

# PROPOSAL FOR BES-CPO

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## Purpose of the proposal:

The RENATE synthetic diagnostic, designed for fluctuation BES diagnostic system modelling is to be integrated into EU-IM. Communication of various actors responsible for executing code is only possible through Coherent Physical Objects (CPO). The current proposal outlines the design of the BES – CPO, responsible for handling all data relevant for a BES synthetic diagnostic within the EU-IM.

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

**A. time** [s] [integer]: Contains the number of the time slice in question.

**B. 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](http://www.efda-itm.eu/ITM/html/itmtypes_4.10b.html#4.10b:beamletgroup)

1. **width** [m] [float]: width of the modelled beam.
2. **height** [m] [float]: height of the modelled beam.
3. **divergence** [rad] [float]: divergence of the beam.
4. **energy** [eV] [int]: beam energy.
5. **species** [-] [string]: the type of atoms composing the beam (H,D,Li,Na).
6. **direction** [-] [int]: Gives the direction of the beam, co and counter clockwise
7. **beamlets** Contains the data for the modelling of the 3D beams.
  - a. **position** [rzphi] [nbeamlets]: Startpoint of the beamlets
  - b. **angle** [rad] [nbeamlets]: Inclination angle
  - c. **tang\_rad** [m] [nbeamlets]: Tangency radius
  - d. **current** [A] [nbeamlets]: Beamlet current values

**C. 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]

**D. observation (:)[n\_observations]** Tag that stores all relevant data regarding the construction of the observation module

1. **lens\_diameter** [m] [float]: Contains the diameter of the last optical element of the observation system.
2. **pixel\_number** [-] [integer]: Gives the number of detector pixels the optical system is modelled with.
3. **collimator** (:) Contains information with regard to the observation volumes used for the pinhole optics modelling. It is taken from fusiondiag CPO.  
[http://www.efda-itm.eu/ITM/html/itm/types\\_4.10b.html#4.10b:fusiondiag\\_collimator](http://www.efda-itm.eu/ITM/html/itm/types_4.10b.html#4.10b:fusiondiag_collimator)
4. **optical\_performance** (:)[ndetectors] Contains the various forms of transmission rates that are applicable for each detector.
  - a. **neutral\_transmission** [-] [float]: Contains the wavelength independent transmission rates for each detector that arises from the optical system in case of the pin hole optical model.
  - b. **filter\_transmission** [-] [float]: Contains the transmission values that arise from optical filtering processes.
  - c. **light\_coll\_eff** Contains the transmission matrix for each detector pixel. Input from detailed optical modelling.
    - i. matrix [-] [1D array]: Contains the light collection weights for a 3D ROI.
    - ii. position [rzphi 1D]: Array Contains the corresponding coordinates of the points within the light collection matrix.
5. **observation\_point** [m] [rzphi]: Contains the coordinates of the entrance pupil of the observation system.
6. **focus\_point** [m] [rzphi]: Contains the coordinates of the focal point of the observation system.

**E. output(:)[n\_detectors]**: Contains output data, is an array of structures for all detectors

1. **simulated\_signal** Contains the modelled BES signal for one detector.
  - a. **clean** [1/s] [1D array] [timestep]: Contains the detected photon count without any noise.
  - b. **noisy** [1/s] [1D array] [timestep]: Contains the detected photon count with any noise.
2. **fluctuation\_sensitive\_area** Contains values for various calculations
  - a. **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.
    - i. r\_extent [m] [float]: Radial component of the total spatial resolution.
    - ii. z\_extent [m] [float]: Vertical component of the total spatial resolution.
    - iii. r\_center [m] [r]: Center of radial extent for sensitive area.
    - iv. z\_center [m] [z]: Center of vertical extent for sensitive area

- b. **fluctuation\_response** Contains the spatial resolution calculated from fluctuation response calculation for all detector pixels.
  - i. r\_extent [m] [float]: Radial component of the total spatial resolution.
  - ii. z\_extent [m] [float]: Vertical component of the total spatial resolution.
  - iii. r\_center [m] [r]: Center of radial extent for sensitive area.
  - iv. z\_center [m] [z]: Center of vertical extent for sensitive area

## **F. measurement (:)**

1. **data** [-] [2D array] [n\_detectors, data\_point]: Contains experimental BES measurements for the shot data in question.
2. **beam\_on** [s] [1D array]: Contains the time intervals where the beam was on, used for beam chopping.