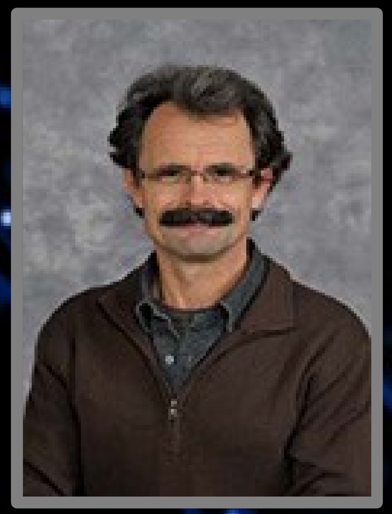
# Analysis of Charged Fusion Product Rates: Initial Data from the Mega Amp Spherical Tokamak (MAST)



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## INTRODUCTION

Tokamaks are feats of modern engineering used to create and contain plasmas. Through the combination of magnetic fields and novel heating methods, plasmas are generated for diagnosis and experimentation. At the Mega Amp Spherical Tokamak, heating deuterium to 100 million degrees centigrade and introducing a neutral beam causes the deuterium plasma to undergo nuclear fusion between Deuterium nuclei.[1] The charged products of the reaction are the main interest of this experiment. Only a particular number of energetic fusion products will drift out of the plasma because of their high energy.[2] Using a computer simulation of the magnetic field determined where the detector system was placed. Determining the emission rates of such charged products will establish an emission profile for the plasma and is one of the main and ongoing objectives of this research. Constructing emission profiles for plasmas may lead to a better understanding of their instabilities. Furthermore, a thorough understanding of plasma instabilities will lend itself to developing efficient and environmentally friendly commercial fusion reactors for electrical power generation.

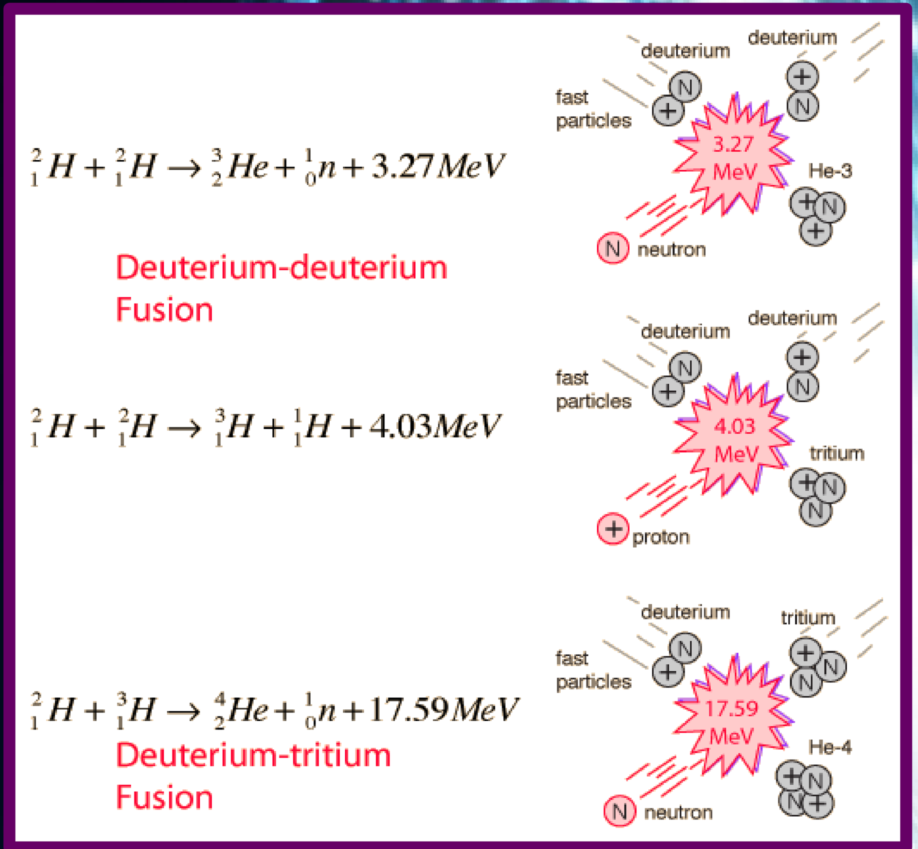



*Figure 1 [5]:Both Nuclear Fusion Reactions observed, each reaction has a 50% chance of occurring.*

*Figure 2 [3]: A sample image of a MAST created "plasma shot".*

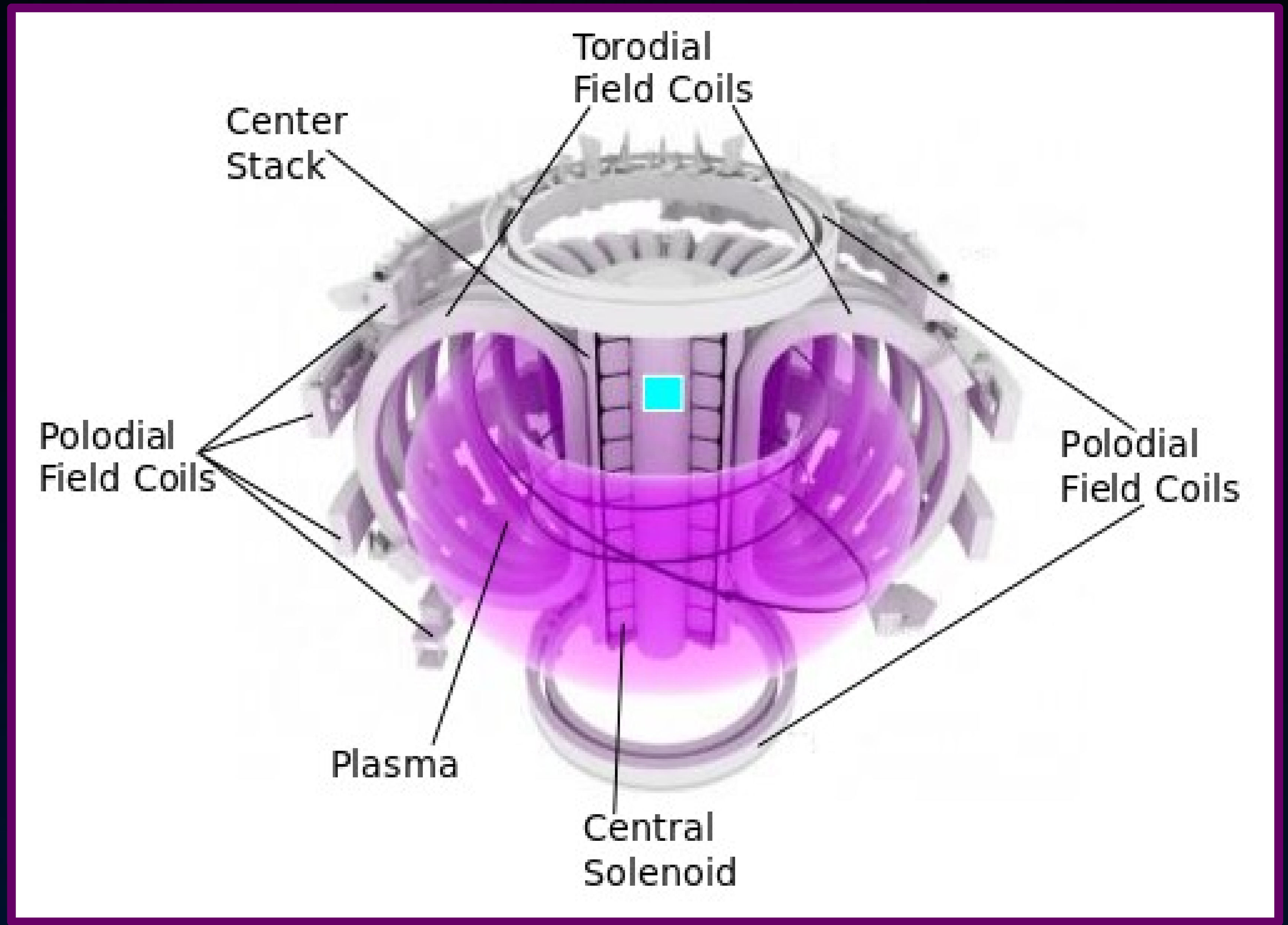



*Figure 3 [4]: Cut-away diagram of a spherical tokamak showing the various components.*

## METHODS & MATERIALS

In order to detect protons and tritons, a diagnostic was built to hold 4 solid surface barrier detectors (SSBDs) and were insulated against the heat of the plasma. Collimators were incorporated into the diagnostic housing so that only charged fusion products from a certain volume of the plasma are accepted. Using the Data Acquisition System (DAQ), fusion products were converted into electrical signals, digitized and stored as data. Data collection began 70 ms after the beginning of the plasma shot. Analysis of this data was completed using a Python based program called wx digiplot to discover & catalog peaks, create rate plots, and plot voltage histograms.

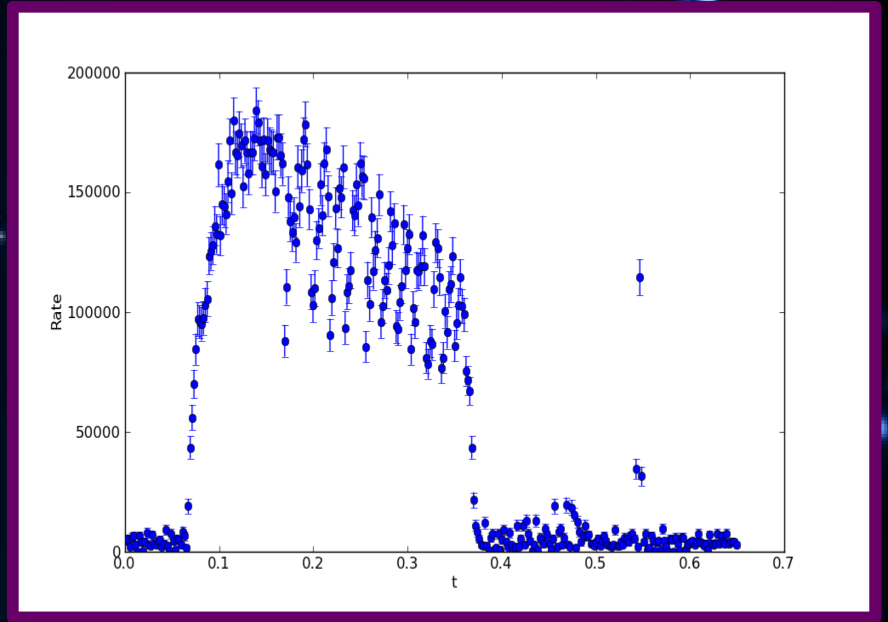
## RESULTS

Preliminary data analysis revealed proton voltage peaks around 600 millivolts. Triton signals were less prevalent due to their smaller electrical signal. Initial rates are proportionally consistent with neutron rates obtained from the Fission Chamber at MAST. Histograms displayed a Gaussian distribution of protons and tritons.

## CONCLUSION

Further data collection and analysis are required to build emission profiles. Results are expected to be aid in creating more efficient plasmas for both experimentation (MAST) and power generation (DEMO).

*Figure 5 : Rate plot of voltage peaks detected in the plasma shot 29879.*



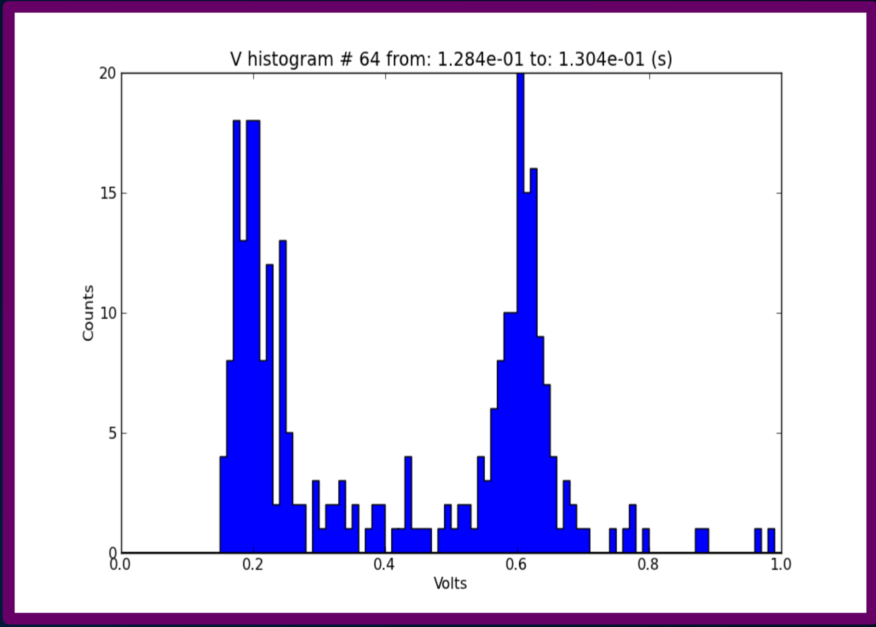




*Figure 6 :Histogram of the voltage of signal peaks detected in plasma shot 29879 of the time slice 1284 ms to 1304 ms.*

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## REFERENCES

[1] United Kingdom. United Kingdom Atomic Energy Authority. tokamak. Abingdon: Culham Centre for Fusion Energy, 2012. Web. < http : //www.ccf e.ac.uk/T okamak.asp&xgt;.
[2] Perez, Ramona Valenzuela. "A charged fusion product diagnostic for a spherical tokamak.." Florida International University Department of Physics Miami, Florida. (2012): n. page. Print.
[3] MAST plasma. 2012. Photograph. Culham Centre for Fusion Energy, Abingdon. Web. 28 Aug 2013. < http : //www.ccf e.ac.uk/images detail.aspx?id = 9 >.
[4] The electromagnetic coils of JET [Web Graphic]. Retrieved from http://www.efda.org/fusion/fusion-machine/types-of-fusion-machines/tokamaks/
[5] Nave, R. (Designer). Hydrogen Fusion Reactions [Web Graphic]. Retrieved from http://hyperphysics.phy-astr.gsu.edu/hbase/nucene/fusion.html

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