Modeling Large Accelerator Structures with the Parallel Field Solver Tau3P

Michael Wolf, Adam Guetz, Cho-Kuen Ng

Advanced Computations,
Stanford Linear Accelerator Center

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Outline

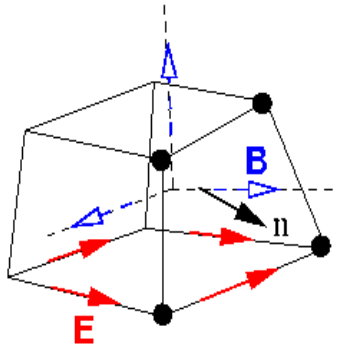
- Introduction
- Tau3P Implementation
- Simulation Results
- Parallel Performance
- Work in Progress

Introduction

- 3D time domain code used to calculate transmission properties of open structures & wakefields
- Uses unstructured grids to conform to geometry
- Uses the **discrete surface integrals*** method

$$\oint E \bullet ds = -\iint \frac{\partial B}{\partial t} \bullet dA$$

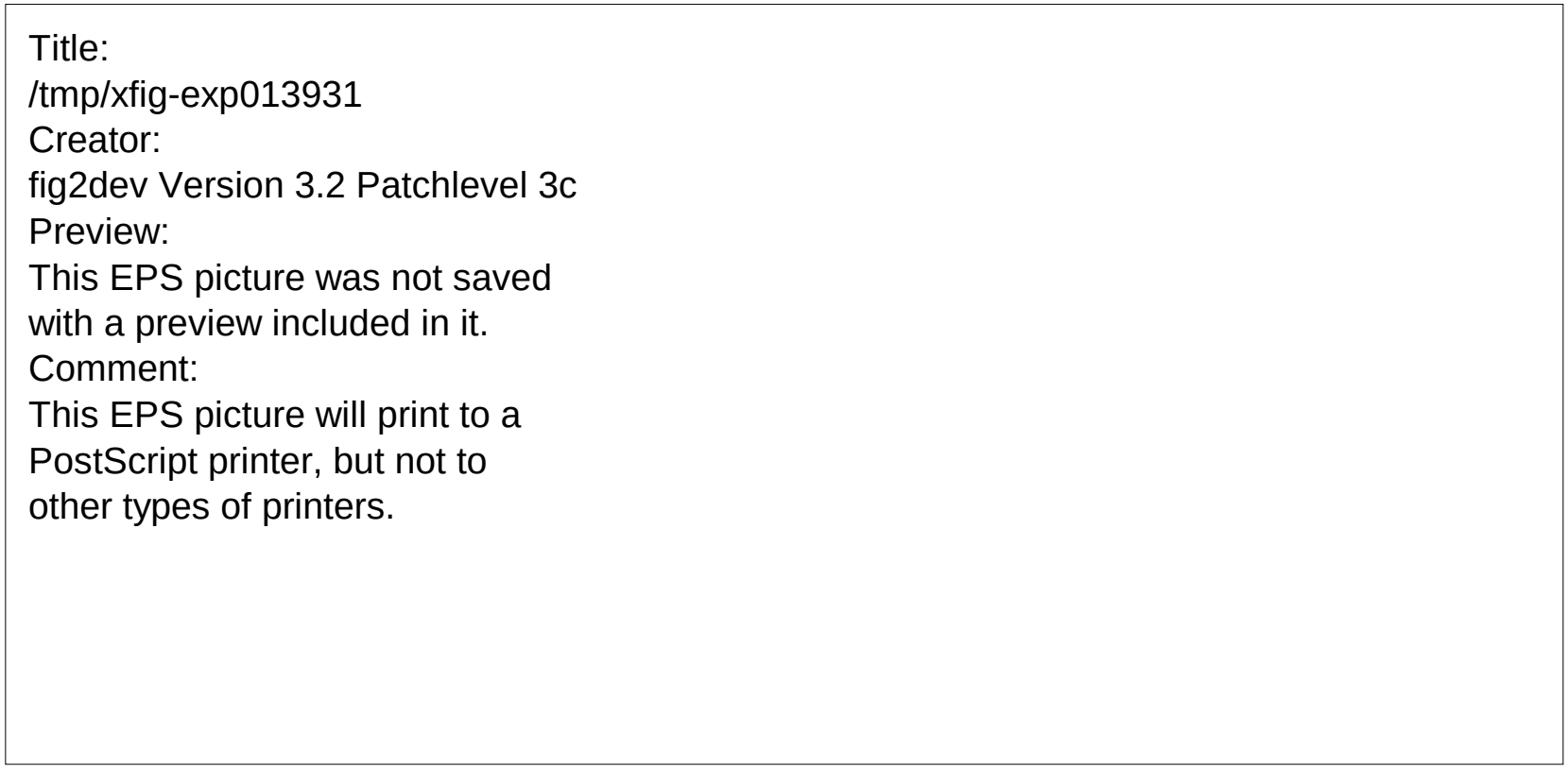
$$\oint H \bullet ds^* = \iint \frac{\partial D}{\partial t} \bullet dA^* + \iint j \bullet dA^*$$



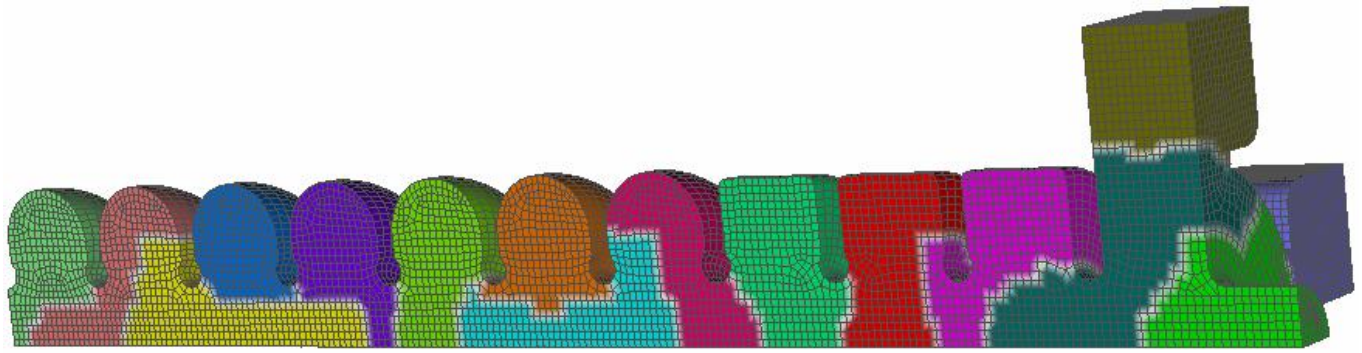
- Calculates E on primary grid, H on dual grid
- Parallel application using domain decomposition and MPI

*N.K. Madsen. Journal of Computational Physics, **119**, 34-45 (1995).

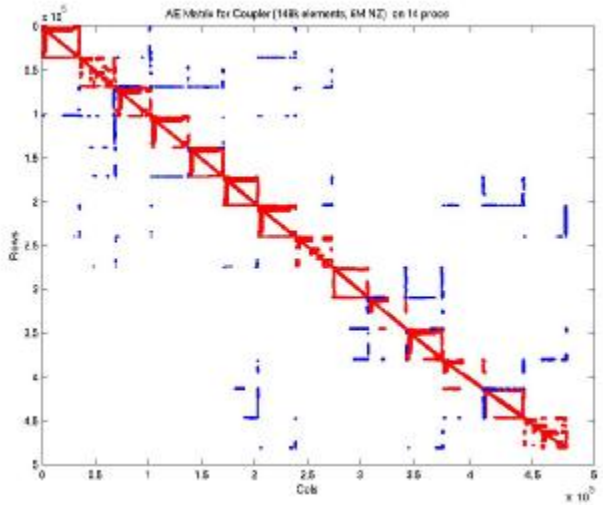
Tau3P Implementation



Tau3P Implementation (cont.)



Example of Distributed Mesh



Typical Distributed Matrix

Tau3P Excitations

- Handles following excitations with appropriate boundary conditions:

Waveguide excitation

Calculate transmission properties of traveling wave structures

Dipole excitation

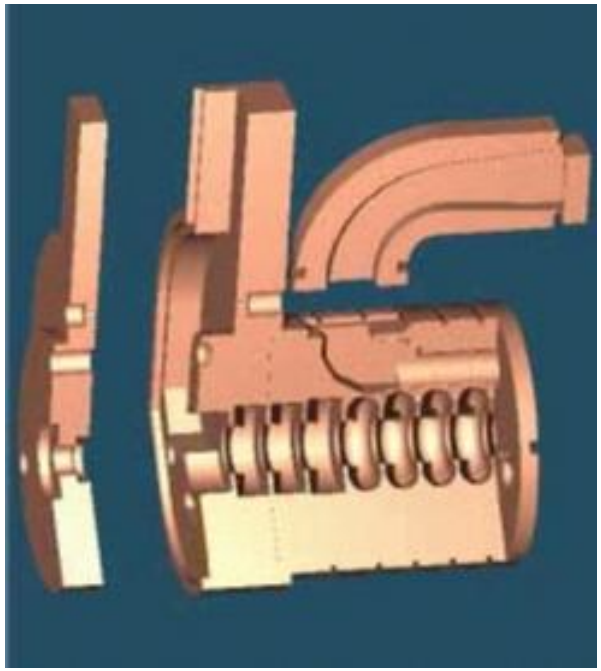
Study transient response of structures driven by electric dipoles

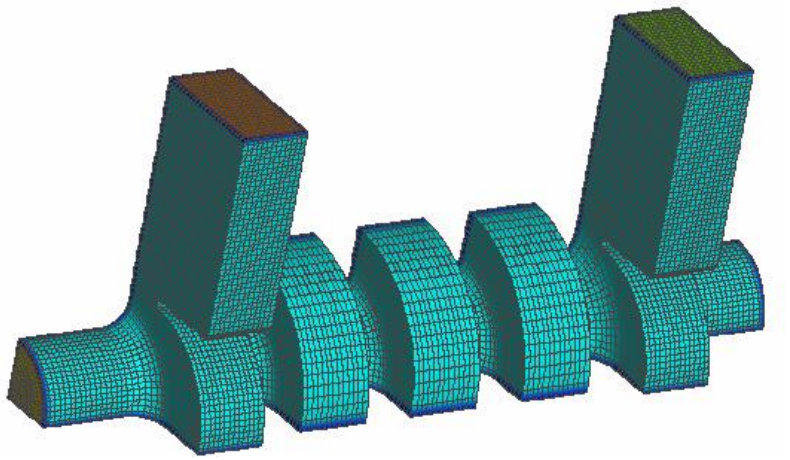
Beam excitation

Calculate wakefields driven by a rigid beam

Waveguide Excitation

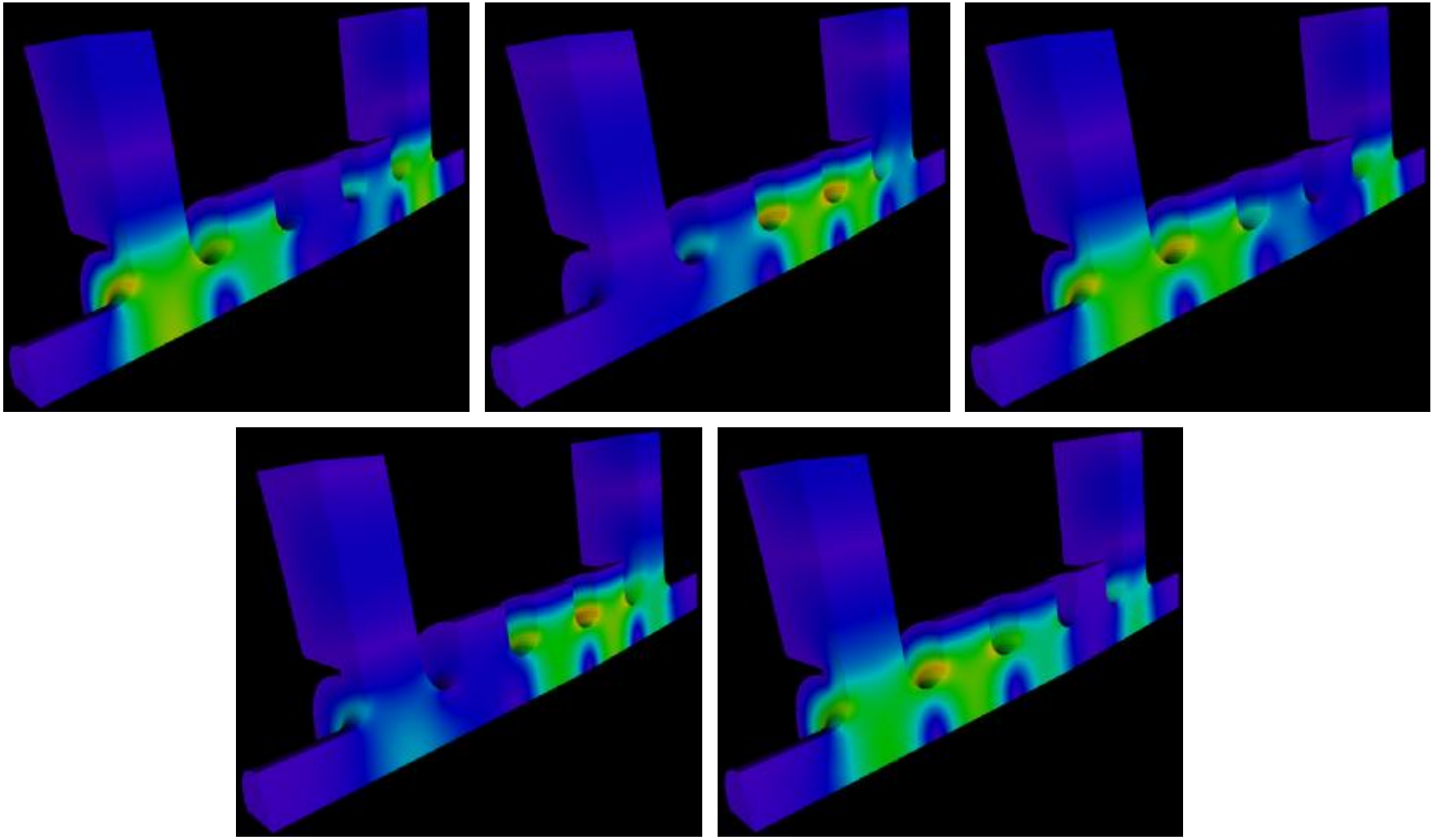
NLC RDDS Input Coupler



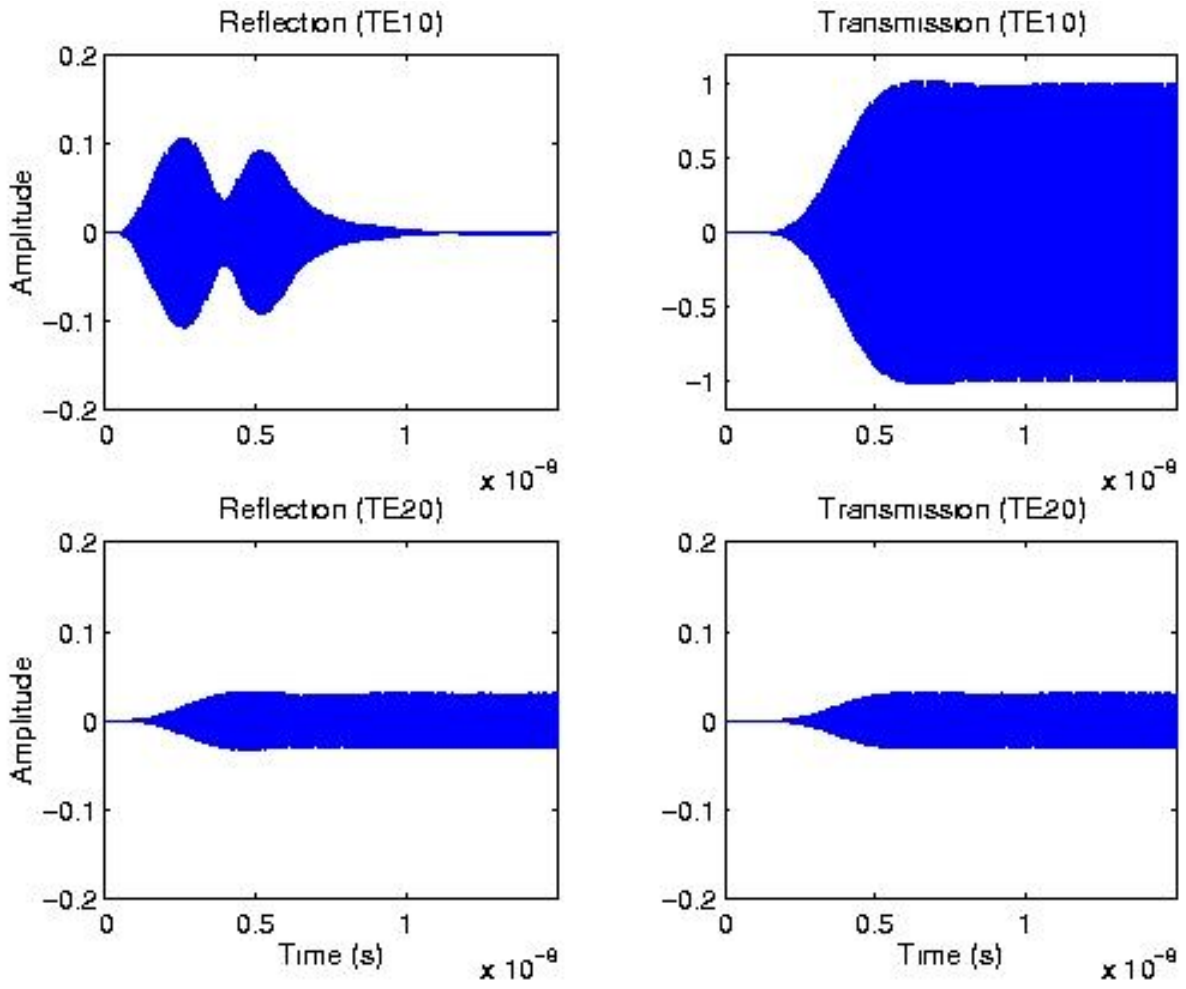


Fundamental Mode Coupler
- Tau3P matching calculations provide accurate cavity dimensions for fabrication by using realistic geometry model

Snapshots of Traveling Wave

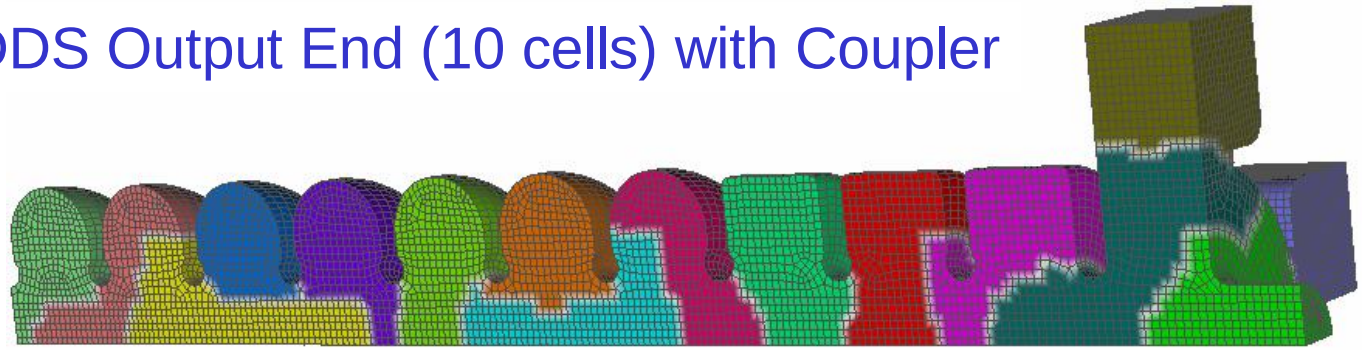


Transmission Calculations

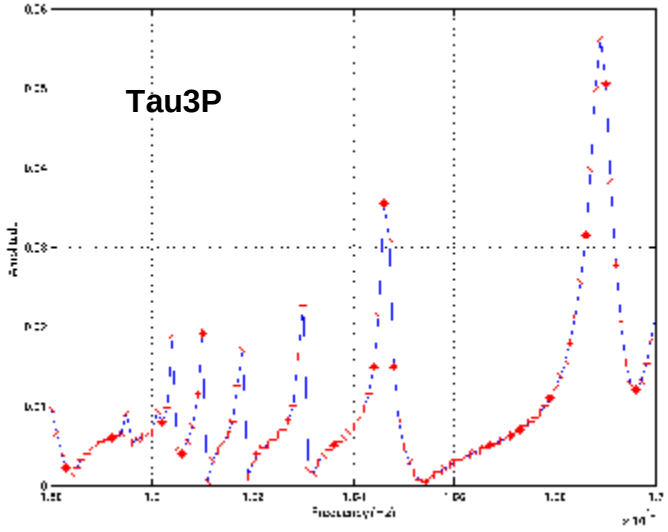


Dipole Field Excitation

RDDS Output End (10 cells) with Coupler



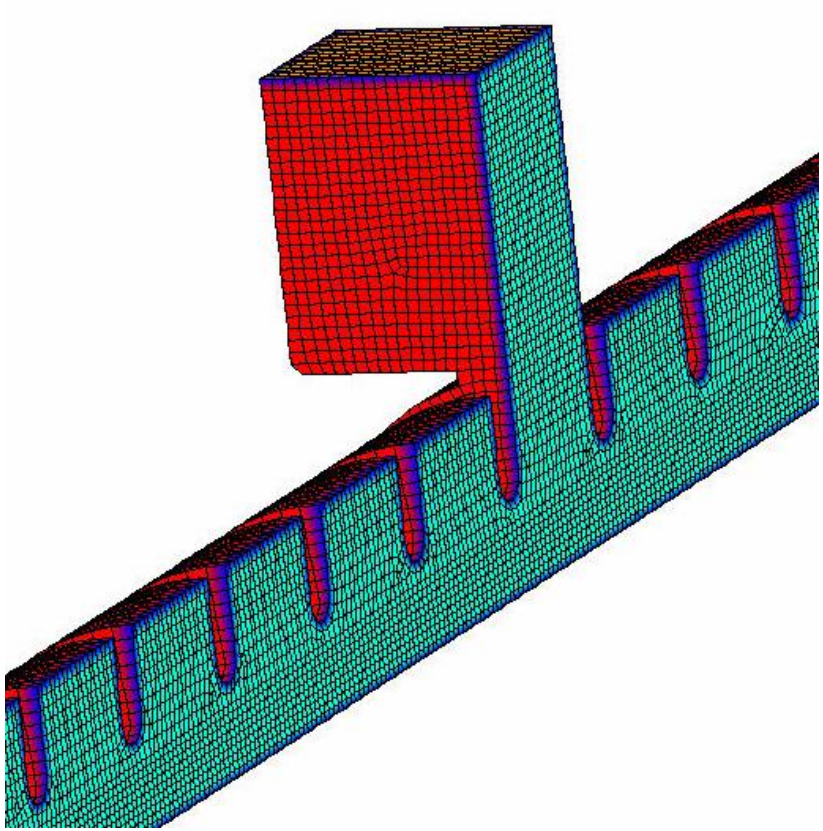
Dipole Mode Spectrum

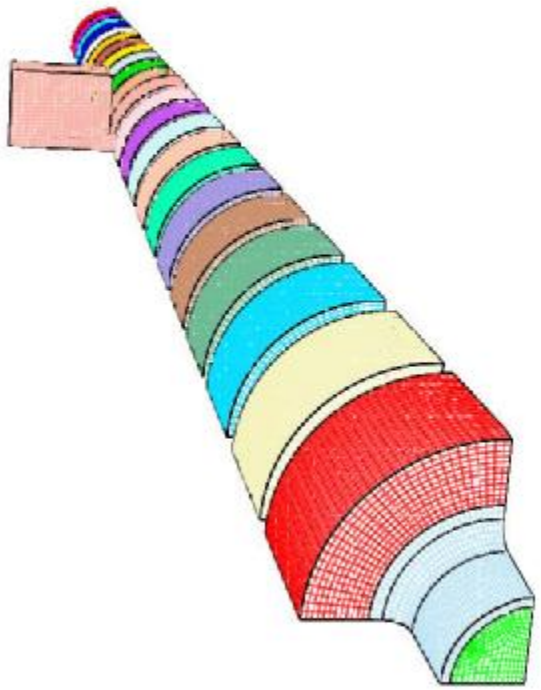


Measurement	Tau3P
16.868	16.89
16.440	16.46
16.280	16.30
16.176	16.18
16.098	16.10
16.034	16.04

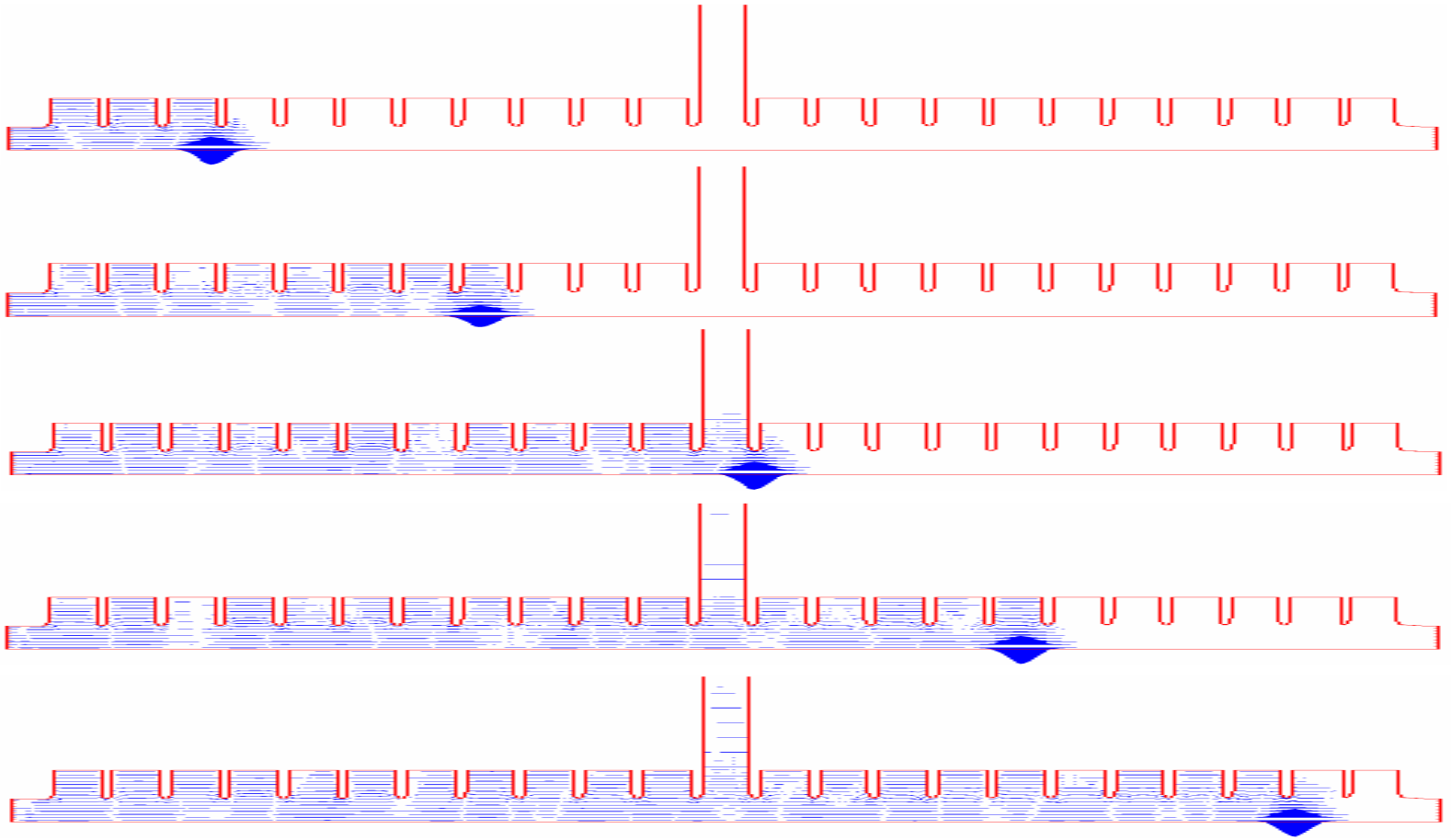
Beam Excitation

Standing Wave Detuned Structure

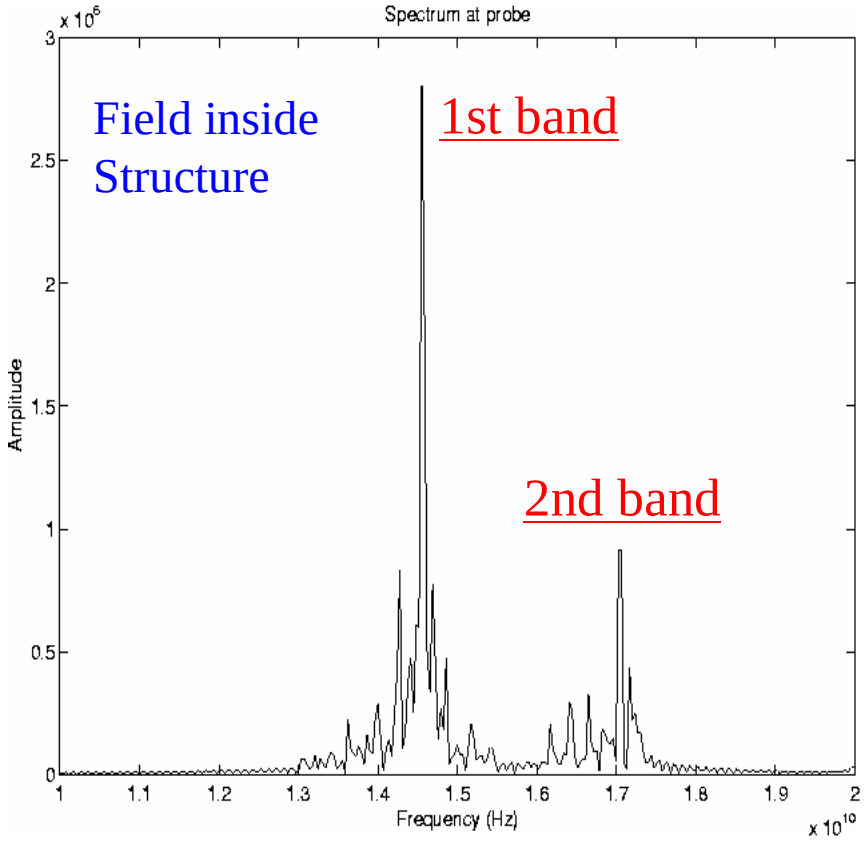


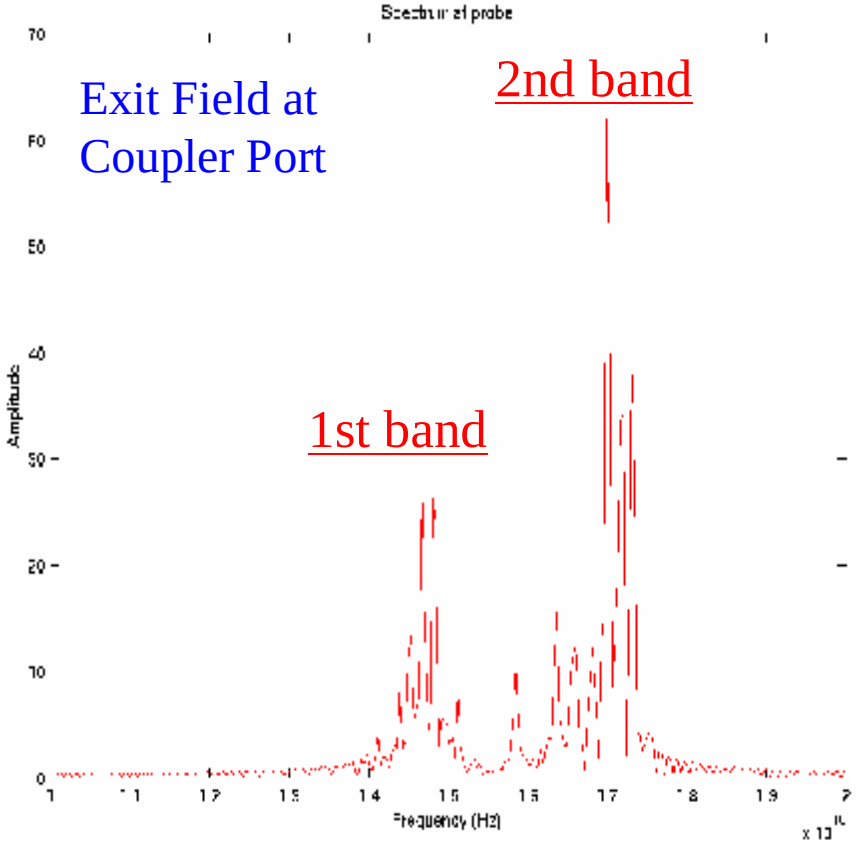


Beam Transit through SW Structure

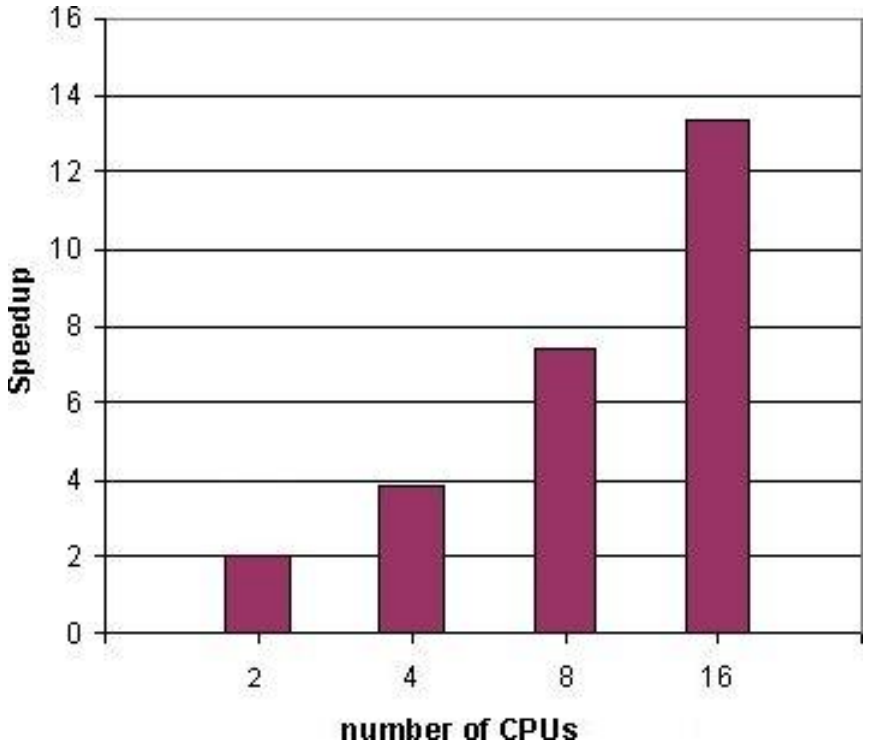


Beam Excited Dipole Mode Spectrum

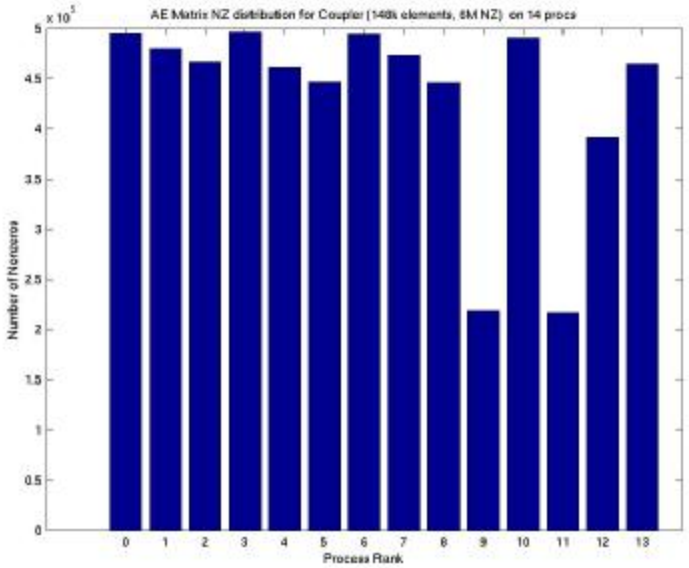




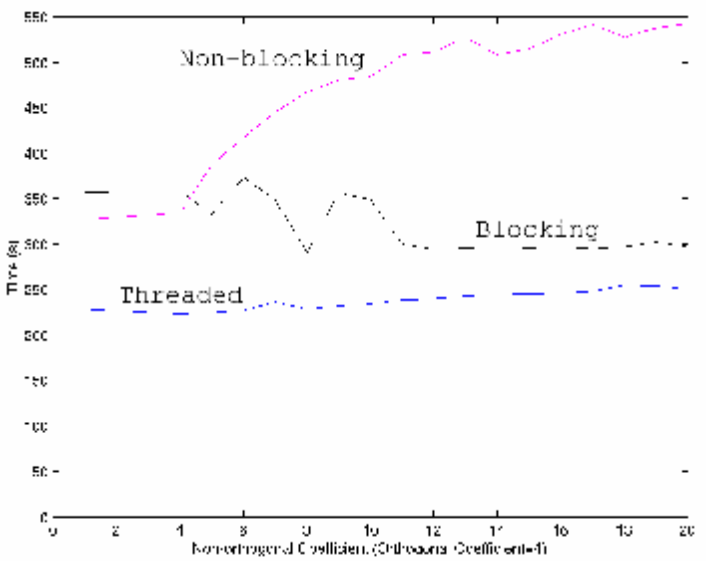
Parallel Performance



Load Balancing



Distribution of non-zeros



Communication Schemes

***Parallel speedup depends on*:**

- Repartition of mesh using weightings in ParMetis
- Communication schemes between processors – blocking, non-blocking and threading

Work in Progress

- *Dielectric and lossy materials*

  need to modify the matrices for advancing the fields

- *Mesh Quality*

  time stability for complex structures depends on the quality of the primary and dual meshes

- *Load Balancing*

  involves optimization between mesh partitioning and communication schemes