Adaptive meshing

Magnetic scalar potential $\mathbf{H} = -\mathrm{grad}\,\psi$

solve $\psi \in H_1\,(order = N)$

$$\int_{\Omega} \mu \nabla \omega \cdot \nabla \psi = -\int_{\partial\Omega} \omega \mathbf{B}_s \cdot \mathbf{n} \quad for\ \ \omega \in H_1^0 (order = N)$$

Error estimation

$$element\, error : E_e = \int_e \mu^{-1} \left| \mathbf{B}' - \mathbf{B} \right|^2$$

$$\mathbf{B} = -\mu \nabla \psi \ \ \mathbf{B}' = I_h\left(\mathbf{B}\right) \ \ I_h : \mathrm{Local\, interpolation\ to\ H_{div}} (order = N - 1)$$

Refinement

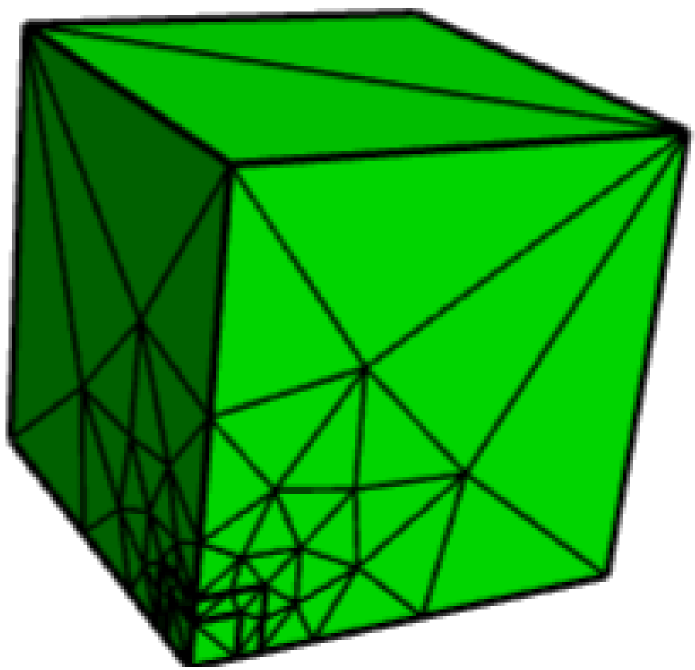
$$for \quad elements, E_e > r * \max(E_e) \qquad r : 0.25\ \mathrm{for\, example}$$

Zienkiewicz-Zhu type error estimator

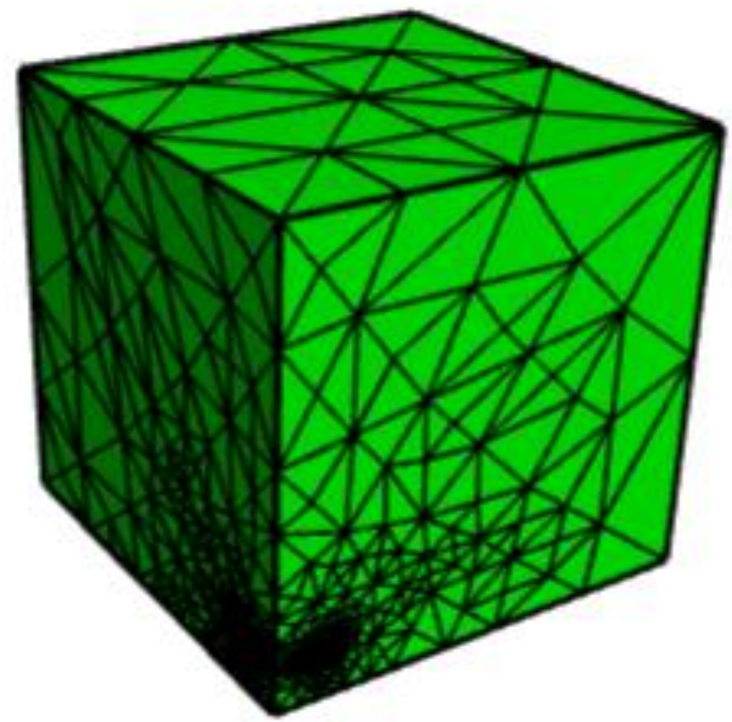
https://docu.ngsolve.org/latest/i-tutorials/unit-1.6-adaptivity/adaptivity.html

Adaptive meshing (Ω-Ωr法）

feOrder=3



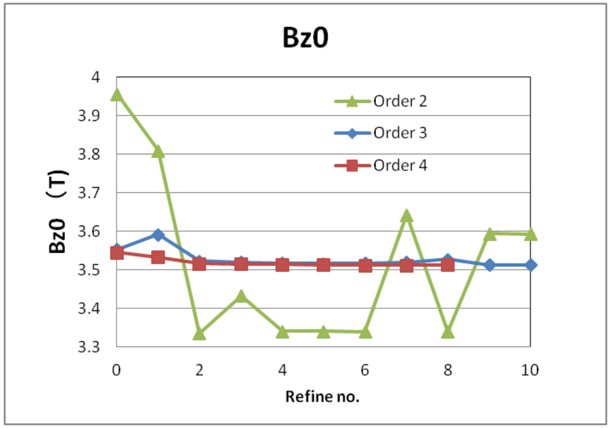
Initial Mesh
Ne=150,
Ndof=783,Nnonzero=26111



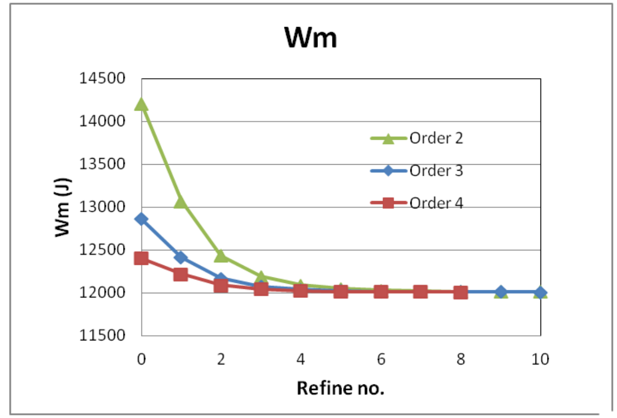
Mesh after 10 Refinement
Ne=243903, Ndof=1108002,
Nnonzero=53237796

Adaptive meshing (Ω-Ωr法）

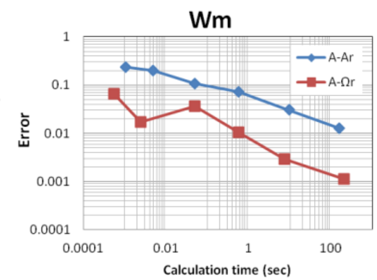
2025/9/2　A. kameari

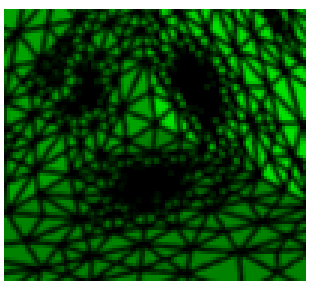


一点の磁場は滑らかに収束しない。
特に、二次要素では精度が出ない。

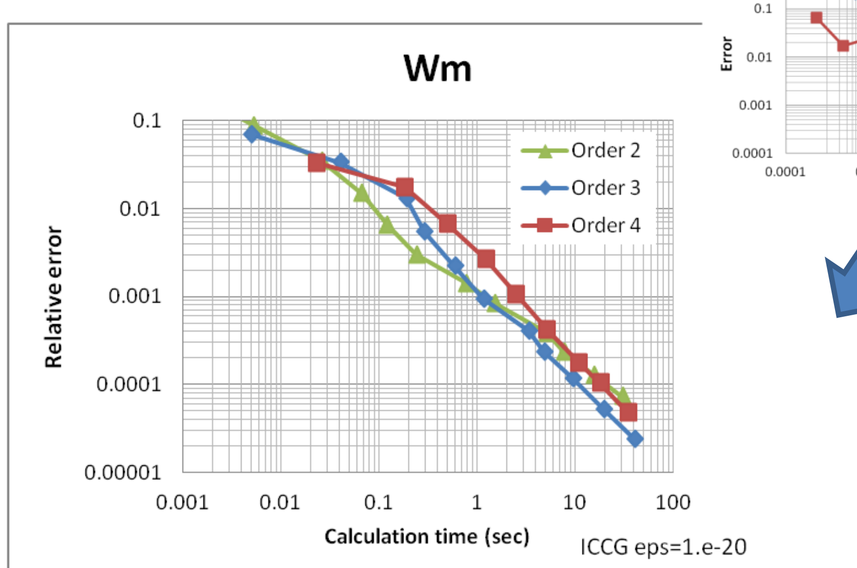


磁気エネルギの積分量は滑らかに収束。





評価点(0,0,0)近傍は細分割されない。
磁場は一様で誤差が小さいと評価される。



$$Error \sim \mathrm{T}_{cal}^{-1.3} \;\text{ for order} \geq 3$$