Ricardo
Energy & Environment

Sensor Systems – Network Design and QA/QC

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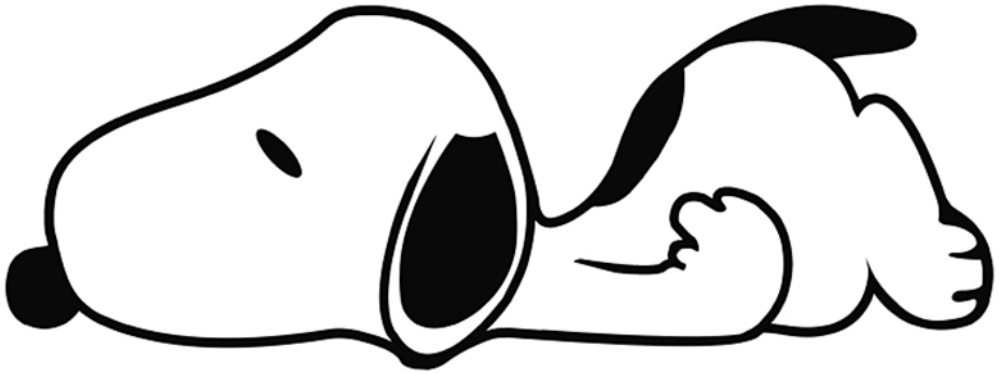
Status of Air Quality Sensors and their use in (official) monitoring strategies, 13 Feb 2017

Discussion points

- Compliance monitoring overview
- Sensor systems – filling the gaps?
- QA/QC – different layers of robustness?
  - *Before use*
  - *Characterisation*
  - *Ongoing*
- Discussion points



Compliance monitoring

2008/50/EC etc. Set out requirements for monitoring networks: how, where, how many, what…

Necessarily restricting: needs to be “representative” and meet DQO requirements

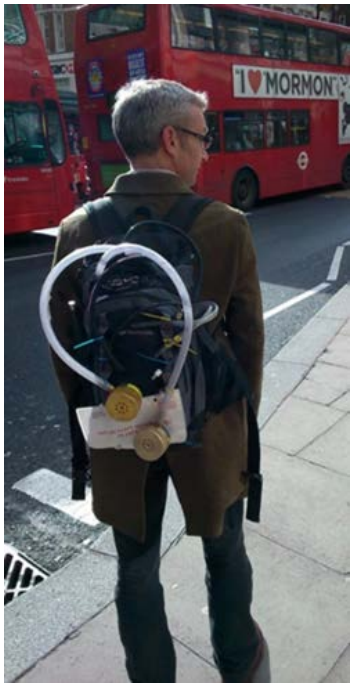
But limits usefulness.

- *Relatively small station numbers*
- *Rigidly fixed locations and types*
- *Long time resolution (10/15 mins)*
- *No individual exposure*
- *No indoor assessment*

All conspire to limit information gathered about how exposure varies both temporally and spatially

Can sensor systems fix this?

Sensor Networks

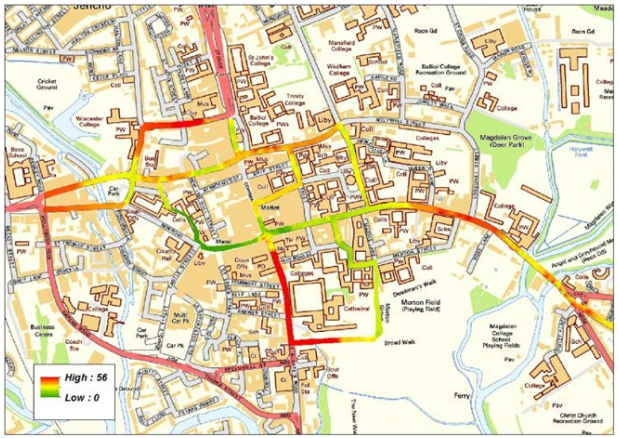


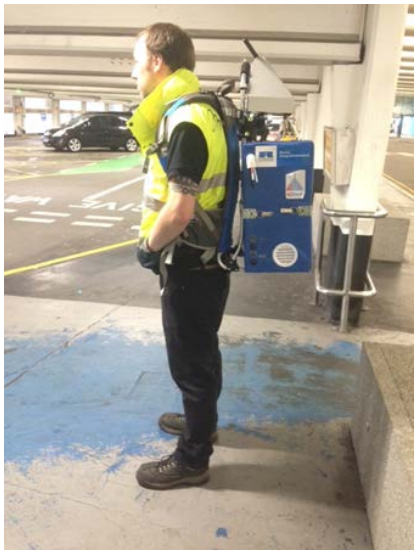
Possibly…

- (Many) sensor systems are cheap, have modest power needs and make promises about performance
- Low price makes it possible to consider a wide range of different deployment regimes:
  - *Many fixed locations*
  - *Mobile measurements*
  - *Personal exposure*
  - *Indoor air assessment*

It's possible to build really pervasive low cost networks

So, what's the catch?





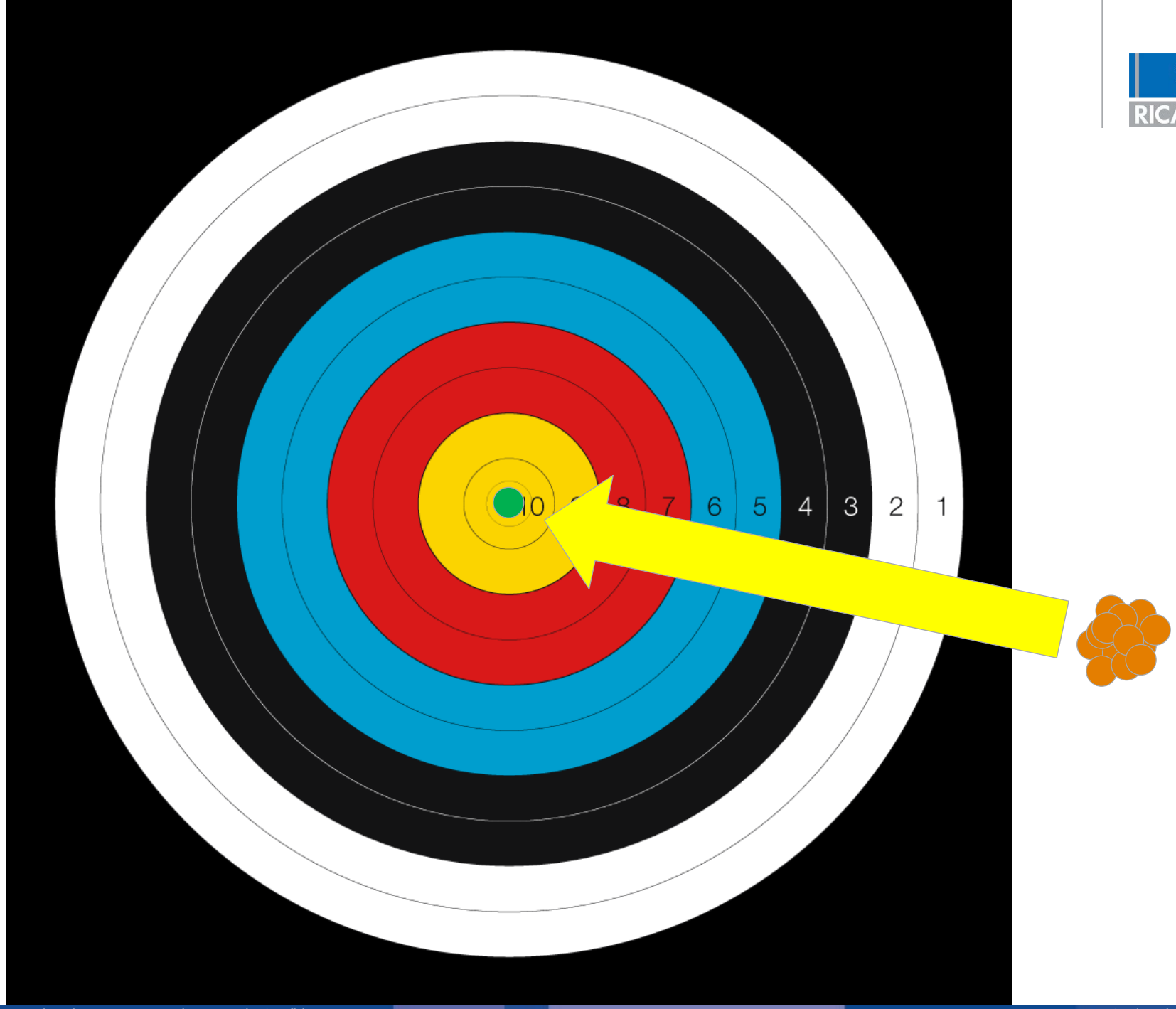
Sensor Systems – DATA QUALITY!

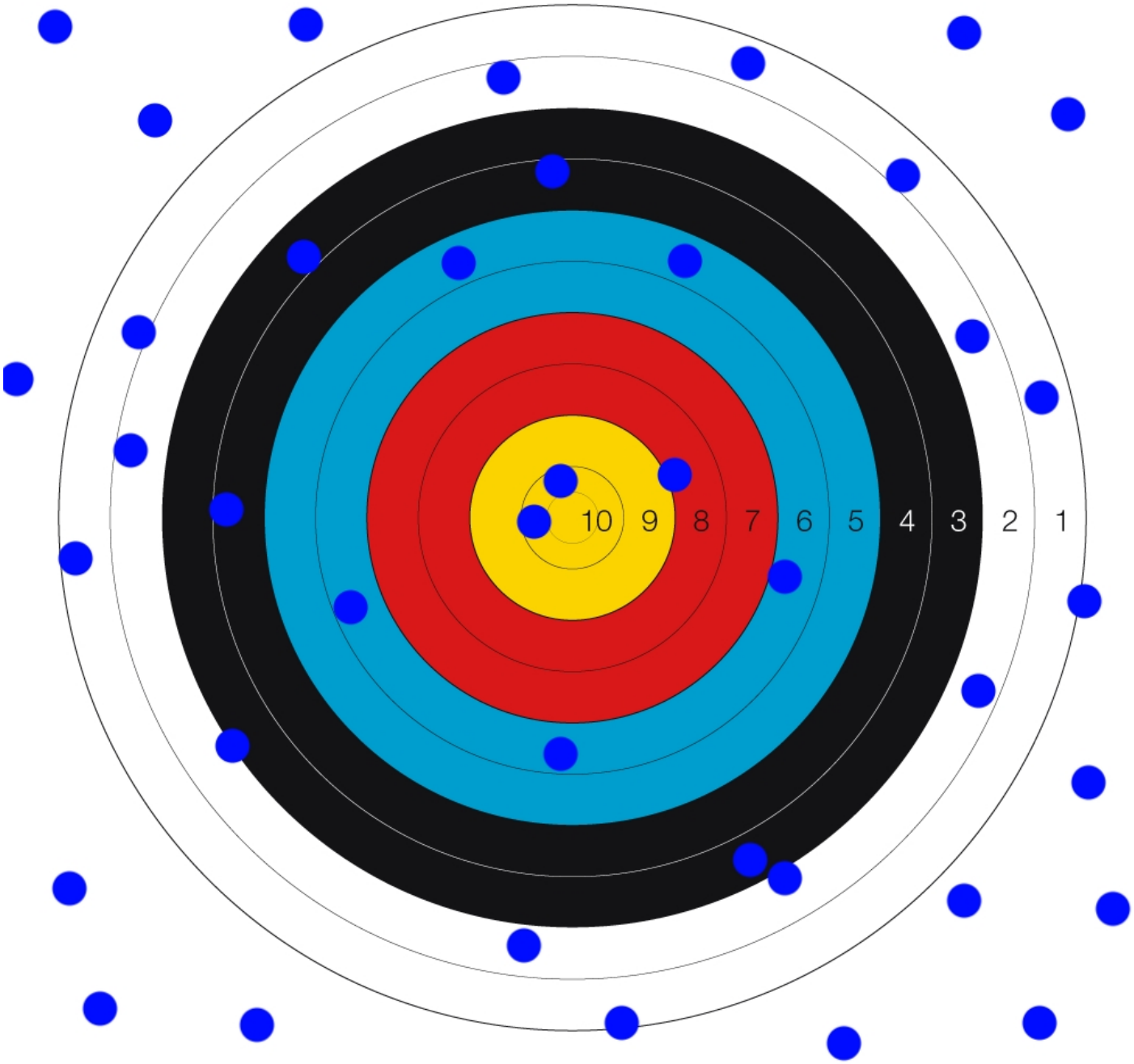
- Sensors have largely unknown measurement performance!
- Sensors can be sensitive to a wide range of cross-interferences (water, temperature, other gases)
- Sensors have no demonstrated measurement uncertainty (equivalent? indicative? objective estimation?)

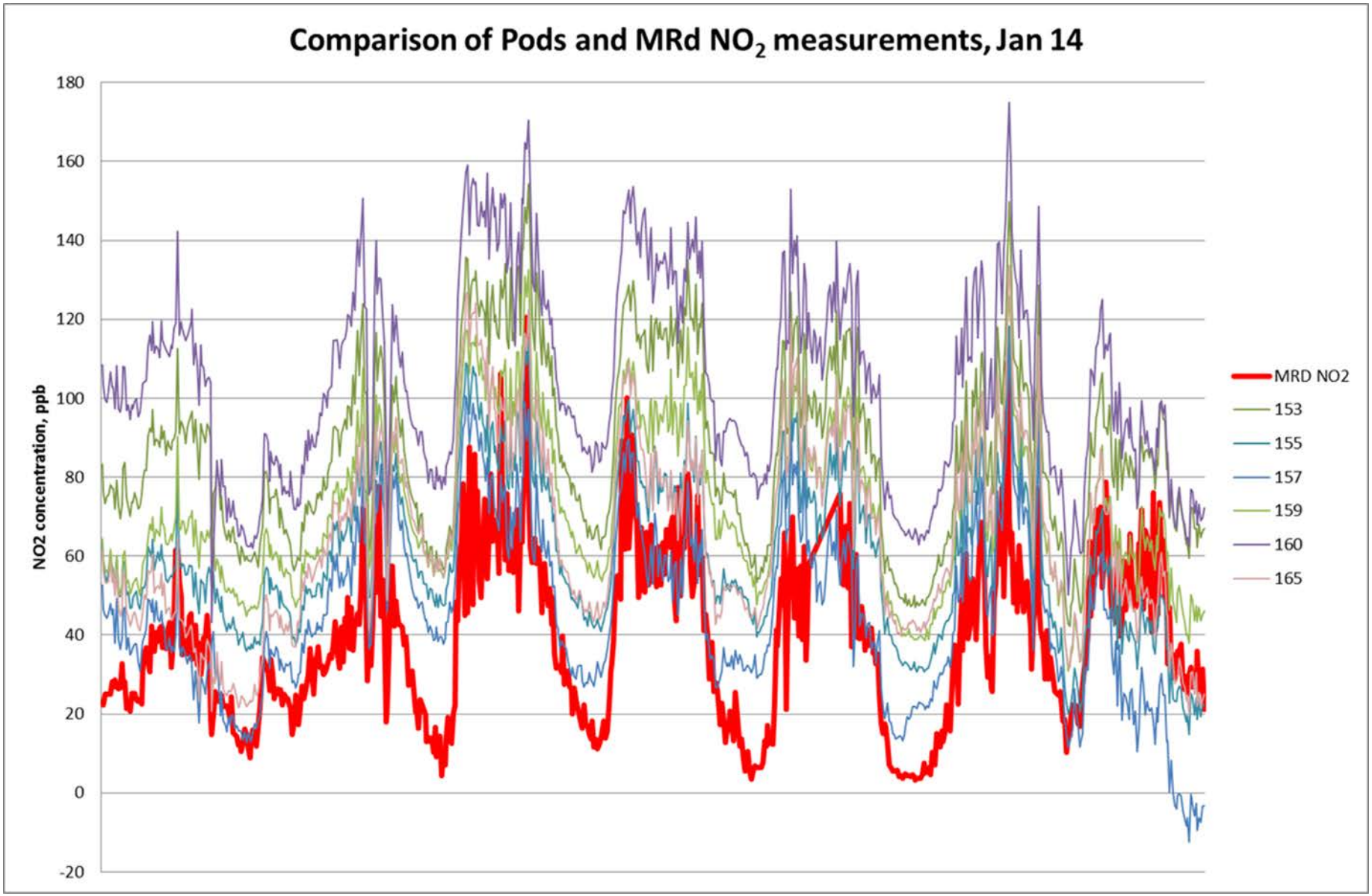
- Calibration and performance testing not conventionally possible with traceable gases.
- No extensive type testing information available before deployment
- Data processing and production of high quality datasets can be extremely complex

- Can’t (currently) use data for compliance, trend analysis, input into models.

- Can we address this?







Sensor networks - Characterisation

- Quality Assurance wish list:
  - *Real world evaluation of sensors*
  - *Characterisation of sensors at production stage*
  - *Knowledge of interferents and response profiles*
  - *Power requirements*
  - *Deployment logistics*
  - *Location identification*
  - *Location preparation*
  - *Procedure documentation for setup, operation, data management, etc.*
  - *Communications arrangements for sensors*
  - *Service and Maintenance, spares and consumables*

- Quality Control wish list:
  - *Use of controlled procedures for operation, characterisation, validation etc*
  - *Control of system calculation algorithms*
  - *Regular characterisation / cross referencing / intercalibration*
  - *Controlled procedures for dealing with replacing sensors*

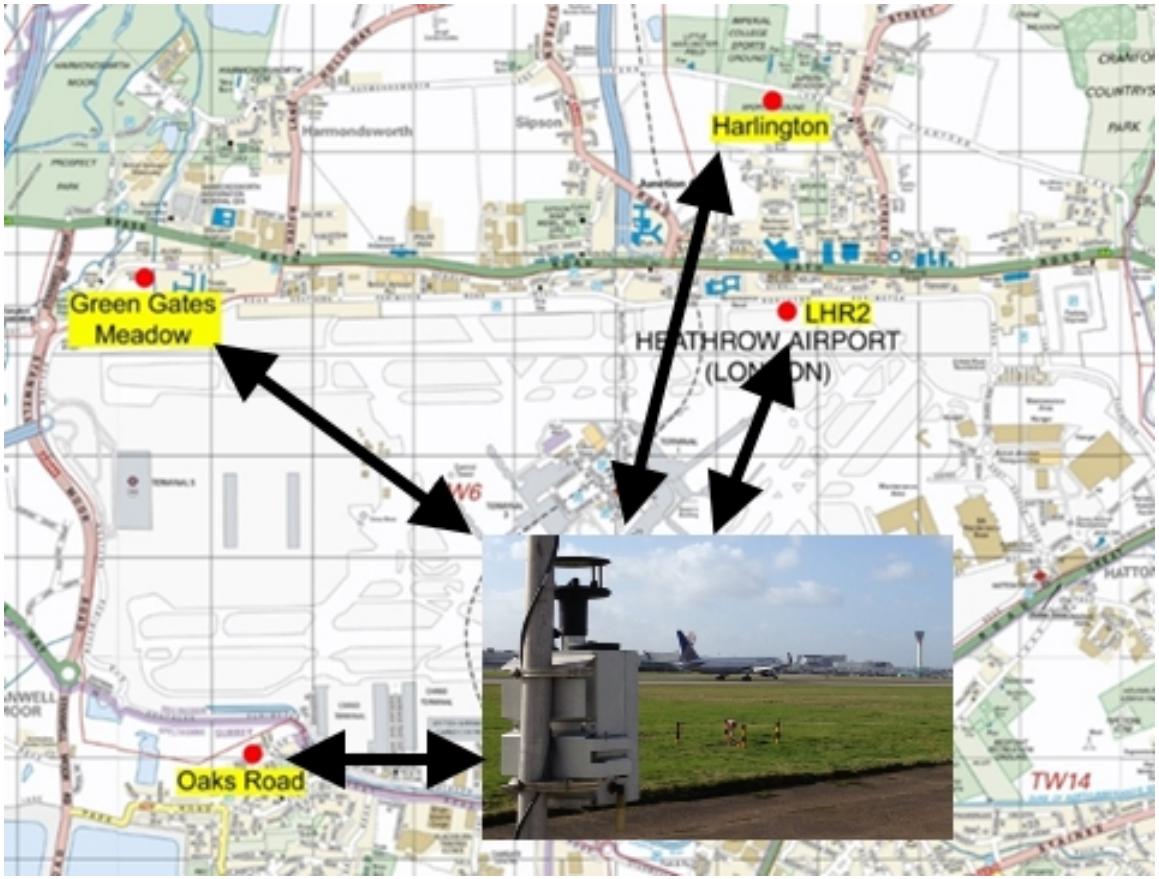
Sensor networks – Initial Evaluation

- Develop a means of testing the performance of sensors!
- Need to understand:
  - What do we want the sensor for?
  - What pollutants are most important?
  - What level of confidence do we want?
  - Life expectancy / performance of the sensor? *
  - How much do we want to pay for a sensor?
  - What performance tests are possible?
  - What performance tests are sensible?
  - How much will the testing cost?
  - Rate of development for updated sensors?

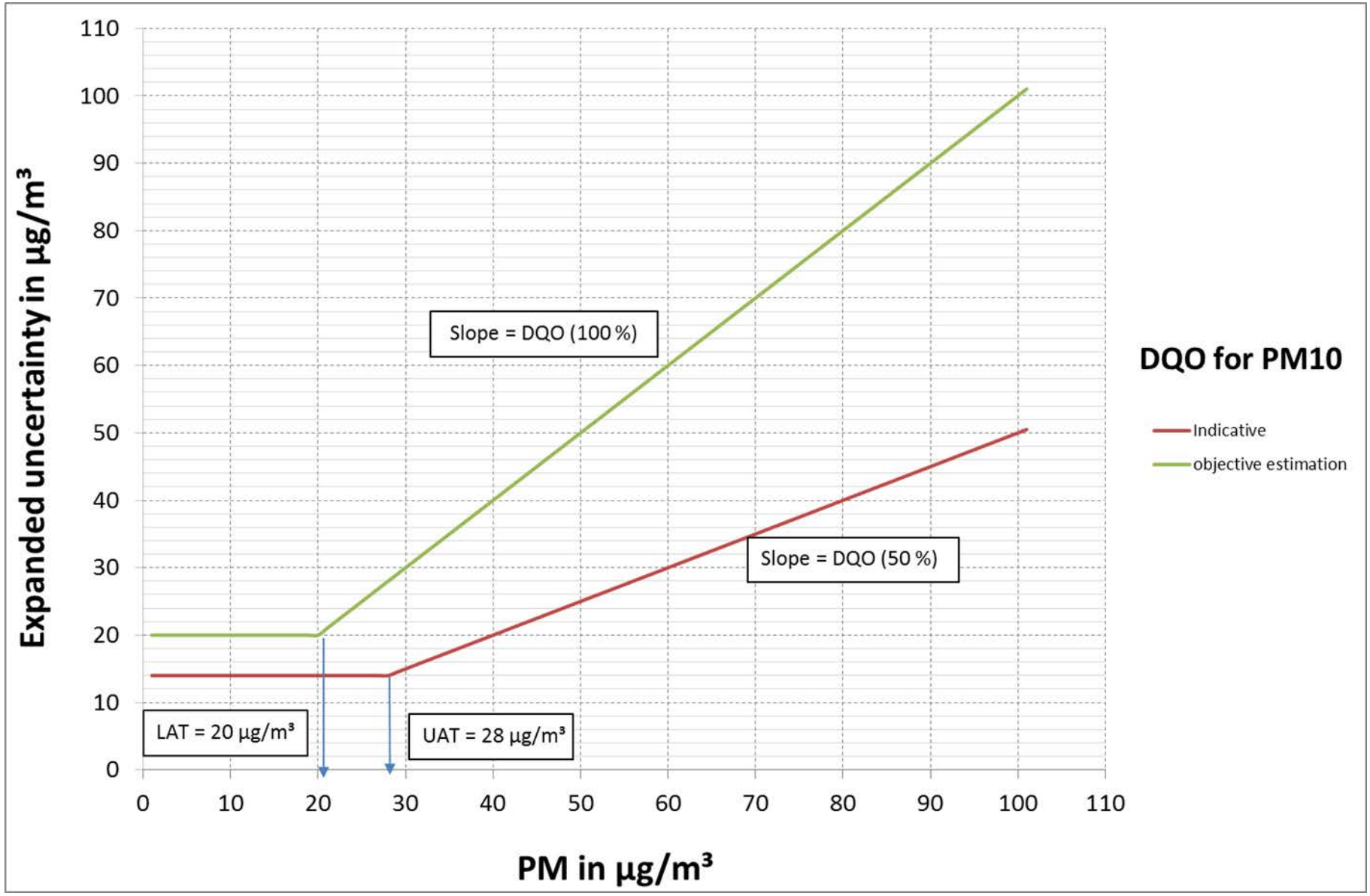
Ongoing QC - characterisation

Suggest three different possibilities:

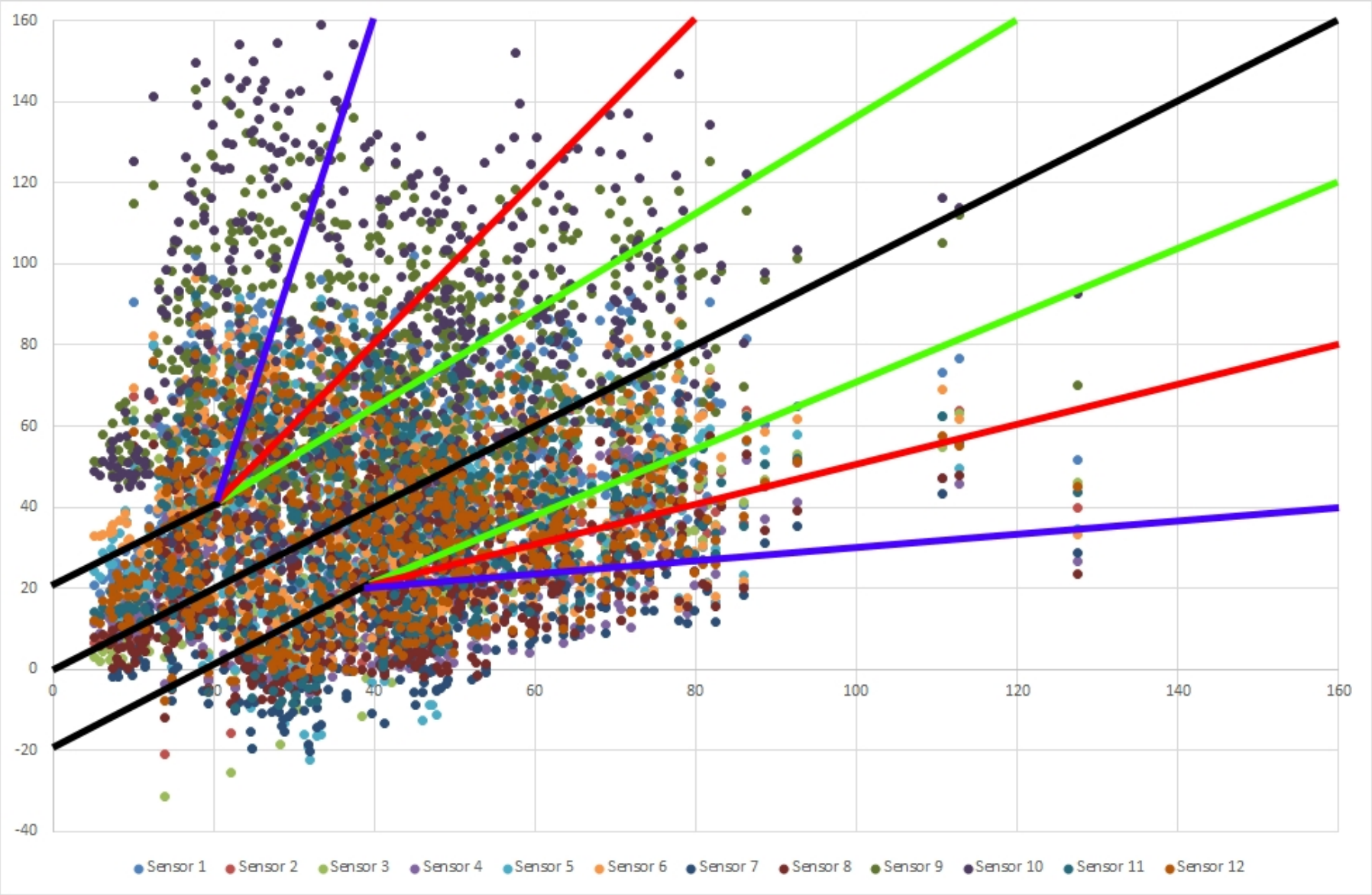
- All sensors regularly assessed against a true reference station (quarterly? 1 week?)
- One sensor regularly assessed against a reference station, then used as a transfer standard for other sensors
- Sensors regularly compared against each other, either using a transfer standard, or by co-location exercises



Tying this all together – performance assessment?



Tying this all together – performance assessment? (2)



Discussion points

- Algorithms! Open Source or IP protected?
- Long term performance
- Individual sensors? Networks? Machine Learning?
- Conformity Testing? Input into WG42
- Speed of development vs (slow) speed of assessment

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