Simulation of Alfvén eigenmodes excited by energetic particles on EAST

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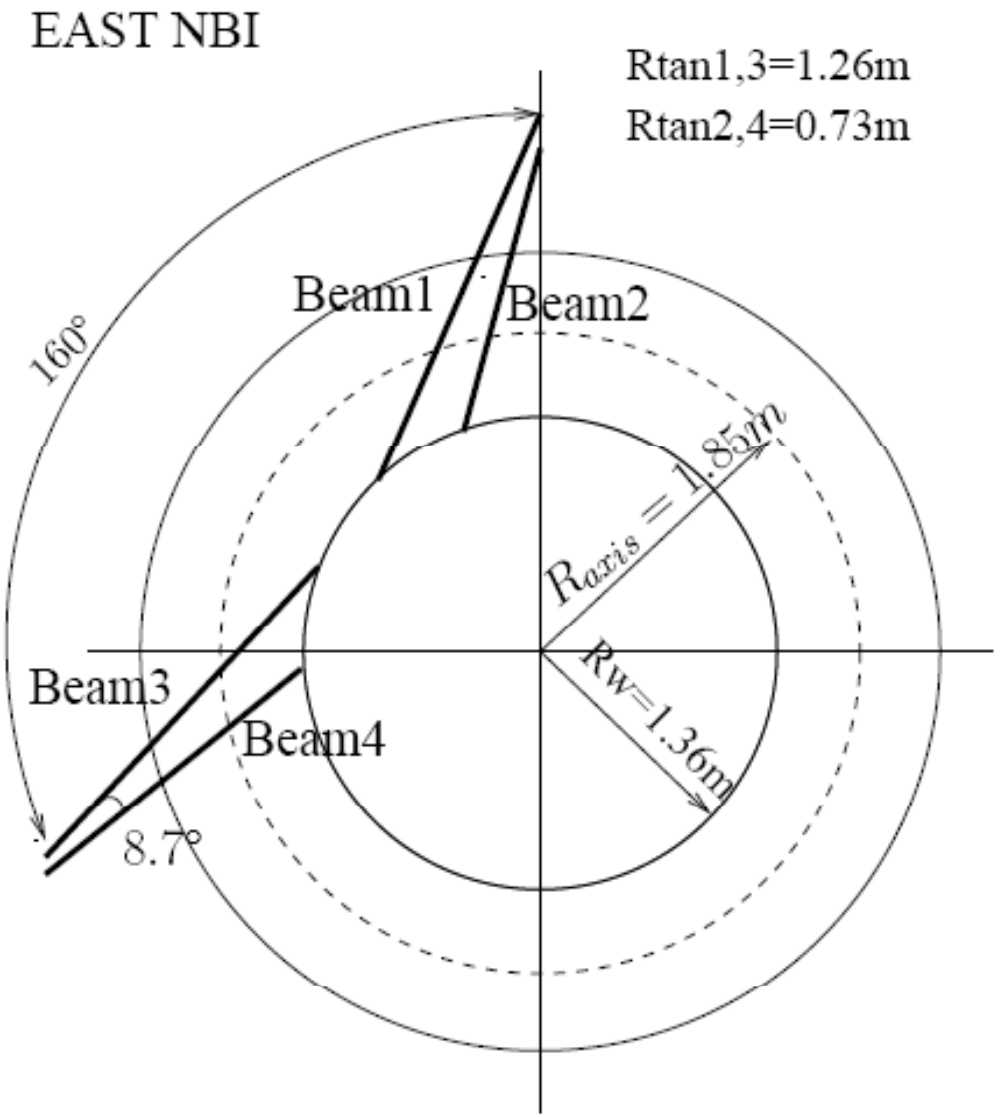
Neutral Beam Injection (NBI) on EAST



Kinetic-MHD hybrid model and code

- MHD momentum equation with EPs effects (current coupling):

$$\rho\left(\frac{\partial \boldsymbol{u}}{\partial t}+\boldsymbol{u}\cdot\nabla\boldsymbol{u}\right)=-\nabla p+\left[(\nabla\times\boldsymbol{B})/\mu_0-\boldsymbol{J}_h'\right]\times\boldsymbol{B},$$

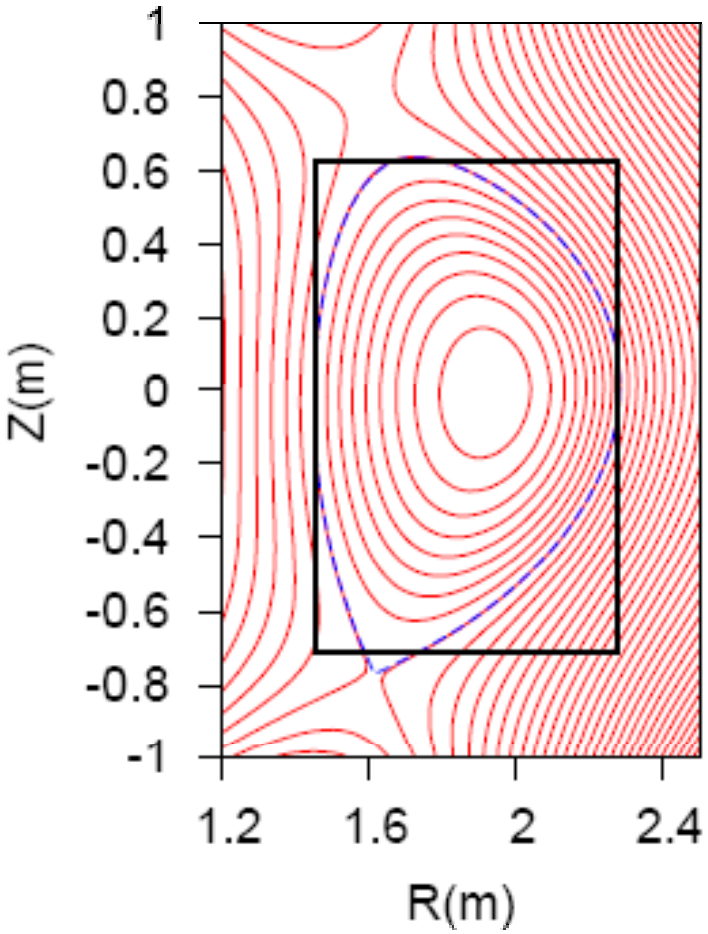
where

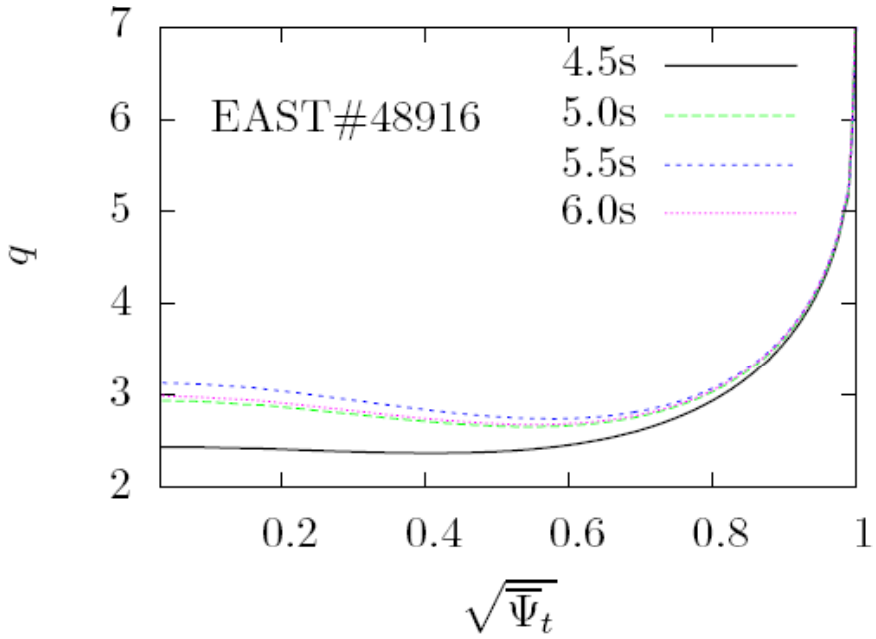
$$\boldsymbol{J}_h'=\int(\boldsymbol{v}_{\parallel}^{\star}+\boldsymbol{v}_B)Z_h e f d^3v-\nabla\times\int\mu\boldsymbol{b}f d^3v,$$

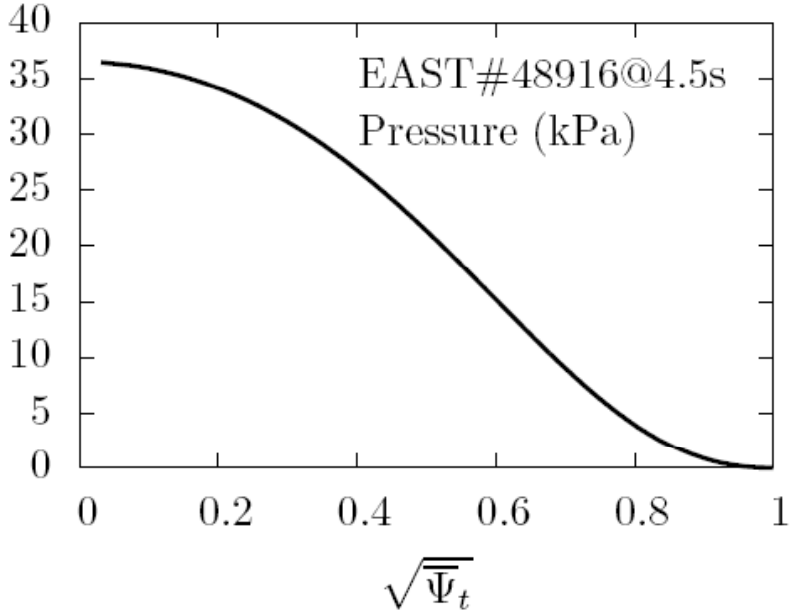
MEGA code:

- developed by Y. Todo et al, NIFS
- uses cylindrical coordinates (R,ϕ,Z) to solve the full MHD equations in toroidal geometry
- EPs are treated by δf gyrokinetic PIC method

Equilibrium of EAST#48916@4.5s





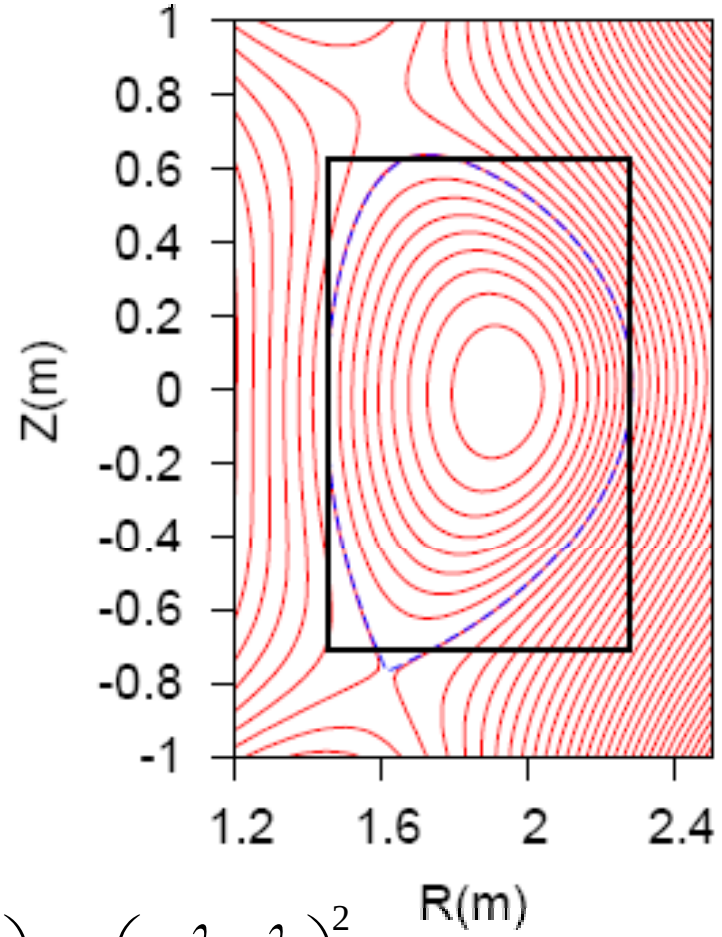


Initial/boundary conditions

- Random magnetic perturbation

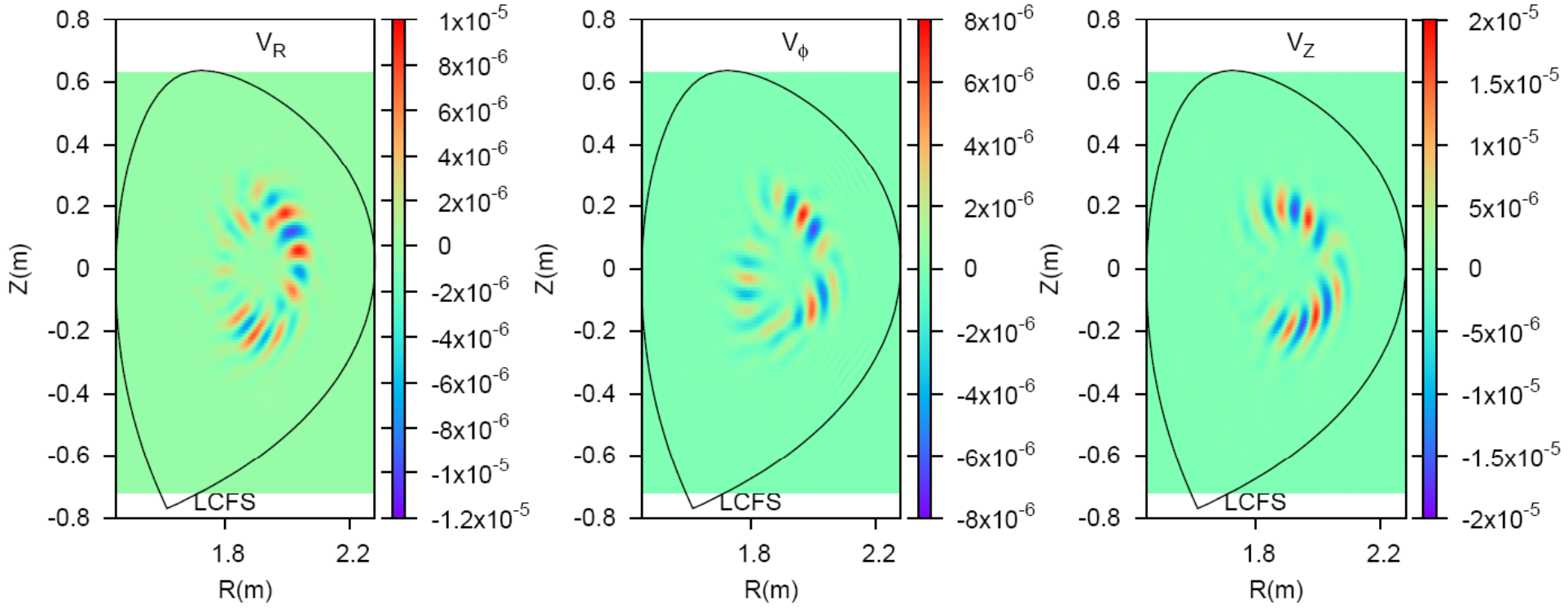
$$\delta B / B_0 \approx 10^{-10}$$

- Fixed zero boundary condition
- Fast ions beta: $\beta_h(0) \approx 1\%$
- Distribution of Fast ions:



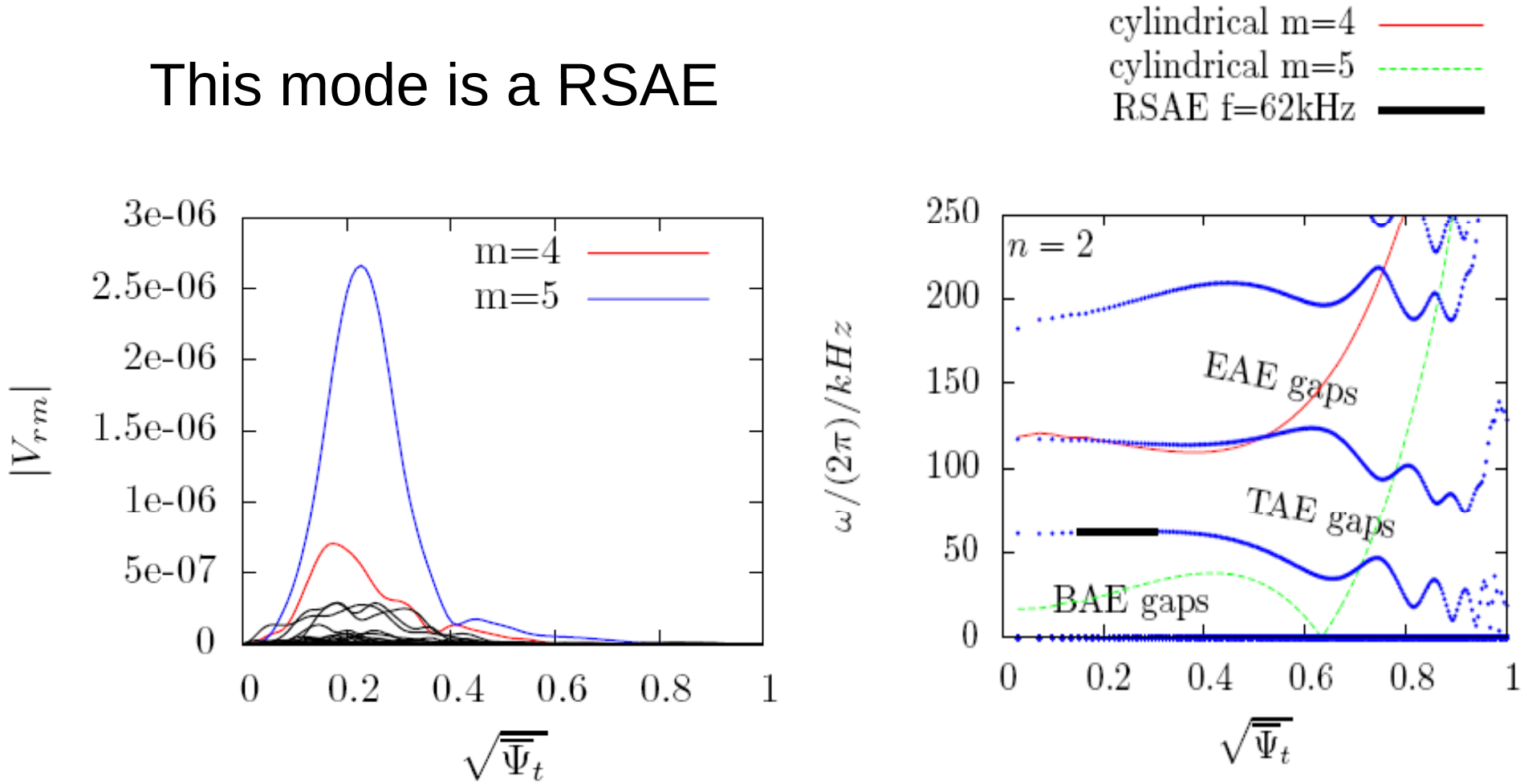
$$f_h(\psi,v,\lambda) = C\exp\left(-\frac{\psi}{\Delta\psi}\right)\frac{1}{v^3+v_{crit}^3}\frac{1}{2}erfc\left(\frac{v-v_b}{\Delta v}\right)\exp\left(-\frac{\lambda-\lambda_0}{\Delta\lambda}\right)^2$$

Cotour of perturbation at t=0.25ms



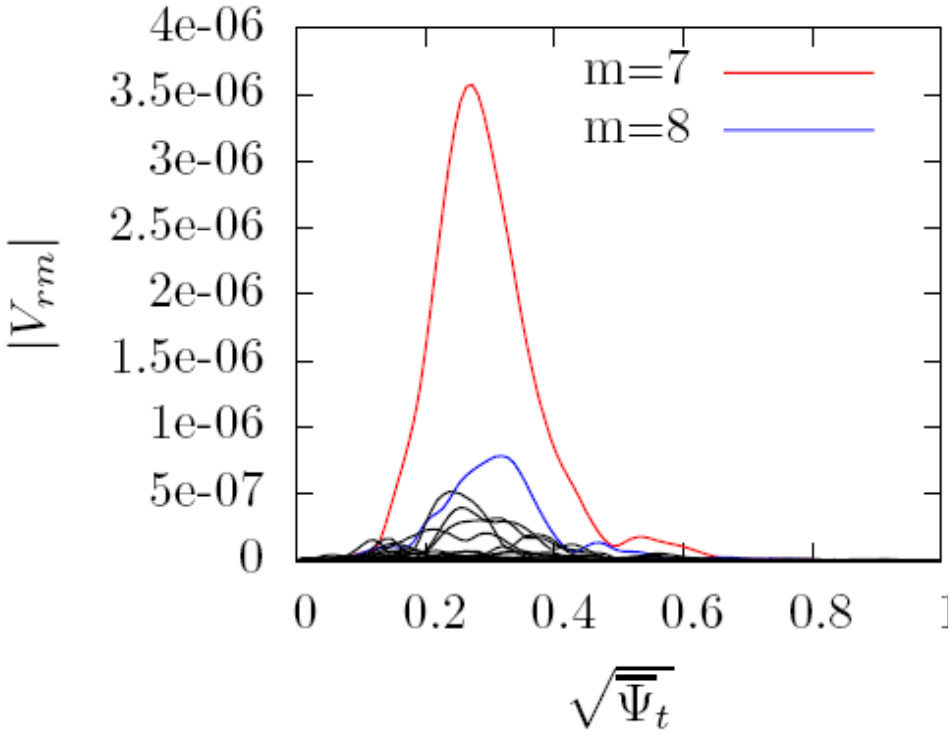
n=2 mode structure

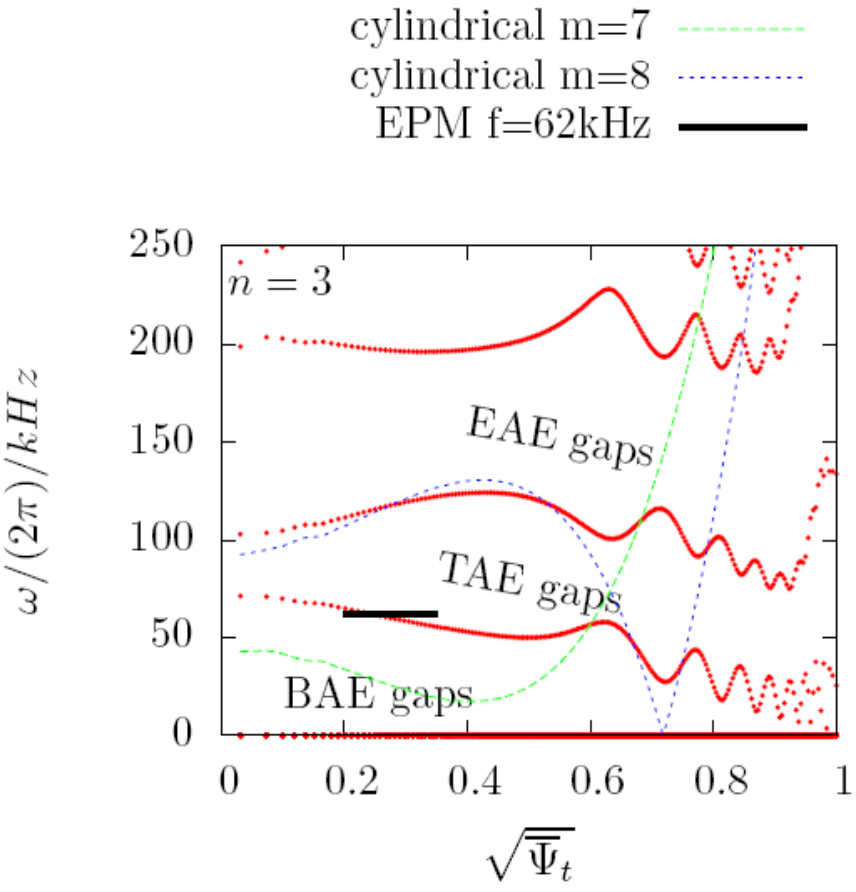
This mode is a RSAE



n=3 mode structure

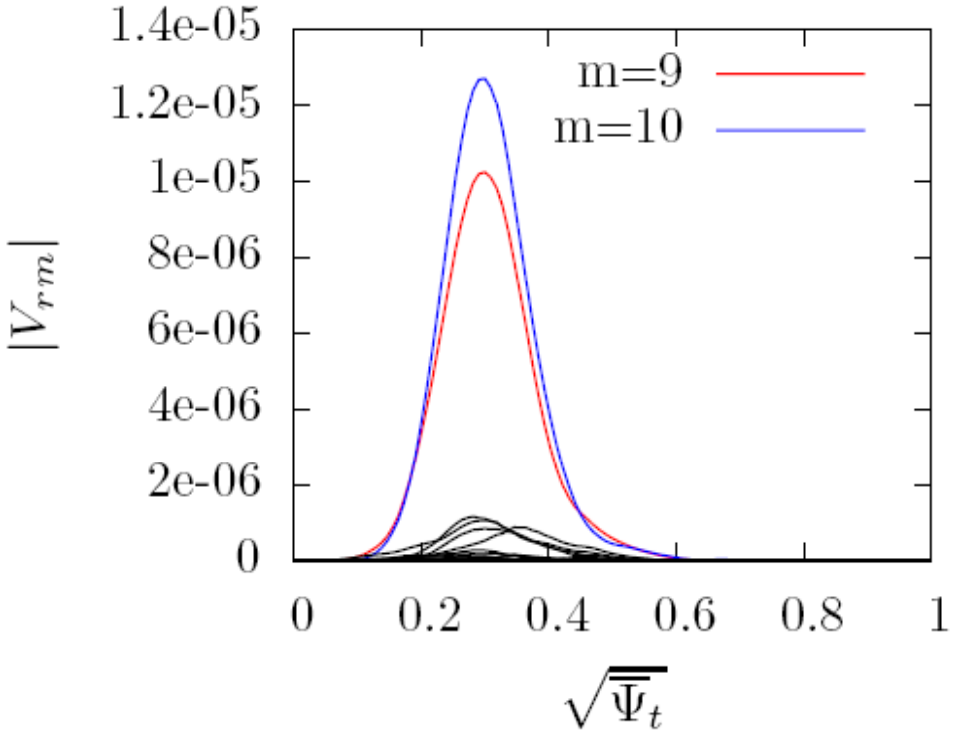
This mode is an EPM

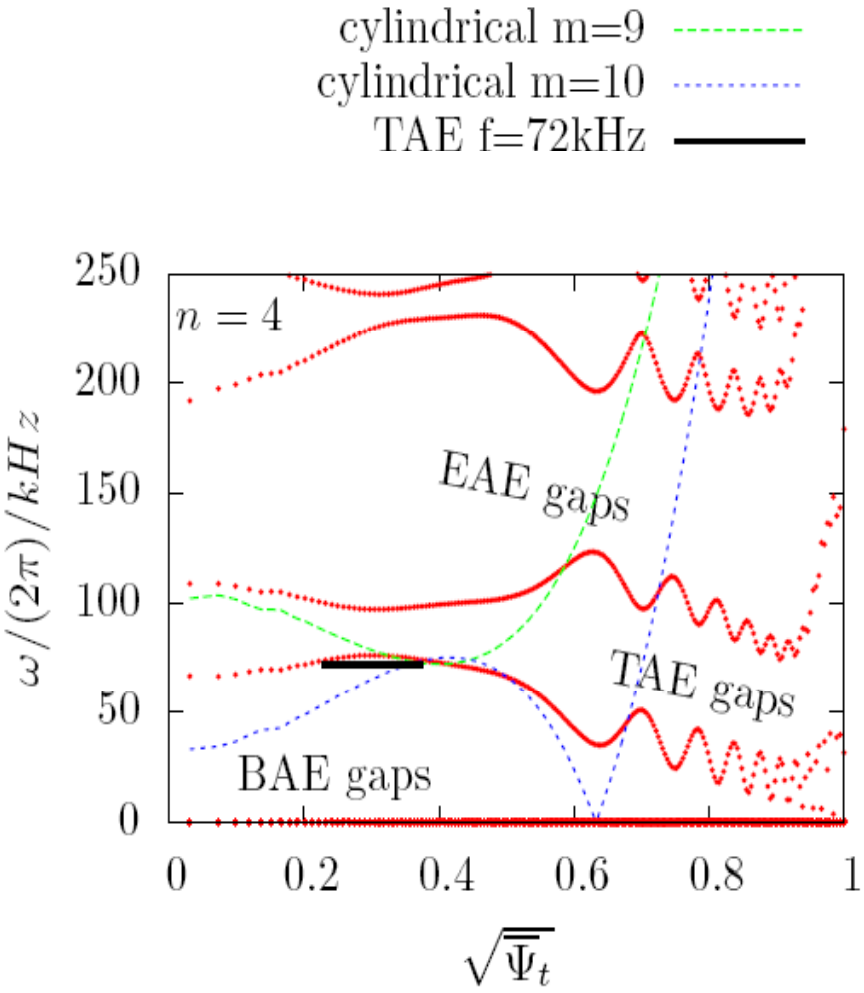




n=4 mode structure

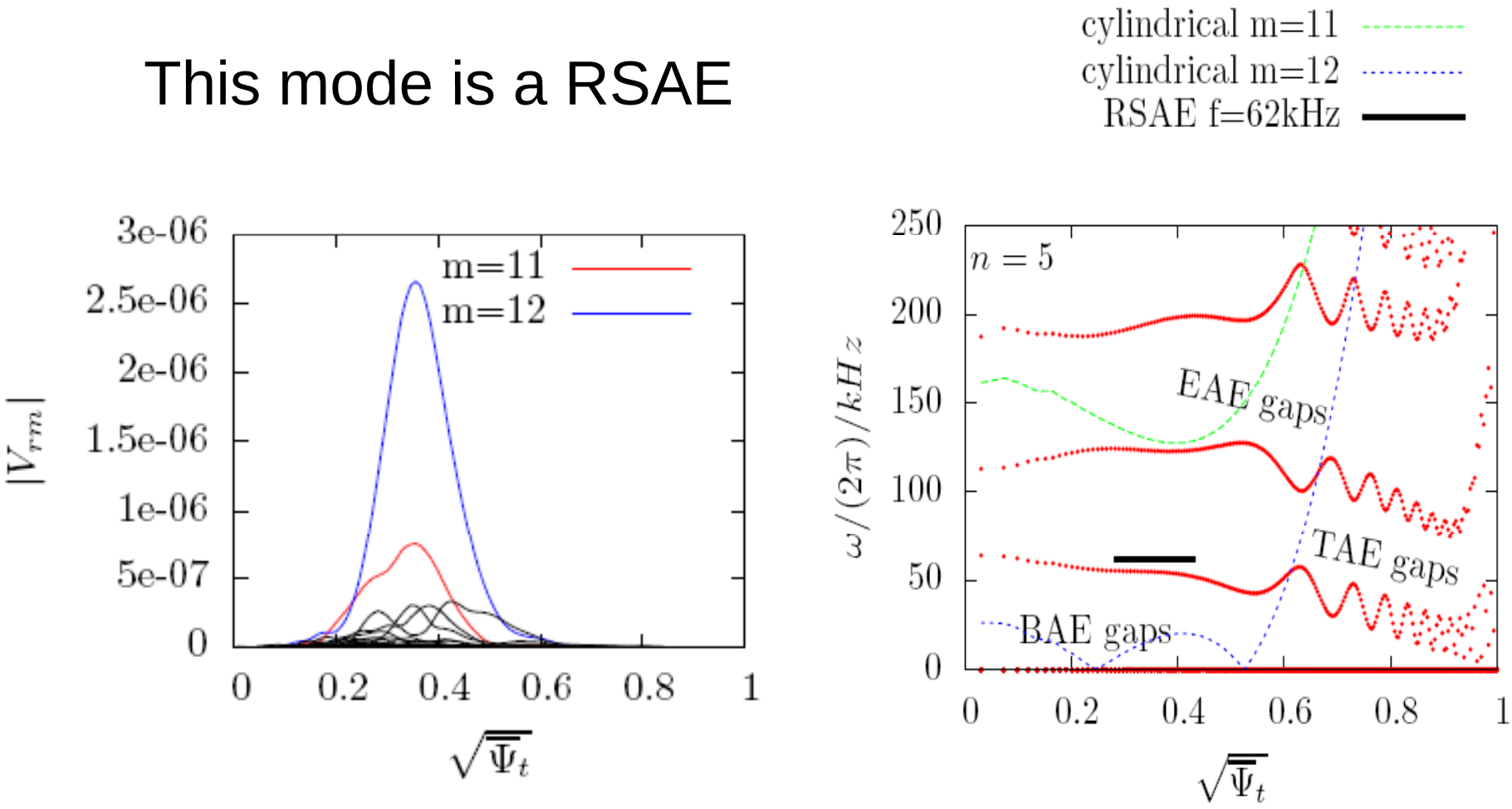
This mode is a TAE





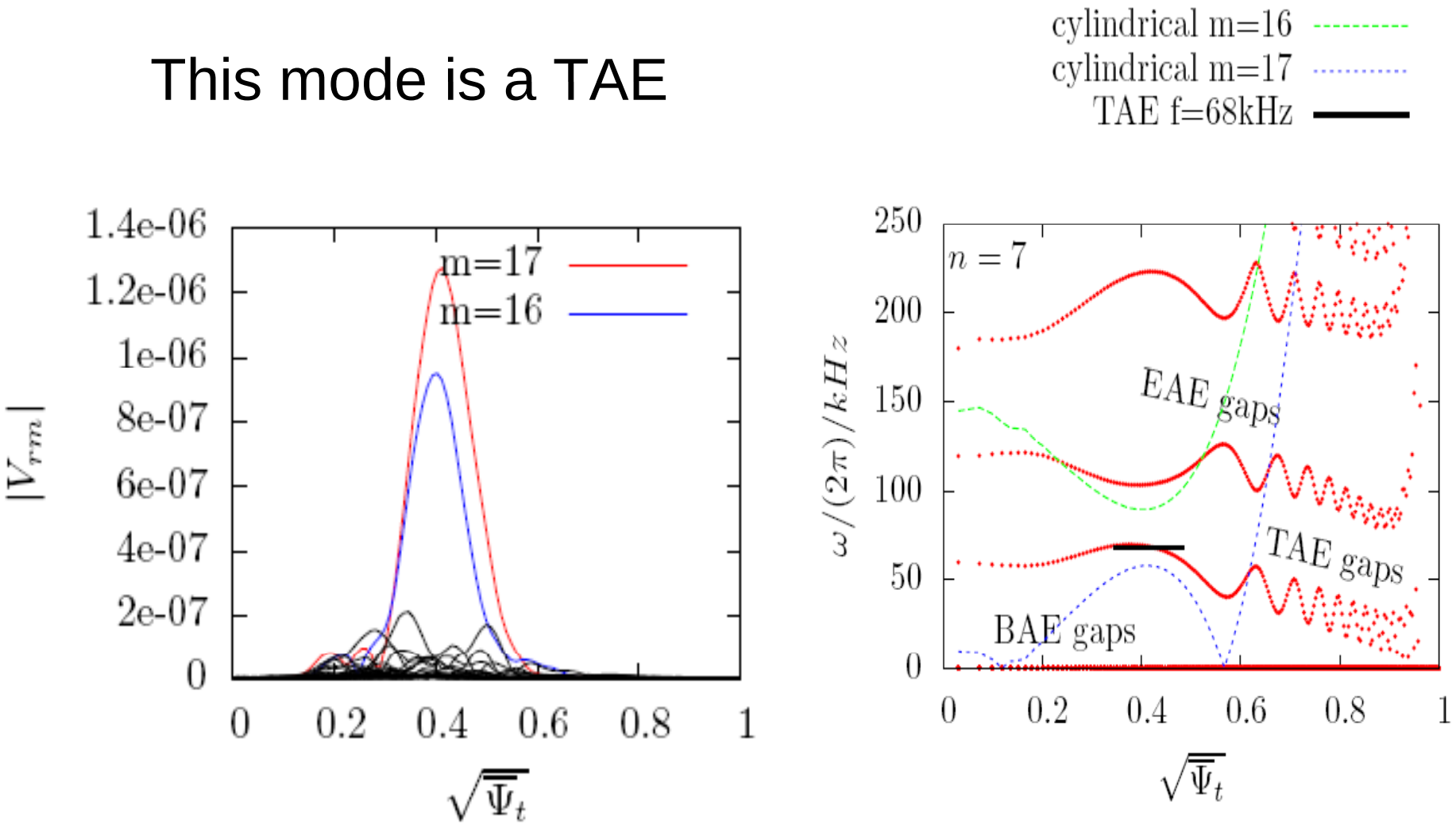
n=5 mode structure

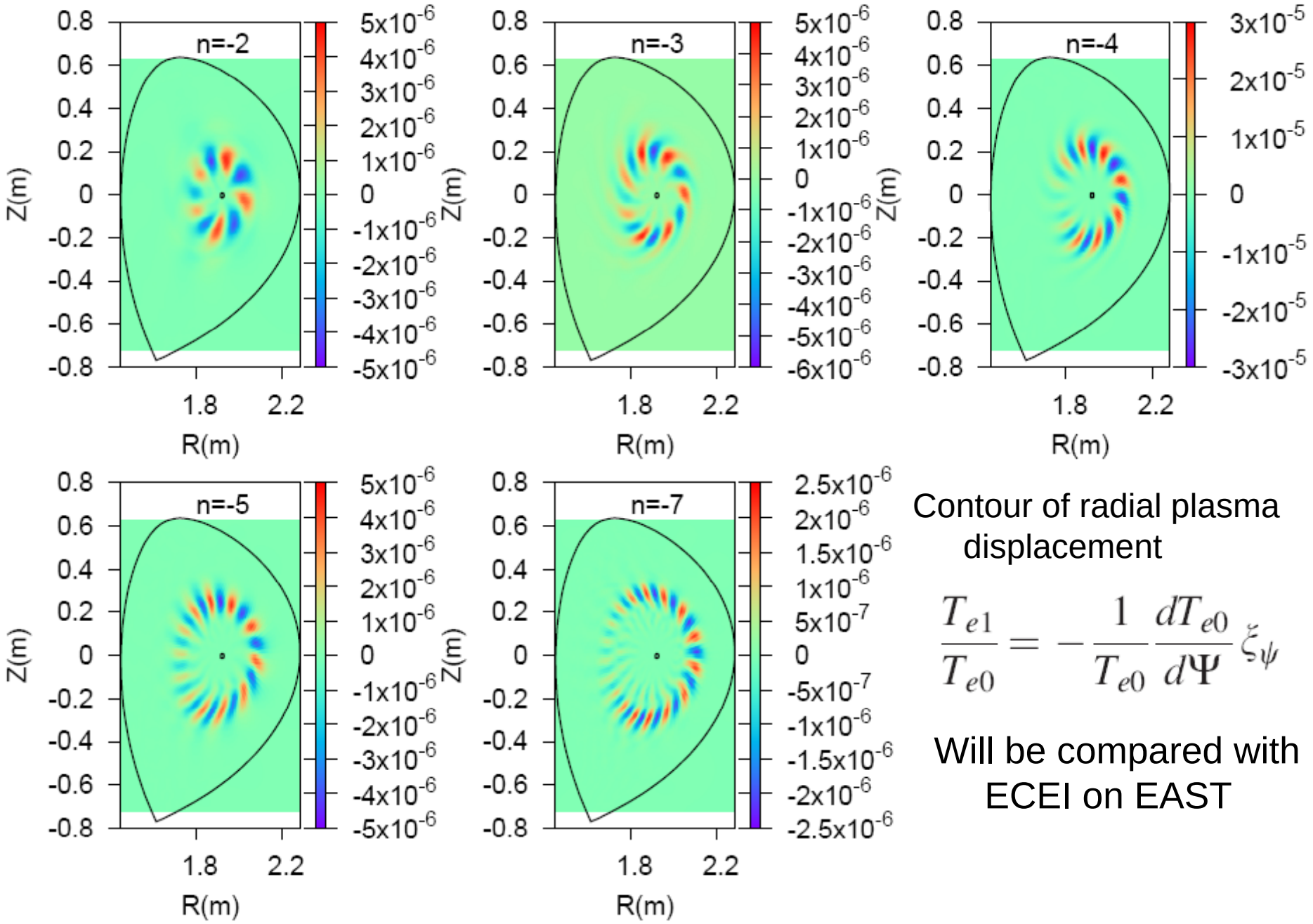
This mode is a RSAE



n=7 mode structure

This mode is a TAE





Contour of radial plasma displacement

$$\frac{T_{e1}}{T_{e0}} = -\frac{1}{T_{e0}}\frac{dT_{e0}}{d\Psi}\xi_\psi$$

Will be compared with ECEI on EAST