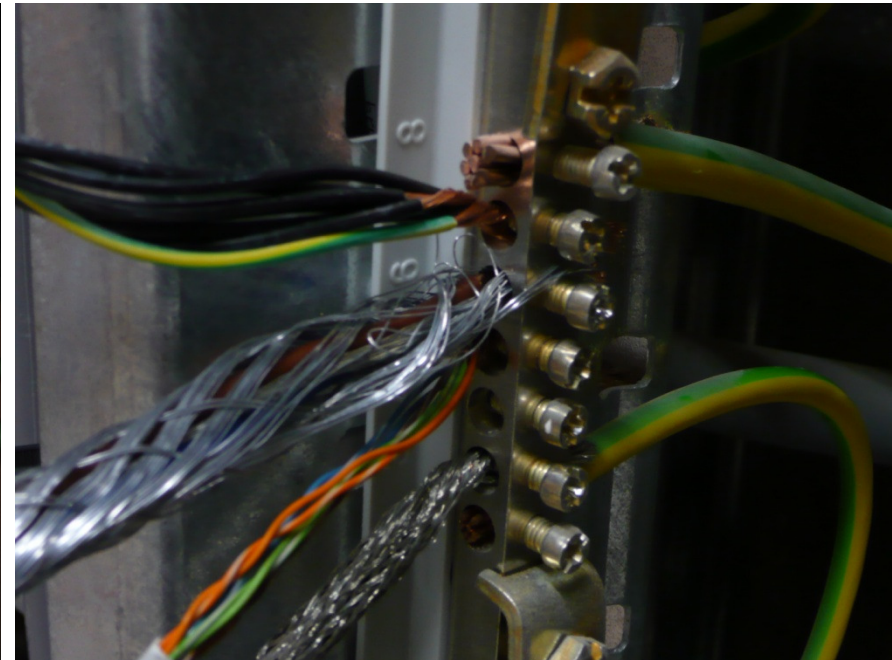
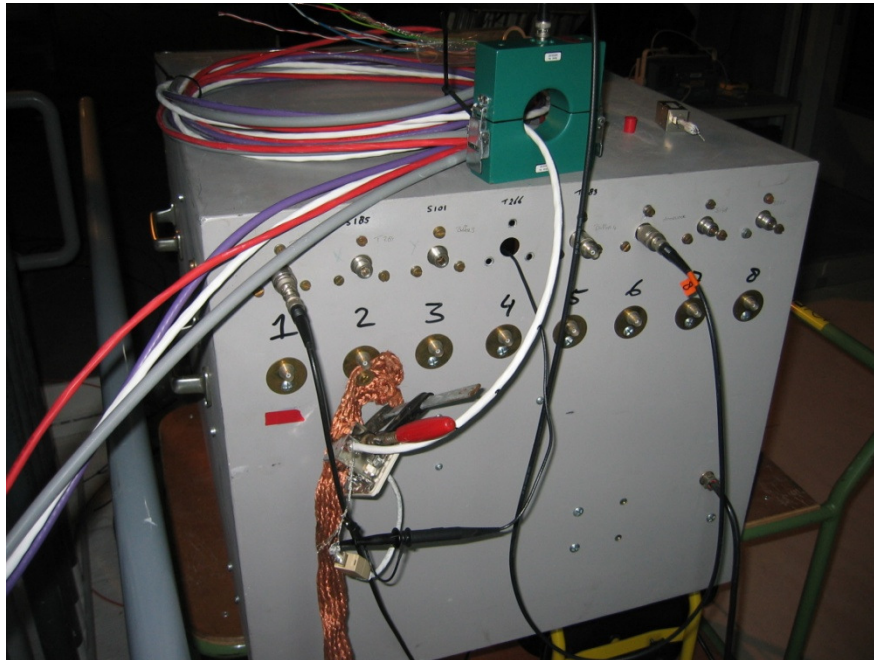
- **IEC 62305 Part 1-4**
 - Visual inspection of Lightning Protection
- **Experiment**
 - Major part protection consists of metallic conduction
 - Lightning not arcing over
 - Frequency high enough

Measurements



Measurements

Compare V and I of testcables Z_t



- **Measurements in chemical plant on 100 m cables**