NRC · CNRC

Expanded Very Large Array

EVLA Correlator
New Connectivity Scheme
Software Impact

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Outline

- How much additional work is required due to change in the correlator architecture ?
- Examples of the Baseline Board configuration (to illustrate the task of the Configuration Mapper software).
- Auto-correlation products.

Software Impact

- Station Board – minimal: upgrade Timing chip MAH (Module Access Handler) and GUI to handle setup of the crossbar switch in the Station Rack.
- Baseline Board – minimal : implement MAH and GUI for the re-timing FPGAs that implement input x-bar switch and phasing.
- CBE – minimal to none.
- CPCC – minimal. Overall, CPCC is simpler.
- MCCC / Configuration Mapper – major impact since connection scheme changed and new cross bar switches have been introduced.

Configuration Mapper

- Based on the subarray configuration which consists of the list of stations and baseband/subband/product specification Configuration Mapper derives configuration of:
  - Station Board filter banks and other Station Board FPGAs,
  - Cross-bar switch in the Station Rack that determines which subband is forwarded to which Baseline Board(s),
  - Cross-bar switch in re-timing FPGAs on the Baseline Board,
  - Recirculation Controllers (another cross-bar switch) and Correlator Chips.

Trading bandwidth for more spectral channels

- The new connection scheme is easier to comprehend:
  - each subband of each baseband is (nominally) assigned 2 Baseline Boards.

    Note: In the old scheme, the same subband of all the basebands were correlated on the same chip.

  - If number of baseband pairs is less than 4 and/or number of subbands is less than 16, other subbands may use the “spare” Baseline Boards to produce more lags (spectral channels).

Products

- For 32 stations 2 Baseline Boards can obtain:
  - All cross correlation products for a single subband of a baseband pair.
  - Only half of auto-correlation products. It is possible to get :
    1. all products for 2 out of 4 stations (see next slide)

    or

    2. one product for each station.
       - In this case the correlator architecture imposes another limitation: it is not possible to obtain auto-correlation products for the same polarization for all the stations; for a group of 4 stations being correlated on the same Correlator Chip, two auto-correlation products are for right and 2 for left polarized baseband.

         For example for the configuration on the next slide it would be possible to get the following products: 1R*1R, 2L*2L, 3R*3R, 4L*4L

1 Subarray, 32 Stations, 4-bit Mode

1 Subarray, 32 stations: 2 Baseline Boards can produce all cross-correlation products and auto-correlation products for 16 stations.

1st Baseline Board

	2 3 4 1	6 7 8 5	10 11 12 9	14 15 16 13	18 19 20 17	22 23 24 21	26 27 28 25	30 31 32 29
1	1 * 1	1 * 5	1 * 9	1 * 13	1 * 17	1 * 21	1 * 25	1 * 29
2	1 * 2	1 * 6	1 * 10	1 * 14	1 * 18	1 * 22	1 * 26	1 * 30
3	1 * 3	1 * 7	1 * 11	1 * 15	1 * 19	1 * 23	1 * 27	1 * 31
4	1 * 4	1 * 8	1 * 12	1 * 16	1 * 20	1 * 24	1 * 28	1 * 32
5	2 * 5	5 * 5	5 * 9	5 * 13	5 * 17	5 * 21	5 * 25	5 * 29
6	2 * 6	5 * 6	5 * 10	5 * 14	5 * 18	5 * 22	5 * 26	5 * 30
7	2 * 7	5 * 7	5 * 11	5 * 15	5 * 19	5 * 23	5 * 27	5 * 31
8	2 * 8	5 * 8	5 * 12	5 * 16	5 * 20	5 * 24	5 * 28	5 * 32
9	2 * 9	6 * 9	9 * 9	9 * 13	9 * 17	9 * 21	9 * 25	9 * 29
10	2 * 10	6 * 10	9 * 10	9 * 14	9 * 18	9 * 22	9 * 26	9 * 30
11	2 * 11	6 * 11	9 * 11	9 * 15	9 * 19	9 * 23	9 * 27	9 * 31
12	2 * 12	6 * 12	9 * 12	9 * 16	9 * 20	9 * 24	9 * 28	9 * 32
13	2 * 13	6 * 13	10 * 13	13 * 13	13 * 17	13 * 21	13 * 25	13 * 29
14	2 * 14	6 * 14	10 * 14	13 * 14	13 * 18	13 * 22	13 * 26	13 * 30
15	2 * 15	6 * 15	10 * 15	13 * 15	13 * 19	13 * 23	13 * 27	13 * 31
16	2 * 16	6 * 16	10 * 16	13 * 16	13 * 20	13 * 24	13 * 28	13 * 32
17	2 * 17	6 * 17	10 * 17	14 * 17	17 * 17	17 * 21	17 * 25	17 * 29
18	2 * 18	6 * 18	10 * 18	14 * 18	17 * 18	17 * 22	17 * 26	17 * 30
19	2 * 19	6 * 19	10 * 19	14 * 19	17 * 19	17 * 23	17 * 27	17 * 31
20	2 * 20	6 * 20	10 * 20	14 * 20	17 * 20	17 * 24	17 * 28	17 * 32
21	2 * 21	6 * 21	10 * 21	14 * 21	18 * 21	21 * 21	21 * 25	21 * 29
22	2 * 22	6 * 22	10 * 22	14 * 22	18 * 22	21 * 22	21 * 26	21 * 30
23	2 * 23	6 * 23	10 * 23	14 * 23	18 * 23	21 * 23	21 * 27	21 * 31
24	2 * 24	6 * 24	10 * 24	14 * 24	18 * 24	21 * 24	21 * 28	21 * 32
25	2 * 25	6 * 25	10 * 25	14 * 25	18 * 25	22 * 25	25 * 25	25 * 29
26	2 * 26	6 * 26	10 * 26	14 * 26	18 * 26	22 * 26	25 * 26	25 * 30
27	2 * 27	6 * 27	10 * 27	14 * 27	18 * 27	22 * 27	25 * 27	25 * 31
28	2 * 28	6 * 28	10 * 28	14 * 28	18 * 28	22 * 28	25 * 28	25 * 32
29	2 * 29	6 * 29	10 * 29	14 * 29	18 * 29	22 * 29	26 * 29	29 * 29
30	2 * 30	6 * 30	10 * 30	14 * 30	18 * 30	22 * 30	26 * 30	29 * 30
31	2 * 31	6 * 31	10 * 31	14 * 31	18 * 31	22 * 31	26 * 31	29 * 31
32	2 * 32	6 * 32	10 * 32	14 * 32	18 * 32	22 * 32	26 * 32	29 * 32

2nd Baseline Board

	4 1 2 3	8 5 6 7	12 9 10 11	16 13 14 15	20 17 18 19	24 21 22 23	28 25 26 27	32 29 30 31
3	2 * 3	3 * 5	3 * 9	3 * 13	3 * 17	3 * 21	3 * 25	3 * 29
4	2 * 4	3 * 6	3 * 10	3 * 14	3 * 18	3 * 22	3 * 26	3 * 30
1	3 * 4	3 * 7	3 * 11	3 * 15	3 * 19	3 * 23	3 * 27	3 * 31
2	4 * 4	3 * 8	3 * 12	3 * 16	3 * 20	3 * 24	3 * 28	3 * 32
7	4 * 5	6 * 7	7 * 9	7 * 13	7 * 17	7 * 21	7 * 25	7 * 29
8	4 * 6	6 * 8	7 * 10	7 * 14	7 * 18	7 * 22	7 * 26	7 * 30
5	4 * 7	7 * 8	7 * 11	7 * 15	7 * 19	7 * 23	7 * 27	7 * 31
6	4 * 8	8 * 8	7 * 12	7 * 16	7 * 20	7 * 24	7 * 28	7 * 32
11	4 * 9	8 * 9	10 * 11	11 * 13	11 * 17	11 * 21	11 * 25	11 * 29
12	4 * 10	8 * 10	10 * 12	11 * 14	11 * 18	11 * 22	11 * 26	11 * 30
9	4 * 11	8 * 11	11 * 12	11 * 15	11 * 19	11 * 23	11 * 27	11 * 31
10	4 * 12	8 * 12	12 * 12	11 * 16	11 * 20	11 * 24	11 * 28	11 * 32
15	4 * 13	8 * 13	12 * 13	14 * 15	15 * 17	15 * 21	15 * 25	15 * 29
16	4 * 14	8 * 14	12 * 14	14 * 16	15 * 18	15 * 22	15 * 26	15 * 30
13	4 * 15	8 * 15	12 * 15	15 * 16	15 * 19	15 * 23	15 * 27	15 * 31
14	4 * 15	8 * 16	12 * 16	16 * 16	15 * 20	15 * 24	15 * 28	15 * 32
19	4 * 17	8 * 17	12 * 17	16 * 17	18 * 19	19 * 21	19 * 25	19 * 29
20	4 * 18	8 * 18	12 * 18	16 * 18	18 * 20	19 * 22	19 * 26	19 * 30
17	4 * 19	8 * 19	12 * 19	16 * 19	19 * 20	19 * 23	19 * 27	19 * 31
18	4 * 20	8 * 20	12 * 20	16 * 20	20 * 20	19 * 24	19 * 28	19 * 32
23	4 * 21	8 * 21	12 * 21	16 * 21	20 * 21	22 * 23	23 * 25	23 * 29
24	4 * 22	8 * 22	12 * 22	16 * 22	20 * 22	22 * 24	23 * 26	23 * 30
21	4 * 23	8 * 23	12 * 23	16 * 23	20 * 23	23 * 24	23 * 27	23 * 31
22	4 * 24	8 * 24	12 * 24	16 * 24	20 * 24	24 * 24	23 * 28	23 * 32
27	4 * 25	8 * 25	12 * 25	16 * 25	20 * 25	24 * 25	26 * 27	27 * 29
28	4 * 26	8 * 26	12 * 26	16 * 26	20 * 26	24 * 26	26 * 28	27 * 30
25	4 * 27	8 * 27	12 * 27	16 * 27	20 * 27	24 * 27	27 * 28	27 * 31
26	4 * 28	8 * 28	12 * 28	16 * 28	20 * 28	24 * 28	28 * 28	27 * 32
31	4 * 29	8 * 29	12 * 29	16 * 29	20 * 29	24 * 29	28 * 29	30 * 31
32	4 * 30	8 * 30	12 * 30	16 * 30	20 * 30	24 * 30	28 * 30	30 * 32
29	4 * 31	8 * 31	12 * 31	16 * 31	20 * 31	24 * 31	28 * 31	31 * 32
30	4 * 32	8 * 32	12 * 32	16 * 32	20 * 32	24 * 32	28 * 32	32 * 32

Correlator Chip: X and Y inputs are from the same group of 4 stations

Correlator Chip: input from stations 1,2,3,4 and 5,6,7,8

1 Subarray, 16 Stations, 7-bit Mode

1 Subarray, 16 stations, 7-bit correlation: All cross-correlation products and auto-correlation for each 7-bit input.

1st Baseline Board

	1 2	3 4	5 6	7 8	9 10	11 12	13 14	15 16
1	1L * 1L 1L * 2R 1L * 2L 1R * 1R	1R * 3R 1R * 3L 1R * 4R 1R * 4L	1R * 5R 1R * 5L 1R * 6R 1R * 6L	1R * 7R 1R * 7L 1R * 8R 1R * 8L	1R * 9R 1R * 9L 1R * 10R 1R * 10L	1R * 11R 1R * 11L 1R * 12R 1R * 12L	1R * 13R 1R * 13L 1R * 14R 1R * 14L	1R * 15R 1R * 15L 1R * 16R 1R * 16L
2								
3	1L * 3R 1L * 3L 1L * 4R 1L * 4L	3L * 3L 3L * 4R 3L * 4L 3R * 3R	3R * 5R 3R * 5L 3R * 6R 3R * 6L	3R * 7R 3R * 7L 3R * 8R 3R * 8L	3R * 9R 3R * 9L 3R * 10R 3R * 10L	3R * 11R 3R * 11L 3R * 12R 3R * 12L	3R * 13R 3R * 13L 3R * 14R 3R * 14L	3R * 15R 3R * 15L 3R * 16R 3R * 16L
4								
5	1L * 5R 1L * 5L 1L * 6R 1L * 6L	3L * 5R 3L * 5L 3L * 6R 3L * 6L	5L * 5L 5L * 6R 5L * 6L 5R * 5R	5R * 7R 5R * 7L 5R * 8R 5R * 8L	5R * 9R 5R * 9L 5R * 10R 5R * 10L	5R * 11R 5R * 11L 5R * 12R 5R * 12L	5R * 13R 5R * 13L 5R * 14R 5R * 14L	5R * 15R 5R * 15L 5R * 16R 5R * 16L
6								
7	1L * 7R 1L * 7L 1L * 8R 1L * 8L	3L * 7R 3L * 7L 3L * 8R 3L * 8L	5L * 7R 5L * 7L 5L * 8R 5L * 8L	7L * 7L 7L * 8R 7L * 8L 7R * 7R	7R * 9R 7R * 9L 7R * 10R 7R * 10L	7R * 11R 7R * 11L 7R * 12R 7R * 12L	7R * 13R 7R * 13L 7R * 14R 7R * 14L	7R * 15R 7R * 15L 7R * 16R 7R * 16L
8								
9	1L * 9R 1L * 9L 1L * 10R 1L * 10R	3L * 9R 3L * 9L 3L * 10R 3L * 10R	5L * 9R 5L * 9L 5L * 10R 5L * 10R	7L * 9R 7L * 9L 7L * 10R 7L * 10R	9L * 9L 9L * 10R 9L * 10L 9R * 9R	9R * 11R 9R * 11L 9R * 12R 9R * 12L	9R * 13R 9R * 13L 9R * 14R 9R * 14L	9R * 15R 9R * 15L 9R * 16R 9R * 16L
10								
11	1L * 11R 1L * 11L 1L * 12R 1L * 12L	3L * 11R 3L * 11L 3L * 12R 3L * 12L	5L * 11R 5L * 11L 5L * 12R 5L * 12L	7L * 11R 7L * 11L 7L * 12R 7L * 12L	9L * 11R 9L * 11L 9L * 12R 9L * 12L	11L*11L 11L * 12R 11L * 12L 11R*11R	11R * 13R 11R * 13L 11R * 14R 11R * 14L	11R * 15R 11R * 15L 11R * 16R 11R * 16L
12								
13	1L * 13R 1L * 13L 1L * 14R 1L * 14L	3L * 13R 3L * 13L 3L * 14R 3L * 14L	5L * 13R 5L * 13L 5L * 14R 5L * 14L	7L * 13R 7L * 13L 7L * 14R 7L * 14L	9L * 13R 9L * 13L 9L * 14R 9L * 14L	11L * 13R 11L * 13L 11L * 14R 11L * 14L	13L*13L 13L*14R 13L*14L 13R*13R	13R * 15R 13R * 15L 13R * 16R 13R * 16L
14								
15	1L * 15R 1L * 15L 1L * 16R 1L * 16L	3L * 15R 3L * 15L 3L * 16R 3L * 16L	5L * 15R 5L * 15L 5L * 16R 5L * 16L	7L * 15R 7L * 15L 7L * 16R 7L * 16L	9L * 15R 9L * 15L 9L * 16R 9L * 16L	11L * 15R 11L * 15L 11L * 16R 11L * 16L	13L * 15R 13L * 15L 13L * 16R 13L * 16L	15L*15L 15L * 16R 15L * 16L 15R*15R
16								

2nd Baseline Board

	1 2	3 4	5 6	7 8	9 10	11 12	13 14	15 16
1	2L * 2L 1R * 2R 1R * 2L 2R * 2R	2R * 3R 2R * 3L 2R * 4R 2R * 4L	2R * 5R 2R * 5L 2R * 6R 2R * 6L	2R * 7R 2R * 7L 2R * 8R 2R * 8L	2R * 9R 2R * 9L 2R * 10R 2R * 10L	2R * 11R 2R * 11L 2R * 12R 2R * 12L	2R * 13R 2R * 13L 2R * 14R 2R * 14L	2R * 15R 2R * 15L 2R * 16R 2R * 16L
2								
3	2L * 3R 2L * 3L 2L * 4R 2L * 4L	4L * 4L 3R * 4R 3R * 4L 4R * 4R	4R * 5R 4R * 5L 4R * 6R 4R * 6L	4R * 7R 4R * 7L 4R * 8R 4R * 8L	4R * 9R 4R * 9L 4R * 10R 4R * 10L	4R * 11R 4R * 11L 4R * 12R 4R * 12L	4R * 13R 4R * 13L 4R * 14R 4R * 14L	4R * 15R 4R * 15L 4R * 16R 4R * 16L
4								
5	2L * 5R 2L * 5L 2L * 6R 2L * 6L	4L * 5R 4L * 5L 4L * 6R 4L * 6L	6L * 6L 5R * 6R 5R * 6L 6R * 6R	6R * 7R 6R * 7L 6R * 8R 6R * 8L	6R * 9R 6R * 9L 6R * 10R 6R * 10L	6R * 11R 6R * 11L 6R * 12R 6R * 12L	6R * 13R 6R * 13L 6R * 14R 6R * 14L	6R * 15R 6R * 15L 6R * 16R 6R * 16L
6								
7	2L * 7R 2L * 7L 2L * 8R 2L * 8L	4L * 7R 4L * 7L 4L * 8R 4L * 8L	6L * 7R 6L * 7L 6L * 8R 6L * 8L	8L * 8L 7R * 8R 7R * 8L 8R * 8R	8R * 9R 8R * 9L 8R * 10R 8R * 10L	8R * 11R 8R * 11L 8R * 12R 8R * 12L	8R * 13R 8R * 13L 8R * 14R 8R * 14L	8R * 15R 8R * 15L 8R * 16R 8R * 16L
8								
9	2L * 9R 2L * 9L 2L * 10R 2L * 10L	4L * 9R 4L * 9L 4L * 10R 4L * 10L	6L * 9R 6L * 9L 6L * 10R 6L * 10L	8L * 9R 8L * 9L 8L * 10R 8L * 10L	10L *10L 9R * 10R 9R * 10L 10R*10R	10R*11R 10R*11L 10R*12R 10R*12L	10R*13R 10R*13L 10R*14R 10R*14L	10R*15R 10R*15L 10R*16R 10R*16L
10								
11	2L * 11R 2L * 11L 2L * 12R 2L * 12L	4L * 11R 4L * 11L 4L * 12R 4L * 12L	6L * 11R 6L * 11L 6L * 12R 6L * 12L	8L * 11R 8L * 11L 8L * 12R 8L * 12L	10L*11R 10L*11L 10L*12R 10L*12L	12L*12L 11R * 12R 11R * 12L 12R*12R	12R*13R 12R*13L 12R*14R 12R*14L	12R*15R 12R*15L 12R*16R 12R*16L
12								
13	2L * 13R 2L * 13L 2L * 14R 2L * 14L	4L * 13R 4L * 13L 4L * 14R 4L * 14L	6L * 13R 6L * 13L 6L * 14R 6L * 14L	8L * 13R 8L * 13L 8L * 14R 8L * 14L	10L*13R 10L*13L 10L*14R 10L*14L	12L*13R 12L*13L 12L*14R 12L*14L	14L*14L 13R * 14R 13R * 14L 14R*14R	14R*15R 14R*15L 14R*16R 14R*16L
14								
15	2L * 15R 2L * 15L 2L * 16R 2L * 16L	4L * 15R 4L * 15L 4L * 16R 4L * 16L	6L * 15R 6L * 15L 6L * 16R 6L * 16L	8L * 15R 8L * 15L 8L * 16R 8L * 16L	10L*15R 10L*15L 10L*16R 10L*16L	12L*15R 12L*15L 12L*16R 12L*16L	14L*15R 14L*15L 14L*16R 14L*16L	16L*16L 15R * 16R 15R * 16L 16R*16R
16								

Correlator Chip: X and Y inputs are from the same stations

Correlator Chip: input from stations 1,2,3 and 4

Time-Multiplexing Auto-Correlations

The configuration of the Correlator Chips on the diagonal, could be periodically changed, so that auto-correlations are obtained for all the stations over time.

- Method 1- all products for 2 stations:
  - The change in configuration would affect at least one more product on the same Correlator Chip, since auto-correlation products 1*1 and 2*2 can not be obtained on the same CCQ.
- Method 2 – one product per station:
  - The same CCQ could be periodically re-configured, so that all the auto-correlations products for all the stations, without affecting other CCQs (cross-correlation products).

1 Subarray, 28 Stations, 4-bit Mode

1 Subarray, 28 stations: 2 Baseline Boards can produce all cross-correlation products and auto-correlation products for 22 stations.

1st Baseline Board

	2 3 4 1	6 7 8 5	10 11 12 9	14 15 16 13	18 19 20 17	22 23 24 21	26 27 28 25	2 3 6 7
1	1 * 1	1 * 5	1 * 9	1 * 13	1 * 17	1 * 21	1 * 25	
2	1 * 2	1 * 6	1 * 10	1 * 14	1 * 18	1 * 22	1 * 26	
3	1 * 3	1 * 7	1 * 11	1 * 15	1 * 19	1 * 23	1 * 27	
4	1 * 4	1 * 8	1 * 12	1 * 16	1 * 20	1 * 24	1 * 28	
5	2 * 5	5 * 5	5 * 9	5 * 13	5 * 17	5 * 21	5 * 25	
6	2 * 6	5 * 6	5 * 10	5 * 14	5 * 18	5 * 22	5 * 26	
7	2 * 7	5 * 7	5 * 11	5 * 15	5 * 19	5 * 23	5 * 27	
8	2 * 8	5 * 8	5 * 12	5 * 16	5 * 20	5 * 24	5 * 28	
9	2 * 9	6 * 9	9 * 9	9 * 13	9 * 17	9 * 21	9 * 25	
10	2 * 10	6 * 10	9 * 10	9 * 14	9 * 18	9 * 22	9 * 26	
11	2 * 11	6 * 11	9 * 11	9 * 15	9 * 19	9 * 23	9 * 27	
12	2 * 12	6 * 12	9 * 12	9 * 16	9 * 20	9 * 24	9 * 28	
13	2 * 13	6 * 13	10 * 13	13 * 13	13 * 17	13 * 21	13 * 25	
14	2 * 14	6 * 14	10 * 14	13 * 14	13 * 18	13 * 22	13 * 26	
15	2 * 15	6 * 15	10 * 15	13 * 15	13 * 19	13 * 23	13 * 27	
16	2 * 16	6 * 16	10 * 16	13 * 16	13 * 20	13 * 24	13 * 28	
17	2 * 17	6 * 17	10 * 17	14 * 17	17 * 17	17 * 21	17 * 25	
18	2 * 18	6 * 18	10 * 18	14 * 18	17 * 18	17 * 22	17 * 26	
19	2 * 19	6 * 19	10 * 19	14 * 19	17 * 19	17 * 23	17 * 27	
20	2 * 20	6 * 20	10 * 20	14 * 20	17 * 20	17 * 24	17 * 28	
21	2 * 21	6 * 21	10 * 21	14 * 21	18 * 21	21 * 21	21 * 25	
22	2 * 22	6 * 22	10 * 22	14 * 22	18 * 22	21 * 22	21 * 26	
23	2 * 23	6 * 23	10 * 23	14 * 23	18 * 23	21 * 23	21 * 27	
24	2 * 24	6 * 24	10 * 24	14 * 24	18 * 24	21 * 24	21 * 28	
25	2 * 25	6 * 25	10 * 25	14 * 25	18 * 25	22 * 25	25 * 25	
26	2 * 26	6 * 26	10 * 26	14 * 26	18 * 26	22 * 26	25 * 26	
27	2 * 27	6 * 27	10 * 27	14 * 27	18 * 27	22 * 27	25 * 27	
28	2 * 28	6 * 28	10 * 28	14 * 28	18 * 28	22 * 28	25 * 28	
2								2 * 2
3								3 * 3
6								6 * 6
7								7 * 7

2nd Baseline Board

	4 1 2 3	8 5 6 7	12 9 10 11	16 13 14 15	20 17 18 19	24 21 22 23	28 25 26 27	10 11 14 15
3	2 * 3	3 * 5	3 * 9	3 * 13	3 * 17	3 * 21	3 * 25	
4	2 * 4	3 * 6	3 * 10	3 * 14	3 * 18	3 * 22	3 * 26	
1	3 * 4	3 * 7	3 * 11	3 * 15	3 * 19	3 * 23	3 * 27	
2	4 * 4	3 * 8	3 * 12	3 * 16	3 * 20	3 * 24	3 * 28	
7	4 * 5	6 * 7	7 * 9	7 * 13	7 * 17	7 * 21	7 * 25	
8	4 * 6	6 * 8	7 * 10	7 * 14	7 * 18	7 * 22	7 * 26	
5	4 * 7	7 * 8	7 * 11	7 * 15	7 * 19	7 * 23	7 * 27	
6	4 * 8	8 * 8	7 * 12	7 * 16	7 * 20	7 * 24	7 * 28	
11	4 * 9	8 * 9	10 * 11	11 * 13	11 * 17	11 * 21	11 * 25	
12	4 * 10	8 * 10	10 * 12	11 * 14	11 * 18	11 * 22	11 * 26	
9	4 * 11	8 * 11	11 * 12	11 * 15	11 * 19	11 * 23	11 * 27	
10	4 * 12	8 * 12	12 * 12	11 * 16	11 * 20	11 * 24	11 * 28	
15	4 * 13	8 * 13	12 * 13	14 * 15	15 * 17	15 * 21	15 * 25	
16	4 * 14	8 * 14	12 * 14	14 * 16	15 * 18	15 * 22	15 * 26	
13	4 * 15	8 * 15	12 * 15	15 * 16	15 * 19	15 * 23	15 * 27	
14	4 * 15	8 * 16	12 * 16	16 * 16	15 * 20	15 * 24	15 * 28	
19	4 * 17	8 * 17	12 * 17	16 * 17	18 * 19	19 * 21	19 * 25	
20	4 * 18	8 * 18	12 * 18	16 * 18	18 * 20	19 * 22	19 * 26	
17	4 * 19	8 * 19	12 * 19	16 * 19	19 * 20	19 * 23	19 * 27	
18	4 * 20	8 * 20	12 * 20	16 * 20	20 * 20	19 * 24	19 * 28	
23	4 * 21	8 * 21	12 * 21	16 * 21	20 * 21	22 * 23	23 * 25	
24	4 * 22	8 * 22	12 * 22	16 * 22	20 * 22	22 * 24	23 * 26	
21	4 * 23	8 * 23	12 * 23	16 * 23	20 * 23	23 * 24	23 * 27	
22	4 * 24	8 * 24	12 * 24	16 * 24	20 * 24	24 * 24	23 * 28	
27	4 * 25	8 * 25	12 * 25	16 * 25	20 * 25	24 * 25	26 * 27	
28	4 * 26	8 * 26	12 * 26	16 * 26	20 * 26	24 * 26	26 * 28	
25	4 * 27	8 * 27	12 * 27	16 * 27	20 * 27	24 * 27	27 * 28	
26	4 * 28	8 * 28	12 * 28	16 * 28	20 * 28	24 * 28	28 * 28	
10								10 * 10
11								11 * 11
14								14 * 14
15								15 * 15

Correlator Chip: X and Y inputs are from the same group of 4 stations

Correlator Chip: input from stations 1,2,3,4 and 5,6,7,8

1 Subarray, 26 Stations, 4-bit Mode

1 Subarray, 26 stations: 2 Baseline Boards can produce all cross-correlation products and all auto-correlation products.

1st Baseline Board

	2 3 4 1	6 7 8 5	10 11 12 9	14 15 16 13	18 19 20 17	22 23 24 21	26 25 2 3	6 7 10 11
1	1 * 1	1 * 5	1 * 9	1 * 13	1 * 17	1 * 21	1 * 25	
2	1 * 2	1 * 6	1 * 10	1 * 14	1 * 18	1 * 22	1 * 26	
3	1 * 3	1 * 7	1 * 11	1 * 15	1 * 19	1 * 23		
4	1 * 4	1 * 8	1 * 12	1 * 16	1 * 20	1 * 24		
5	2 * 5	5 * 5	5 * 9	5 * 13	5 * 17	5 * 21	5 * 25	
6	2 * 6	5 * 6	5 * 10	5 * 14	5 * 18	5 * 22	5 * 26	
7	2 * 7	5 * 7	5 * 11	5 * 15	5 * 19	5 * 23		
8	2 * 8	5 * 8	5 * 12	5 * 16	5 * 20	5 * 24		
9	2 * 9	6 * 9	9 * 9	9 * 13	9 * 17	9 * 21	9 * 25	
10	2 * 10	6 * 10	9 * 10	9 * 14	9 * 18	9 * 22	9 * 26	
11	2 * 11	6 * 11	9 * 11	9 * 15	9 * 19	9 * 23		
12	2 * 12	6 * 12	9 * 12	9 * 16	9 * 20	9 * 24		
13	2 * 13	6 * 13	10 * 13	13 * 13	13 * 17	13 * 21	13 * 25	
14	2 * 14	6 * 14	10 * 14	13 * 14	13 * 18	13 * 22	13 * 26	
15	2 * 15	6 * 15	10 * 15	13 * 15	13 * 19	13 * 23		
16	2 * 16	6 * 16	10 * 16	13 * 16	13 * 20	13 * 24		
17	2 * 17	6 * 17	10 * 17	14 * 17	17 * 17	17 * 21	17 * 25	
18	2 * 18	6 * 18	10 * 18	14 * 18	17 * 18	17 * 22	17 * 26	
19	2 * 19	6 * 19	10 * 19	14 * 19	17 * 19	17 * 23		
20	2 * 20	6 * 20	10 * 20	14 * 20	17 * 20	17 * 24		
21	2 * 21	6 * 21	10 * 21	14 * 21	18 * 21	21 * 21	21 * 25	
22	2 * 22	6 * 22	10 * 22	14 * 22	18 * 22	21 * 22	21 * 26	
23	2 * 23	6 * 23	10 * 23	14 * 23	18 * 23	21 * 23		
24	2 * 24	6 * 24	10 * 24	14 * 24	18 * 24	21 * 24		
25	2 * 25	6 * 25	10 * 25	14 * 25	18 * 25	22 * 25	25 * 25	
26	2 * 26	6 * 26	10 * 26	14 * 26	18 * 26	22 * 26	25 * 26	
2							2 * 2	
3							3 * 3	
6								6 * 6
7								7 * 7
10								10 * 10
11								11 * 11

2nd Baseline Board

	4 1 2 3	8 5 6 7	12 9 10 11	16 13 14 15	20 17 18 19	24 21 22 23	26 25 14 15	18 19 22 23
3	2 * 3	3 * 5	3 * 9	3 * 13	3 * 17	3 * 21	3 * 25	
4	2 * 4	3 * 6	3 * 10	3 * 14	3 * 18	3 * 22	3 * 26	
1	3 * 4	3 * 7	3 * 11	3 * 15	3 * 19	3 * 23		
2	4 * 4	3 * 8	3 * 12	3 * 16	3 * 20	3 * 24		
7	4 * 5	6 * 7	7 * 9	7 * 13	7 * 17	7 * 21	7 * 25	
8	4 * 6	6 * 8	7 * 10	7 * 14	7 * 18	7 * 22	7 * 26	
5	4 * 7	7 * 8	7 * 11	7 * 15	7 * 19	7 * 23		
6	4 * 8	8 * 8	7 * 12	7 * 16	7 * 20	7 * 24		
11	4 * 9	8 * 9	10 * 11	11 * 13	11 * 17	11 * 21	11 * 25	
12	4 * 10	8 * 10	10 * 12	11 * 14	11 * 18	11 * 22	11 * 26	
9	4 * 11	8 * 11	11 * 12	11 * 15	11 * 19	11 * 23		
10	4 * 12	8 * 12	12 * 12	11 * 16	11 * 20	11 * 24		
15	4 * 13	8 * 13	12 * 13	14 * 15	15 * 17	15 * 21	15 * 25	
16	4 * 14	8 * 14	12 * 14	14 * 16	15 * 18	15 * 22	15 * 26	
13	4 * 15	8 * 15	12 * 15	15 * 16	15 * 19	15 * 23		
14	4 * 15	8 * 16	12 * 16	16 * 16	15 * 20	15 * 24		
19	4 * 17	8 * 17	12 * 17	16 * 17	18 * 19	19 * 21	19 * 25	
20	4 * 18	8 * 18	12 * 18	16 * 18	18 * 20	19 * 22	19 * 26	
17	4 * 19	8 * 19	12 * 19	16 * 19	19 * 20	19 * 23		
18	4 * 20	8 * 20	12 * 20	16 * 20	20 * 20	19 * 24		
23	4 * 21	8 * 21	12 * 21	16 * 21	20 * 21	22 * 23	23 * 25	
24	4 * 22	8 * 22	12 * 22	16 * 22	20 * 22	22 * 24	23 * 26	
21	4 * 23	8 * 23	12 * 23	16 * 23	20 * 23	23 * 24		
22	4 * 24	8 * 24	12 * 24	16 * 24	20 * 24	24 * 24		
26	4 * 25	8 * 25	12 * 25	16 * 25	20 * 25	24 * 25	26 * 26	
25	4 * 26	8 * 26	12 * 26	16 * 26	20 * 26	24 * 26	14 * 14	
14							15 * 15	
15								
18								18 * 18
19								19 * 19
22								22 * 22
23								23 * 23

Correlator Chip: X and Y inputs are from the same group of 4 stations

3 Subarrays, 4-bit Mode – 1st Example

3 Subarrays, dumps are not harmonically related, subarrays can not share rows and columns.
Black: 1 - 10 (10 stations): all cross and auto correlations
Blue: 11 - 19 (9 stations): all cross and auto correlations
Red: 25 - 32 (8 stations): all cross-correlations and auto-correlation for 4 stations

1st Baseline Board

	2 3 4 1	6 7 8 5	10 2 3 9	12 13 - 11	15 16 - 14	18 19 - 17	21 22 23 20	25 26 27 24
1	1 * 1	1 * 5	1 * 9					
2	1 * 2	1 * 6	1 * 10					
3	1 * 3	1 * 7						
4	1 * 4	1 * 8						
5	2 * 5	5 * 5	5 * 9					
6	2 * 6	5 * 6	5 * 10					
7	2 * 7	5 * 7						
8	2 * 8	5 * 8						
9	2 * 9	6 * 9	9 * 9					
2	2 * 10	6 * 10	9 * 10					
3			2 * 2					
10			3 * 3					
11				11 * 11	11 * 14	11 * 17		
12				11 * 12	11 * 15	11 * 18		
-								
13				11 * 13	11 * 16	11 * 19		
14				12 * 14	14 * 14	14 * 17		
15				12 * 15	14 * 15	14 * 18		
-								
16				12 * 16	14 * 16	14 * 19		
17				12 * 17	15 * 17	17 * 17		
18				12 * 18	15 * 18	17 * 18		
-								
19				12 * 19	15 * 19	17 * 19		
20							20 * 20	20 * 24
21							20 * 21	20 * 25
22							20 * 22	20 * 26
23							20 * 23	20 * 27
24							21 * 24	24 * 24
25							21 * 35	24 * 25
26							21 * 26	24 * 26
27							21 * 27	24 * 27

2nd Baseline Board

	4 1 2 3	8 5 6 7	9 6 7 10	13 11 - 12	16 14 - 15	19 17 - 18	24 20 21 22	27 24 25 26
3	2 * 3	3 * 5	3 * 9					
4	2 * 4	3 * 6	3 * 10					
1	3 * 4	3 * 7						
2	4 * 4	3 * 8						
7	4 * 5	6 * 7	7 * 9					
8	4 * 6	6 * 8	7 * 10					
5	4 * 7	7 * 8						
6	4 * 8	8 * 8						
10	4 * 9	8 * 9	10 * 10					
6	4 * 10	8 * 10	6 * 6					
7			7 * 7					
9								
13				12 * 12	13 * 14	13 * 17		
11				12 * 13	13 * 15	13 * 18		
-								
12				13 * 13	13 * 16	13 * 19		
16					15 * 15	16 * 17		
14					15 * 16	16 * 18		
-								
15					16 * 16	16 * 19		
19						18 * 18		
17						18 * 19		
-								
18						19 * 19		
22							22 * 22	23 * 24
23							22 * 23	23 * 25
20							23 * 23	23 * 26
21							23 * 23	23 * 27
26							23 * 24	25 * 26
27							23 * 25	25 * 27
24							23 * 26	26 * 27
25							23 * 27	27 * 27

3 Subarrays, 4-bit Mode – 2nd Example

3 Subarrays - product dumps are harmonically related to the same minimum hardware integration time.
Black: 1 - 10 (10 stations): all cross and auto correlations
Blue: 11 - 19 (9 stations): all cross and auto correlations
Red: 20 - 27 (8 stations): all cross and auto correlations

1st Baseline Board

	2 3 4 1	6 7 8 5	10 11 12 9	14 15 16 13	18 19 20 17	22 23 24 21	26 27 25 22	2 3 6 7
1	1 * 1	1 * 5	1 * 9					
2	1 * 2	1 * 6	1 * 10					
3	1 * 3	1 * 7						
4	1 * 4	1 * 8						
5	2 * 5	5 * 5	5 * 9					
6	2 * 6	5 * 6	5 * 10					
7	2 * 7	5 * 7						
8	2 * 8	5 * 8						
9	2 * 9	6 * 9	9 * 9					
11	2 * 10	6 * 10	9 * 10					
12			10 *10					
10								
13				13 * 13	13 * 17			
14				13 * 14	13 * 18			
15				13 * 15	13 * 19			
16				13 * 16				
17				14 * 17	17 * 17			
18				14 * 18	17 * 18			
19				14 * 19	17 * 19			
20					18*18			
21						21 * 21	21 * 25	
22						21 * 22	21 * 26	
23						21 * 23	21 * 27	
24						21 * 24		
25						22 * 25	25 * 25	
26						22 * 26	25 * 26	
27						22 * 27	25 * 27	
22							22*22	
2								2 * 2
3								3 * 3
6								6 * 6
7								7 * 7

2nd Baseline Board

	4 1 2 3	8 5 6 7	12 9 10 11	16 13 14 15	20 17 18 19	24 21 22 23	26 25 19 27	14 15
3	2 * 3	3 * 5	3 * 9					
4	2 * 4	3 * 6	3 * 10					
1	3 * 4	3 * 7						
2	4 * 4	3 * 8						
7	4 * 5	6 * 7	7 * 9					
8	4 * 6	6 * 8	7 * 10					
5	4 * 7	7 * 8						
6	4 * 8	8 * 8						
11	4 * 9	8 * 9	11 * 11	11 * 13	11 * 17			
9	4 * 10	8 * 10	11 * 12	11 * 14	11 * 18			
10			12 * 12	11 * 15	11 * 19			
12				11 * 16				
15			12 * 13	14 * 15	15 * 17			
16			12 * 14	14 * 16	15 * 18			
13			12 * 15	15 * 16	15 * 19			
14			12 * 16	16 * 16				
19			12 * 17	16 * 17	18 * 19			
20			12 * 18	16 * 18	19*19			
17			12 * 19	16 * 19	20*20			
18								
23					20 * 21	22 * 23	23 * 25	
24					20 * 22	22 * 24	23 * 26	
21					20 * 23	23 * 24	23 * 27	
22					20 * 24	24 * 24		
26					20 * 25	24 * 25	26*26	
25					20 * 26	24 * 26	26*27	
23					20 * 27	24 * 27	27*27	
27							23*23	
14								14 * 14
15								15 * 15

Summary

- For the new configuration scheme the greatest challenge is to arrange the Baseline Board input data streams to maximize the number of products.
- The software may be gradually improved to allow more complex configurations.
- In spite of some challenges, the new configuration allows for better structured configuration mapping code.

- The overall software impact is not significant.