# Measurements of ultrafine particulate material around Schiphol airport

E.P. Weijers **(ECN)**
M.J. Blom **(ECN)**
G.P.A. Kos **(ECN)**
J. van Laer **(VITO)**
P. Berghmans **(VITO)**
M. van Poppel **(VITO)**
M. Moerman **(TNO)**
M. Keuken **(TNO)**
J. Wesseling **(RIVM)**
A. Bezemer **(RIVM)**

April 2016
ECN-L--16-026

ECN
Your energy. Our passion.

# Measurements of ultrafine particulate material around Schiphol airport

**Ernie Weijers**, Mark Blom, Gerard Kos (ECN)
Jo van Laer, Patrick Berghmans, Martine van Poppel (VITO)
Marcel Moerman, Menno Keuken (TNO)
Joost Wesseling, Aad Bezemer (RIVM)

Netherlands Aerospace Centre
Amsterdam, 14 April 2016


www.ecn.nl

# Request Ministry of Infrastructure and Environment

"Given the existing uncertainties in the amount and distribution of ultrafine particles around Schiphol I will ask for additional measurements. With the expertise and technical capabilities present in the Netherlands it should be possible to obtain insight in the levels of ultrafine particles around Schiphol within a relatively short time. This will provide a more detailed picture of the (difference in) exposure to ultrafine particles in the vicinity of Schiphol."

"The first phase of the research can be expected to be completed by summer 2015. This phase will include an inventory of available knowledge and exploratory measurements of ultrafine particles to obtain a sufficient understanding of the levels around Schiphol."

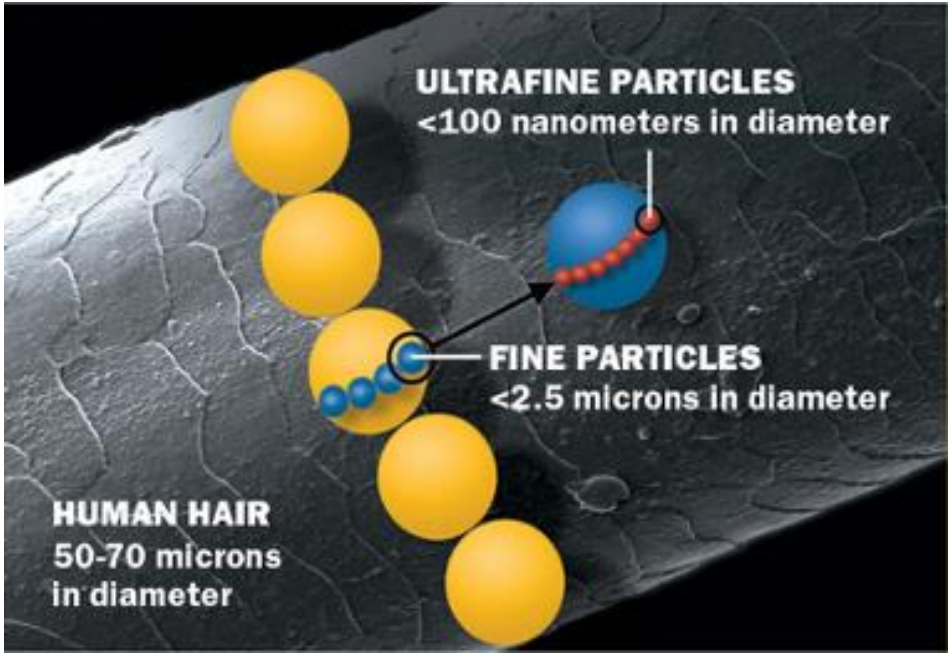
# Research

- Steps:
  - Literature search for data on emissions, distribution and concentration distribution of ultrafine particles in the vicinity of airports;
  - Literature search for knowledge in the field of potentially harmful effects of ultrafine particles in the air around airports in relation to effects on health of residents in that area;
  - Exploratory measurements of ultrafine particles in the vicinity of Schiphol;
  - Generalization of the results to an annual average concentration distribution of ultrafine particles for the area around Schiphol using model calculations.

# Further contents

- What is particulate matter and how do ultrafine particles fit in?
- Design of the campaign
- Results of the measurements
  - i. mobile
  - ii. fixed
- Conclusions

# Small, Smaller, Smallest




Coarse particles: “PM10”

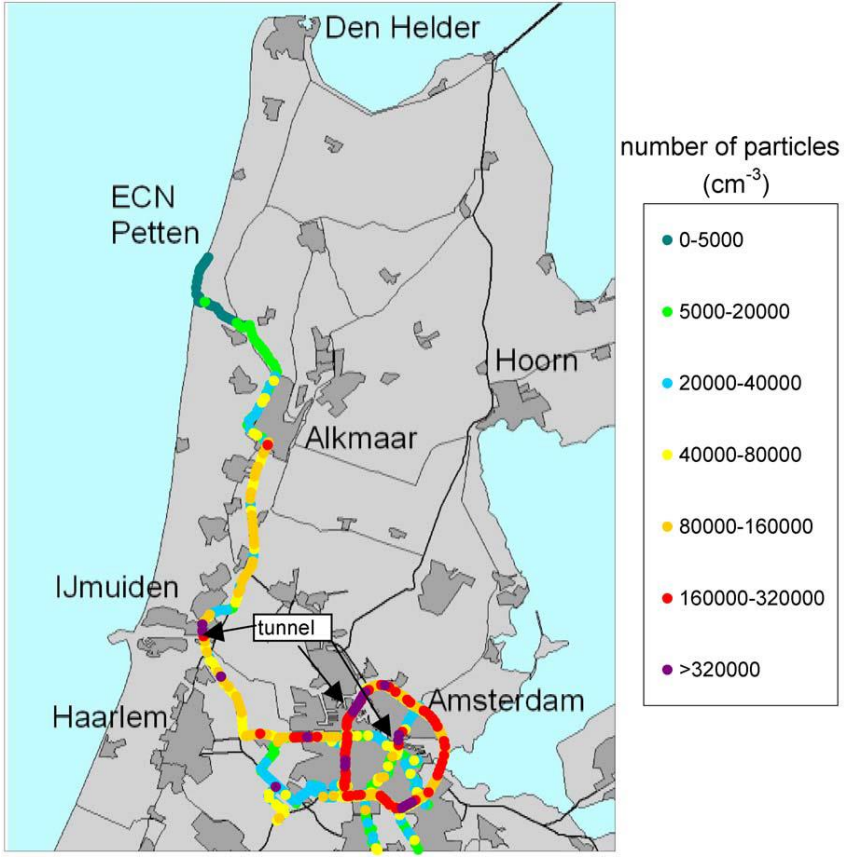
Fine particles: “PM2.5”

Ultrafine particles: “PM0.1”

# What do we know about ultrafines?

- Concentrations of ultrafine particles observed in general
- Large variation depending on location, time of the day, time resolution and instrument used
- Ultrafines ‘stick’ to their source

| Locatie en bron | Typical particle numbers (1000 #/cm³) |
|---|---|
| Clean mountain air | < 1 |
| Clean office | 2 - 4 |
| Urban background (NL) | 8 (R’dam) -9.5 /22 (A’dam) |
| Urban background (EU) | 7 - 11 |
| Urban streets (NL) | 30 - 40 |
| Urban streets (EU) | 31.5 ± 16 |
| Outdoors, smog | > 50 |
| Airport near gate | 40 |
| Airport end runway (LAX) | 150 |
| Industry (melting / furnace) | 200-2700 |


Den Helder
ECN
Petten
Hoorn
Alkmaar
IJmuiden
tunnel
Haarlem
Amsterdam
number of particles
(cm-3)
0-5000
5000-20000
20000-40000
40000-80000
80000-160000
160000-320000
>320000

# Instruments

| Apparatuur | aantal | Locaties | | | |
|---|---|---|---|---|---|
| **SMPS/UFP (aantal/diam)** | 4 | Nieuwe Meer/ Schiphol Noord (ECN) | Oude Meer NH2 (ECN) | Amsterdamse Bos (TNO) | Polderbaan Zuid NH1 (VITO) |
| **CPC/EPC (aantal)** | 4 | Nieuwe Meer/ Schiphol Noord (ECN) | Spaarnwoude (ECN) | Amsterdamse Bos (TNO) | Polderbaan Zuid NH1 (VITO) |
| **miniDISCs (aantal/diam)** | 5 | Amstelveen (RIVM) | Hoofddorp (RIVM) | Vijfhuizen/ Schiphol West (RIVM) | Spaarnwoude (VITO) 2x |
| **Aerasense (aantal/diam)** | 2 | Rozenburg/ Schiphol Zuid (VITO) | Badhoevedorp (RIVM) | | |
| **MAAP (BC)** | 2 | Nieuwe Meer/ Schiphol Noord (ECN) | Amsterdamse Bos (TNO) | | |

18 instrumenten in totaal
Alle meten aantallen
14 meten grootte
2 Black Carbon

10 locaties in totaal
4 scientific
6 “eenvoudig”

# Time schedule

2015

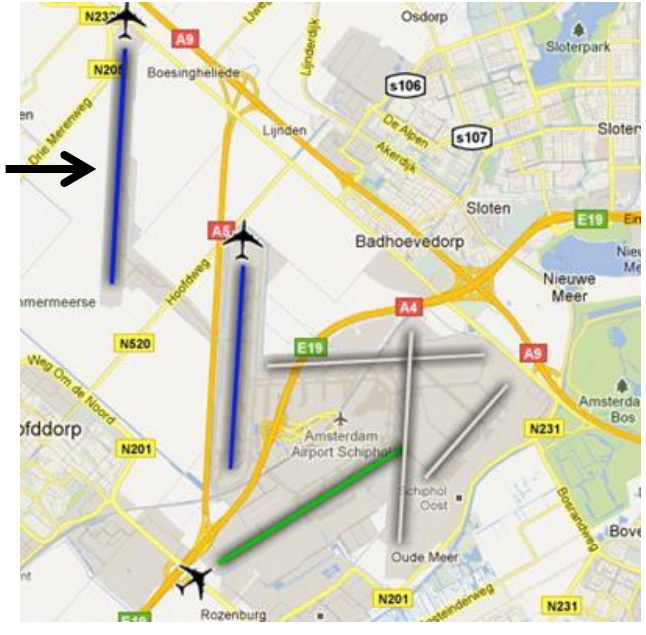
- 1 April: comparison of all the instruments

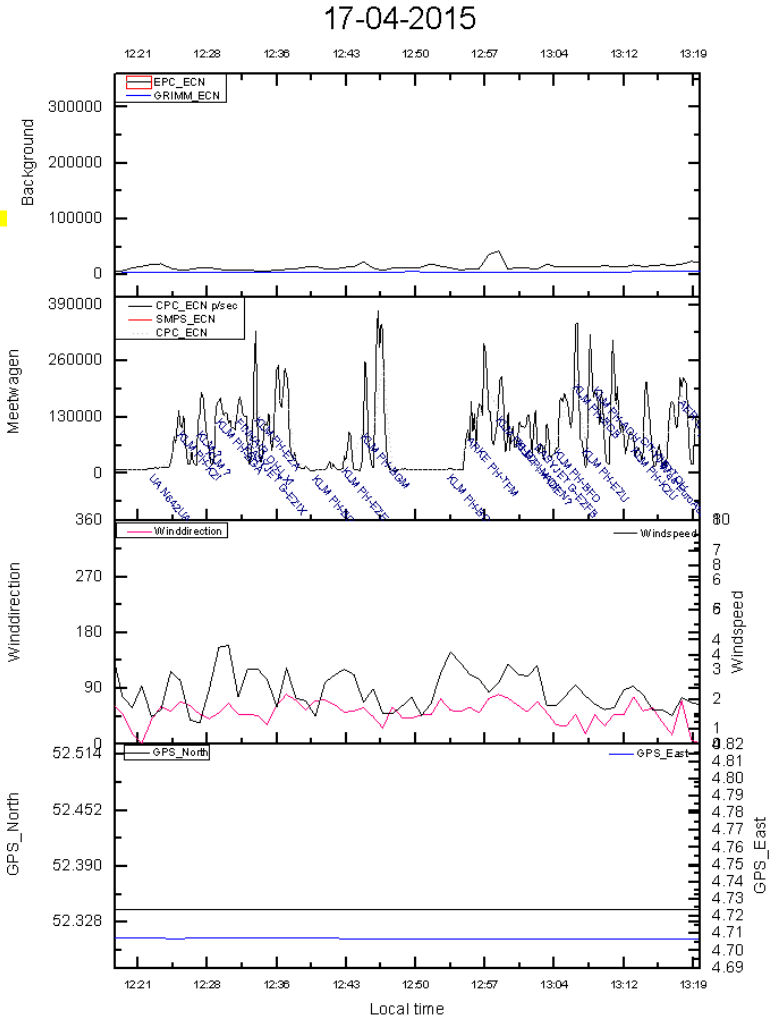
- > 1 April: ‘mobile’
  - 11 days in total with two mobile stations
  - Along runways for measuring the aircraft emission plumes
  - Up- and downwind to estimate the contribution

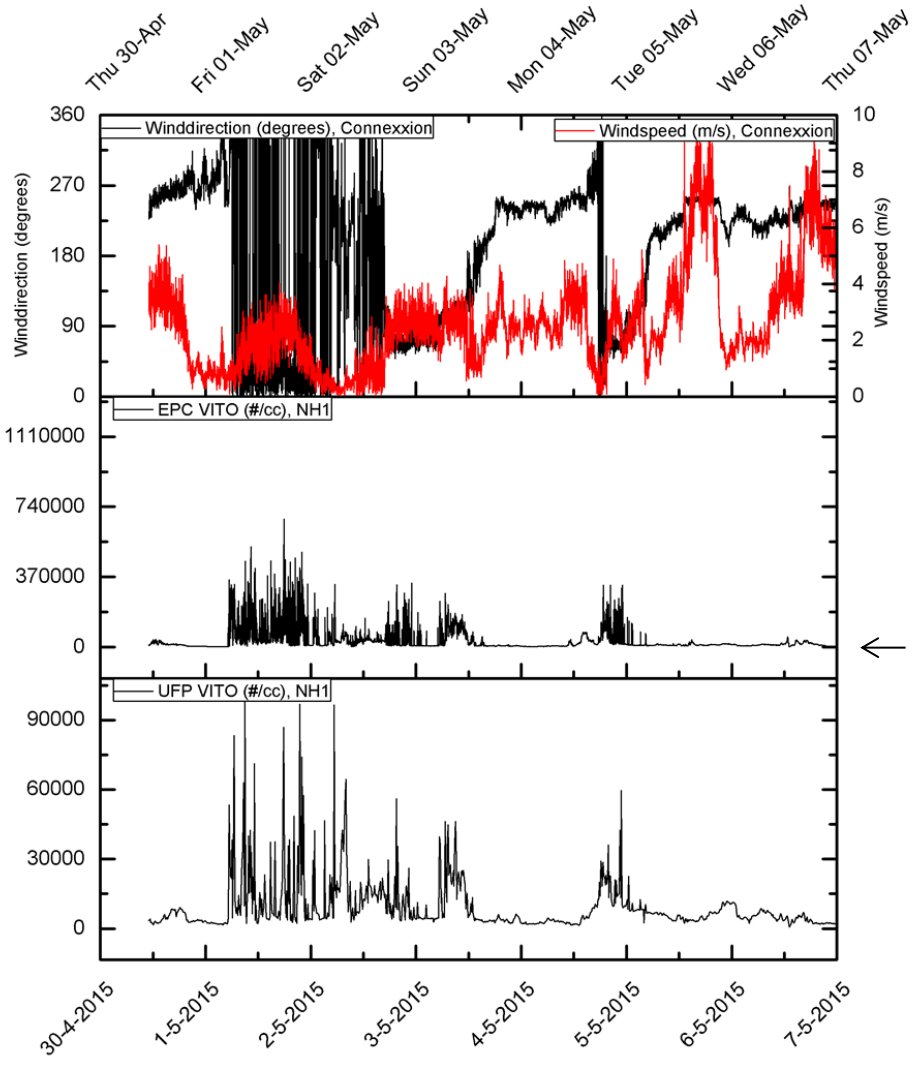
- > 1 May: ’fixed’
  - Observations at fixed sites during roughly a month
  - Average number concentrations around Schiphol and in populated areas
  - Hours of measurements vary between 300 and 1300

# ‘mobile’: example 1

- 17 april: Polderbaan



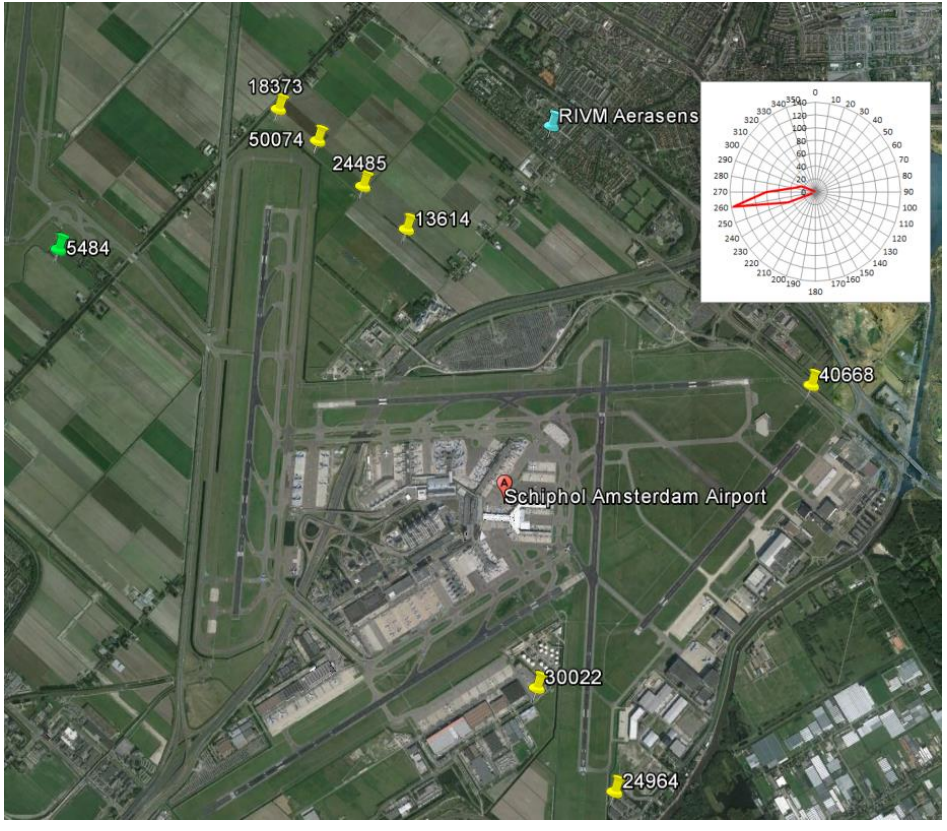





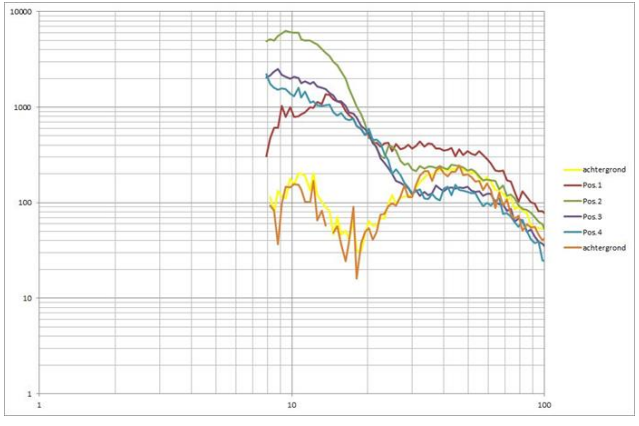


Basislijn: ca. 12000 /cm^3

# ‘mobile’: example 3



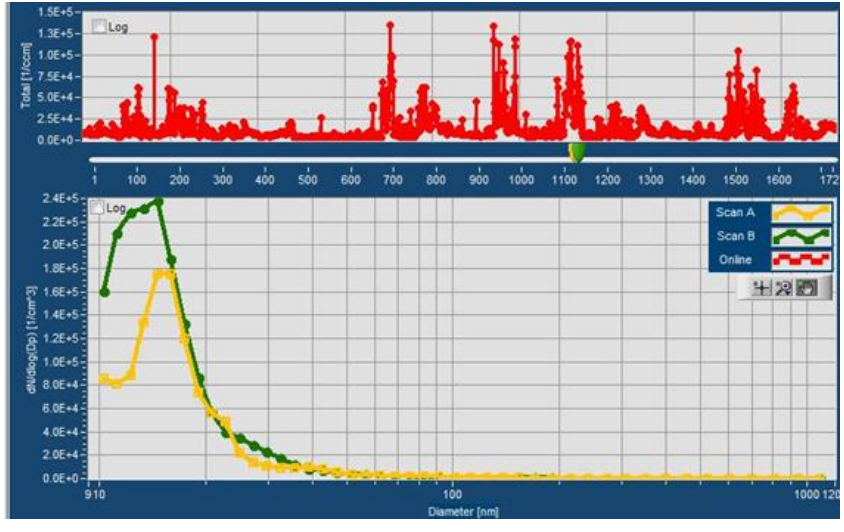

DD=260;ff 3.5-6 m/s

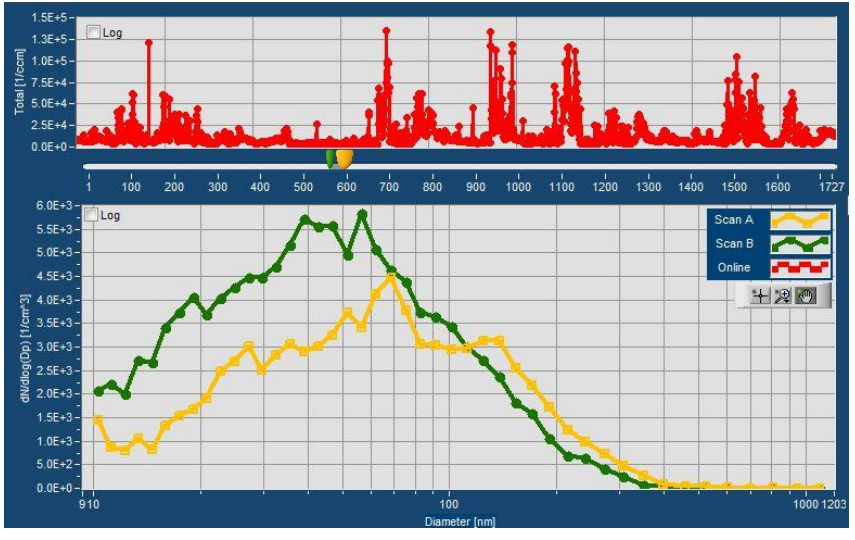


# ‘mobile’: example 4

**Downwind: Schiphol Noord**

- Display spectra Grimm  SMPS: size distribution

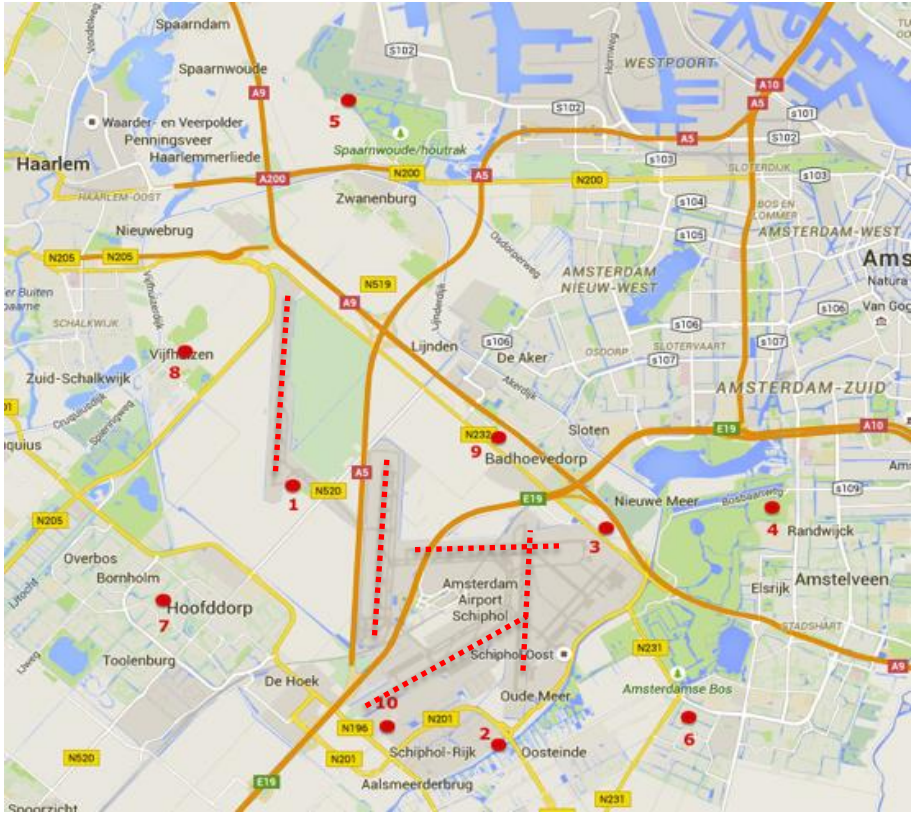


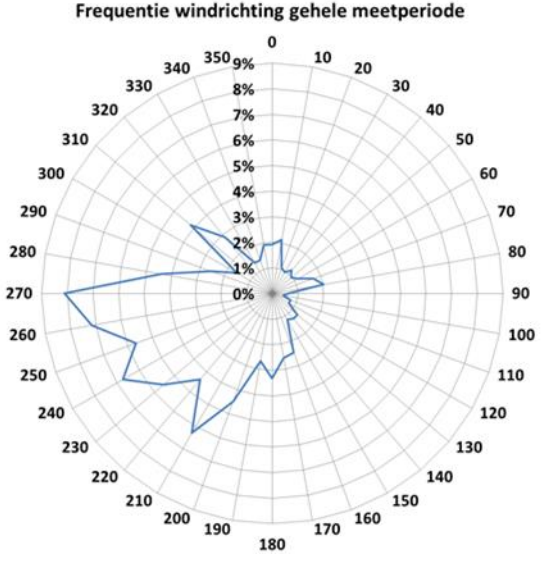
# ‘Fixed’ measurements

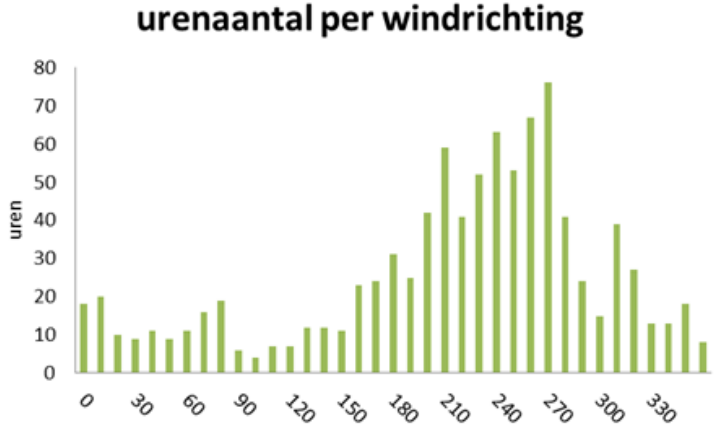
**VASTE MEETLOCATIES**

| | |
|---|---|
| 1. Polderbaan Zuid (NH1) | VITO |
| 2. Oude Meer (NH2) | ECN |
| 3. Nieuwe Meer/ Schiphol Noord | ECN |
| 4. Amsterdamse Bos | TNO |
| 5. Spaarnwoude | ECN |
| 6. Amstelveen | RIVM |
| 7. Hoofddorp | RIVM |
| 8. Vijfhuizen | RIVM |
| 9. Badhoevedorp | RIVM |
| 10. Rozenburg / Schiphol Zuid | VITO/ ECN |

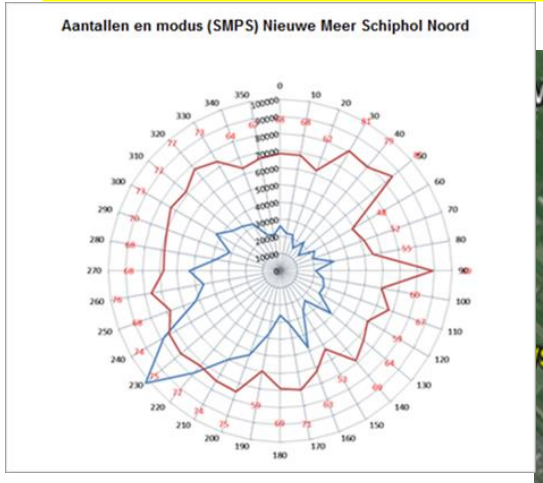


# Meteorology

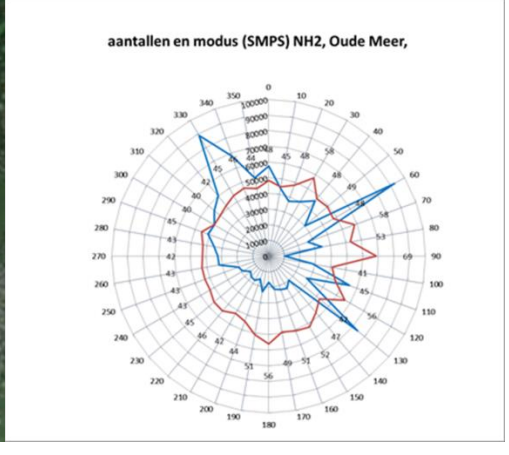


# ‘Fixed’: example 1



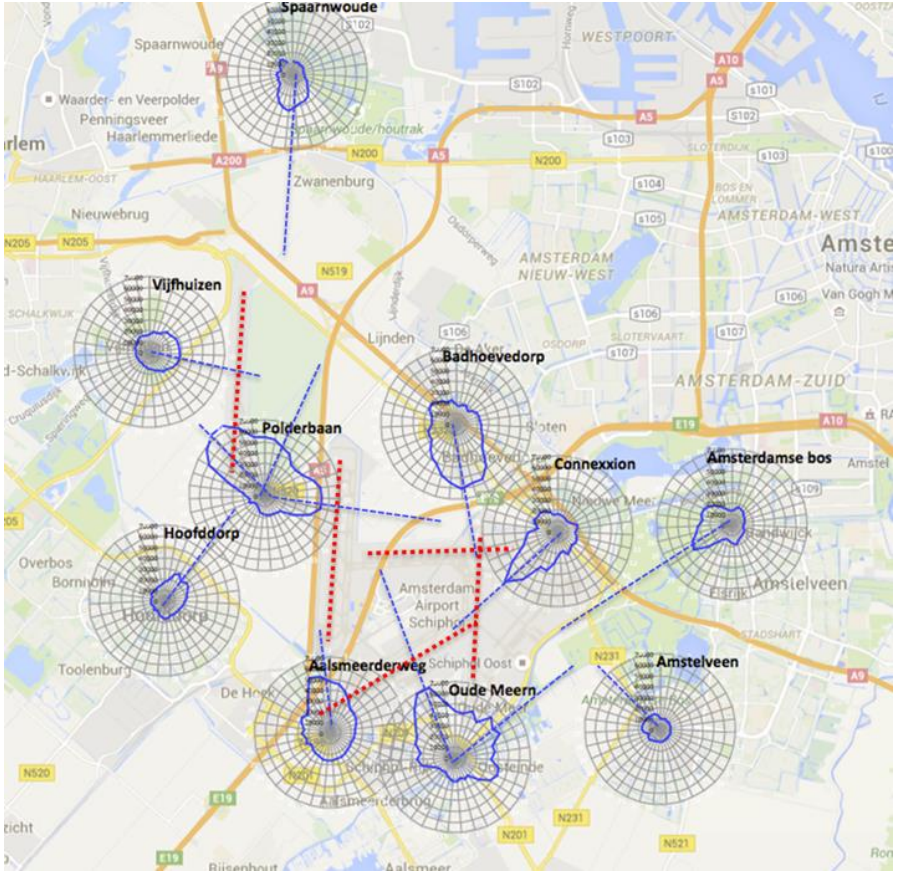




# ‘Fixed’: averages per site

**Results**

| Location | Ultrafine (x1000) |
|---|---|
| 1. Polderbaan | *27,8* |
| 2. Oude Meer | *31,7* |
| 3. Connexxion | *46,5* |
| 4. Amsterdamse Bos | 22,5 |
| 5. Spaarnwoude | 17,1 |
| 6. Amstelveen | 11,9 |
| 7. Hoofddorp | 15,3 |
| 8. Vijfhuizen | 14,9 |
| 9. Badhoevedorp | *30,6* |
| 10. Aalsmeerderweg | *29,9* |

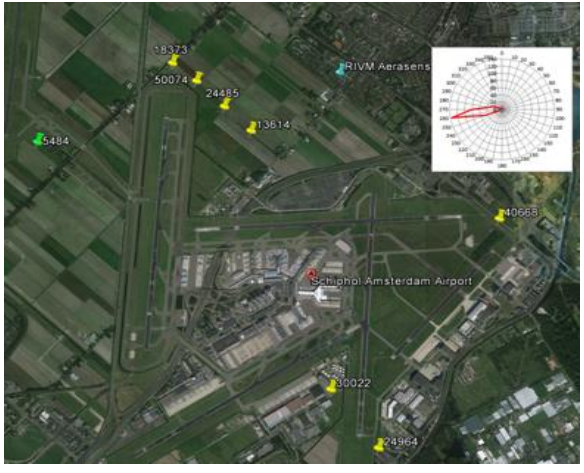



Source: RIVM

# Concluding (1)

Mobile measurements

- The highest contributions are observed next to the runway. Averaged over 10 seconds, the numbers are approximately 200,000 to 300,000 particles per $cm^3$.
- The particle numbers decrease with increasing distance from the source. One day the numbers decreased from 200,000 particles per $cm^3$ next to a runway to 20,000 approximately 5 km away.
- Aircraft emissions are distinguished from other sources by the very small particle sizes, which are observed around Schiphol. Dominant particle size between 10 and 20 nm



# Concluding (2)

- Ultrafine concentrations are elevated around Schiphol airport confirming what is observed near other airports (but literature is scarce)
- Estimated as annual averages, concentrations near the airport appears comparable to road traffic in inner-cities streets (~15.000 $cm^{-3}$); at 15 km contribution decreased to some 20% (presentation Hans Erbrink this afternoon)
- No studies found about health effects related to long-term exposure to UF emitted from aircraft similar for other emission sources
- A follow-up study will be proposed

Questions?

*Email: weijers@ecn.nl*

**ECN**
Westerduinweg 3
1755 LE Petten
The Netherlands

P.O. Box 1
1755 ZG Petten
The Netherlands

T +31 88 515 4949
F +31 88 515 8338
info@ ecn.nl
www.ecn.nl