



# Clean Air Summit

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## Air Sensing Technology

**Prof. Benjamin J. Eggleton FAA, FTSE**

Co-director, NSW Smart Sensing Network

@NSWsensing

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The NSSN brings together smart sensing expertise in academia, industry and government to develop a strong, collaborative and innovative network that will deliver economic and social benefits for New South Wales.



**Initiator**  
Mary O'Kane  
Chief Scientist and  
Engineer



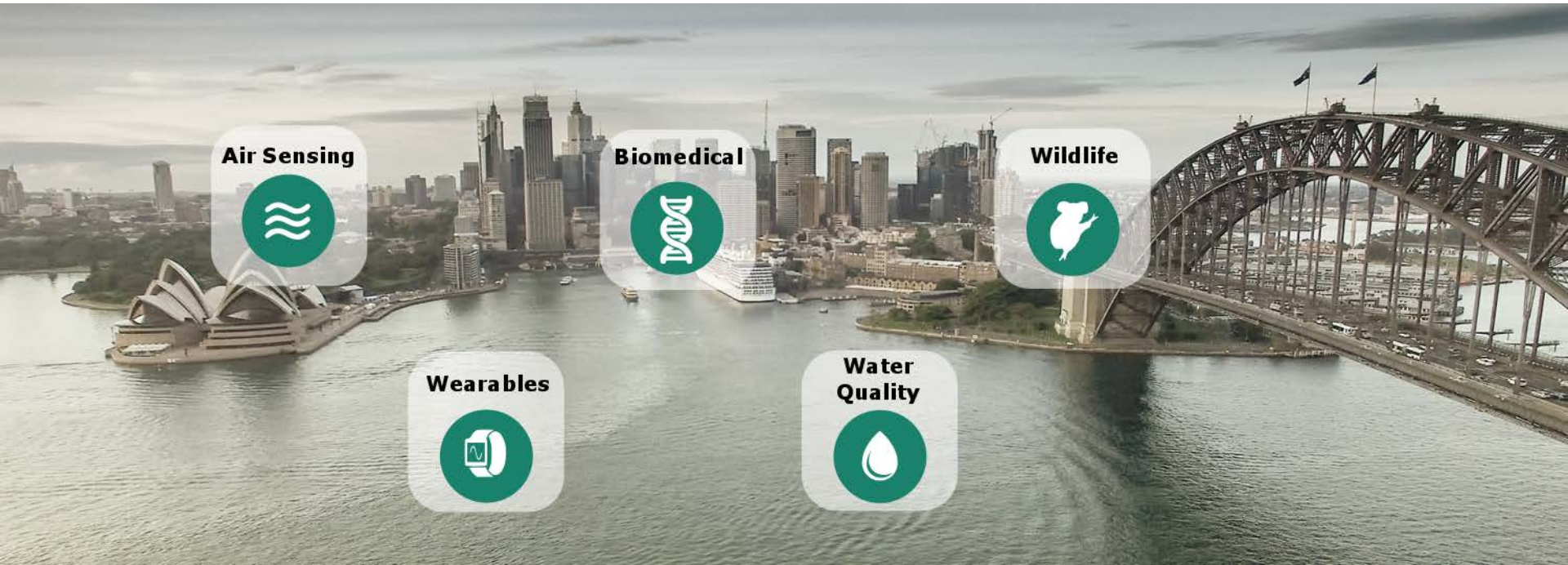
**Co-Director**  
Ben Eggleton  
Nanophotonics  
and phononics



**Co-Director**  
Justin Gooding  
Surface chemistry  
& biosensors

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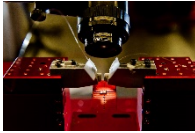
**NSSN – motivated by real challenges and providing solutions for end users.**



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## The NSW Smart Sensing Network (NSSN) Timeline

Sep 2016 Launch  
Technical Pilot



Feb 2017 Formal  
Launch of the NSSN



Apr 2017 Air  
sensor Prototype



Jul 2016 Soft  
Launch

Nov 2016  
Strategic  
Planning

May 2017  
Funding  
second  
tranche

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**“Nearly 92% of the world suffers from bad air”\* ... and we need more data!**

Air pollution growing concern in many areas around the world

Specific locations in Australia at risk

- Heavy traffic areas
- Firewood burning
- Construction sites

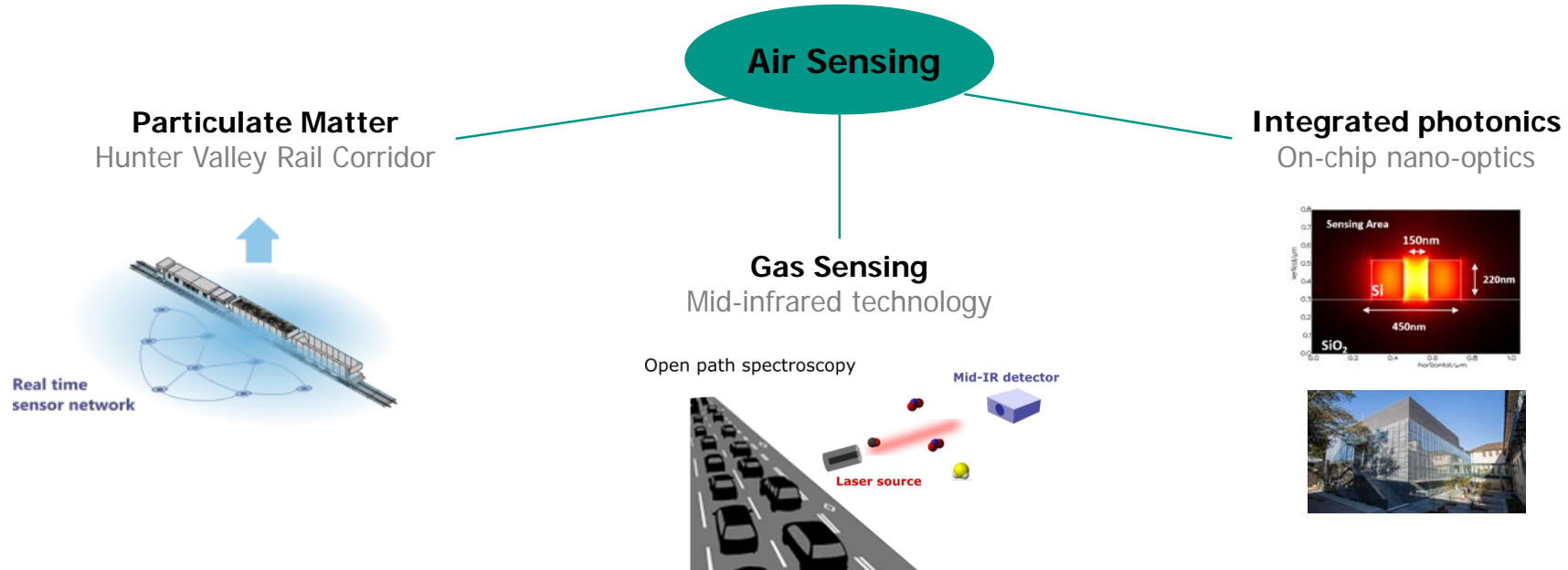


Image source: COAL DUST - Catalyst  
<http://www.abc.net.au/catalyst/stories/3831563.htm>

\* Sydney Morning Herald (27 September 2016)

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New technology from advanced photonics for air sensing of gas and particles



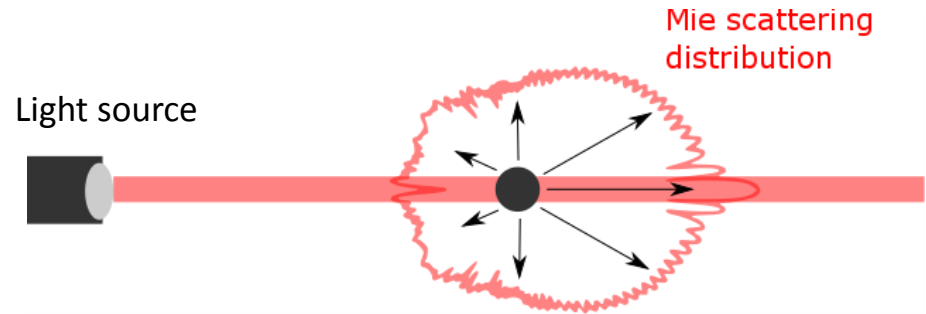
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## Developing our own sensors based on Mie Scattering principles from optics

Unique scattering pattern from particles when illuminated with light

Mie scattering theory used to determine particle size and shape

Typically 1-100 particles/s depending upon flow rates



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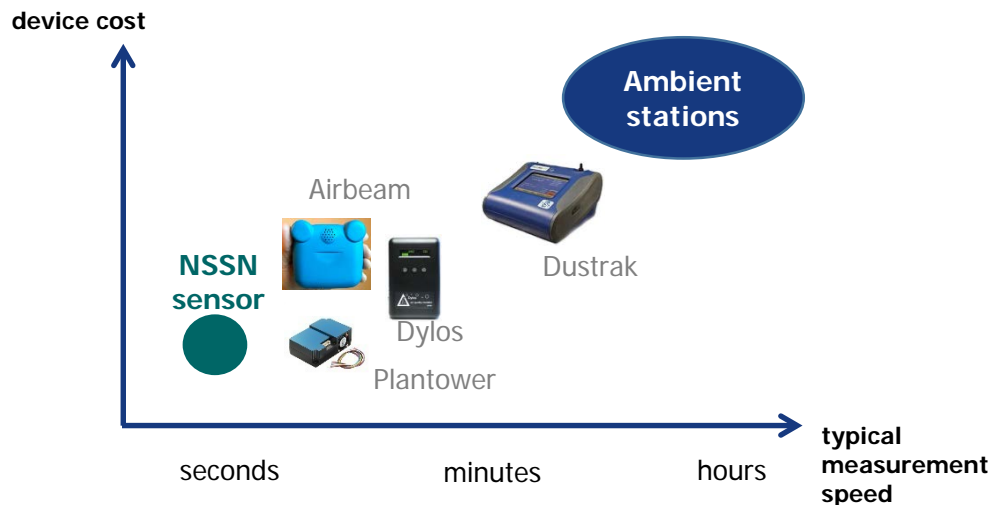
## Aiming for unique performance - compact and fast (~ 1 second readings)

Wide range of low cost sensors available  
(accuracy questionable, but can be used in mass)

Many operate on minutes to hour scales for ambient measurements

Interest in fast dynamics and high resolution data

- Rail corridor
- Traffic
- Smoke diffusion





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## NSSN Air Sensor Prototype

Parameter	Value
Size	12 cm x 7 cm x 3 cm
Measurement speed	< 1 s
Size resolution (aerodynamic diameter)	0.8 – 10 $\mu\text{m}$
Sensitivity	5-200 $\mu\text{g}/\text{m}^3$ *
Communication	USB (Wireless in next version using Zigbee)

\*-subject to further testing and calibration

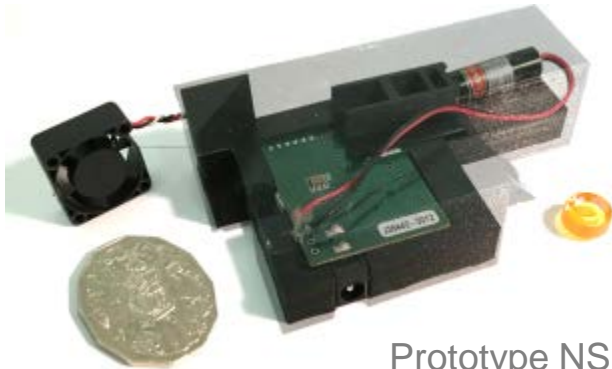


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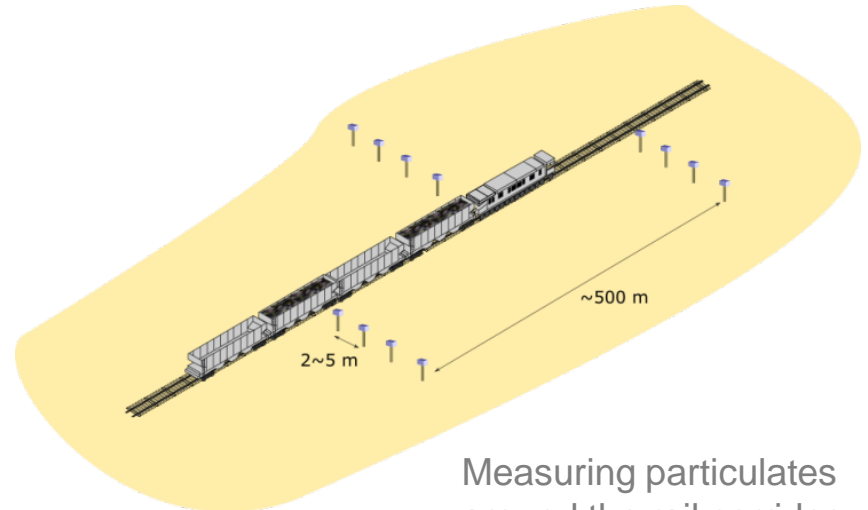
## Network of low costs sensors in the Hunter Valley

Building sensors ground-up to have full control on signals

Allows for tailored performance at high speeds



Prototype NSSN sensor



Measuring particulates around the rail corridor

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**Field tests and calibrations on-going,  
in future looking at creating larger sensor networks**

Wi-Fi communications in a network

Creating high resolution spatio-temporal maps

Data analytics to measure diffusion of particulates  
over short time scales, e.g. rail corridor and  
construction sites

Internet of Things – combine data with other sensors  
(temperature, wind, humidity, etc...) , → Smart cities



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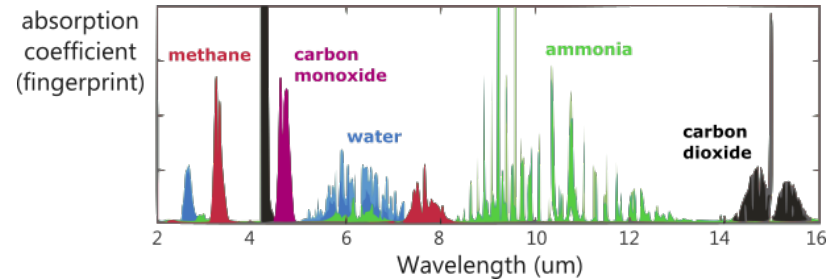
## Optical gas sensing research

Open path gas sensing using infrared lasers

Methane, NO<sub>x</sub>, SO<sub>2</sub>, CO, ...

Southern Photonics methane sensor

Parameter	Value
Range	5 - 10 m
Measurement speed	~ 5 s
Sensitivity	~ 1 ppm



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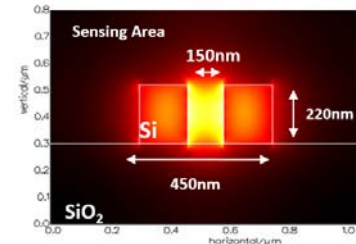
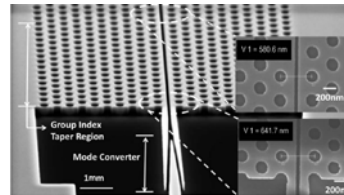
## Future works - integrated photonics for nano-sensing

Integrated silicon chips for optical sensing of trace gases

- Heavy water (body fat measurement)
- Methane (agriculture)

Using the fabrication facilities of the Sydney Nanoscience Hub

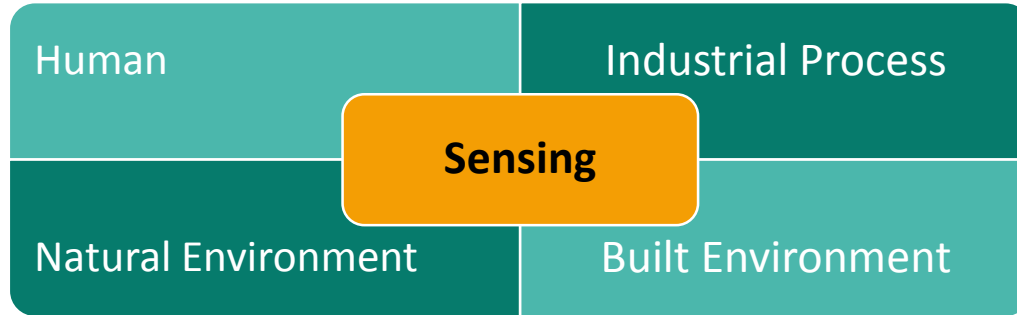
Long term agenda – sensing via smart phones



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**NSSN – will focus on four themes moving forward**



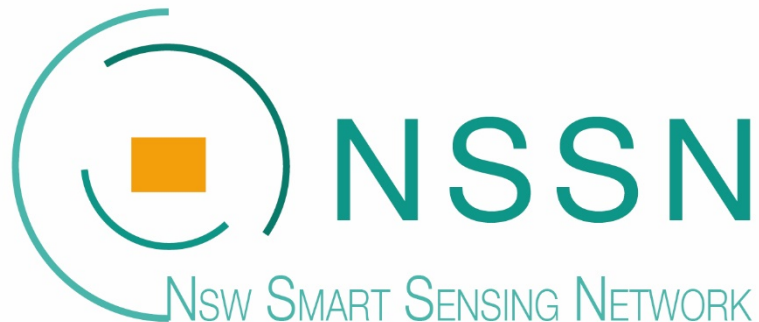
Our network is growing and we are welcoming more people

Industry, government organisations, universities ...

**Not only regarding air pollution, but general to any sensing technologies.**



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Benjamin Eggleton  
NSW Smart Sensing Network

[www.nssn.org.au](http://www.nssn.org.au)



**@NSWsensing**