Definition of flux loops in the EU-ITM datastructure

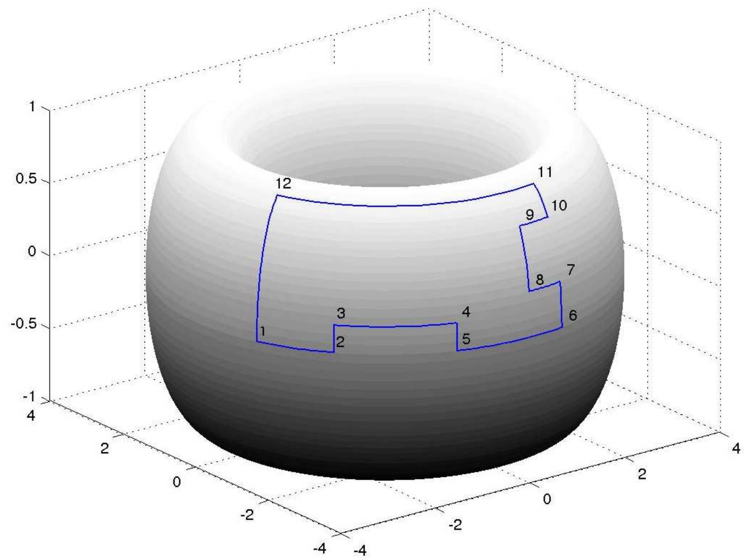
Flux loops are closed loops of wire attached to the fusion device to measure the enclosed total flux. The measured tension U is related to the flux by

$$U = -\oint \mathbf{E}\cdot\mathbf{dl} = \frac{\partial}{\partial t}\int \mathbf{B}\cdot\mathbf{da} = \frac{\partial}{\partial t}\int \mathbf{A}\cdot\mathbf{dl} \qquad \text{with } \nabla\times\mathbf{A} = \mathbf{B}$$

In principle, flux loops can have any shape (see e.g. NCSX stellarator). In tokamaks with axisymmetric plasmas, the interpretation of the flux loop signals is considerably simplified by using a specific layout:

1) Purely toroidal sections
2) Sections in poloidal plane that project onto a common line in the poloidal plane. The contributions from these sections cancel out each other.

For axisymmetric fields, the toroidal component of the vector potential **A** is given by $A_\varphi = \Psi/R$, where Ψ is identical to the flux function from the Grad-Shafranov equation. A more complicated path of a flux loops is shown in the figure:



Due to the axisymmetry, the integration along the toroidal sections is carried out immediately. The signal is given by

$$U = \Psi(R_1,Z_1)(\varphi_2-\varphi_1)+\Psi(R_3,Z_3)(\varphi_4-\varphi_3)+\Psi(R_5,Z_5)(\varphi_6-\varphi_5)+\Psi(R_7,Z_7)(\varphi_8-\varphi_7)$$
$$+\Psi(R_9,Z_9)(\varphi_{10}-\varphi_9)+\Psi(R_{11},Z_{11})(\varphi_{12}-\varphi_{11})$$

The coordinates of the corners of the loops should be specified in the ITM datastructure

magdiag/flux_loops/setup_floops/position

It should be noted that there is some redundancy in this representation.

For simplicity, full flux loops can be described by one single coordinate, saddle loops with two toroidal sections with two coordinates. The angle is ignored in theses two cases.