SnT 2021
CTBT: SCIENCE AND TECHNOLOGY CONFERENCE

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PREPARATORY COMMISSION

Maintaining IMS particulate radioactivity measurement capabilities – integration of a next generation automated air sampler – Cinderella G2

Aleksandr Tarasov, Bernd Wernsperger, Richard Britton, Nikolaus Helmut Hermanspahn

P3.1-299

POSTER

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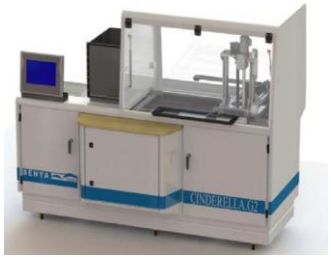
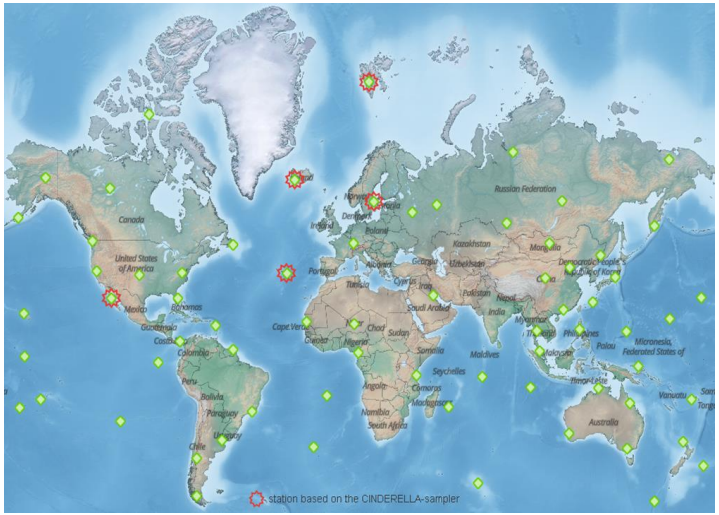
Air sampler “Cinderella” G.2 - Introduction

The verification regime of the CTBT includes radionuclide monitoring technology which comprises 80 stations distributed around the globe. Basic components of a radionuclide station include **a high-volume air sampler**, a gamma ray detection system, and a communication link. Around 36 % of installed IMS radionuclide stations are equipped with automated air sampling systems. 5 stations (**7%** of installed base) are built based on the automated air sampler **CINDERELLA** by Senya Ltd., Finland.



- ISP34 (Reykjavik)
- MXP44 (Mexico)
- NOP49 (Spitsbergen)
- PTP53 (Ponta Delgada)
- SEP63 (Stockholm)



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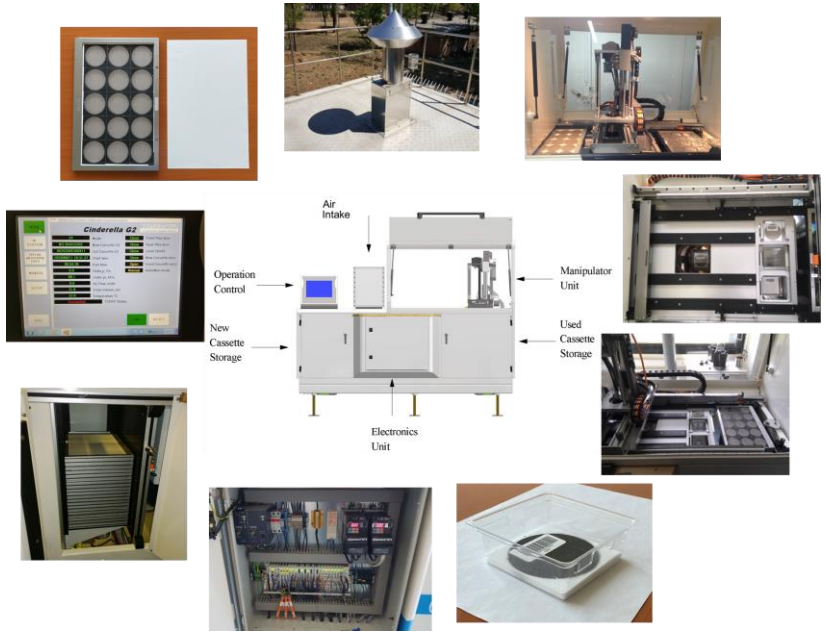
Air sampler “Cinderella” G.2 - Technical specifications

The relevant technical specs of the industrial prototype meet Minimum Requirements for Particulate Monitoring System Specifications.

Characteristics	Requirements	CINDERELLA sampler parameters
System Manual or automated	Manual or automated	automated
Airflow	≥ 500 m3/h	> 550 m3/h in STP with clean filter
Collection time	24 h	fulfilled
Collection efficiency for filter	≥ 80% at Ø = 0.2 µm	> 80% for particles of 0.2um diameter
Collection efficiency Global	≥ 60% at Ø = 10 µm	>60% for particles of 10um diameter
Decay time	≤ 24 h	fulfilled
Time before reporting	≤ 72 h	fulfilled
Measurement time	≥ 20 h	fulfilled
Measurement mode	HPGe high resolution gamma spectrometry	HPGe detectors are supposed to be in use as a pat of the system
Auxiliary data	Meteorological data, Flow rate, SoH data	– Connection for the WXT536 weather station. – Air flow calculation in real-time in m3/h at STP (273.15K, 101.325 Pa) – Air flow measurement accuracy equal or better than + 5%



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Air sampler “Cinderella” G.2 - Other technical specifications

- 30 cassettes (automated cycles) as standard, option for 60;
- Traceable 3rd body calibration available;
- Filter size: 460 x 285mm, active area 15 x Ø77mm;
- Laboratory quality background shielding, 10 cm wall thickness, 1mm Cu and 2.0 mm Sn lining inside;
- Split type lead shield cover, mounted permanently into the body of the sampler;
- Shielding has a form of cylinder, made of casted lead, OD Ø450 x ID Ø250mm, IH 250mm.;
- Hidden beakers, only the decay beaker is still in the robot compartment;
- New and used beakers handled through beaker compartment;
- LED lightning in the robot compartment.

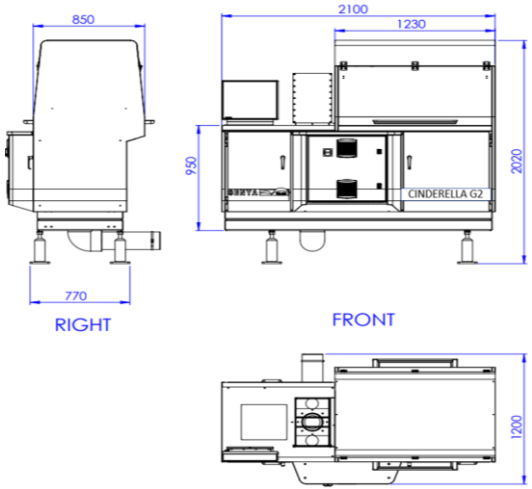
Power:

- Main pump, 2BH1900-7AH07, 9kW, 3-phase,400V/50Hz, N, PE;
- Electronics powered throw the UPS that connected to the single-phase power supply source;
- Omron frequency converter with PID flow control and motor PTC.

The dimensions are:

- Length ~2300 mm
- Width ~ 1400 mm
- Hight ~ 2000 mm

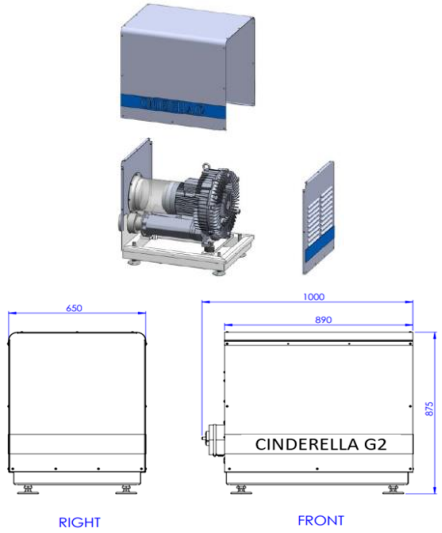
Total weight(shielding is included) ~ 1500 kg



The pump is a separated part/unit.
The dimensions are:

- Length ~1200 mm
- Width ~ 800 mm
- Hight ~ 1000 mm

Total weight ~ 300 kg



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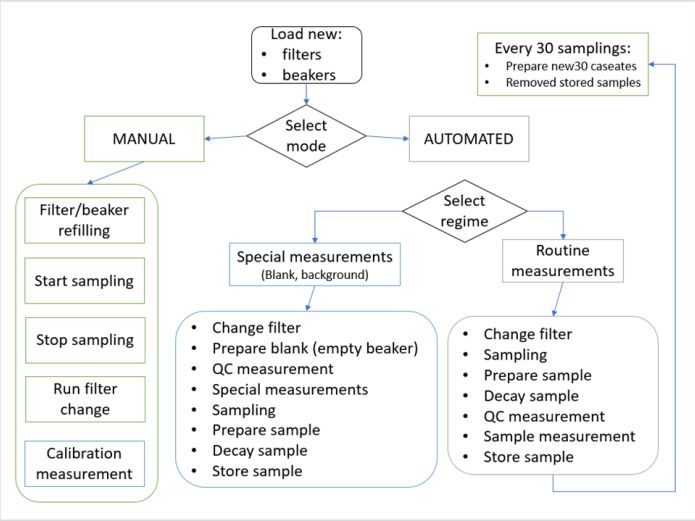
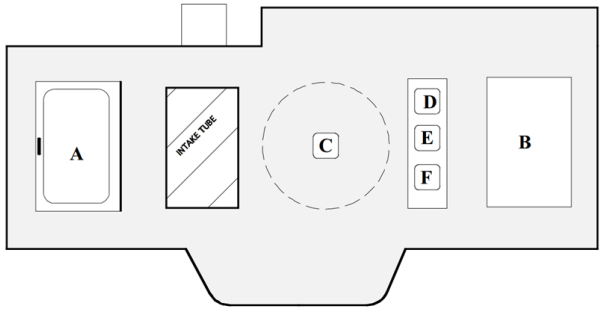
Air sampler “Cinderella” G.2 - Process

The CINDERELLA sampler provides manual and automated modes to manipulate samples. In daily routine the sampler is run in automated mode with sampling time, decay time and measurement time adjusted for Minimum Requirements for Particulate Monitoring System Specifications. The sampler is operated in manual mode for maintenance and calibration purposes.



Initial position before starting



1. New filter cassettes in New Cassette Storage — A
2. Used Cassette Storage empty — B
3. Empty beaker in lead shield — C
4. Empty beaker in decay position — D
5. New beakers in New Beaker Storage — E
6. Used Beaker Storage, only bottom plate — F

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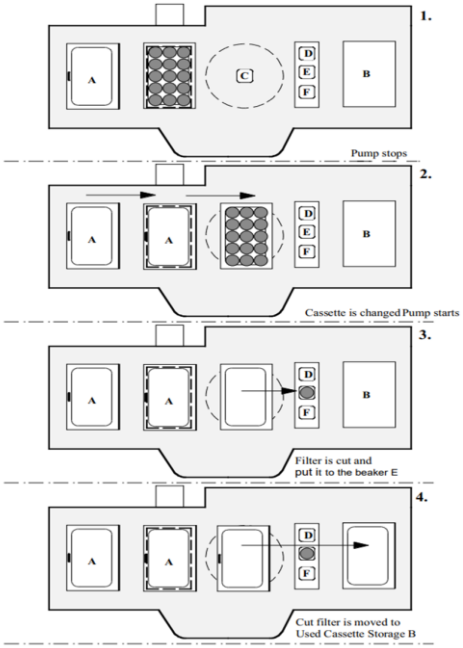
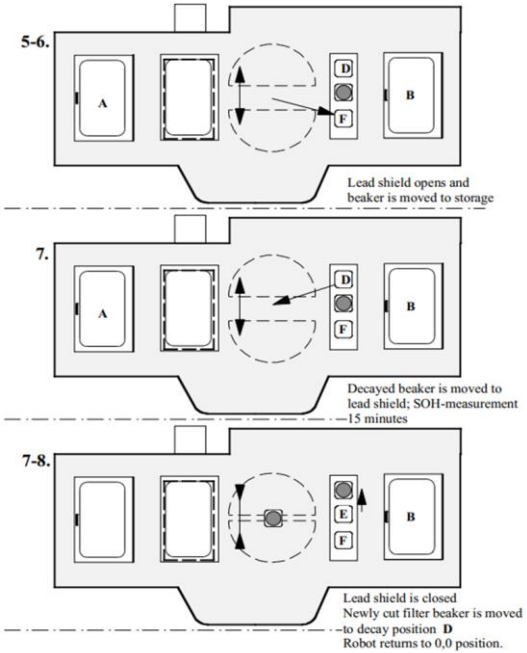
Air sampler “Cinderella” G.2 – Process.
Sequence of manipulations in automated mode



1. Pump stops.
2. Cassette is changed.
   When cassette change is done the pump starts.
3. Filter is cut and put to a new beaker **E**.
4. Cut cassette is moved to Storage **B**.
5. Lead shield is opened.
6. Beaker from Lead Shield is moved to Used Beaker Storage **F**.
7. Decayed beaker is moved to Lead Shield.
   Now when robot arm is in the Lead Shield, there is 15 min pause for QC measurements.
8. Lead Shield is closed.
9. Today cut filter beaker is moved to Decay **D**.
10. Robot returns to parking position.



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Air sampler “Cinderella” G.2 – Output Data

SRID<TAB>	Cycle ID [1)]
ID_SAMPLE<TAB>	Changing ordinal [6.0f]
ST_TIME<TAB>	Start time of sampling (dd.mm.yyyy hh:mm:ss)
UP_TIME<TAB>	Update time (dd.mm.yyyy hh:mm:ss)
RUN_TIME<TAB>	Sampling duration (hh:mm:ss)
FLOW<TAB>	Air flow (m^3/h), [6.1f]
VOLUME<TAB>	Total Volume (m^3), [9.1f]
P1<TAB>	Pressure difference over orifice, [6.1f]
PABS<TAB>	Static pressure at orifice, [6.1f]
T1<TAB>	Temperature at orifice, [6.1f]
TA1<TAB>	Air temperature, [6.1f]
RO<TAB>	Rain information, [7.1f]
RDUR<TAB>	Rain duration, [4.1f]
SW<TAB>	Sampler ON/OFF, [1d]
WS<TAB>	Wind speed, [3.0f]
WD<TAB>	Wind direction [4.1f]
WSA1<TAB>	Wind speed, 10min awg, [3.0f]
WDA1<TAB>	Wind direction, 10min awg, [4.1f]
RHUM<TAB>	Relative humidity, [5.1f]
TAMPER1>TAB>	Tamper 1 status (0/1), [1d]
FLOWH<TAB>	*Carbon air flow, only in systems with carbon cartridge), [6.1f]*
PH<TAB>	*Carbon pressure difference, only with carbon systems), [6.1f]*
VOLUMEH<TAB>	*Carbon total volume, only with carbon systems [8.1f]*
FC	Calculation code, 1=short formula, 2=STP, [1d]
ETX	End of text (ASCIIcode 003)

Data outputs interface:

- Ethernet/RJ45, all measured data are retrieved through Ethernet

Cinderella PC is identified by its IP address, and provides via Ethernet all relevant data in data string to RSSI:

- Cinderella operational status,
- sampling data,
- weather data,
- bar code reading.

bit 0 = not used	
bit 1 = Lead shield open	1= Lead shield is open
bit 2 = Lead shield closed	1= Lead shield is closed
bit 3 = Transferor home position	1= Transferor is in home position
bit 4 = Left door	1= Left door is closed
bit 5 = Right door	1= Right door is closed
bit 6 = New beakers empty	1= New beakers empty
bit 7 = SOH-measurement	1= Execute SOH calibration (15min)
bit 8 = Front plexi door	1= Front plexi door is closed
bit 9 = Beakers holder OK	1= Beakers holder is OK
bit 10 = New cassette error	1= new cassette is wrong in storage
bit 11 = Change mode 1h	Only one of the following four can be active
bit 12 = Change mode 6h	
bit 13 = Change mode 8h	
bit 14 = Change mode 24h	
bit 15 = Automatic/manual	1= control is in manual mode
bit 16 = not in use	
bit 17 = Used cassette storage full	1= Used cassette storage is full
bit 18 = Cutting Position cassette error	1= Cassette is wrong in cutting position
bit 19 = New cassette storage is empty	1= New cassette storage is empty
bit 20 = not use	
bit 21= Pump driver drop	1= Pump is in lower speed
bit 22 = Read plexi door	1= Rear plexi door closed
bit 23 = Cassette change	1 = changing starts

poll_cind - Shortcut

24	99999999999999	99999999999999	2020/05/15 15:01:00	00:00:00	2020/05/15 15:01:24	0.0	99.6	0.0	0.0	17.4	18.9	0.0	0.2	125.0	47.3	995.6	99124	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:00:00	2020/05/15 15:01:34	0.0	99.6	0.0	0.0	17.4	18.9	0.0	0.4	180.0	47.3	995.6	99124	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:00:00	2020/05/15 15:01:44	0.0	99.5	0.0	0.0	17.4	18.9	0.0	0.2	107.0	47.3	995.6	99132	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:00:00	2020/05/15 15:01:54	20.8	94.9	162.5	0.0	17.5	18.9	0.0	0.1	135.0	47.2	995.6	99132	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:00:02	2020/05/15 15:02:04	56.9	92.9	268.7	0.1	17.5	18.9	0.0	0.3	146.0	47.2	995.6	99132	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:00:11	2020/05/15 15:02:14	87.1	91.9	332.1	0.9	17.4	18.9	0.0	0.3	139.0	47.2	995.6	99132	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:00:22	2020/05/15 15:02:24	105.4	91.3	365.0	2.0	17.3	18.9	0.0	0.1	300.0	47.2	995.6	99132	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:00:32	2020/05/15 15:02:34	117.8	91.0	385.9	3.0	17.3	18.9	0.0	0.2	81.0	47.2	995.6	99132	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:00:42	2020/05/15 15:02:44	123.3	90.9	394.7	4.1	17.3	18.9	0.0	0.3	133.0	47.2	995.6	99132	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:00:51	2020/05/15 15:02:54	123.3	90.9	394.7	5.1	17.3	18.9	0.0	0.2	162.0	47.2	995.6	99132	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:01:02	2020/05/15 15:03:04	126.3	90.8	399.5	6.3	17.3	18.9	0.0	0.2	96.0	47.2	995.6	99132	S
24	99999999999999	99999999999999	2020/05/15 15:01:00	00:01:12	2020/05/15 15:03:14	127.7	90.8	401.8	7.4	17.3	18.9	0.0	0.1	150.0	47.3	995.6	99132	S

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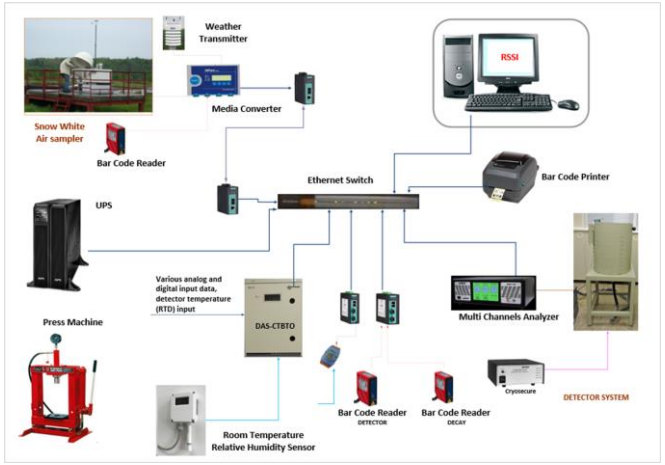
Air sampler “Cinderella” G.2 – 2 Integration into the standard IMS configuration

The entire In-house project for the integration of Cinderella 2 into IMS framework, including new SW with full control of the development from the PTS.

Manual RN station hardware configuration

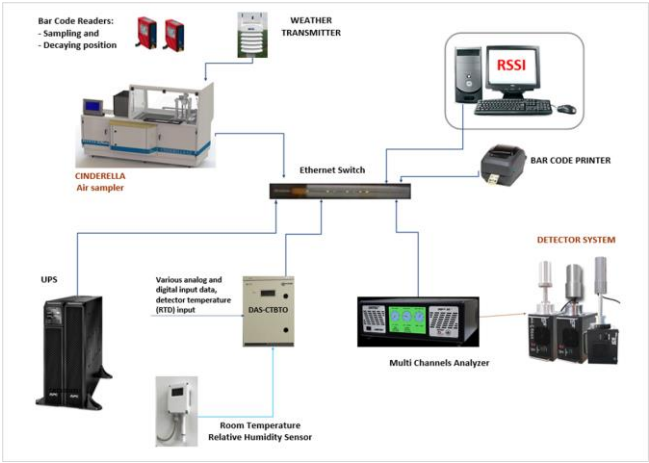


Several daily manual tasks: Filter change, Sample preparation, measurements, etc. Each step with the possibility of human errors.

The main principles of the integration:

- Keep (as much as possible) commonalities with manual station configuration
- Use of the same ancillary equipment:
  - weather transmitter
  - environmental and tamper sensors
  - UPS as for manual station
  - Authentication
- Use of the same detectors, with flexibility in detector choice
- Use of the same software and computer hardware

“Cinderella” G.2 based on the RN station hardware configuration



One monthly manual task, minimal possibility of human errors.

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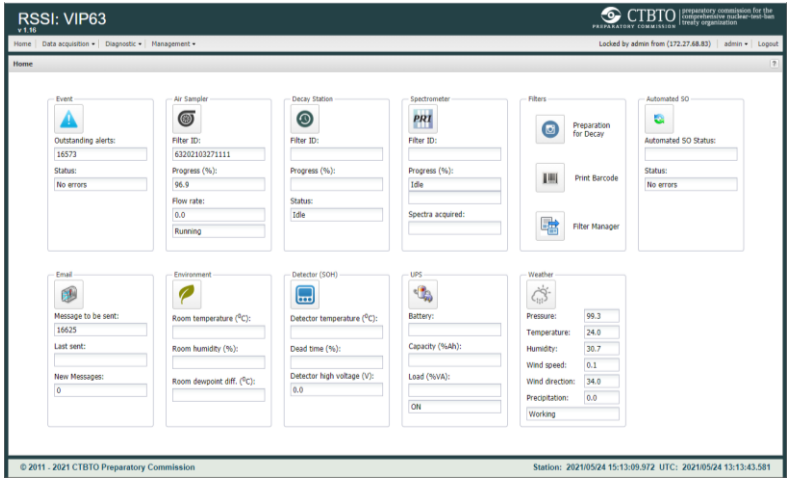
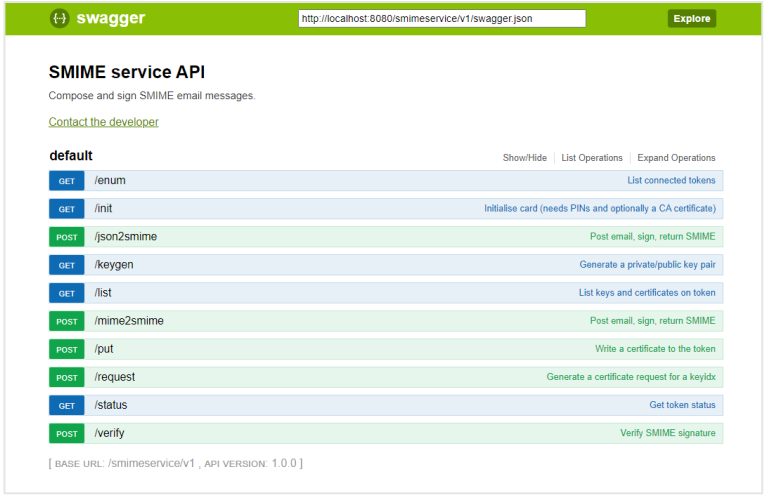
The entire In-house project for the integration of Cinderella 2 into IMS framework, including new Soft Ware with full control of the development from the PTS.

- All aspects controlled via new RSSI browser interface
- Cinderella specific module (Automated SO) continually updates status via poll
- Automatically performs routine tasks that currently require manual operator (measurement, etc.)



Radionuclide
Station
Software
Interface



- Authentication fully integrated via a web API
- Supports multiple tokens for flexibility
- Based on Python & OpenSC, maintainable
- Easy to set up

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Steps for integration Air sampler “Cinderella” G.2 into the standard configuration

- Cinderella Hardware testing and combining with other equipment:
  - Test of routine and special automated and manual operation modes
  - Assess lead shielding design change to accommodate multiple detector types
  - Integration with a detector system, DAS, ancillaries and an uninterrupted power supply
- Software: new RSSI upgrade to interface CINDERELLA G2 outputs
- Hardware upgrades:
  - Integration a QC source into CINDERELLA G2 (as for G1)
  - Integration with authentication tokens
- 6 months testing with full configuration
- Developing Standard Operation Procedures (SOP)
- System acceptance

START in Q3 2019

Item	Progress
Hardware	80%
Software	70%
SOP	30%
Testing	20%

EXPECTED FINISH in Q4 2021

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Air sampler “Cinderella” G.2 – Roll-out plan

As the old Cinderella systems have reached obsolescence and frequent problems are encountered, it is planned to roll out installation of Cinderella G2 systems without delay (after the new station configuration has been accepted). The test system has been assigned to RN63 and will be transferred and installed at RN63 once testing is complete. All five stations are planned to be upgraded within a 2-3 year time frame.

	Upgrade
ISP34 (Reykjavik)	Q1 2023
MXP44 (Mexico)	Q1 2023
NOP49 (Spitsbergen)	Q2 2022
PTP53 (Ponta Delgada)	Q1 2023
SEP63 (Stockholm)	Q1 2022