Appendix D: List of Modules Table (see section 2.3)

MODULE	NEEDED BY	AVAILABLE FROM	EFFORT
ANOMALOUS TRANSPORT MODELS	NTC (**DEMO CODE**) Phase I: IFS/PPPL, GLF23, MMM	GA (**ONETWO**) GLF23	0.5 Months
		GA (**ONETWO**) Itoh-Itoh-Fukuyama module. Level I.	0.25 Months
	PPPL (**TSC**)	ITER (**SMC**) Transport model modules: Mixed Shear, Culham, IIF, RLW, IFS/PPPL. C++. Level I.	1 Month
	Lehigh (**BALDUR**) GLF23	Lehigh (**BALDUR**) Updated Multi-Mode Model with improved interface. Fortran. Level II.	2 Months
	GA (**ONETWO**) MMM	LLNL (**CORSICA**) Transport models [RLW, IFS/PPPL, GLF-23 (modularized version beginning with Waltz source-code), specifiable profiles + 0-d lifetimes–ITER89, etc]. Level I.	0.75 Months
		GA (**ONETWO**) Flow shear transport stabilization module (G. Staebler). Level I.	
NEOCLASSICAL TRANSPORT MODELS	NTC(**DEMO CODE**) Phase II	ORNL NCLASS neoclassical multiple species transport code, bootstrap, electrical resistivity, particle transport and heat transport, plasma rotation and radial electric field, in TRANSP, ONETWO, ASTRA, being installed in JETTO (JET) and TOPICS (JAERI), modular F77, stand-alone driver. Level II.	1 Month
	PPPL (**TRANSP**) resistivity, bootstrap current, beam current shielding, transport		
	LLNL (**CORSICA**) upgrade bootstrap-current and neoclassical modules to include potato orbits and improved collisions	ITER (**PRETOR**) Bootstrap current. Language C. Level I.	< 1 Month
	ITER (**PRETOR**) bootstrap	PPPL (**TSC**) Bootstrap current	< 1 Month
	GA (**ONETWO**) Nclassm		
TRANSPORT EQUATION SOLVERS	NTC (**DEMO CODE**) Phase I	LLNL (**CORSICA**) Well-modularized C++ finite-element 1D diffusion-equation solver. Level II.	0 Month
	PPPL (**TRANSP**) predictive solver	GA (**ONETWO**) Predictor/Corrector solution method with arbitrary combination of analysis and simulation. Level III.	
	PPPL (**TRANSP**) inverse solvers, e.g., given T_e return χ_e		

MODULE	NEEDED BY	AVAILABLE FROM	EFFORT
EQUILIBRIUM SOLVERS	**NTC (DEMO CODE)** Phase II	**ITER (PRETOR)** Fixed boundary equilibrium solver. Language C. Level II.	≳ 3 Months
	PPPL (TRANSP) MHD equilibrium solvers of all types	**PPPL (TSC)** Equilibrium and Stability packages. These include SESC, POLAR2D, PEST-II, MAPPING routines, JSOLVER. Fortran.	≈ 12 Months
	ITER (PRETOR) free boundary	**LLNL (CORSICA)** TEQ – calculates free-boundary equilibria via either direct-solver or embedded fixed-boundary inverse-solver options.	
	GA (ONETWO) External circuits module	basis version	0.25 Months
		quick and dirty non-basis version (need input from user community re desired application, wrapper)	2 Months
		well done stand-alone module, including full documentation and clean-up so that outside person could follow source code and debug problems: Level II with respect to CPU time; Level III with respect to source-code length and number of options.	12 Months
		ORNL VMEC - 2D or 3D MHD equilibrium code, fixed or free boundary, used extensively in stellarator studies throughout the world, in TRANSP, recently converted to F90, stand-alone driver. Level II/III.	1-2 Months
		ORNL VMOMS - simplified three poloidal moment solution to 2D MHD equilibria, first of the inverse coordinate codes, 2D predecessor to VMEC, modular F77, stand-alone driver. Level II.	12 Months
		GA(ONETWO) Free boundary equilibrium solution – Direct method with search for plasma boundary included. Level III.	1 Month
		GA(ONETWO) Flux surface finding/averaging routines to complement above. Level II.	0.75 Months

MODULE	NEEDED BY	AVAILABLE FROM	EFFORT
NEUTRAL BEAM	Lehigh (BALDUR) . Level III.	PPPL (TRANSP) Monte Carlo beam deposition	$\approx$ 1 Month
	ITER (PRETOR) Level II)	PPPL (TRANSP) Monte Carlo fast ion slowing down model – 2D orbit modeling	$\gg$ 1 Month
	PPPL (TRANSP)	PPPL (TRANSP) Fokker Planck fast ion slowing down – bounce averaged, small banana width	$\gg$ 1 Month
	PPPL (TSC)	LLNL (CORSICA) Neutral-beam heating module (NFREYA + orbits). Level II.	2 Months
	LLNL (CORSICA)	ORNL MIRTH Multiple energy group solution of the FP equation for the time-dependent slowing down distribution from beam and alpha sources, includes radial transport options during thermalization, modular F77, stand-alone driver. Level II.	1 Month
	GA (ONETWO)	ORNL BEAM Multiple beamlet code for arbitrary orientation of beam relative to 2D or 3D toroidal geometry (beamlets assumed parallel with no divergence or focus, but the method is generalizable) modular F77, stand-alone driver. Level II.	1 Month
NEUTRALS	PPPL (TRANSP)	ORNL SPUDNUT - slab multiple species neutral transport code in multiple ion species background with impurities, kernel method for solution of kinetic equation, beam and energetic recycle, recombination, predecessor to FRANTIC, modular F77, stand-alone driver. Level II.	1 Month
	GA (ONETWO)	ORNL FRANTIC - cylindrical multiple species neutral transport code in multiple ion species background with impurities, kernel method for solution of kinetic equation, beam and energetic particle, recycle, recombination, modular F77, stand-alone driver. Level II.	1 Month

MODULE	NEEDED BY	AVAILABLE FROM	EFFORT
LOWER HYBRID	PPPL (TRANSP), LLNL (CORSICA), ITER (PRETOR) Level II	PPPL (TSC) LSC code	3 Months
ICRH and FAST WAVE	PPPL (TRANSP), Lehigh (BALDUR) Level II, PPPL (TSC) alternate package, LLNL (CORSICA) FW current drive	ITER (PRETOR) ICRH (PION) FORTRAN. Level III.	2 Months
		PPPL (TSC) Fast-Wave code.	3 Months
		PPPL (TRANSP) Various RF packages (when agreeable to authors; it might be more appropriate to go to the authors directly).	1 Month
		GA (ONETWO) Fast wave module. Level III.	1 Month
ECH	PPPL (TRANSP), PPPL (TSC)	Lehigh/LLNL TORCH/TORAY Level II.	2 Months
IMPURITY RADIATION	PPPL (TRANSP) atomic cross sections, PPPL(TSC) non-equilibrium radiation, LLNL (CORSICA), GA (ONETWO)	PPPL (TRANSP) atomic/nuclear reaction rate database, including integrated rate tables useful for calculation of beam-target and beam-beam reactions.	$\gtrsim$ 1 Month
		Lehigh (BALDUR) Non-equilibrium Impurity Radiation package. Fortran. Level II.	$\gtrsim$ 3 Months
		ITER (PRETOR) Synchrotron radiation modules. Language C. Levels I and II.	$<$ 1 Month
SYNCHRONTRON RADIATION	GA (ONETWO)	ORNL CYTRAN synchrotron radiation transport code (simplified version of SNECTR code also developed by Tamor and now in custody of PPPL), stand-alone driver, modular F77, stand-alone driver. Level II.	1 Month

MODULE	NEEDED BY	AVAILABLE FROM	EFFORT
PELLET	PPPL (TRANSP) PPPL (TSC) LLNL (CORSICA) GA (ONETWO)	ORNL. Pellet ablation code, hydrogenic and impurity pellets, arbitrary 3D injection geometry, used extensively around the world, modular F77 - could use some housecleaning, stand-alone driver. Level. II	1-2 Months
SAWTOOTH	PPPL (TRANSP) PPPL (TSC) LLNL (CORSICA) GA (ONETWO)	ITER (PRETOR) Criteria for trigger of sawtooth crash. Language C. Level 1.	1 Month
MHD STABILITY	PPPL (TRANSP) ITER (PRETOR) 'real-time' analysis	PPPL (TSC) Equilibrium and Stability packages, including: SESC, POLAR2D, PEST-II, MAPPING routines, JSOLVER. Fortran.	12 Months
		PPPL (TSC) Balloon analysis subroutine for transport code	2 Months
		Lehigh (BALDUR) Saturated tearing mode package. Fortran. Level II.	1 Month
		LLNL (CORSICA) Linear-vertical-stability module. Level II.	1 Month
		LLNL (CORSICA) Ballooning-stability module. Level II.	1 Month
		LLNL (CORSICA) DCON (internal-mode version from Glasser; external coming soon). Level II.	0.25 Months
TAE	ITER (PRETOR) 'real-time' analysis PPPL (TRANSP)		

MODULE	NEEDED BY	AVAILABLE FROM	EFFORT
NUCLEAR REACTIONS	**PPPL (TRANSP)** thermonuclear, fast ion – thermal reactions, fast ion – fast ion reactions	**PPPL (TRANSP)** Atomic/nuclear reaction rate database, including integrated rate tables useful for calculation of beam-target and beam-beam reactions	1 Month
	PPPL (TRANSP) fusion products slowing down	**PPPL (TRANSP)** Monte Carlo fusion product deposition (given reaction rates)	1 Month
RUNAWAY ELECTRONS	**PPPL (TSC)**	**ORNL MIRTH** see NBI section	
	PPPL (TRANSP) cross sections	**LLNL (CORSICA)** simple runaway-electron model (Putvinskii/Rosenbluth). Level I.	0.25 Months
DIVERTOR/EDGE	**GA (ONETWO)** coupling to 2D edge	**ITER (PRETOR)** Divertor boundary condition modules (Level I fitted from Level II itself fitted from complete divertor code). Language C. Level I. (Note: specific to ITER geometry.)	1 Month
	LLNL (CORSICA)	**LLNL (UEDGE)** EDGE (basis and non-basis versions available). Level III.	0 Months
H-MODE PHYSICS	**ITER (PRETOR)** edge pedestal and ELMs		
IMPURITY TRANSPORT	**LLNL (CORSICA)** **GA (ONETWO)**	Currently included in GLF23, Multi-Mode and NCLASS (Neoclassical) modules (see TRANSPORT MODELS).	
MOMENTUM TRANSPORT	**LLNL (CORSICA)** transport model	Currently included in GLF23 and NCLASS (Neoclassical) modules (see TRANSPORT MODELS).	

MODULE	NEEDED BY	AVAILABLE FROM	EFFORT
DIAGNOSTICS	PPPL (TRANSP) ITER (PRETOR)	PPPL (TRANSP) Diagnostic simulators:	1 Month
		LLNL (CORSICA) Synthetic diagnostics: X- and O-mode reflectometry	0.25 Months
		LLNL (CORSICA) Soft X-rays	0.25 Months
		LLNL (CORSICA) interferometry/polarimetry. Level II.	1 Month
EQUILIBRIUM LINE-of-SIGHTS	PPPL (TRANSP)	PPPL (TRANSP) straight line tracker	1 Month
		ORNL TRACK Suite of routines to track viewing chords through 3D toroidal geometry based on inverse coordinate representation of MHD equilibrium (e.g., VMEC and VMOMS codes), used extensively in analysis of stellarator data, geometric basis for NBI and pellet injection, etc, modular F77, stand-alone driver. Level II.	1 - 2 Months
ALGORITHMS		LLNL (CORSICA) Coupling algorithms: Tex document, PVM interface routines and basis-scripts are available for fully implicit self-consistent inclusion of surface-averaged profile-dependent fluxes obtained from some other code (e.g., a turbulence code) or highly nonlinear model in the diffusion equation.	1 Month
NON - PHYSICS	NTC (DEMO CODE) Phase I: I/O to Database for input profiles.	PPPL (TRANSP) f77-based output data generator	1 Month
		PPPL (TRANSP) f77-based data acquisition code generator	> 1 Month
	PPPL (TRANSP) i/o modules: namelist / control; data acquisition; data output; check-point / restart	PPPL (TRANSP) f77-based namelist control system generator	> 1 Month
		LLNL (CORSICA) DCE (distributed computing environment) package (accesses and puts out data interfacing with MDS-plus and GA's Ptdata format). Level II.	2 Months