CCDPIV for Linux RH7.0

1. Usage

ccdpiv <−o> <−i> <−MinRho min> <−MaxVelRat mvr> <−GHcheck C3> <−MVOcheck C4> <−DMVOcheck C1 C2> <−s> <−gspac dx dy> <−all start inc stride> <−tec "name".plt> −dft dftx<xdfty> B16−IMAGE−FILENAME

< *> = specifies options

ccdpiv will analyse one or a sequence of digital single−exposed image pairs using cross−correlation analysis with optional second pass analysis which uses 2nd image sub−window offset for improved measurement uncertainty. The executable runs under Linux RH7.0 OS. It may also run on other flavours of Linux, although this has not been tested.

INPUT:

−dft dftx<xdfty> : specify DFT size, if only dftx specified => dfty = dftx
B16−IMAGE−FILENAME : File containing digital image pairs

OPTIONS:

−o : optimise FFT
−i : iterate => 2 Pass CCDPIV analysis with image offset
−MinRho : specify minimum Max(CC) = min
−MaxVelRat : specify max ratio = mvr = velocity/(hypot(dftx,dfty)
−GHcheck : Global Histogram Validation
C3 = number of standard deviations − MUST BE SPECIFIED!
−MVOcheck : Meadian Value Operator Data Validation
C4 is a user supplied threshold value − MUST BE SPECIFIED!
−DMVOcheck: Dynamic Mean Value Operator Data Validation
C1, C2 are user supplied constants − MUST BE SPECIFIED!
−s : smooth data using 3x3, except at boundary
−gspac : specify grid spacing: dx − horizontal (default = dftx)
dy − vertical (default = dfty)
−all : analyse multiple image pairs − USER MUST SPECIFY:
start = id of first image in first image pair
inc = increment between 1st & 2nd image in image pair
stride = stride in 1st image between image pairs
−tec : write out data in TecPlot file
for single image pair "name".plt is output file name
for multi image pair analysis "name".xxxx.plt is output file names

Note that the following default values apply:

MinRho = 0.0
MaxVelRat = 0.5
C1 = 1.0
C2 = 1.0
C3 = 3.0
C4 = 1.0
dx = dftx
dy = dfty

ccdpiv will analyse 1 image pair or an entire sequence of image pairs stored in the file "B16−IMAGE−FILENAME". The options are self−explanatory. The output will be by default one ASCII file per image pair with the following structure:

```
##############################################################################
#  TITLE = CCDPIV−Velocity File: dpiv−filename"
#
#  Data Structure:
#       Column 1: 0 data has been rejected; 1 data has been accepted.
#       Column 2: x−position of data point
#       Column 3: y−position of data point
#       Column 4: x−velocity component of data point
#       Column 5: y−velocity component of data point
#       Column 6: CC function value corresponding to data point
#
##############################################################################
1       1.500000e+01    1.500000e+01    3.650532e+00    −4.343503e+00   0.716
1       3.100000e+01    1.500000e+01    4.227856e+00    −4.207712e+00   0.830
1       4.700000e+01    1.500000e+01    4.272276e+00    −3.983122e+00   0.777
1       6.300000e+01    1.500000e+01    4.923340e+00    −3.878592e+00   0.819
etc .....
```

Note that data rejection if data validation is requested is indicated only by column 1. The CCDPIV determined velocity is still available although data validation in ccdpiv may have rejected it.

In addition to the default DPIV ASCII file, a tecplot output file can be specified with the option "<−tec filename>". Note in the tecplot file rejected data points have a velocity value of 0, unless the <−s> , 3 x 3 moving average option is specified.

2. Image Data File Structure

The BINARY input image data file to ccdpiv is of the following structure:

(unsigned short)nx (unsigned short)ny **[**image 1 in row major, nx x ny pixels each pixel intensity represented by (unsigned short)**]** **[**image 2 in row major, nx x ny pixels each pixel intensity represented by (unsigned short)**]** **[**image 3 in row major, nx x ny pixels each pixel intensity represented by (unsigned short)**]** .... **[**image N in row major, nx x ny pixels each pixel intensity represented by (unsigned short)**]**

nx and ny specify the width and height of each image in pixels.

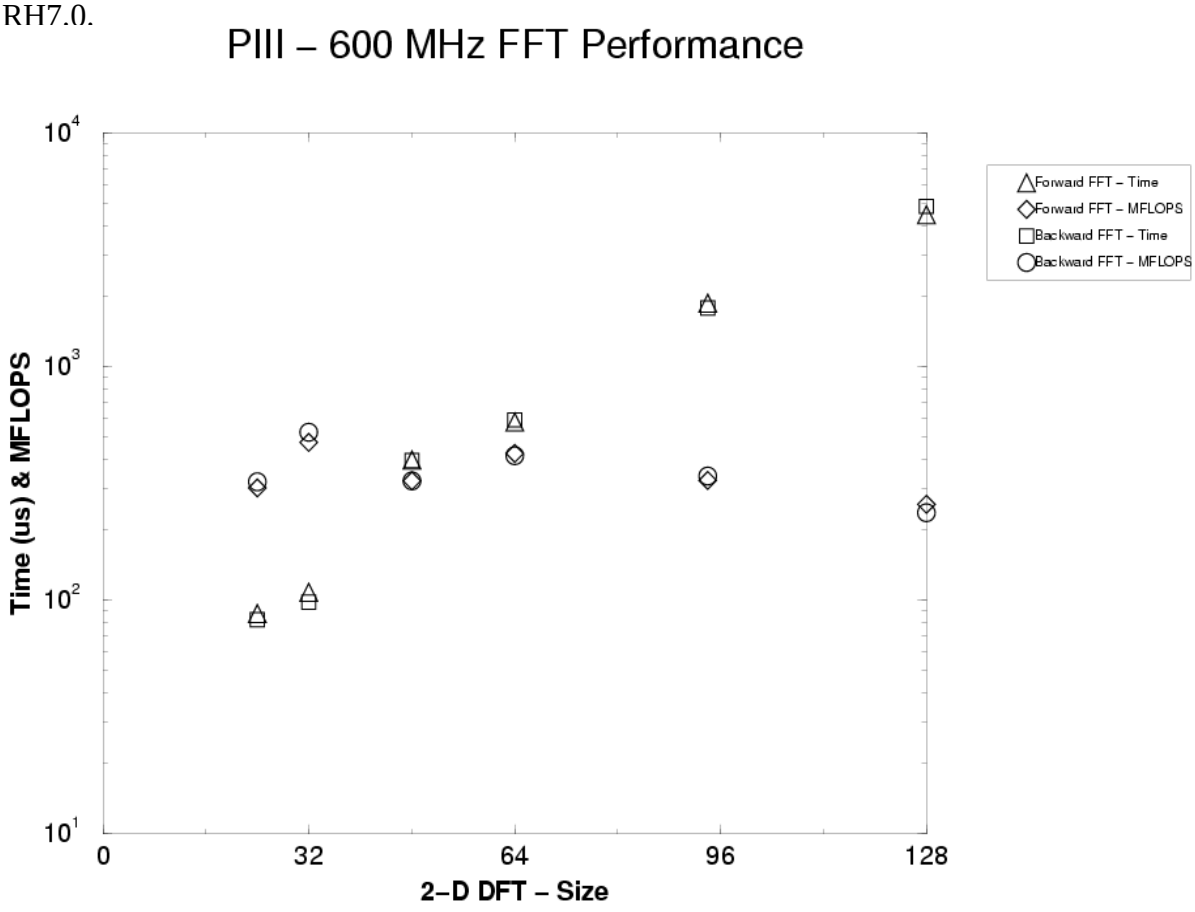
3. CCDPIV

The algorithm and performance of ccdpiv, i.e. precision, uncertainty, etc are described in the following papers:

1. J. Soria (1994) Digital cross−correlation particle image velocimetry measurements in the near wake of a circular cylinder. Int. Colloquium on Jets, Wakes and Shear Layers, 25.1 − 25.8. Melbourne, Australia.

2. J. Soria (1996) An investigation of the near wake of a circular cylinder using a video−based digital cross−correlation particle image velocimetry technique. *Experimental Thermal and Fluid Science*, **12**, 221 − 233.
3. J. Soria (1996) An adaptive cross−correlation digital PIV technique for unsteady flow investigations. 1st Australian Conference on Laser Diagnostics in Fluid Mechanics and Combustion, 29 − 48. Dec., Sydney, Australia.
4. J. Soria (1998) Multigrid approach to cross−correlation digital PIV and HPIV analysis. 13th Australasian Fluid Mechanics Conference. Monash University, Melbourne, 13 − 18 December.
5. J. Soria, J. Cater & J. Kostas (1999) High resolution multigrid cross−correlation digital PIV measurements of a turbulent starting jet using half frame image shift recording. *Optics and Laser Technology*, **31**, 3 − 12.
6. K. von Ellenrieder, J. Kostas & J. Soria (2001) Measurements of a wall−bounded, turbulent, separated flow using HPIV. Journal of Turbulence (In Press).

ccdpiv uses the FFTW library (www.fftw.org) to compute the 2−D DFT. The graph below provides some guide of the speed of typical 2−D DFT sizes on a PIII 600 MHz PC running RH7.0.

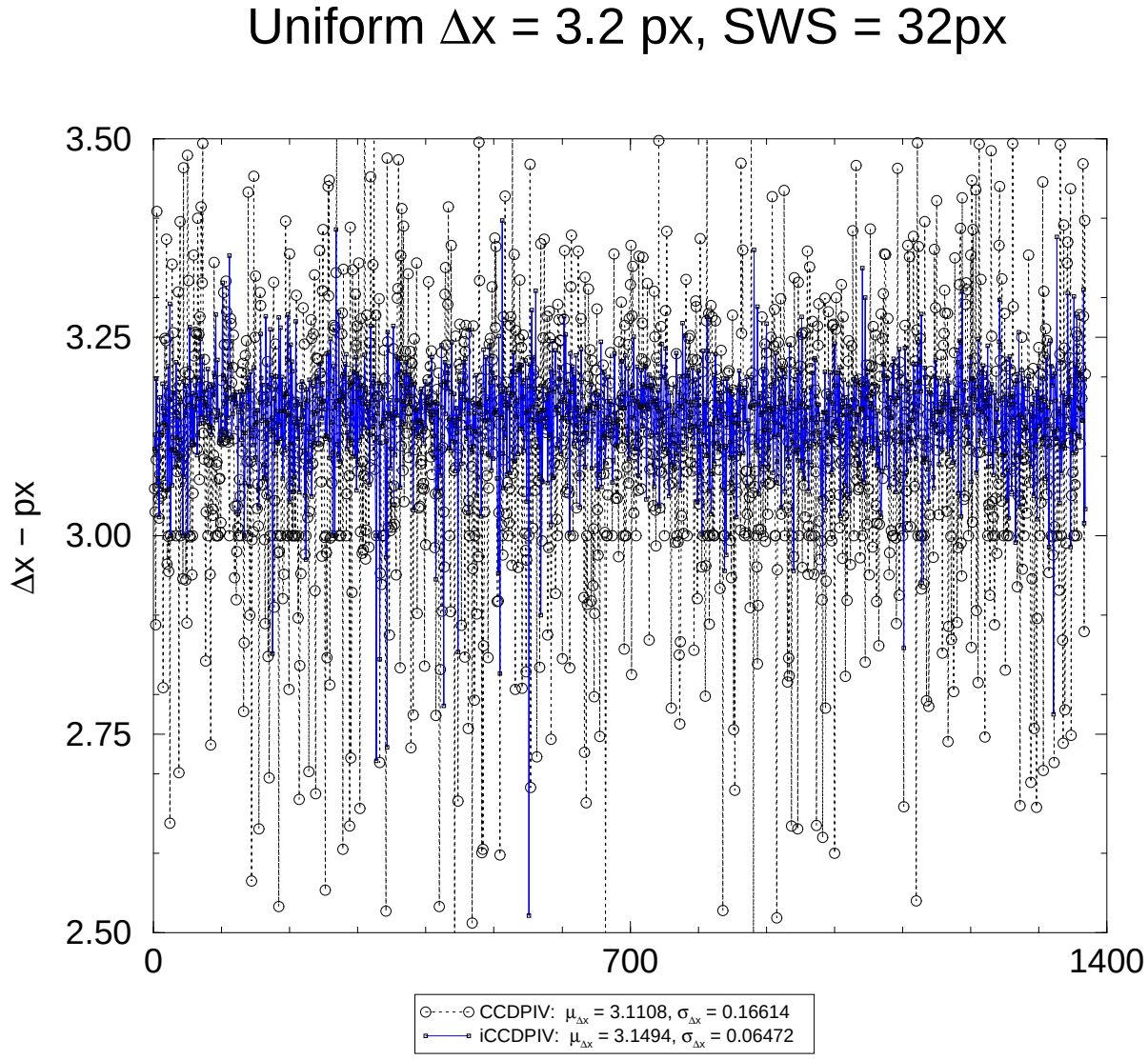


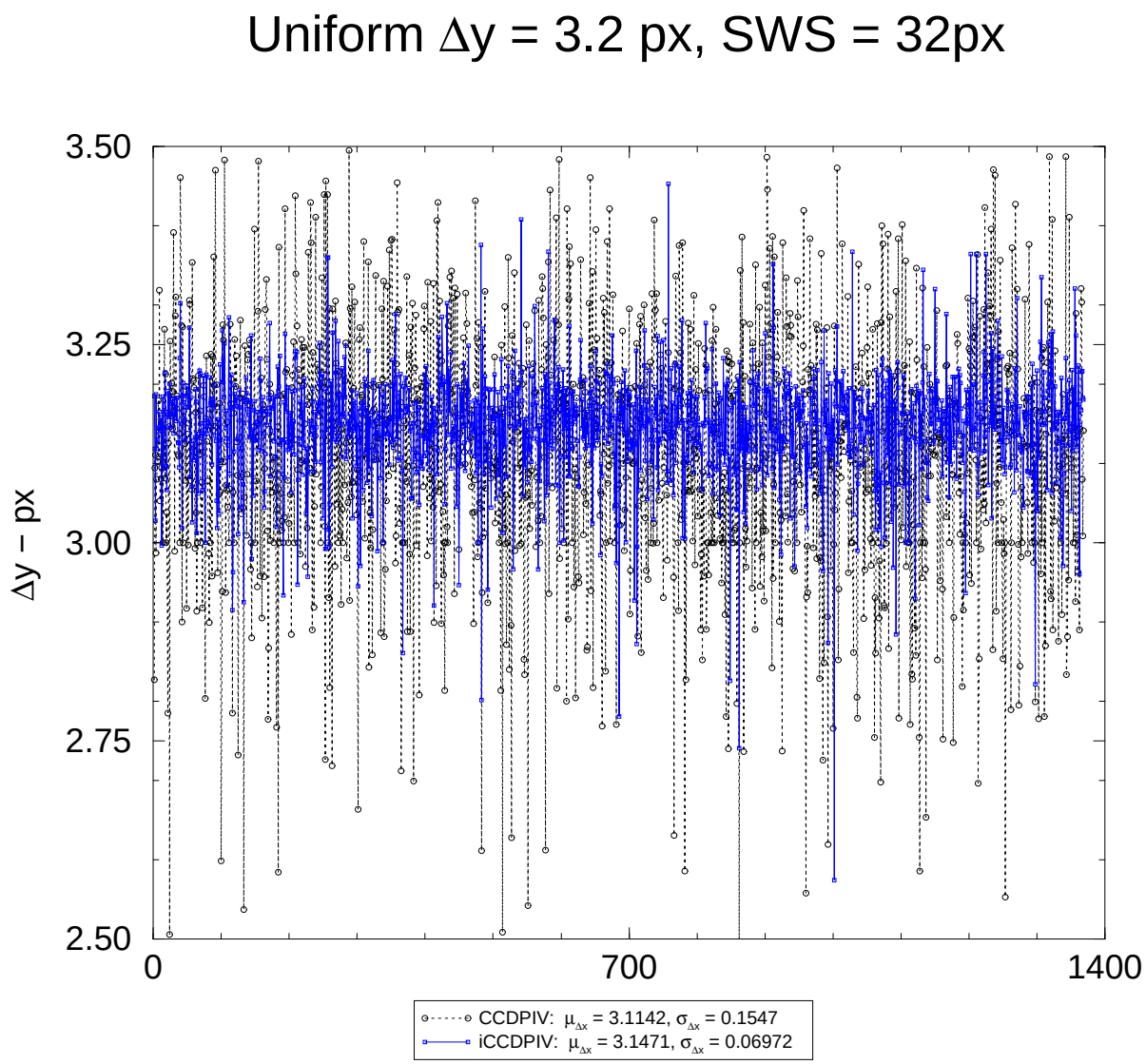
Typical timing of (complete) DPIV analyses (no data validation checks):

DFT Size	*Number of Vectors*	*User Time (s)*	*System Time (s)*	*Elapsed (wall clock) time (m:ss)*	*Percent of CPU*	*Time/CCDPIV Measurement (μs)*
24	5476	13.5	0.28	00:13.96	98.7	51.13
32	5476	14.05	0.27	00:14.50	98.7	49.31
48	5329	20.24	1.62	00:22.09	98.9	304
64	5184	27.27	3.16	00:30.80	98.7	609.57
80	5041	40.26	6.83	00:47.87	98.3	1354.89
96	4900	52.78	11.39	01:10.67	90.8	2324.49
128*	4624	87.130	22.880	2:55.04	62.8	4948.1

*Performance degraded due to HD/memory swapping.

The figures below indicate the benefits of using the −i option in reducing the uncertainty in the CCDPIV measurements.





4. Auxiliary Image Pre−Processing Programs

4.1 8dat−2−B16dat

Use: 8dat−2−B16dat <InputFile> <OutputFile>

converts image data file with pixel intensity stored as 8 bit (unsigned char) to image data file with pixel intensity stored as 16 bit (unsigned short) required by **ccdpiv**.

4.2 DoubleShutterB16−2−B16dat

Use: DoubleShutterB16−2−B16dat <InputFile(/SeriesName)> <OutputFile> (Start Index)

converts one or a series of sequentially numbered PCO digital camera 16 bit output files into one file of the format required by **ccdpiv**.

4.3 TIFF−2−B16dat

Use: TIF−2−B16dat TIFF−1 <TIFF−2 ... TIFF−N> OutputFile

converts one or a number of tiff image files and stored them sequentially into one file of the format required by **ccdpiv**. Note that if the tiff files are appropriately numbered use can use the wildcard *, e.g.

TIF−2−B16dat tiffimage* out.B16dat