Proposal for the changes in IDS data structure to accommodate the fluctuation BES synthetic diagnostic

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*Date: 15 May, 2017*

# Purpose of the proposal

The RENATE-OD synthetic diangnostic, designed for fluctuation BES diagnostic system modelling is to be integrated into EU-IM and IMAS, consequently. Communication of various actors responsable for executing code is only possible through IDS data structures. The current proposal outlines a possible extension of the existing IDS structure necessary to accommodate fluctuation BES data.

# General considerations

There are a large number of diagnostic systems at a magneric fusion device. As the integrated modelling effort matures there will be a need to integrate a growing number of different synthetic diagnostic codes. These diagnostic systems typically share the physics models with other diagnostic or auxiliary systems in some of sub-level functioning. In order to avoid massive duplication of IDS sub-structures in the IDSs of different diagnostic systems we propose to identify key common components and design corresponding IDSs with general enough structure to accommodate the needs of every synthetic diagnostic using it.

In the context of RENATE-OD this would imply to have:

1. A neutral beam IDS that is capable of describing all necessary aspects including fast temporal changes, like tilting or chopping the beam, and emissivity.
2. An optical system IDS that is capable of describing the optical system in the required large detail.
3. An actual BES IDS that would serve solely as an output of the modelling and maybe the import of the actual measurement.

The specific proposal below is to be reworked based on these quidelines!

**Detailed layout and design of BES – CPO tags:**

1. **time** [s] [integer]: Contains the number of the time slice in question.
2. **beams (:) [nbeams]** The tag will contain relevant data for beam modelling. The CPO will be set-up such as to handle a time dependent beam geometry or simultaneous beam modelling of 2 or more beams. Array of structures containing any number of beams. It is based on the NBI CPO beamlet handling structures. <http://www.efda-itm.eu/ITM/html/itmtypes__4.10b.html#4.10b:beamletgroup>
3. **width** [m] [float]: width of the modelled beam.
4. **height** [m] [float]: height of the modelled beam.
5. **divergence** [rad] [float]: divergence of the beam.
6. **energy** [eV] [int]: beam energy.
7. **species** [-] [string]: the type of atoms composing the beam (H,D,Li,Na).
8. **direction** [-] [int]: Gives the direction of the beam, co and counter clockwise
9. **beamlets** Contains the data for the modelling of the 3D beams.
   1. **position** [rzphi] [nbeamlets]: Startpoint of the beamlets
   2. **angle** [rad] [nbeamlets]: Inclination angle
   3. **tang\_rad** [m] [nbeamlets]: Tangency radius
   4. **current** [A] [nbeamlets]: Beamlet current values
10. **modelled\_plasma\_species** [-] [string list]: Contains all the plasma species to be accounted for in beam evolution calculations (e, H, D, T, Li, etc) [coreprof, coreimpur, turbulence CPO]
11. **observation (:)[n\_observations]** Tag that stores all relevant data regarding the construction of the observation module
12. **lens\_diameter** [m] [float]: Contains the diameter of the last optical element of the observation system.
13. **pixel\_number** [-] [integer]: Gives the number of detector pixels the optical system is modelled with.
14. **collimator** (:) Contains information with regard to the observation volumes used for the pinhole optics modelling. It is take from fusiondiag CPO.

<http://www.efda-itm.eu/ITM/html/itmtypes__4.10b.html#4.10b:fusiondiag_collimator>

1. **optical\_performance** (:)[ndetectors] Contains the various forms of transmission rates that are applicable for each detector.
   1. **neutral\_tranmission** [-] [float]: Contains the wavelength independent transmission rates for each detector that arises from the optical system in case of the pin hole optical model.
   2. **filter\_transmission** [-] [float]: Contains the transmission values that arise from optical filtering processes.
   3. **light\_coll\_eff**  Contains the transmission matrix for each detector pixel. Input from detailed optical modelling.
      1. matrix [-] [1D array]: Contains the light collection weights for a 3D ROI.
      2. position [rzphi 1D]: Array Contains the corresponding coordinates of the points within the light collection matrix.
2. **observation\_point** [m] [rzphi]: Contains the coordinates of the entrance pupil of the observation system.
3. **focus\_point** [m] [rzphi]: Contains the coordinates of the focal point of the observation system.
4. **output(:)[n\_detectors]**:Contains output data, is an array of structures for all detectors
5. **simulated\_signal** Contains the modelled BES signal for one detector.
   1. **clean** [1/s] [1D array] [timestep]: Contains the detected photon count without any noise.
   2. **noisy**[1/s] [1D array] [timestep]: Contains the detected photon count with any noise.
6. **fluctuation\_sensitive\_area** Contains values for various calculations
   1. **estimated** Contains the total spatial resolution as a convolution of the atomic smearing, magnetic and beam geometry smearing and detector projection components for each detector pixel.
      1. r\_extent [m] [float]: Radial component of the total spatial resolution.
      2. z\_extent [m] [float]: Vertical component of the total spatial resolution.
      3. r\_center [m] [r]: Center of radial extent for sensitive area.
      4. z\_center [m] [z]: Center of vertical extent for sensitive area
   2. **fluctuation\_response** Contains the spatial resolution calculated from fluctuation response calculation for all detector pixels.
      1. r\_extent [m] [float]: Radial component of the total spatial resolution.
      2. z\_extent [m] [float]: Vertical component of the total spatial resolution.
      3. r\_center [m] [r]: Center of radial extent for sensitive area.
      4. z\_center [m] [z]: Center of vertical extent for sensitive area
7. **measurement** (:)
8. **data** [-] [2D array] [n\_detectors, data\_point]: Contains experimental BES measurements for the shot data in question.
9. **beam\_on** [s] [1D array]: Contains the time intervals where the beam was on, used for beam chopping.