parSYNC FLEX-PNC Overview

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Challenges in the Implementation of Cleaner Transport Technologies in Latin American Cities

Overview

- Context
- Instrument Overview, Specs, Accessories, Maintenance, Training
- Implementation in field trials
  - Presence in LATAM
- Challenges for PN in PTI in LATAM
- Suggestions for enhanced PTI in LATAM

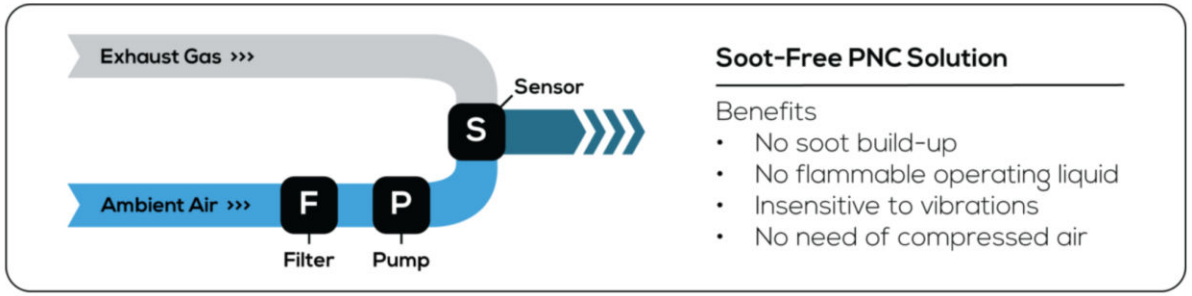
Context

- Need for cleaner urban transportation in LATAM countries, reducing:
  - Ultrafine particles
  - Black carbon
  - NOx
  - Greenhouse gases
- Diesel particulate filters (DPFs) have reduced PN emissions, such that a smoke opacity test cannot distinguish between clean *vs* dirty vehicle
- Need to evaluate particle counters for vehicle emissions
- Many countries plan to incorporate NOx into PTI regulations
- Design PTI procedures for LATAM countries

parSYNC FLEX-PNC iPEMS

➢FLEX-PNC features and benefits:

- Small size/lightweight
  - Size: 40 cm x 55 cm x 24 cm
  - Weight: 16.5 kg (with batteries), 14.3 kg (without batteries)
- Battery life: 1.5 hr with two Milwaukee batteries, hot-swap during test
- Gases and particles in one package
- 23nm and 10nm simultaneously
- Chiller and VPR
- Simple and quick calibration process for gases and particles
- Easy to maintain and operate



Specifications

- Pollutants measured:
  - PN (10 nm and 23 nm cutoff, VPR ~ SPN23),
  - CO, CO_2, HC, O_2, NO, and NO_2.
- FLEX-PNC incorporates a (Pegasor) NMi, METAS, and PTB certified particle number concentration (PNC) sensor based on the extended diffusion charging principle.

PNC		10nm cutoff	23nm cutoff
Range		1,000 - 100x10^6 #/cm^3	
Resolution		200 #/cm^3	
Accuracy		5,000 #/cm^3 absolute or ± 25% relative	
Counting Efficiency	10nm±5%	30–50 %	N/A
	23nm±5%	75–100 %	34 – 60 %
	50nm±5%	71–101 %	71 – 101 %
	80nm±5%	97–127 %	97–127 %

Gases	Non-Dispersive Infrared Spectrometer (NDIR)			Individual Electro-Chemical Cells		
	CO_2	CO	HC	O_2	NO	NO_2
Measurement Range	0-20%	0-15%	0-4000 ppm	0-100%	0-5000 ppm	0-300 ppm
T_{90} Response Time	< 3.5 s	< 3.5 s	< 3.5 s	< 6 s	< 5 s	< 35 s
Resolution	0.01 %	0.0001 %	1 ppm	0.01 %	1 ppm	0.1 ppm
Accuracy	±0.3% abs ±3% rel	±0.02% abs ±3% rel	±8 ppm abs ±3% rel	±0.1% abs ±2% rel	±15 ppm abs ±2% rel	±5 ppm abs ±2% rel
Repeatability	±0.1% abs ±2% rel	±0.02% abs ±2% rel	±6 ppm abs 2% rel	±0.1% abs 2% rel	5 ppm 2% of signal	5 ppm 2% of signal

Accessories Examples

- ECU: Vehicle Speed, Engine RPM, Mass Air Flow, Fuel Flow Rate, Manifold Pressure, etc
- GPS and Ambient Weather: Ambient Temperature, Pressure, and Humidity. Latitude, Longitude, Heading, Altitude, and Ground Speed.
- Thermocouples: CAN based thermocouple interface allows for temperature data collection.
- Exhaust Flow Meter (EFM): Real-time flow rate measurement allows mass emission calculation
- J1939 Adapter: Allows ECU information to be gathered from heavy duty vehicles.
- Fuel Flow Meter: Allows calculation of carbon emission rates where EFM or ECU-based flow rate is unavailable.
- Onboard NH3 and NOx Sensor Module: Can be installed as a tailpipe extension for better assessment of SCR performance.

ECU reader

GPS and ambient monitor

Fuel Flow Meters

Calibration and Maintenance

- PNC factory calibration: using the Saltwater Calibrator with Certified (METAS number 235-11402) reference Particle Number Counter (S/N 01518).
- PNC field calibration: Once in 12 months using the Capelec salt-water PN PTI Calibrator (ISO 17025).
- Gas sensors field calibration: Once in 3 months using traceable calibration gases
- PNC and gas sensor maintenance: None. Sensors do not need any working fluids.
- Water traps: Should be checked, drained, and dried regularly.
- HEPA filters: should be checked and replaced when necessary.
- Sampling lines: Should be checked and cleaned or replaced

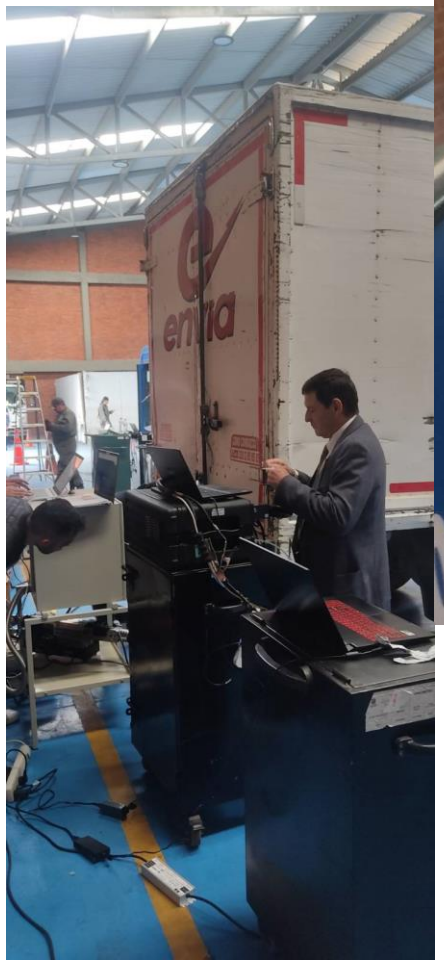
Training Requirements

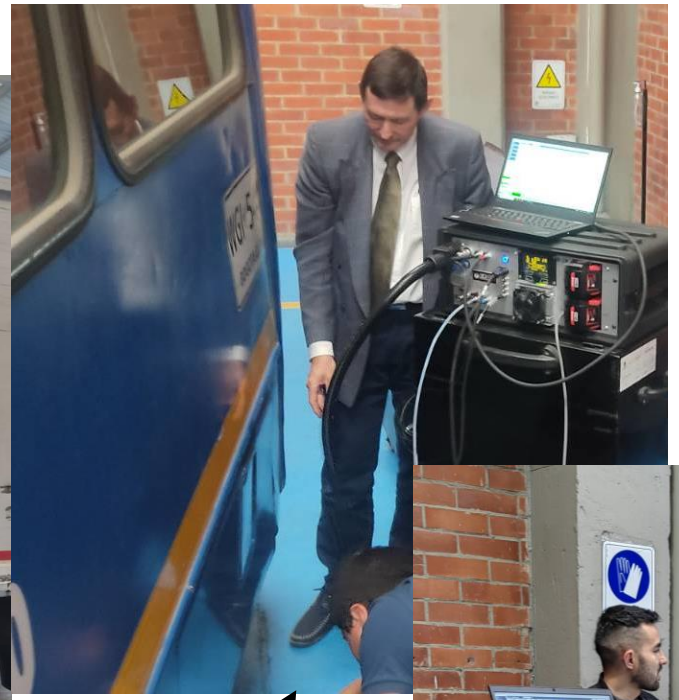
- 3DATX provides remote and/or hands-on training for customers, as requested
- Online user training for ~2 hours provided as standard on purchase of equipment
  - Further training available if requested
  - Separate training on post-processing software PQAS is provided if requested
- System use requires basic computer and intermediate automotive technology skills. Graduate students and technicians typically have the necessary skills to operate the unit, even without previous experience in vehicle emissions testing.

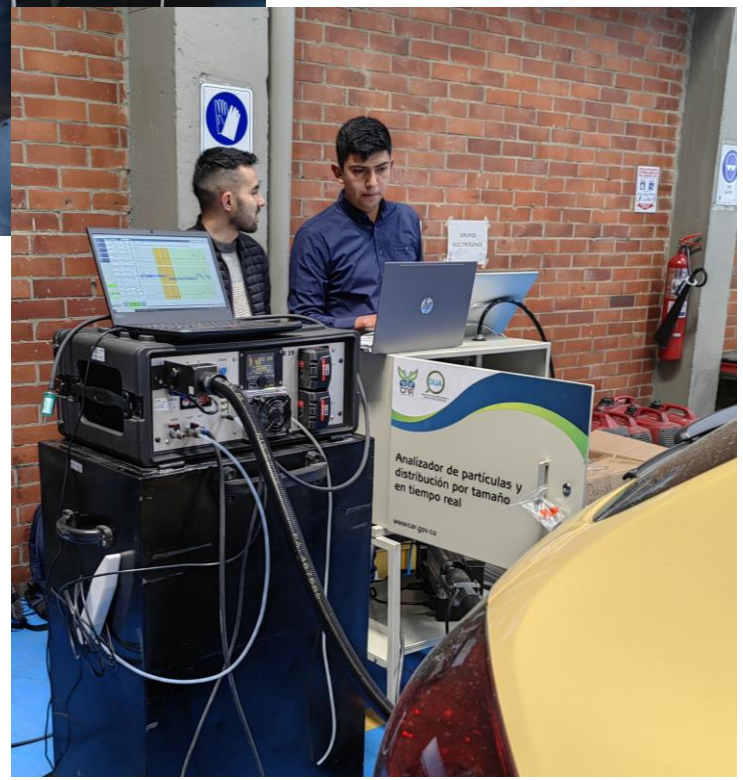
Implementation in PTI-type Field Trials

Location	Date	Duration	Vehicles	Comments
parSYNC PLUS (obsolete model)				
Borås, Sweden	2021-2022	1.5 years	607 LDVs	Enhanced PTI trial with Opus Sweden
parSYNC FLEX				
Abuja, Nigeria	Autumn 2023	9 days	103 LDVs	PTI trial including TWC repair-repeats
Abuja, Nigeria	Spring 2024	3 days	36 LDVs	PTI trials, focusing on SO2 sensing
Bogota, Colombia	Summer 2023	4 days	8 light and 4 heavy-duty vehicles	CALAC+ Colombia
parSYNC FLEX-PNC				
Bogota, Colombia	Summer 2023	5 days	12 light and heavy-duty vehicles	Range of short test types were trialed
Bogota, Colombia	Summer 2024	4 days	31 light and heavy-duty vehicles	Data yet to be analysed

FLEX-PNC in LATAM (Summer 2023)







SDA
CALAC

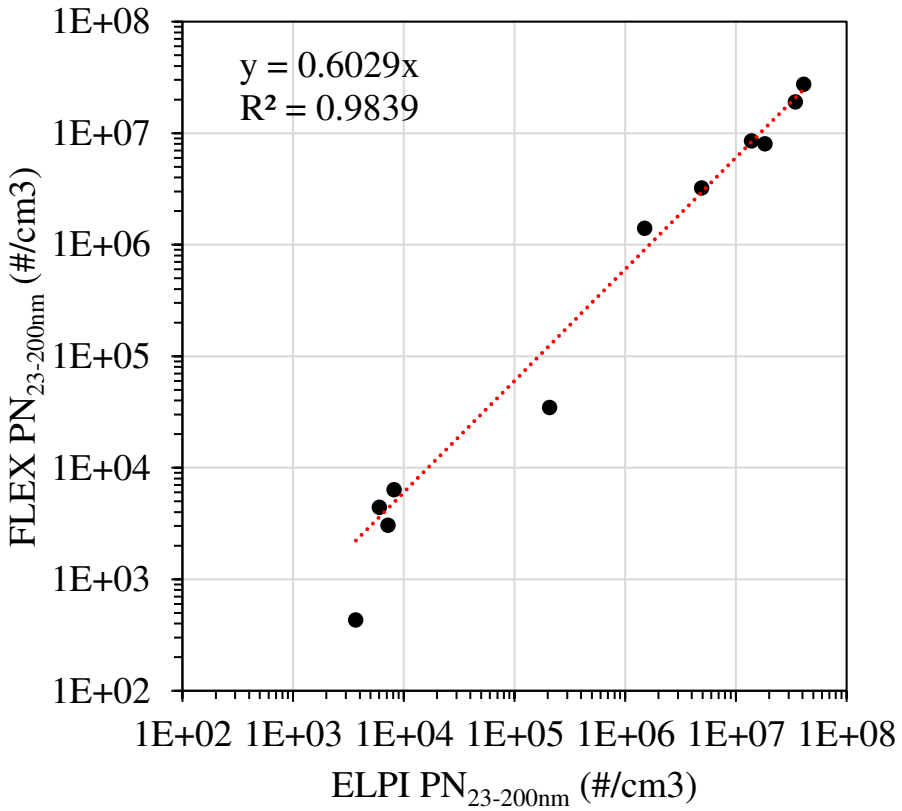
University
of Sabana

FLEX-PNC *vs* ELPI+ (LATAM, Summer 2023)

- FLEX-PNC had acceptable correlation to ELPI+ for 23-200 nm measurement range. 5 vehicles were tested for (idle or high idle) and ambient.

5% are super-200nm fraction

53% are sub-23nm fraction

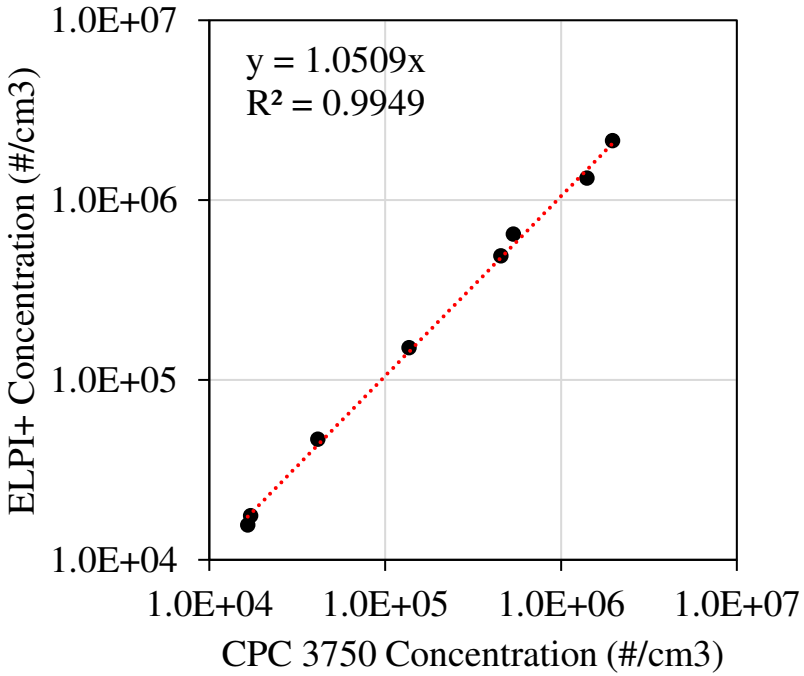


ELPI+ *vs* CPC 3750 (LATAM, Summer 2023)

- The Dekati ELPI+ was verified against TSI CPC 3750
  - Portable Test Aerosol Generator (TSI 3073) was used in combination with a Diffusion Dryer (TSI 3062) and Advanced Aerosol Neutralizer (TSI 3088).

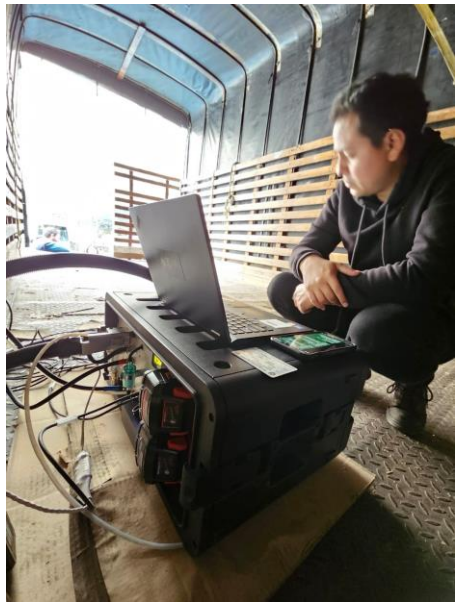
Source: https://tsi.com/

Source: https://dekati.com/



FLEX-PNC in LATAM (Summer 2024)

SDA-Bogota



CDA

CAR

Challenges for PN in PTI in LATAM

- Low ECU parameter availability limits the vehicle data that can be captured (E.g. catalyst temperature info, mass emission calculations, OBD/MIL issues etc.).
- Homogeneity of test conditions across the wide geographical area may be difficult to achieve (due to different ambient temperatures, altitude, humidity etc.).
- Vehicle conditioning: Engine and catalyst temp. (esp. NOx).
- Drive cycles: Ability to replicate across PTI test centres. Relax limit?
- DPF regeneration: Requirements (recent vs overdue)? Does it matter?
- Vehicle tampering: How to handle delete kits?

Suggestions for enhanced PTI in LATAM

- Test protocol: Idle, high idle, driving?
  - Idle PN: well correlated to high idle and short drive sections [Swedish study].
  - Idle NOx: less well correlated to high idle and short drive sections [Swedish study] – Thus, detection efficacy benefits from high idle and short drive test.
  - Defeat device (one case): PN was okay on idle but very high on high idle and driving [Swedish study]
- Particle size: collect 10 nm data for future regulation.
- Retrofit vehicles: Large population in LATAM. Same pass/fail limit? How to determine age?
- Fuel quality: Is this a concern? Impact? What about CNG and dual-fuel vehicles?
- Deterioration: Account for age-/mileage-based deterioration after “useful life”.
- Beyond Pass/Fail: Track vehicle deterioration; predict high-emitters.

3DATX Distributor in LATAM

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Thank You for Listening. Any Questions?

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