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Cyclotron median plane errors due to asymmetric RF cavities

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IBA is currently investigating asymmetric RF cavities for some of its PET cyclotrons. Those cavities will only occupy two upper pumping holes with dee-stems and outer cavity walls. The corresponding two lower pumping holes will be empty. The advantages of such a configuration are: i) The four oil diffusion pumps mounted underneath the cyclotron are more efficient, ii) the cavities become considerably shorter due to the almost twice higher effective dee-capacity per cavity and iii) the system becomes less expensive and more rigid. A possible disadvantage could be the vertical asymmetry of the structure which could distort the median plane

An equation is derived for the electric median plane error as a function of position and RF phase. A CST Microwave Studio® cavity model was used to obtain the vertical median plane E-fields. Combining both results, the distorted median plane at any point in the cyclotron is calculated. For realistic values of the vertical betatron tune and for reasonable values of the RF phase, the median plane excursion remains below 0.1 mm. It is concluded that the vertical asymmetry of the cavity does not pose any problem with respect to the beam optics.

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Primary author: Dr KLEEVEN, Willem (IBA)

Co-author: Dr ABS, Michel (IBA)

Presenters: Dr ABS, Michel (IBA); Dr KLEEVEN, Willem (IBA)

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