



# Halifax Metro Centre Monitoring Project

# Halifax Metro Centre



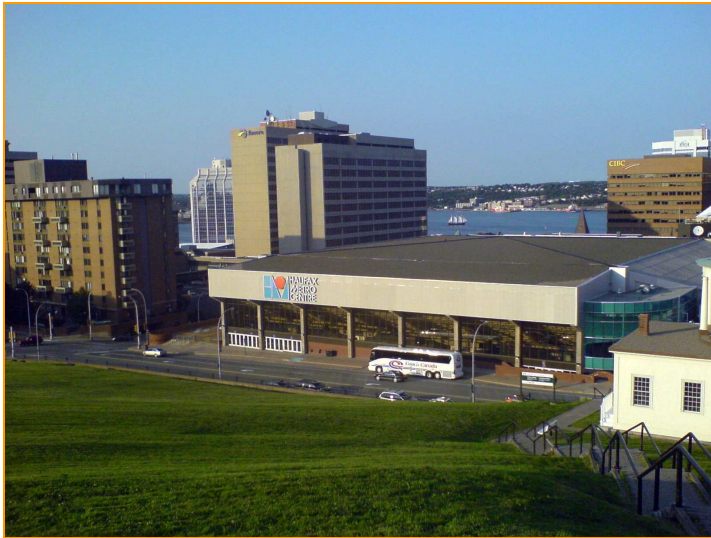
**TEC**



**ROCTEST**  
GROUP

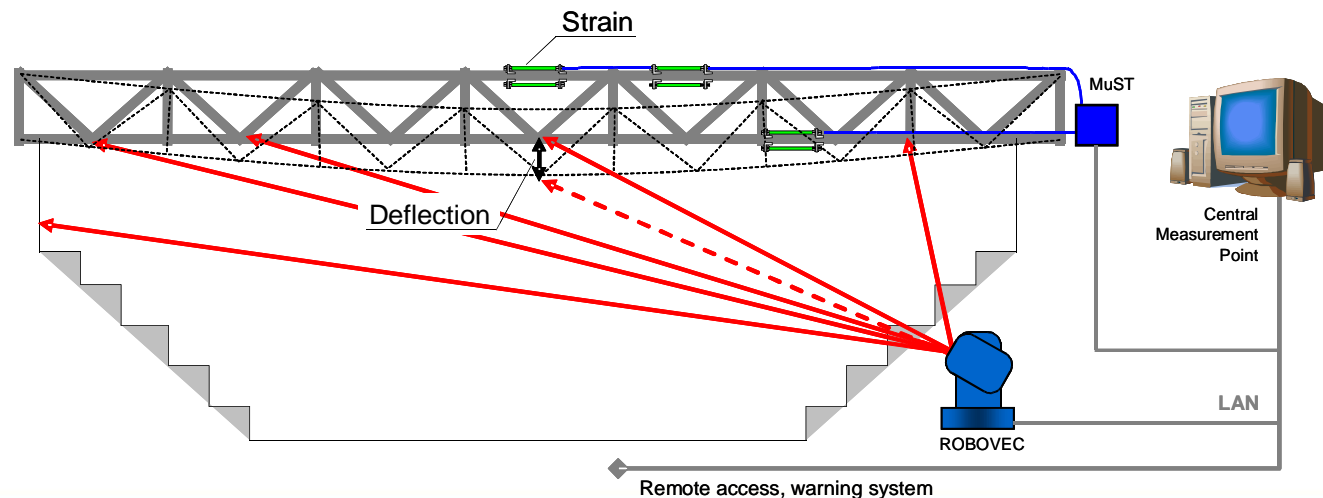
Where instrumentation technologies meet

# Case study: Roof deflection monitoring, Halifax Metro Centre, Canada

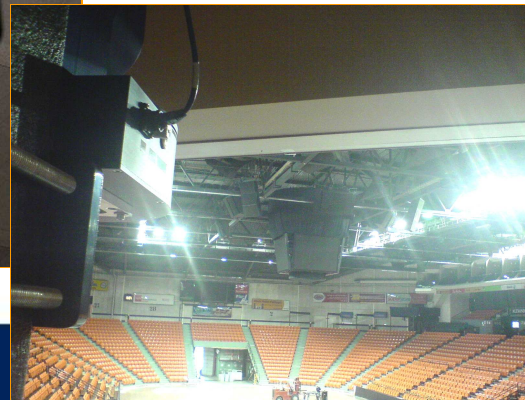
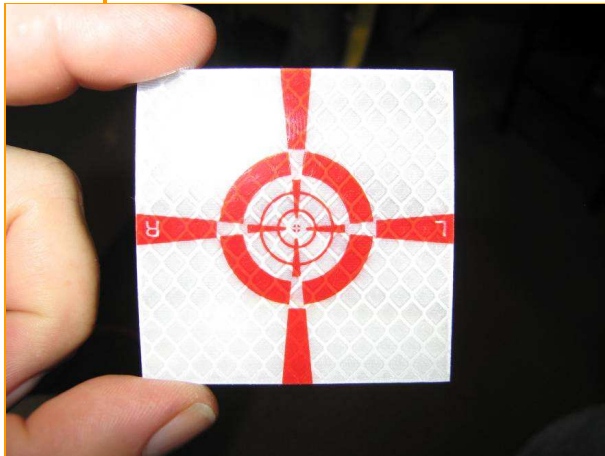
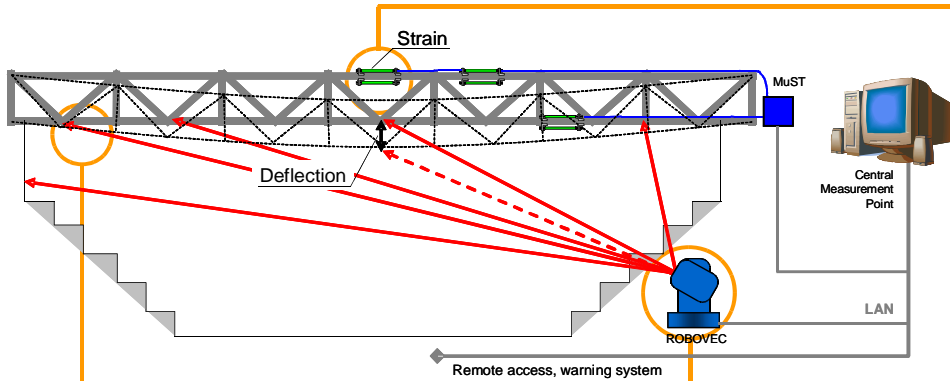


- Construction: **late 1970s**
- multi-entertainment, sports facility and exhibition centre
- seating capacity: 10,595 (ice hockey)
- **Increase of roof loads:** increasing use of **suspended equipment** for lights and sound for special events, **snow**
- structural investigation → implementation a **Structural Health Monitoring System**

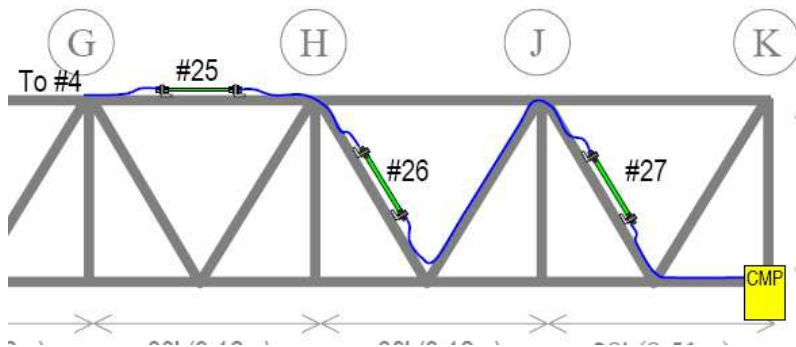
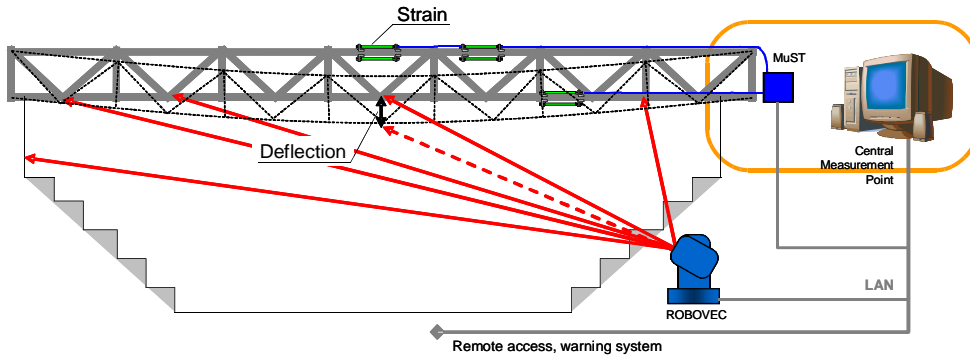
- 18 ROBOVEC targets
- 36 FO Strain (and temperature) sensors



# Case study: Roof deflection monitoring, Halifax Metro Centre, Canada



# Case study: Roof deflection monitoring, Halifax Metro Centre, Canada



# Halifax Metro Centre

- **Monitoring project aims:**
  - **monitor the average strain on the roof truss system beams during service and under additional suspended “entertainment loads”**
  - **increase knowledge on the structural behaviors**
  - **plan and design maintenance interventions**
  - **verify hypotheses**
  - **reduce uncertainty and to insure safety**

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Monitoring parameters:

- average strain (deformations) at selected locations of the truss beams
- relative vertical displacement of the whole roof truss system
- temperature of steel structural elements
- automatic and continuous static monitoring

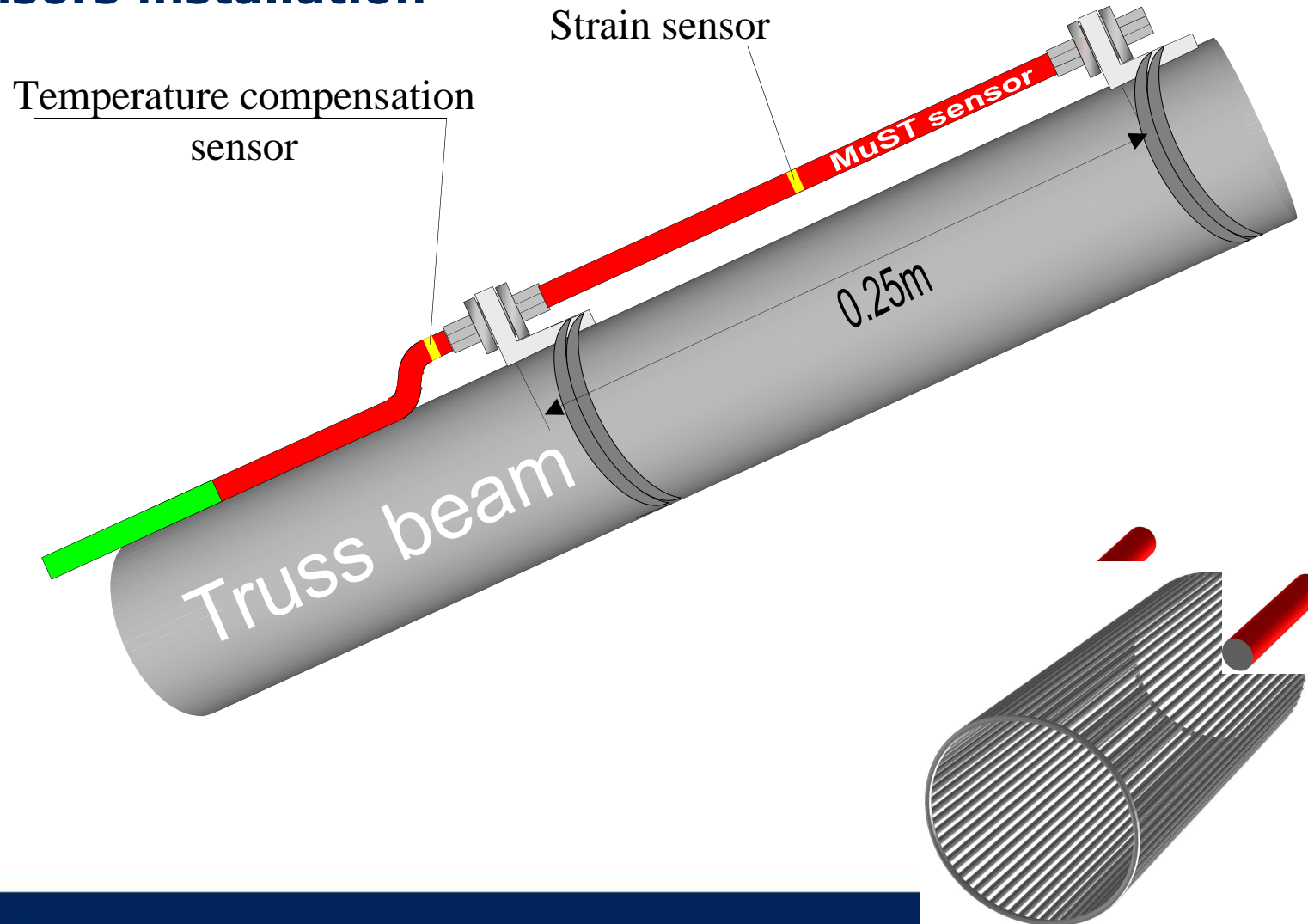
# Halifax Metro Centre

- **MuST system main advantages:**
  - **high resolution and accuracy**
  - **insensitivity to environmental influences (temperature, humidity, corrosion and electromagnetic fields)**
  - **easy and fast installation**
  - **temperature monitoring**
  - **long-term stability and durability**

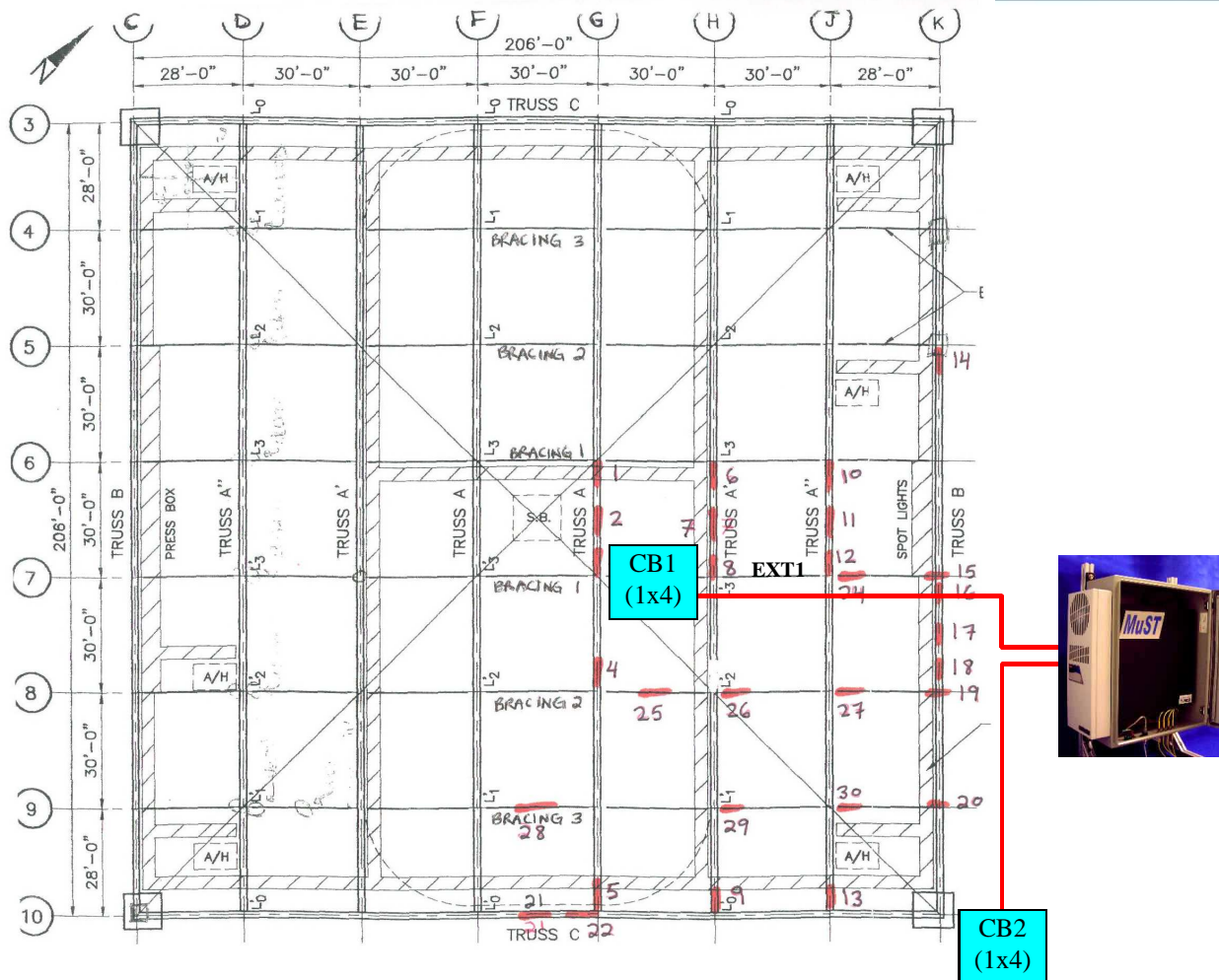


# Halifax Metro Centre - Installation

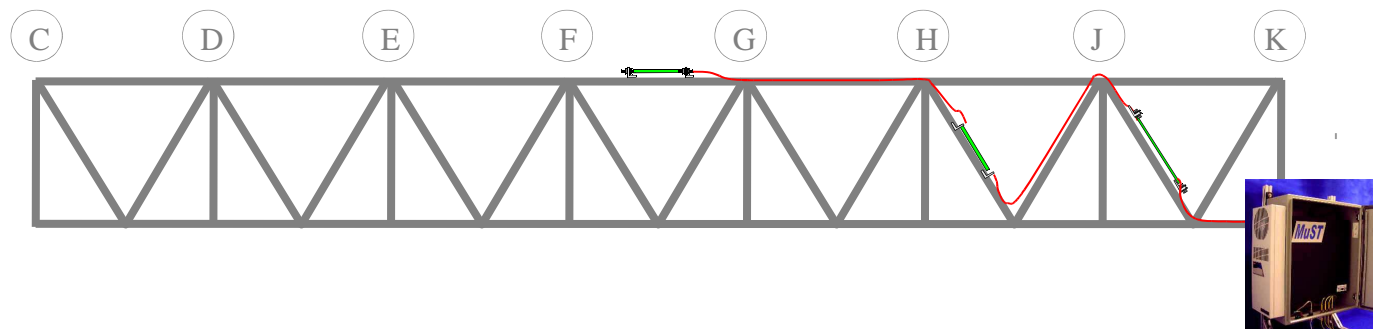
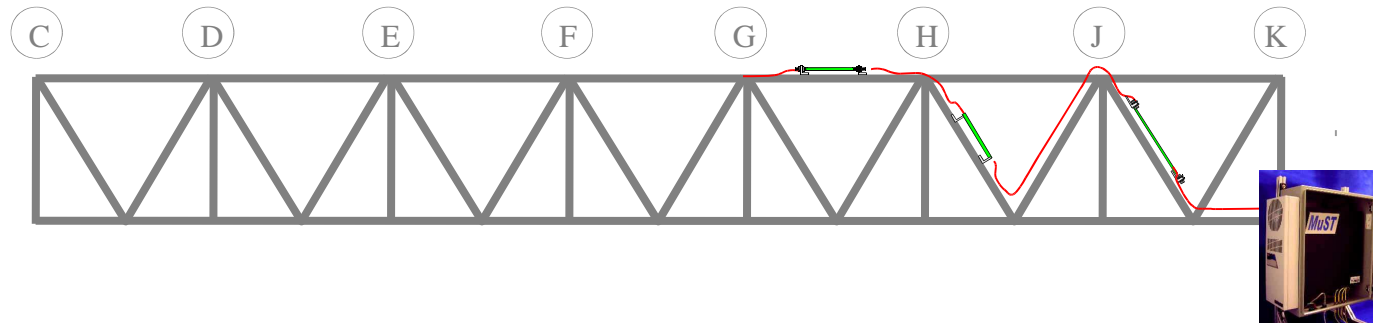
## Sensors installation



# Halifax Metro Centre

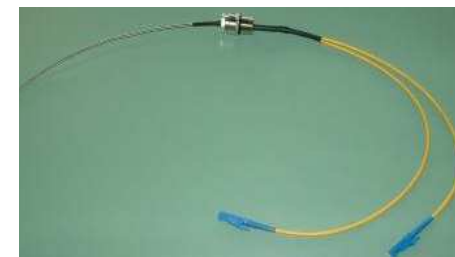
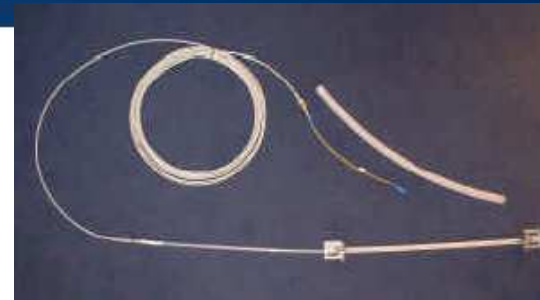


# Halifax Metro Centre



# Halifax Metro Centre - Instrumentation

- 6 MuST deformation sensors single-ended with T sensor
- 24 MuST deformation sensors double-ended with T sensor
- 6 MuST deformation sensors single-ended without T sensor
- 2 connection boxes for 1 to 10 sensors
- 2 extension reinforced steel FO cables



# Halifax Metro Centre - Instrumentation

- 1 MuST Fiber Optic 4 channels reading unit

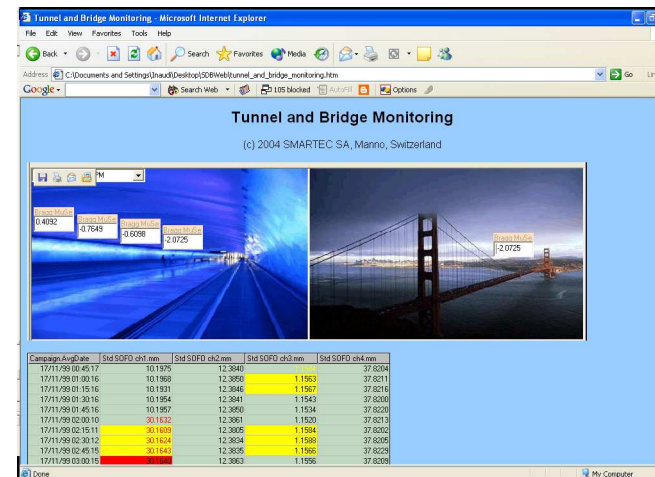


- 1 outdoor casing with climate control



# Halifax Metro Centre - Instrumentation

- 1 SOFO PRO software for real time analysis and data interpretation
- 1 SOFO VIEW software for graphic display and warning alerts



## Halifax Metro Centre – Monitored parameters

- All MuST sensors
  - ➔ **Relative displacements / average strains (in the direction of the sensor) , total 36 points**
- Network containing the MUST sensors belonging to the same vertical plane
  - ➔ **Monitoring of deformed shape in sensors' (vertical) plane , total 9 points**
- Pairs of MuST sensors parallel to the horizontal plane
  - ➔ **curvature measurement in horizontal direction, total 6 points**

## Halifax Metro Centre – Monitored parameters

- Temperature sensors
- ➔ **Thermally generated strains, total of 30 points (with condition that the thermal expansion coefficient of construction material is known)**
- ➔ **Measurement of temperature variation, total of 30 points**



# Halifax Metro Centre – Measurements' Schedule

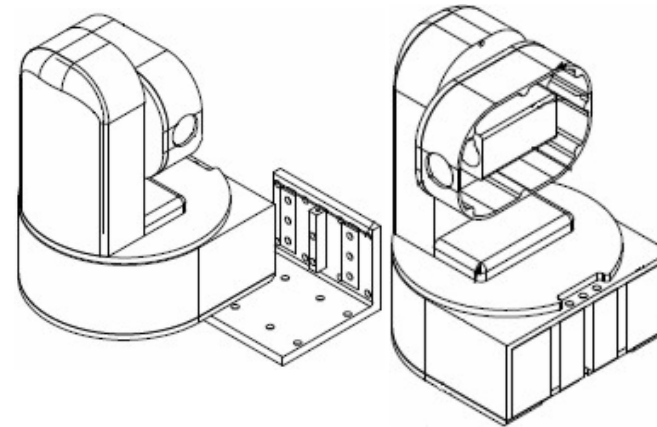
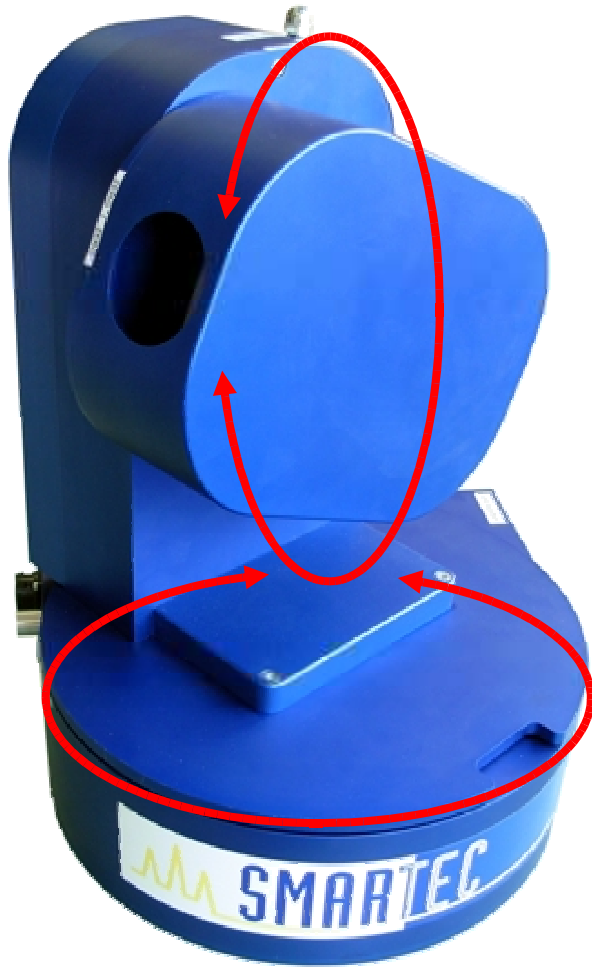
## Proposed measurements' schedule

- 24 - 48 hours continuous monitoring
- ➔ **Behavior of the structure due to temperature daily variations**
  
- Testing load (if any)
- ➔ **1 session of measurements after each step of load**
  
- Period before repair (if any)
- ➔ **several times per day (e.g. one session in the morning, noon, afternoon and night)**

## Halifax Metro Centre – Measurements' Schedule

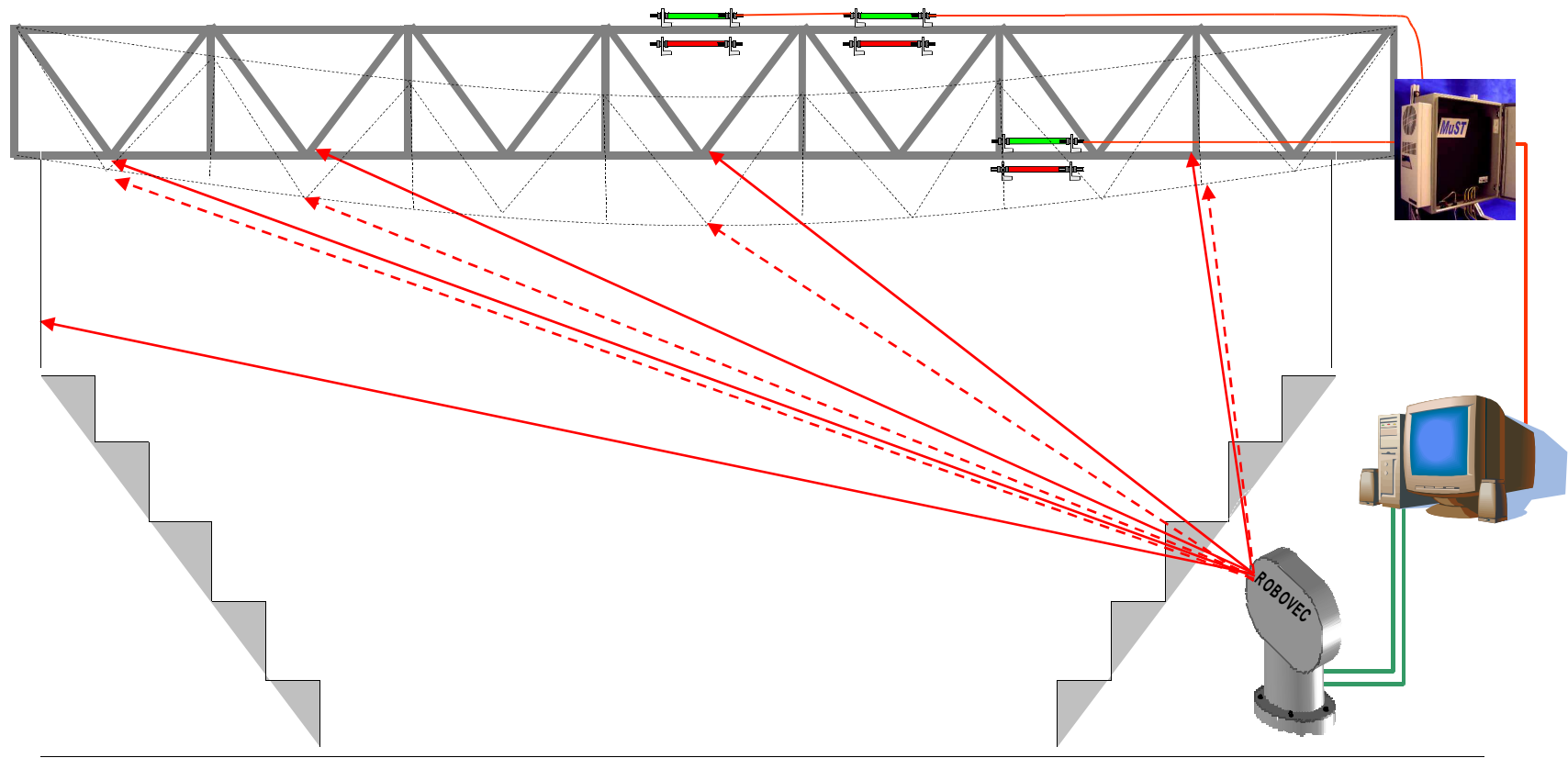
- Long-term monitoring during the service
- ➔ **1 session per week to 1 session per month and yearly 24 hours continuous campaign**
  
- Special events
- ➔ **Measurements during and after strong wind, heavy rain or public events**

# ROBOVEC



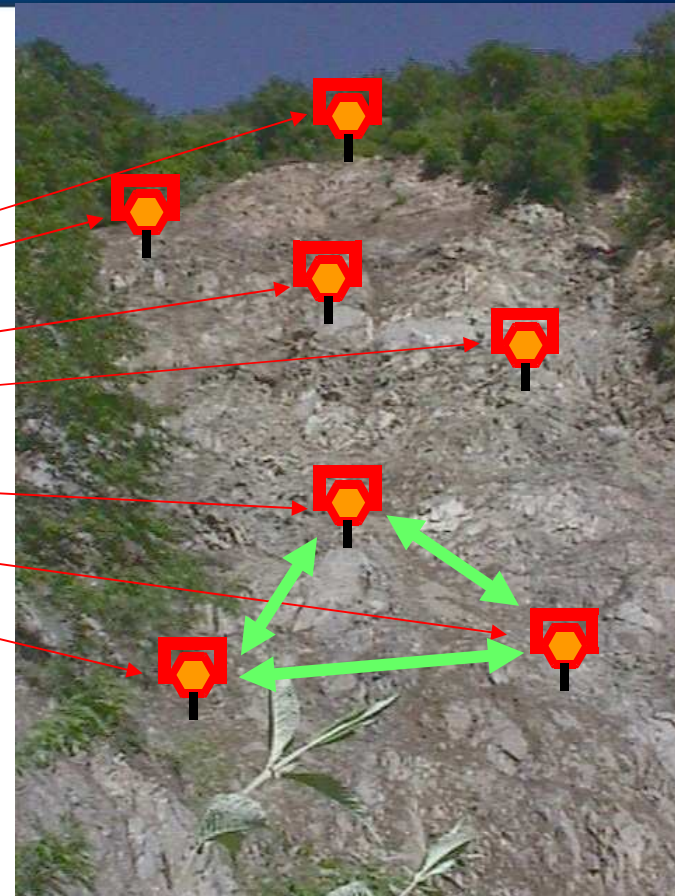
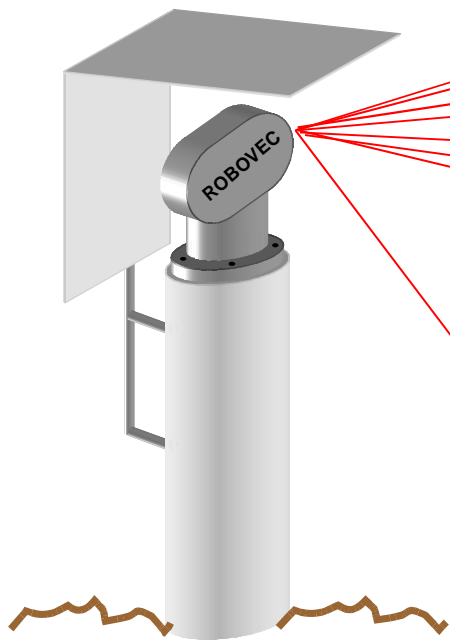
- Automatic operation
- High resolution and precision
- Auto calibration
- Max. distance ~500m
- Distance accuracy <math><1\text{mm}</math>
- Angle accuracy  $\sim 0.001^\circ$
- Compatible with SOFO<sup>®</sup> SDB

# Halifax Metro Centre - Option: Robovec

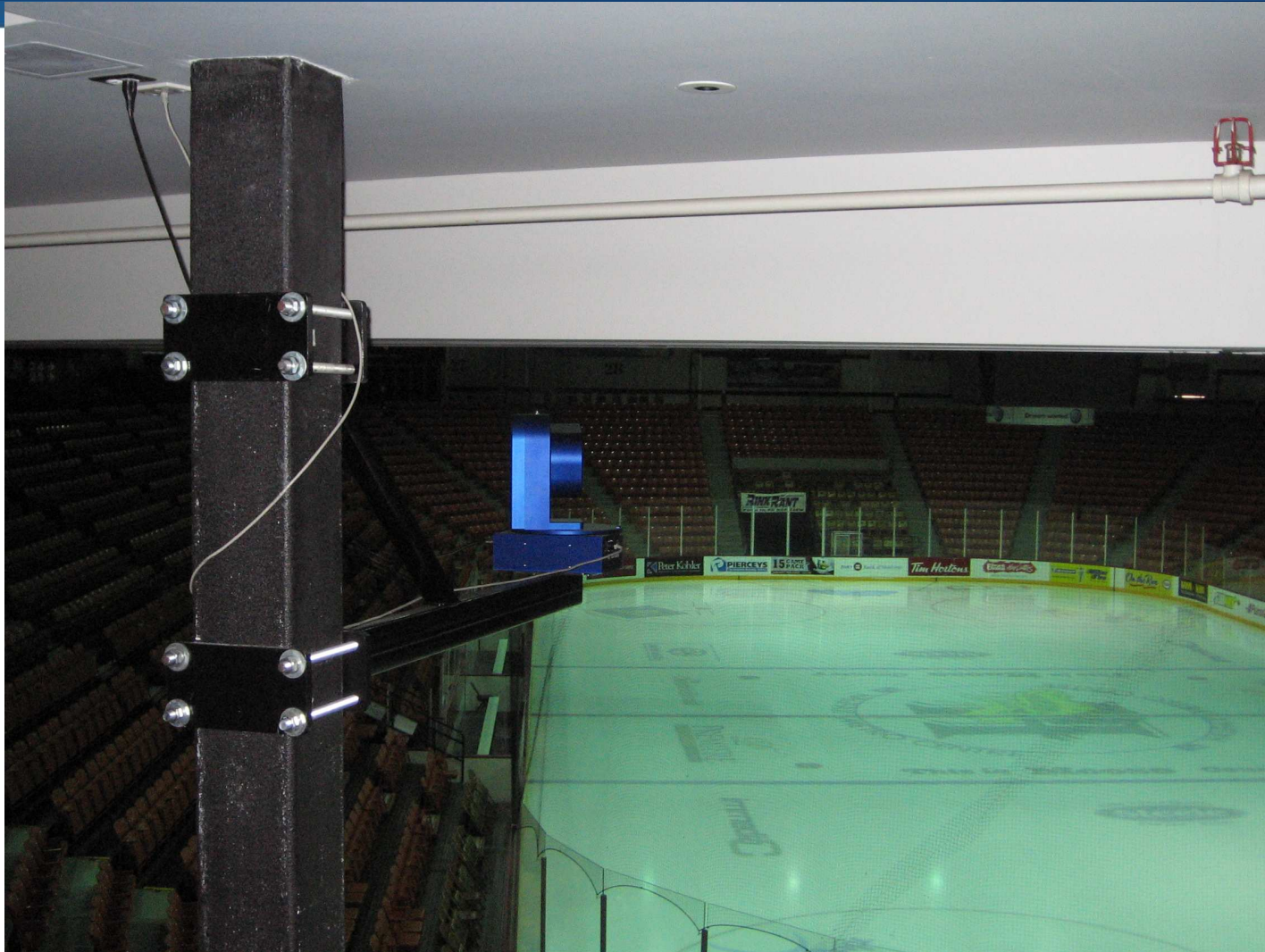


# Key features

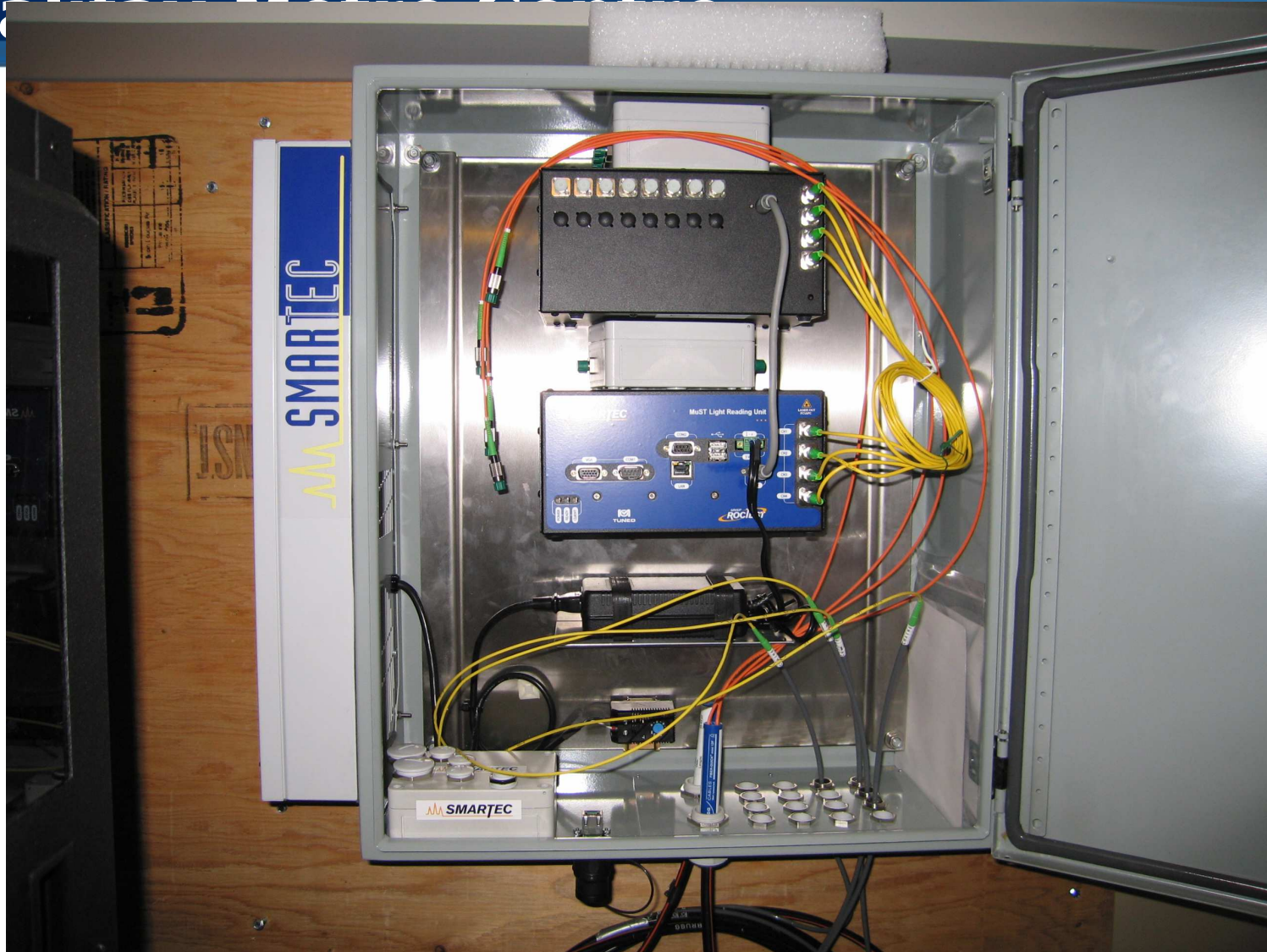
- Measurements on N points
- Measurements correction with control point(s)
- Relative displacements between points (target center finder algorithm)



# Halifax Metro Centre



# High-Multi-Color



# Halifax Metro Centre





# Halifax Metro Centre



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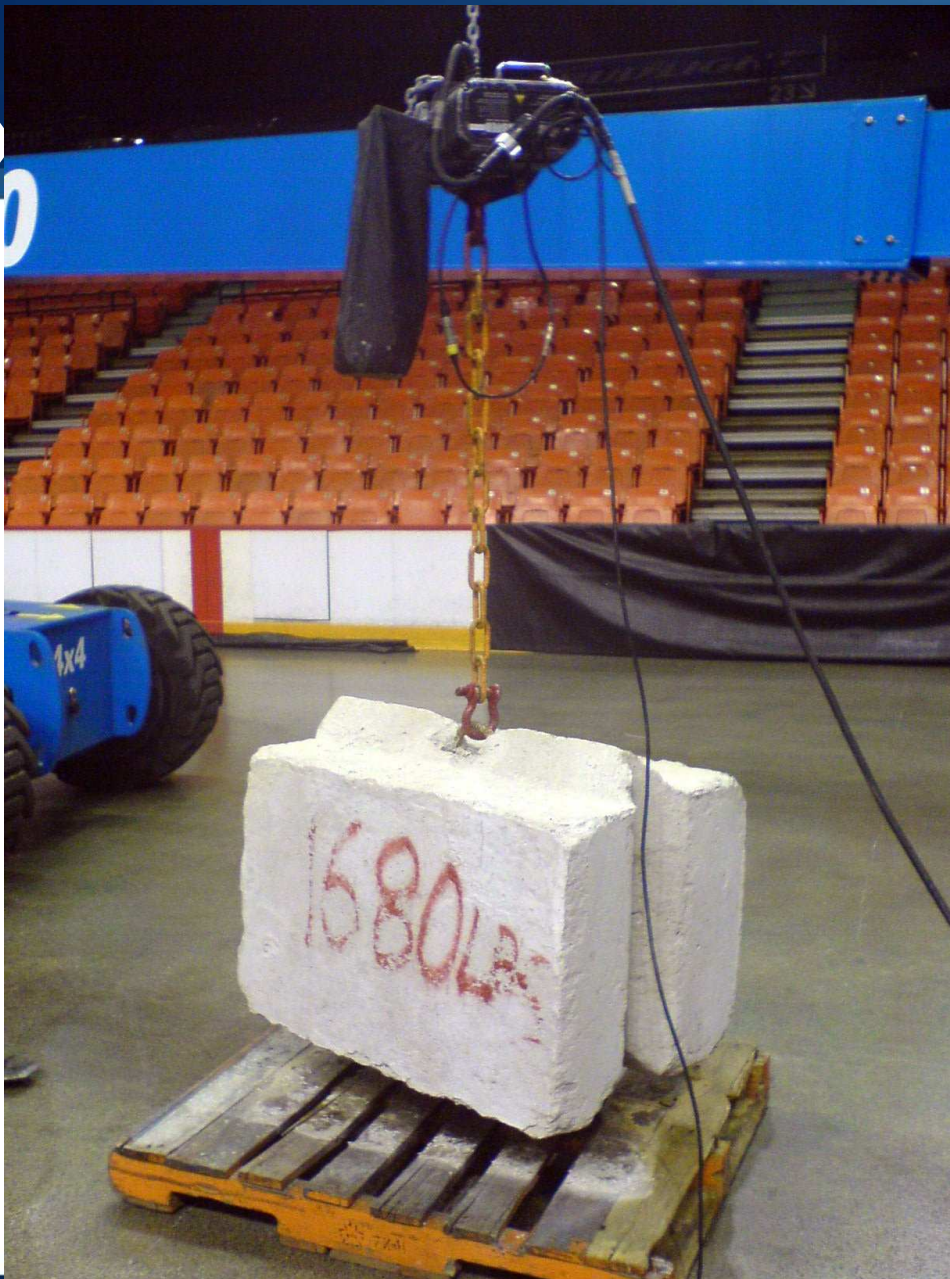
# Halifax Metro Centre



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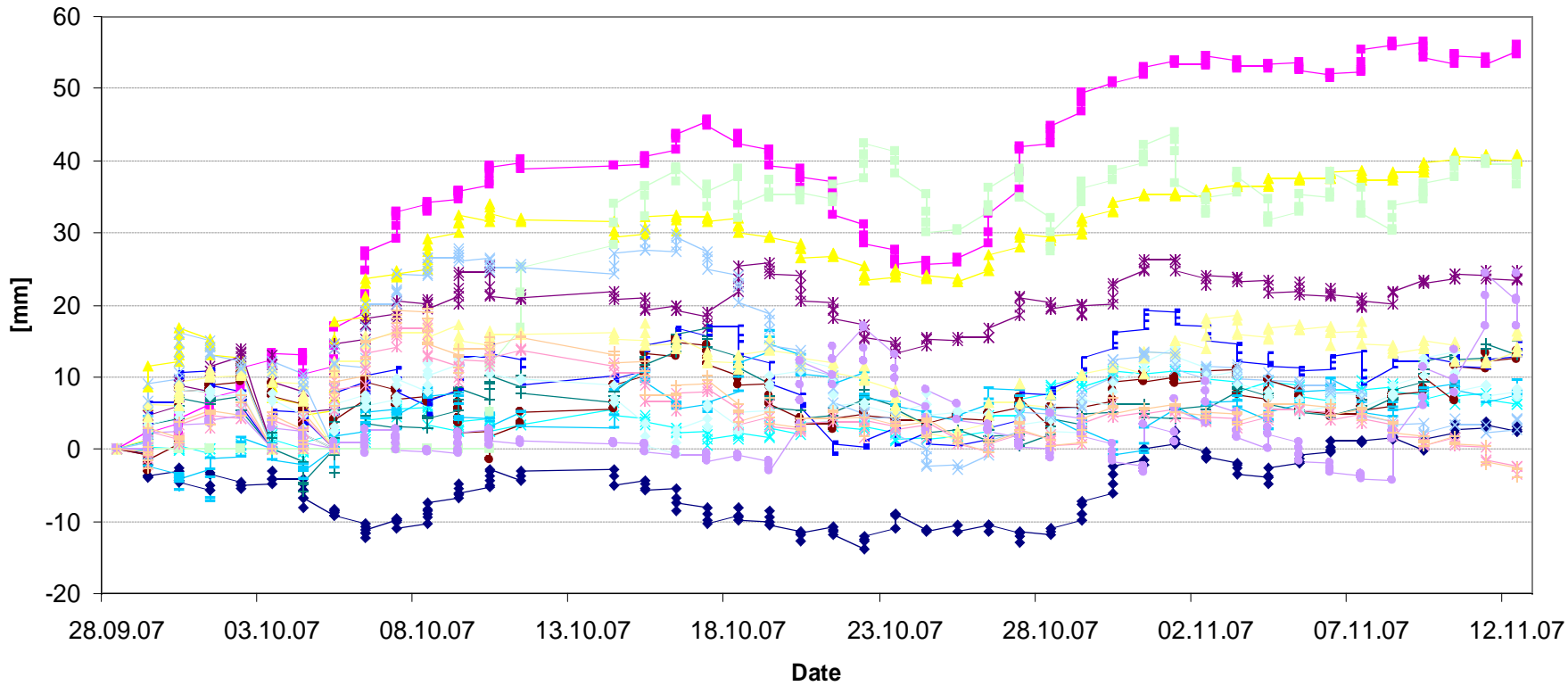


Halifax



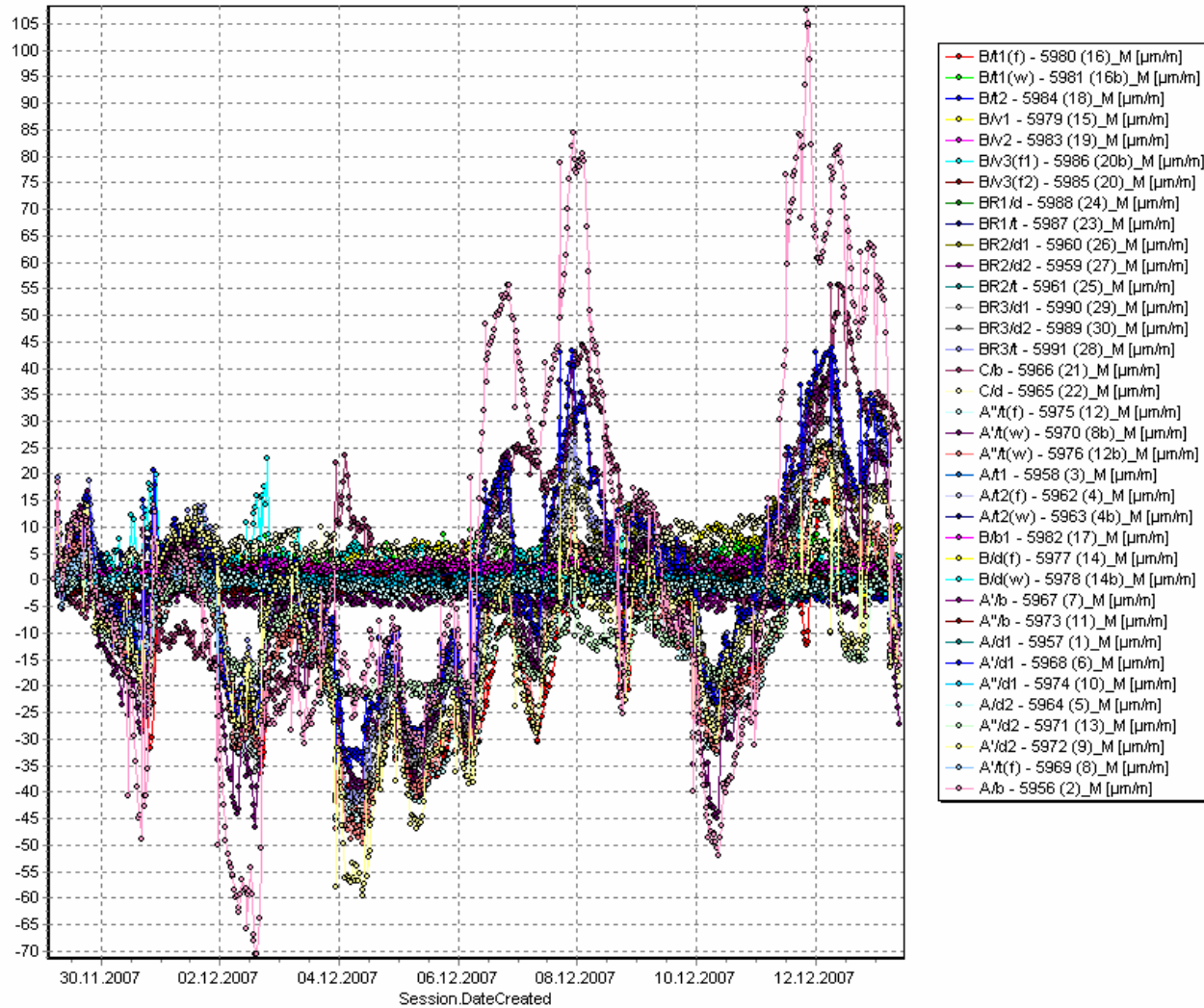
# Monitoring results: ROBOVEC

## Halifax Metro Centre, Deflections [mm]



- ROB\_(01)\_defl [mm]
- ROB\_(02)\_defl [mm]
- ROB\_(03)\_defl [mm]
- ROB\_(04)\_defl [mm]
- ROB\_(05)\_defl [mm]
- ROB\_(06)\_defl [mm]
- ROB\_(08)\_defl [mm]
- ROB\_(09)\_defl [mm]
- ROB\_(10)\_defl [mm]
- ROB\_(11)\_defl [mm]
- ROB\_(12)\_defl [mm]
- ROB\_(13)\_defl [mm]
- ROB\_(14)\_defl [mm]
- ROB\_(15)\_defl [mm]
- ROB\_(16)\_defl [mm]
- ROB\_(18)\_defl [mm]

# Monitoring results: Fiber optic sensors



# Halifax Metro Centre - Closure

**Based on SMARTeC's experience the presented monitoring system is suggested for the following highlights:**

- 1. High resolution and accuracy**
- 2. Insensitive to electro magnetic fields**
- 3. Temperature detection**
- 4. Easy and fast installation**
- 5. Provided with a comprehensive and user-friendly software for advanced data management and full alarms management capabilities.**