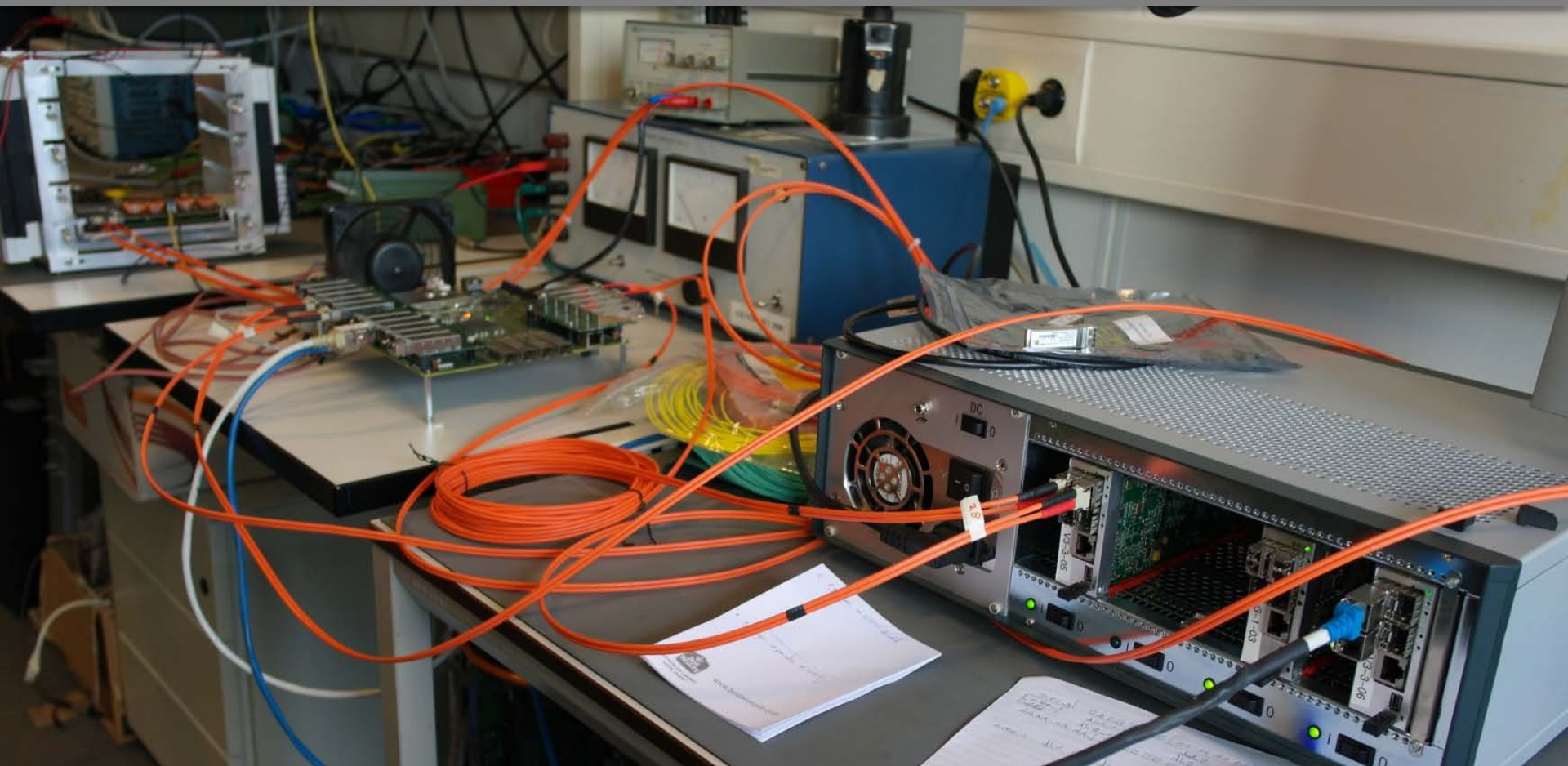
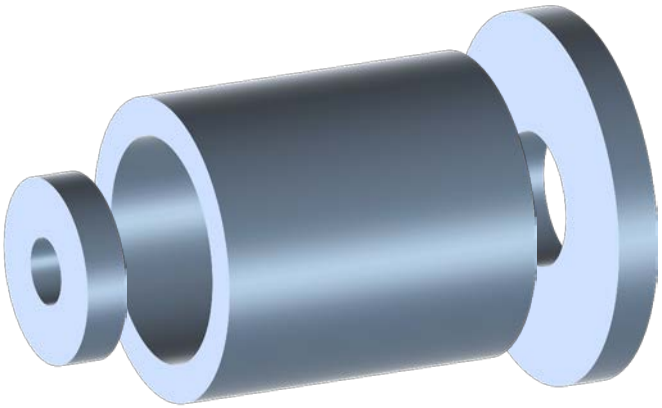
university of groningen
kvi - center for advanced radiation technology
M. Tiemens

The hardware implementation of the cluster finding algorithm and the Burst Building Network

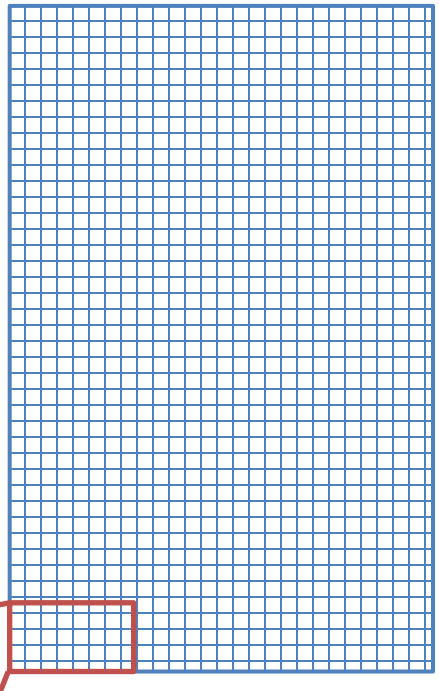


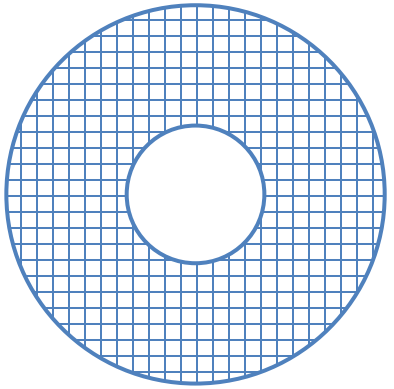
Recap

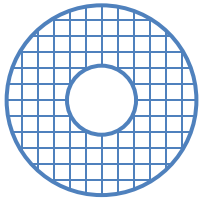


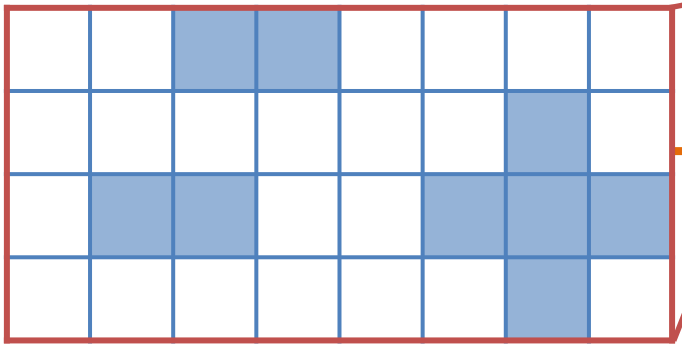
EMC

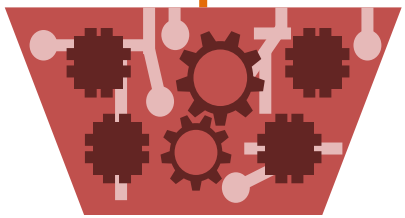
Map





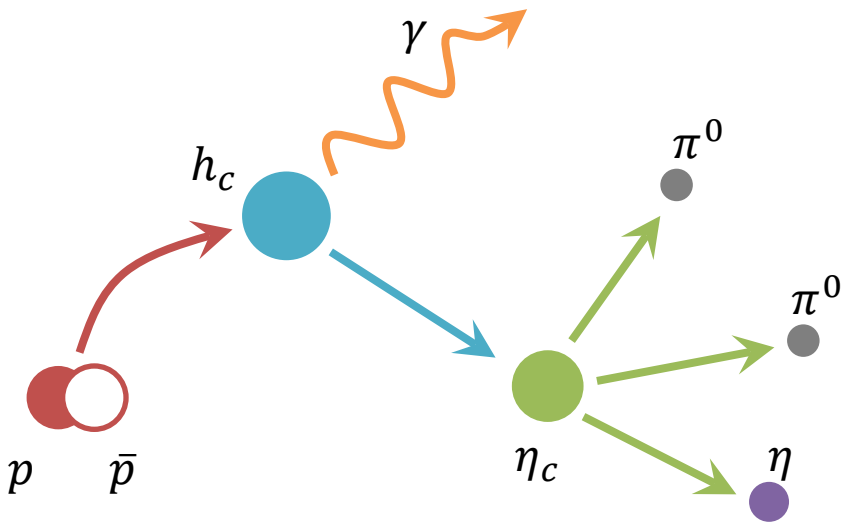




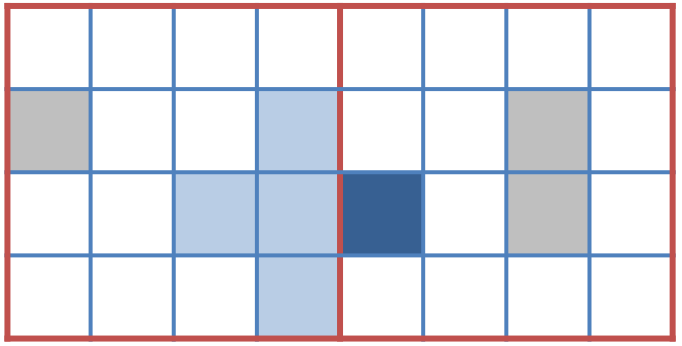


Data Concentrator

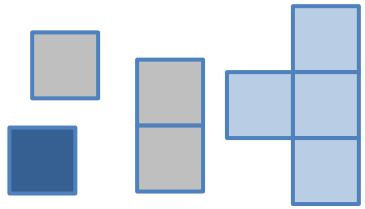
Distributed Cluster Finding



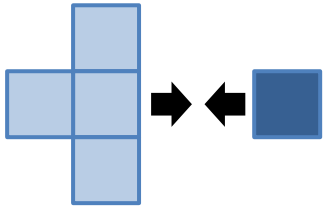
5000 events @200 kHz



1 Form preclusters:

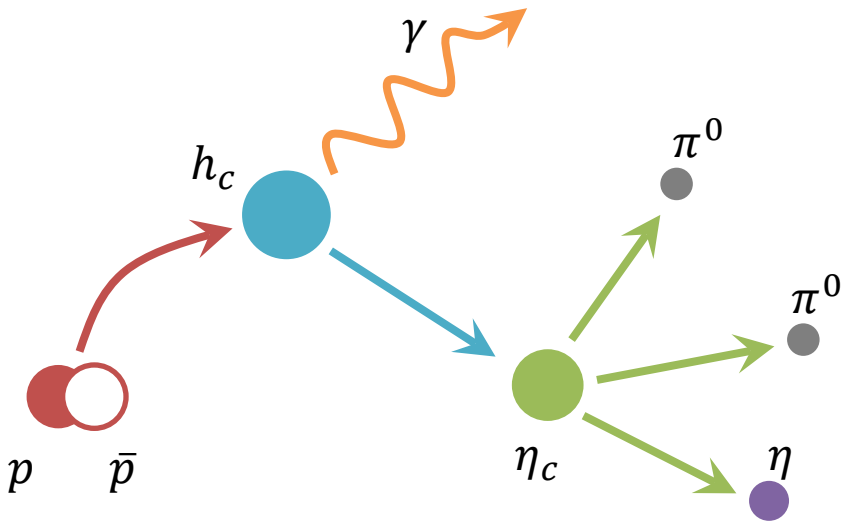


2 Merge preclusters: (if needed)



3 (Set properties of completed clusters)

Distributed Cluster Finding



5000 events @200 kHz

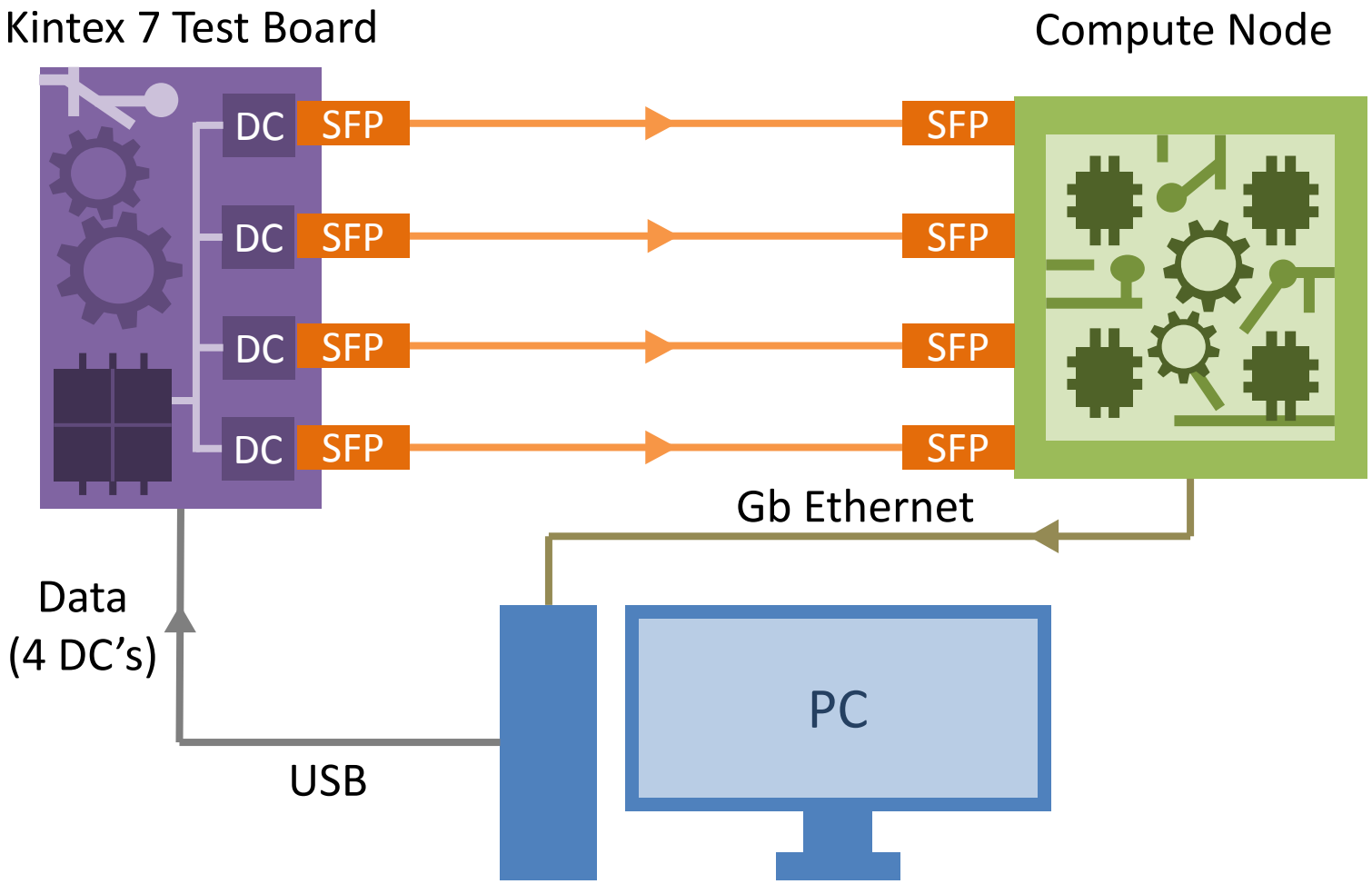
Relative nr of events reconstructed:

Default:	29.4%
Online:	28.7%
Distributed:	23.9%

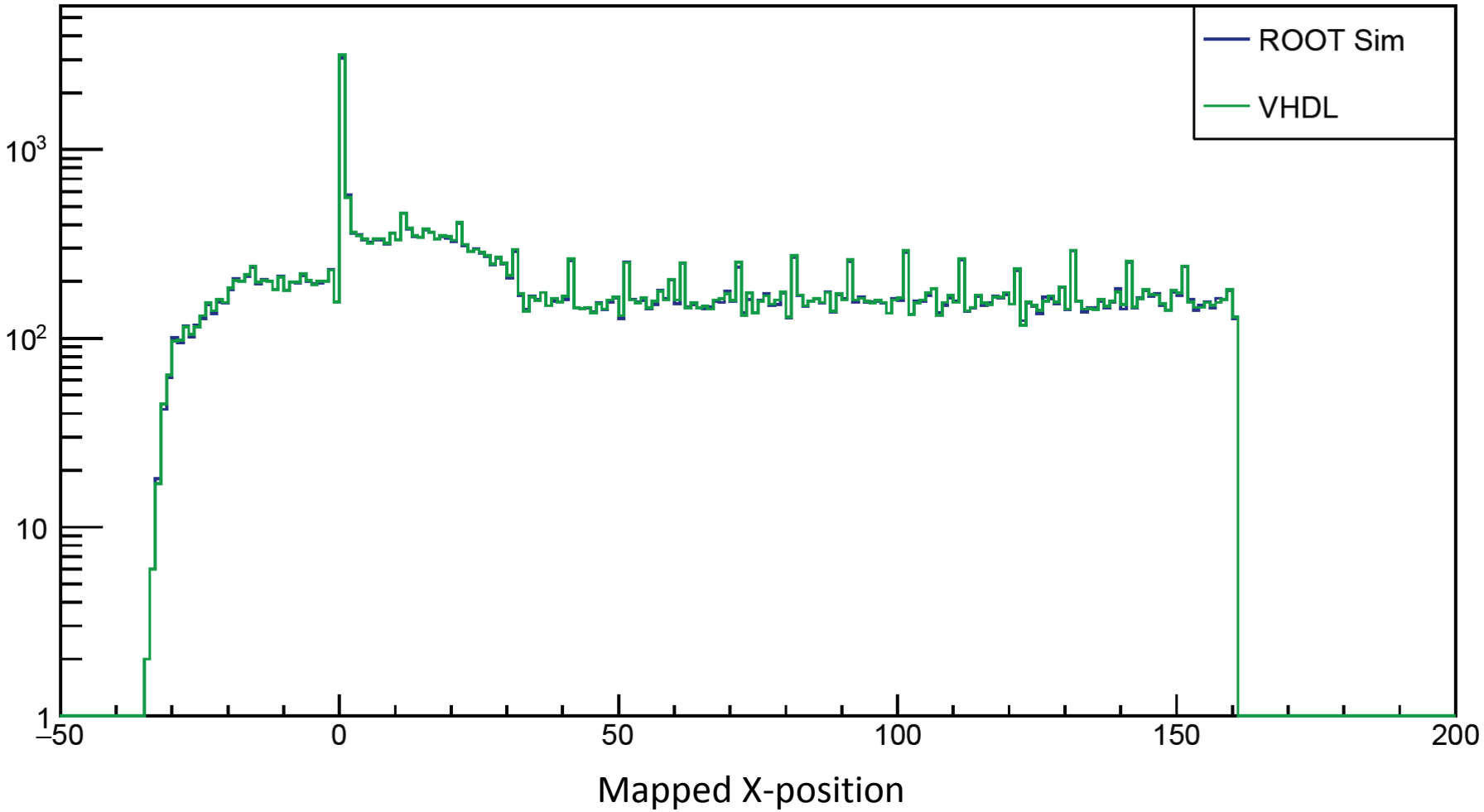
CPU processing time (relative to Default):

Default:	1
Online:	1.19
Distributed:	0.93 (0.05 + 0.88)

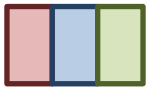
VHDL Implementation Test Setup



Comparison Between PandaRoot and VHDL Simulation



Data Structure



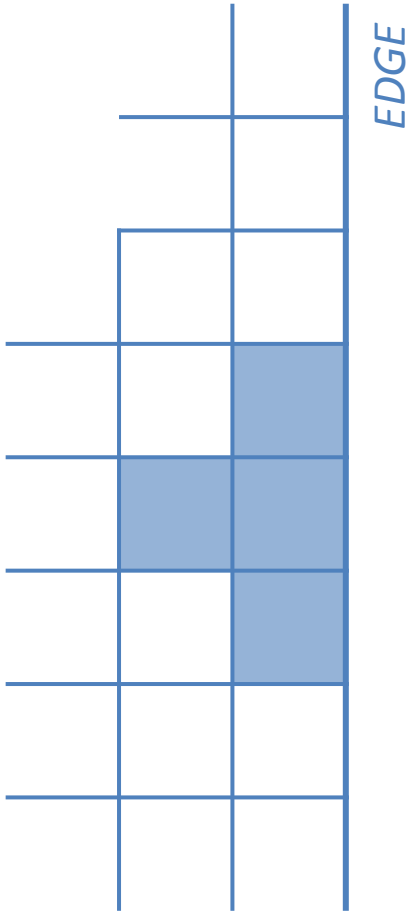
64-bit words

PRECLUSTER1	X	Y	D	t	NR_OF_HITS
HIT1	t	E	ch. nr		
HIT2	t	E	ch. nr		
...					

CLUSTER1	x	y	z	t	E	NR_OF_HITS
HIT1	t	E	ch. nr			
HIT2	t	E	ch. nr			
...						

X, Y : Position in 2D Map
D : Diameter of Precluster
t : Time
E : Energy

What if a Photon Hits the Edge?



Detection:

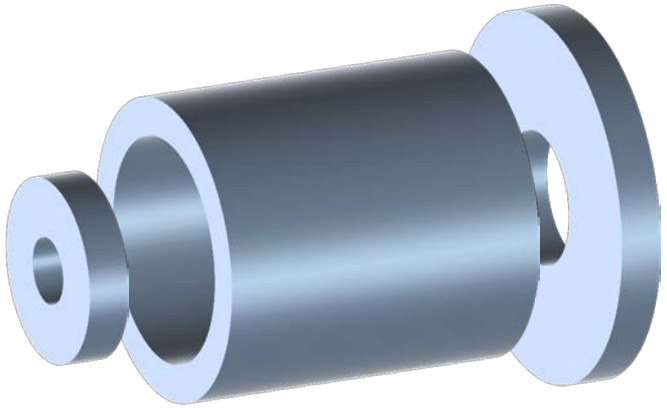
Energy-weighted position is close to edge of map

Options:

1. Discard these clusters
2. Apply correction factor to E
3. Use complicated neighbour relation to edge of other map

All right, so what does this all mean for the data flow, and the processing thereof?

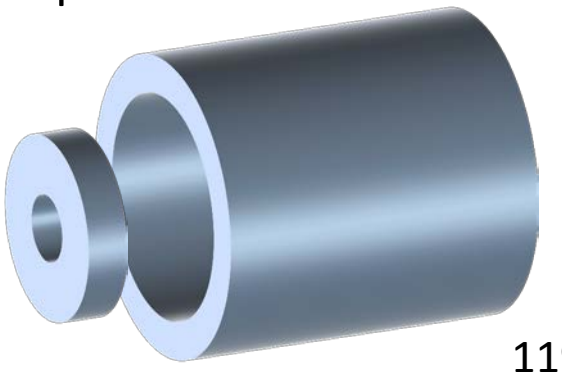
Data Collection



EMC

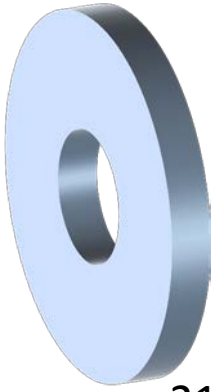
BwEndcap + Barrel	#	Rate /device (Gbps)	Total rate (Gbps)	FwEndcap	#	Rate/device (Gbps)	Total rate (Gbps)
SADCs <10 kHz	572	0.05	28.6	SADCs 300 kHz	217	1.2	260.4
SADCs >10, <50 kHz	512	0.27	138.24				
SADCs >50 kHz	112	0.6	67.2				
Total	1196		234.04		217		260.4

BwEndcap Barrel

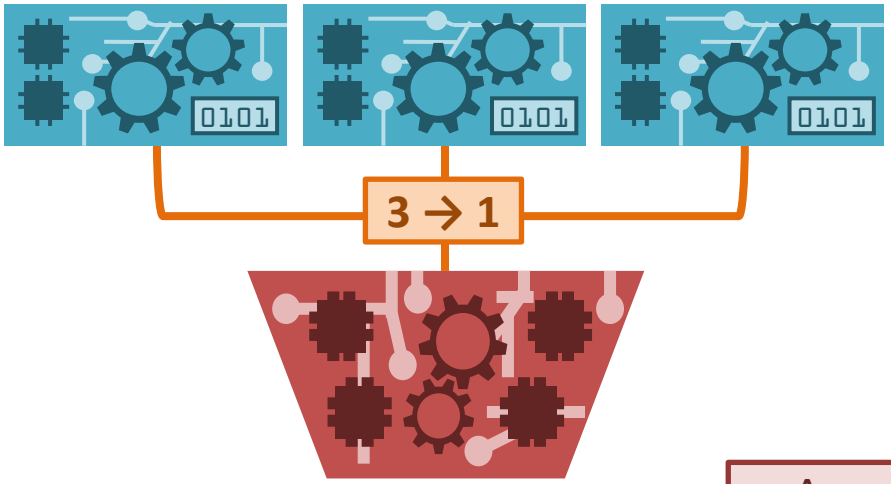


1196 digitisers
Total rate: 234 Gbps

FwEndcap

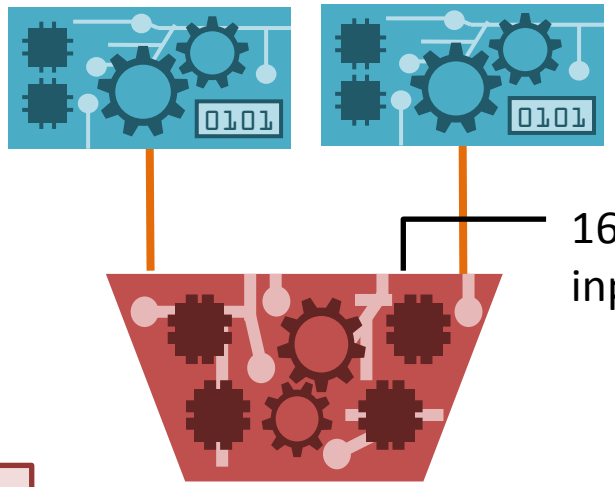


217 digitisers
Total rate: 260 Gbps



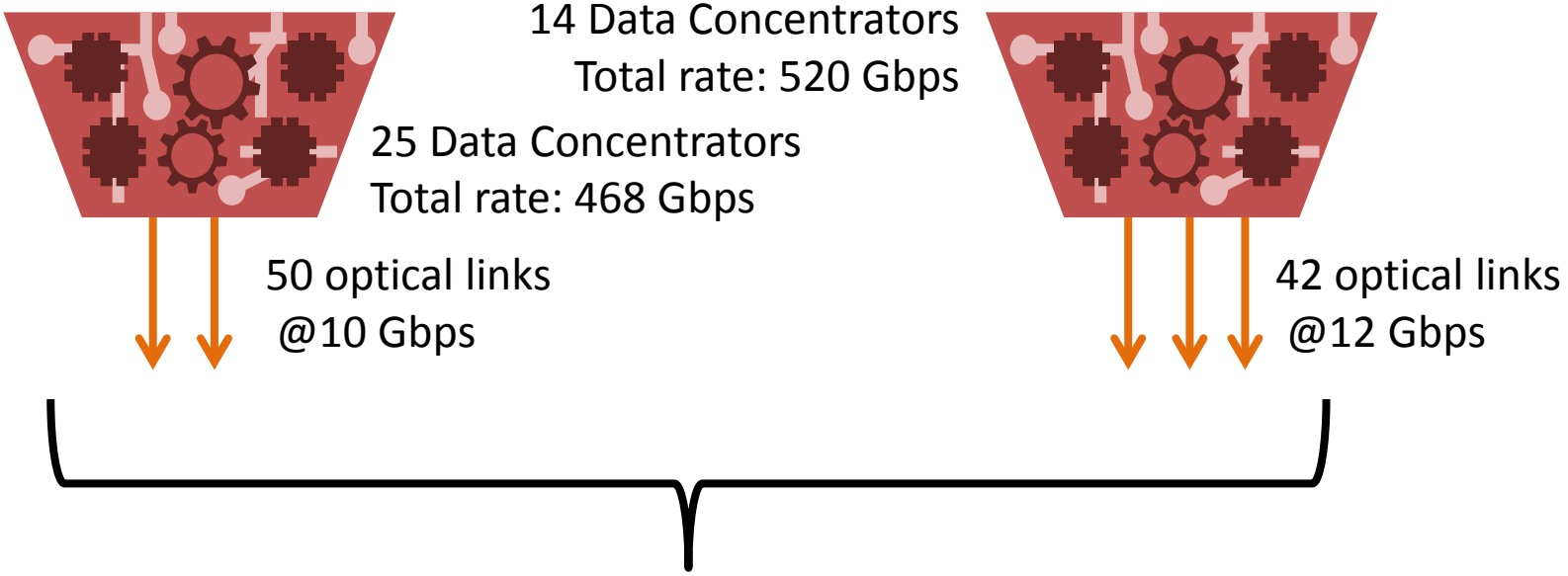
25 Data Concentrators
Total rate: 468 Gbps

Assuming worst case where each hit becomes a cluster



14 Data Concentrators
Total rate: 520 Gbps

Output Produced by Data Concentrators (DCs)



Now what?

Processing the DC Output

3 Options for the BBN*:

1. Throw everything into one big data collection network, which may or may not do more advanced processing (at least collect and sort data).

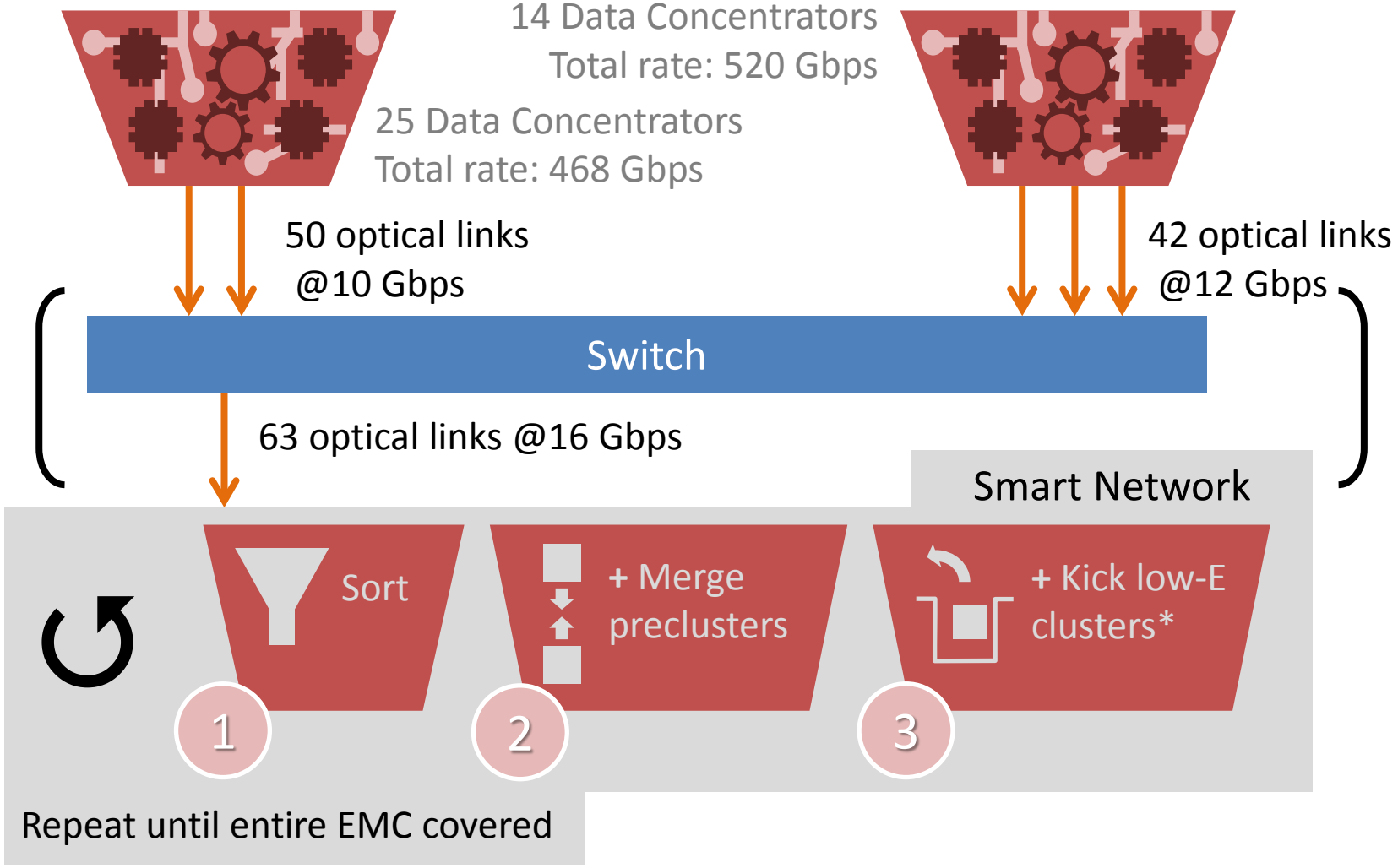
2. Do some data merging, then do 1.

3. Collect everything in a switch, and let one big FPGA board do the rest.

*Burst Building Network, PANDA's data collection and processing network

Processing the DC Output

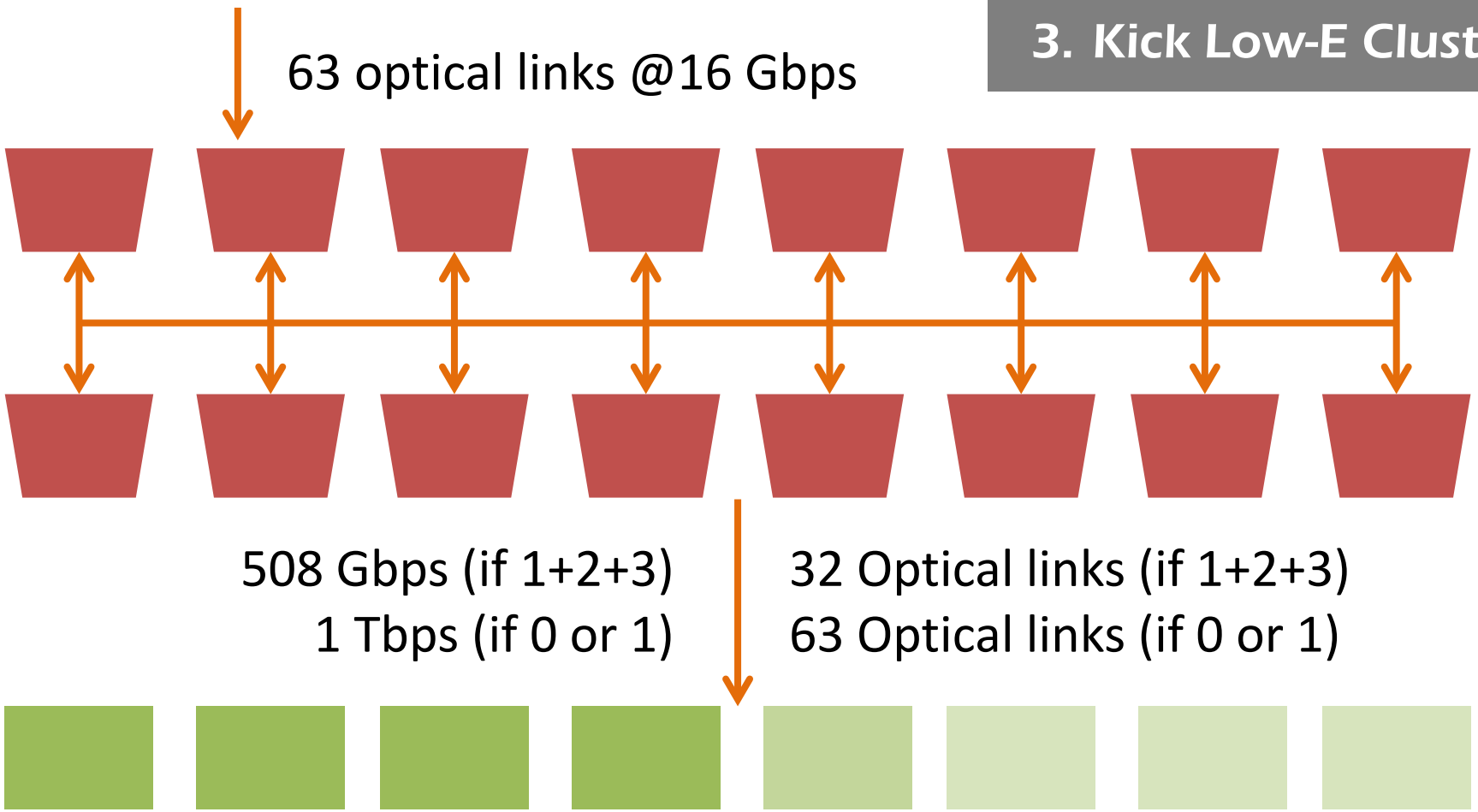
1



Topology of the Network

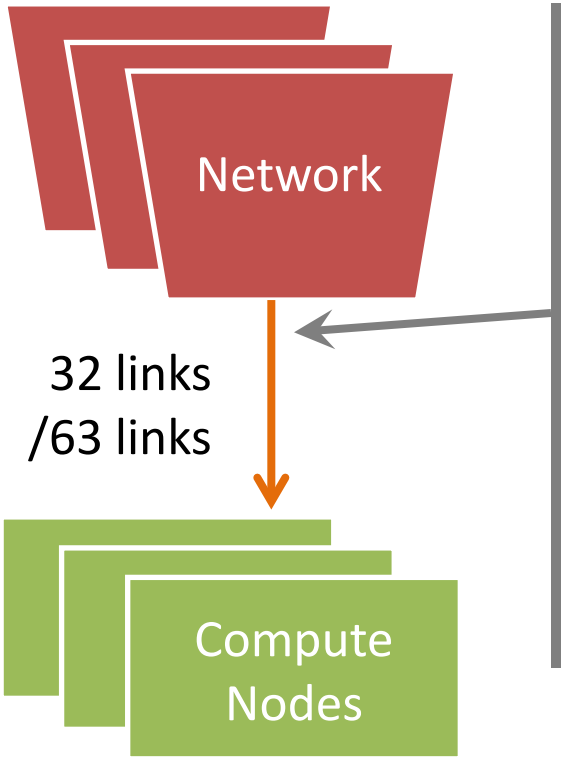
1. Sort
2. Merge Preclusters
3. Kick Low-E Clusters*

1



Topology of the Network

1



Procedure (after sorting):

1. Make timebunches: 
2. Send 1st *n* timebunches to *n* FPGAs on 1st CN
3. Send 2nd *n* timebunches to *n* FPGAs on 2nd CN
4. Etc until *m*th CN, then send to 1st CN again and repeat from 2.

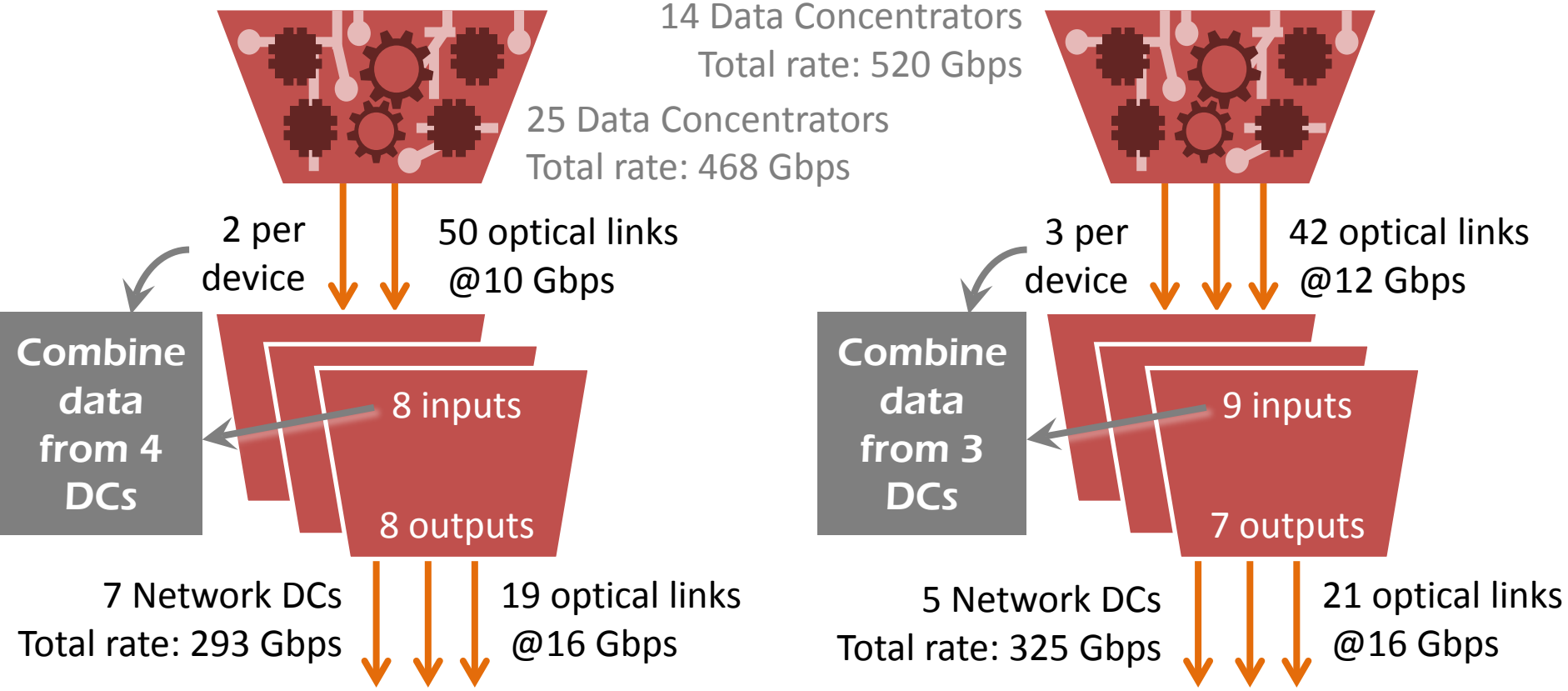
Processing the DC Output

3 Options for the BBN:

1. Throw everything into one big data collection network, which may or may not do more advanced processing (at least collect and sort data).
2. Do some data merging, then do 1.
3. Collect everything in a switch, and let one big FPGA board do the rest.

Processing the DC Output

2



Processing the DC Output

3 Options for the BBN:

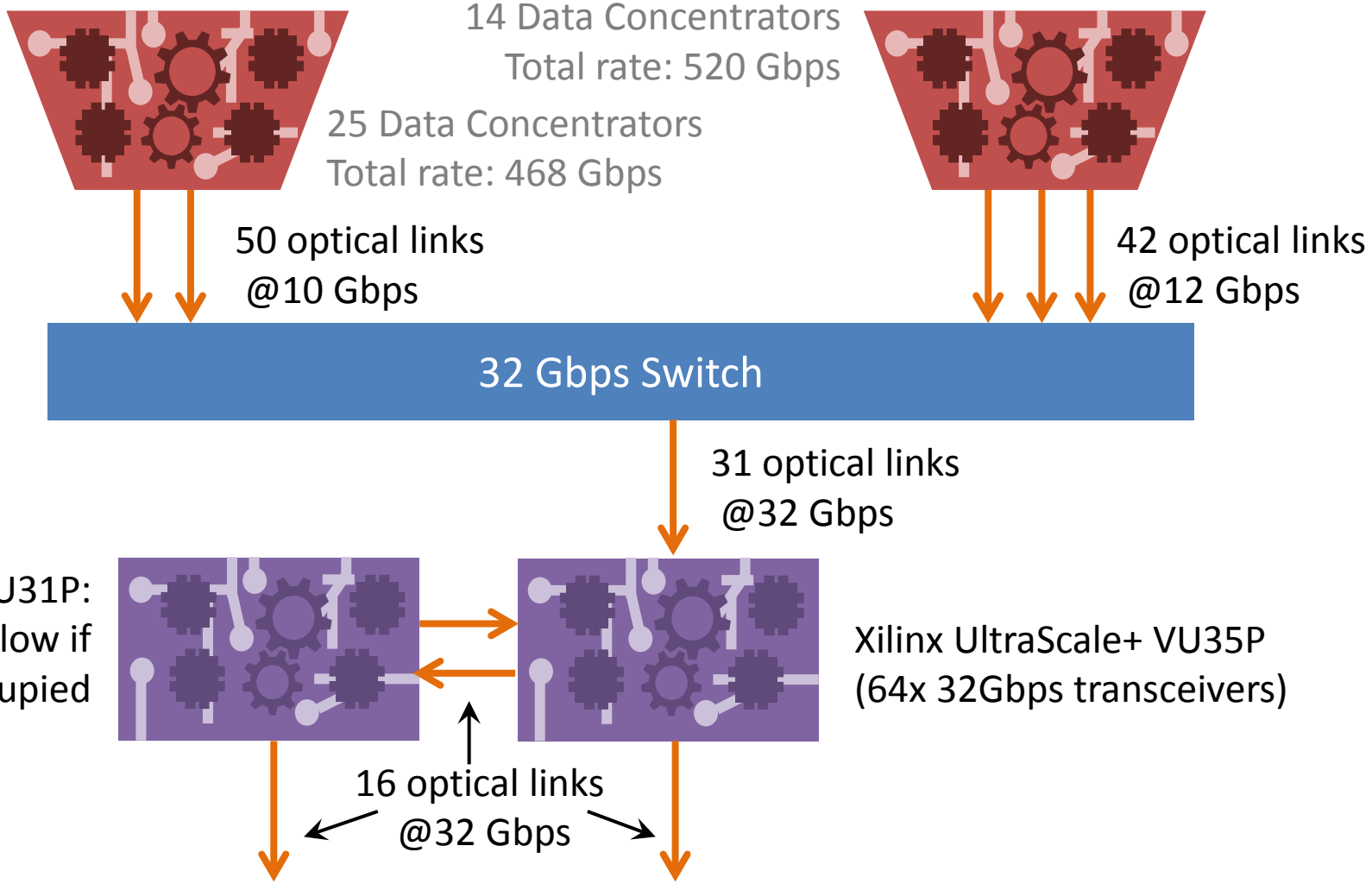
1. Throw everything into one big data collection network, which may or may not do more advanced processing (at least collect and sort data).

2. Do some data merging, then do 1.

3. Collect everything in a switch, and let one big FPGA board do the rest.

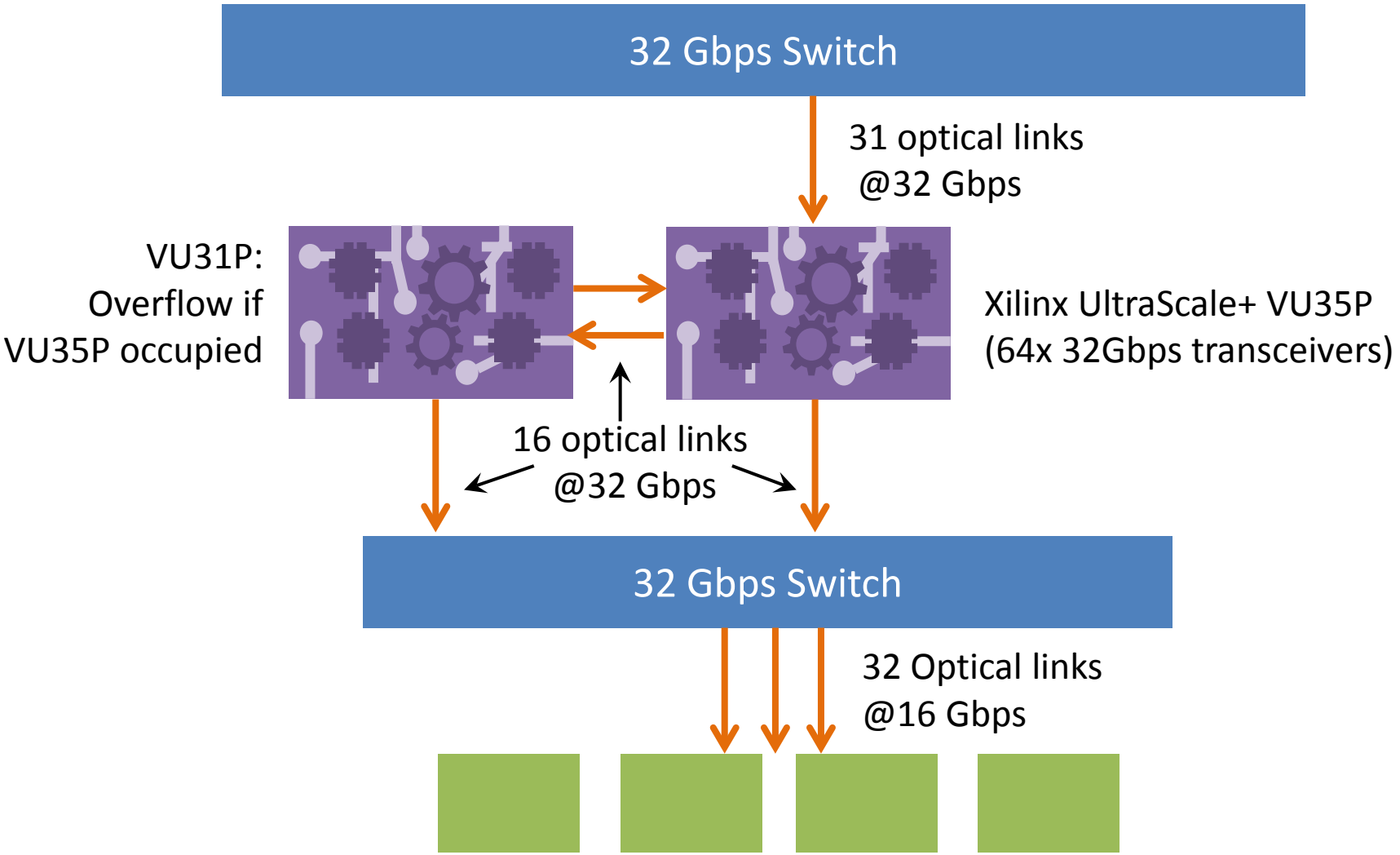
Processing the DC Output

3



Processing the DC Output

3



Summary and Outlook

1. Hardware implementation of clustering has been made:
   a. Results agree with PandaRoot sim.
   b. → Check with FPGA specifications to explore possibilities.
2. Several options for the BBN are being explored.

Recommendation:

1. Use Option 3 (big FPGA board).
2. If not possible (see 1b), use Option 2 (do data merging, then feed to BBN).

Open Question to Collaboration:
What do other subsystems require of the BBN?