

Particle and Ray Tracing Codes (PARMILA & TURTLE Introduction)

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Presentation Outline

Particle & Ray Tracing Codes

1. Beam Dynamics Codes Used in LINAC Design
2. Introduction to TURTLE
3. Introduction to PARMILA - For Simulation of Transfer Lines
⇒ Other Applications of PARMILA Later in Course
4. Space Charge Modeling in PARMILA
5. Using PARMILA & TURTLE to Study Some Beamlines ⇐
⇒ You will use the Simulation Lab computers in the classroom

5. Using PARMILA & TURTLE to Study Some Beamlines

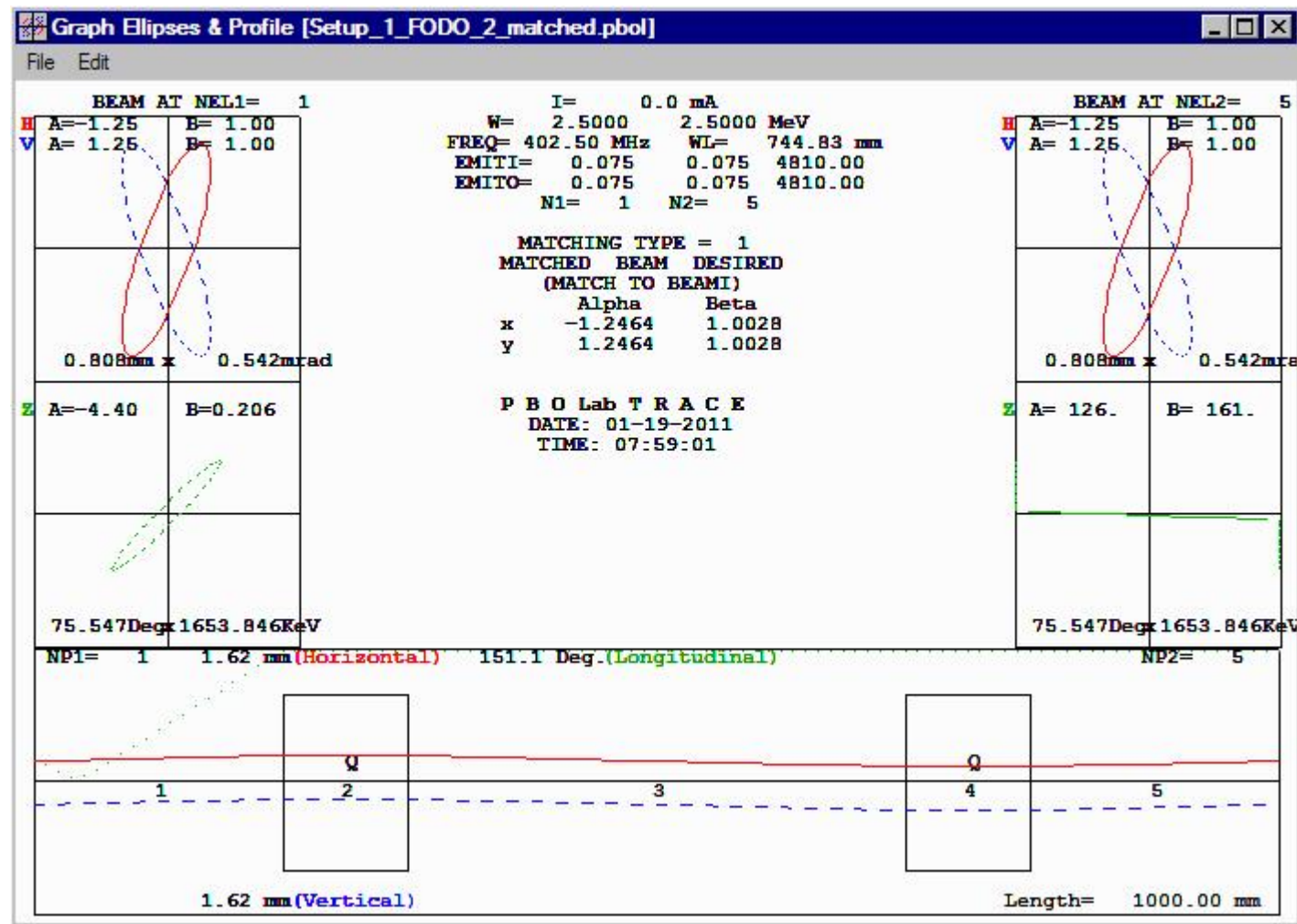
⇒ **Use the Simulation Lab computers in the classroom**

- Compare PARMILA & TRACE 3-D at Low (~ 0) Current
- Explore the use of Lingraf to display data
- Compare PARMILA & TURTLE at Low (~ 0) Current
- Use PARMILA to Study High Current Transport
- Compare SCHEFF & PICNIC Space Charge Calculations
- Compare PARMILA & TRACE 3-D at High Current

5. Using PARMILA & TURTLE to Study Some Beamlines

1. Open the Model "Setup_1_FODO_2_Matched"
(or the Model "Setup_2_FODO_2_Fitted")

Use TRACE 3-D Command "Graph Beam Line"

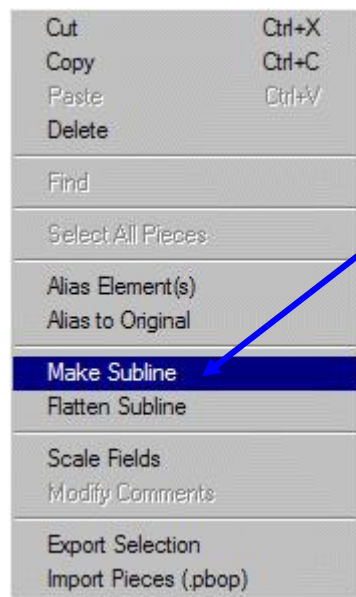
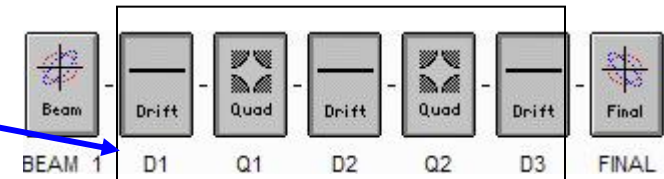


5. Using PARMILA & TURTLE to Study Some Beamlines (con't)

2. Create a Cell Subline

Select (Highlight) Pieces **D1 through D3**:

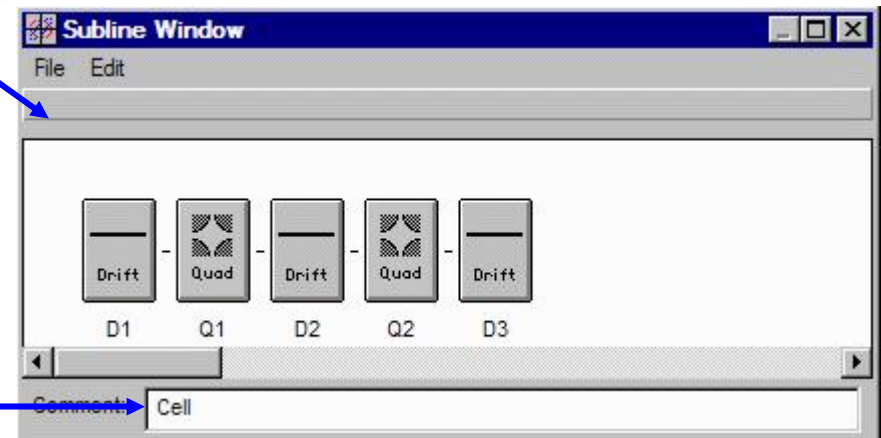
Use **View Menu** to "Make Subline"



Use **View Menu** to "Make Subline":



Open (Double Click) Subline

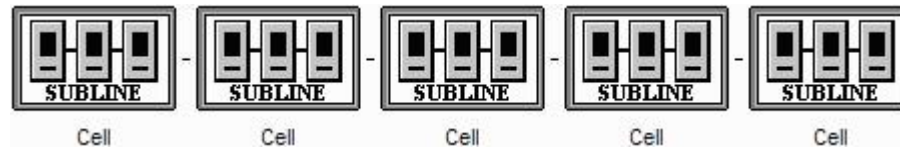


Type "**Cell**" into the Comment

5. Using PARMILA & TURTLE to Study Some Beamlines (con't)

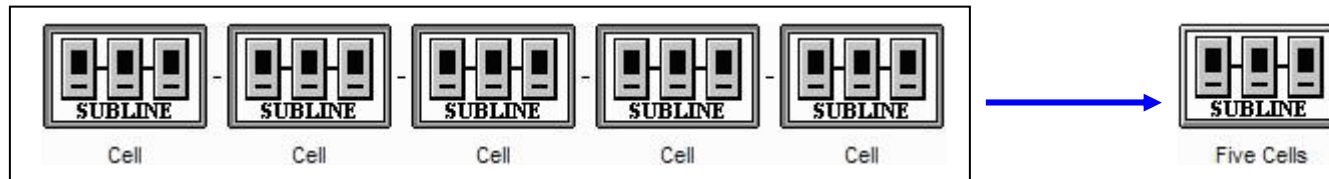
Save the Model as "**Setup_1_FODO_2_Matched_Cell**"

3. Build a 5 Cell Lattice - Add 4 Copies of "Cell" to the Beamline



Save the Model as "**Setup_1_FODO_2_Matched_Five_Cell**"

4. Build a 25 Cell Lattice - Create a "Five Cell" Subline



Your 25 Cell Model Should Look Something Like This:



Save the Model as "**Setup_1_FODO_2_Matched_25_Cell**"

5. Using PARMILA & TURTLE to Study Some Beamlines (con't)

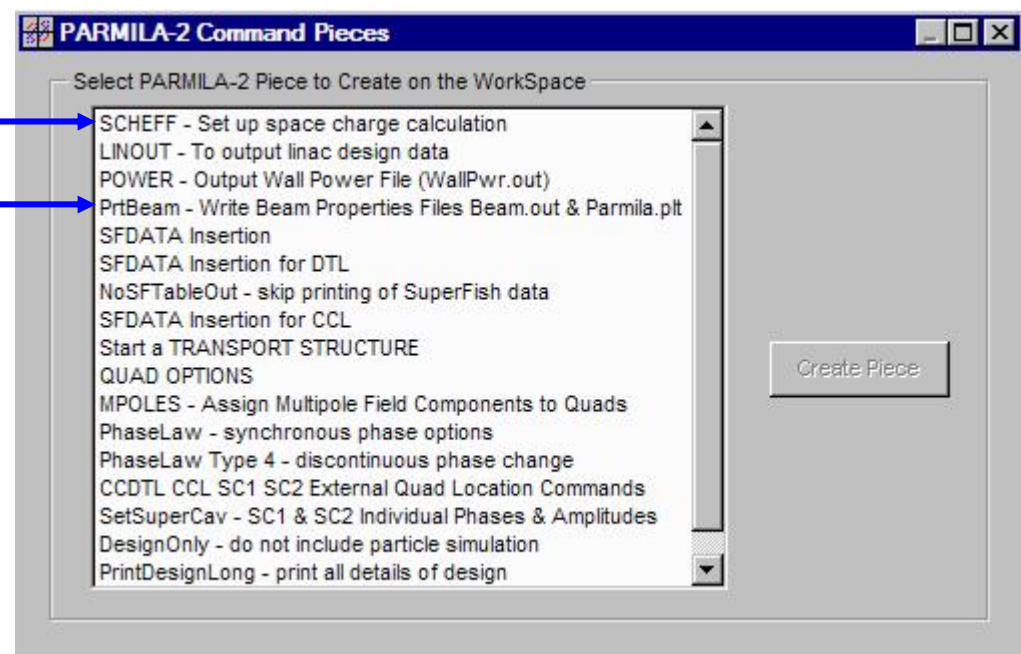
Use TRACE 3-D Command "**Graph Beam Line**"

Is the Beam Still Well-Matched Through 25 Cells?

5. Add 2 PARMILA Commands

SCHEFF

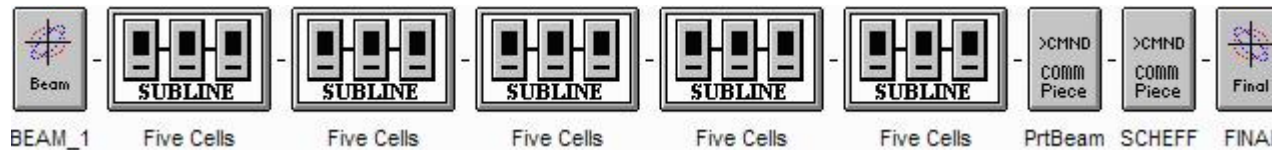
PrtBeam



Place the PrtBeam and SCHEFF elements at end of beamline
- PrtBeam **First**, SCHEFF **Following** - (default parameters)

5. Using PARMILA & TURTLE to Study Some Beamlines (con't)

Model Should Look Something Like This:



Set the PARMILA-2
Option "OutputFlag"
to "1":

Set **Accept**

The screenshot shows the 'PARMILA-2 Options' dialog box with the 'Numeric Constants' tab selected. A table lists various numeric constants. The 'OutputFlag' option is highlighted, and its value is set to 1. Below the table, the 'Output Particle Distribution after Each Element' is also set to 1. The 'Accept' button is visible at the bottom.

Name	Type	Default Value	Default Units	Lower Limit	Upper Limit
OutputFlag	Int	0	none	0	1
Read_Dist_from_File	Int	0	none	0	1
Add_Phase_to_Dist	Real	0.000000	Degrees	-180.000000	0.000000
Initial_Beam_Seed_S	Real	0.000000	none	0.000000	1.000000
Use_Picnic2D_Everywhere	Int	0	none	0	1
Output_Beam_Type_Override	Int	0	none	0	158
Fit_Input_Beam_Type	Int	0	none	0	1

Output Particle Distribution after Each Element: Int **1** none

Accept

Reset Defaults

Save the Model as:

"Setup_1_FODO_2_Matched_25_Cell_Parmila"

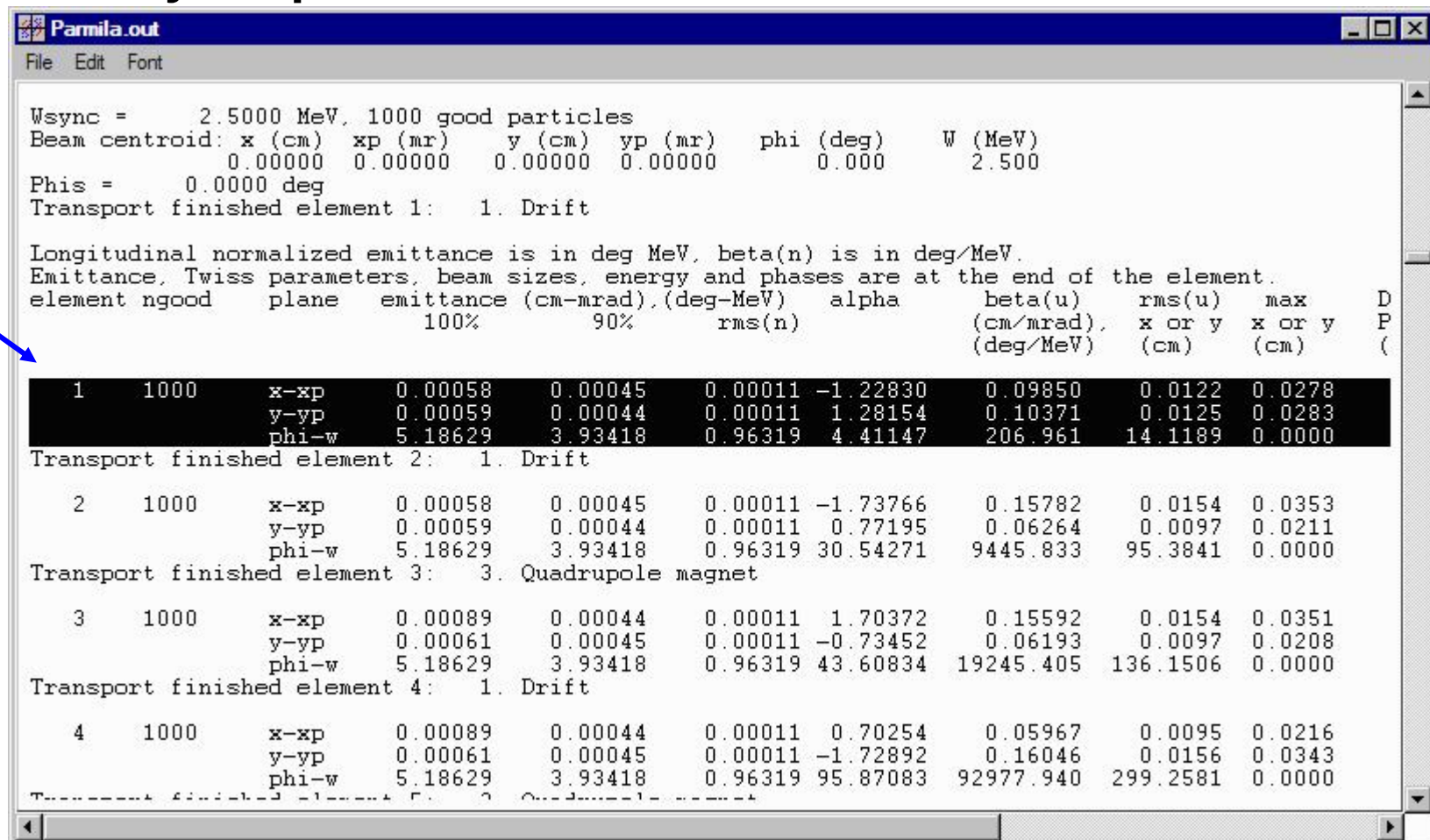
5. Using PARMILA & TURTLE to Study Some Beamlines (con't)

6. Use PARMILA-2 Command "Write and Run input.LIN"

The Main PARMILA-2 Output File **Parmila.out** Should Appear

Scroll Down & Browse Through the **Parmila.out** File

Eventually Stop When You Can See **PARMILA's** "element" No 1



```

Wsync =      2.5000 MeV, 1000 good particles
Beam centroid: x (cm)  xp (mr)    y (cm)  yp (mr)    phi (deg)    W (MeV)
                0.00000  0.00000    0.00000  0.00000    0.000      2.500
Phis =      0.0000 deg
Transport finished element 1:  1. Drift

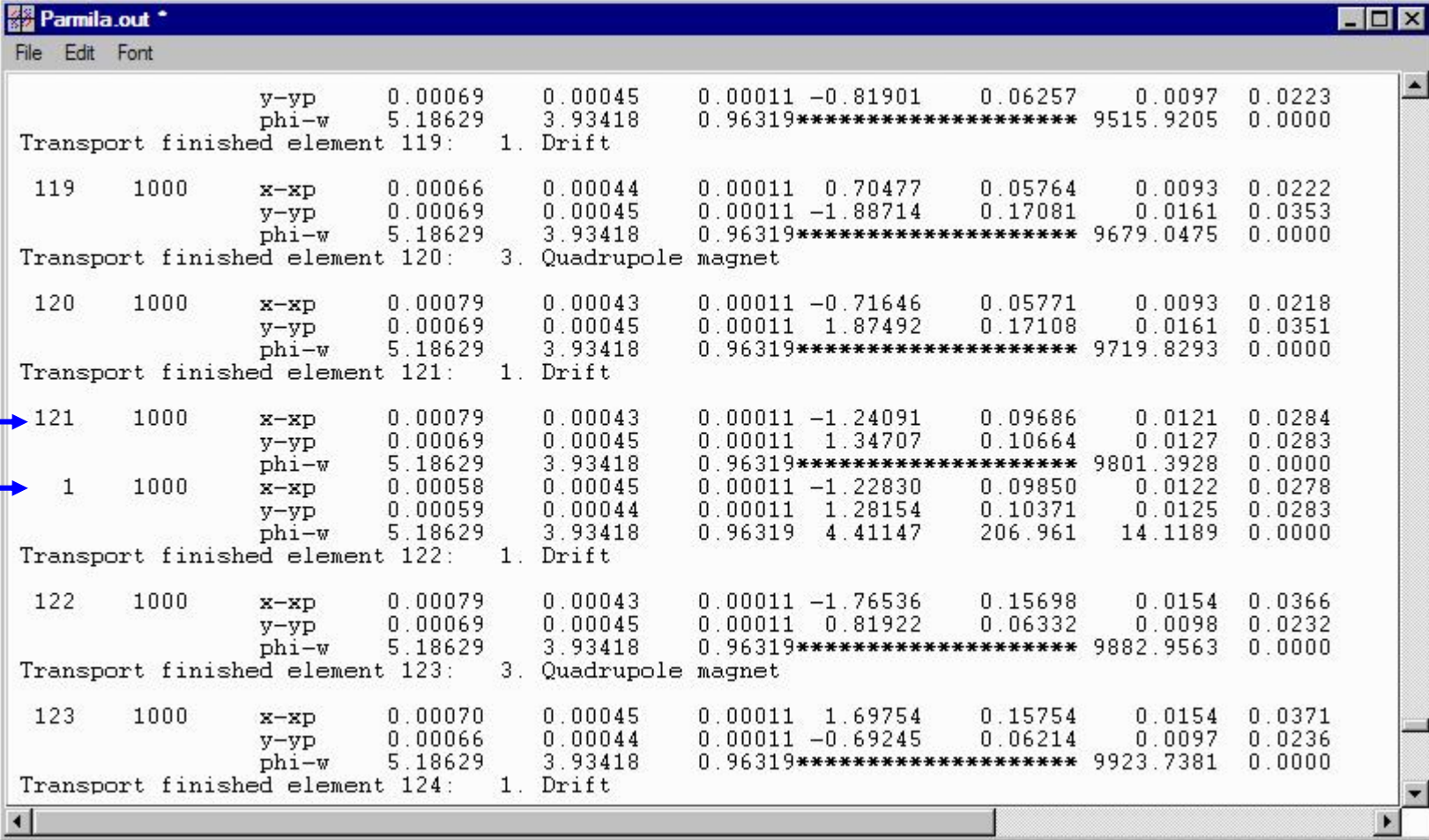
Longitudinal normalized emittance is in deg MeV, beta(n) is in deg/MeV.
Emittance, Twiss parameters, beam sizes, energy and phases are at the end of the element.
element ngood    plane    emittance (cm-mrad), (deg-MeV)    alpha    beta(u)    rms(u)    max    D
                100%      90%      rms(n)    (cm/mrad),    x or y    x or y    P
                (deg/MeV)    (cm)      (cm)
1      1000      x-xp      0.00058    0.00045    0.00011  -1.22830    0.09850    0.0122  0.0278
                y-yp      0.00059    0.00044    0.00011    1.28154    0.10371    0.0125  0.0283
                phi-w      5.18629    3.93418    0.96319    4.41147    206.961    14.1189  0.0000
Transport finished element 2:  1. Drift
2      1000      x-xp      0.00058    0.00045    0.00011  -1.73766    0.15782    0.0154  0.0353
                y-yp      0.00059    0.00044    0.00011    0.77195    0.06264    0.0097  0.0211
                phi-w      5.18629    3.93418    0.96319   30.54271   9445.833    95.3841  0.0000
Transport finished element 3:  3. Quadrupole magnet
3      1000      x-xp      0.00089    0.00044    0.00011    1.70372    0.15592    0.0154  0.0351
                y-yp      0.00061    0.00045    0.00011   -0.73452    0.06193    0.0097  0.0208
                phi-w      5.18629    3.93418    0.96319   43.60834   19245.405   136.1506  0.0000
Transport finished element 4:  1. Drift
4      1000      x-xp      0.00089    0.00044    0.00011    0.70254    0.05967    0.0095  0.0216
                y-yp      0.00061    0.00045    0.00011   -1.72892    0.16046    0.0156  0.0343
                phi-w      5.18629    3.93418    0.96319   95.87083   92977.940   299.2581  0.0000
Transport finished element 5:  3. Quadrupole magnet
  
```

5. Using PARMILA & TURTLE to Study Some Beamlines (con't)

Copy the 3 Data Lines for element **1**

Scroll Down to See **PARMILA's** element **121**

Paste the 3 Data Lines for element **1** just below element **121**



```

File Edit Font

y-yp 0.00069 0.00045 0.00011 -0.81901 0.06257 0.0097 0.0223
phi-w 5.18629 3.93418 0.96319***** 9515.9205 0.0000
Transport finished element 119: 1. Drift

119 1000 x-xp 0.00066 0.00044 0.00011 0.70477 0.05764 0.0093 0.0222
y-yp 0.00069 0.00045 0.00011 -1.88714 0.17081 0.0161 0.0353
phi-w 5.18629 3.93418 0.96319***** 9679.0475 0.0000
Transport finished element 120: 3. Quadrupole magnet

120 1000 x-xp 0.00079 0.00043 0.00011 -0.71646 0.05771 0.0093 0.0218
y-yp 0.00069 0.00045 0.00011 1.87492 0.17108 0.0161 0.0351
phi-w 5.18629 3.93418 0.96319***** 9719.8293 0.0000
Transport finished element 121: 1. Drift
121 1000 x-xp 0.00079 0.00043 0.00011 -1.24091 0.09686 0.0121 0.0284
y-yp 0.00069 0.00045 0.00011 1.34707 0.10664 0.0127 0.0283
phi-w 5.18629 3.93418 0.96319***** 9801.3928 0.0000
1 1000 x-xp 0.00058 0.00045 0.00011 -1.22830 0.09850 0.0122 0.0278
y-yp 0.00059 0.00044 0.00011 1.28154 0.10371 0.0125 0.0283
phi-w 5.18629 3.93418 0.96319 4.41147 206.961 14.1189 0.0000
Transport finished element 122: 1. Drift

122 1000 x-xp 0.00079 0.00043 0.00011 -1.76536 0.15698 0.0154 0.0366
y-yp 0.00069 0.00045 0.00011 0.81922 0.06332 0.0098 0.0232
phi-w 5.18629 3.93418 0.96319***** 9882.9563 0.0000
Transport finished element 123: 3. Quadrupole magnet

123 1000 x-xp 0.00070 0.00045 0.00011 1.69754 0.15754 0.0154 0.0371
y-yp 0.00066 0.00044 0.00011 -0.69245 0.06214 0.0097 0.0236
phi-w 5.18629 3.93418 0.96319***** 9923.7381 0.0000
Transport finished element 124: 1. Drift

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