Measurements of the Hard X-ray (HXR) flux have been combined with CQL3D modelling to infer diffusion coefficient, fast electron population and current density during PPCD plasmas.

EXPERIMENTAL SETUP

Hard X-rays (>10KeV) emitted by runaway electrons via bremsstrahlung are measured using solid state CdZnTe detectors.

The output pulses from the detectors are digitized directly rather than pulse height discrimination and counting.

ADVANTAGES:

Software can distinguish noise and pile up better than simple pulse height analysers. Data stored as discrete events at definite times, allowing the data to be binned for low energy resolution with high time resolution, or simultaneously low time resolution with high energy resolution. Simple to implement DISADVANTAGES:

Prior to processing, a lot of data must be stored, limiting shot length.

X-ray events are seen as Gaussian pulses, produced by a shaping amplifier - the amplitude is proportional to the energy. A 6MHz digitizer records the pulses, as shown on the right.

Each pulse is then individually fit using a Gaussian fitting function. A combination of the width (determined by the shaping time of the amplifier) and the area of the fit are used to determine whether pile up has occurred.

The data can then be fit using a double Gaussian. In this way the effective bandwidth can be increased, the dead-time due to pileup can be reduced.

Pileup is still reduced by adjusting the solid angle of the detector.

INTRODUCTION

The question of the application, a large resistivity drop due to the presence of runaway electrons.

More sophisticated analysis can be done - using CQL3D.

CQL3D is a Fokker-Planck code which evolves the electron and ion distribution functions in space and time.

Given ambient plasma conditions (equilibrium, Te,J,L density) CQL3D evolves the electron distribution function.

Diffusion (and optionally Zeff) are adjustable parameters.

E|| is internally adjusted (based on the computed resistivity) to match the input J||

Diffusion and Zeff are adjusted to best fit the data.

Basic plasma parameters are used as input, of which Zeff is the most controversial.

Broad range of basic plasma parameters are input to the code.

Zeff is a difficult measurement on MST, but E|| reduced as well.

Extensive work has resulted in a measurement of Zeff during PPCD which is surprisingly high.

However, these plasmas had no boronization (MST has carbon and aluminium first wall).

Simulations of EBW into PPCD plasmas show an order of magnitude increase in flux in the edge.

The question of the effects of RF heating on the fast electrons will be addressed. Simulations have been performed using CQL3D.

During EBW application, a large increase in the edge HXR flux is expected.

Conclusions

Measurement and analysis of HXR flux shows a clear confinement increase during PPCD plasmas over standard plasmas.

Approximately 4 order of magnitude increase in flux seen.

Corresponds to a diffusion coefficient of ~5m^2/s, and connection lengths of ~100km.

Implies transport in the core may be dominated by electrostatic effects, not flow along stochastic field lines.

1-2% runaway electron population carries ~25% of current in the core, with a corresponding drop in the resistivity.

Simulated parallel electric field matches measured value and confinement estimates.

Measured HXR flux supports high Zeff measurements in core during PPCD plasmas.

Many thanks to Yves Peysson and Lena Delpech. Thanks to John Sarff for frequency doubling our V8R193X.

This work was supported by U.S.D.O.E.