MAX-PLANCK-INSTITUT
FÜR PLASMAPHYSIK

AMNS Data

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EUROfusion

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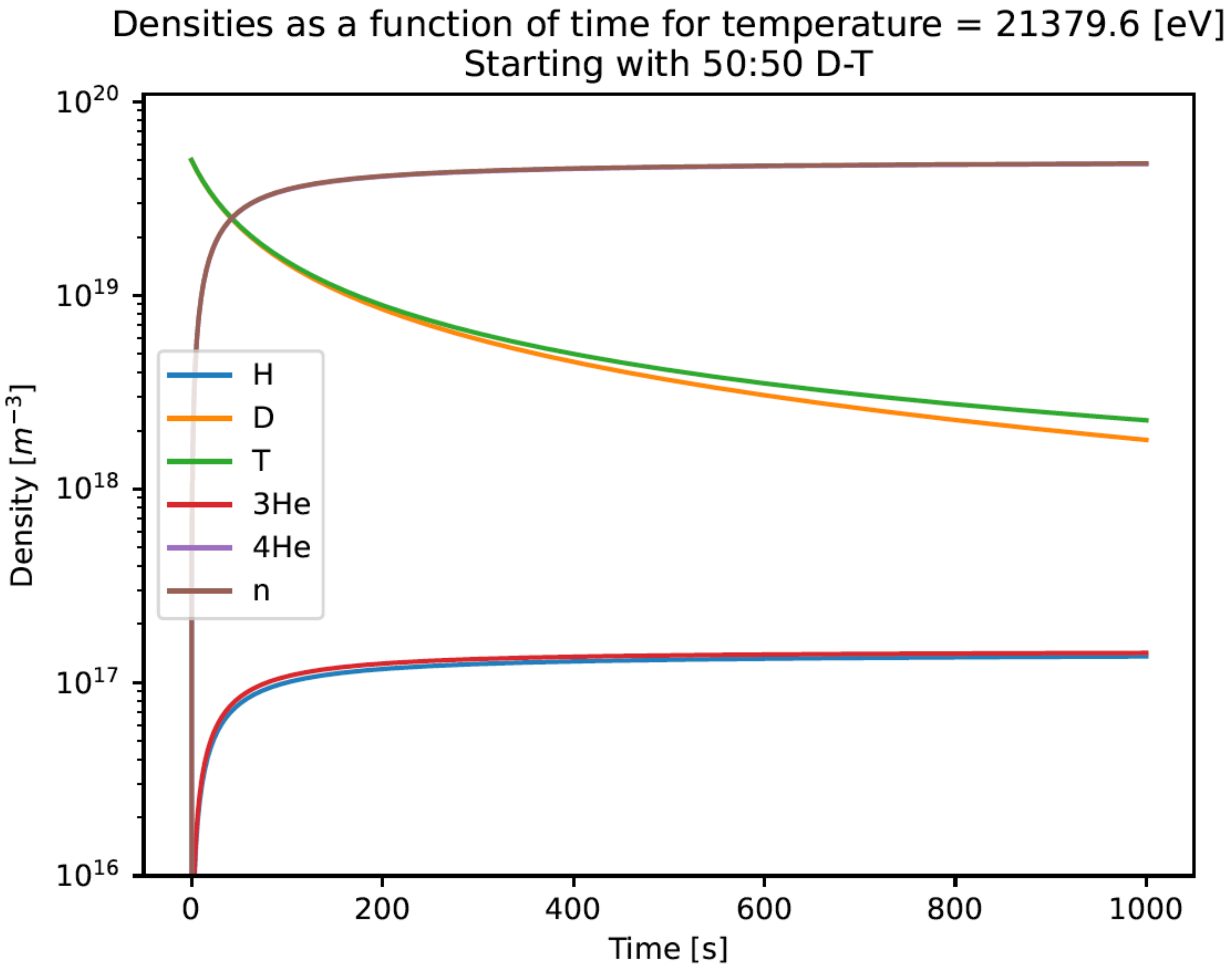
What happens if you start with a D:T plasma, with a density for D and T of 5×10^{19} m^{-3}?



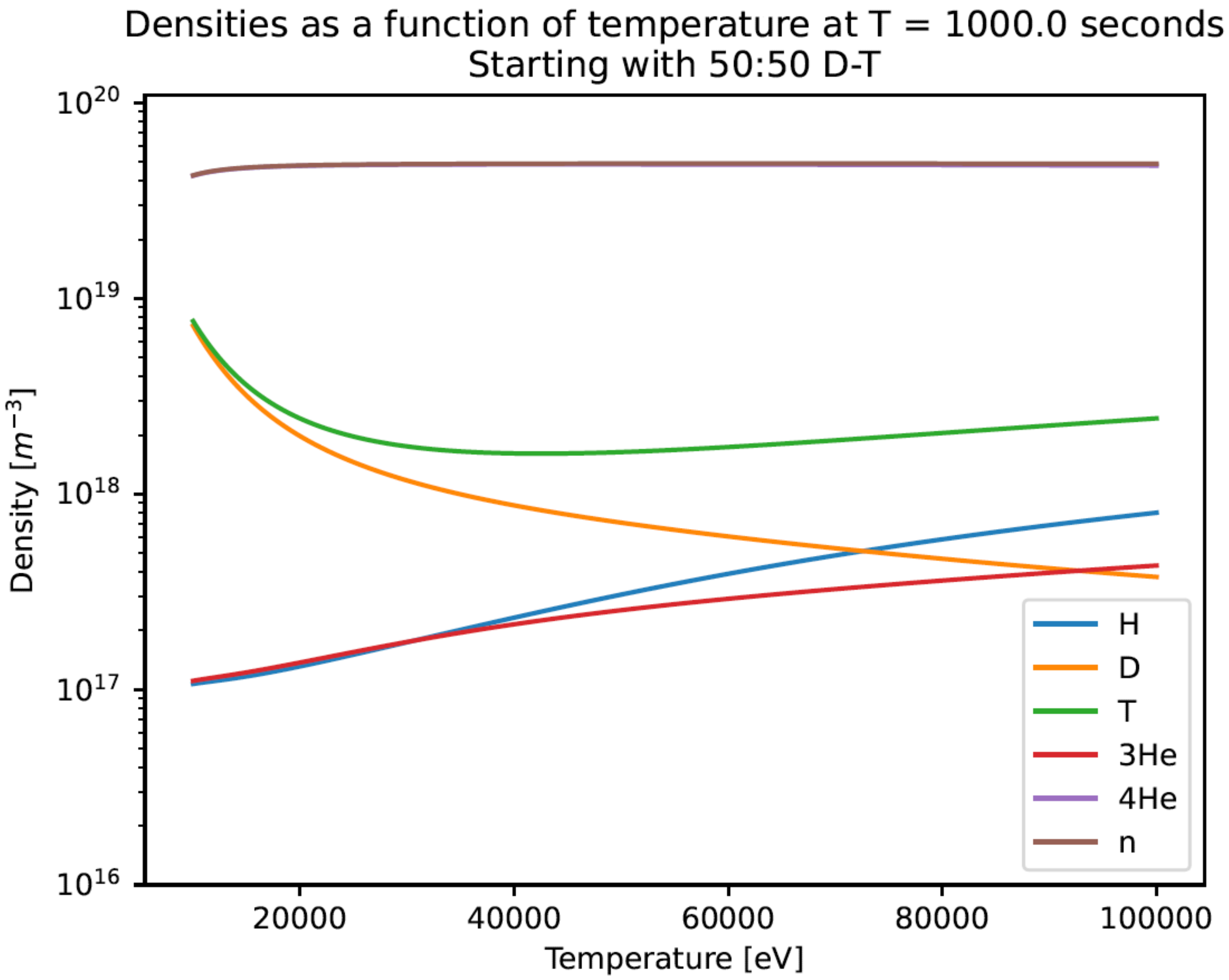
Reactions (thermal):

- D(D,p)T
- D(D,n)^3He
- D(T,n)^4He
- D(^3He,p)^4He
- T(T,2n)^4He

How would you do this?

In this case, use the AMNS library to access the needed data, and solve this with a simple python program

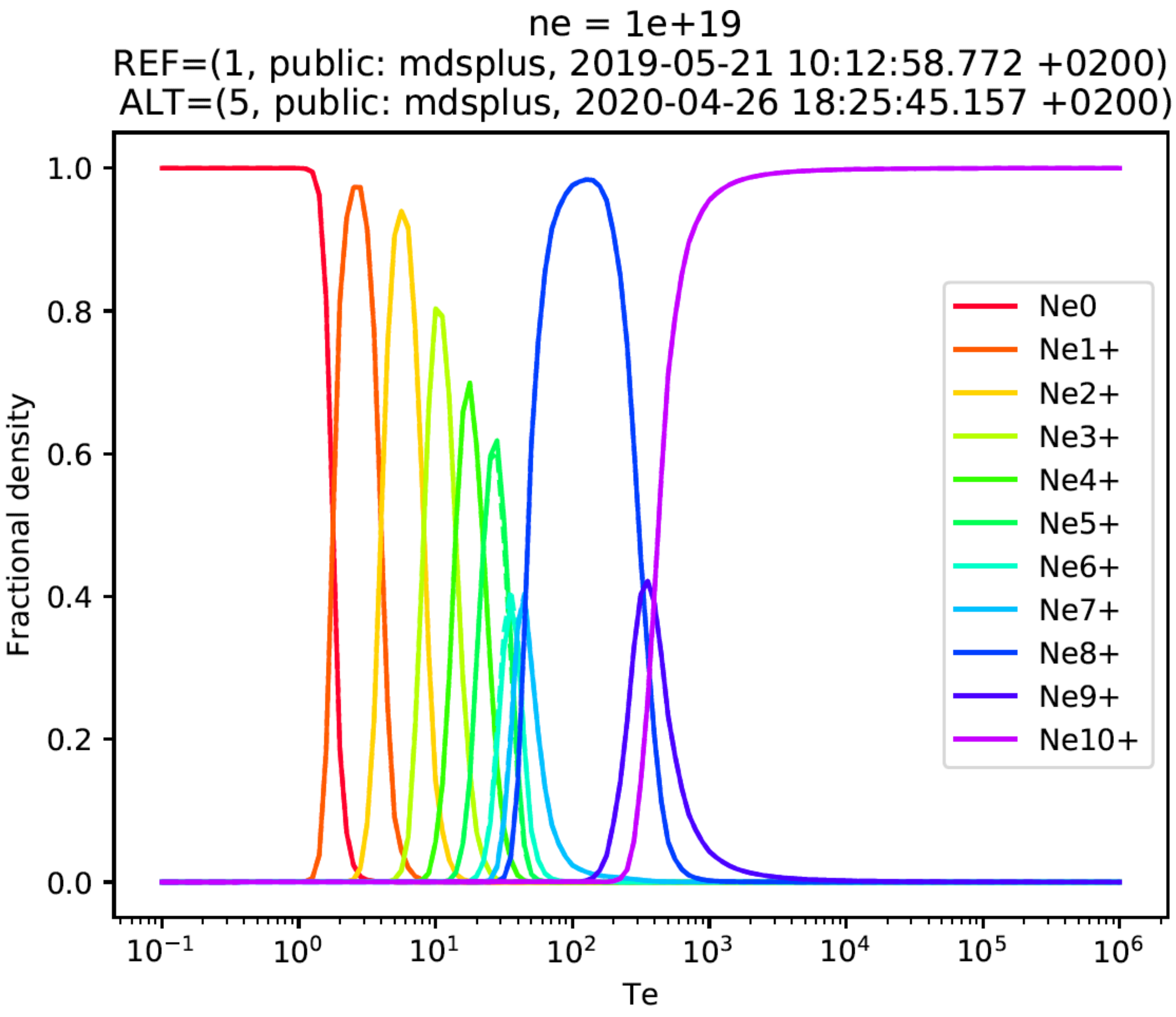
What happens if you start with a D:T plasma, with a density for D and T of 5×10^{19} m^{-3}?



Now how does this change with different assumed temperatures?

In this case, use the AMNS library to access the needed data, and solve this with a simple python program

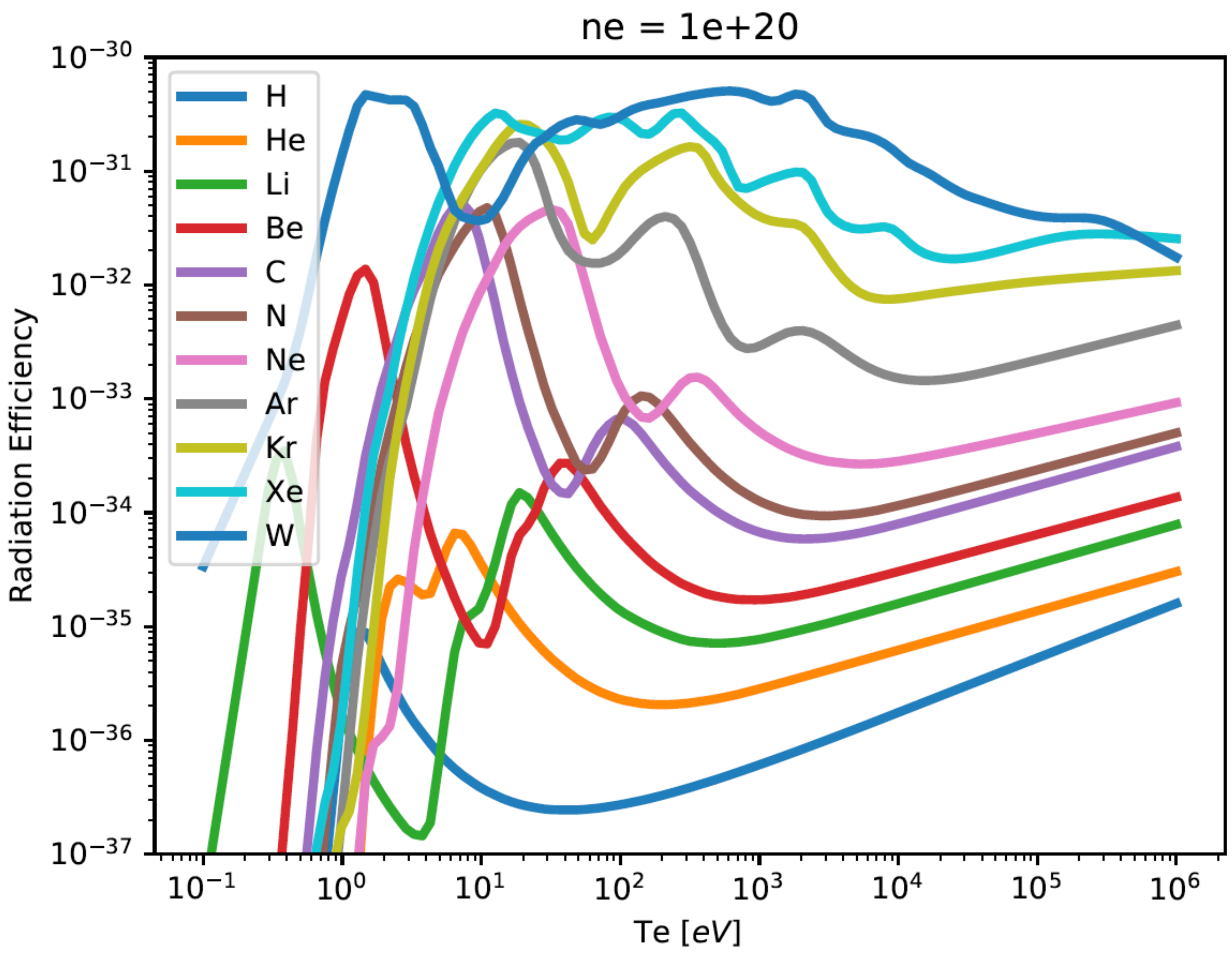
Or you would like to know the fractional abundances by charge state for Ne?



In this case, use the AMNS library to access the needed data, and solve this with a simple python program

Coronal balance is assumed, with a background electron density of 1×10^{19} m^{-3}

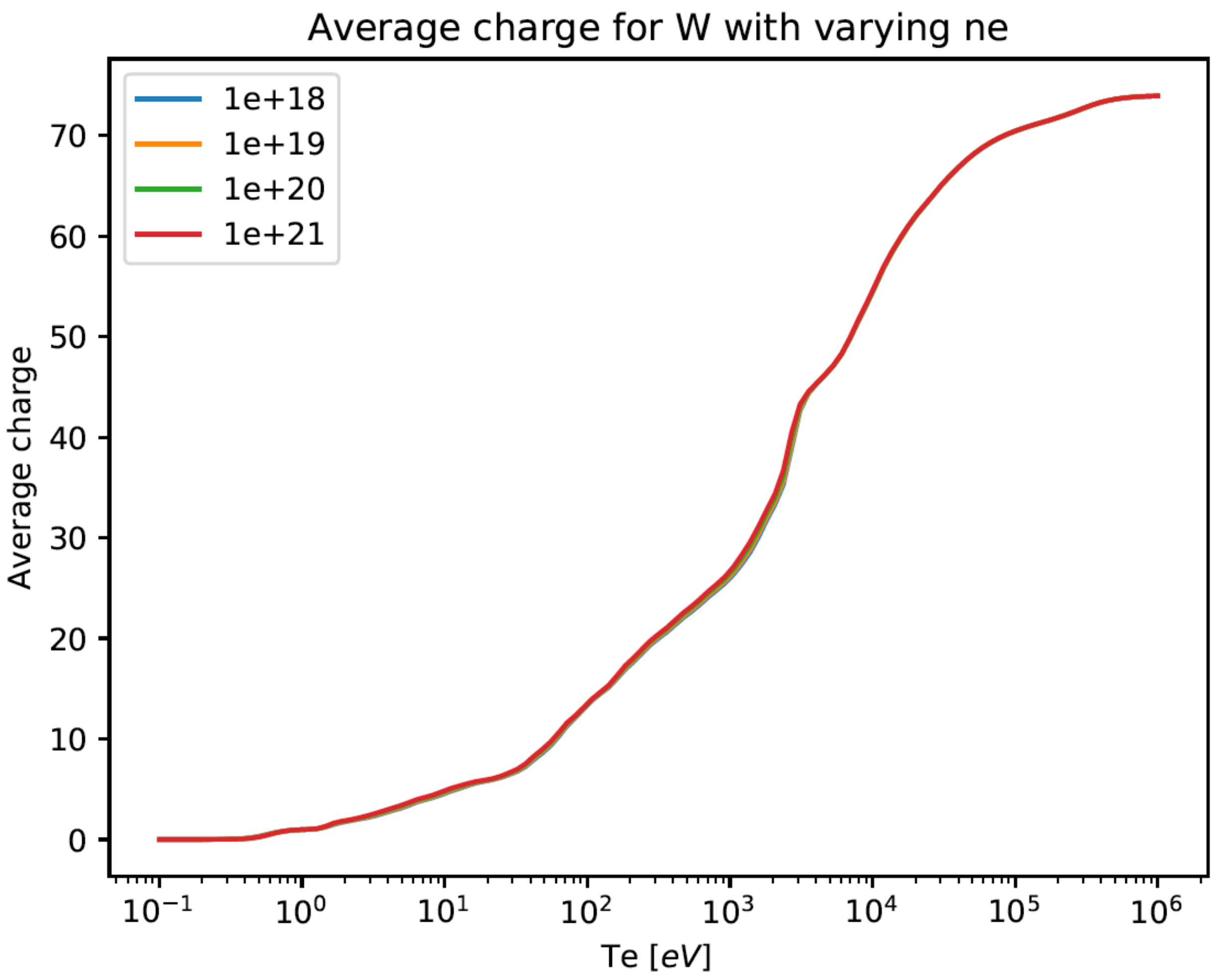
Or you would like to know the (coronal) radiation efficiencies of various fusion relevant species?



In this case, use the AMNS library to access the needed data, and solve this with a simple python program

Coronal balance is assumed, with a background electron density of 1×10^{20} m^{-3}

Or you would like to know the (coronal) average charge of W at various electron temperatures?



In this case, use the AMNS library to access the needed data, and solve this with a simple python program

Coronal balance is assumed, with a background electron density of 1×10^{18}, 1×10^{19}, 1×10^{20} and 1×10^{21} m^{-3}

What is the AMNS library? Where is it being used?

The AMNS library provides a standardized method for accessing Atomic, Molecular, Nuclear or Surface data. It does this by providing a library of routines that can be accessed from Fortran, C, Python or Java.

The AMNS library is being used by (at least):

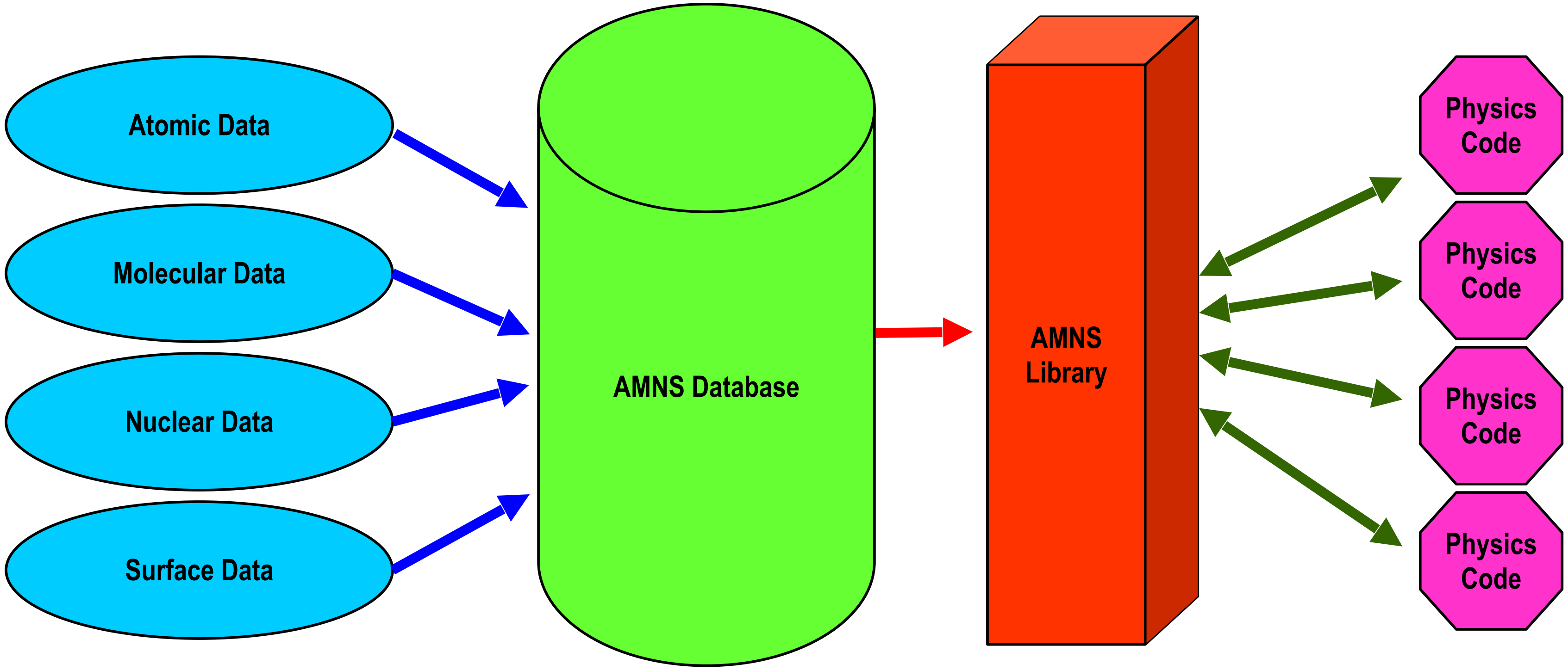
- SOLPS-ITER (as one of the options for atomic rates)
- ETS (for its impurity handling and neutral model)
- fusion_thermal for calculating thermal nuclear sources

Design Goals for AMNS access

- From the ITM era:
  - AMNS data should be centralized and managed
    - Version control of data imported to the ITM-TF data base is mandatory.
    - The provenance of the data must be accurate and stored in the ITM database
    - For “production” runs with ITM-TF codes using AMNS data it is important that the data have been given a stamp of approval by an expert.

- The data should be comprehensive, ubiquitous and easily used
  - This means identifying what data is needed
    - not always easy!
  - The AMNS data must be communicated to EUROfusion codes via a standardised interface
    - this should also ensure coherence between different EUROfusion codes needing the same type of data
  - All AMNS data used by codes should be available through the AMNS data interface
    - no back doors

Design Goals for AMNS access

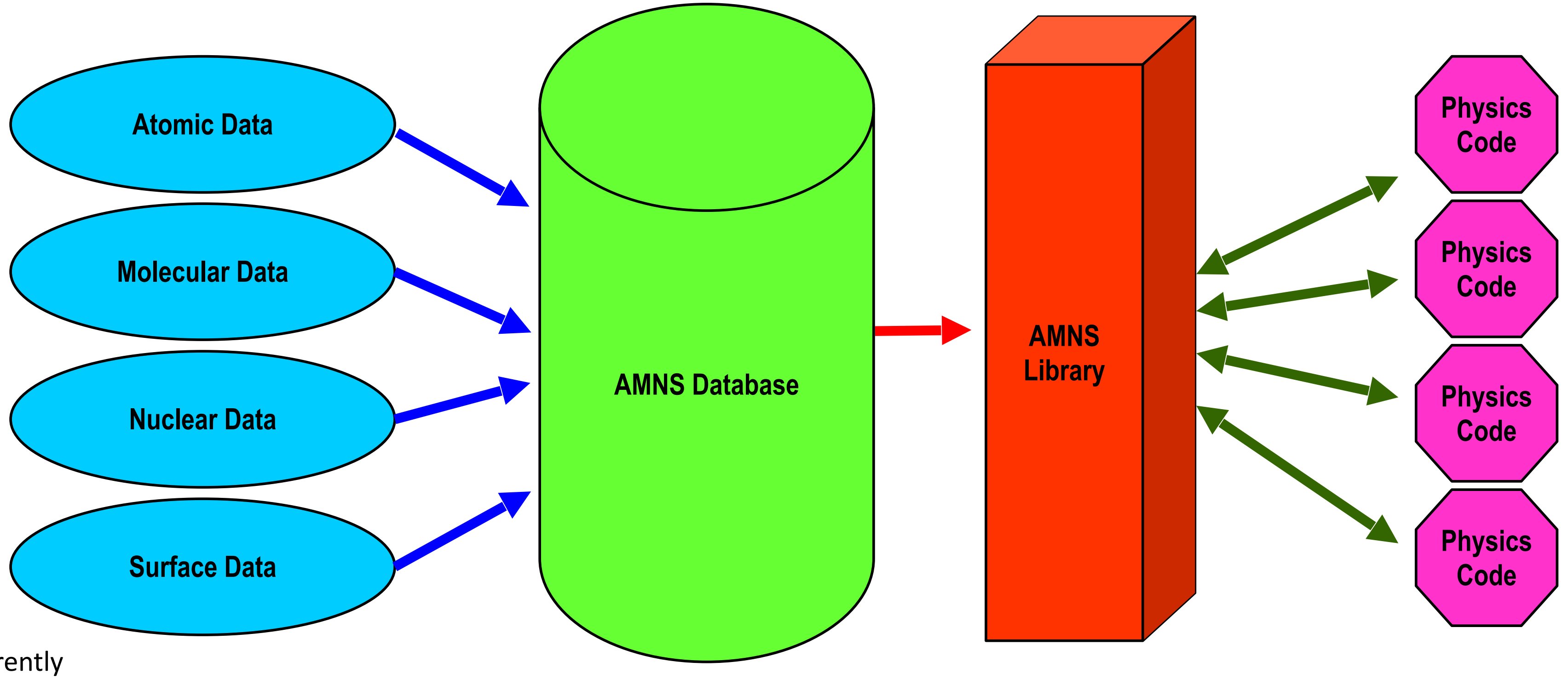


- Data selection
- Data import

- Data storage
- Data transport

- User interface design
- Supporting multiple languages

Design Goals for AMNS access



Currently
- ADAS ADF11
- Nuclear cross section and rates

- Initially used CPOs
- Now using IDSs

- Library written in Fortran
- Interfaces to Fortran, Python, C, MATLAB, Java

Design Goals for AMNS access

Physics code

- Access to AMNS data only via interface
  - initialization (2)
  - finalization (2)
  - querying parameters (2)
  - setting parameters (2)
  - **getting data** (1)
- Separation between use of the data and the implementation of the data
- Code author doesn't need to become an expert in AMNS
- Ensures compatibility between codes

AMNS implementation

- Only accessed by a set of defined calls
- Implementation by AMNS experts
- Different versions can be supported
- Different implementations possible
  - Analytic formulae
  - Table lookup
- "Old" versions should always be recoverable (even if wrong)
- Should become easier to implement "new" data

Currently available processes (for DD 4.0.0)

Zn=1, Am=1.00794, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/12', 'EI/12', 'BR/12', 'LR/12', 'RC/96', 'EI/96', 'CX/96', 'BR/96', 'LR/96', 'ZE/96', 'ZE2/96', 'EIP/96', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89', 'BMS']
Zn=1, Am=2.0, Processes=['NUC_BB', 'NUC_BB', 'NUC_TT', 'NUC_TT', 'NUC_BT', 'NUC_BT']
Zn=1, Am=3.0, Processes=['NUC_BB', 'NUC_TT', 'NUC_BT', 'NUC_BT', 'NUC_BB', 'NUC_TT']
Zn=2, Am=4.002602, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/96', 'EI/96', 'CX/96', 'BR/96', 'LR/96', 'ZE/96', 'ZE2/96', 'EIP/96', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=2, Am=3.0, Processes=['NUC_BB', 'NUC_TT', 'NUC_BT', 'NUC_BT']
Zn=3, Am=6.941, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/96', 'EI/96', 'BR/96', 'LR/96', 'ZE/96', 'ZE2/96', 'EIP/96', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
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Zn=5, Am=10.811, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=6, Am=12.011, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/96', 'EI/96', 'CX/96', 'BR/96', 'LR/96', 'ZE/96', 'ZE2/96', 'EIP/96', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=7, Am=14.00674, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/96', 'EI/96', 'BR/96', 'LR/96', 'ZE/96', 'ZE2/96', 'EIP/96', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=8, Am=15.9994, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/96', 'EI/96', 'BR/96', 'LR/96', 'ZE/96', 'ZE2/96', 'EIP/96', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=9, Am=18.9984032, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=10, Am=20.1797, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/96', 'EI/96', 'BR/96', 'LR/96', 'ZE/96', 'ZE2/96', 'EIP/96', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=13, Am=26.981539, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=14, Am=28.0855, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=16, Am=32.066, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=17, Am=35.4527, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=18, Am=39.948, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=24, Am=51.9961, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=26, Am=55.847, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=28, Am=58.6934, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=29, Am=63.546, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=32, Am=72.61, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=36, Am=83.8, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=42, Am=95.94, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=54, Am=131.29, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']
Zn=74, Am=183.84, Processes=['RC', 'EI', 'CX', 'BR', 'LR', 'ZE', 'ZE2', 'EIP', 'LR/41', 'LR/42', 'RC/50', 'EI/50', 'CX/50', 'BR/50', 'LR/50', 'ZE/50', 'ZE2/50', 'EIP/50', 'RC/89', 'EI/89', 'CX/89', 'BR/89', 'LR/89', 'ZE/89', 'ZE2/89', 'EIP/89']