This repository contains the equilibrium solver  - source codes tkin.p and tkin\_read.p, input and output data files and IDL gui1.pro code to plot equilibrium data. It is set up to generate NSTX equilibrium for shot#141711 t=0.47 from “TRANSP\_141711P07\_classical.dat” using tkin\_read.p code.

/MPP/ directory includes source code and executable for pre-processor compiler which is used in HYM and this equilibrium solver.

Preprocessor language called MPPL.

**Directions:**

1. Copy MPP directory to your $HOME directory.

2. In .cshrc or .bashrc file add line:  
          alias   MPPL '$HOME/MPP/MPPL'

3. Now you should be able to generate a f90 code by typing "MPPL tkin\_read" in any directory. You'll get tkin\_read.f a Fortran code (it does not have comments, but the source code tkin\_read.p does).

4. make executable by typing

   make tkin\_read\_mpi.x

5. This is parallel MPI code, so if you want to run the code, copy the whole TKIN directory to

 $SCRATCH directory. To submit an interactive job on Permutter use commands from “Interactive job Perlmutter” file. It will run less than 5min. The code will calculate equilibrium, load particles, and generate input file for HYM.

**Brief description of files in TKIN:**

tkin\_read.p - source code in MPPL

 hmin.i - input parameters for tkin\_read.p (size of simulation region, BCs, initial perturbation, beam ion parameters)

 tk.i - input parameters needed for GS solver (total current, q\_0 etc)

tkin\_read.p will read boundary values for ‘psi’ from file=psi\_bc.dat

tkin.p can generate equilibrium without ‘psi\_bc.dat’ input using ‘tk.i’ and several tkin.p parameters.

 hym\_norm.dat and hyb\_norm.idl - normalization for the run   
 makefile - commands to make executables      
 [colorbar.pro](http://colorbar.pro) - idl code used by [qui1.pro](http://qui1.pro)  
 [gui1.pro](http://gui1.pro) - idl code to plot equilibrium profiles, and scalar and vector data from 3D runs.

7. After submitting and running the job, output will be in ‘psi.dat’ and ‘rhoi.dat’ files (to make plots with **gui1.pro** code) and start.d file which contains all initial conditions for 3D run. You can look at profiles by running [qui1.pro](http://qui1.pro) code in IDL. Choose 'Equilibrium' from bottom menu, and "other" instead of FRC (default). Load data files using "Data" button in the top menu (files- psi.dat, rhoi.dat)

Note that simulation region is cylindrical, with q-direction (first index, i) being Z direction;

r-direction (second index, j) being R-direction, and s- (third index, k) being phi direction.

Description of relevant parameters in **hmin.i**:

vpert=0.01 – perturbation amplitude normalized to v\_A

q1in - corresponds to –Zc, min value of z for (z,R) – cylindrical grid

q2in - corresponds to Zc, max value of z

r1in - min value of R

r2in. - max value of R, ie R=Rc

s1in=0., s2in=6.283185307179586, min and max of phi.

npsp=1000000 – number of simulation particles loaded

r(ijk)(12)in – define boundary conditions

dennsp – beam ion density normalized to e density

vthplsp – injection velocity normalized to v\_A

Parameters in **tk.i** are mostly needed for initial guess for tkin.p Grad-Shafranov solver, except:

q0 – is q on axis (fixed in GS iterations)

riphi – is normalized total current (fixed in GS iterations)

Thermal pressure and h=R\*B\_phi profiles are defined in subroutines ‘pdpdpsi()’ and ‘hdhdpsi()’

Fast ion current and stream function are calculated in ‘j\_i()’ which is called outside the main GS loop.

MPI is used in j\_i to calculate 3D velocity integrals.

GS solver is in ‘gs\_tk’ and ‘gssolve\_tk’ subroutines, which in principle can use (Z,R) grid different from main code.

Parameter description can also be found in tkin\_read.p code in

COMMON\_FLD and PARAM, and etc macros.

MPPL manual is added to TKIN repository (No need to read it all, mostly read about macros).

https://ssl.gstatic.com/ui/v1/icons/mail/images/cleardot.gif

MPPL\_manual.pdf

HYM\_Normalization.pdf

HYM\_description.pdf