PROPOSAL FOR BES-CPO

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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

A. 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]

B. 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

A. output_data [tag]:

1. 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.
    a. emissivity [au] $_{SI}$: 2D float array, contains the emissivity along each individual beamlet.
    b. photon_current [1/s] $_{SI}$: 1D float array, contains the detected photon count on each detector.
    c. relative_population [au] $_{SI}$: 2D float array, contains the relative populations for all calculated atomic levels along each individual beamlet.
2. fluctuation_response [au] $_{SI}$: 2D matrix containg the responses in the detected photon current to various density perturbations.
3. 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.
    a. atomic_phys [m] $_{SI}$: 1D float array, contains the smearing caused by the atomic physics processes on each detector pixel
    b. 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.
    c. pix_proj [m] $_{SI}$: 1D float array, contains the size of the projections for each detector pixel in the focal plane.
    d. total [m] $_{SI}$: 1D float array, contains the total spatial resolution as a convolution of the above mentioned three components for each detector pixel.
    e. fluct_resp [m] $_{SI}$: 1D float array, contains the spatial resolution calculated from fluctuation response calculation for all detector pixels.

B. time_data [tag]:

1. time [s] $_{SI}$: 1D array containing all the time instances used for modelling
2. fluct_time (:) Contains necessary data to create fluctuation timescale. All
    a. t0 [s] $_{SI}$: starting time instance
    b. dt [s] $_{SI}$: time step

C. equilibrium_data [tag]:

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

D. 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.

E. Observation_data [tag]:

1. basic_obs (:) Contains all the necessary data for pinhole observation and furthermore common elements for any advanced observation scenario.
    a. lens_diameter: float, contains the diameter of the last optical element
    b. observation_point: 1D array, containing the [x,y,z] coordinates of the observation point.
    c. det_pixels: interger, containing the number of detector pixels used for modelling.
    d. pixel_type: string, determines the shape of the detector pixels. Can be ‘rectangular’ for detector pixels or ‘elliptical’ for optical wire based observation.
    e. obs_volumes (:) Structure containing information regarding the observation volumes
        i. pyramid:
        ii. elliptic:
2. lens_diameter [m]$_{SI}$: float, contains the diameters of the last optical element
3. observation_point [m]$_{SI}$: 1D array, containing the [x,y,z] coordinates of the observation point.
4. pixel_type [-]$_{SI}$: 1D list of strings conting the type of

F. Beam_data [tag]:

G. Simulation_data [tag]:

H. Experimantal_data [tag]: