



Detecting intrusion pathways of soil gas to indoor air

SoBRA London December 2013

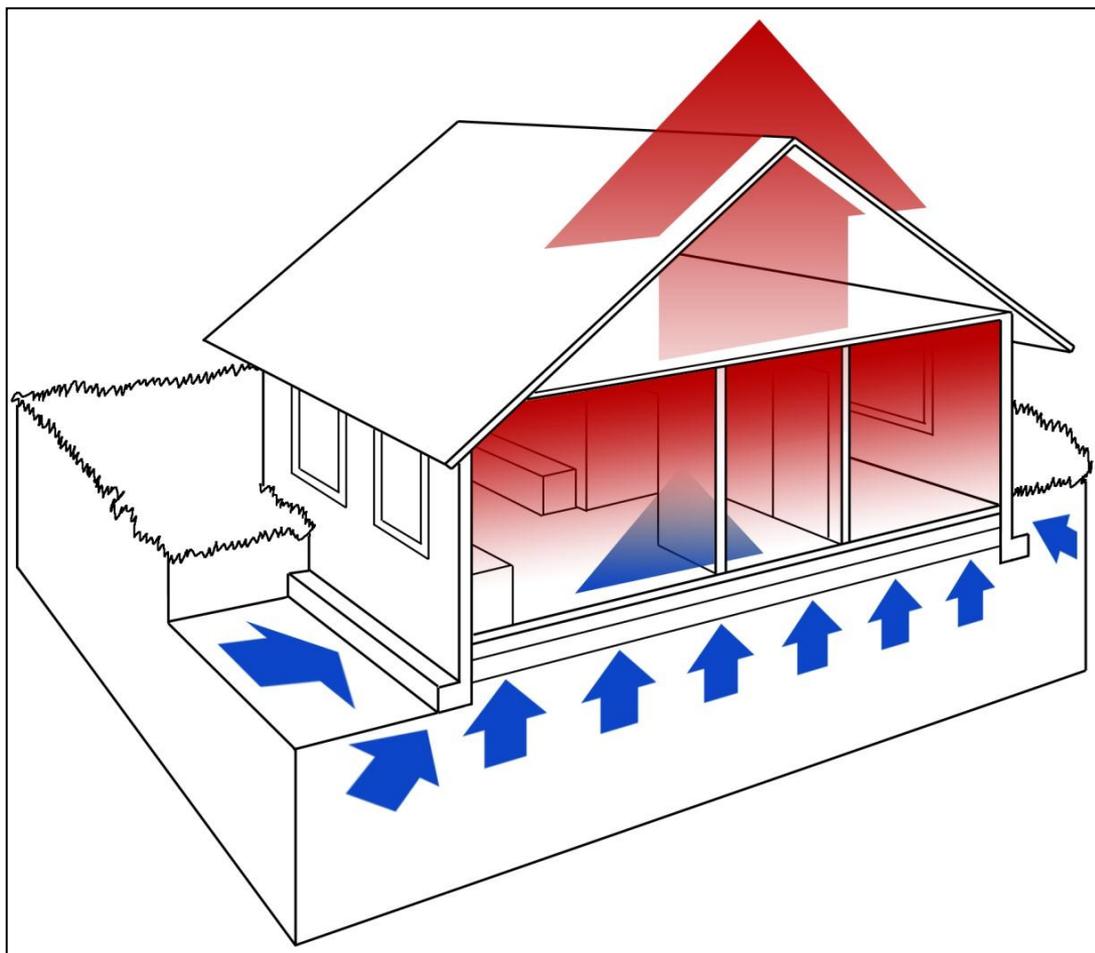
Boerge Hvidberg, Central Denmark Region

Acknowledgements

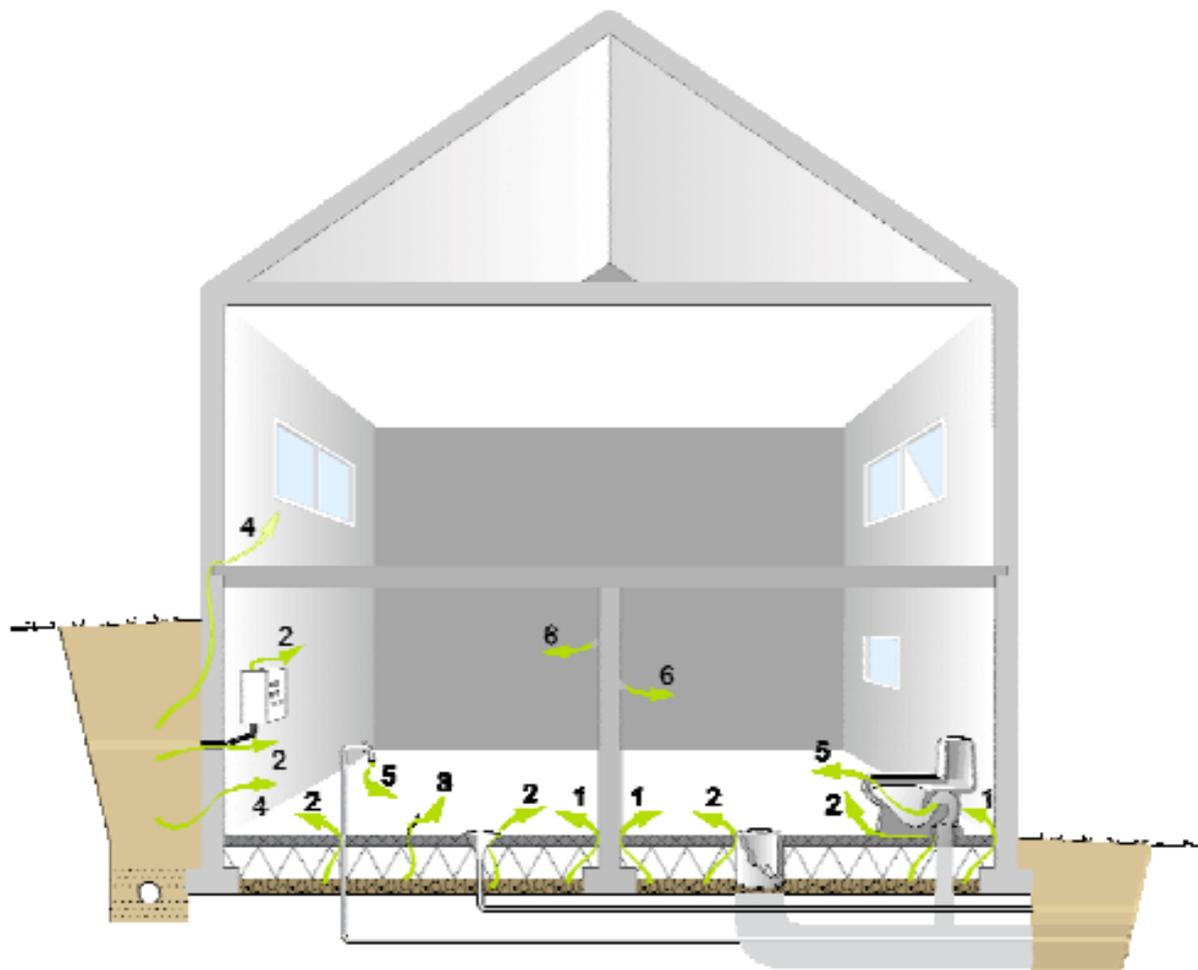
- **Results from 3 projects**
- **Performed by 2 Consultants:**
- **Niras A/S, Denmark**
 - **Mette Neerup Jepsen**
 - **Jesper Bruun Petersen**
- **Grontmij A/S, Denmark**
 - **Majbrith Langeland**
 - **Winnie Hyldegaard**
 - **Søren Kreilgaard**
- **All 3 projects funded by Danish EPA and Central Denmark Region**



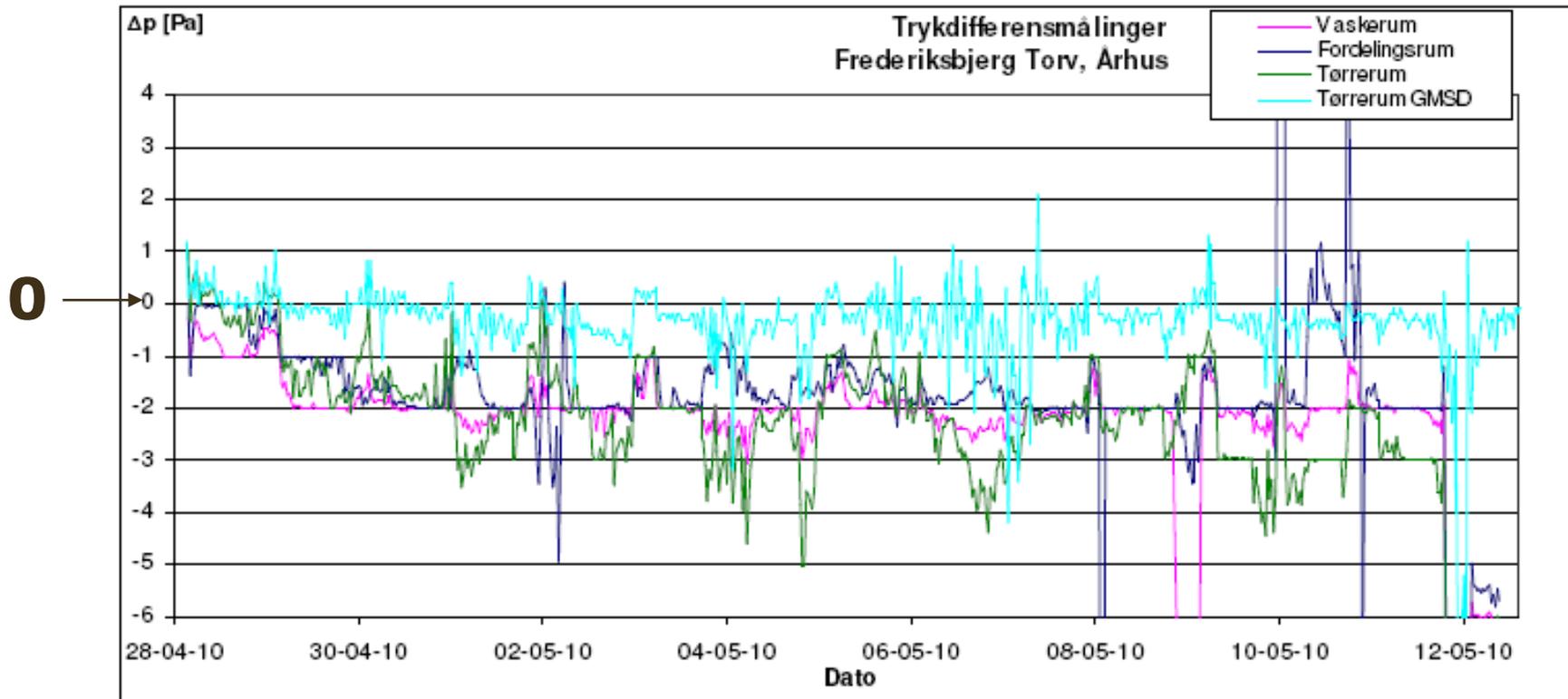
Pressure differential



Advective intrusion pathways



Pressure differential across the slab

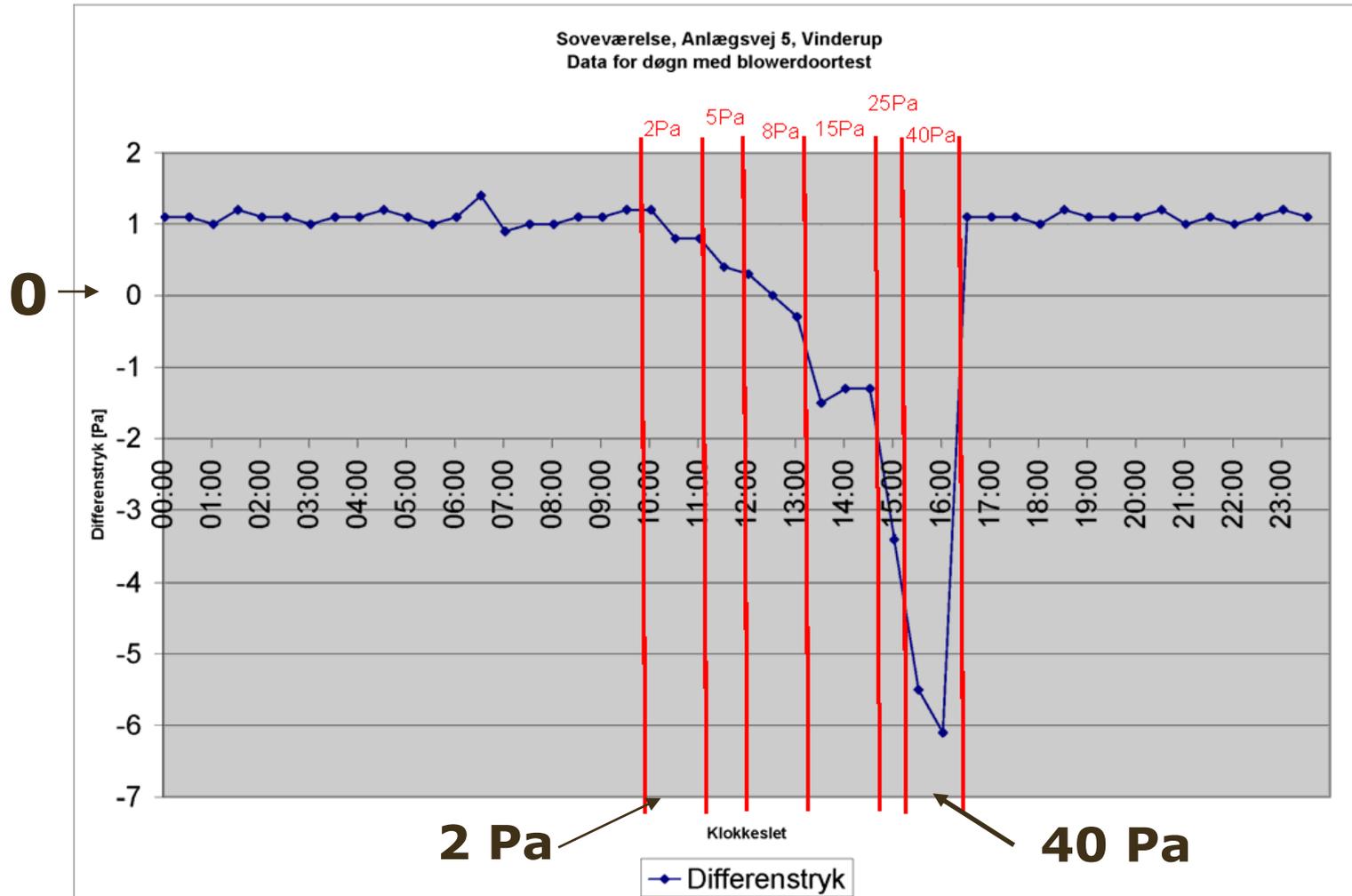


Pressure differential

- **Pressure differential can be controlled**
- **Depressurization indoor can be increased by:**
- **All fans on full power or**
- **Blower door**



Pressure differential across the slab with Blower door

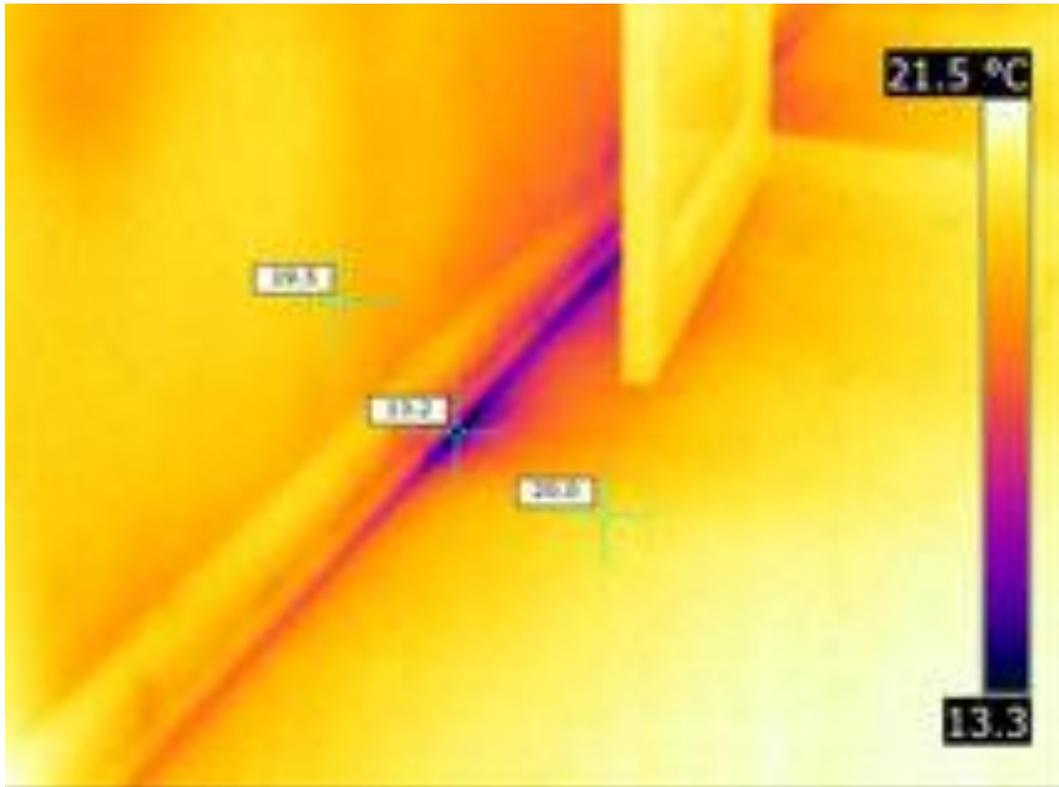


Methods for detecting intrusion pathways

- **Thermography**
- **PID (pbb)**
- **Thoron (radon)**
- **Tracer gas**

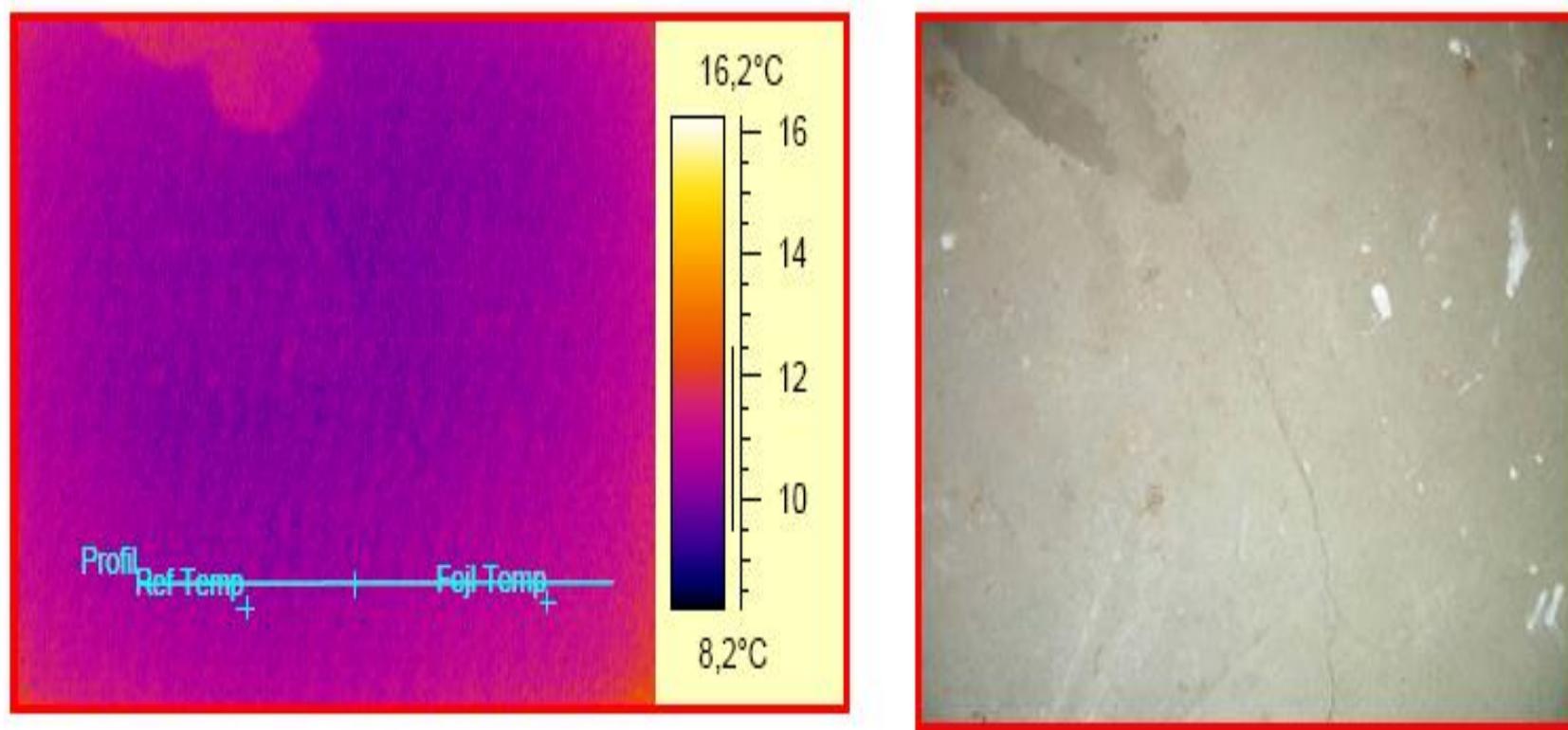
- **Air samples from sewer-lines**

Thermography (thermal imaging)



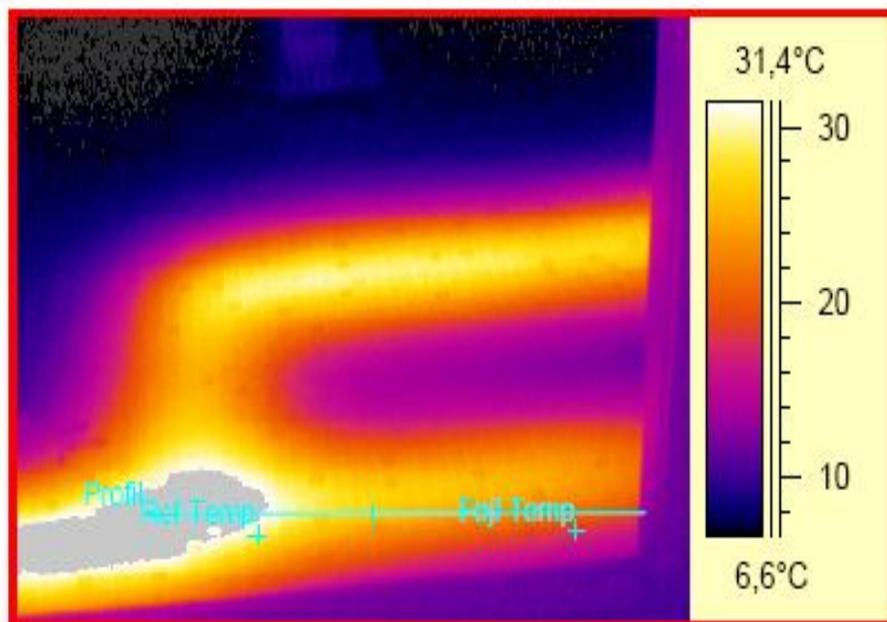
- **Cold air intrusion under wall**

Thermography (thermal imaging)



- **No indication of intrusion through visibel crack**

Thermography (thermal imaging)



- **Excellent to detect hot water pipes**

Thermography

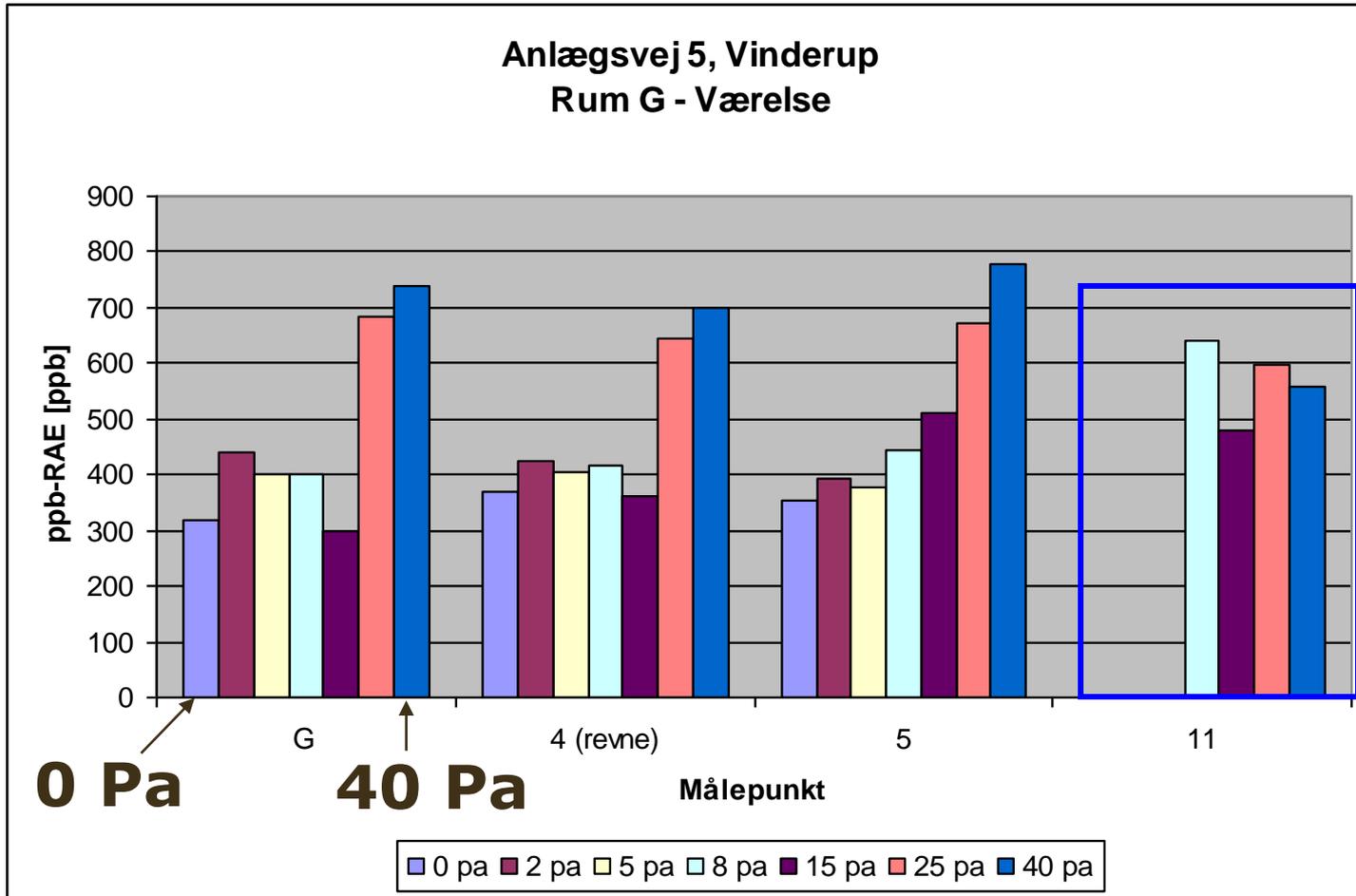
- **Detects temperature differences of 0,05-0,1 °C**
- **Can map location of hot water tubes in concrete slab**
- **Not able to detect intrusion pathways in this projects**

PID

- **High sensitive PID (pbb-Photo Ionization Detector)**
- **Measurements in 2-5 seconds**
- **Well known technique**
- **Responds on "all" gases => risk for false positive**



PID pbb-RAE and blower door



PID

- **Effective in detecting intrusion pathways with VOC's (Volatile Organic Compounds)**
- **Fast**
- **Can be used as a sniffer**
- **Cost effective**

- **False responds from gases**
- **Does not detect intrusion pathways without VOC's**

Thoron (radon)

- **Radon is a radioactive gas, half-life 3,8 days**
- **Thoron is a radon isotope, half-life 55 seconds**
- **Thoron is naturally occurring like radon (almost) everywhere**
- **Thoron is measured with a specialized radon monitor**

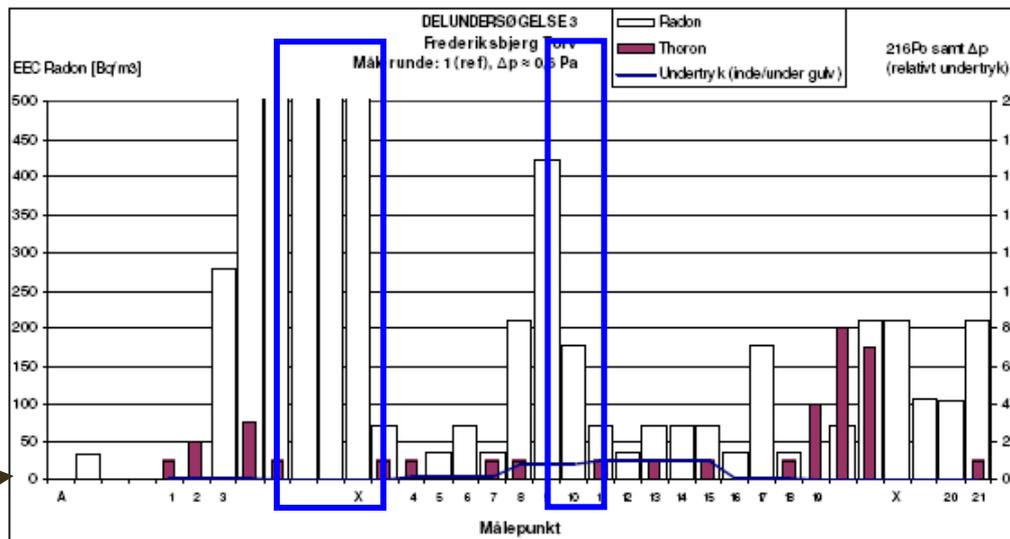
Thoron (radon)

- **Instrument: "RAD7"**
- **Detects radon and thoron**
- **Measurements in 5-15 minutes**

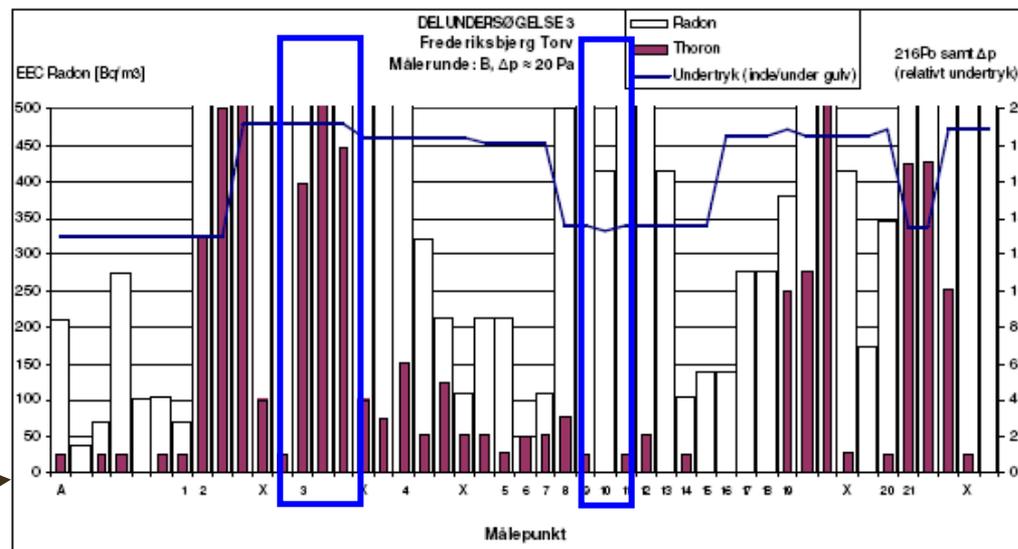


Thoron

**0 Pa
(normal)**



**20 Pa
(blower door)**



Thoron

- **Effective in detecting intrusion pathways**
- **Detects intrusion pathways with no VOC**
- **Measure at potential intrusion pathways (takes 5-15 minutes)**

Tracer gas

- **Requires injection of tracer gas**
- **Fast measurements**



Tracer gas

- **Effective in detecting intrusion pathways**
- **Fast**
- **Sniffer**
- **Detects intrusion pathways with no VOC**
- **Can be injected into sewer-pipes**

- **Injection/distribution of tracer gas sub-slab can be difficult**

Conclusion

- **Thermography:** Not able to detect intrusion pathways
- **PID:** OK when VOC, sniffer
- **Thoron (radon):** OK, detects pathways regardless of VOC, only potential pathways
- **Tracer gas:** OK, detects pathways regardless of VOC, sniffer, distribution of tracer gas sub-slab can be difficult,
- **Blower door:** Controls pressure differential, and gives a higher chance of detecting most pathways

Conclusion

- **PID gives an overview**
- **Technical structure examination**
- **PID combined with thoron or tracer gas gives a higher chance of detecting intrusion pathways**
- **Blower door will detect “all” intrusion pathways, for a larger cost**

Remediation

- **Seal the intrusion pathways with a sealant**

- **Membrane**
 - **Plastic membrane**
 - **Spray membrane**

- **New concrete slab**

Remediation

Seal the intrusion pathways

- **Radon literature: Reduces radon impact of indoor air by a factor 1-1,5**
- **Danish results: Reduces VOC impact of indoor air by a factor 1-3**
- **Reduces radon intrusion**
- **Sealing will enhance sub-slab depressurization-systems**

Remediation Membrane

- **Plastic membrane. Very difficult to seal off along walls and around pipes**
- **Spray-membrane: Good results**
- **Reduces VOC impact of indoor air by a factor 1-10**
- **Reduces radon intrusion**
- **Will enhance sub-slab depressurization-systems**

Spray-membrane



Spray-membrane



Sewer-system as a major intrusion pathway

- **Sewer-system is a major intrusion pathways in about 20% of the contaminated dry-cleaner sites in Denmark**
- **Inflow of contaminated groundwater into the sewer-lines**
- **Inflow of contaminated soil gas into the sewer-lines**
- **Sewer shafts acts like a chimney (causes depressurization)**

Sewer-system as a major intrusion pathway

- **Outflow of contaminated air from the sewer to indoor air**
- **To detect if the sewer is a major intrusion pathway:**
 - **Active sample VOC on activated carbon-tubes through water-traps in the building**
 - **Passive sample on adsorption tubes in sewer-manholes**

Sewer-system depressurization

- **Active depressurization of the sewer-system (by a fan)**
- **Reduces VOC impact of indoor air by a factor 5-200**



Thank you for your attension

- **The reports are/will be published on the Danish EPA homepage www.mst.dk**
 - **Thoron: Miljoeproject nr. 1453, 2013**
 - **Membrane: Miljoeproject nr. 1444, 2012**
 - **Termografi/PID/blower door: 2014**