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 **Lehigh (BALDUR)** GLF23 **PPPL (TSC)** **GA (ONETWO)** MMM	**GA (ONETWO)** GLF23 **GA (ONETWO)** Itoh-Itoh-Fukuyama module. Level I. **ITER (SMC)** Transport model modules: Mixed Shear, Culham, IIF, RLW, IFS/PPPL. C++. Level I. **Lehigh (BALDUR)** Updated Multi-Mode Model with improved interface. Fortran. Level II. **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. **GA (ONETWO)** Flow shear transport stabilization module (G. Staebler). Level I.	0.5 Months 0.25 Months 1 Month 2 Months 0.75 Months
NEOCLASSICAL TRANSPORT MODELS	**NTC(DEMO CODE)** Phase II **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 **GA (ONETWO)** Nclassm	**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. **ITER (PRETOR)** Bootstrap current. Language C. Level I. **PPPL (TSC)** Bootstrap current	1 Month $<$1 Month $<$1 Month
TRANSPORT EQUATION SOLVERS	**NTC (DEMO CODE)** Phase I **PPPL (TRANSP)** predictive solver **PPPL (TRANSP)** inverse solvers, e.g., given T_e return χ_e	**LLNL (CORSICA)** Well-modularized C++ finite-element 1D diffusion-equation solver. Level II. **GA (ONETWO)** Predictor/Corrector solution method with arbitrary combination of analysis and simulation. Level III.	0 Month

MODULE	NEEDED BY	AVAILABLE FROM	EFFORT
EQUILIBRIUM SOLVERS	**NTC (DEMO CODE)** Phase II **PPPL (TRANSP)** MHD equilibrium solvers of all types **ITER (PRETOR)** free boundary **GA (ONETWO)** External circuits module	**ITER (PRETOR)** Fixed boundary equilibrium solver. Language C. Level II.	$\approx$ 3 Months
		PPPL (TSC) Equilibrium and Stability packages. These include SESC, POLAR2D, PEST-II, MAPPING routines, JSOLVER. Fortran.	$\approx$ 12 Months
		LLNL (CORSICA) TEQ – calculates free-boundary equilibria via either direct-solver or embedded fixed-boundary inverse-solver options.	
		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.	1 Month
		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. **PPPL (TSC)** Fast-Wave code **PPPL (TRANSP)** Various RF packages (when agreeable to authors; it might be more appropriate to go to the authors directly). **GA (ONETWO)** Fast wave module. Level III.	2 Months 3 Months 1 Month 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. **Lehigh (BALDUR)** Non-equilibrium Impurity Radiation package. Fortran. Level II.	$\approx$ 1 Month $\approx$ 3 Months
SYNCHRONTRON RADIATION	**GA (ONETWO)**	**ITER (PRETOR)** Synchrotron radiation modules. Language C. Levels I and II. **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 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. **PPPL (TSC)** Balloon analysis subroutine for transport code **Lehigh (BALDUR)** Saturated tearing mode package. Fortran. Level II. **LLNL (CORSICA)** Linear-vertical-stability module. Level II. **LLNL (CORSICA)** Ballooning-stability module. Level II. **LLNL (CORSICA)** DCON (internal-mode version from Glasser; external coming soon). Level II.	12 Months 2 Months 1 Month 1 Month 1 Month 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)** fusion products slowing down **PPPL (TRANSP)** cross sections	**PPPL (TRANSP)** Atomic/nuclear reaction rate database, including integrated rate tables useful for calculation of beam-target and beam-beam reactions **PPPL (TRANSP)** Monte Carlo fusion product deposition (given reaction rates) **ORNL MIRTH** see NBI section	1 Month 1 Month
RUNAWAY ELECTRONS	**PPPL (TSC)** **LLNL (CORSICA)**	**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.) **LLNL (UEDGE)** EDGE (basis and non-basis versions available). Level III.	1 Month 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: **LLNL (CORSICA)** Synthetic diagnostics: X- and O-mode reflectometry **LLNL (CORSICA)** Soft X-rays **LLNL (CORSICA)** interferometry/polarimetry. Level II.	1 Month 0.25 Months 0.25 Months 1 Month
EQUILIBRIUM LINE-of-SIGHTS	**PPPL (TRANSP)**	**PPPL (TRANSP)** straight line tracker **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 Month 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)** i/o modules: namelist / control; data acquisition; data output; check-point / restart	**PPPL (TRANSP)** f77-based output data generator **PPPL (TRANSP)** f77-based data acquisition code generator **PPPL (TRANSP)** f77-based namelist control system generator **LLNL (CORSICA)** DCE (distributed computing environment) package (accesses and puts out data interfacing with MDS-plus and GA's Ptdata format). Level II.	1 Month >1 Month >1 Month 2 Months