Adding REGCOIL as a code to be used for an optimization target in STELLOPTV2 (the PPPL branch of STELLOPT).

Overview - What is STELLOPT going to do?

1. STELLOPT will call VMEC and calculate the MHD equilibrium for the specified equilibrium in the INPUT file.
2. STELLOPT will call REGCOIL with a specified requirement on the plasma-coil spacing, ‘SEP’, and a desired root-mean-square current density, ‘K’. REGCOIL will create a winding surface located ‘SEP’ meters away from the plasma. REGCOIL will then find the current potential on that winding surface that minimizes the value of $\chi_B^2 = \int dA\, B_{normal}^2$ on the plasma surface and has the desired ‘K’.

The flowchart of the STELLOPT execution loop is shown below. This chart highlights some of the functions in STELLOPT that will be modified to include targets, parameters, and calls to REGCOIL.

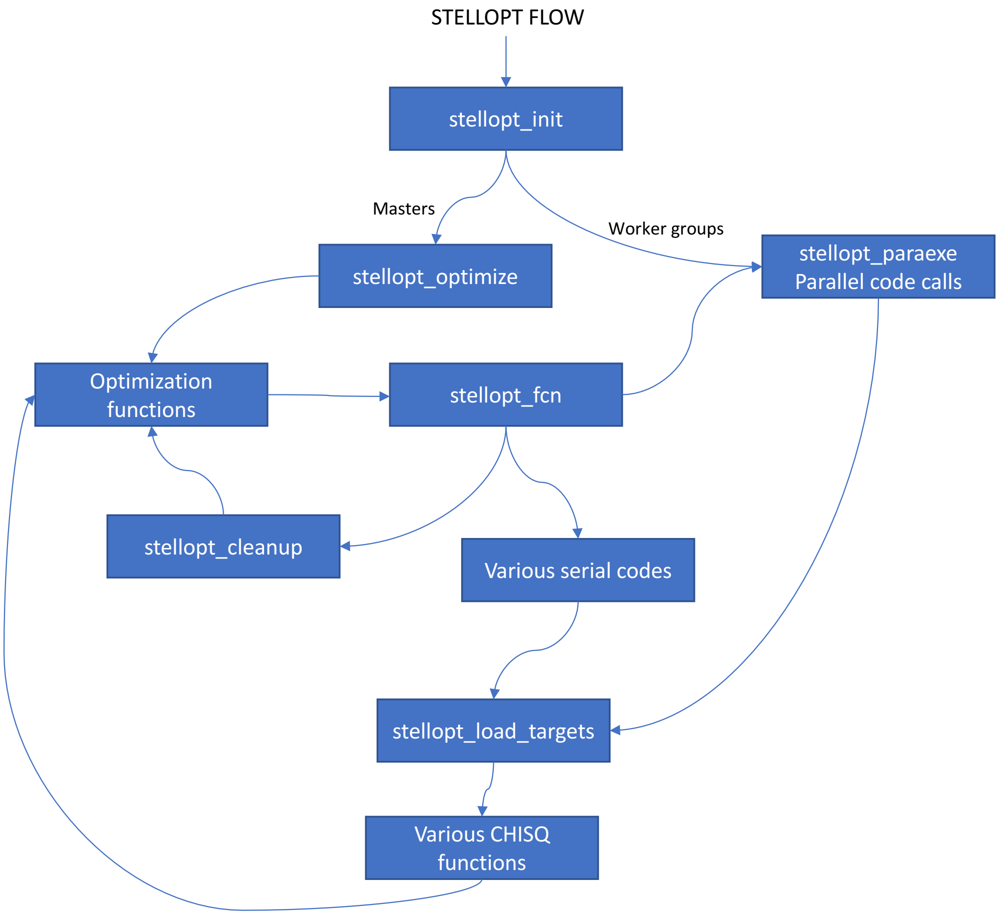

Figure 1: Flowchart of the STELLOPT execution loop.

The changes that were made to each of the STELLOPT source code files are listed below. The differences between the modified and original code are listed in ‘git diff’ format, as generated by the ‘git diff’ command (See git documentation for details, available at: https://git-scm.com/documentation).

Stellopt_targets.f90

Summary: Target and sigma variables were added for the winding surface separation, current density, bnorm and chi2_b. Unique integer indices for these targets were also added. Case statements and output expressions were added.

```
diff --git a/STELLOPTV2/Sources/Modules/stellopt_targets.f90
b/STELLOPTV2/Sources/Modules/stellopt_targets.f90
index 3f08aee..94e216b 100644
```

```
--- a/STELLOPTV2/Sources/Modules/stellopt_targets.f90
+++ b/STELLOPTV2/Sources/Modules/stellopt_targets.f90
@@ -166,12 +166,6 @@
       INTEGER     ::  numws
       REAL(rprec) ::  target_coil_bnorm, sigma_coil_bnorm
       INTEGER     ::  nu_bnorm,nv_bnorm
-
-      REAL(rprec) ::  target_regcoil_winding_surface_separation
-      REAL(rprec) ::  sigma_regcoil_winding_surface_separation
-      REAL(rprec) ::  target_regcoil_bnorm, sigma_regcoil_bnorm
-      REAL(rprec) ::  target_regcoil_chi2_b, sigma_regcoil_chi2_b
-      REAL(rprec) ::  target_regcoil_current_density,
sigma_regcoil_current_density

       INTEGER, PARAMETER :: jtarget_aspect     = 100
       INTEGER, PARAMETER :: jtarget_rbtor      = 1001
@@ -230,9 +224,6 @@
       INTEGER, PARAMETER :: jtarget_bmax       = 611
       INTEGER, PARAMETER :: jtarget_orbit      = 612
       INTEGER, PARAMETER :: jtarget_coil_bnorm = 613
-      INTEGER, PARAMETER :: jtarget_regcoil_bnorm = 5150
-      INTEGER, PARAMETER :: jtarget_regcoil_chi2_b = 5151
-      INTEGER, PARAMETER :: jtarget_regcoil_current_density = 5152


       CONTAINS
@@ -355,12 +346,6 @@
             WRITE(iunit, out_format) 'Limiter'
          CASE(jtarget_coil_bnorm)
            WRITE(iunit, out_format) 'COILOPT++ Normal Field'
-         CASE(jtarget_regcoil_bnorm)
-            WRITE(iunit, out_format) 'REGCOIL Normal Field (or something useful)'
-         CASE(jtarget_regcoil_chi2_b)
-            WRITE(iunit, out_format) 'REGCOIL Chi^2 B'
-         CASE(jtarget_regcoil_current_density)
-            WRITE(iunit, out_format) 'REGCOIL Current Density on Winding Surface'
       END SELECT
       END SUBROUTINE write_targets
```

stellopt_init.f90
Logical checks were added to modify the variable ‘nvars’, ‘vars’, ‘vars_min’, ‘vars_max’,’var_dex’, ‘diag’, ‘arr_dex’ as necessary.

```

diff --git a/STELLOPTV2/Sources/General/stellopt_init.f90
b/STELLOPTV2/Sources/General/stellopt_init.f90
index ab98b4c..1865cb1 100644
--- a/STELLOPTV2/Sources/General/stellopt_init.f90
+++ b/STELLOPTV2/Sources/General/stellopt_init.f90
@@ -112,8 +112,6 @@
       nvars = 0
       SELECT CASE (TRIM(equil_type))
          CASE('vmec2000','flow','animec','satire','paravmec','parvmec','vboot')
-              IF (lregcoil_winding_surface_separation_opt) nvars = nvars + 1
-              IF (lregcoil_current_density_opt) nvars = nvars + 1
               IF (lphiedge_opt) nvars = nvars + 1
               IF (lcurtor_opt)  nvars = nvars + 1
               IF (lpscale_opt)  nvars = nvars + 1
@@ -268,40 +266,6 @@
               IF (ier /= 0) CALL handle_err(VMEC_RUN_ERR,'Initialization call
(stellopt_init)',ier)
               ! Now count
               nvar_in=0
-              IF (lregcoil_winding_surface_separation_opt) THEN
-                 IF (lauto_domain) THEN
-                    regcoil_winding_surface_separation_min = &
-                        regcoil_winding_surface_separation - &
-                        ABS(pct_domain*regcoil_winding_surface_separation)
-                    regcoil_winding_surface_separation_max = &
-                        regcoil_winding_surface_separation + &
-                        ABS(pct_domain*regcoil_winding_surface_separation)
-                 END IF
-                 nvar_in = nvar_in + 1
-                 vars(nvar_in) = regcoil_winding_surface_separation
-                 vars_min(nvar_in) = regcoil_winding_surface_separation_min
-                 vars_max(nvar_in) = regcoil_winding_surface_separation_max
-                 var_dex(nvar_in) = iregcoil_winding_surface_separation
-                 diag(nvar_in)    = dregcoil_winding_surface_separation_opt
-                 arr_dex(nvar_in,1) = 1
-              END IF
-              IF (lregcoil_current_density_opt) THEN
-                 IF (lauto_domain) THEN
-                    regcoil_current_density_min = &
-                        regcoil_current_density - &
-                        ABS(pct_domain*regcoil_current_density)
-                    regcoil_current_density_max = &
-                        regcoil_current_density + &
-                        ABS(pct_domain*regcoil_current_density)
-                 END IF
-                 nvar_in = nvar_in + 1
-                 vars(nvar_in) = regcoil_current_density
-                 vars_min(nvar_in) = regcoil_current_density_min
-                 vars_max(nvar_in) = regcoil_current_density_max
-                 var_dex(nvar_in) = iregcoil_current_density
-                 diag(nvar_in)    = dregcoil_current_density_opt
-                 arr_dex(nvar_in,1) = 1
-              END IF
               IF (lphiedge_opt) THEN
                  IF (lauto_domain) THEN
                    phiedge_min = phiedge - ABS(pct_domain*phiedge)
```

chisq_regcoil_chi2_b.f90
This is a new source file that needed to be created. It is a fairly similar to the other ‘chisq_*.f90’ source files. This function check to see if REGCOIL optimizations will be performed, and if so, reads the REGCOIL input namelist from the main stellopt input file (usually named something like input.*name*). It uses the ‘regcoil_input_mod’ module to perform the reading, which is included in REGCOIL.

```
diff --git a/STELLOPTV2/Sources/Chisq/chisq_regcoil_chi2_b.f90
b/STELLOPTV2/Sources/Chisq/chisq_regcoil_chi2_b.f90
deleted file mode 100644
index 2ca3073..0000000
--- a/STELLOPTV2/Sources/Chisq/chisq_regcoil_chi2_b.f90
+++ /dev/null
```

```
@@ -1,95 +0,0 @@
-!-----------------------------------------------------------------------
-!     Subroutine:    chisq_regcoil_chi2_b
-!     Authors:       J.C. Schmitt (Auburn/PPPL) (jcschmitt@auburn.edu)
-!     Date:          2017
-!     Description:   Chisq routine(s) for REGCOIL.
-!                    More description needed
-!                    This is a template for the chisq routines.  In
-!                    general all chisq routines should take a target
-!                    variable, a sigma variable, and and error flag. On
-!                    entry, if niter is less than 1 the
-!                    code should simply increment the mtargets value by
-!                    the number of sigmas less than bigno.  On entry, if
-!                    iflag is set to a positive number the code should
-!                    output to screen.  On entry, if iflag is set to
-!                    zero the code should operate with no screen output.
-!                    On exit, negative iflag terminates execution,
-!                    positive iflag, indicates error but continues, and
-!                    zero indicates the code has functioned properly.
-!-----------------------------------------------------------------------
-      SUBROUTINE chisq_regcoil_chi2_b(target,sigma,niter,iflag)
-!-----------------------------------------------------------------------
-!     Libraries
-!-----------------------------------------------------------------------
-
-! JCS TO DO: Verify that all of these are necessary.
-      USE stellopt_runtime
-      USE stellopt_targets
-      USE stellopt_input_mod
-      USE stellopt_vars, ONLY: nlambda_regcoil
-      USE equil_vals, ONLY: curtor
-      ! USE neo_input_mod, ONLY: read_neoin_input, write_neoin_namelist
-      USE regcoil_input_mod
-      USE regcoil_variables
-
-!-----------------------------------------------------------------------
-!     Input/Output Variables
-!
-!-----------------------------------------------------------------------
-      IMPLICIT NONE
-      REAL(rprec), INTENT(in)    ::  target
-      REAL(rprec), INTENT(in)    ::  sigma
-      INTEGER,     INTENT(in)    ::  niter
-      INTEGER,     INTENT(inout) ::  iflag
-      integer :: iunit
-
-!-----------------------------------------------------------------------
-!     Local Variables
-!
-!-----------------------------------------------------------------------
-
-!----------------------------------------------------------------------
-!     BEGIN SUBROUTINE
-!----------------------------------------------------------------------
-      IF (iflag < 0) RETURN
-      IF (iflag == 1) WRITE(iunit_out,'(A,2(2X,I3.3))') &
-         'REGCOIL CHI2_B ',1,4
-      IF (iflag == 1) WRITE(iunit_out,'(A)') 'TARGET  SIGMA  DUMMY  CHI'
-      IF (niter >= 0) THEN
-        IF (sigma < bigno) THEN
-           mtargets = mtargets + 1
-           targets(mtargets) = target
-           sigmas(mtargets)  = sigma
-           vals(mtargets)    = sqrt(chi2_B_target)
-           !   targets(mtargets) = 0.0
-           !  sigmas(mtargets)  = bigno
-           !  vals(mtargets)    = 0.0
-           IF (iflag == 1) WRITE(iunit_out,'(3ES22.12E3)')
target,sigma,0.0,vals(mtargets)
-        ENDIF
-      ELSE
-         ! IF (sigma < bigno .and. myid == master) THEN
-         IF (sigma < bigno) THEN
-           write(6,'(a,i12)') '<---- niter=', niter
-            mtargets = mtargets + 1
-            IF (niter == -2) target_dex(mtargets)=jtarget_regcoil_chi2_b
-           ! Read the regcoil namelist from the input."id_string" file
-           ! WRITE(6,'(a,a)') '<---- id_string=', id_string
-
-           CALL safe_open(iunit, iflag, TRIM('input.'//TRIM(id_string)), 'old',
'formatted')
-           CALL read_regcoil_input(iunit, iflag)
-           ! save an internal copy of the value of nlambda here (regcoil may
-           ! overwrite it)
-           nlambda_regcoil = nlambda
-           close(iunit)
-           IF (iflag < 0) THEN
-              WRITE(6,*) '!!!!!!!!!!!!ERRROR!!!!!!!!!!!!!!'
-              WRITE(6,*) '  REGCOIL Namelist not found     '
-              WRITE(6,*) '!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!!'
-           END IF
-         END IF
-      END IF
-      RETURN
-!----------------------------------------------------------------------
-!     END SUBROUTINE
-!----------------------------------------------------------------------
-      END SUBROUTINE chisq_regcoil_chi2_b
```

chisq_regcoil_bnorm.f90

This is a new source file that was created with the intention to be used in the future. It is a fairly similar to the other 'chisq_*.f90' source files. This code does not do anything useful at this point, but may be used in the future for further extensions of the STELLOPT-REGCOIL optimization process.

```
diff --git a/STELLOPTV2/Sources/Chisq/chisq_regcoil_bnorm.f90
b/STELLOPTV2/Sources/Chisq/chisq_regcoil_bnorm.f90
deleted file mode 100644
index fb0a4b4..0000000
--- a/STELLOPTV2/Sources/Chisq/chisq_regcoil_bnorm.f90
+++ /dev/null
@@ -1,71 +0,0 @@
-!-----------------------------------------------------------------------
-!     Subroutine:    chisq_regcoil_bnorm
-!     Authors:       J.C. Schmitt (Auburn/PPPL) (jcschmitt@auburn.edu)
-!     Date:          2017
-!     Description:   Chisq routine(s) for REGCOIL.
-!                    More description needed
-!                    This is a template for the chisq routines.  In
-!                    general all chisq routines should take a target
-!                    variable, a sigma variable, and and error flag. On
-!                    entry, if niter is less than 1 the
-!                    code should simply increment the mtargets value by
-!                    the number of sigmas less than bigno.  On entry, if
-!                    iflag is set to a positive number the code should
-!                    output to screen.  On entry, if iflag is set to
-!                    zero the code should operate with no screen output.
-!                    On exit, negative iflag terminates execution,
-!                    positive iflag, indicates error but continues, and
-!                    zero indicates the code has functioned properly.
-!-----------------------------------------------------------------------
-      SUBROUTINE chisq_regcoil_bnorm(target,sigma,niter,iflag)
-!-----------------------------------------------------------------------
-!     Libraries
-!-----------------------------------------------------------------------
-      USE stellopt_runtime
-      USE stellopt_targets
-      USE equil_vals, ONLY: curtor
-
-!-----------------------------------------------------------------------
-!     Input/Output Variables
-!
-!-----------------------------------------------------------------------
-      IMPLICIT NONE
-      REAL(rprec), INTENT(in)    ::  target
-      REAL(rprec), INTENT(in)    ::  sigma
-      INTEGER,     INTENT(in)    ::  niter
-      INTEGER,     INTENT(inout) ::  iflag
-
-!-----------------------------------------------------------------------
-!     Local Variables
-!
-!-----------------------------------------------------------------------
-
-!----------------------------------------------------------------------
-!     BEGIN SUBROUTINE
-!----------------------------------------------------------------------
-      IF (iflag < 0) RETURN
-      IF (iflag == 1) WRITE(iunit_out,'(A,2(2X,I3.3))') 'REGCOIL BNORM',1,4
-      IF (iflag == 1) WRITE(iunit_out,'(A)') 'TARGET  SIGMA  DUMMY  CHI'
-      IF (niter >= 0) THEN
-         ! A note on how to calculate temp_val.
-         ! If target value is designed to be a limiter type target
-         ! (wall in parameter space) please define temp_val via a
-         ! hyperbolic tangent with width equal to 4-5 times EPSFCN.
-         ! This will allow the code to properly handle the optimization
-         ! process, define a gradient in search space.
-         mtargets = mtargets + 1
-         targets(mtargets) = 0.0
-         sigmas(mtargets)  = bigno
-         vals(mtargets)    = 0.0
-         IF (iflag == 1) WRITE(iunit_out,'(3ES22.12E3)')
target,sigma,0.0,vals(mtargets)
-      ELSE
-         IF (sigma < bigno) THEN
-            mtargets = mtargets + 1
-            IF (niter == -2) target_dex(mtargets)=jtarget_regcoil_bnorm
-         END IF
-      END IF
-      RETURN
-!----------------------------------------------------------------------
-!     END SUBROUTINE
-!----------------------------------------------------------------------
-      END SUBROUTINE chisq_regcoil_bnorm
```

stellopt_load_targets.f90
This function was modified to include checks for REGCOIL optimization targets and it calls the corresponding 'chisq_regcoil_*' functions if the targets are requested. The BNORM optimization is not functional. The CHI_2_B optimization is functional.

```
diff --git a/STELLOPTV2/Sources/General/stellopt_load_targets.f90
b/STELLOPTV2/Sources/General/stellopt_load_targets.f90
index 2c60cde..fa87eb1 100644
--- a/STELLOPTV2/Sources/General/stellopt_load_targets.f90
+++ b/STELLOPTV2/Sources/General/stellopt_load_targets.f90
@@ -216,14 +216,6 @@
       ! Coil Optimization
       IF (sigma_coil_bnorm < bigno) &
          CALL chisq_coil_bnorm(target_coil_bnorm, sigma_coil_bnorm, ncnt,iflag)
-      ! REGCOIL Coil Optimization (BNORM)
-
-!      IF (sigma_regcoil_bnorm < bigno) &
-!         CALL chisq_regcoil_bnorm(target_regcoil_bnorm, sigma_regcoil_bnorm,
ncnt,iflag)
-      ! REGCOIL Coil Optimization (CHI2_B)
-      IF (sigma_regcoil_chi2_b < bigno) &
-         CALL chisq_regcoil_chi2_b(target_regcoil_chi2_b, sigma_regcoil_chi2_b,
ncnt,iflag)
-
       ! Kink
       IF (ANY(sigma_kink < bigno)) &
          CALL chisq_kink(target_kink, sigma_kink, ncnt,iflag)
```

stellopt_regcoil_chi2_b.f90
This is a new function. It is the function that performs the calls to the various REGCOIL functions to calculate the winding surfaces and current potentials. In many ways, this duplicates the main 'REGCOIL' function loop (at least the parts required for the optimizations performed here). All variables needed by REGCOIL are passed through memory, but the code does write out the REGCOIL input namelist for debugging purposes. This will probably go away in the future.

```
diff --git a/STELLOPTV2/Sources/General/stellopt_regcoil_chi2_b.f90
b/STELLOPTV2/Sources/General/stellopt_regcoil_chi2_b.f90
deleted file mode 100644
index 90e20ff..0000000
--- a/STELLOPTV2/Sources/General/stellopt_regcoil_chi2_b.f90
+++ /dev/null
@@ -1,155 +0,0 @@
-!-----------------------------------------------------------------------
-!     Subroutine:    stellopt_regcoil_chi2_b
-!     Authors:       J.C.Schmitt (Auburn/PPPL) jcschmitt@auburn.edu
-!     Date:          2017
-!     Description:   This subroutine calls the coil regularization code
-!                    REGCOIL in 'target sqrt(<K^2>)' mode
-!
-!-----------------------------------------------------------------------
-      SUBROUTINE stellopt_regcoil_chi2_b(lscreen, iflag)
-!  proc_string is in memory, unique to optimzer function evaluation
-!-----------------------------------------------------------------------
-!     Libraries
-!-----------------------------------------------------------------------
-      USE stellopt_runtime
-      USE stellopt_input_mod
-      USE stellopt_vars
-      USE equil_utils
-!      USE neswrite, ONLY: coil_separation
-
-      ! REGCOIL files
-      USE regcoil_variables
-      USE regcoil_input_mod
-      USE validate_regcoil_input
-      USE compute_regcoil_lambda
-      USE init_regcoil_plasma
-      USE init_regcoil_coil_surface
-      USE read_regcoil_bnorm
-      USE build_regcoil_matrices
-      USE regcoil_auto_regularization_solve
-      USE write_regcoil_output
-
-!-----------------------------------------------------------------------
-!     Subroutine Parameters
-!        iflag         Error flag
-!----------------------------------------------------------------------
-      IMPLICIT NONE
-      !CHARACTER(256), INTENT(inout)    :: file_str
-      INTEGER, INTENT(inout) :: iflag
-      LOGICAL, INTENT(inout)        :: lscreen
-
-!-----------------------------------------------------------------------
-!     Local Variables
-!        ier         Error flag
-!        iunit       File unit number
-!----------------------------------------------------------------------
-!-----------------------------------------------------------------------
-!     Local Variables
-!        iverb         REGCOIL screen control
-!        istat         Error status
-!        iunit         File unit number
-      INTEGER ::  ier, iunit_rzuv
-      ! FOR REGCOIL
-      ! INTEGER(4)     :: regcoiloutTEMP,regcoilScrOut
-      LOGICAL :: lexists
-      INTEGER :: iverb, istat, nu, nv, mf, nf, md, nd, iunit, m, n, &
-                 ivmec, ispline_file
-!      REAL(rprec), ALLOCATABLE, DIMENSION(:,:) :: bnfou, bnfou_c
-      CHARACTER(8)   :: temp_str
-      CHARACTER(256) :: copt_fext
-!----------------------------------------------------------------------
-!     BEGIN SUBROUTINE
-!----------------------------------------------------------------------
-!      IF (iflag < 0) RETURN
-      IF (lscreen) then
-         WRITE(6,'(a)') ' -------------  REGCOIL CALCULATION  ---------'
-      ENDIF
-!DEC$ IF DEFINED (REGCOIL)
-
-      !IF (lscreen) WRITE(6,'(a,a)') '<---- proc_string=', proc_string
-      wout_filename = 'wout_'//TRIM(proc_string)//'.nc'
-      separation = regcoil_winding_surface_separation
-      current_density_target = regcoil_current_density
-      ! regcoil will overwrite nlambda - need to restore it to the
-      ! original value here
-      nlambda = nlambda_regcoil
-      ! write(6,'(a)') '<----safe_open'
-      CALL safe_open(iunit, iflag, TRIM('regcoil_in.'// &
-               TRIM(proc_string)), 'replace', 'formatted')
-      ! write(6,'(a)') '<----write_regcoil_input'
-      CALL write_regcoil_input(proc_string, iunit, istat)
-      ! write(6,'(a)') '<----flush'
-      CALL FLUSH(iunit)
-      ! write(6,'(a)') '<----close'
-      CLOSE(iunit)
-
-      ! input file should be written. Now perform regcoil operation
-      ! This should be *almost* a duplicate of the main code from
-      ! regcoil.f90
-      ! JCS : Probably don't need to re-read the namelist, but I like
-      ! to do things in baby-steps with lots of debugging opptions and
-      ! info
-      !write(6,'(a)') '<----safe_open'
-      !CALL safe_open(iunit, iflag, TRIM('input.'//TRIM(proc_string)), &
-      !          'old', 'formatted')
-      !write(6,'(a)') '<----read_regcoil_input'
-      !call read_regcoil_input(iunit, iflag)
-      ! write(6,'(a)') '<----Validate'
-      call validate_input()
-      ! write(6,'(a)') '<----Compute lambda'
-      !if (allocated(lambda)) deallocate(lambda)
-      call compute_lambda(lscreen)
-
-      ! Define the position vector and normal vector at each grid point for
-      ! the surfaces:
-      ! write(6,'(a)') '<----init_plasma'
-      call init_plasma(lscreen)
-      ! write(6,'(a)') '<----init coil surfs'
-      call init_coil_surface(lscreen)
-
-      ! Initialize some of the vectors and matrices needed:
-      ! write(6,'(a)') '<----read bnorm'
-      call read_bnorm(lscreen)
-      ! write(6,'(a)') '<----build matrices'
-      call build_matrices(lscreen)
-
-      ! JCS: I disabled all options except for #5 (for now)
-      ! write(6,'(a)') '<----select a case'
-      select case (general_option)
-      !case (1)
-      !   call solve()
-      !case (2)
-      !   call compute_diagnostics_for_nescout_potential()
-      !case (3)
-      !   call svd_scan()
-      !case (4)
-      !   call auto_regularization_solve()
-      case (5)
-      ! write(6,'(a)') '<----auto_reg solve'
-         call auto_regularization_solve(lscreen)
-      case default
-         print *,"Invalid general_option:",general_option
-         stop
-      end select
-
-!      write(6,'(a)') '<----safe_open'
-!      CALL safe_open(iunit, iflag, TRIM('regcoil_in.'// &
-!                TRIM(proc_string)), 'replace', 'formatted')
-!      write(6,'(a)') '<----write_output'
-!      call write_output()
-!
-!      write(6,'(a)') '<----flush'
-!      CALL FLUSH(iunit)
-
-      ! print *, chi2_B_target
-      ! print *,"REGCOIL complete. Total time=",totalTime,"sec."
-
-
-      IF (lscreen) WRITE(6,'(a)') ' ---------------------------  REGCOIL
CALCULATION DONE  ---------------------'
-!DEC$ ENDIF
-      RETURN
-
-!----------------------------------------------------------------------
-!     END SUBROUTINE
-!----------------------------------------------------------------------
-      END SUBROUTINE stellopt_regcoil_chi2_b
```

stellopt_fcn.f90

This function was modified to include reading REGCOIL variables of interest from the 'x' variable array and to call the function that performs the REGCOIL optimization routine (when necessary).

```

diff --git a/STELLOPTV2/Sources/General/stellopt_fcn.f90
b/STELLOPTV2/Sources/General/stellopt_fcn.f90
index a7dd6d5..3138401 100644
--- a/STELLOPTV2/Sources/General/stellopt_fcn.f90
+++ b/STELLOPTV2/Sources/General/stellopt_fcn.f90
@@ -101,10 +101,6 @@
          IF (var_dex(nvar_in) == icurtor) curtor = x(nvar_in)
          IF (var_dex(nvar_in) == ipscale) pres_scale = x(nvar_in)
          IF (var_dex(nvar_in) == imixece) mix_ece = x(nvar_in)
-         IF (var_dex(nvar_in) == iregcoil_winding_surface_separation) &
-                regcoil_winding_surface_separation = x(nvar_in)
-         IF (var_dex(nvar_in) == iregcoil_current_density) &
-                regcoil_current_density = x(nvar_in)
          IF (var_dex(nvar_in) == ibcrit) bcrit = x(nvar_in)
          IF (var_dex(nvar_in) == iextcur) extcur(arr_dex(nvar_in,1)) = x(nvar_in)
          IF (var_dex(nvar_in) == iaphi) aphi(arr_dex(nvar_in,1)) = x(nvar_in)
@@ -380,13 +376,6 @@
          ctemp_str = 'coilopt++'
          IF (sigma_coil_bnorm < bigno .and. (iflag>=0)) CALL
stellopt_paraexe(ctemp_str,proc_string,lscreen)
 !DEC$ ENDIF

-!DEC$ IF DEFINED (REGCOIL)
-         ! JCS: skipping parallelization for now - gonna try to do this
-         ! in serial
-         ! ctemp_str = 'regcoil_chi2_b'
-         ! IF (sigma_regcoil_chi2_b < bigno .and. (iflag>=0)) CALL
stellopt_paraexe(ctemp_str,proc_string,lscreen)
-         IF (sigma_regcoil_chi2_b < bigno) CALL stellopt_regcoil_chi2_b(lscreen,
iflag)
-!DEC$ ENDIF

          ! Now we load target values if an error was found then
          ! exagerate the fvec values so that those directions are not
```

stellopt_regcoil_bnorm.f90

This function is not called by STELLOPT, but was included with the intent to be modified in the future.

```

diff --git a/STELLOPTV2/Sources/General/stellopt_regcoil_bnorm.f90
b/STELLOPTV2/Sources/General/stellopt_regcoil_bnorm.f90
deleted file mode 100644
index 0bebb5c..0000000
--- a/STELLOPTV2/Sources/General/stellopt_regcoil_bnorm.f90
+++ /dev/null
@@ -1,121 +0,0 @@
-!-----------------------------------------------------------------------
-!     Subroutine:    stellopt_regcoil_bnorm
-!     Authors:       J.C.Schmitt (Auburn/PPPL) jcschmitt@auburn.edu
-!     Date:          2017
-!     Description:   This subroutine call the coil regularization code
-!                    REGCOIL to create a coil set given some winding
-!                    surface
-!-----------------------------------------------------------------------
-      SUBROUTINE stellopt_regcoil_bnorm(file_str,lscreen)
-!      SUBROUTINE stellopt_regcoil(file_str,iflag)
-!-----------------------------------------------------------------------
-!     Libraries
-!-----------------------------------------------------------------------
-      USE stellopt_runtime
-      USE stellopt_input_mod
-      USE stellopt_vars
-      USE equil_utils
-      USE neswrite, ONLY: coil_separation
-
-!-----------------------------------------------------------------------
-!     Subroutine Parameters
-!        iflag         Error flag
-!----------------------------------------------------------------------
-      IMPLICIT NONE
-      CHARACTER(256), INTENT(inout)    :: file_str
-      ! INTEGER, INTENT(inout) :: iflag
-      LOGICAL, INTENT(inout)        :: lscreen
-
-!-----------------------------------------------------------------------
```

```
-!     Local Variables
-!        ier         Error flag
-!        iunit       File unit number
-!----------------------------------------------------------------------
-!-----------------------------------------------------------------------
-!     Local Variables
-!        iverb         REGCOIL screen control
-!        istat         Error status
-!        iunit         File unit number
-!        bnfou/_c      B-Normal Fourier coefficients
-      INTEGER ::  ier, iunit_rzuv
-      ! FOR REGCOIL
-      ! INTEGER(4)     :: regcoiloutTEMP,regcoilScrOut
-      LOGICAL :: lexists
-      INTEGER :: iverb, istat, nu, nv, mf, nf, md, nd, iunit, m, n, &
-                 ivmec, ispline_file
-      REAL(rprec), ALLOCATABLE, DIMENSION(:,:) :: bnfou, bnfou_c
-      CHARACTER(8)   :: temp_str
-      CHARACTER(256) :: copt_fext
-!----------------------------------------------------------------------
-!     BEGIN SUBROUTINE
-!----------------------------------------------------------------------
-!      IF (iflag < 0) RETURN
-      IF (lscreen) WRITE(6,'(a)') ' ----------------------------  REGCOIL
CALCULATION  -------------------------'
-!DEC$ IF DEFINED (REGCOIL)
-
-
-      ! reset the params file
-      copt_fext = 'coilopt_params'//CHAR(0)
-      ! CALL init_settings(MPI_COMM_MYWORLD,copt_fext)
-      ! initialize
-      iverb = 0
-      ivmec = 0
-      ispline_file = 0
-      copt_fext = 'coilopt_params.'//TRIM(file_str)
-      ! Have master run bnorm
-      nu = nu_bnorm
-      nv = nv_bnorm
-      mf=24; nf=10; md=24; nd=20; coil_separation = 0.33;
-         ! Run BNORM code
-      !    ALLOCATE(bnfou(0:mf,-nf:nf),bnfou_c(0:mf,-nf:nf),STAT=istat)
-      !    IF (lscreen) WRITE(6,"(A)") '   - Calculating B-Normal File'
-      !    CALL bnormal(nu,nv,mf,nf,md,nd,bnfou,bnfou_c,TRIM(file_str)//'.nc')
-      !    IF (lscreen) WRITE(6,"(A,ES22.12E3)") '      Max. B-Normal:
',MAXVAL(MAXVAL(bnfou,DIM=2),DIM=1)
-      !    IF (lscreen) WRITE(6,"(A,ES22.12E3)") '      MIN. B-Normal:
',MINVAL(MINVAL(bnfou,DIM=2),DIM=1)
-      !    ! WRITE BNORMAL
-      !    CALL safe_open(iunit, istat, 'bnorm.' // TRIM(file_str),
'replace','formatted')
-      !    DO m = 0, mf
-      !       DO n = -nf, nf
-      !          WRITE(iunit,"(1x,2i5,ES22.12E3)") m,n,bnfou(m,n)
-      !       END DO
-      !    END DO
-      !    CLOSE(iunit)
-      !    DEALLOCATE(bnfou,bnfou_c)
-      !    IF (lscreen) WRITE(6,"(A)") '      Coefficients output to:
'//'bnorm.' // TRIM(file_str)
-      !    ! Turn on screen output
-      !    IF (lscreen) iverb = 1
-      ! CALL MPI_BCAST(iverb,1,MPI_INTEGER, master, MPI_COMM_MYWORLD,ierr_mpi)
-      ! IF (ierr_mpi /= MPI_SUCCESS) CALL
handle_err(MPI_ERR,'stellopt_coiloptpp1',ierr_mpi)
-      ! ! Update file names
-      ! INQUIRE(FILE='wout_'//TRIM(file_str)//'.nc',EXIST=lexists)
-      ! IF (lexists) ivmec = 1
-      ! DO m = 0, numws-1
-      !     ispline_file = 0
-      !     WRITE(temp_str,'(I3.3)') m
-      !
INQUIRE(FILE='coil_spline'//TRIM(temp_str)//'_reset_file.out',EXIST=lexists)
-      !     IF (lexists) ispline_file = 1
-      ! END DO
-      ! CALL
coilopt_update_parameters(nu,nv,ivmec,ispline_file,iverb,TRIM(file_str))
-      ! CALL MPI_BARRIER(MPI_COMM_MYWORLD,ierr_mpi)
-      ! IF (ierr_mpi /= MPI_SUCCESS) CALL
handle_err(MPI_ERR,'stellopt_coiloptpp2',ierr_mpi)
-      ! ! Output the file
-      ! CALL coilopt_writeparams(MPI_COMM_MYWORLD,TRIM(copt_fext))
-      ! ! Run init
-      ! CALL MPI_BARRIER(MPI_COMM_MYWORLD,ierr_mpi)
-      ! IF (ierr_mpi /= MPI_SUCCESS) CALL
handle_err(MPI_ERR,'stellopt_coiloptpp3',ierr_mpi)
-      ! IF (lscreen) WRITE(6,"(A)") '   - Initializing COILOPT++ '
-      ! CALL coilopt_init(MPI_COMM_MYWORLD,TRIM(copt_fext))
-      ! ! Run Coilopt++
-      ! IF (lscreen) WRITE(6,"(A)") '   - Executing COILOPT++ '
-      ! CALL coilopt_run(MPI_COMM_MYWORLD,iverb,TRIM(file_str))
-      ! ! Write Output
-      ! CALL coilopt_writeoutput(MPI_COMM_MYWORLD,TRIM(file_str))
-      ! CALL MPI_BARRIER(MPI_COMM_MYWORLD,ierr_mpi)
-      IF (lscreen) WRITE(6,'(a)') ' --------------------------  REGCOIL
CALCULATION DONE  ---------------------'
-!DEC$ ENDIF
-      RETURN
-
-!-----------------------------------------------------------------------
-!     END SUBROUTINE
-!-----------------------------------------------------------------------
-      END SUBROUTINE stellopt_regcoil_bnorm
```

stellopt_vars.f90

This file was modified to include declarations for the variables required for optimizing REGCOIL quantities (logicals, mins, maxes) and integer index numbers (which should match those define in stellopt_targets.f90). Case statements were added for output messages.

```

diff --git a/STELLOPTV2/Sources/Modules/stellopt_vars.f90
b/STELLOPTV2/Sources/Modules/stellopt_vars.f90
index 1750567..e88c0fe 100644
--- a/STELLOPTV2/Sources/Modules/stellopt_vars.f90
+++ b/STELLOPTV2/Sources/Modules/stellopt_vars.f90
```

```
@@ -45,8 +45,6 @@
 !            lphi_s_opt         Logical array to control PHI_AUX_S variation
 !            lphi_f_opt         Logical array to control PHI_AUX_F variation
 !            lbound_opt         Logical array to control Boudnary variation
-!            lregcoil_winding_surface_separation_opt Logical to control the
-!                    distance between the plasma and the winding surface
 !            equil_type         Name of Equilibrium Code
 !            ne_aux_f           Spline Knots for NE Profile (normalized to 1E19)
 !            te_aux_f           Spline Knots for TE Profile
@@ -58,8 +56,7 @@
 !------------------------------------------------------------------------
       IMPLICIT NONE
       LOGICAL  ::  lphiedge_opt, lcurtor_opt, lpscale_opt, lbcrit_opt,&
-                   lmix_ece_opt, lregcoil_winding_surface_separation_opt, &
-                   lregcoil_current_density_opt
+                   lmix_ece_opt
      LOGICAL, DIMENSION(nigroup)  ::  lextcur_opt
      LOGICAL, DIMENSION(1:20)  ::  laphi_opt
      LOGICAL, DIMENSION(0:20)  ::  lam_opt, lac_opt, lai_opt,&
@@ -81,17 +78,11 @@
      LOGICAL, DIMENSION(nigroup,20)             ::  lcoil_spline
      INTEGER  ::  nfunc_max
      REAL(rprec)     ::  dphiedge_opt, dcurtor_opt, dbcrit_opt, &
-                          dpscale_opt, dmix_ece_opt, &
-                          dregcoil_winding_surface_separation_opt, &
-                          dregcoil_current_density_opt
+                          dpscale_opt, dmix_ece_opt
     REAL(rprec)     ::  phiedge_min, curtor_min, bcrit_min, &
-                          pscale_min, mix_ece_min, &
-                          regcoil_winding_surface_separation_min, &
-                          regcoil_current_density_min
+                          pscale_min, mix_ece_min
     REAL(rprec)     ::  phiedge_max, curtor_max, bcrit_max, &
-                          pscale_max, mix_ece_max, &
-                          regcoil_winding_surface_separation_max, &
-                          regcoil_current_density_max
+                          pscale_max, mix_ece_max
     REAL(rprec), DIMENSION(nigroup)  ::  dextcur_opt,extcur_min,extcur_max
     REAL(rprec), DIMENSION(1:20)     ::  daphi_opt,aphi_min,aphi_max
     REAL(rprec), DIMENSION(0:20)     ::  dam_opt, dac_opt, dai_opt,&
@@ -105,10 +96,7 @@
                                            te_min, ne_min, ti_min, th_min, &
                                            te_max, ne_max, ti_max, th_max, &
                                            zeff_max, zeff_min
-      REAL(rprec)                       :: mix_ece
-      REAL(rprec)                       :: regcoil_winding_surface_separation
-      REAL(rprec)                       :: regcoil_current_density
-      INTEGER :: nlambda_regcoil
+      REAL(rprec)                       ::  mix_ece
      REAL(rprec), DIMENSION(0:20)      ::  te_opt, ti_opt, ne_opt, th_opt,
zeff_opt
     REAL(rprec), DIMENSION(ndatafmax) ::  ne_aux_s, te_aux_s, &
                                            ti_aux_s, th_aux_s, &
@@ -219,8 +207,6 @@
      INTEGER, PARAMETER ::  iraxis_cs    = 912
      INTEGER, PARAMETER ::  izaxis_cc    = 913
      INTEGER, PARAMETER ::  izaxis_cs    = 914
-      INTEGER, PARAMETER ::  iregcoil_winding_surface_separation   = 5150
-      INTEGER, PARAMETER ::  iregcoil_current_density   = 5151
```

```
       REAL(rprec), PARAMETER :: ne_norm = 1.0E18

@@ -233,10 +219,6 @@
       CHARACTER*(*), PARAMETER ::  out_format_2D = '(5X,A,I3.3,A,I3.3,A)'
       CHARACTER*(*), PARAMETER ::  out_format_2DB = '(5X,A,I4.3,A,I4.3,A)'
       SELECT CASE(var_num)
-         CASE(iregcoil_winding_surface_separation)
-            WRITE(iunit,out_format) 'REGCOIL_SEPARATION: Coil winding surface
separation'
-         CASE(iregcoil_current_density)
-            WRITE(iunit,out_format) 'REGCOIL_CURRENT_DENSITY: Current density on
winding surface'
          CASE(iphiedge)
             WRITE(iunit,out_format) 'PHIEDGE:  Total Enclosed Toroidal Flux'
          CASE(imixece)
```

stellopt_input_mod.f90

This function was modified to included logical, sigma, and target variables for the various quantities that STELLOPT will need to keep track of the REGCOIL optimization. Default values are declared. Precompiler flags are used to prevent the compilation of sections of the code if REGCOIL is not included in the STELLOPT distribution. Output statements were added to print out the REGCOIL optimization input and output values.

```
diff --git a/STELLOPTV2/Sources/Modules/stellopt_input_mod.f90
b/STELLOPTV2/Sources/Modules/stellopt_input_mod.f90
index 329780e..db70352 100644
--- a/STELLOPTV2/Sources/Modules/stellopt_input_mod.f90
+++ b/STELLOPTV2/Sources/Modules/stellopt_input_mod.f90
@@ -333,18 +333,7 @@
                          antennaposition_ece, targetposition_ece, rbeam_ece,
rfocus_ece, &
                          targettype_ece, antennatype_ece, nra_ece, nphi_ece, &
                          target_kink,
sigma_kink,mlmnb_kink,mlmns_kink,ivac_kink,&
-                         nj_kink, nk_kink, lssl_kink, lssd_kink, mmaxdf_kink,
nmaxdf_kink, &
-                         lregcoil_winding_surface_separation_opt, &
-                         dregcoil_winding_surface_separation_opt, &
-                         lregcoil_current_density_opt, &
-                         dregcoil_current_density_opt, &
-                         target_regcoil_winding_surface_separation, &
-                         sigma_regcoil_winding_surface_separation, &
-                         target_regcoil_bnorm, sigma_regcoil_bnorm, &
-                         target_regcoil_chi2_b, sigma_regcoil_chi2_b, &
-                         target_regcoil_current_density,
sigma_regcoil_current_density, &
-                         regcoil_winding_surface_separation, &
-                         regcoil_current_density
+                         nj_kink, nk_kink, lssl_kink, lssd_kink, mmaxdf_kink,
nmaxdf_kink

 !-----------------------------------------------------------------------
 !     Subroutines
@@ -454,10 +443,6 @@
       drho_opt(:,:) = -1.0
       ddeltamn_opt(:,:) = -1.0
       dcoil_spline(:,:) = -1.0
-      lregcoil_winding_surface_separation_opt    = .FALSE.
-      dregcoil_winding_surface_separation_opt    = -1.0
-      lregcoil_current_density_opt    = .FALSE.
-      dregcoil_current_density_opt    = -1.0
       IF (.not.ltriangulate) THEN  ! This is done because values may be set by
trinagulate
          phiedge_min     = -bigno;  phiedge_max     = bigno
          curtor_min      = -bigno;  curtor_max      = bigno
@@ -499,16 +484,6 @@
       coil_splinefx_min       = -bigno;  coil_splinefx_max       = bigno
       coil_splinefy_min       = -bigno;  coil_splinefy_max       = bigno
       coil_splinefz_min       = -bigno;  coil_splinefz_max       = bigno
-      target_regcoil_winding_surface_separation = 0.0
-      sigma_regcoil_winding_surface_separation = bigno
-      regcoil_winding_surface_separation = 1.0
-      regcoil_winding_surface_separation_min = 0.0
-      regcoil_winding_surface_separation_max = bigno
-      target_regcoil_current_density = 0.0
-      sigma_regcoil_current_density = bigno
-      regcoil_current_density = 8.0e6
-      regcoil_current_density_min = 0.0
-      regcoil_current_density_max = bigno
       ne_type         = 'akima_spline'
       zeff_type       = 'akima_spline'
       te_type         = 'akima_spline'
@@ -796,12 +771,6 @@
       sigma_coil_bnorm  = bigno
       nu_bnorm          = 256
       nv_bnorm          = 64
-      target_regcoil_bnorm = 0.0
-      sigma_regcoil_bnorm  = bigno
-      target_regcoil_chi2_b = 0.0
-      sigma_regcoil_chi2_b  = bigno
-      target_regcoil_current_density = 8.0e6
-      sigma_regcoil_current_density  = bigno
       ! Read name list
       lexist            = .false.
       istat=0
@@ -973,32 +942,6 @@
          END IF
       END IF
 !DEC$ ENDIF
-!DEC$ IF DEFINED (REGCOIL)
-      IF (myid == master .and. ((sigma_regcoil_bnorm < bigno) .or. &
-                                (sigma_regcoil_chi2_b < bigno) .or. &
-                                (sigma_regcoil_current_density < bigno) )) THEN
-         WRITE(6,*)        " Stellarator REGCOIL Optimization provided by: "
-         WRITE(6,"(2X,A)")
"================================================================================
"
-         WRITE(6,"(2X,A)") "=========                            REGCOIL
========="
-         WRITE(6,"(2X,A)") "=========                        (M. Landreman)
========="
-         WRITE(6,"(2X,A)") "=========               Matt dot Landreman at gmail
dot com             ========="
```

```
-         WRITE(6,"(2X,A)")
"==================================================================================
"
-         WRITE(6,*)        "    "
-      END IF
-!DEC$ ELSE
-      IF (myid == master .and. ((sigma_regcoil_bnorm < bigno) .or. &
-                                (sigma_regcoil_chi2_b < bigno) .or &
-                                (sigma_regcoil_current_density < bigno) ) THEN
-         sigma_regcoil_bnorm = bigno
-         sigma_regcoil_chi2_b = bigno
-         sigma_regcoil_current_density = bigno
-         WRITE(6,*) '!!!!!!!!!!!!!!!!!!!! WARNING !!!!!!!!!!!!!!!!!!!!!!!!!'
-         WRITE(6,*) '  Coil optimization with the REGCOIL
-         WRITE(6,*) '  code has been disabled.  Coil optimziation'
-         WRITE(6,*) '  has been turned off.  Contact your vendor for'
-         WRITE(6,*) '  further information.'
-      END IF
-!DEC$ ENDIF
 !DEC$ IF DEFINED (DKES_OPT)
       IF (myid == master .and. ANY(sigma_dkes < bigno)) THEN
          WRITE(6,*)        " Drift-Kinetic Equation Solver (DKES) provided by: "
@@ -1152,34 +1095,6 @@
       WRITE(iunit,'(A)') '!--------------------------------------------------------
----------------'
       WRITE(iunit,'(A)') '!       Optimized Quantities'
       WRITE(iunit,'(A)') '!--------------------------------------------------------
----------------'
-      IF (lregcoil_winding_surface_separation_opt) THEN
-         WRITE(iunit,'(2X,A,E22.14)') &
-                'REGCOIL_WINDING_SURFACE_SEPARATION = ', &
-                regcoil_winding_surface_separation
-         WRITE(iunit,onevar) 'LREGCOIL_WINDING_SURFACE_SEPARATION', &
-                lregcoil_winding_surface_separation_opt, &
-                'REGCOIL_WINDING_SURFACE_SEPARATION_MIN', &
-                regcoil_winding_surface_separation_min, &
-                'REGCOIL_WINDING_SURFACE_SEPARATION_MAX', &
-               regcoil_winding_surface_separation_max
-         IF (dregcoil_winding_surface_separation_opt > 0) &
-                 WRITE(iunit,outflt) 'DREGCOIL_WINDING_SURFACE_SEPARATION', &
-                 dregcoil_winding_surface_separation_opt
-      END IF
-      IF (lregcoil_current_density_opt) THEN
-         WRITE(iunit,'(2X,A,E22.14)') &
-                'REGCOIL_CURRENT_DENSITY = ', &
-                regcoil_current_density
-         WRITE(iunit,onevar) 'LREGCOIL_CURRENT_DENSITY', &
-                lregcoil_current_density_opt, &
-                'REGCOIL_CURRENT_DENSITY_MIN', &
-                regcoil_current_density_min, &
-                'REGCOIL_CURRENT_DENSITY_MAX', &
-               regcoil_current_density_max
-         IF (dregcoil_current_density_opt > 0) &
-                 WRITE(iunit,outflt) 'DREGCOIL_CURRENT_DENSITY', &
-                 dregcoil_current_density_opt
-      END IF
       IF (lphiedge_opt) THEN
          WRITE(iunit,onevar)
'LPHIEDGE_OPT',lphiedge_opt,'PHIEDGE_MIN',phiedge_min,'PHIEDGE_MAX',phiedge_max
```

```
          IF (dphiedge_opt > 0) WRITE(iunit,outflt) 'DPHIEDGE_OPT',dphiedge_opt
@@ -1952,21 +1867,6 @@
          WRITE(iunit,outflt) 'TARGET_COIL_BNORM',target_coil_bnorm
          WRITE(iunit,outflt) 'SIGMA_COIL_BNORM',sigma_coil_bnorm
       END IF
-      IF ((sigma_regcoil_bnorm < bigno) .or. &
-          (sigma_regcoil_chi2_b < bigno) .or.  &
-          (sigma_regcoil_current_density < bigno)) THEN
-         WRITE(iunit,'(A)') '!---------------------------------------------------
-------------------'
-         WRITE(iunit,'(A)') '!          REGCOIL BNORM OPTIMIZATION'
-         WRITE(iunit,'(A)') '!---------------------------------------------------
-------------------'
-         WRITE(iunit,outint) 'NU_BNORM',nu_bnorm
-         WRITE(iunit,outint) 'NV_BNORM',nv_bnorm
-         WRITE(iunit,outflt) 'TARGET_COIL_BNORM',target_regcoil_bnorm
-         WRITE(iunit,outflt) 'SIGMA_COIL_BNORM',sigma_regcoil_bnorm
-         WRITE(iunit,outflt) 'TARGET_COIL_CHI2_B',target_regcoil_chi2_b
-         WRITE(iunit,outflt) 'SIGMA_COIL_CHI2_B',sigma_regcoil_chi2_b
-         WRITE(iunit,outflt)
'TARGET_CURRENT_DENSITY',target_regcoil_current_density
-         WRITE(iunit,outflt)
'SIGMA_CURRENT_DENSITY',sigma_regcoil_current_density
-      END IF
       WRITE(iunit,'(A)') '!------------------------------------------------------
---------------'
       WRITE(iunit,'(A)') '!         EQUILIBRIUM/GEOMETRY OPTIMIZATION PARAMETERS'
       WRITE(iunit,'(A)') '!------------------------------------------------------
---------------'
```

stellopt_clean_up.f90
The modifications to this file are not actually used at this point. These changes were made in anticipation of future optimization strategies to be performed with REGCOIL.

```
diff --git a/STELLOPTV2/Sources/General/stellopt_clean_up.f90
b/STELLOPTV2/Sources/General/stellopt_clean_up.f90
index dc2556f..a891575 100644
--- a/STELLOPTV2/Sources/General/stellopt_clean_up.f90
+++ b/STELLOPTV2/Sources/General/stellopt_clean_up.f90
@@ -194,23 +194,6 @@
                      END DO
                   END IF
 !DEC$ ENDIF
-!DEC$ IF DEFINED (REGCOIL)
-                ! OUTPUT FILES SHOULD BE WRITTEN HERE - Use the regcoil
-                ! write_output functions to write the hdf5 output file
-                 IF (sigma_coil_bnorm < bigno) THEN
-                    CALL move_txtfile('bnorm.'//TRIM(proc_string_old),&
-                                      'bnorm.'//TRIM(proc_string))
-                    CALL move_txtfile('regcoil_params.'//TRIM(proc_string_old),&
-                                      'regcoil_params.'//TRIM(proc_string))
-                    ! CALL
copy_txtfile('Bnormal_from_plasma_current'//TRIM(proc_string_old)//'.dat',&
-                    !
'Bnormal_from_plasma_current'//TRIM(proc_string)//'.dat')
```

```
-                     ! CALL
copy_txtfile('Bnormal_total_'//TRIM(proc_string_old)//'.dat',&
-                     !
'Bnormal_total'//TRIM(proc_string)//'.dat')
-                     ! CALL
move_txtfile('Bnormal_from_plasma_current'//TRIM(proc_string_old)//'.dat',&
-                     !
'Bnormal_from_plasma_current'//TRIM(proc_string)//'.dat')
-                     ! Need to write out the winding surface.
-                  END IF
-!DEC$ ENDIF
 !DEC$ IF DEFINED (TERPSICHORE)
                   IF (ANY(sigma_kink < bigno)) THEN
                      CALL move_txtfile('terpsichore_eq.'//TRIM(proc_string_old),&
@@ -298,14 +281,6 @@
                   END DO
                END IF
 !DEC$ ENDIF
-!DEC$ IF DEFINED (REGCOIL)
-               IF (sigma_regcoil_bnorm < bigno .and.
(proc_string.ne.proc_string_old) ) THEN
-                  ! MUST Call 'write regcoil in'
-                  !CALL write_regcoil_namelist(iunit_out,ier)
-                  ! MUST Write out winding surface
-
-               END IF
-!DEC$ ENDIF
                ! Keep minimum states
                IF (lkeep_mins) THEN
                   WRITE(temp_str,'(i5.5)') ncnt
@@ -413,21 +388,6 @@
                      END DO
                   END IF
 !DEC$ ENDIF
-!DEC$ IF DEFINED (REGCOIL)
-                  IF (sigma_coil_bnorm < bigno) THEN
-                     ! CALL move_txtfile('bnorm.'//TRIM(proc_string_old),&
-                     !                    'bnorm.'//TRIM(proc_string))
-                     ! CALL
move_txtfile('regcoil_params.'//TRIM(proc_string_old),&
-                     !                    'regcoil_params.'//TRIM(proc_string))
-                     ! CALL
copy_txtfile('Bnormal_from_plasma_current'//TRIM(proc_string_old)//'.dat',&
-                     !
'Bnormal_from_plasma_current'//TRIM(proc_string)//'.dat')
-                     ! CALL
copy_txtfile('Bnormal_total_'//TRIM(proc_string_old)//'.dat',&
-                     !
'Bnormal_total'//TRIM(proc_string)//'.dat')
-                     ! CALL
move_txtfile('Bnormal_from_plasma_current'//TRIM(proc_string_old)//'.dat',&
-                     !
'Bnormal_from_plasma_current'//TRIM(proc_string)//'.dat')
-                     ! Need to write out the winding surface.
-                  END IF
-!DEC$ ENDIF
 !DEC$ IF DEFINED (TERPSICHORE)
                   IF (ANY(sigma_kink < bigno)) THEN
                      CALL move_txtfile('terpsichore_eq.'//TRIM(proc_string_old),&
```

stellopt_paraexe.f90

The changes in this function DO NOT GET CALLED. If REGCOIL were a MPI code, these lines would get executed. Currently, REGCOIL uses OpenMP and does not make use of the MPI parallelization techniques. If a code did use MPI, the function calls would go in this function. These calls are only included here for reference.

```
diff --git a/STELLOPTV2/Sources/General/stellopt_paraexe.f90
b/STELLOPTV2/Sources/General/stellopt_paraexe.f90
index 290e62a..b676670 100644
--- a/STELLOPTV2/Sources/General/stellopt_paraexe.f90
+++ b/STELLOPTV2/Sources/General/stellopt_paraexe.f90
@@ -353,12 +353,6 @@
 !DEC$ ENDIF
             CASE('coilopt++')
                CALL stellopt_coiloptpp(file_str,lscreen)
-!DEC$ IF DEFINED (REGCOIL)
-            CASE('regcoil_bnorm')
-               CALL stellopt_regcoil_bnorm(file_str,lscreen)
-            CASE('regcoil_chi2_b')
-               CALL stellopt_regcoil_chi2_b(file_str,lscreen)
-!DEC$ ENDIF
             CASE('terpsichore')
                proc_string = file_str
                ier = 0
```

makestelloptv2

This is the makefile for stelloptv2. It has been modified to remove existing REGCOIL.a libraries and to build them, if necessary. The makefile for REGCOIL needs to be modified to make this .a library.

```
diff --git a/STELLOPTV2/makestelloptv2 b/STELLOPTV2/makestelloptv2
index b55f5ef..c62d004 100644
--- a/STELLOPTV2/makestelloptv2
+++ b/STELLOPTV2/makestelloptv2
@@ -15,7 +15,7 @@ VPATH =
$(SPATH):$(SPATH)/Chisq:$(SPATH)/General:$(SPATH)/Modules

 .SUFFIXES :
 .SUFFIXES : .f .f90 .o
-xstelloptv2:  $(LIB) $(LIB_VMEC) $(LIB_BEAMS3D) $(LIB_BNORM) $(LIB_BOOTSJ)
$(LIB_BOOZ) $(LIB_COBRA) $(LIB_DIAGNO) $(LIB_DKES) $(LIB_JINV) $(LIB_MGRID)
$(LIB_NEO) $(LIB_GENE) $(LIB_COILOPTPP) $(LIB_REGCOIL) $(LIB_TERPSICHORE)
$(ObjectFiles)
+xstelloptv2:  $(LIB) $(LIB_VMEC) $(LIB_BEAMS3D) $(LIB_BNORM) $(LIB_BOOTSJ)
$(LIB_BOOZ) $(LIB_COBRA) $(LIB_DIAGNO) $(LIB_DKES) $(LIB_JINV) $(LIB_MGRID)
$(LIB_NEO) $(LIB_GENE) $(LIB_COILOPTPP) $(LIB_TERPSICHORE) $(ObjectFiles)
        $(LINK) $@ $(ObjectFiles) $(LIB_LINK)
 ifdef VMEC_DIR
        @rm $(VMEC_DIR)/$(LOCTYPE)/$(LIB_VMEC)
@@ -56,9 +56,6 @@ endif
 ifdef COILOPTPP_DIR
        @rm $(COILOPTPP_DIR)/$(LIB_COILOPTPP)
 endif
-ifdef REGCOIL_DIR
-       @rm $(REGCOIL_DIR)/$(LIB_REGCOIL)
-endif
 ifdef TERPSICHORE_DIR
        @rm $(TERPSICHORE_DIR)/$(LIB_TERPSICHORE)
 endif
@@ -160,10 +157,6 @@ endif
 $(LIB_COILOPTPP) :
        @cd $(COILOPTPP_DIR); make; ar -cruv $(LIB_COILOPTPP) *.o

-#Construct COILOPT library.
-$(LIB_REGCOIL) :
-       @cd $(REGCOIL_DIR); make; ar -cruv $(LIB_REGCOIL) *.o
-
 #Construct TERPSICHORE library.
 $(LIB_TERPSICHORE) :
        @cd $(TERPSICHORE_DIR);make; ar -cruv $(LIB_TERPSICHORE) *.o *.mod
```

Debug/STELLOPTV2.dep

This is the dependency file for DEBUG/STELLOPTV2. It has been updated to include the object file dependencies for chisq_regcoil_bnorm.o (which isn't used at this point), so these changes may not be necessary. They are included for future modifications.

```
diff --git a/STELLOPTV2/Debug/STELLOPTV2.dep b/STELLOPTV2/Debug/STELLOPTV2.dep
index 9790ea9..7c922e0 100644
--- a/STELLOPTV2/Debug/STELLOPTV2.dep
+++ b/STELLOPTV2/Debug/STELLOPTV2.dep
@@ -74,14 +74,6 @@ chisq_coil_bnorm.o : \
       ../../LIBSTELL/Debug/mpi_params.o


-chisq_regcoil_bnorm.o : \
-      stellopt_runtime.o \
-      stellopt_targets.o \
-      equil_vals.o \
-      ../../LIBSTELL/Debug/safe_open_mod.o \
-      ../../LIBSTELL/Debug/mpi_params.o
-
-
 chisq_rbtor.o : \
       stellopt_runtime.o \
       stellopt_targets.o \
```

Release/STELLOPTV2.dep

These are the changes for the Release version of the STELLOPTV2 dependencies file. Again, these changes are not required, as they are for future optimization strategies using REGCOIL, but are included here for reference.

```
diff --git a/STELLOPTV2/Release/STELLOPTV2.dep b/STELLOPTV2/Release/STELLOPTV2.dep
index 1c37a6b..df305e6 100644
--- a/STELLOPTV2/Release/STELLOPTV2.dep
+++ b/STELLOPTV2/Release/STELLOPTV2.dep
@@ -93,14 +93,6 @@ chisq_coil_bnorm.o : \
       equil_vals.o \
       $(LIB_DIR)/Release/safe_open_mod.o \
       $(LIB_DIR)/Release/mpi_params.o
-
-
-chisq_regcoil_bnorm.o : \
-      stellopt_runtime.o \
-      stellopt_targets.o \
-      equil_vals.o \
-      $(LIB_DIR)/Release/safe_open_mod.o \
-      $(LIB_DIR)/Release/mpi_params.o


 chisq_rbtor.o : \
```

ObjectList
This is the ObjectList file for STELLOPTV2. It has been updated to include the new functions that were created.

```
diff --git a/STELLOPTV2/ObjectList b/STELLOPTV2/ObjectList
index ac35d37..8bebd9f 100644
--- a/STELLOPTV2/ObjectList
+++ b/STELLOPTV2/ObjectList
@@ -34,8 +34,6 @@ chisq_mse.o \
 chisq_balloon.o \
 chisq_pmin.o \
 chisq_coil_bnorm.o \
-chisq_regcoil_bnorm.o \
-chisq_regcoil_chi2_b.o \
 chisq_vessel.o \
 chisq_z0.o \
 chisq_curvature.o \
@@ -70,8 +68,6 @@ stellopt_load_targets.o \
 stellopt_toboozer.o \
 stellopt_init.o \
 stellopt_coiloptpp.o \
-stellopt_regcoil_bnorm.o \
-stellopt_regcoil_chi2_b.o \
 stellopt_bootsj.o \
 stellopt_clean_up.o \
 stellopt_main.o \
```