Interacting with STAX
- Data Access and Processing

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STAX Overview

The STAX (**S**ource **T**erm **A**nalysis of **X**enon) project is an experiment to better understand the radioxenon background in the environment.

Consists of a stack release monitoring network to measure radioxenon isotopes released from medical isotope production (MIP) facilities.

Data collected at MIP facilities is processed and securely transferred to a central data repository where additional processing is performed.

Five types of STAX data messages are generated and distributed to authorized users.

STAX Data Products

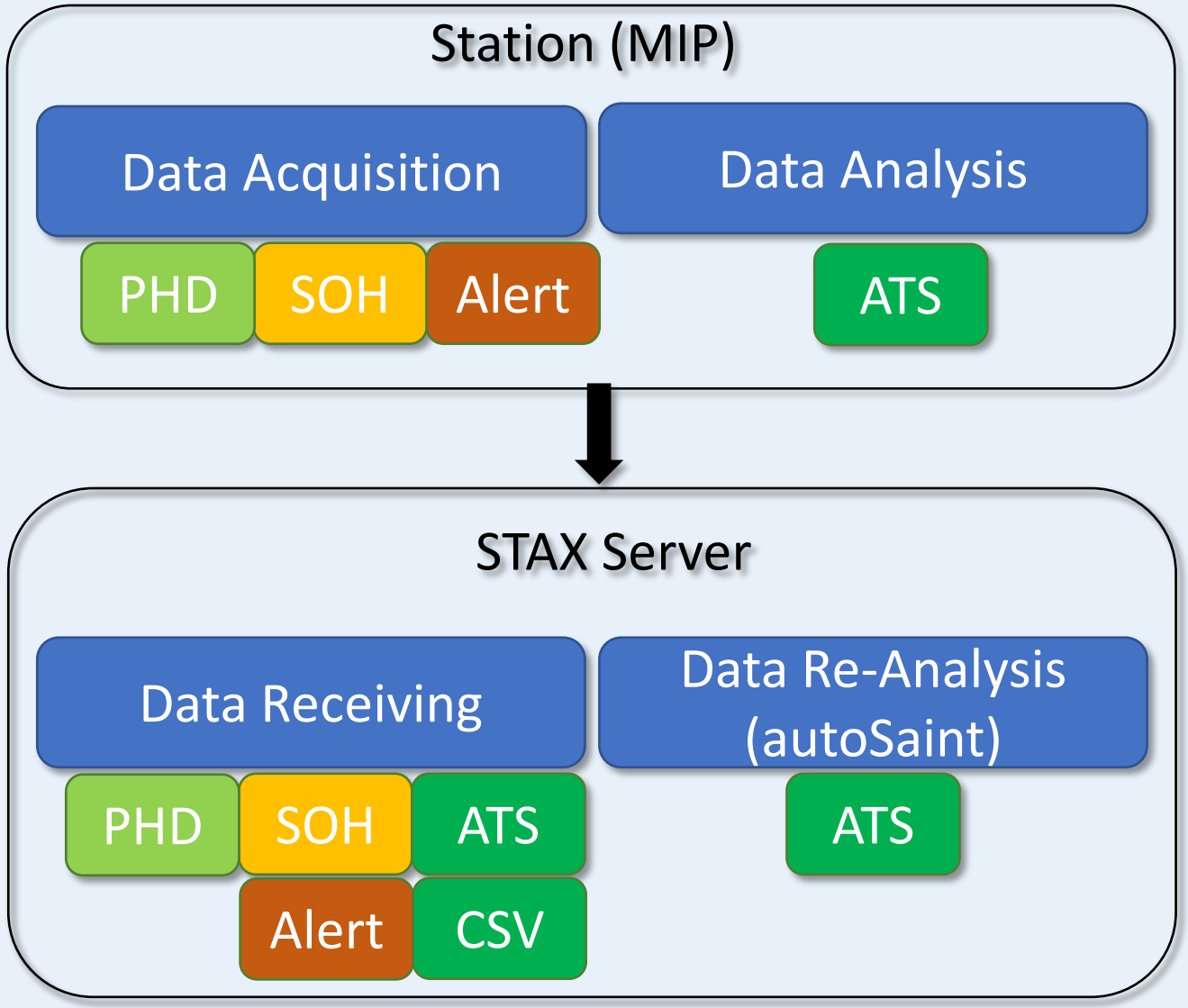
ATS - Automatic Time Series, daily results summary

CSV - Emissions time series as a comma-separated values file

SOH - State of health reports, every 2 hours

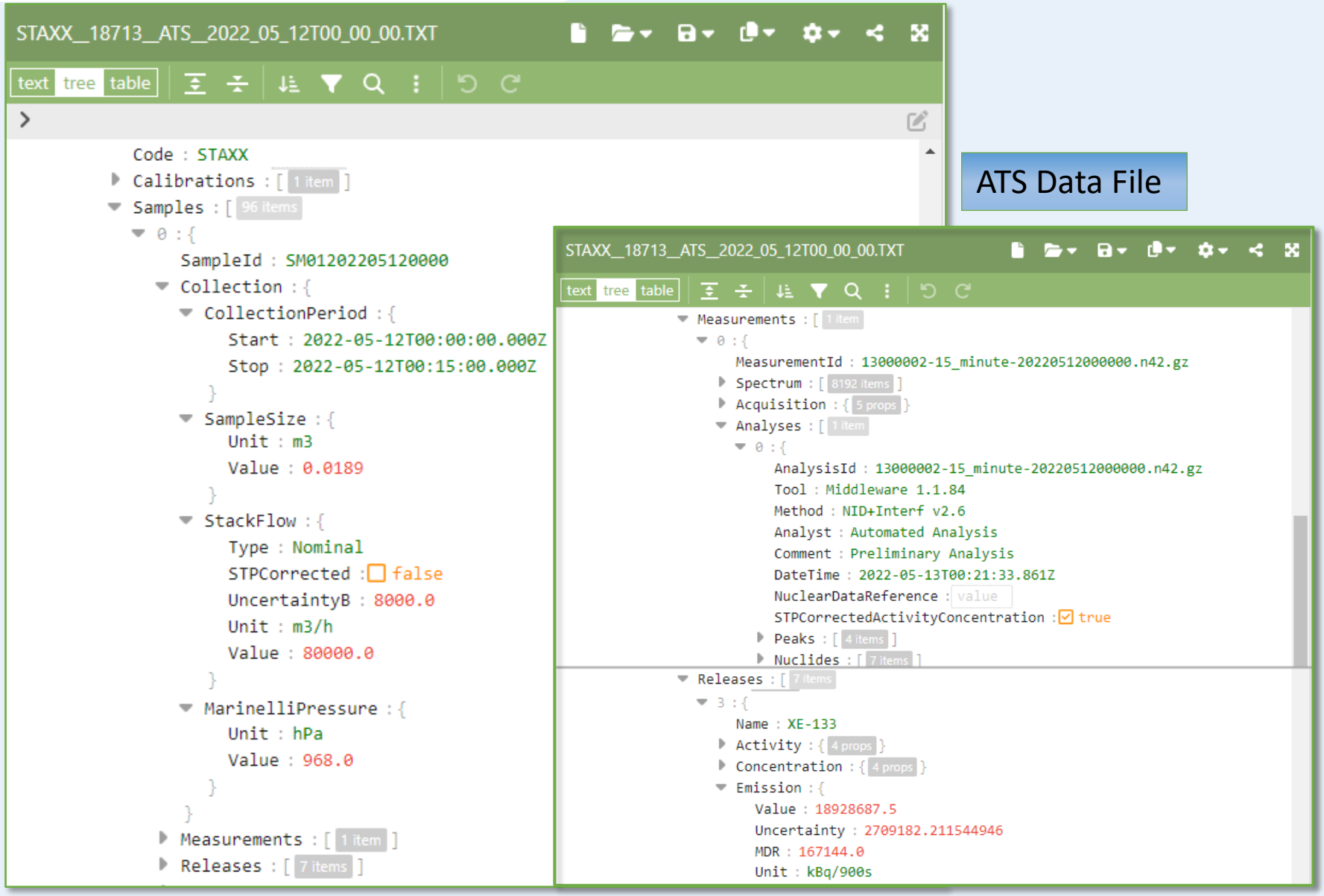
PHD - High-Resolution Gamma Spectra, every 15 minutes

Alert **-** sent from the Facility or STAX server when customizable alert conditions are met



ATS - Automatic Time Series

Daily results summary with ***sample data***, ***measurement*** and ***analysis*** results, in JSON text format

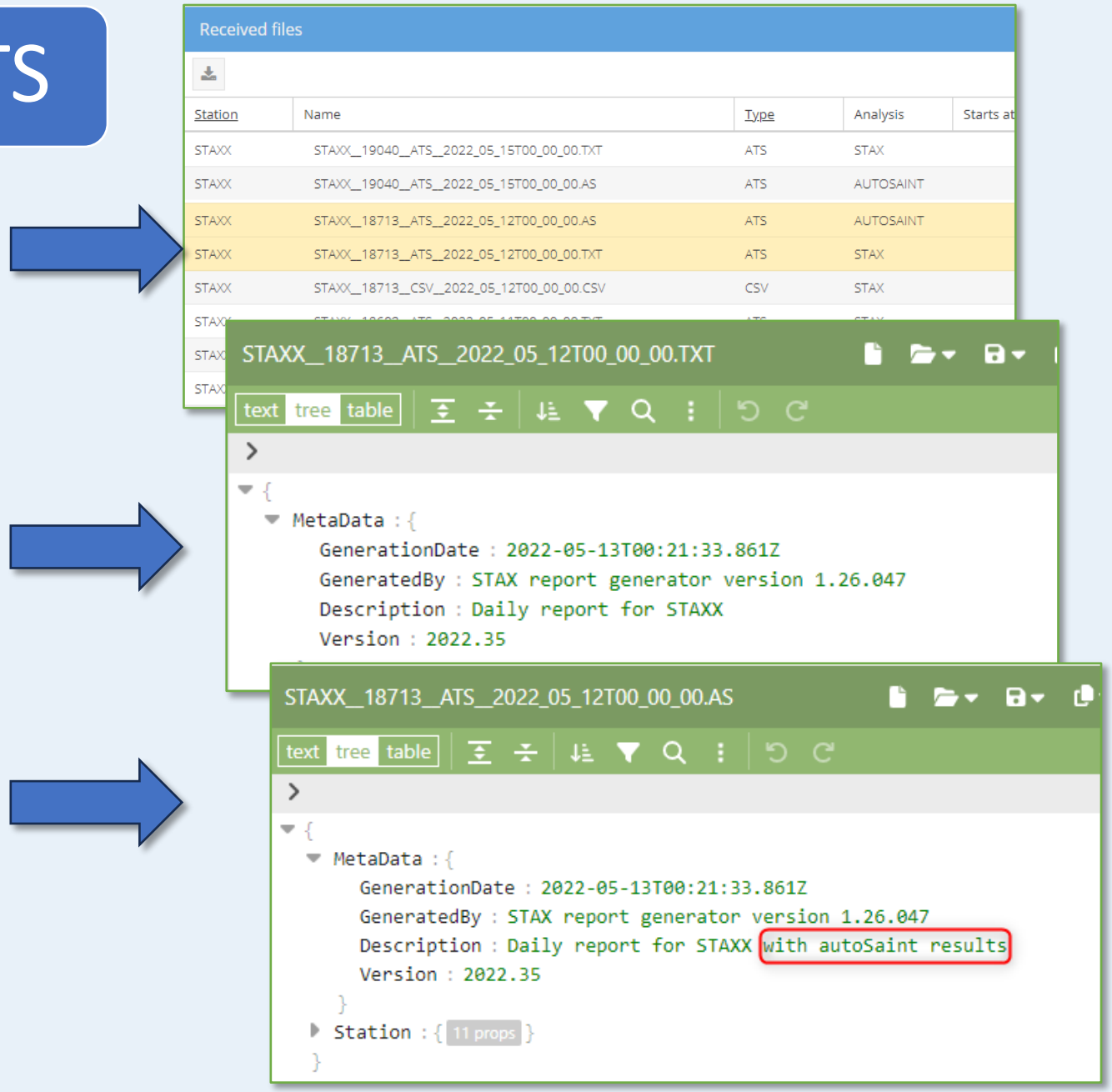


STAX and autoSaint ATS

Both STAX Station and autoSaint analysis results are stored on the STAX system as ATS data files

STAX ATS files (.TXT) result from station analysis

autoSaint ATS files (.AS) result from data re-analysis at the STAX server with CTBTO NDC-in-a-box tools



CSV - Emissions Time Series

Daily emissions time series
extracted from the ATS STAX files,
in Excel comma-separated values
(CSV) text format

CSV Data File

	A	B	D	H	O	P	R	S	T	V	W	AE
1	Station	Time	I-131 mdr	KR-85M mdr	XE-133 val	XE-133 mdr	XE-133 unc	XE-133M val	XE-133M mdr	XE-133M un	XE-135 val	Unit
2	STAXX	5/15/2022 0:00	3.77E+03	5.55E+03	6.21E+06	7.97E+04	8.94E+05		7.75E+04		9.73E+04	kBq/900s
3	STAXX	5/15/2022 0:15	4.95E+03	4.26E+03	6.22E+06	8.31E+04	8.95E+05		6.94E+04		7.90E+04	kBq/900s
4	STAXX	5/15/2022 0:30	4.09E+03	4.47E+03	6.36E+06	8.32E+04	9.15E+05		7.56E+04		9.10E+04	kBq/900s
5	STAXX	5/15/2022 0:45	4.74E+03	4.71E+03	6.36E+06	7.91E+04	9.14E+05		7.79E+04		9.54E+04	kBq/901s
6	STAXX	5/15/2022 1:00	3.75E+03	4.26E+03	6.22E+06	8.02E+04	8.94E+05	3.20E+05	3.59E+04	6.09E+04	7.47E+04	kBq/900s
7	STAXX	5/15/2022 1:15	4.71E+03	4.28E+03	6.08E+06	8.20E+04	8.75E+05		7.41E+04		8.68E+04	kBq/900s
8	STAXX	5/15/2022 1:30	3.40E+03	5.16E+03	5.96E+06	8.37E+04	8.58E+05		6.91E+04		8.72E+04	kBq/900s
9	STAXX	5/15/2022 1:45	4.13E+03	4.51E+03	5.93E+06	9.03E+04	8.54E+05		6.58E+04		8.44E+04	kBq/900s
10	STAXX	5/15/2022 2:00	3.76E+03	4.49E+03	6.14E+06	8.24E+04	8.83E+05		6.87E+04		8.07E+04	kBq/900s
92	STAXX	5/15/2022 22:30	2.34E+03	5.38E+03	3.25E+07	1.77E+05	4.64E+06	6.80E+05	4.59E+04	1.09E+05		kBq/900s
93	STAXX	5/15/2022 22:45	3.84E+03	5.49E+03	3.22E+07	1.91E+05	4.60E+06	7.14E+05	4.23E+04	1.13E+05		kBq/900s
94	STAXX	5/15/2022 23:00	4.49E+03	4.56E+03	3.23E+07	1.87E+05	4.62E+06	7.87E+05	3.75E+04	1.22E+05		kBq/900s
95	STAXX	5/15/2022 23:15	4.13E+03	4.89E+03	3.19E+07	1.79E+05	4.57E+06	6.79E+05	4.08E+04	1.08E+05		kBq/900s
96	STAXX	5/15/2022 23:30	4.75E+03	5.10E+03	3.16E+07	1.85E+05	4.52E+06	6.46E+05	5.08E+04	1.06E+05		kBq/900s
97	STAXX	5/15/2022 23:45	3.44E+03	4.78E+03	3.20E+07	1.88E+05	4.57E+06	6.26E+05	4.88E+04	1.03E+05		kBq/900s

STAXX_19040_CSV_2022_05_15T0

SOH – State of Health Data

SOH data samples collected every 15 minutes, and reported every 2 hours, in text format

SOH reports contain equipment parameters available from the station like air flow, high voltage, status, cooler power, temperature

SOH Data File

STAXX_53789_SOH_2023_04_22

```
BEGIN IMS2.0
MSG_TYPE DATA
MSG_ID 053789 STAXX
DATA_TYPE STAXSOH
#Header 3
STAXX NA
2023/04/22 20:00:00   2023/04/22 22:00:00   2023/04/22 22:30:36
#AirSamplerFlow
3.4000     -9999.999   2023/04/22 20:00:00   900
3.4000     -9999.999   2023/04/22 20:15:00   900
3.4000     -9999.999   2023/04/22 21:45:00   900
#DetEnv
-9.9  CLOSED -9  4187  -185 ON  -9.9 -99.99 2023/04/22 20:00:00   900
-9.9  CLOSED -9  4187  -185 ON  -9.9 -99.99 2023/04/22 20:15:00   900
-9.9  CLOSED -9  4187  -185 ON  -9.9 -99.99 2023/04/22 21:45:00   900
#PowerSupply
MAIN ON  AUX OFF UPS OFF 2023/04/22 20:00:00   900
#EquipStatus
C: SM01202304222000 P: SM01202304222000 A: SM01202304222000 2023/04/22 20:00:00   900
#ProcessSensors
CoolerPower     CP5Power            103.53              2023/04/22 20:00:00   900
Temp            Compressor          43.30               2023/04/22 20:00:00   900
CoolerPower     CP5Power            103.82              2023/04/22 20:15:00   900
Temp            Compressor          43.30               2023/04/22 20:15:00   900
CoolerPower     CP5Power            103.89              2023/04/22 21:45:00   900
Temp            Compressor          43.30               2023/04/22 21:45:00   900
STOP
```

PHD – Spectra Data

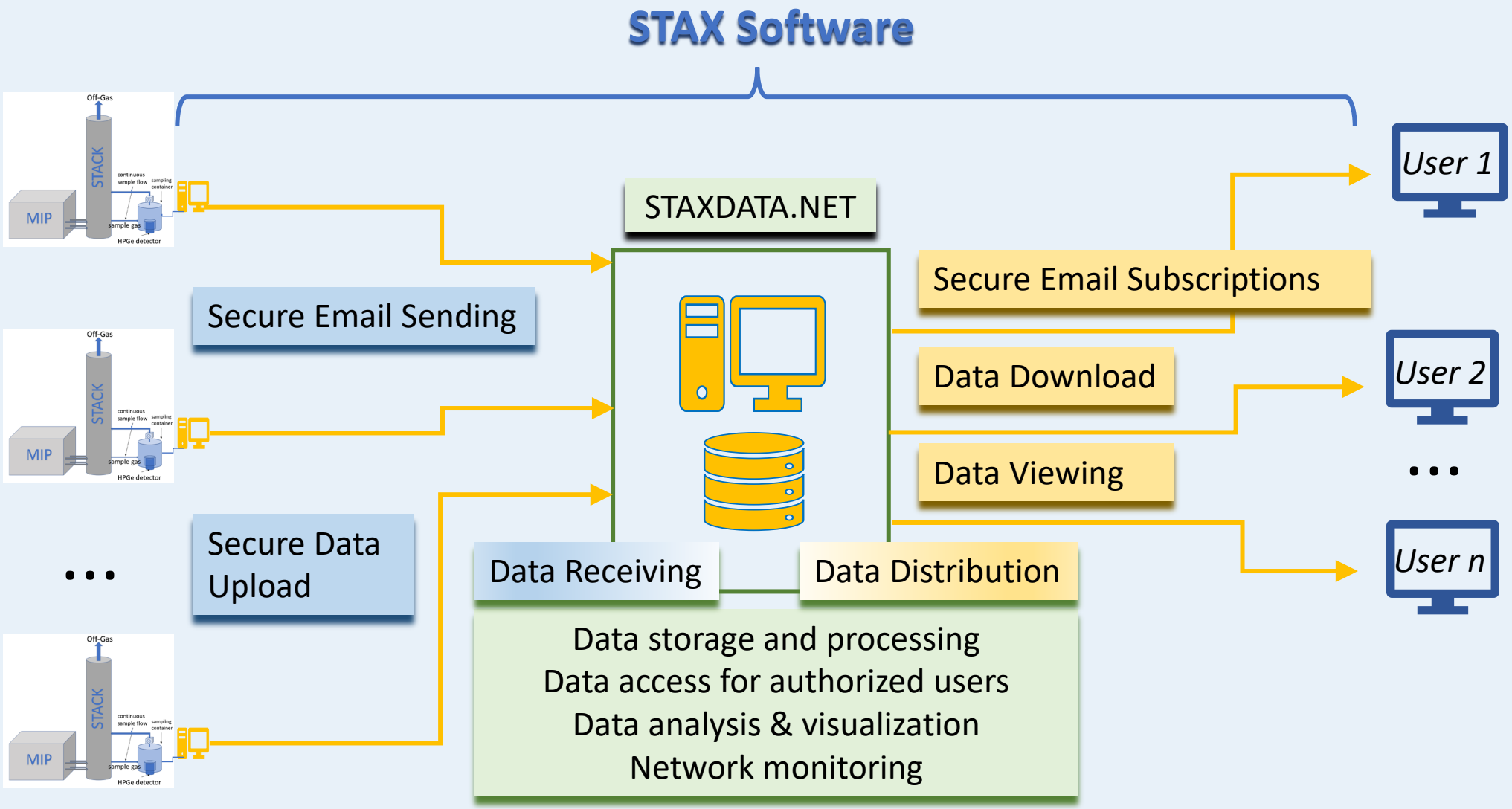
High-resolution gamma spectra collected every 15 minutes

Contains collection information, energy, resolution and efficiency calibration, and spectrum data, in a text format similar with IMS2.0

PHD Data File

```
BEGIN STX1.0
MSG_TYPE DATA
MSG_ID 019037 STAXX
DATA_TYPE SAMPLEPHD
#Header 3
STAXX STAXX_001 P Marinelli         FULL
SM01202205152345
STAXX_001-2022/05/15-23:45
2022/05/16 00:21:49
#Collection
2022/05/15 23:45:00.0 2022/05/16 00:00:00.0 0.01890    20000.0000 -999.99    965.0000
#Acquisition
2022/05/15 23:45:00.0 900.000        899.556
#Sample
-999  -999
#Calibration
2022/03/28 08:55:09.0
#g_Energy
80.997000         246.157          0.000
1332.490000       4044.520         0.000
#g_Resolution
0.000             0.513189         0.000
269.959           1.105450         0.000
2699.590          2.386120         0.000
#g_Efficiency
45.000            0.000248         0.000037
2800.000          0.000990         0.000040
#g_Spectrum
8192  2700
0     7           45          45          30          87
5     310         115         7           7           1
10    1           12          12          65          300
8185  0           0           0           0           0
8190  0           0
STOP
```

STAX Monitoring System

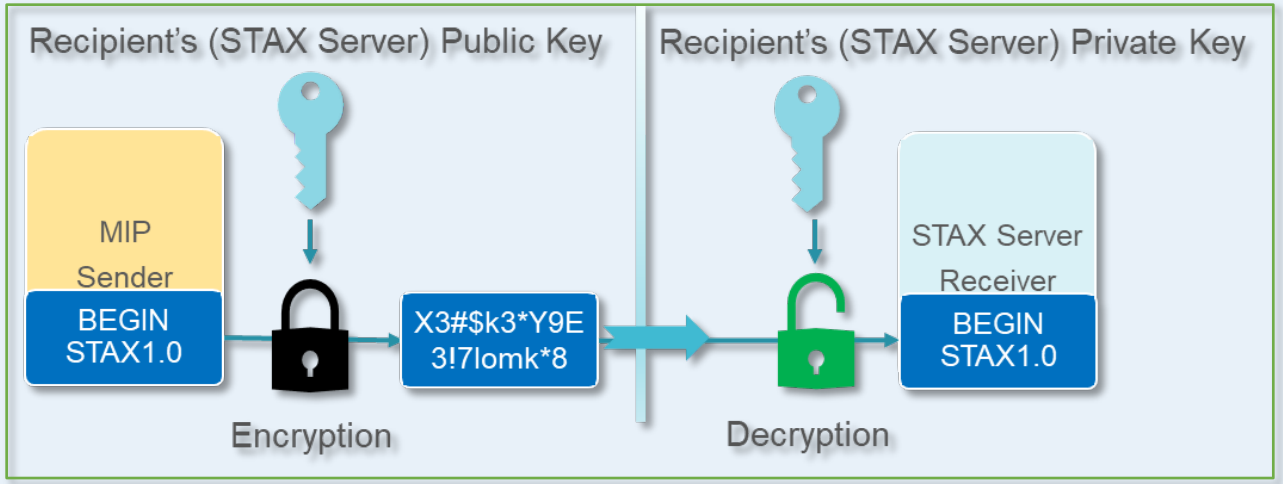


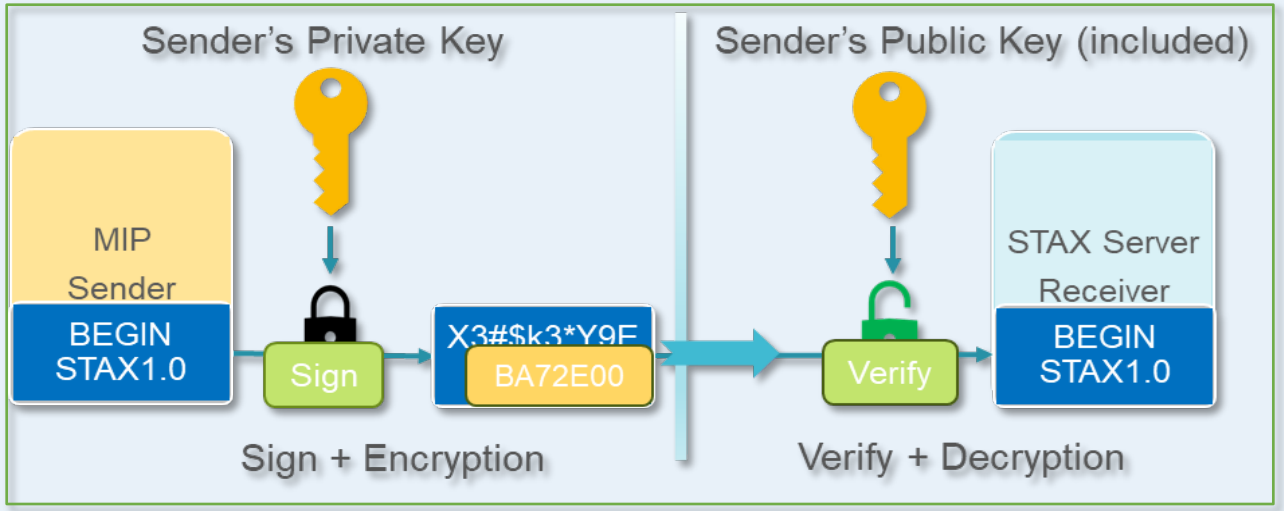
Secure Station Emails

STAX email messages **privacy** is protected by using ***encryption***, where messages are converted from readable plain text into scrambled cipher text for transmission.

STAX software **secures** email messages by using a ***digital signature***, including a certificate and public key. Messages signed using the sender's private key are verified at the STAX Server using the public key that is included in the message.

All data messages transmitted by email are encrypted and digitally signed at the MIP, then decrypted and verified upon receipt at the STAX Server.



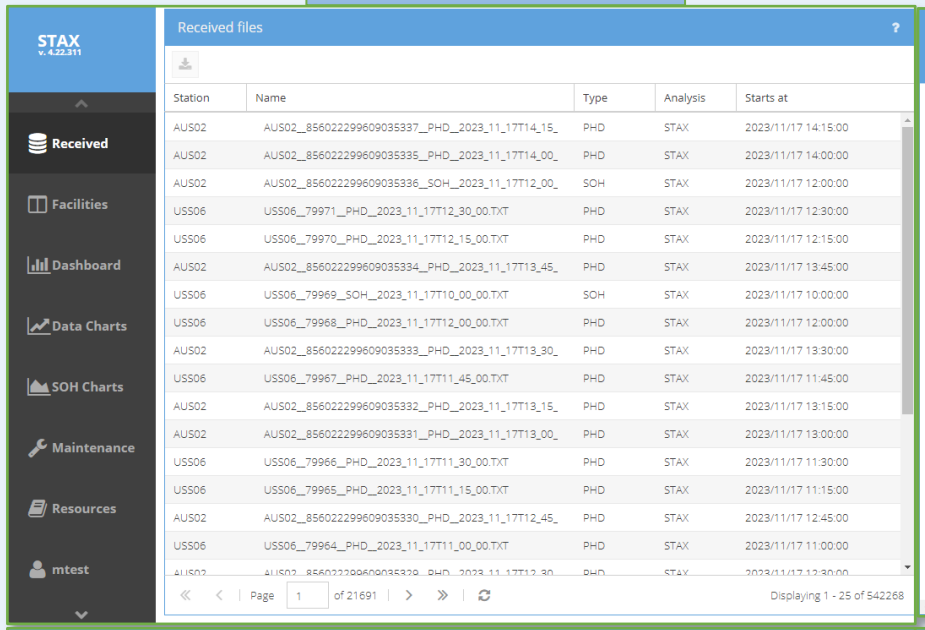


STAX Web Interface

Provides tools for accessing the data received from facilities and for viewing the analysis results.

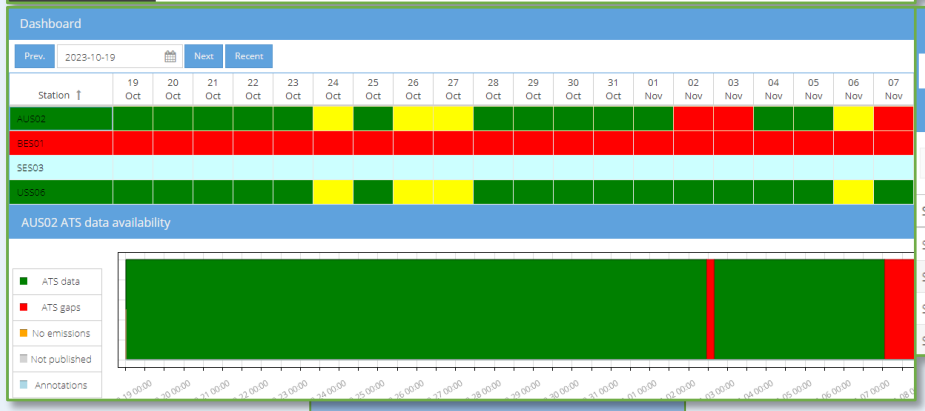
Access to SOH status, maintenance events, documentation, and other data resources.

Received Data

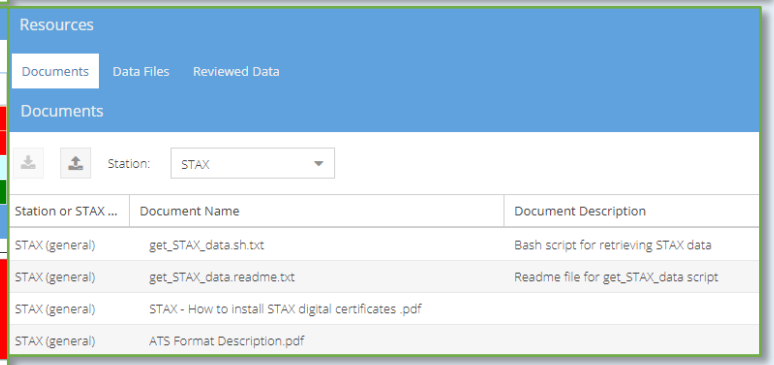


Data Charts

SOH Dashboard



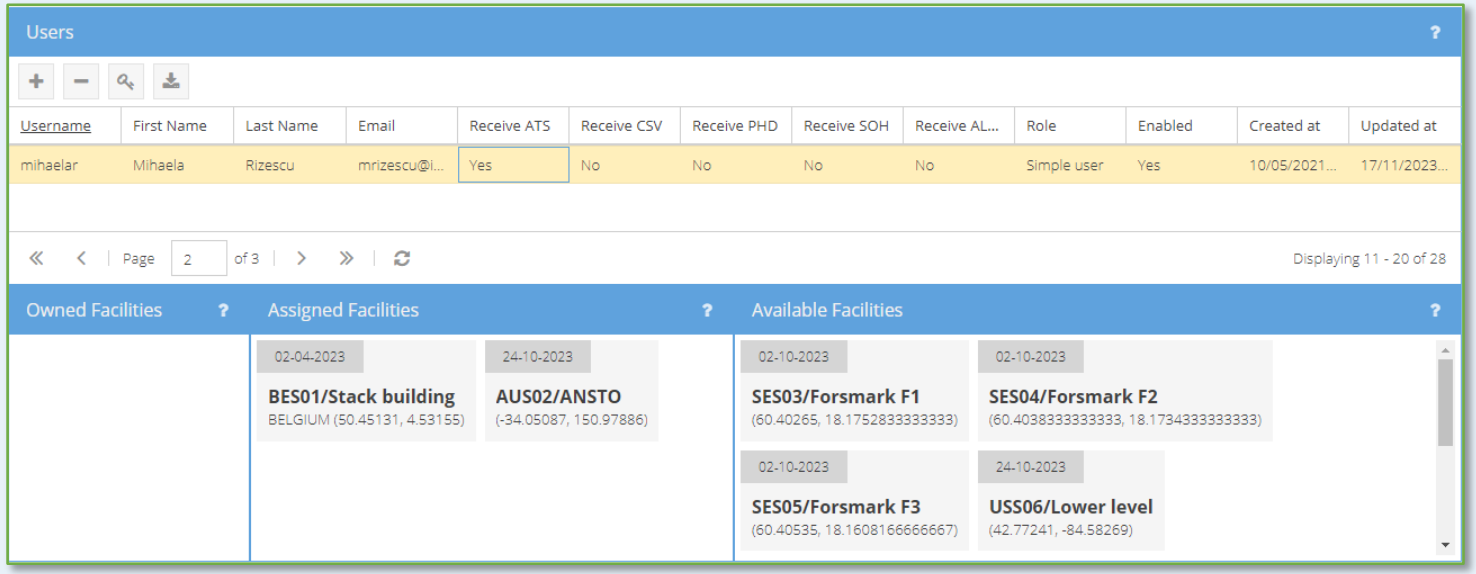
Resources

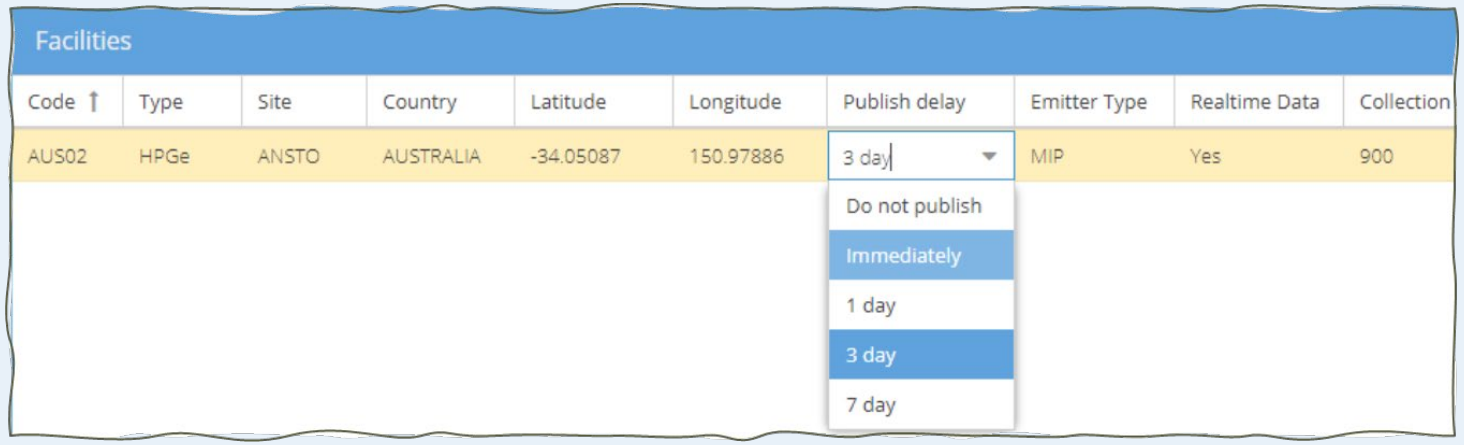


STAX Data Access Control

- User data access is set for each facility separately, so that the user has access to the specifically ***assigned facilities***.

- Facility owners can set and control ***delays*** for publishing data, to allow time for data review before distributing.





STAX Data Access

Data is accessible to ***authorized*** users using several mechanisms:

- Subscription with secure email messages
- Secured download of the received data files by user interaction from the STAX web interface
- Secured download using an automated, scripted procedure
- Multiple data viewing and saving options from the staxdata.net web user interface

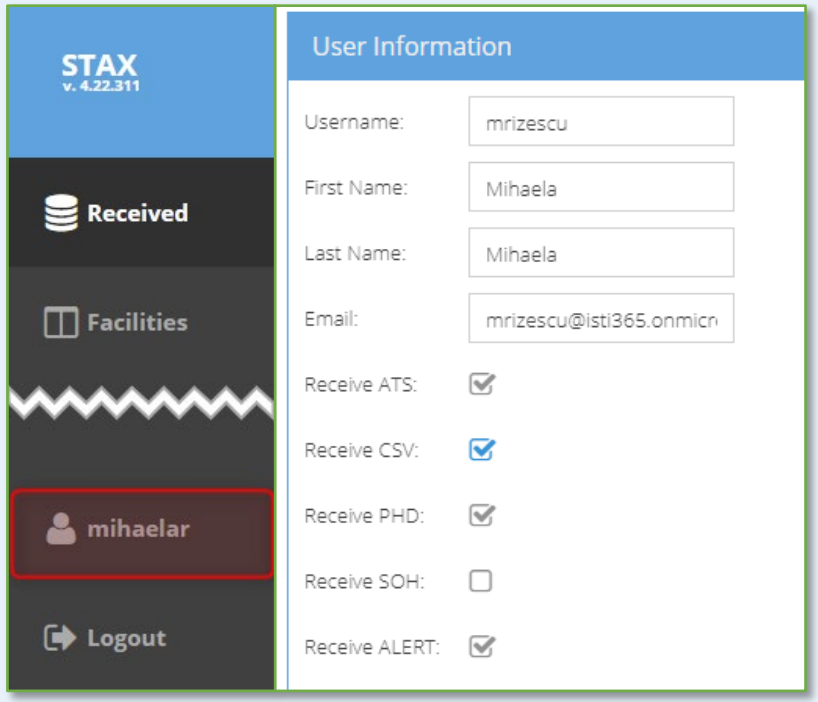
Email Subscriptions

Subscription preferences can be set on the ***User*** page at staxdata.net

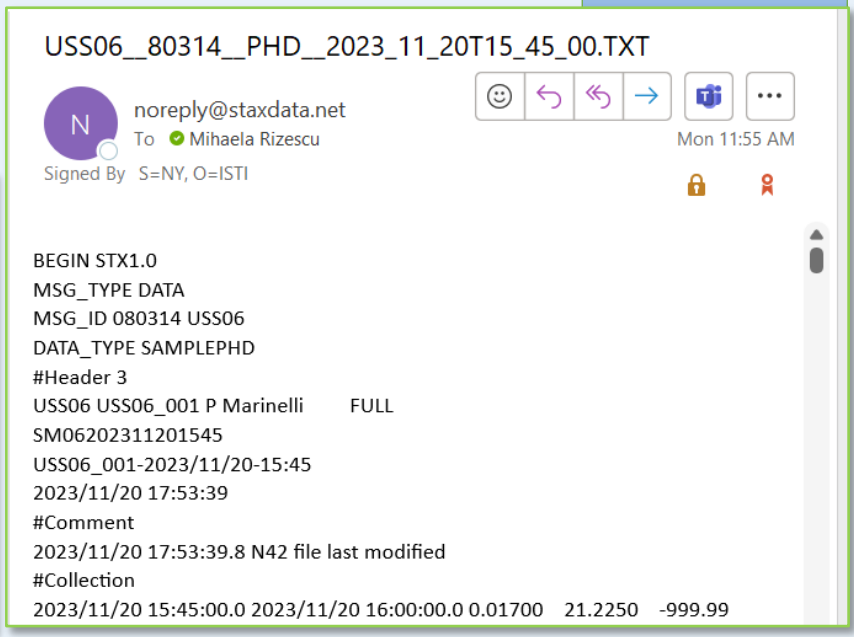
Available for each of the five data products: ATS, CSV, PHD, SOH, ALERT

Emails sent for all authorized stations

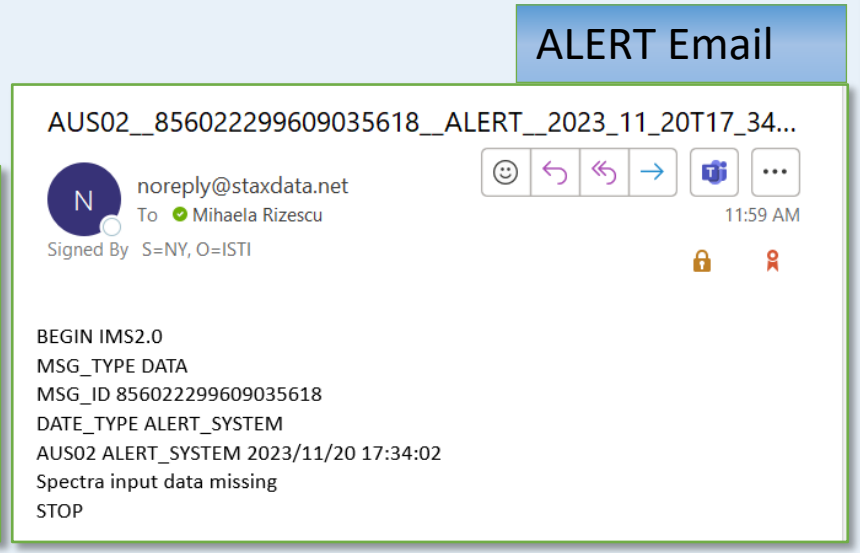
Data file name is the email subject



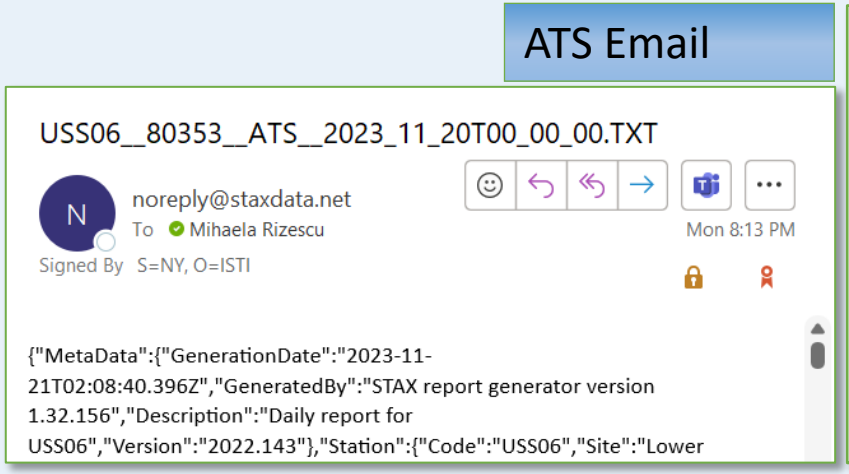
PHD Email



ALERT Email



ATS Email

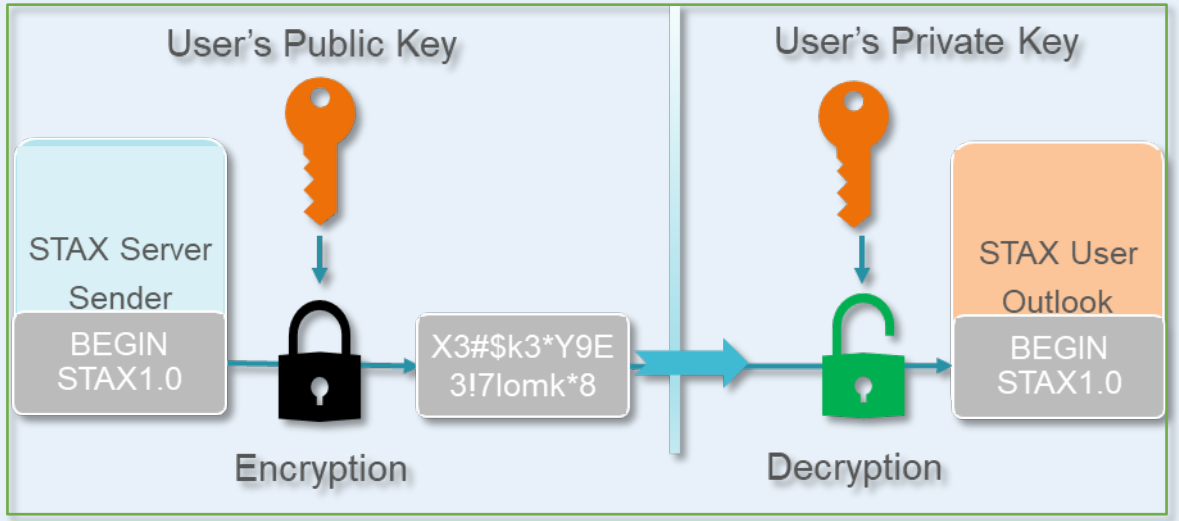


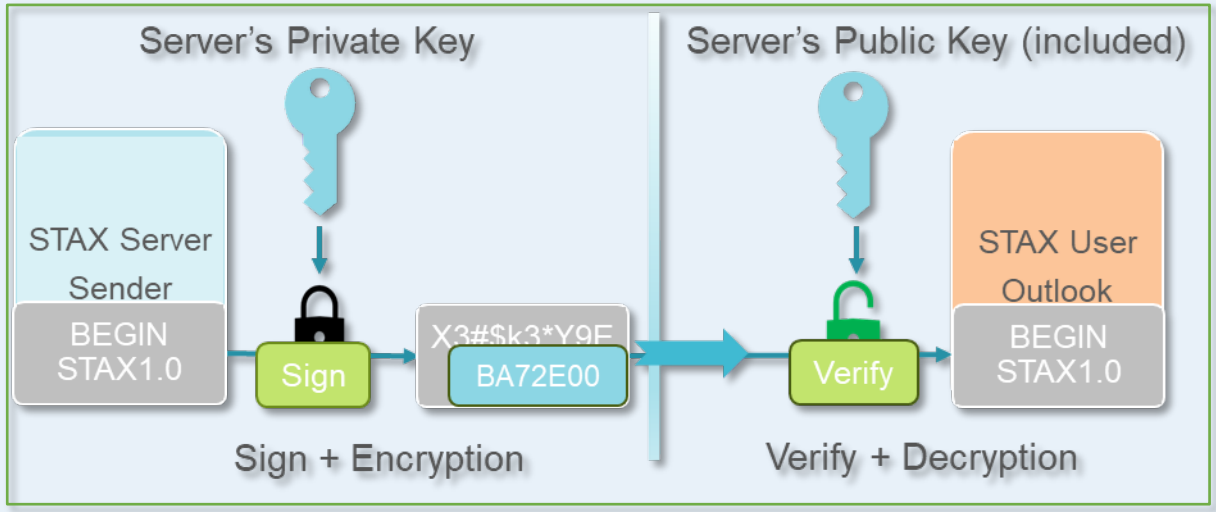
Secure User Emails

The privacy of the emails distributed from the STAX server to the users is protected by using ***S/MIME encryption***, supported by Outlook email client.

From the STAX web interface, users can ***generate*** their own encryption certificate, and ***download*** it to use for decryption in Outlook.

STAX user email messages are secured by using a ***digital signature*** originating from the STAX server's digital ID.



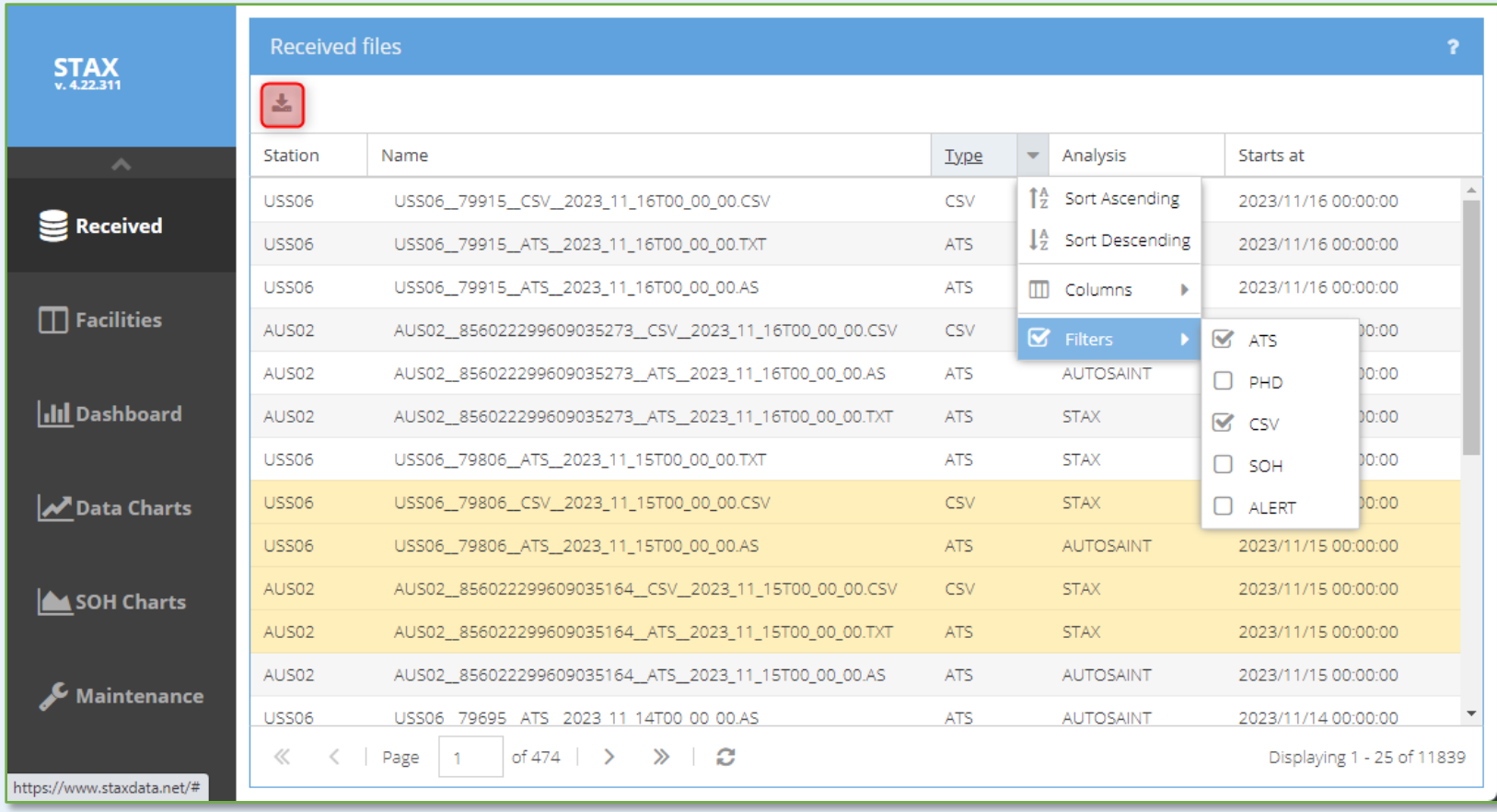


Received Data Files Download

STAX users can use a web browser to securely access staxdata.net and download data files using the application's user interface.

On ***Received*** page, data files can be filtered by station name, data type, analysis type, or start time.

Multiple files can be selected and retrieved by a single click on the Download button.



Automated Data Files Download

Secured download using shell script:

get_STAX_data.sh

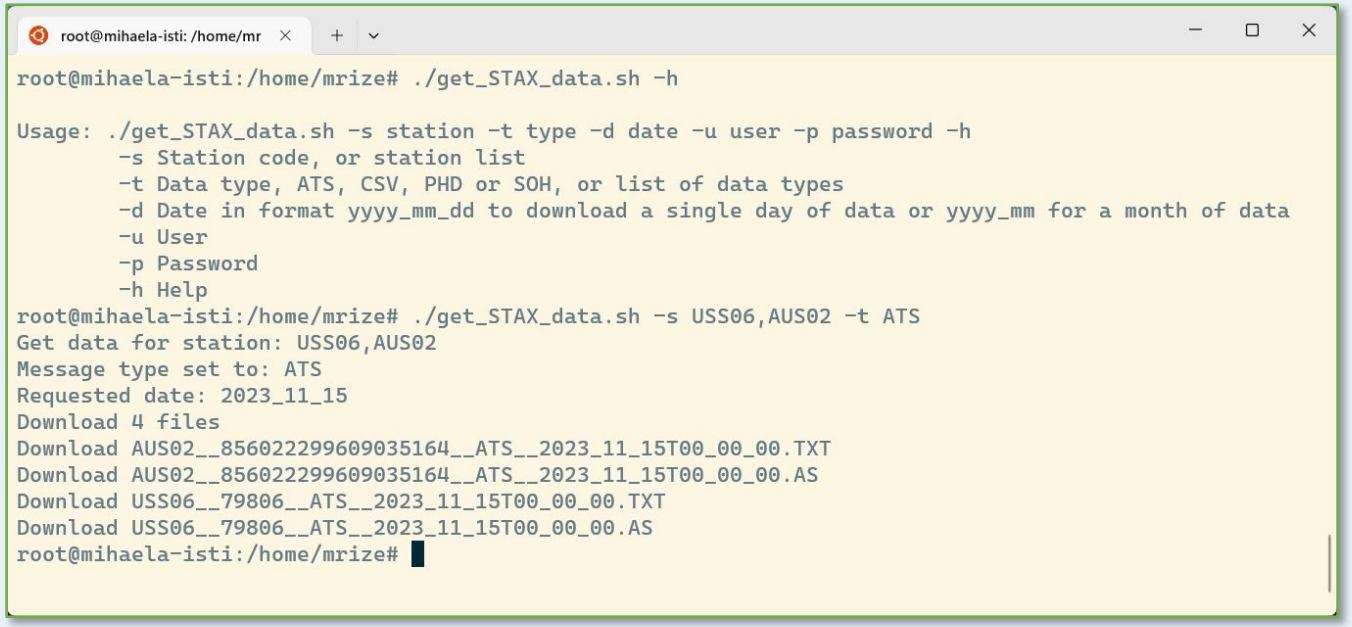
Retrieves data files for selected stations and product types

Single station or multiple stations in one step

One or more data types from ATS, CSV, PHD, SOH, ALERT can be configured

Single day, or one month data download in one run

Shell script runs on Linux, macOS, Ubuntu on Windows, and requires wget, python



STAX Data Viewer (separate presentation by Matthias Auer)

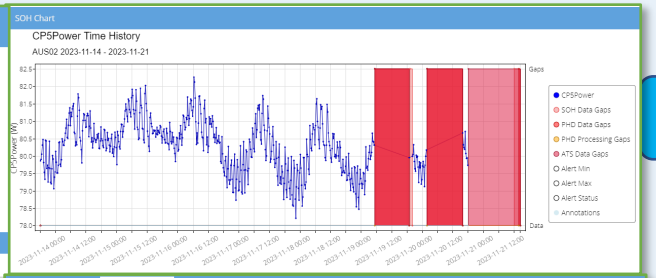
STAX web interface provides data charts viewing for:

- ***emissions time series***
- ***isotopic ratios***
- ***spectra and peaks***
- ***state-of-health data***
- ***long term trends***
- ***impact on IMS monitoring***

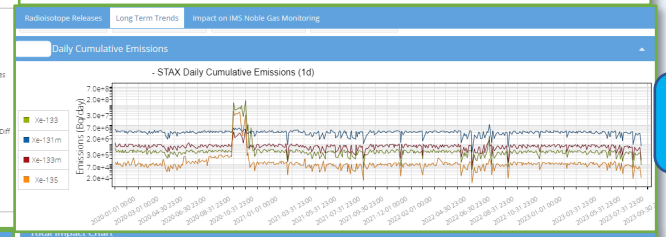
Allows the user to inspect the STAX and autoSaint analysis results

Emissions

SOH

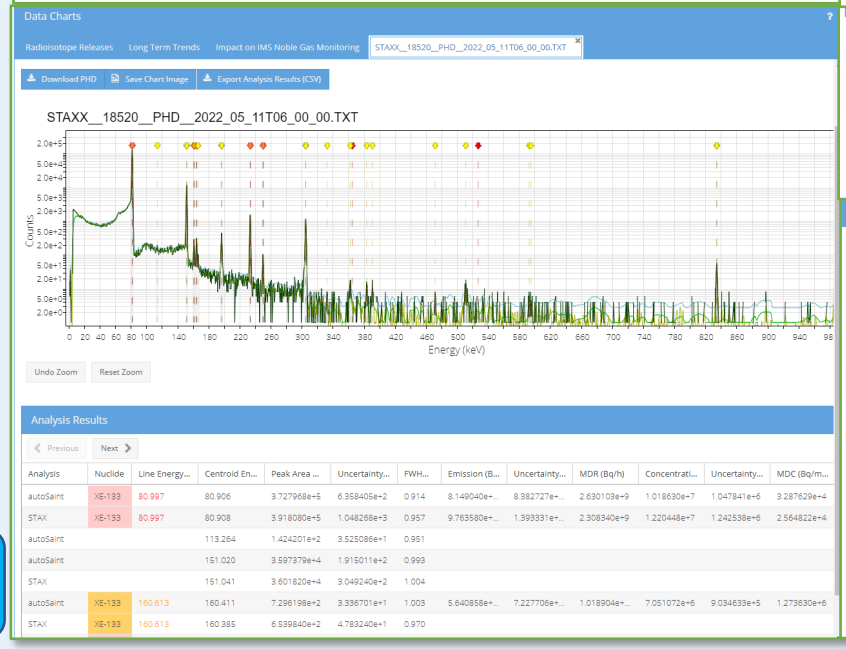


Trends

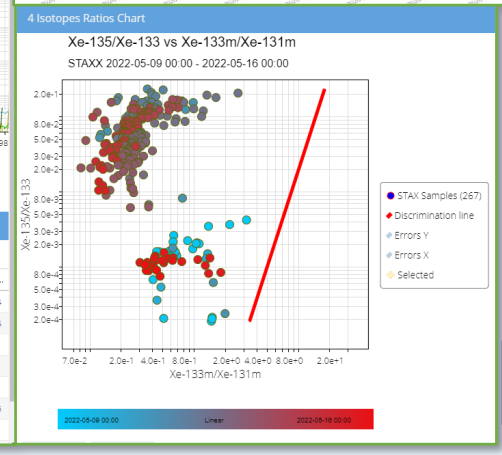


IMS Impact

Spectra & Peaks



Isotopic Ratios



ATS Download from Emissions Chart

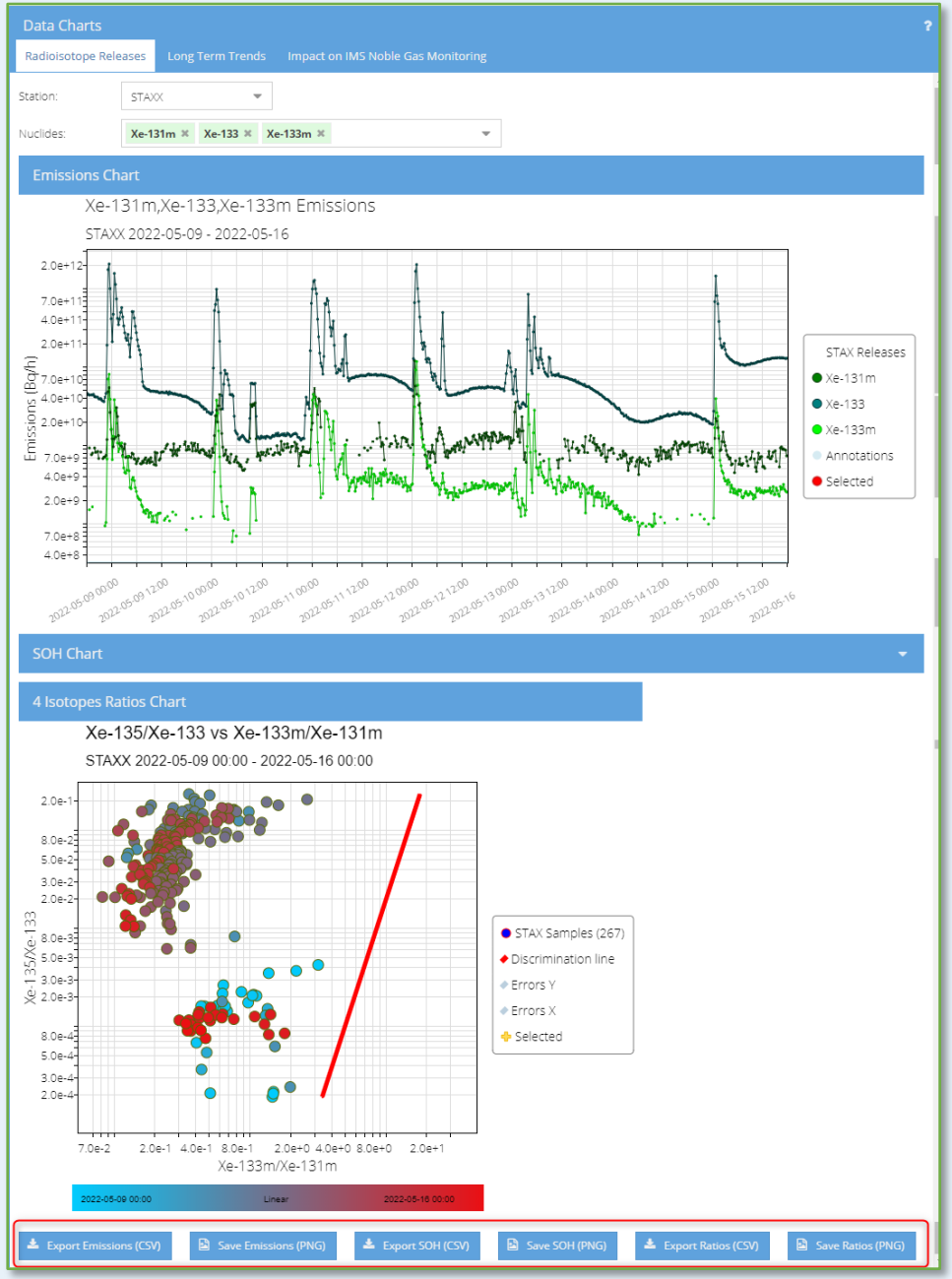
From the ***Emissions Chart***, the user can select a sample and open a menu to download the STAX ATS file of the day containing the selected data sample

Charts Data and Results

From each data charts page, the STAX user can export the data used for the plot in CSV format, and the chart image as PNG, and download the files

Releases page contains multiple charts and exports – emissions, SOH and isotopic ratios

Data exports for emissions, SOH and isotope ratios charts



Customized Emissions Time Series

Emissions time series, in units of Bq/h, can be exported from the ***Emissions Chart*** page

Both STAX and autoSaint emissions data for the entire selected time interval (e.g. one week), as Excel comma-separated values file (CSV)

	A	I	J	K	L	M	N	O	P
1	time	Xe-133 STAX	Xe-133 autoSaint	Xe-133 diff	Xe-133 MDR STAX	Xe-133 MDR autoSaint	Xe-133 err STAX	Xe-133m STAX	Xe-133m autoSaint
2	5/9/2022 0:00	4.55768E+10	3.79209E+10	7.65580E+09	4.28439E+08	5.72950E+08	6.53226E+09		1.05971E+09
3	5/9/2022 0:15	4.39512E+10	3.66511E+10	7.30008E+09	4.78233E+08	6.02388E+08	6.30251E+09		1.12023E+09
4	5/9/2022 0:30	4.33013E+10	3.64042E+10	6.89704E+09	4.34919E+08	5.72495E+08	6.20808E+09	1.49335E+09	1.31288E+09
5	5/9/2022 0:45	4.34536E+10	3.69469E+10	6.50669E+09	4.84477E+08	5.67073E+08	6.23165E+09		9.51448E+08
6	5/9/2022 1:00	4.37118E+10	3.65023E+10	7.20950E+09	4.12619E+08	5.79780E+08	6.26554E+09		9.83189E+08
662	5/15/2022 21:00	1.29222E+11	1.07298E+11	2.19244E+10	7.56344E+08	9.57444E+08	1.84664E+10	2.33967E+09	2.23750E+09
663	5/15/2022 21:15	1.28504E+11	1.07681E+11	2.08222E+10	8.13258E+08	9.70364E+08	1.83652E+10	2.81920E+09	2.50699E+09
664	5/15/2022 21:30	1.28969E+11	1.07325E+11	2.16440E+10	7.35660E+08	9.37319E+08	1.84303E+10	2.62093E+09	2.48196E+09
665	5/15/2022 21:45	1.30638E+11	1.09046E+11	2.15928E+10	7.47829E+08	9.48671E+08	1.86690E+10	2.35941E+09	2.13002E+09
666	5/15/2022 22:00	1.29720E+11	1.09253E+11	2.04672E+10	7.78453E+08	9.53490E+08	1.85391E+10	2.22324E+09	2.13160E+09
667	5/15/2022 22:15	1.28675E+11	1.07365E+11	2.13097E+10	7.27364E+08	9.64082E+08	1.83888E+10	2.95460E+09	2.67988E+09
668	5/15/2022 22:30	1.29816E+11	1.09669E+11	2.01465E+10	7.08868E+08	9.64104E+08	1.85514E+10	2.71820E+09	2.45816E+09
669	5/15/2022 22:45	1.28663E+11	1.07859E+11	2.08049E+10	7.65203E+08	9.53096E+08	1.83886E+10	2.85737E+09	2.50398E+09
670	5/15/2022 23:00	1.29318E+11	1.07560E+11	2.17589E+10	7.47056E+08	9.78078E+08	1.84816E+10	3.14728E+09	2.79085E+09
671	5/15/2022 23:15	1.27794E+11	1.06426E+11	2.13678E+10	7.15808E+08	9.46375E+08	1.82635E+10	2.71692E+09	2.46456E+09
672	5/15/2022 23:30	1.26455E+11	1.06124E+11	2.03308E+10	7.38704E+08	9.58163E+08	1.80731E+10	2.58487E+09	2.31485E+09
673	5/15/2022 23:45	1.27991E+11	1.07064E+11	2.09274E+10	7.53244E+08	9.37956E+08	1.82928E+10	2.50583E+09	2.14038E+09
674									

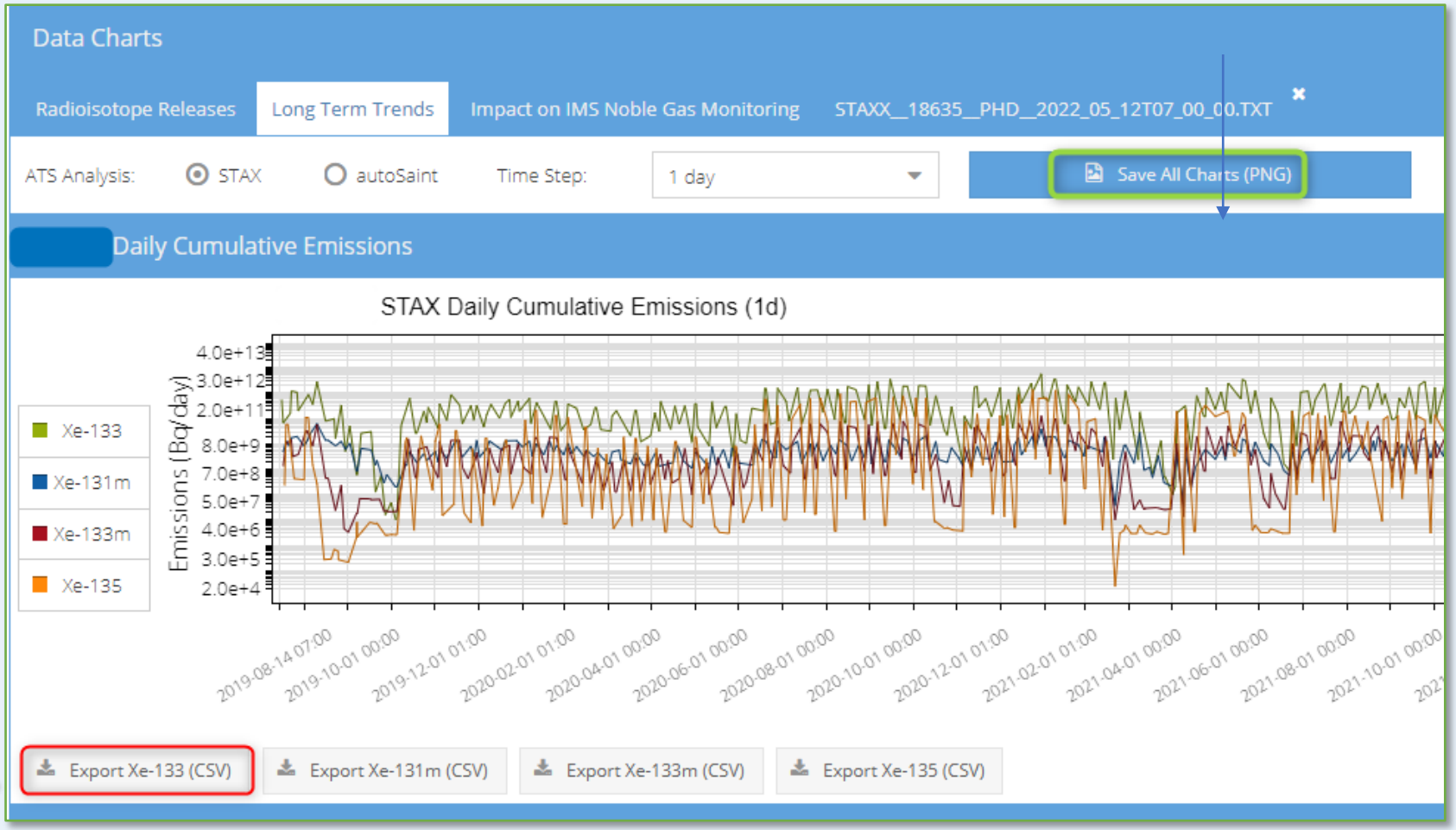
STAXX_emissions_Xe-131m_Xe-133_

Long Term Trends Data

All station charts images can be saved from one button

Time history of daily cumulative emissions from STAX or autoSaint analysis can be exported as CSV

- from each station chart
- for each of the four Xenon radionuclides (Xe-133, Xe-131m, Xe-133m, Xe-135) individually

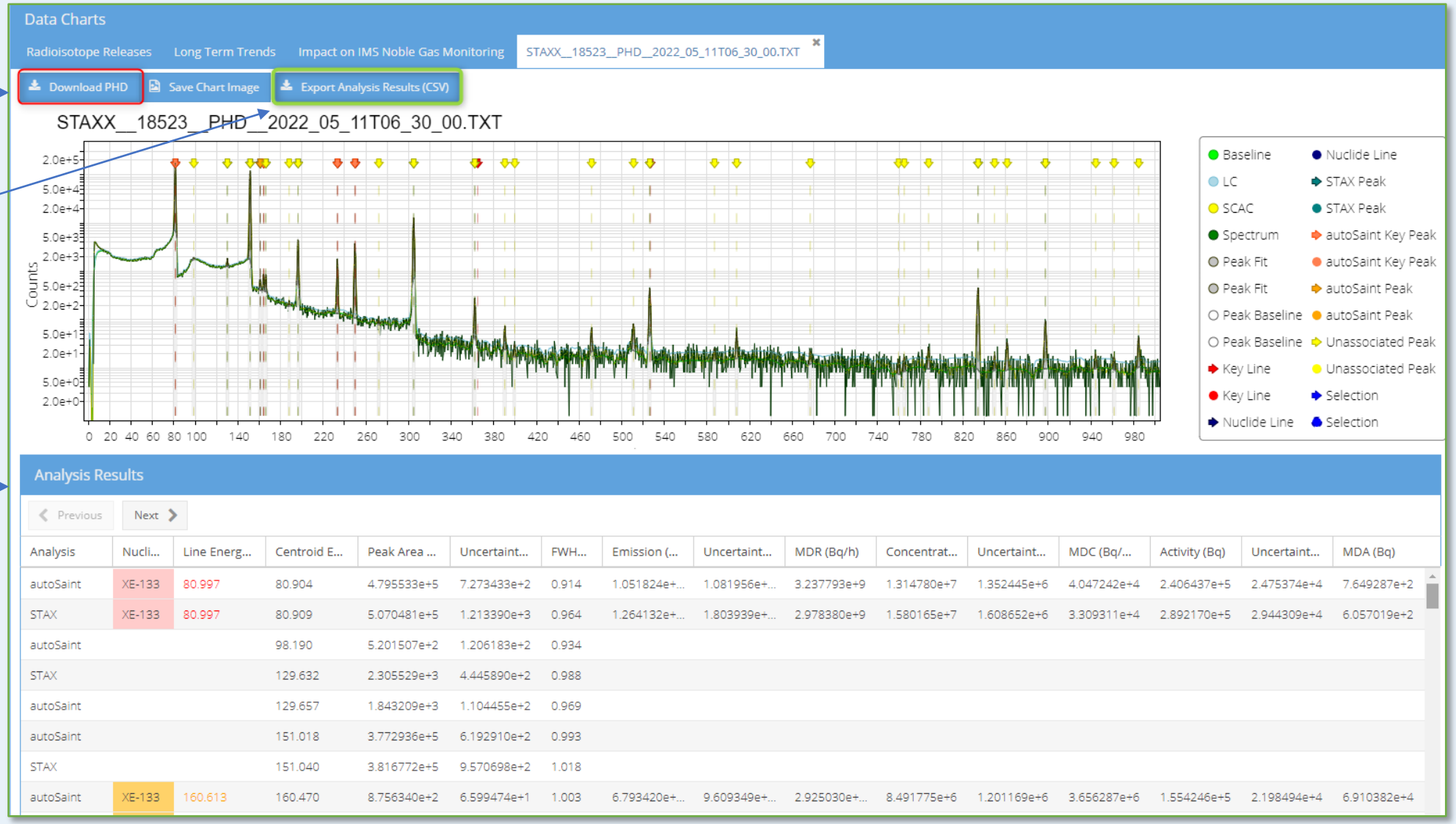


Spectra Charts Data

PHD file download

Analysis results CSV export

STAX and autoSaint analysis results, including emissions and peaks



Analysis	Nucli...	Line Energ...	Centroid E...	Peak Area ...	Uncertaint...	FWH...	Emission (...	Uncertaint...	MDR (Bq/h)	Concentrat...	Uncertaint...	MDC (Bq/...	Activity (Bq)	Uncertaint...	MDA (Bq)
autoSaint	XE-133	80.997	80.904	4.795533e+5	7.273433e+2	0.914	1.051824e+...	1.081956e+...	3.237793e+9	1.314780e+7	1.352445e+6	4.047242e+4	2.406437e+5	2.475374e+4	7.649287e+2
STAX	XE-133	80.997	80.909	5.070481e+5	1.213390e+3	0.964	1.264132e+...	1.803939e+...	2.978380e+9	1.580165e+7	1.608652e+6	3.309311e+4	2.892170e+5	2.944309e+4	6.057019e+2
autoSaint			98.190	5.201507e+2	1.206183e+2	0.934									
STAX			129.632	2.305529e+3	4.445890e+2	0.988									
autoSaint			129.657	1.843209e+3	1.104455e+2	0.969									
autoSaint			151.018	3.772936e+5	6.192910e+2	0.993									
STAX			151.040	3.816772e+5	9.570698e+2	1.018									
autoSaint	XE-133	160.613	160.470	8.756340e+2	6.599474e+1	1.003	6.793420e+...	9.609349e+...	2.925030e+...	8.491775e+6	1.201169e+6	3.656287e+6	1.554246e+5	2.198494e+4	6.910382e+4

Offline Data Processing

STAX and autoSaint analysis results stored in the ATS files, and emissions time series stored in the CSV files, can both be downloaded from STAX by authorized users and used for further processing with their own tools, e.g. to refine ATM models.

Gamma spectra (PHD) files retrieved from STAX can be easily reprocessed offline using CTBTO's NDC in a box or other analysis software tools, for example if there are quality concerns regarding the STAX/autoSaint results.

STAX Resources Access

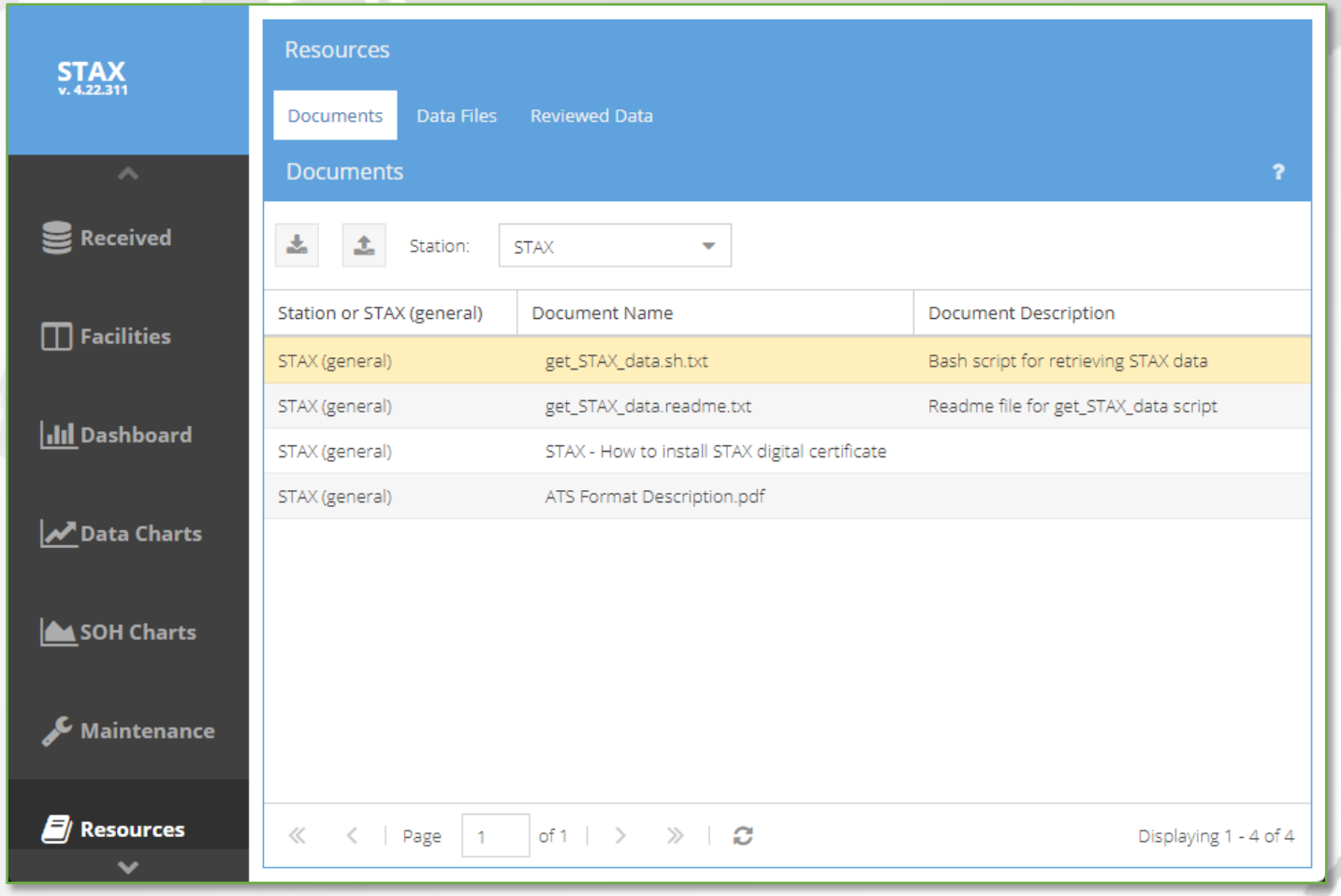
Documents, additional data files, and reviewed data are available for ***download*** by authorized users from the ***Resources*** page

Station-specific

*Facility operators can **upload** data for their own stations.*

General STAX resources:

- *documentation and user's manuals*
- ***get_STAX_ data** script for automatic download*



THANK YOU

Questions ?