**PROPOSAL FOR BES-CPO**

*Authors: Ö. Asztalos1, G.I. Pokol1 and B. Szondy1*

*1BME NTI, Budapest, Hungary*

**Purpose of the proposal:**

The RENATE synthetic diangnostic, designed for arbitrary BES diagnostic system modelling is to integrated into EU-IM. Communication of various actors responsable for executing code is only possible through **C**oherent **P**hysical **O**bjects (CPO). The current proposal outline the design of the BES – CPO, responsable for handling all data relevant for the RENATE sysnthetic diagnostic within the EU-IM mainframe.

**Summary layout of the BES-CPO:**

**beam\_data [tag]:**

* beamlet positions, current and energy distribution on beamlets

**observation\_data [tag]:**

* observation point, spatail calibration, lens size, transmission rate

**equilibrium\_data [tag]:**

* RENATE relevant data inherited from equilibrium CPO

**profiles\_data [tag]:**

* density, temperature and impurity values registered for every point along the beamlets

**time\_data [tag]:**

* parameter that tags each timeslice with the corresponding values of the CPO

**output\_data [tag]:**

* contains the light profile along each beamlet, the detected photon current on each detector, the expected spatial resolution for each detector and a fluctiuation response matrix for given time interval

**simulation\_info [tag]:**

* contains data relevant to simulation (switches and distributions applied)
* contains data gathered from shot (beam current, beam energy, beam radius)

**experimental\_data [tag]:**

* contains the registered signal from the existing shot modelled if it is available

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

Simulation info [tag]:

The „Simulation\_info” tag should contain all the pertinet data needed for the responsable actors to populate the BES – CPOs various tags, such as beam\_data, observation\_data, profiles\_data etc. necessary to finally invoce the actors populating the output\_data tag. This tag is time independent.

The current tag should be divided into two subtags:

* simulation data
* experimantal data

1. Experimantal data: This subtag should contain data relevant to the simulation that is specific to set-up that is being modelled.

* Beam energy [float]
* Beam energy distribution [TBD]
* Beam current [float]
* Beam current distribution [TBD]
* Beam size [float, float]
* Beam shape [sting]
* Shot number [int]
* Beam type [sting]
* Beam divergence [float]

1. Simulation data: This subtag should contain data that influences the methods of calculation.

* Beam resolution [perp\_x, perp\_y, along] [int, int, int] number of beamlets in perpendicular directions to the beam propagation, number of points along the beamlet
* Numerical solver [switch]
* Beam position [2, x, y, z] [float, float, float]
* Levels for atomic physics calculation [int]
* Method for spatial resolution calculation [switch]
* Profile of plasma species to be considered [list] [sting]

Beam\_data [tag]:

beam\_position [3, perp\_x, perp\_y, along, time]: stores the xyz coordinates of each point along all beamlets as well as time array allowing for beam deflection.

beam\_time [int]: contains the various time indexes used for different beam positions.

beam\_energy [perp\_x, perp\_y]: the beamlet energy for each individual beamlet.

beam\_current [perp\_x, perp\_y]: the current distribution on all beamlets

1. **output\_data [tag]:**
2. beam\_evolution (:) Contains data resulting from the beam evolution calculation as well as detected photon current profiles. All arrays of the output\_data.beam\_evolution tag will have an added temporal dimension to accommodate for turbulence timescale.
   1. emissivity [au] SI: 2D float array, contains the emissivity along each individual beamlet.
   2. photon\_current [1/s] SI: 1D float array, contains the detected photon count on each detector.
   3. relative\_population [au] SI: 2D float array, contains the relative populations for all calculated atomic levels along each individual beamlet.
3. fluctuation\_response [au] SI: 2D matrix containg the responses in the detected photon current to various density perturbations.
4. spatial\_resolution (:) Contains values for various calculations for the spatial resolution. All tags will contain 2 separate arrays, one for the radial contribution and one for the poloidal contribution of the spatial resolution.
   1. atomic\_phys [m] SI: 1D float array, contains the smearing caused by the atomic physics processes on each detector pixel
   2. magbeam\_geom [m] SI: 1D float array, contains the smearing of emission caused by the beam and magnetic geometry with respect to the LOS, for each detector pixel.
   3. pix\_proj [m] SI: 1D float array, contains the size of the projections for each detector pixel in the focal plane.
   4. total [m] SI: 1D float array, contains the total spatial resolution as a convolution of the above mentioned three components for each detector pixel.
   5. fluct\_resp [m] SI: 1D float array, contains the spatial resolution calculated from fluctuation response calculation for all detector pixels.
5. **time\_data [tag]:**
6. time [s] SI: 1D array containing all the time instances used for modelling
7. fluct\_time (:) Contains necessary data to create fluctuation timescale. All
   1. t0 [s] SI: starting time instance
   2. dt [s] SI: time step
8. **equilibrium\_data [tag]:**

It will be a duplicate of the equilibrium CPO for the relevant time indexes. Relevance of duplication is still in question.

1. **profiles\_data [tag]:**

The tag contains the density and temperature profiles along all the beamlets modelled. The profiles included are for all plasma components.

1. plasma\_components [-] SI: list of strings containing all the plasma components: (e, H, D, Li, C, O, etc)
2. density\_data [m^-3] SI: dictionary containing 2D density values for all beamlets. Every tag has the corresponding density values.
3. temperature\_data [eV] SI: dictionary containing 2D temperature values for all beamlets. Every tag has the corresponding temperature values.
4. **Observation\_data [tag]:**
5. basic\_obs (:) Contains all the necessary data for pinhole observation and furthermore common elements for any advanced observation scenario.
   1. lens\_diameter: float, contains the diameter of the last optical element
   2. observation\_point: 1D array, containing the [x,y,z] coordinates of the observation point.
   3. det\_pixels: interger, containing the number of detector pixels used for modelling.
   4. pixel\_type: string, determines the shape of the detector pixels. Can be ‘rectangular’ for detector pixels or ‘elliptical’ for optical wire based observation.
   5. obs\_volumes (:) Structure containing information regarding the observation volumes
      1. pyramid:
      2. elliptic:
6. lens\_diameter [m]SI: float, contains the diameters of the last optical element
7. observation\_point [m]SI: 1D array, containing the [x,y,z] coordinates of the observation point.
8. pixel\_type [-]SI: 1D list of strings conting the type of
9. **Beam\_data [tag]:**
10. **Simulation\_data [tag]:**
11. **Experimantal\_data [tag]:**