





Performance Evaluation of an embedded NIR spectrometer using a tablet press feed frame simulator

IFPAC 2025 – Emerging technologies for spectroscopic PAT applications



- Technical details and specification of SentroPAT Compact compared to SentroPAT FO
  - Goals, Challenges, Specification
- Performance evaluation using the EXPO Process Feed Frame Simulator and 3-component mixture experiment
- Results and Observations





- We started into Pharma PAT with Fibre Optic probes (here in HSWG, Pfizer 2005).
- Long term stability can be a challenge!
- Our search for solutions resulted in the SentroProbe DR LS.
- Can we go further and integrate the spectrometer as well?
- What's a nice thing about small companies?
- We just gave it a try and developed it.





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	Fibre optic probes	SentroProbe	SentroPAT Compact
Illumination fibre	$\checkmark$	$\checkmark$	$\checkmark$
Detection fibres	$\checkmark$	$\checkmark$	$\checkmark$
2 x Light sources		$\checkmark$	$\checkmark$
Internal white reference		$\checkmark$	$\checkmark$
Electronic control and interface		$\checkmark$	✓
Sapphire window heating		$\checkmark$	$\checkmark$
Diode array spectrometer			$\checkmark$
Internal wavelength reference			$\checkmark$
Internal shutter			$\checkmark$
i.MX based Linux computer			$\checkmark$
ATEX certification		$\checkmark$	In preparation



	SentroPAT FO	SentroPAT Compact
Spectral range	1100 – 2100nm	1100 – 1900nm
Linear array detector	Cooled extended InGaAs	Heated extended InGaAs
Number of pixels	256	512
Pixel dispersion (average)	4.3nm	1.6nm
Wavelength resolution	approx. 10nm	approx. 9nm
Lamp power consumtion (typ.)	4.5 W	2.5 W

Experimental settings	SentroPAT FO	SentroPAT Compact
Integration time	10ms	15ms
Averages	83	45
Delay between scans	2ms	7ms
Measurement cycle time	1s	1s

# Comparison of WC1920 Wavelength Standard Spectra



- Let's compare with the SentroPAT FO, which we have most experience with and from which the development was derived.
- We want to focus on noise, as limits the limit of quantification.
- No focus on method optimization.
- 1s measurement cycle for FO and Compact, operated in parallel under same conditions.
- No outlier filtering required due to the blend behavior under test conditions.







#### Noise over wavelength at 1s measurement interval



- Preparing the test setup
- SentroProbe: 300mm shaft
- SentroPAT Compact: 200mm shaft
- Probe tip penetration
  - SentroProbe DR LS: 2mm
  - SentroPAT Compact: 5mm







### Test Setup with the Feed Frame Simulator



- Probe locations on spider wheel
- Product flow reaches SentroProbe DR
  LS first and then SentroPAT Compact.
- The difference in penetration depth improves sample presentation.
- The feed frame simulator standard configuration has cut-outs in the probe area to improve flow guidance and sample presentation.
- View into the open probe port, with material still loaded.









Step	Components	Addition [g]	Caffeine [%]
1	Lactose	90	
2	Avicel	40	0.00
3	Caffeine	1.3	0.99
4	Caffeine	1.3	1.96
5	Caffeine	1.3	2.91
6	Caffeine	1.3	3.85
7	Caffeine	1.3	4.76

	Process parameters
Feed Frame Speed	50 rpm
Sample mass per meaurement (1s)	approx. 250 mg (5mm spot, 0.5 g/cm <sup>3</sup> , 0.3mm penetration depth
Mode	Stepwise addition during continuous measurement

## Component Spectra – Both Instruments



![](_page_13_Figure_1.jpeg)

![](_page_13_Figure_2.jpeg)

![](_page_14_Picture_1.jpeg)

![](_page_14_Figure_2.jpeg)

## SentroPAT Compact - PCA Prediction (PC 1) on all 6 Test Batches

![](_page_15_Picture_1.jpeg)

![](_page_15_Picture_2.jpeg)

### SentroPAT Compact - PCA Prediction (PC 2) on all 6 Test Batches

![](_page_16_Figure_1.jpeg)

![](_page_16_Figure_2.jpeg)

### **FO Caffeine Prediction Overview**

![](_page_17_Figure_1.jpeg)

#### Caffeine Prediction Overview for the FO

![](_page_18_Figure_1.jpeg)

	SentroPAT FO	SentroPAT Compact
Spectral noise [1s]	14 µ AU	84 µ AU
Prediction noise @50rpm	0.040 %	0.061 %
Prediction noise static sample	0.015 %	0.035 %

![](_page_19_Figure_3.jpeg)

![](_page_20_Picture_1.jpeg)

- It's not the magic wonder!
- There are limitations resulting from the compact design of the instrument.
- Still, in many cases the overall performance will be sufficient.
- The rugged design and internal reference, combined with the removal of fibre optic connections clearly show advantages for routine operation.

![](_page_21_Picture_1.jpeg)

Thank you for your attention!

You've got Questions?

Thank you for all your inputs, feedback and reviews, as usual!

- Phil Doherty, EXPO Process Analytics
- Owen Rehrauer, Sentronic US Corp
- Sebastian Sowinski, Sentronic GmbH

#### Thanks for the 3 months we had with the Feed Frame Simulator!

Manuel Kuhs @ Expo Process Analytical