```
# Notation for output array dimensions
#   R  regions
#   T  time steps
#   N  max number of nuclides found in a single region
#   E  number of gamma energy bins
# le10 for top 10 lists, a number <= 10


dchain_output = {
'time':{                            #  ~  Time information
    'from_start_sec'                # [T] list of times from start time [sec]
    'from_EOB_sec'                  # [T] list of times from end of final bombardment [sec]
    'of_EOB_sec'                    #     scalar time marking end of final bombardment [sec]
    }

'region':{                          #  ~  Information which only varies with region
    'numbers'                       # [R] region numbers
    'number'                        # [R] region numbers
    'irradiation_time_sec'          # [R] irradiation time per region
    'volume'                        # [R] volume in [cc] per region
    'neutron_flux'                  # [R] neutron flux in [n/cm^2/s] per region
    'beam_power_MW'                 # [R] beam power in [MW] per region
    'beam_energy_GeV'               # [R] beam energy in [GeV] per region
    'beam_current_mA'               # [R] beam current in [mA] per region
    }

'nuclides':{                        #  ~  Main nuclide results from *.act file
    'names'                         # [R][N] names of nuclides produced in each region
    'TeX_names'                     # [R][N] LaTeX-formatted names of nuclides produced
    'ZZZAAAM'                       # [R][N] ZZZAAAM values (=10000*Z+10*A+M) of nuclides
                                    #        (ground state m=0, metastable m=1,2,etc.)
    'half_life'                     # [R][N] half lives of nuclides produced [sec]
    'inventory':{'value'            # [R][T,N] atoms [#/cc]
                 'error'}           # [R][T,N] atoms [#/cc]
    'activity':{'value'             # [R][T,N] activity [Bq/cc]
                'error'}            # [R][T,N] activity [Bq/cc]
    'dose_rate':{'value'            # [R][T,N] dose-rate [uSv/h*m^2]
                 'error'}           # [R][T,N] dose-rate [uSv/h*m^2]
    'decay_heat':{
        'total':{'value'            # [R][T,N] total decay heat [W/cc]
                 'error'}           # [R][T,N] total decay heat [W/cc]
        'beta':{'value'             # [R][T,N] beta decay heat [W/cc]
                'error'}            # [R][T,N] beta decay heat [W/cc]
        'gamma':{'value'            # [R][T,N] gamma decay heat [W/cc]
                 'error'}           # [R][T,N] gamma decay heat [W/cc]
        'alpha':{'value'            # [R][T,N] alpha decay heat [W/cc]
                 'error'}           # [R][T,N] alpha decay heat [W/cc]
        }
    'column_headers'                # Length 7 list of the *.act columns' descriptions
    'total':{                       #  ~  Total values summed over all nuclides
        'activity':{'value'         # [R][T] total activity [Bq/cc]
                    'error'}        # [R][T] total activity [Bq/cc]
        'decay_heat':{'value'       # [R][T] total decay heat [W/cc]
                      'error'}      # [R][T] total decay heat [W/cc]
        'beta_heat':{'value'        # [R][T] total beta decay heat [W/cc]
                     'error'}       # [R][T] total beta decay heat [W/cc]
        'gamma_heat':{'value'       # [R][T] total gamma decay heat [W/cc]
                      'error'}      # [R][T] total gamma decay heat [W/cc]
        'alpha_heat':{'value'       # [R][T] total alpha decay heat [W/cc]
                      'error'}      # [R][T] total alpha decay heat [W/cc]
        'activated_atoms':{'value'  # [R][T] total activated atoms [#/cc]
                           'error'} # [R][T] total activated atoms [#/cc]
        'gamma_dose_rate':{'value'  # [R][T] total gamma dose rate [uSV/h*m^2]
                           'error'} # [R][T] total gamma dose rate [uSV/h*m^2]
        }
    }


```

```
'gamma':{                           #  ~  Gamma spectra and totals
    'spectra':{
        'group_number'              # [R][T,E] group number
        'E_lower'                   # [R][T,E] bin energy lower-bound [MeV]
        'E_upper'                   # [R][T,E] bin energy upper-bound [MeV]
        'flux':{'value'             # [R][T,E] flux [#/s/cc]
                'error'}            # [R][T,E] flux [#/s/cc]
        'energy_flux':{'value'      # [R][T,E] energy flux [MeV/s/cc]
                       'error'}     # [R][T,E] energy flux [MeV/s/cc]
        }
    'total_flux':{'value'           # [R][T] total gamma flux [#/s/cc]
                  'error'}          # [R][T] total gamma flux [#/s/cc]
    'total_energy_flux':{'value'    # [R][T] total gamma energy flux [MeV/s/cc]
                         'error'}   # [R][T] total gamma energy flux [MeV/s/cc]
    'annihilation_flux':{'value'    # [R][T] annihilation gamma flux [#/s/cc]
                         'error'}   # [R][T] annihilation gamma flux [#/s/cc]
    'current_underflow':{'value'    # [R][T] gamma current underflow [#/s]
                         'error'}   # no error reported
    'current_overflow':{'value'     # [R][T] gamma current overflow [#/s]
                        'error'}    # no error reported
    }

'top10':{                           #  ~  Top 10 lists from *.act file
    'activity':{
        'rank'                      # [R][T,le10] rank
        'nuclide'                   # [R][T,le10] nuclide name
        'value'                     # [R][T,le10] activity [Bq/cc]
        'error'                     # [R][T,le10] activity [Bq/cc]
        'percent'                   # [R][T,le10] percent of total activity
        }
    'decay_heat':{
        'rank'                      # [R][T,le10] rank
        'nuclide'                   # [R][T,le10] nuclide name
        'value'                     # [R][T,le10] decay heat [W/cc]
        'error'                     # [R][T,le10] decay heat [W/cc]
        'percent'                   # [R][T,le10] percent of total decay heat
        }
    'gamma_dose':{
        'rank':                     # [R][T,le10] rank
        'nuclide'                   # [R][T,le10] nuclide name
        'value'                     # [R][T,le10] dose-rate [uSv/h*m^2]
        'error'                     # [R][T,le10] dose-rate [uSv/h*m^2]
        'percent'                   # [R][T,le10] percent of total gamma dose rate
        }
    }
'number_of':{                       #  ~  Maximum values of R, T, N, and E
    'regions'                       #  R  = total number of regions
    'time_steps'                    #  T  = total number of time steps
    'max_nuclides_in_any_region'    #  N  = maximum unique nuclides found in any region
    'gamma_energy_bins'             #  E  = number of gamma energy bins (default=42)
    }
}

if process_dtrk_file: dchain_output.update({
'neutron':{                         #  ~  Neutron spectra and totals
    'spectra':{                     #  -  Actual values used in DCHAIN
        'E_lower'                   # [R][E] bin energy lower-bound [MeV]
        'E_upper'                   # [R][E] bin energy upper-bound [MeV]
        'flux':{'value'             # [R][E] neutron flux [#/s/cm^2]
                'error'}            # [R][E] neutron flux [#/s/cm^2]
        }
    'total_flux':{'value'           # [R]    total neutron flux [#/s/cm^2]
                  'error'}          # [R]    total neutron flux [#/s/cm^2]
    'unit_spectra':{                #  -  Flux per unit source particle (raw *.dtrk output)
        'E_lower'                   # [R][E] bin energy lower-bound [MeV]
        'E_upper'                   # [R][E] bin energy upper-bound [MeV]
        'flux':{'value'             # [R][E] neutron flux [#/s/cm^2/s.p.]
                'error'}            # [R][E] neutron flux [#/s/cm^2/s.p.]
}})
```

```
139
140 if process_dyld_files:
141     dchain_output.update({
142     'yields':{                      #  ~  Yield spectra
143         'all_names'                 # [N] names of all nuclides produced
144         'names'                     # [R][N] names of nuclides produced in each region
145         'TeX_names'                 # [R][N] LaTeX-formatted names of nuclides produced
146         'ZZZAAAM'                   # [R][N] ZZZAAAM values (=10000Z+10A+M) of nuclides
147                                     #        (ground state m=0, metastable m=1,2,etc.)
148         'rate':{                    #  -  Actual values used in DCHAIN (at 100% beam power)
149               'value'               # [R][E] nuclide yield rate [#/s/cm^3]
150               'error'               # [R][E] nuclide yield rate [#/s/cm^3]
151               }
152         'unit_rate':{               #  -  Yields per unit source particle
153               'value'               # [R][E] nuclide yield rate [#/s.p.]
154               'error'               # [R][E] nuclide yield rate [#/s.p.]
155 }}})
156
157 if process_DCS_file: # add extra information
158     # Notation for output array dimensions
159     #   R  (n_reg)    regions
160     #   Td (ntsteps)  time steps in DCS file (usually different from that of *.act file!)
161     #   Nd (nnuc_max) max number of nuclides (this index differs from the *.act N index)
162     #   C  (chni_max) maximum index of relevant chains
163     #   L  (chln_max) maximum number of links per chain
164
165 dchain_output.update({
166 'DCS':{
167     'time':{
168         'from_start_sec'            # [Td] list of times from start time [sec]
169         'from_EOB_sec'              # [Td] list of times from end of final bombardment [sec]
170         'of_EOB_sec'                #      scalar time marking end of final bombardment [sec]
171         }
172
173     'number_of':{                   #  ~  Maximum values of R, Td, Nd, C, and L
174         'regions'                   #  R  = total number of regions
175         'time_steps'                #  Td = total number of time steps
176         'max_nuclides'              #  Nd = max number of end nuclides in any time step
177         'max_number_of_chains'      #  C  = highest index of a relevant chain found
178         'max_chain_length'          #  L  = max number of links (nuclides) in any chain
179         }
180
181     'end_nuclide':{                 #  ~  Informtaion on nuclides at the end of each chain
182         'names'                     # [R][Td,Nd] nuclide names
183         'inventory':{
184             'N_previous'            # [R][Td,Nd,C] inventory in previous time step [atoms/cc]
185             'N_now'                 # [R][Td,Nd,C] inventory in current time step [atoms/cc]
186             'dN'                    # [R][Td,Nd,C] change in inventory of end nuclide from
187                                     #              previous to current time step [atoms/cc]
188             }
189         'activity':{
190             'A_previous'            # [R][Td,Nd,C] activity in previous time step [Bq/cc]
191             'A_now'                 # [R][Td,Nd,C] activity in the current time step [Bq/cc]
192             'dA'                    # [R][Td,Nd,C] change in activity of end nuclide from
193                                     #              previous to current time step [Bq/cc]
194             }
195         }
196
197     'chains':{                      #  ~  Chains, individual links, and their contributions
198         'indices_of_printed_chains' # [R][Td,Nd]     the chain indices which were printed
199         'length'                    # [R][Td,Nd,C]   length of listed chain
200         'link_nuclides'             # [R][Td,Nd,C,L] strings of the nuclides in each chain
201         'link_decay_modes'          # [R][Td,Nd,C,L] strings of the decay modes each link
202                                     #                undergoes to produce the next link
203         'link_dN':{                 # (only generated if values in file, 'None' otherwise)
204             'beam'                  # [R][Td,Nd,C,L] beam contribution to dN from each link
205             'decay_nrxn'            # [R][Td,Nd,C,L] decay + neutron rxn contribution to dN
206             'total'                 # [R][Td,Nd,C,L] total contribution to dN from each link
207             }
```

```
208         }
209
210     'relevant_nuclides':{           #  ~  A vs t profiles of nuclides over relevancy threshold
211         'names'                     # [R]        list of relevant nuclides per region
212         'times'                     # [R][Td,Nd] time [s]
213         'inventory'                 # [R][Td,Nd] inventory [atm/cc]
214         'activity'                  # [R][Td,Nd] activity [Bq/cc]
215         }
216     }
217 })
```