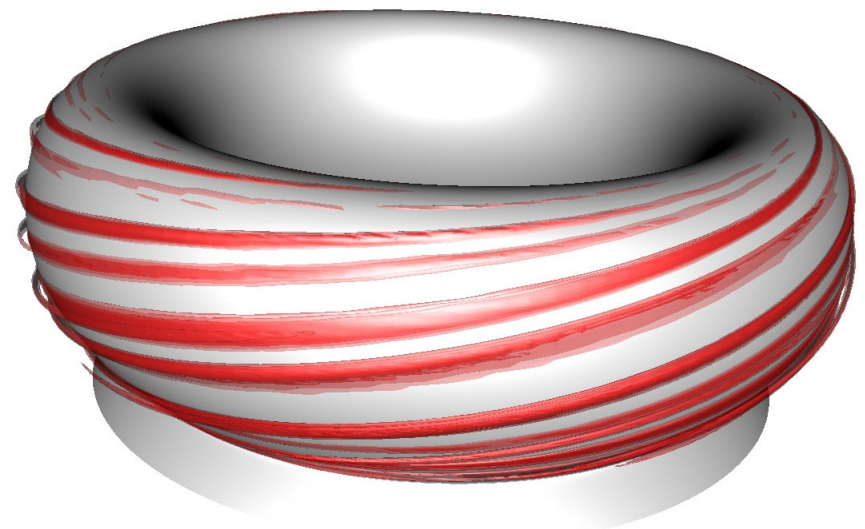


# Adaptive mhd Simulation of Tokamak Elms for iteR

Projet ANR-CIS 2006  
Meeting Cadarache  
*22/1/2009*



# Agenda

- Progress reports 1 (10:00-12:30)
  - Robin
  - Stanislas
  - Emiel
  - Dirk
  - Pierre
- Lunch 12:40-13:30
- Progress reports (13:30-15:00)
  - Pascal
  - Boniface
  - Guido
- Discussion ASTER2 15:00 (Remi by phone)
- 17:30 Taxi

## High Resolution

- Towards higher resolution:
  - $N_{\text{nodes}} = 13581$  nodes, 8 toroidal harmonics
  - $N_{\text{dof}} = 5.7 \times 10^6$ ,  $N_{\text{precond}} = 7.7 \times 10^5$ 
    - Goal :  $N_{\text{nodes}} \sim 15000$  nodes, 16-32 toroidal harmonics
- (lots of) Problems:
  - MUMPS on platine
  - PastiX memory overhead with MPI only
  - 4 byte integers too small
- Solution:
  - PastiX with MPI+THREADS
  - JOREK2 MPI+OPENMP

## OPENMP in JOREK2

- Only the routine `construct_matrix` is parallelised using OPENMP:
  - finite elements are distributed
  - Some quantities moved to a module
  - Some subroutine interfaces changed
  - Seems rather unstable! But now magically works on IBM SP6
    - Still problems on Norma and Platine for  $N_{\text{tor}} > 7$

```
!$omp parallel default(none) &
!$omp  shared(n_local_elms,irn_glob,jcn_glob,A_glob,RHS_loc,local_elms,element_list,node_list, &
!$omp      index_min, index_max,xpoint2,psi_axis,psi_bnd,Z_xpoint, my_id)          &
!$omp  private(ife,ielm,iv,inode,element,nodes,ELM,RHS,ELM2,RHS2,i,inode1,i_order,index_node1, &
!$omp      index_large_i,j,index_ij,k,knode,k_order,index_node2,index_large_k,ijA_position, &
!$omp      l,index_kl,ilarge2,omp_nthreads,omp_tid)

do ife =1, n_local_elms
  !      local finite elements matrices
  ...
enddo
```

## Status

- JOREK2 MPI+OPENMP

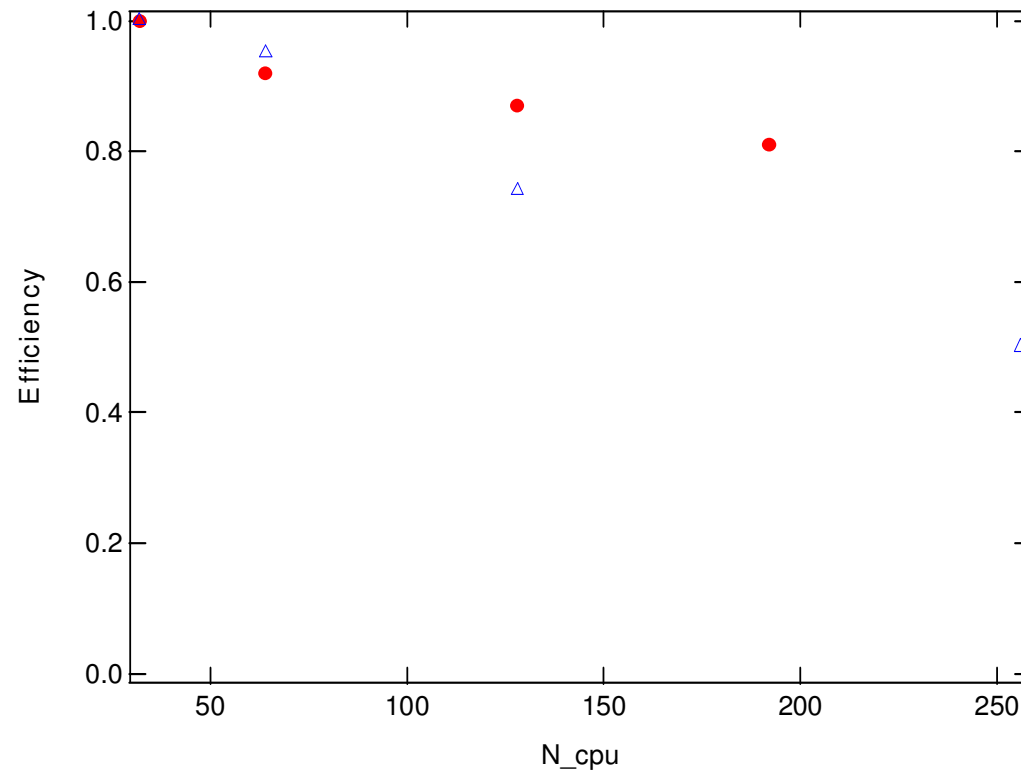
- Running correctly on IBM SP6 (Garching)
- Problems on PLATINE and NORMA for large problem size
  - Stack size problem?
- Adaptation to 8 byte integers in progress
- Expert help required!

- PASTIX MPI+THREADS

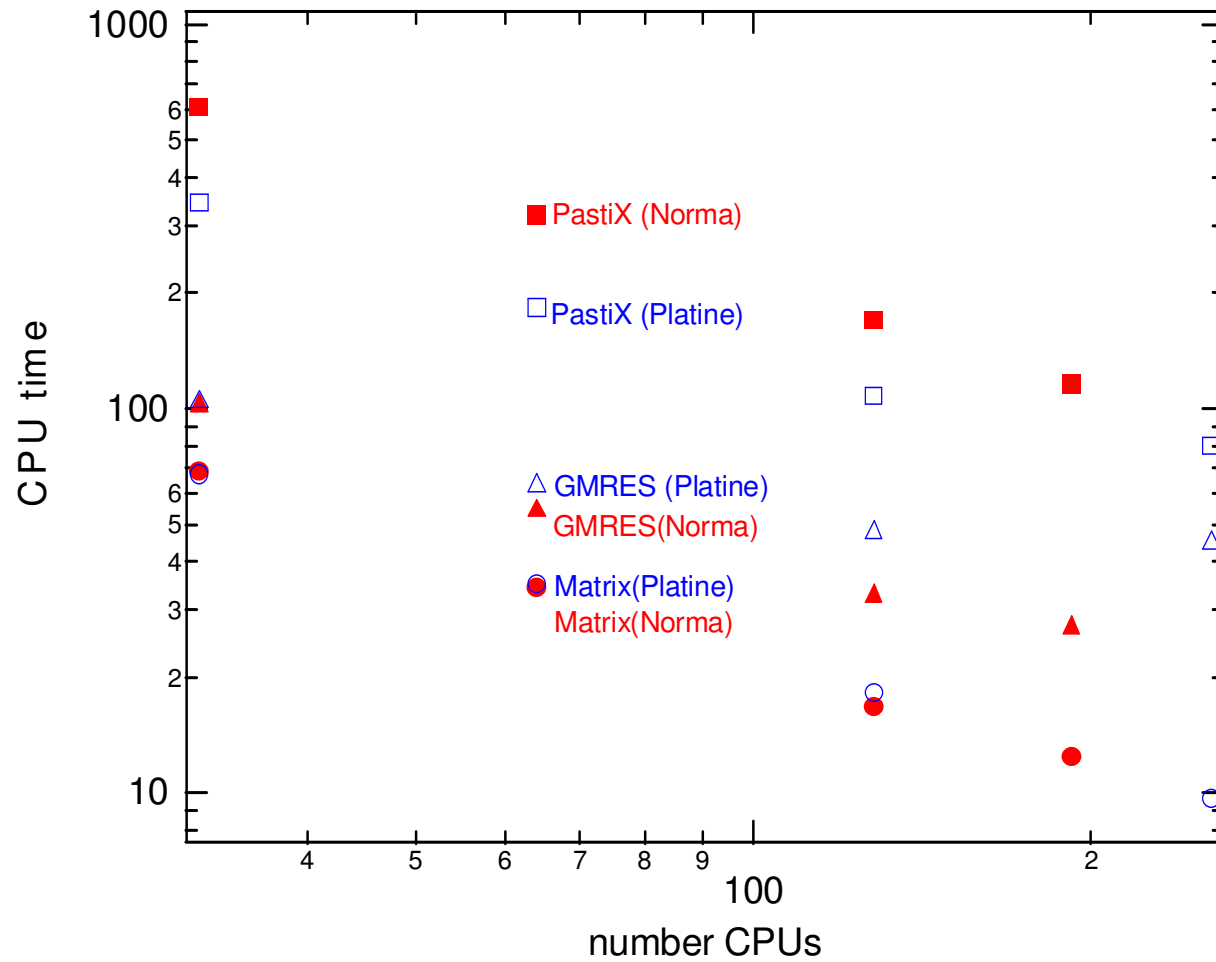
- Running very well on IBM SP6
- Problem with large problem size and 2<sup>nd</sup> call to Pastix
  - Could be related to integer\*4 being too small

# Scaling

- Scaling results on Norma and Platine
  - Tearing mode test case (medium size  $N_{\text{dof}} \sim 10^6$ )
  - MPI+OPENMP



# Scaling details



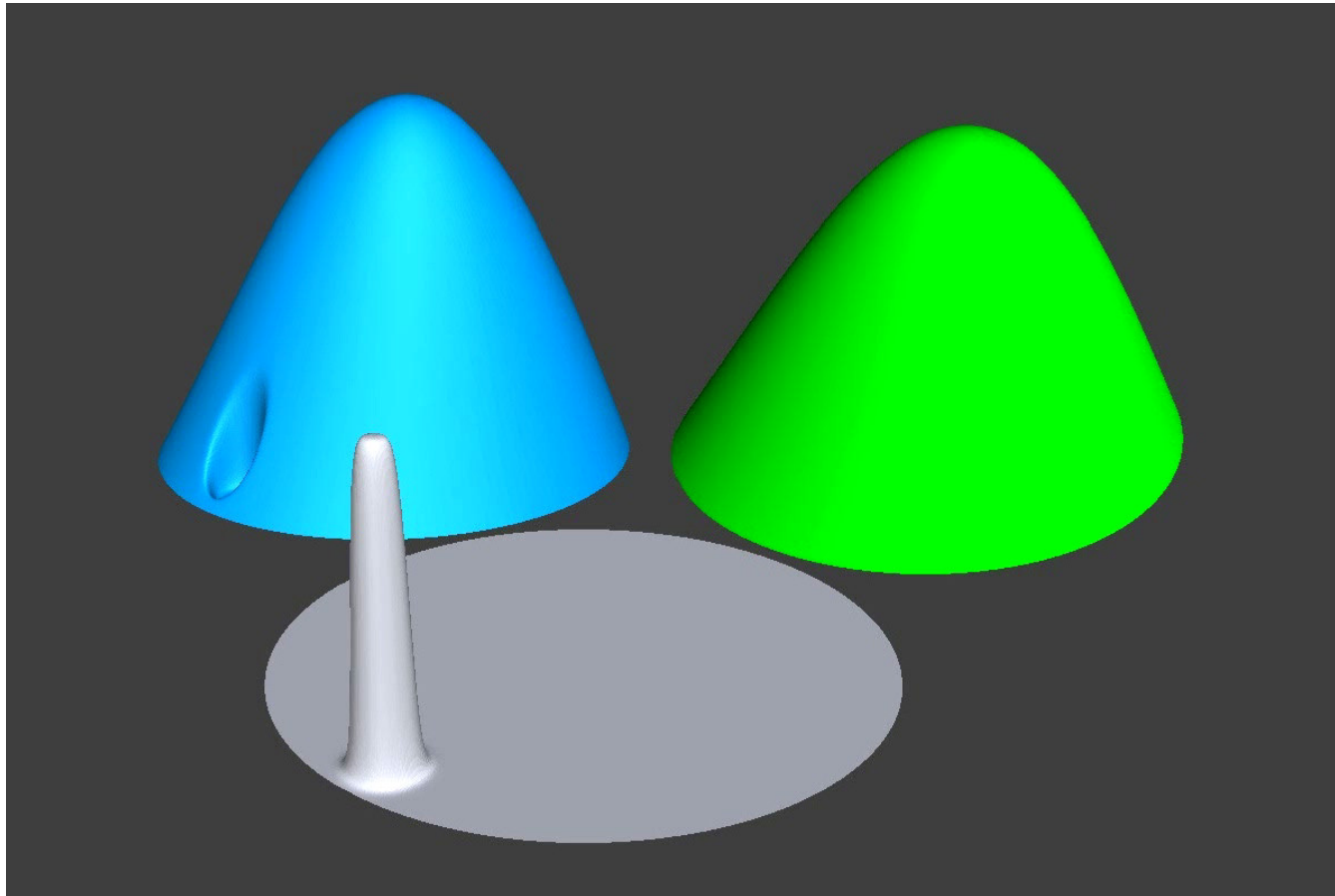
## Other developments

- ELM control/stabilisation
  - Applied external magnetic fields
  - First attempt pellet simulations
  
- Vacuum region and resistive wall
  - Collaboration with Ian Chapman, UKAEA, UK
  - Vacuum region :  $\nabla \cdot \mathbf{B} = 0$ ,  $\nabla \times \mathbf{B} = 0$ :  $\nabla \cdot \nabla \Phi = 0$
  - solution using boundary element method
    - Requires finite element grid only on JOEREK boundary
  - To be coupled to JOEREK
  - Resistive wall included in JOEREK grid
    - Equations can be chosen in each finite element



# 'Pellets'

- Pellets modelled as a localised perturbation in the density (density source):



Density, temperature, current density