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

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# Purpose of the proposal

The RENATE-OD synthetic diagnostic, designed for fluctuation BES diagnostic system modelling is to be integrated into EU-IM and IMAS, consequently. Communication of various actors responsible 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 magnetic 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.

# Modifications deemed necessary to existing IDS:

1. The **nbi** IDS is suitable for BES modelling. To be able to model accurately beam tilting, which may be employed for the purpose of 2D measurements, a temporal dimension will have to be added to the beamlets\_group structure. Due to the repetitive nature of the tilting mechanism, the temporal dimension does not have to be homogeneous.
2. The **spectrometer\_visible** IDS is suitable for the modelling of the observation system used by the BES synthetic diagnostic. We propose the following additions to the IDS structure:
   1. **lens\_diameter** [m] [float]: Value holding the diameter of the first element of the optical system. Global parameter holding true for the entire observation system.
   2. **collimator** (:) Contains the description of collimator used for the pinhole optics. Particular for each detector pixel or channel.
      1. **circular** (:) Contains data to model circular observation cones.
         1. radius [m] [float]: For circular collimators holds the base are of the observation cone
         2. ellipticity [-] [float]: Shapes the base cone of the
      2. **rectangula**r (:) Contains the coordinates of four points marking the edges of the observation pyramid
         1. point\_one [rzphi]
         2. point\_two [rzphi]
         3. point\_three [rzphi]
         4. point\_four [rzphi]
   3. **light\_collection\_efficiency** (:) For non-pinhole optics presents a data structure that contains emission weights of various 3D ROI-s designated for each detector or channel.
      1. **positions** [rzphi] [1D]: Contains the coordinates of 3D points belonging to a specific ROI.
      2. **emission\_frac** [-] [1D]: Contains the emission fraction detected by the observation system from each corresponding point.
3. A **BES\_diagnostic** IDS would be needed to store all the BES data resulted from the modelling. For reasons of transparency and clarity observation modelling and beam modelling should occur separately and stored separately. The data stored in the BES\_diagnostic IDS would contain:
   1. **species** [string] : a list of the plasma species. If need might contain the corresponding masses and charges as well.
   2. **simulated\_signal (i1):** Contains the modelled BES signal for one detector.
      1. **clean** [1/s] [1D array]: Contains the detected photon count without any noise on one detector for the duration of the modelling
      2. **noisy** [1/s] [1D array]: Contains the detected photon count with any noise for the duration of the modelling.
      3. **time** [s]: Generic time.
   3. **measured\_signal (i1):** Contains potential measured signal for the modelled discharge.
      1. **signal** [1D array]: Contains the measured data for a particular detector channel.
      2. **time [s]**: Generic time.
   4. **fluctuation\_sensitive\_area (il):** Contains values for various calculations regarding spatial resolution and location of detector sensitivity.
      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.