Multi-dimensional Interpolation

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2-Dimensional Interpolation and Trim

- Elliptical Polarization Undulator (EPU) has two independent control variables: Gap and Phase
- Need to adjust quadrupole strength to avoid diverged beam size after the undulator adjustment
- Requires 2 dimensional look up tables (gap vs. phase) for each quadrupole, and total 8 look up tables
- The look up tables give trim current which is difference from optimal lattice settings

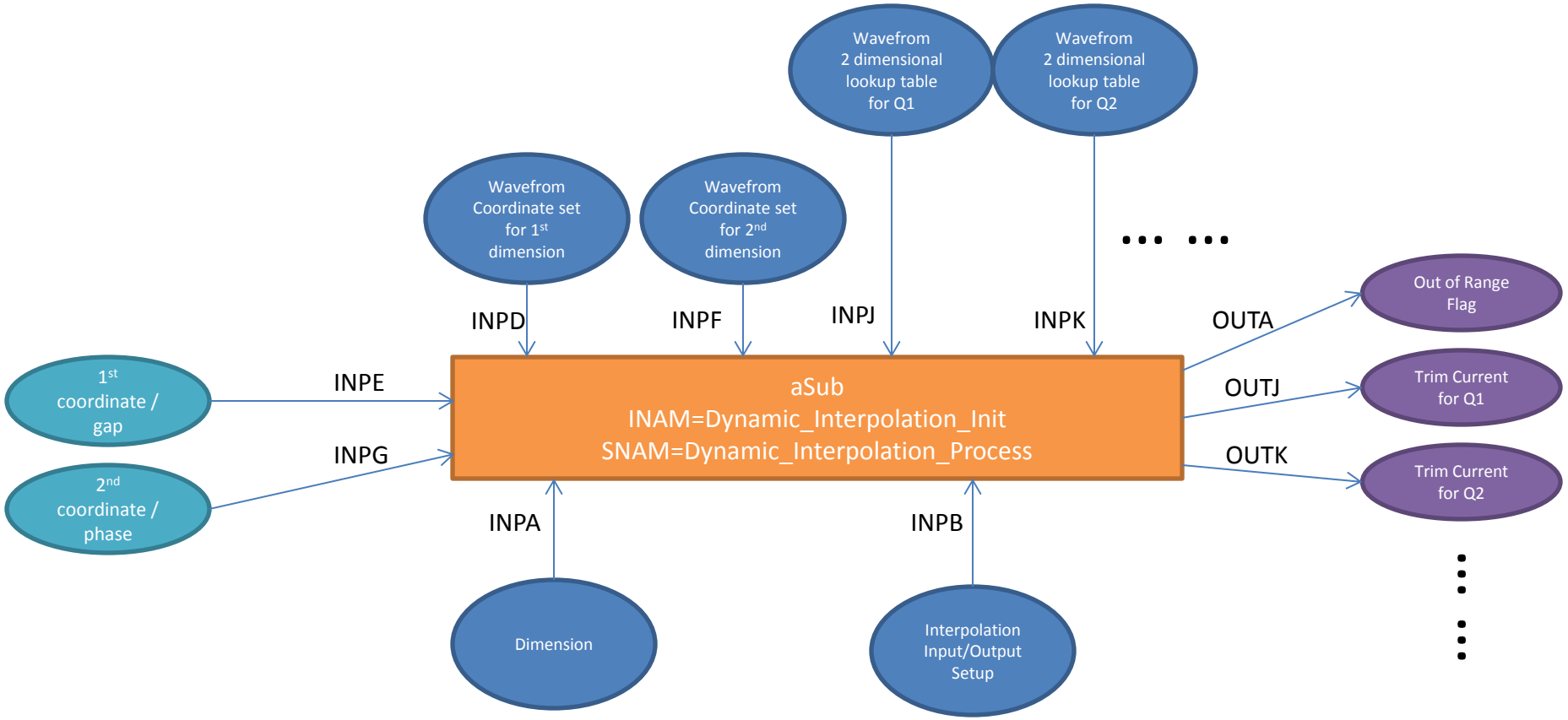
Multiple-Dimensional Interpolation Code

- Code from Australian Light Source
- Support up to 8 dimensional interpolation (linear interpolation)
- Support multiple Trim current calculation simultaneously (depends on the demansion but, up to 10)
- Use aSub record

How to import the library into an application

- Copy the following files into your source directory
  - dynamic_interpolation.c : API file
  - dynamic_interpolation.h : header file
  - dynamic_interpolation_subroutines.c : aSub function file
  - dynamic_interpolation_subroutines.dbd : DBD file for the function registration
- Add to compile Liabrary in your Makefile
  - LIBRARY_IOC += interpolationSupport
  - interpolationSupport_SRCS += dynamic_interpolation.c
  - interpolationSupport_SRCS += dynamic_interpolation_subroutines.c
  - <my_application>_LIBS += interpolationSupport
- Add the DBD file to install and use in your application
  - DBD += dynamic_interpolation_subroutines.dbd
  - <my_application>_DBD += dynamic_interpolation_subroutines.dbd

Input/Output for the aSub (Example for 2 dimensional interpolation)



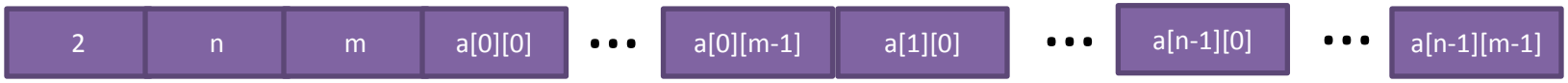
1010: use only J
1011: use J and K
1012: use J, K, and L
… …

Waveform and Table format

- For Dengenerated value or Scalar

- For 1 dimension

- For 2 dimension



Example for 2 Dimensional Look up Table (1)

Tables and Input/Output PVs

```
record(waveform, "INP1_COORDINATE_SET")
{
    field(VAL, "1 3 -1 0 1")
    field(PINI, "YES")
    field(FTVL, "DOUBLE")
    field(NELM, "5")
}
record(waveform, "INP2_COORDINATE_SET")
{
    field(VAL, "1 3 -1 0 1")
    field(PINI, "YES")
    field(FTVL, "DOUBLE")
    field(NELM, "5")
}

record(waveform, "TABLE")
{
    field(PINI, "YES")
    field(FTVL, "DOUBLE")
    field(NELM, "12")

}

record(ai, "OUT")
{
   field(SCAN, "Passive")
}

record(ai, "INP1")
{
    field(SCAN, "Passive")
}

record(ai, "INP2")
{
    field(SCAN, "Passive")
}
```

aSub record

```
record(aSub, "INTER_CALC")
{
    field(DESC, "2D interpolation")
    field(SCAN, "Passive")
    field(INAM, "Dynamic_Interpolation_Init")
    field(SNAM, "Dynamic_Interpolation_Process")

    # Number of Dimensions
    #
    field(INPA, "2")
    field(FTA, "LONG")

    # Out of Range Indicator
    field(FTVA, "LONG")

    # Interpolation Input and Output
    # D = 4, E = 5, ... J = 10,  ... U = 21
    # Encoded as 100*First + Last
    field(INPB, "1010")      # use J
    field(FTB, "LONG")

    # 1st input coordinate set
    field(INPD, "INP1_COORDINATE_SET")
    field(NOD, "5")
    field(FTD, "DOUBLE")

    # 2nd input coordinate set
    field(INPF, "INP2_COORDINATE_SET")
    field(NOF, "5")
    field(FTF, "DOUBLE")


    # 1st Input/2nd Input
    field(INPE, "INP1 CPP")
    field(FTE, "DOUBLE")
    field(INPG, "INP2 CPP")
    field(FTG,  "DOUBLE")

    #
    field(INPJ, "TABLE")
    field(NOJ, "12")
    field(FTJ, "DOUBLE")
    field(OUTJ, "OUT PP")
    field(FTVJ, "DOUBLE")

}
```

Example for 2 Dimensional Look up Table (2)

INP2_COORDINATE_SET

INP1_COORDINATE_SET	-1	0	1
-1	1 P5	2 P1	3 P2
0	4	5 P3	6 P4
1	7 P6	8	9

```
caput –a INP1_COORDINATE_SET    5      1   3   -1   0   1
caput –a INP2_COORDINATE_SET    5      1   3   -1   0   1
caput  -a TABLE     12      2  3  3   1  2  3  4  5  6  7  8  9
```

Array elements for CAPUT

2 dimensions

3x3 table

Table elements

Test Results

P1: caput INP1 -0.5; caput INP2 -0.5	OUT	2014-04-28 15:45:40.300974 3
P2: caput INP1 -0.5; caput INP2 0.5	OUT	2014-04-28 15:47:28.157312 4
P3: caput INP1 0.5; caput INP2 -0.5	OUT	2014-04-28 15:49:00.847334 6
P4: caput INP1 0.5; caput INP2 0.5	OUT	2014-04-28 15:49:50.665776 7
P5: caput INP1 -0.5; caput INP2 -0.75	OUT	2014-04-28 15:51:44.306297 2.75
P6: caput INP1 0.95; caput INP2 -0.75	OUT	2014-04-28 15:53:48.255643 7.1