MAST Status, Plans & MAST/NSTX Collaborations 2005

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NSTX Research Forum PPPL 22nd Sep 2004

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OUTLINE

Technical developments & present status

MAST operating schedule

Key elements of 2005 programme

High priority areas for collaboration

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Technical Developments - Plant

- New centre column
  - longer, more robust, operation with higher flux swing
- P2 modifications
  - coils moved further away from mid-plane
  - reversible supply
- New divertor and in-vessel armour
- Error field correction coils
- Digital control system
- Fuelling system improvements
  - pellet injector top launch
  - upper/lower inboard puffing (+ existing HFS mid-plane puffing)
- 28GHz EBW start-up system
  - install Summer 2005
- NBI upgrade
  - new long pulse calorimeters & RIDs based on hypervapotrons
  - replacement of ORNL sources by JET style PINIs
  - high power operation of 1st PINI now expected early 2005
  - second PINI will come on line Autumn 2005

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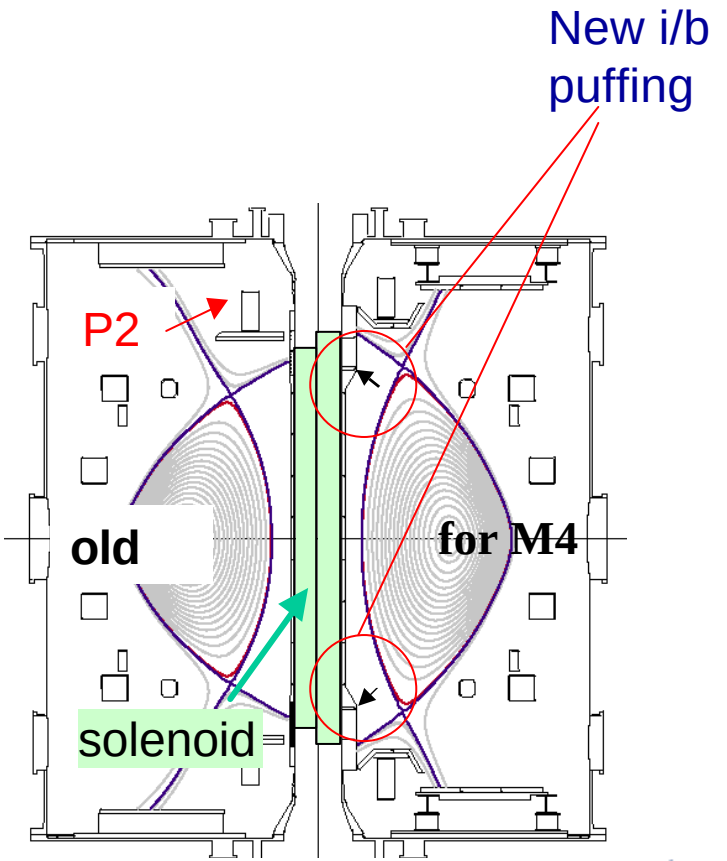
Load Assembly Changes

Installation of new centre column



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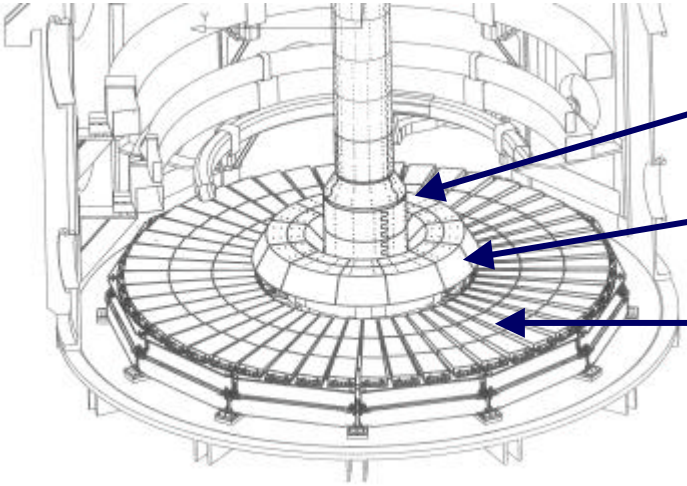
Improved Divertor



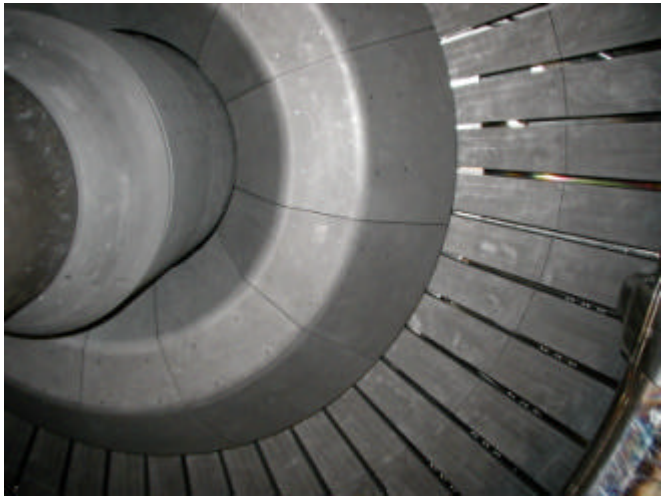
improved c/col armour

shaped P2 plates

imbricated tile divertor plates

Structure replicated at top of machine

Divertor biasing capability



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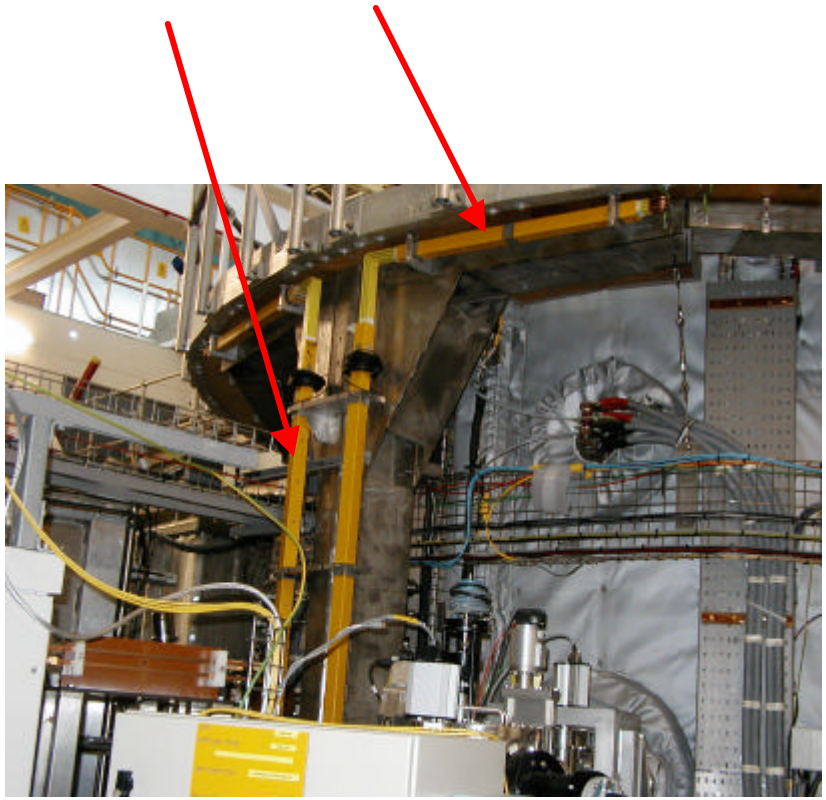
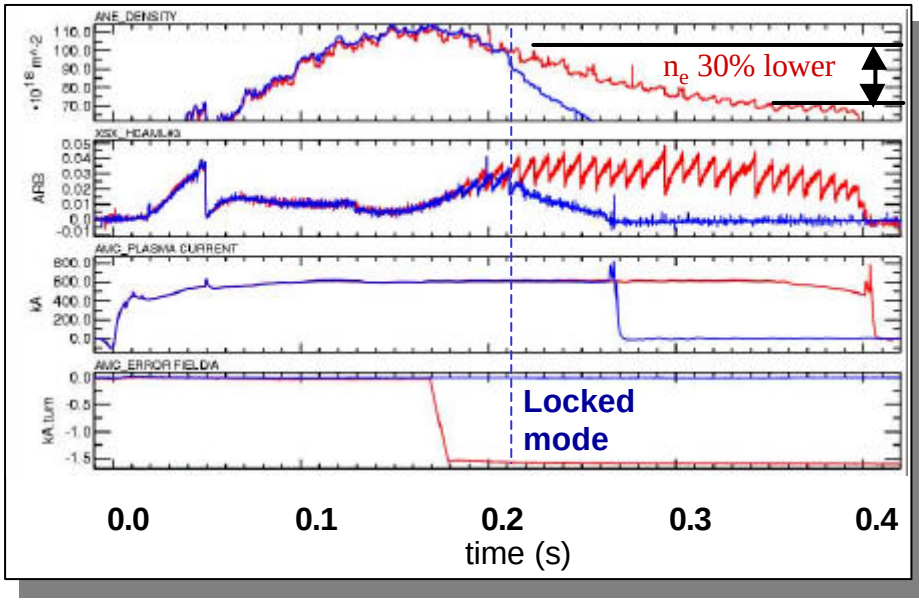
Error Field Correction Coils

Error field correction coils (4) installed outside vessel



Error field correction gives access to lower density



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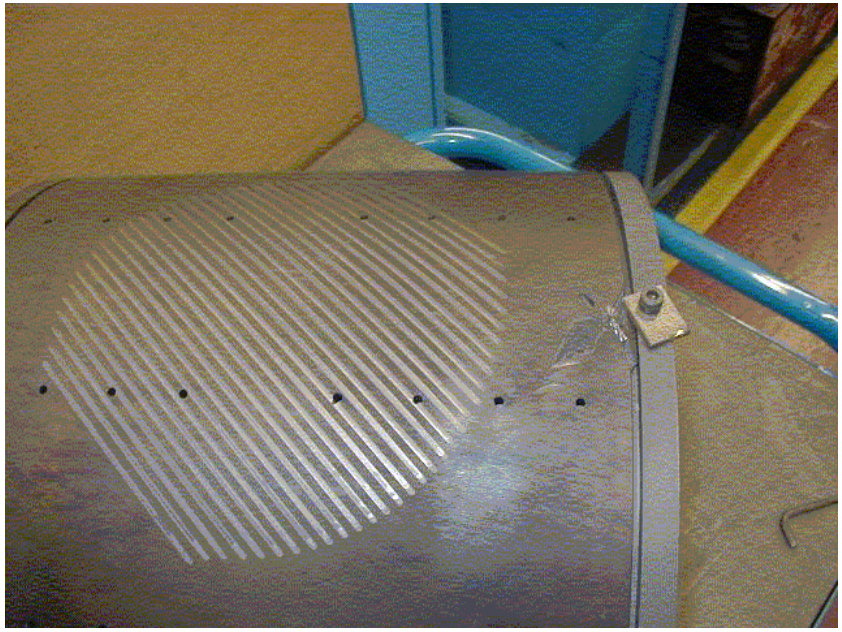
28GHz start-up system



Mirror polariser test piece

- Mirror polariser: grooves on midplane centre-column tile
- Plan to install Summer 2005

28GHz tubes (200kW, 40ms) being re-commissioned, transmission components ordered, antenna designed (collaborations with PPPL, ORNL)

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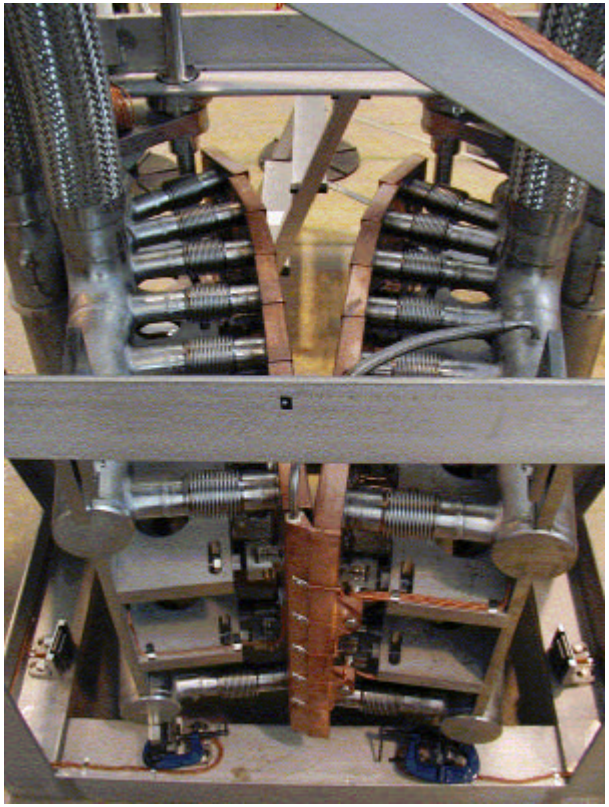
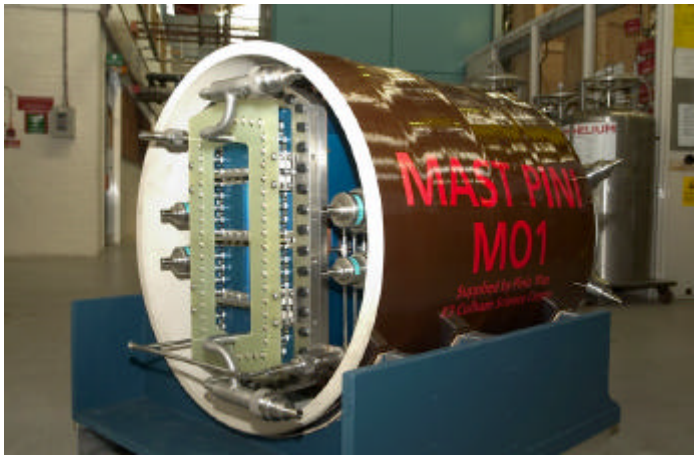
NBI Upgrade

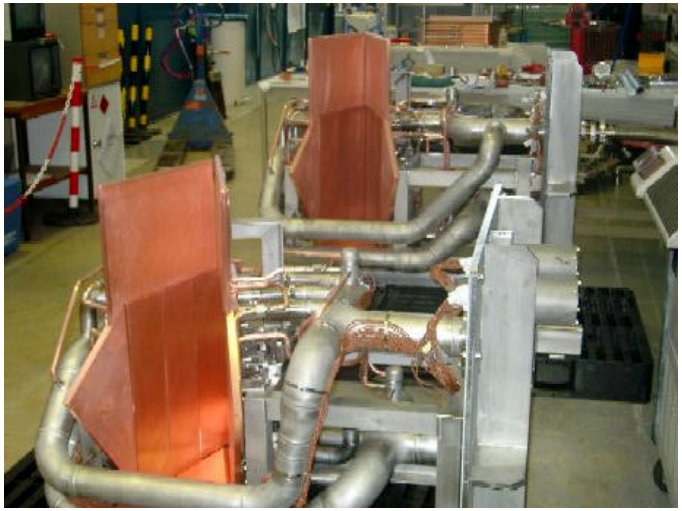
NBI system upgrade for reliable long pulse operation at high power (5MW, ≥ 5s)



Actively cooled calorimeter (gate in closed position)



New JET-style PINI



Residual Ion Dumps

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Technical Developments - Diagnostics

Many diagnostic improvements are being implemented in 2004-05 plus re-optimisation of diagnostic views. Examples include:

Thomson scattering

Lower edge T_e capability & more edge channels for 300pt ruby system

4 Nd:YAG lasers installed giving 200Hz capability

Bolometry

16 tangential chords (4 cntr/12 co) in addition to existing 16 vertical chords

CXRS

> 200 chords (total) viewing both beams, toroidal and poloidal velocity measurements

High resolution X-ray crystal spectroscopy (THEMIS)

Initial scanning system installed

Scanning reflectometer (16 to 60GHz)

Scan period changed from 100ms to 10ms

Infra-red imaging

Fast camera with wide angle lens and more port views

Beam emission spectroscopy

Diagnosis of beam parameters

Magnetics

New coils with 5MHz capability

EBW radiometers/Interferometry

New radiometers & 1mm interferometer

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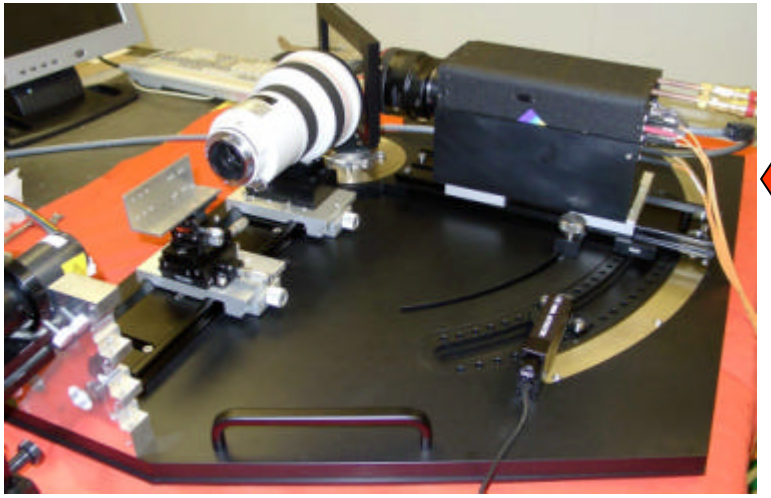
Charge-exchange recombination spectroscopy

New ports drilled in vessel for optimum views



Upgraded CXRS
⇒ 200+ chord spectrometer
spatial resolution ~ ρ_i
poloidal and toroidal chords
separate views of two NBI beams

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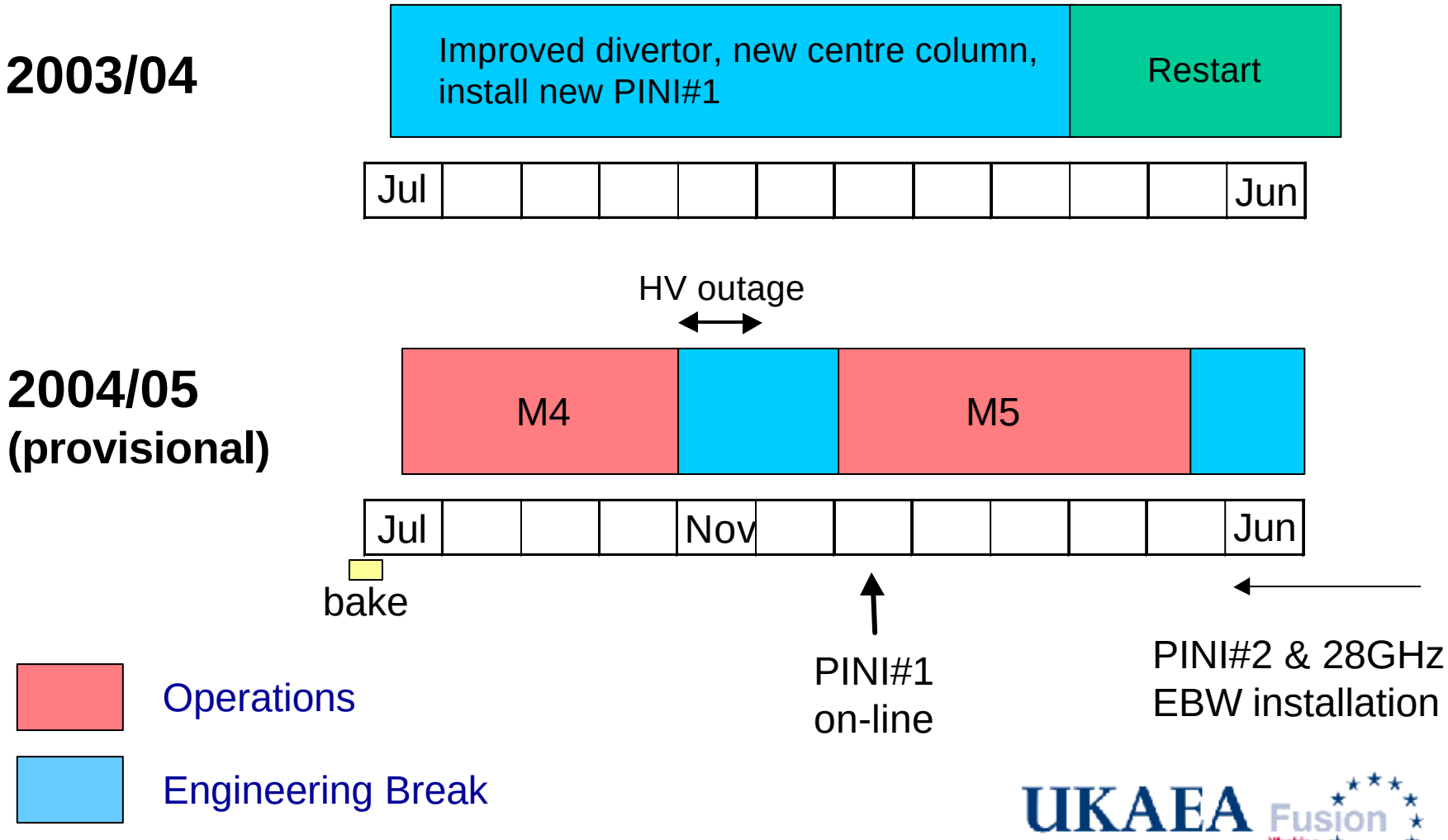
Operating schedule: 2004-2005



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Key Elements of 2005 Programme

- Development of long pulse high beta regimes with high non-inductively driven current fraction
  - neutral beam current drive studies
  - EBW heating
- Non-solenoid start-up studies
  - incl. ECRH/EBW start-up assist
- Expansion of confinement database (higher power, plasma current etc.)
  - scaling with engineering parameters and dimensionless parameters (e.g. beta, aspect ratio)
- Detailed transport studies
  - assess role of micro-instabilities
  - improve understanding of transport barrier formation
- Characterisation, impact & control of performance-limiting instabilities
  - ELMs, NTMs, fast particle driven instabilities
- Plasma exhaust
  - steady-state and transient events (disruptions, ELMs etc.)
  - exhaust techniques (e.g. divertor biasing)

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IEA-ITPA Co-ordinated Experiments

Confinement

beta scaling, pellet studies, low-A scaling (MAST-NSTX-DIII-D)

Transport Physics

high performance with T_e=T_i, QDB/QH mode (links to AUG team), ITB scaling studies (MAST-NSTX)

Pedestal Physics

similarity studies (MAST-NSTX (-DIII-D)), magnetic configuration effects (MAST-AUG), ELMs & first wall effects (MAST-AUG), influence of particle sources.

Divertor & SOL

Scaling of type 1 energy loss, scaling of radial transport, disruptions & effects on materials choices, parallel transport in the SOL

MHD

NTM physics-aspect ratio effects (MAST-AUG), improved NTM models

Steady State & Energetic Particles

Hybrid scenarios

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MAST/NSTX Collaboration (1)

Proposed high priority areas for collaboration include:

Confinement scaling (Valovic, Akers)
- expansion of low A confinement database
- scaling with beta, aspect ratio (+ DIII-D)

Transport studies
- TRANSP development (Akers, Muir)
- GS2 simulations (Roach, Field)
- ITB studies (Field)

Pedestal physics (Kirk, Meyer)
- pedestal similarity studies (+ DIII-D)

ELM structure & effluxes (Kirk, Counsell)

Fuelling optimisation (Field)
- inboard fuelling
- supersonic gas injection

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MAST/NSTX Collaboration (2)

EBW heating, current drive & emission (Shevchenko, Volpe)

- code comparison & benchmarking
- emission measurements & heating studies
- hardware development

Non -solenoid start-up (Sykes, Gryaznevich)

Fast particle driven instabilities (Gryaznevich, Sharapov)

- e.g. beta dependence

NPA diagnostics (Tournianski, Akers)

+……..

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Concluding Remarks

The list of proposed collaborative activities is not exhaustive

- additional suggestions & notification of inadvertent omissions welcome

The MAST team value very highly our close links with NSTX and the benefits derived from close collaboration

- collaborative activities & experiments will be given very high priority in our programme.

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