



Ian Faust

Education

- 2009–August 2016 **Doctorate in Nuclear Science and Engineering**, *Massachusetts Institute of Technology*, Cambridge, MA, USA, 4.6/5.0.
Dissertation - Quantification of Lower Hybrid wave absorption in the edge of the Alcator C-Mod tokamak
- 2005–2009 **B.S.E in Nuclear Engineering and Radiological Sciences**, *University of Michigan*, Ann Arbor, MI, USA, 3.825/4.0.
Summa Cum Laude, minor in Mathematics, Dean's List - 6 of 8 semesters, University Honors - 5 of 8 Semesters, Tau Beta Pi and Alpha Nu Sigma engineering honor societies

Work Experience

- 2016–Current **Postdoctoral Associate, ASDEX-Upgrade Tokamak**, *Max Planck Institute for Plasma Physics*, Garching bei München, DE.
- Worked as an experimental physicist focused on soft x-ray and vacuum ultraviolet spectrometer systems (spectroscopy under vacuum). This encompassed the repair, maintenance, design, development and analysis of these systems. Additional machine learning analysis and IoT-based hardware were developed to improve operational capabilities. This work has included the following highlights:
- Reverse engineering of a vacuum-ultraviolet spectrometer system
 - Rapid development/prototyping of a calibration system for the spectrometer, returning it to proper operation
 - Large data meta-analysis of ~ 3000 experimental discharges using likelihood-based statistical and regularization-based machine learning methods as well as SVMs for characterizing an unknown radiation line of tungsten
 - Installation and maintenance of Python and machine learning related software (LAPACK, BLAS, Tensorflow and Scikit-learn for example) on various Solaris 10, 11 and Solaris Linux servers
 - Development of an IoT device for measurement monitoring using ESP8266-based hardware (full description available on ianfaust.com)
 - RNN for automated spectral analysis (with tensorflow)

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2009–2016 **Graduate Student Researcher, Alcator C-Mod Tokamak, MIT Plasma Science and Fusion Center, Cambridge, MA, USA.**

Research focused on the measurement of radiofrequency (LHRF) power and related attributes on a tokamak. This work spanned from design, manufacture and data acquisition for several plasma measurement systems, all of which operated in an extreme thermal, radiation, vacuum, and electromagnetic environment. Thesis work analyzed multiple diagnostics with modulated RF power to synthesize an understanding its deposition.

- design and implementation of X-ray and vacuum ultraviolet radiometers
- meta-analysis of large datasets and formulation of advanced analysis codes for fusion science
- hands-on RF system work for high-power antenna operation
- rapid prototyping and implementation of several low cost visible and near-infrared camera systems

summer 2008,2009 **Summer Intern, Schlumberger - Princeton Technology Center, Princeton Junction, NJ, USA.**

Experimentalist in the neutron and X-ray generator group

- Worked on inductively coupled plasmas for use on neutron generators. This included the implementation of a wideband 1 kW RF source and a small high-vacuum system.
- Tested x-ray generators and detectors for future innovation for downhole X-ray use.
- Tested high voltage breakdown and tracking for oil exploration applications.

summer 2007 **SULi Intern, Los Alamos National Laboratory, Los Alamos, NM, USA.**

Student researcher on the FRX-L experiment (P-24 group)

- Helped build Marx banks for the integration of field reversed plasmas with the Shiva Star facility at the AFRL laboratory. This work was for magnetized target fusion research using reversed field plasmas and imploding metallic liners.
- Implemented shielded analog integrators for the FRX-L experiment

summer 2006 **Summer Intern, University of Missouri Research Reactor, Columbia, MO, USA.**

- Worked on lithium spinel growth for QCP testing on a triple axis neutron spectrometer (condensed matter physics).

Skills

Languages Native english speaker, B2 German (without qualification exam), I expect to test for B2 Zeugnis by Jan 2019

Codes Python (Scikit-learn, Tensorflow), MATLAB, IDL, C and SQL, LaTeX, and MDSplus

CAD Solid Edge and CATIAv5

Other Well-versed in unix and windows. Knowledge in vacuum system design and implementation, 3D printing and microcontrollers. Courses on machine learning taken through Udacity and Coursera.

Honors, Awards, and Professional Memberships

Memberships American Physical Society, Eagle Scout

Awards Doroghazi Eagle Scout award, NANT fellowship, 2nd year NERS fellowship (University of Michigan), Outstanding Student Service award (MIT, 2012)

Publications and Presentations

Refereed 2 first author papers, 2 first author contributed conference papers, 20 co-author papers, 7

Journals co-author conference proceedings. 6 manuscripts in preparation (1 first author, 5 co-author)

Conference Presentations 2 first author presentations (one invited talk at 2015 APS-DPP conference in Savannah, GA, USA)

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Programming Languages

- Python
- Co-developed the EqTools Python package, an object-oriented API for interpolating and or determining experimental characteristics from disparate tokamak equilibrium analysis and data storage frameworks, used worldwide at 5 experiments in at least 4 countries ([Github Link](#)) ([Documentation Link](#)) ([Publication Link](#))
 - Camera control software development for integration in a fusion experiment (triggering, acquisition and conversion of H.264 to YUV420-based intensity files) ([Github Link](#)) ([Overview Link](#))
 - Machine learning, signal processing, regression and statistical analysis scripts for analysis of time series 1D, 2D and 3D data using (but not limited to) regularization (Lasso and Ridge), nonlinear optimization, matrix methods (like SVD), Fourier transforms, inverse methods (for tomography), statistical bootstrapping, Jacobians/Hessians, Fischer information, cross-correlation and autocorrelation, cross-validation, Support Vector Machines and various digital filters. Mainly used Numpy/Scipy, Pandas, Scikit-Learn, Scikit-Image and Tensorflow ([Github link](#))
 - Database modification and entry using SQL, NetCDF and MDSplus
 - Monte-Carlo-based Ishihara plate generator ([Github link](#)) ([Overview Link](#))
 - Translation of Cython to Python3 and ctypes for interfacing with an SDK, this includes related GUI development with Tkinter for hardware control (on Windows)
 - Object-oriented ray-tracing Tomography framework used in axis-symmetric geometries, still in alpha ([Github Link](#))
- C
- Wrote a library for 3D cubic spline interpolants including a novel regular grid optimized implementation (first of its kind) ([Github link](#)) ([Overview Link](#))
 - Embedded IoT development using Espressif ESP-SDK for the creation of a JSON parser and display using bit-banged SPI ([Github link](#)) ([Overview Link](#))
 - Optimized single-thread feature-finding in 2GB spectral datafiles for fast analysis
 - Python/C API implementation of Poisson and Gaussian distribution maximum likelihood objective functions and associated Jacobians for Gaussian functions (used in conjunction with nonlinear optimizers such as LM or L-BFGS algorithms)
- MATLAB
- Advanced 2D data image visualizations including efficient polar image plotting
 - Boundary value problems, shooting methods, and Runge-Kutta methods for electron distribution functions
 - Clearer re-implementation of quantum-mechanical bremsstrahlung probabilities from scattering process (namely electron and ion scattering cross sections)
 - Data analysis of time-series data with linear and non-linear solvers
- IDL
- Data entry and older hardware control, GUI visualization, Code reverse engineering and obsolete code maintenance
- VBA
- GUI control and automation of hardware via a proprietary SDK
- HTML
- Personal website development ([Link](#))

Data analysis and machine learning, database softwares and misc.

Data analysis and machine learning

- Numpy/scipy
- Pandas
- Scikit-Learn
- Tensorflow
- Jupyter Notebook

Database softwares

- SQL - SQLite3
- NetCDF4
- MDSplus

Git 10 personal public repositories, 1 private repository, 1 shared repository on GitHub

Systems

Linux/Unix Built and maintained personal FTP and SSH servers, camera controllers and motion cameras using Debian. RAID array maintenance and related software on Red Hat. Implemented and maintained Bazel and Tensorflow on a local Oracle Linux server. Touchscreen control, GPIO interfaces, startup scripts and other software using RaspbianOS/ Raspberry Pis

Windows General control and repair of USB, PCIe and other Windows only hardware using Windows XP and 7. General business and office software. Use of CAD programs such as CATIAv5 and Solid Edge

SunOS Maintained and developed scientific and GUI software on Solaris 10 and 11. This includes compilation and testing of Python2.7, LAPACK, BLAS, NetCDF, wxWidgets3.0, and tk8.5 using Oracle Fortran and C compilers on both x86 and SPARC machines

PXIe, CAMAC, NIM Fusion Science specific data acquisition and storage. Worked with several (~ 10) 1-10MS/s digitizers with their control and storage. This included, but was not limited to the control of stepper motors, triggers, and pulse generators

Design and Development

- Optics
 - Designed a custom under-vacuum VUV pinhole camera using an AXUV-22 photodiode array. Special considerations were made with respect to overall signal intensity versus the field of view. Efforts were taken to properly baffle the design and passivate materials, with a custom vacuum-gasket-like approach used for the VUV filter.
 - Worked with Chinese suppliers for optimized M12 optics for fisheye and narrow-field views in the limited geometry of the Alcator C-Mod tokamak
 - Used a Hamiltonian optics-approach for a highly optimized axisymmetric, optically-thin, ray-tracing tomography code, this included geometric transformations to simplify calibration schemes and it allowed for in-depth analysis of étendue, vignetting, and throughput in pinhole systems.
- Mechanical Design
 - Reverse engineered the mechanical design (no prior available art) of a 25-year-old VUV and EUV set of spectrometers for further calibration, refurbishment and improvement of the design. The device was returned to service after creating and using a series of precise ($\sim .1^\circ$) laser-based calibration and verification widgets.
 - Designed a precision, vacuum compatible X-ray camera mount which minimizes strong eddy-current-induced mechanical loads
 - Creation of various 3D printed parts (SLS (nylon), SLA (resin), and traditional FDM (PLA)) for project types like prototyping, camera mounts and widget cases.
 - Experience with vacuum hardware and related calculations/design (conductance, vacuum quality, virtual leaks) for ultra-high-vacuum interfaces
- Electrical Design
 - Developed a fully-shielded DB-25-based transimpedance circuit for use in noisy environments for maximum bandwidth for VUV measuring photodiodes (generally low (nA) current measurements)
 - Fully designed, laid out, and soldered an SMT PCB for an ESP8266 bit-bang SPI interface for an IoT device which included voltage switching (with microcontroller interface)
 - Created various custom triggering (opto-coupler), integration and lighting circuits dictated by experimental requirements
 - Assembled high voltage capacitors and utilized HV test equipment for both high and low power use-cases