



## Use of Transmissometry for PM Measurements

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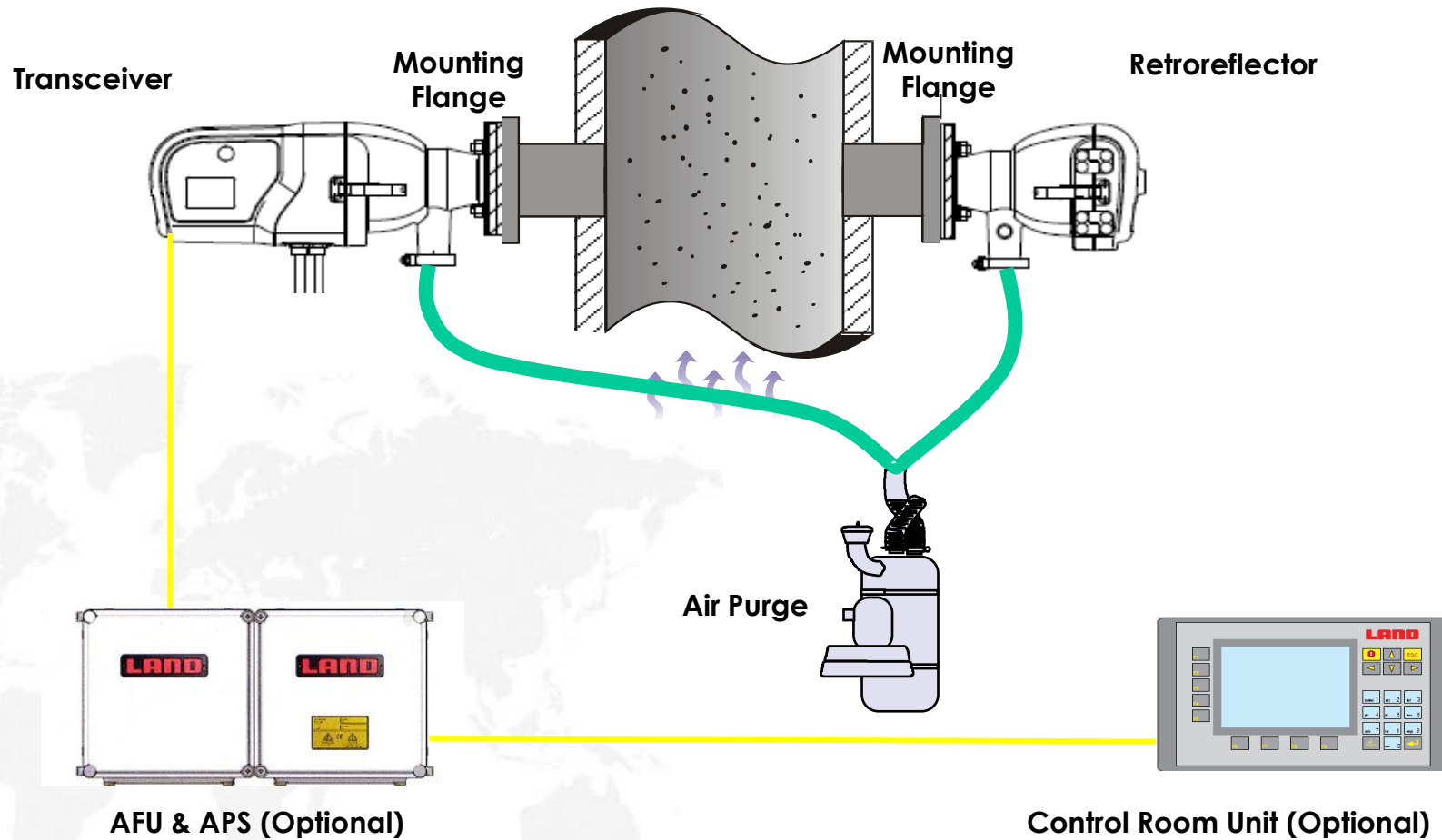


## PM and Transmissometry

- Widely-held belief that transmissometers are only suitable for opacity measurement
- In fact, transmissometry is a very good method for measuring PM concentration
- Used in Europe for many years
- Many transmissometers have been approved for PM measurements down to  $15 \text{ mg/m}^3$



## Main components of a Transmissometer



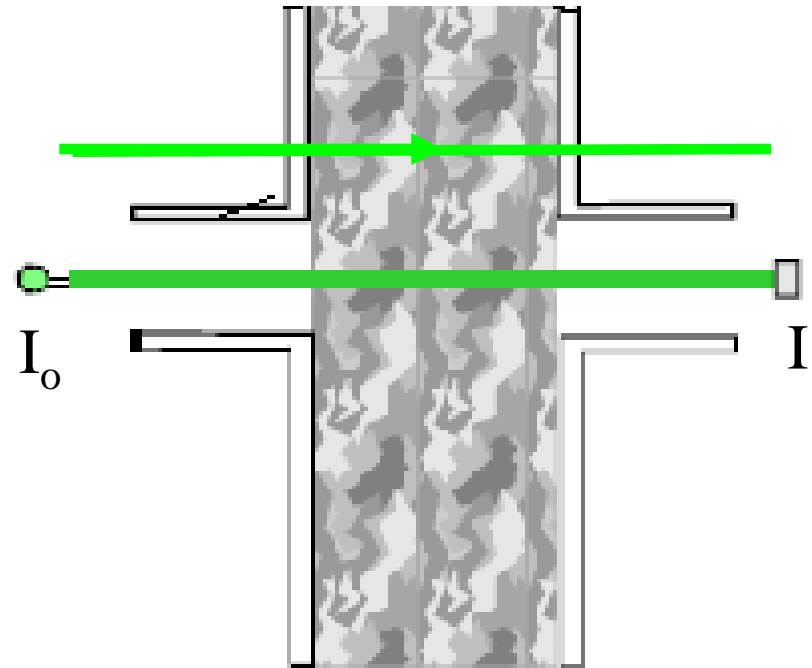


## Definition of Transmittance

$$\text{Transmittance} = I / I_0$$

$I$  = received light intensity

$I_0$  = transmitted light intensity



*Transmittance is the fraction of light which has passed through a medium*

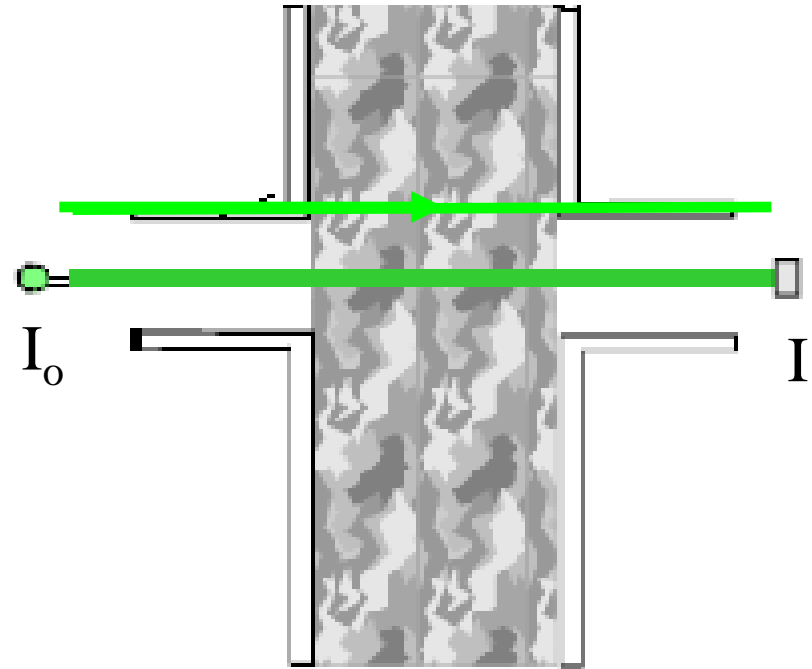


## Definition of Opacity

$$\text{Opacity} = 1 - I / I_0$$

$I$  = received light intensity

$I_0$  = transmitted light intensity



*Opacity is the fraction of light which is lost in passing through a medium*





## Transmissometry and Dust

- Beer-Lambert law

Transmittance

$$= \exp(-k c l)$$

const

Dust conc

pathlength

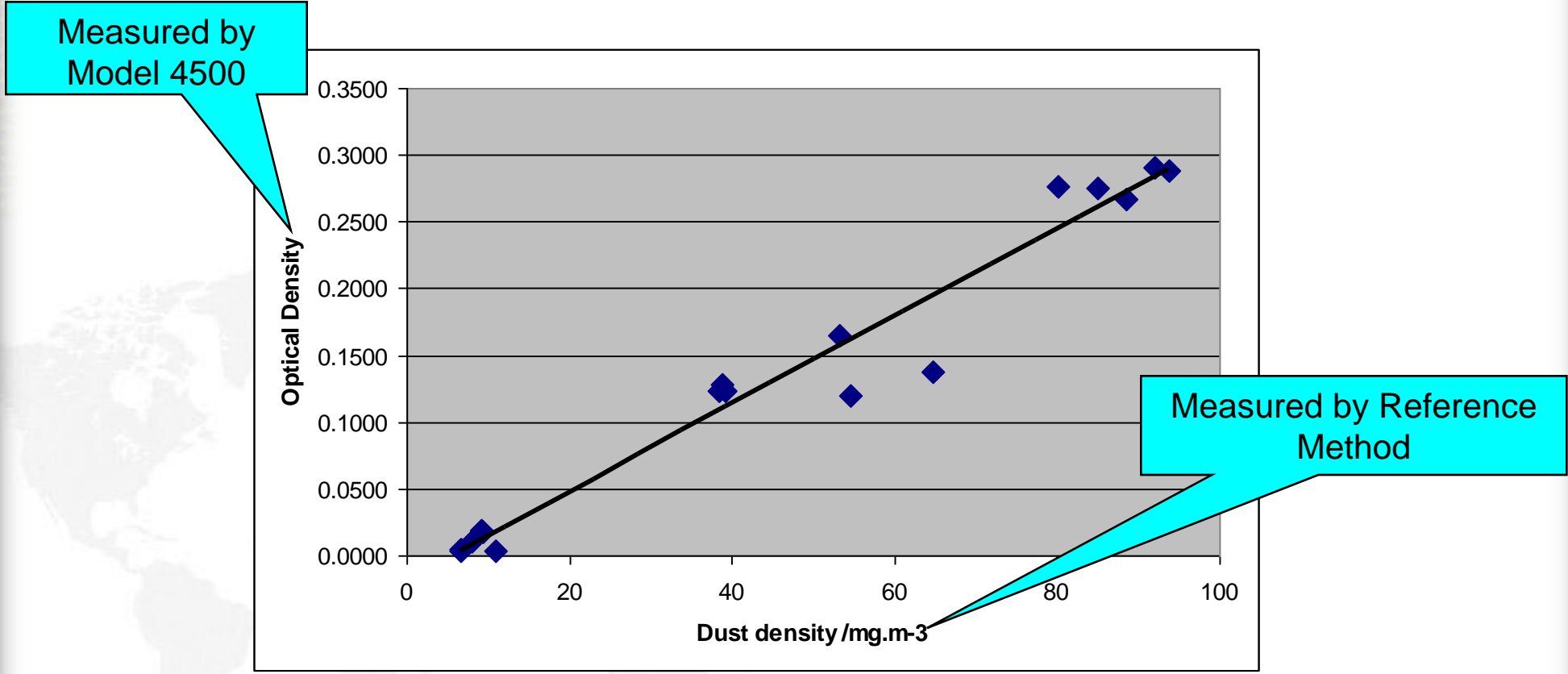
Optical Density (OD) =  $-\log(\text{Transmittance})$

$$= Kcl$$

**Dust concentration = const x OD**



## Correlation with a Reference Method





## Transmissometry - Advantages

- Can measure PM and opacity simultaneously
  - Many analyzers can output both values
- Very reliable
  - Only moving parts are for daily calibration check
- Theory well-understood (Beer-Lambert law)
- Gives path-averaged concentration
- Non-contact measurement
- Relatively inexpensive







## Reliability

Study by Dominion Power in 2005 found

- Transmissometer availability **99.6%**
- Light Scattering 97.6%
- Beta gauge availability 88.2%

EPA Study in 2000 found

- Light Scattering 99.4%
- Beta gauge 96.9%



## Transmissometry - Limitations

- Lowest certified range 0 to 15 mg.m<sup>-3</sup> at 5 m path
- Need to keep optics clean
- Sensitive to droplets – cannot use in wet stacks



## Correlation with a Reference Method

- All continuous dust concentration monitors use inferential methods
- Must calibrate using a reference method (RM)
- PS-11 defines the correlation procedure
  - EN13284:2 in Europe is similar
- Correlate 15 RM measurements with simultaneous CEMS measurement to generate a calibration curve
- Statistical tests are required to demonstrate for accuracy of fit



## Conclusions

- Transmissometry is used worldwide to measure dust emissions
- Very reliable and accurate
- USA: calibrate PM-CEMS correlation test according to PS-11
- Europe: calibrate PM-CEMS correlation test according to EN 13284 part 2