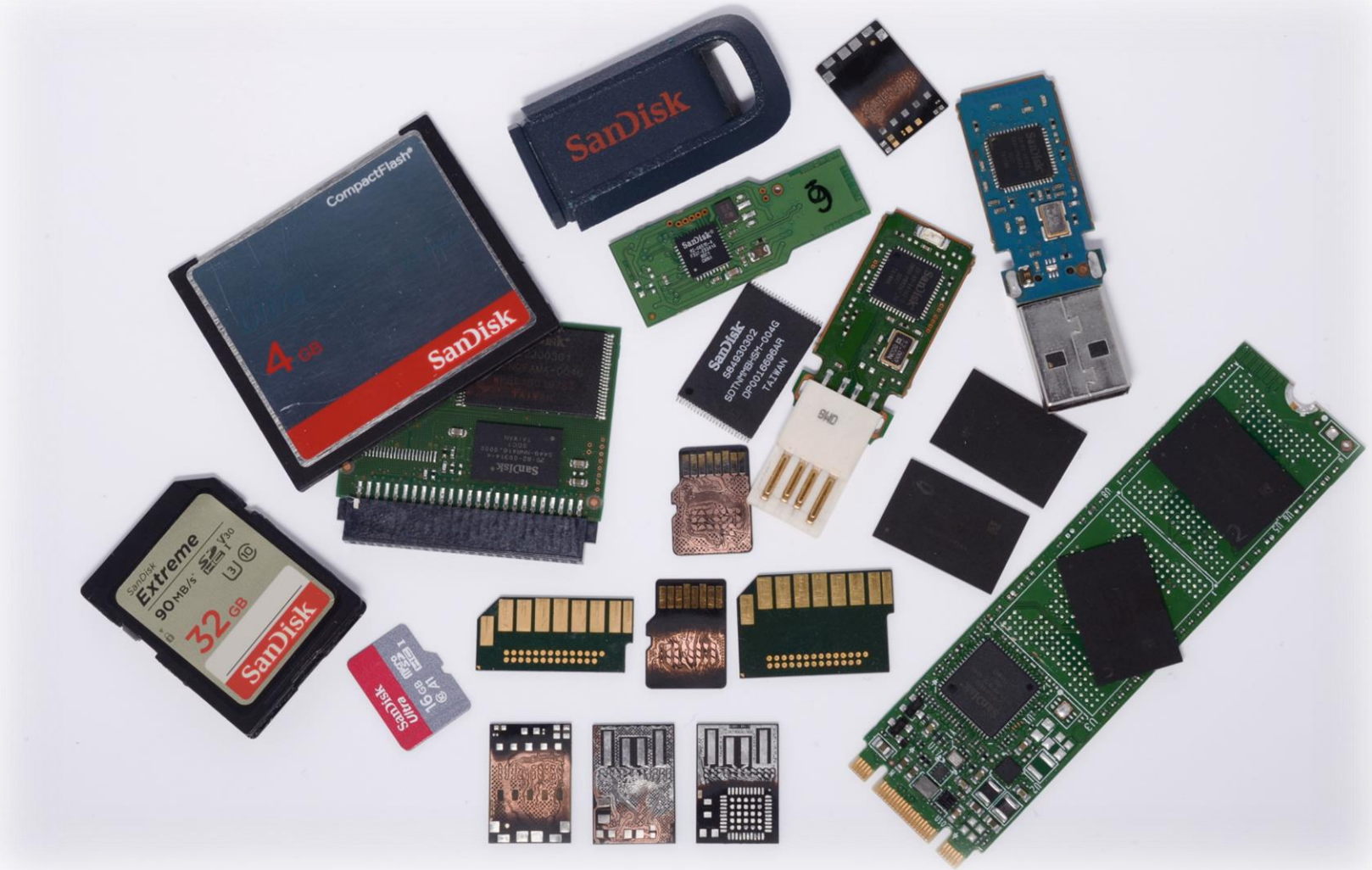
SanDisk controllers and logical image assembly from WD SSD

Michał Gmurek, Rusolut

Types of SanDisk devices



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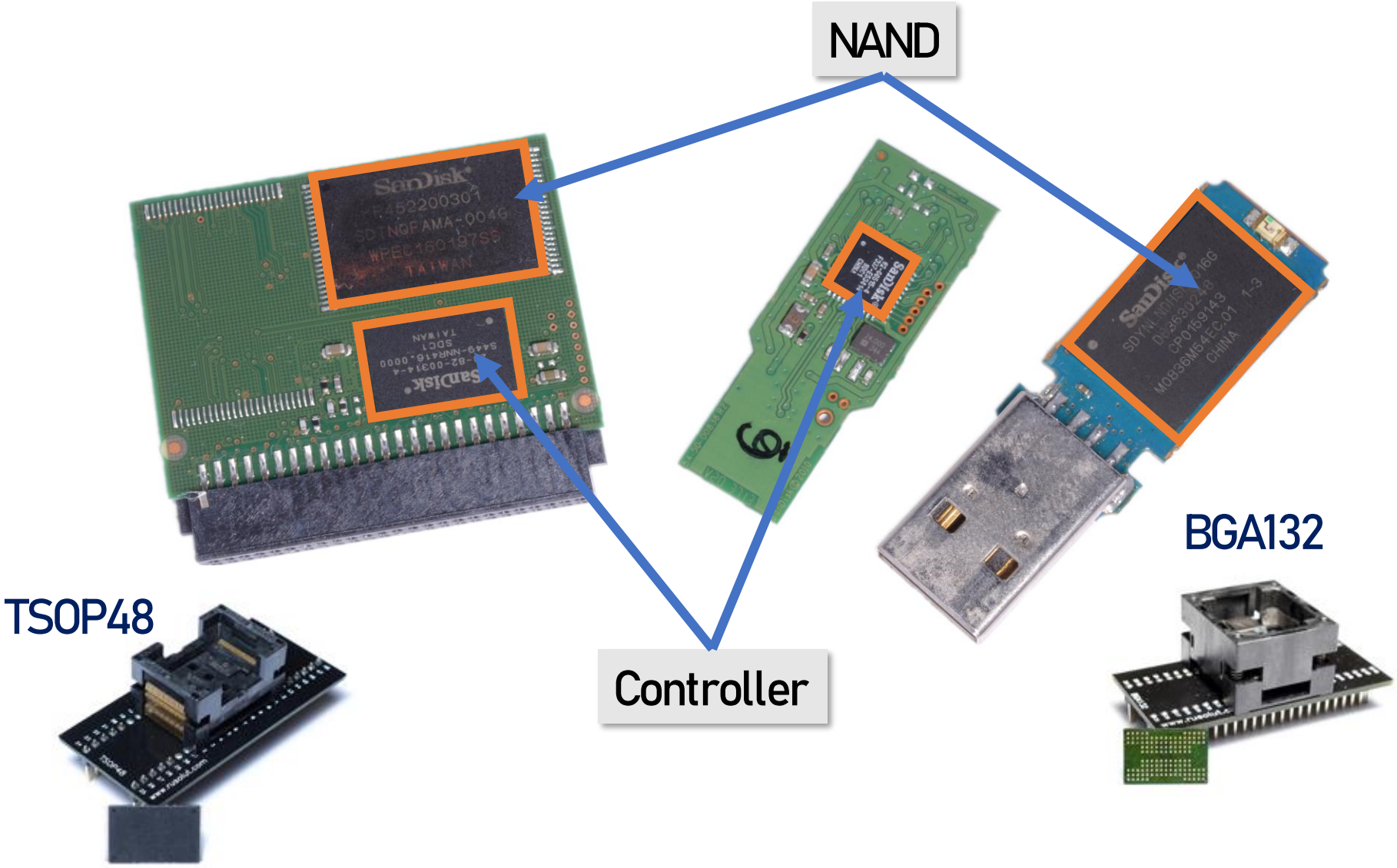
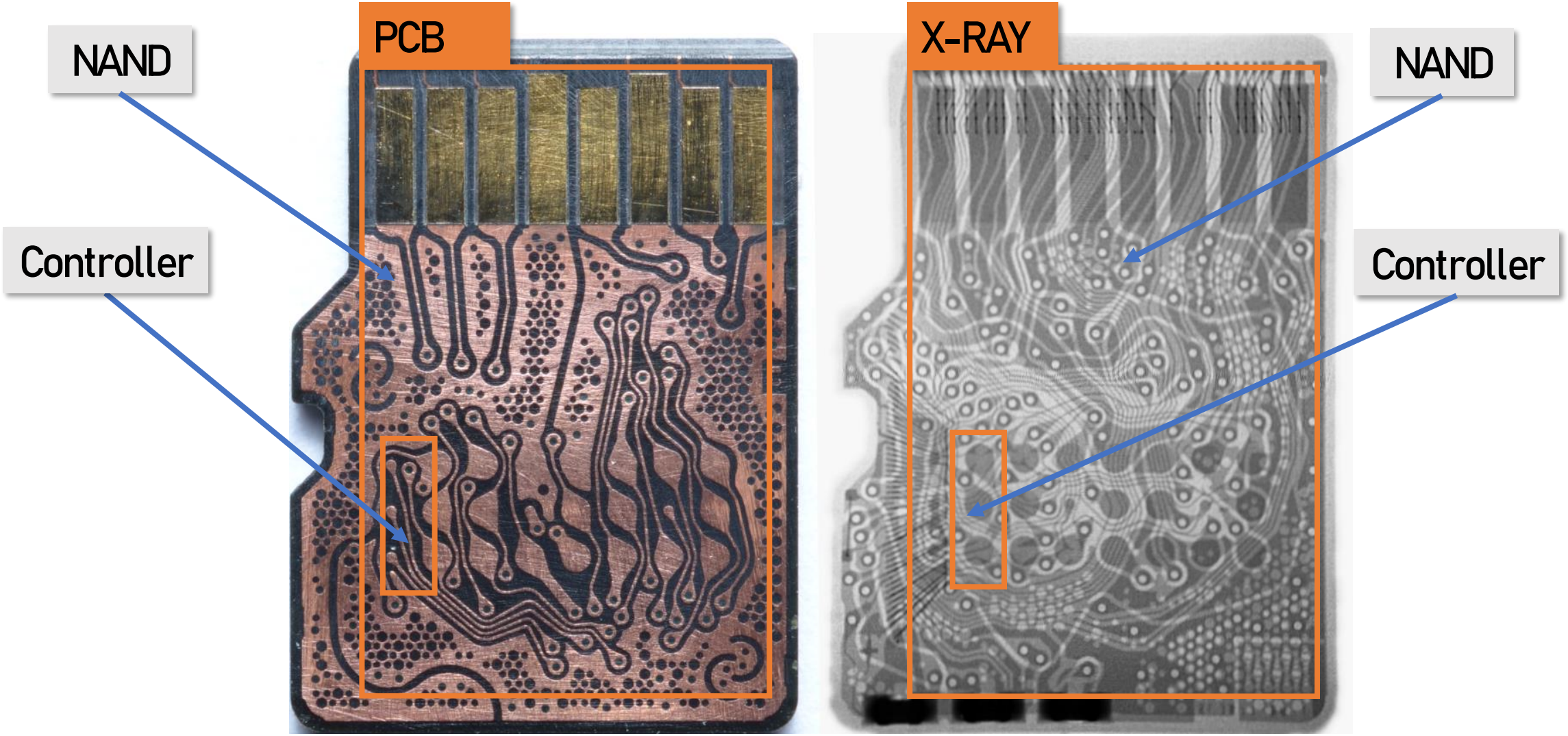
Standard devices



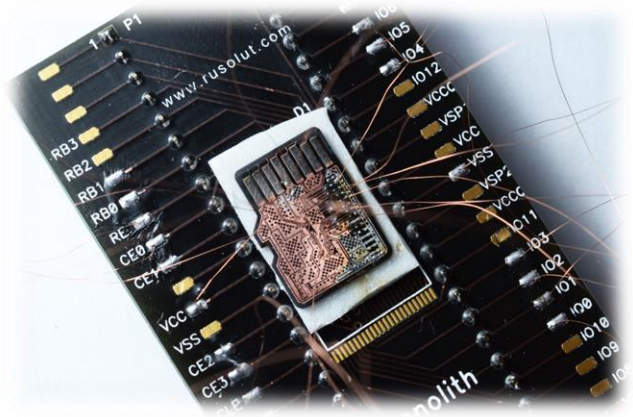
Monolith device



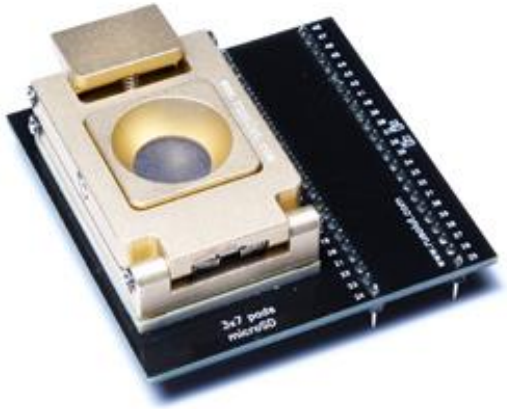
Monolith device

Soldering mask removal

Soldering



Adapter



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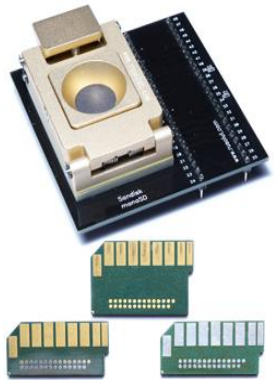
NAND Adapters for SanDisk devices

Removable Storage Media

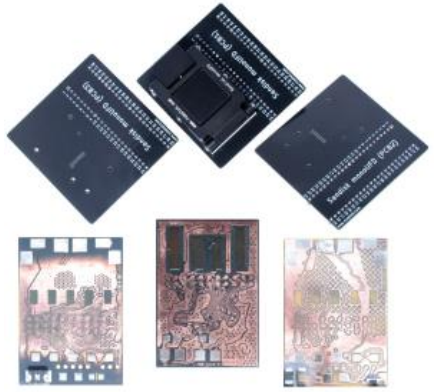
monoSD



TSOP48

microSD

MonoUFD



SSD Drives

BGA152

BGA132

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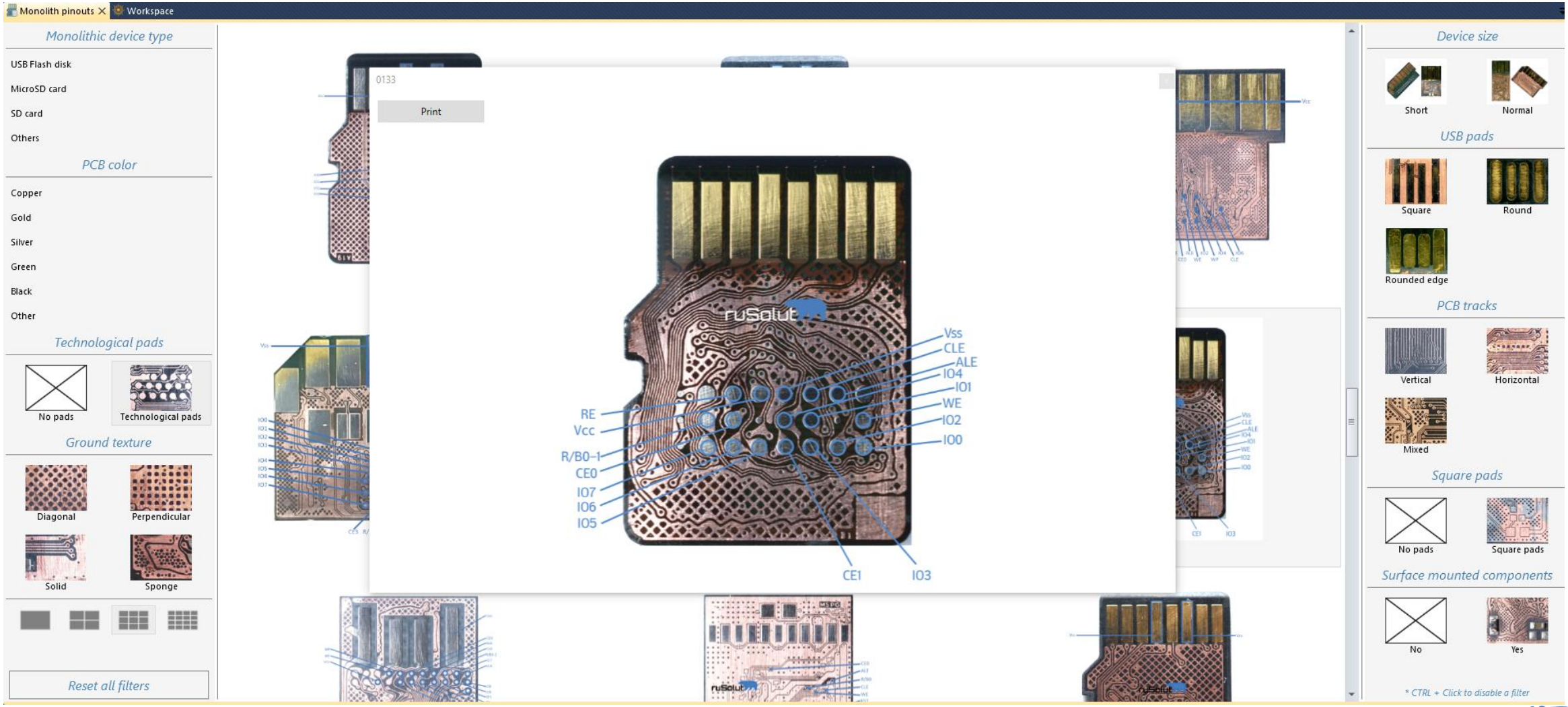
Monolith device - Pinout

Monolith Pinout Database

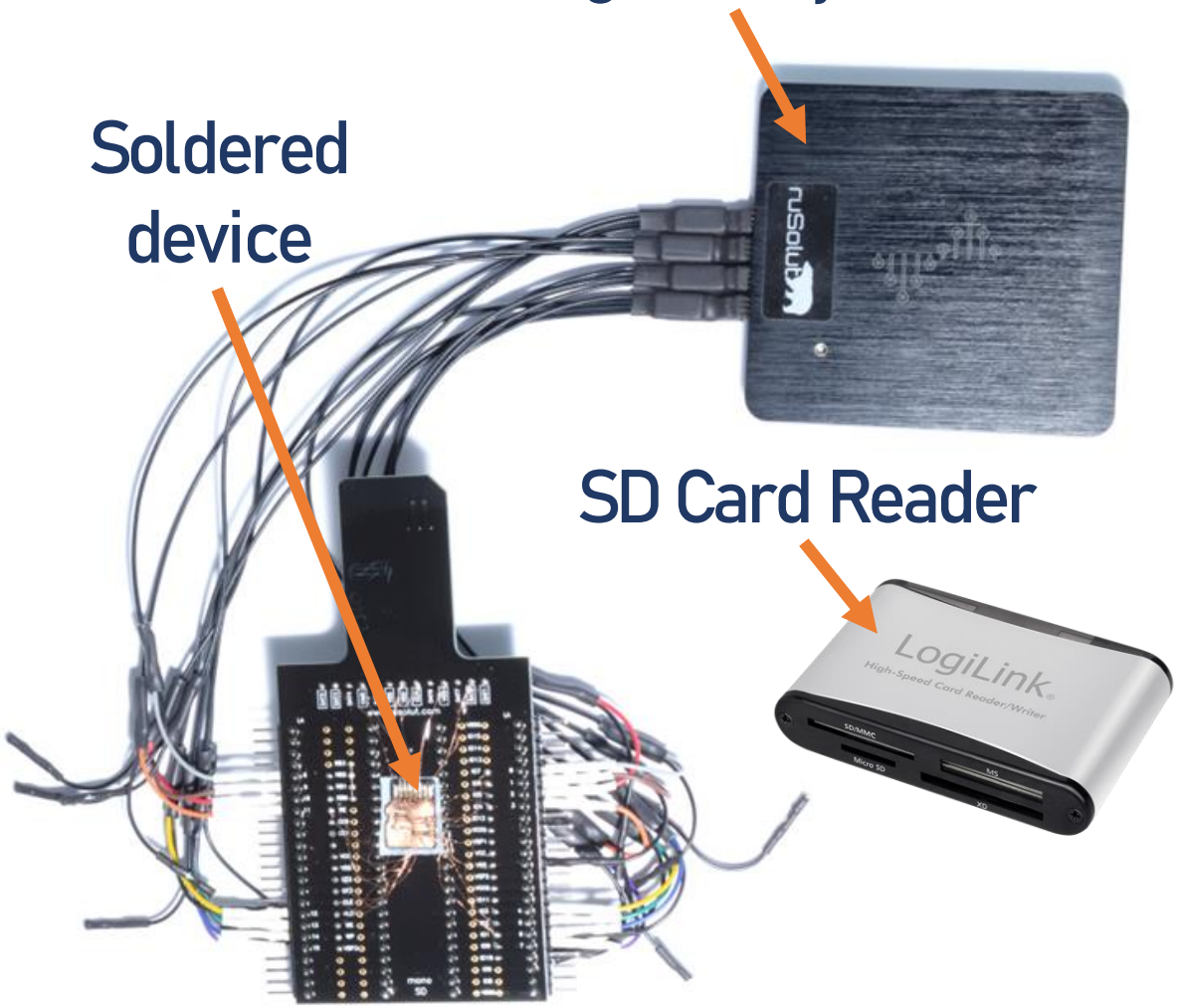


Monolith device – Pinout analysis

Logic analyser

Soldered device

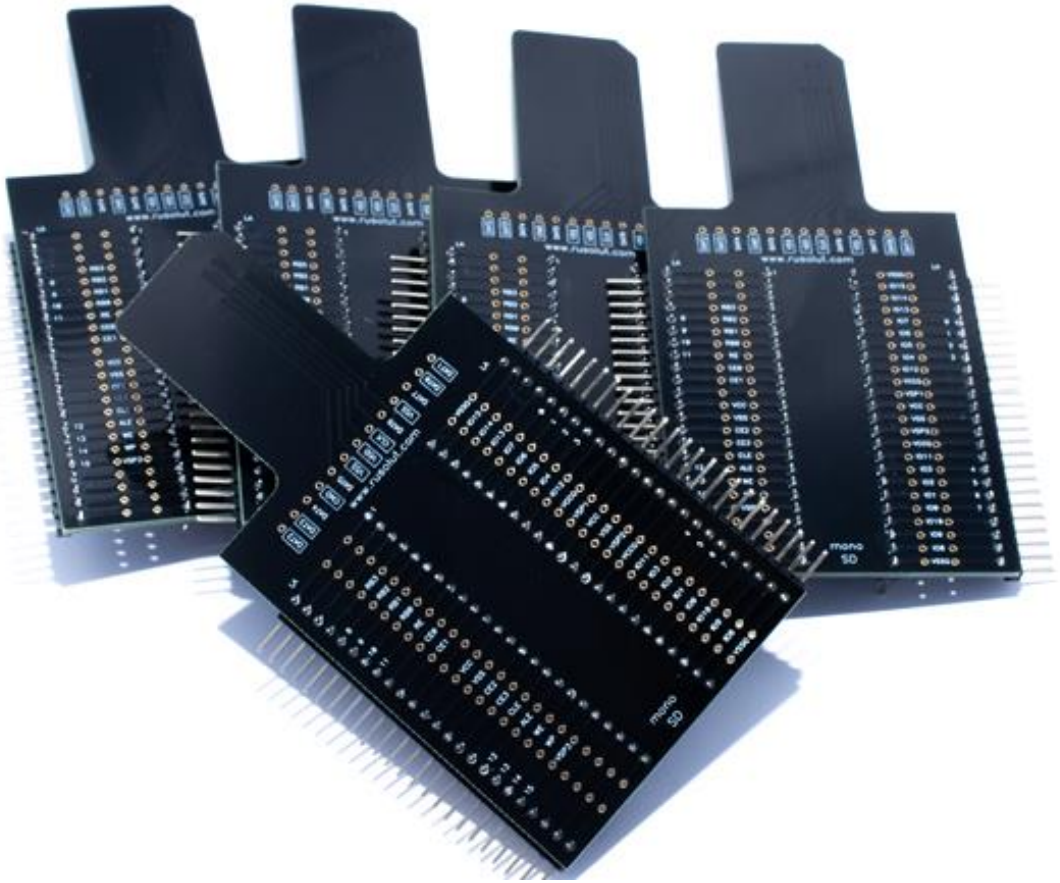
SD Card Reader



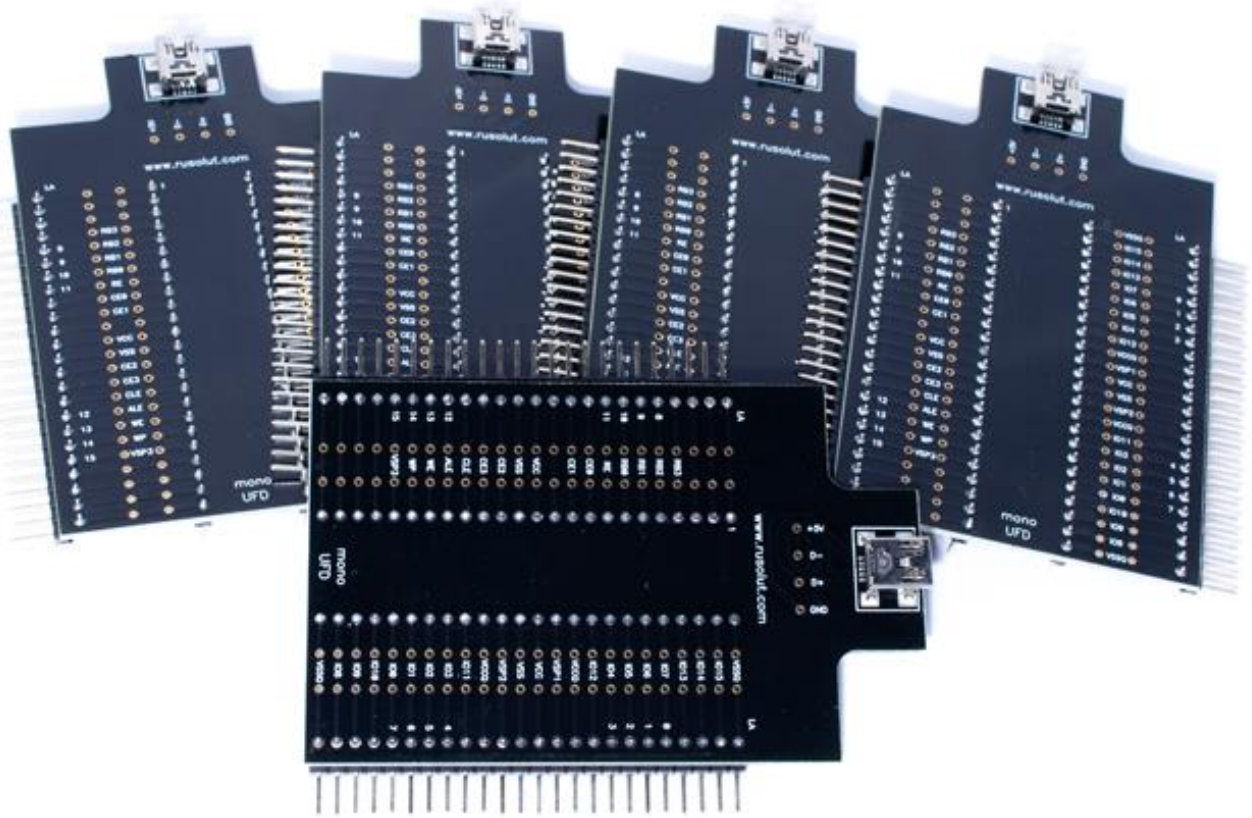
Logic analyser Software – Signal analysis

NAND Adapters for pinout analysis

MonoSD



MonoUFD



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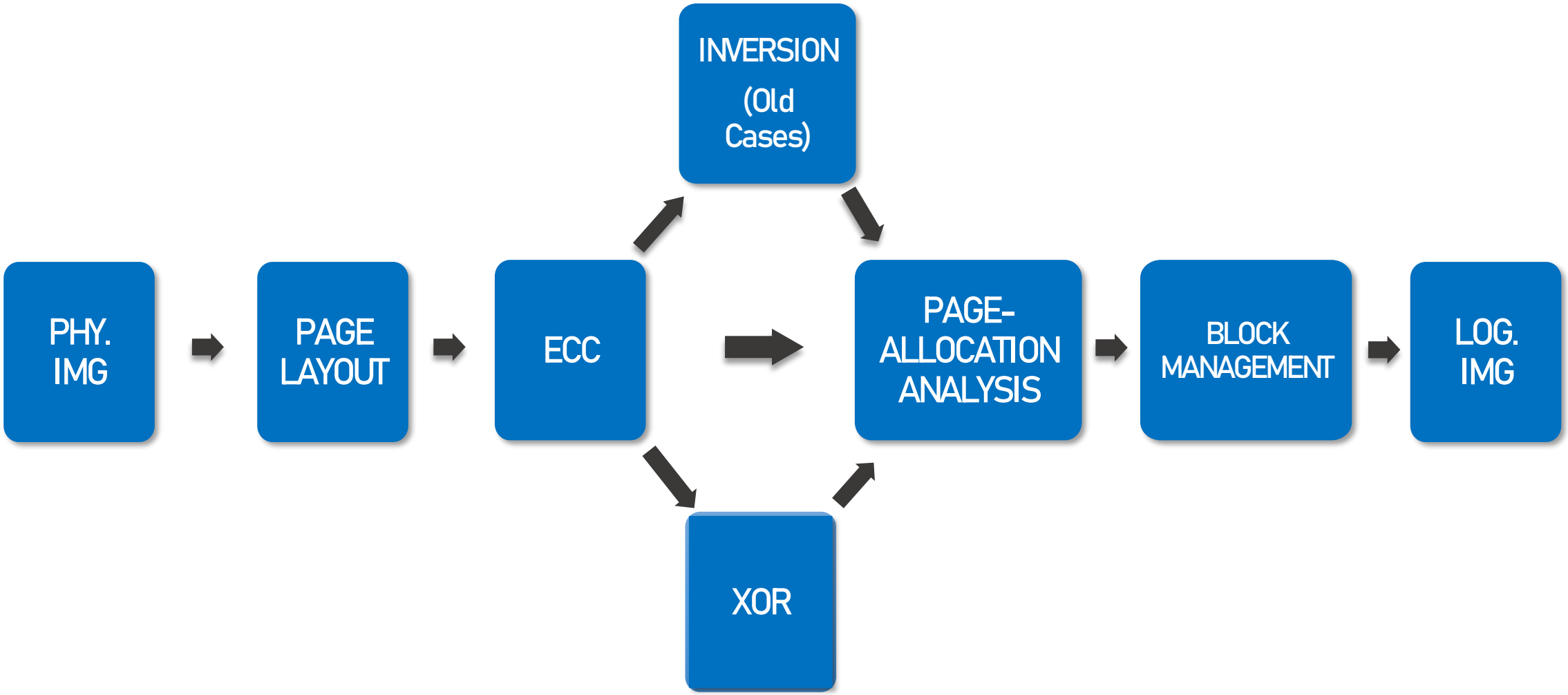
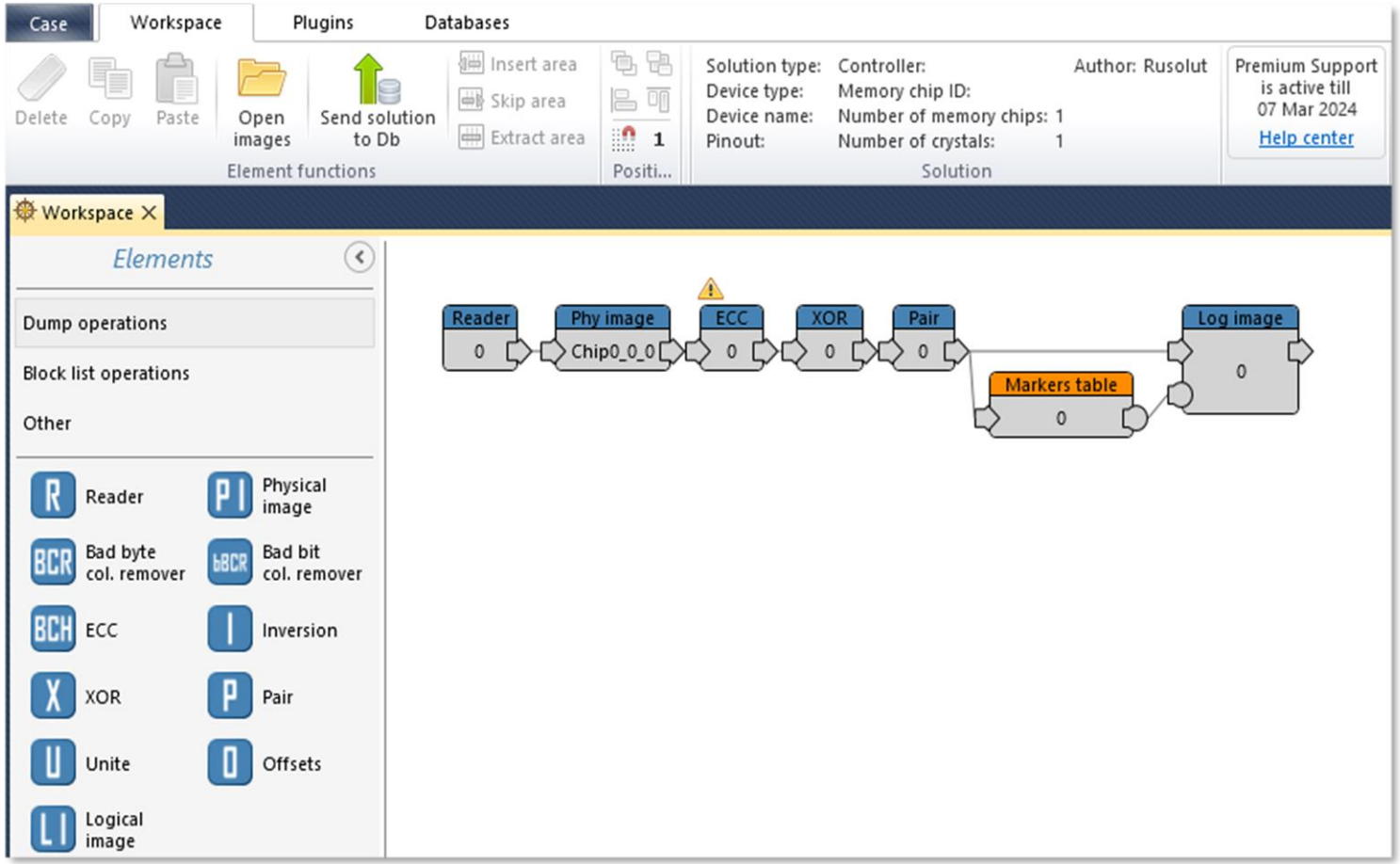
Chip-off data recovery procedure

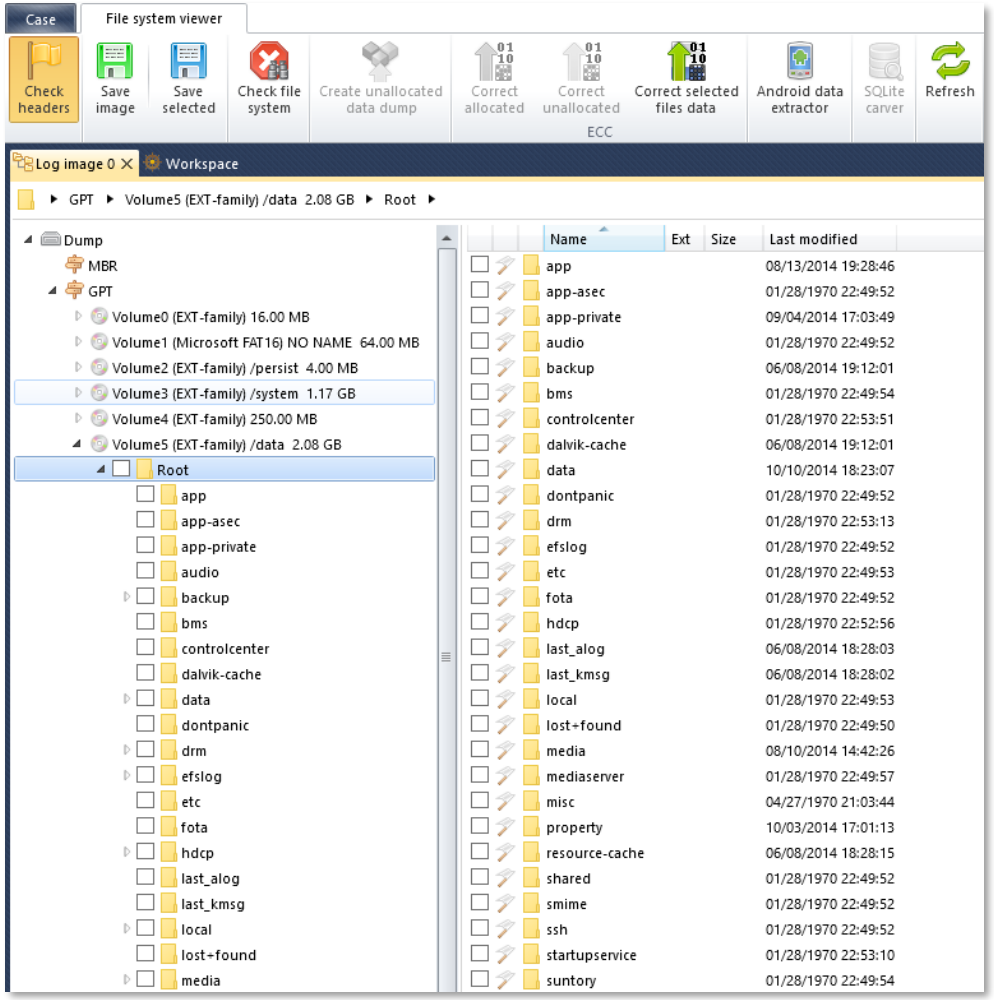


Fully solved case in VNR

Physical image reconstruction in VNR



Data extraction



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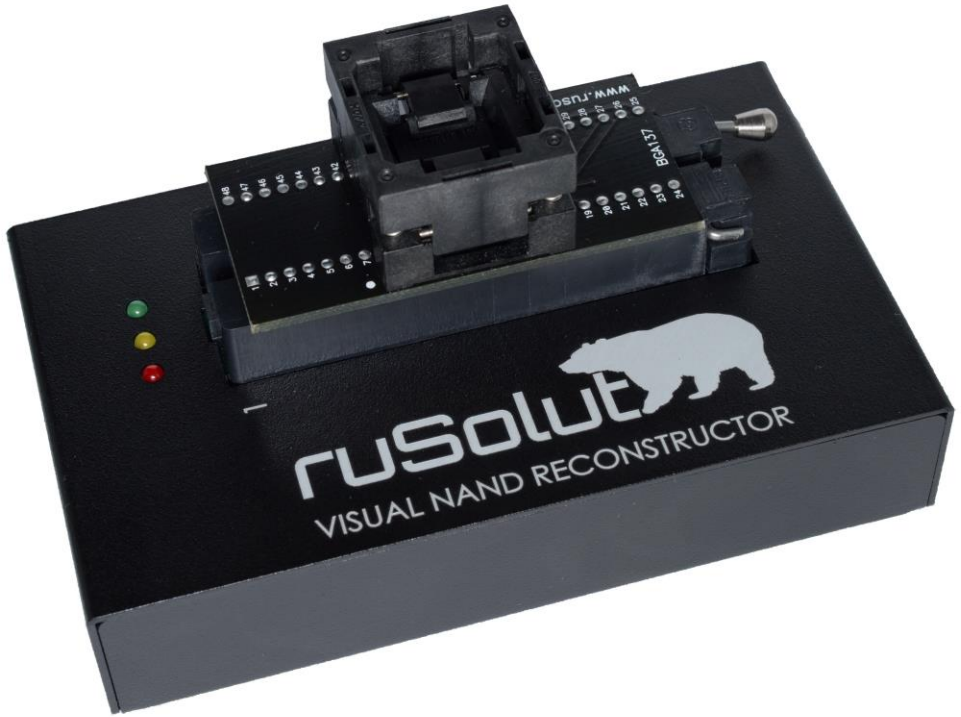
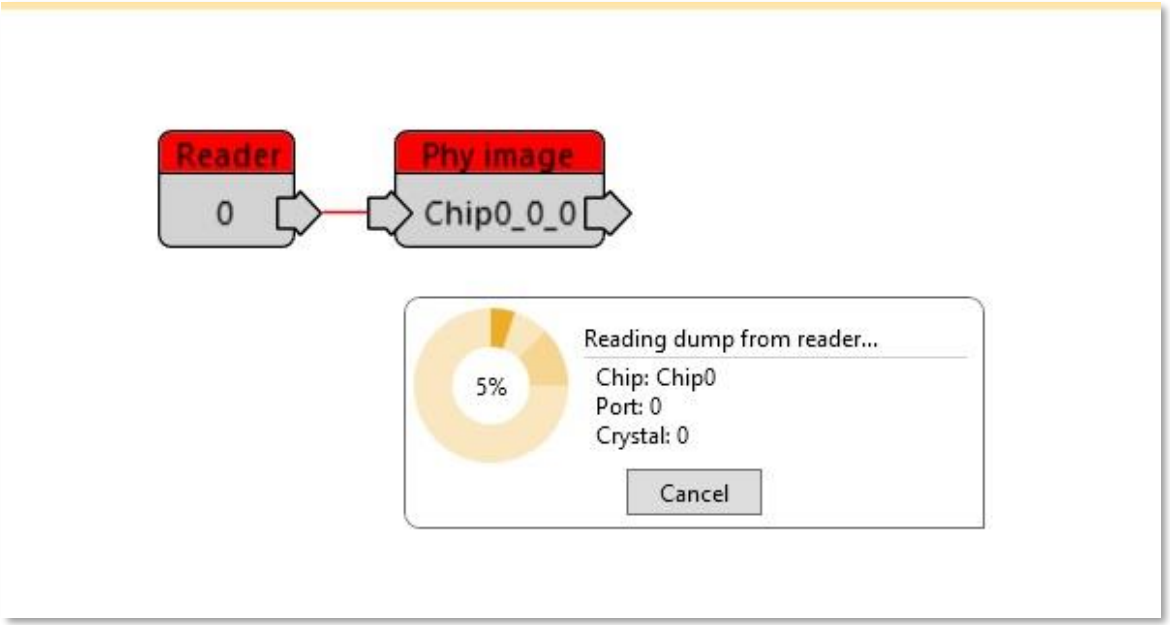
Physical image extraction

Device in the VNR Reader



Reading initialised in the software



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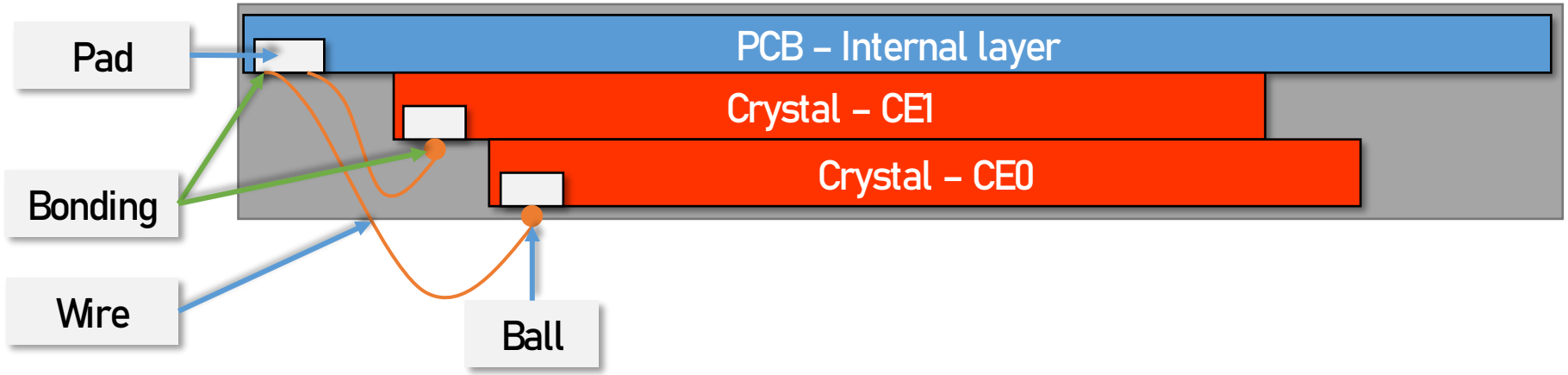
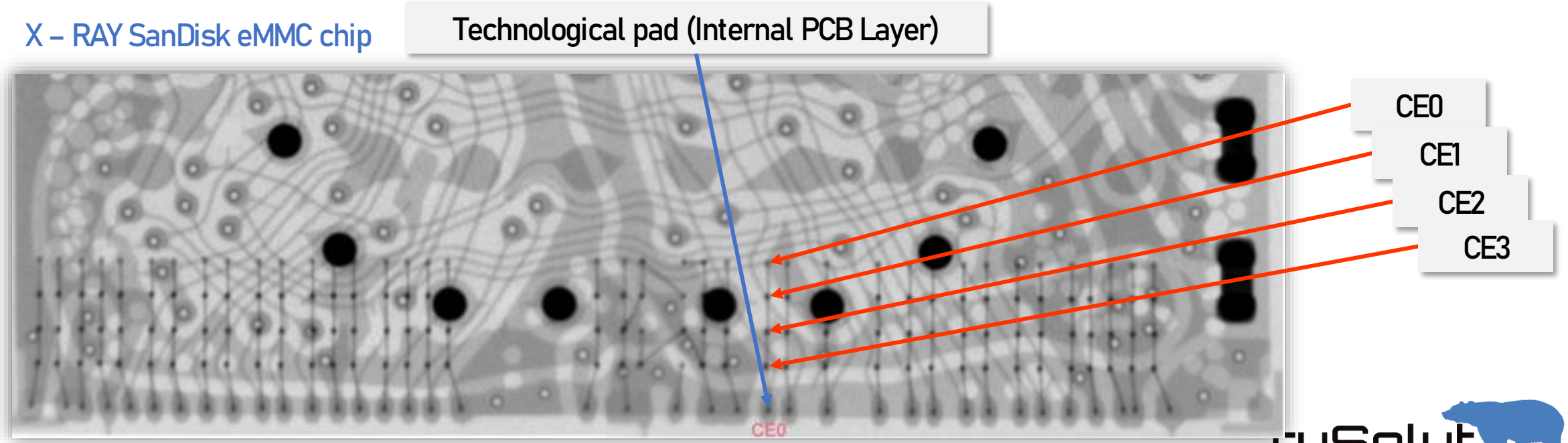
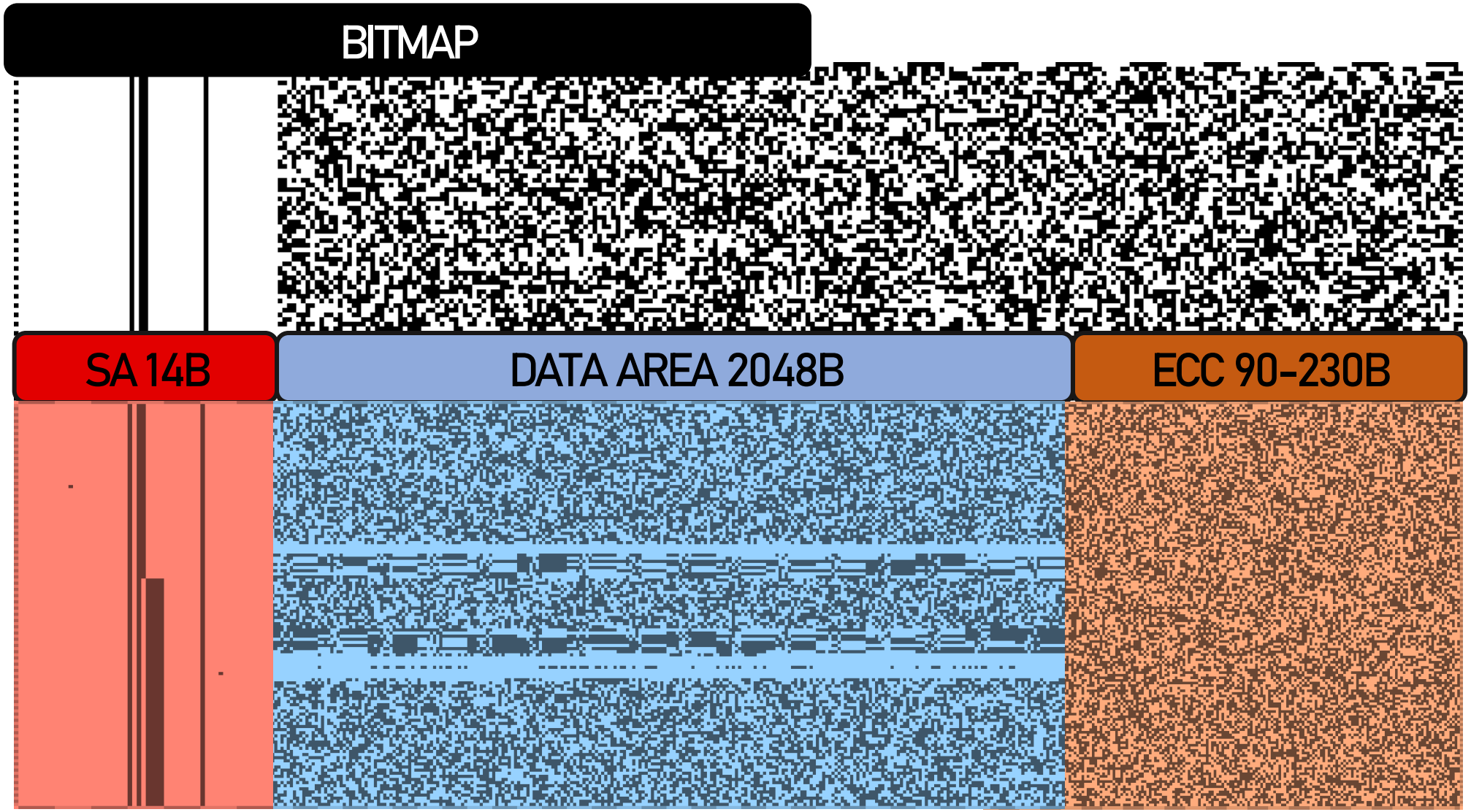
SanDisk multi-crystal devices/chips



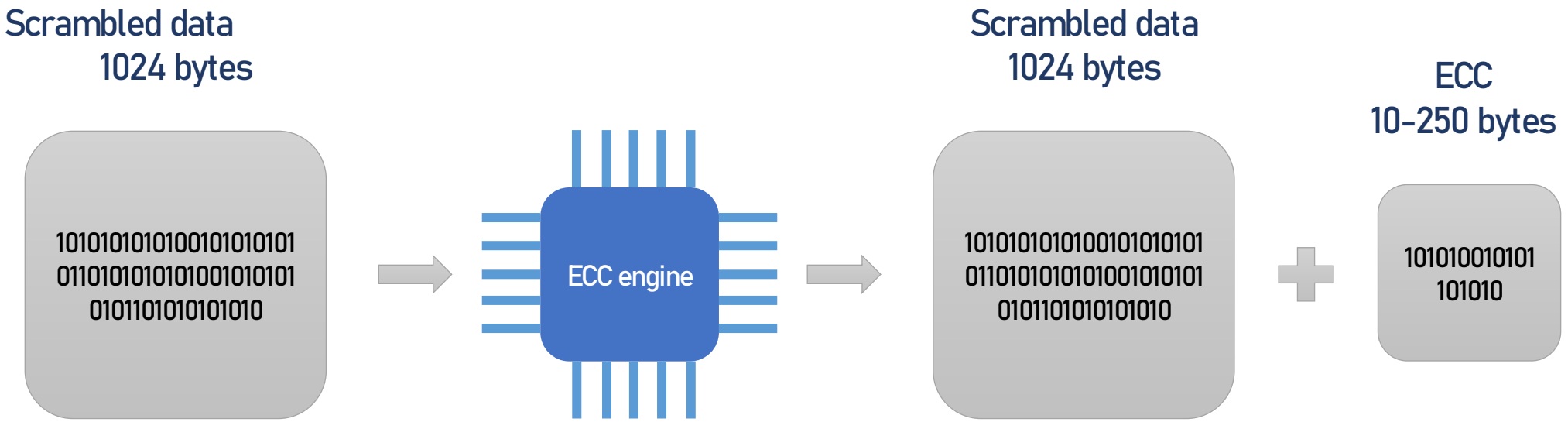
X – RAY SanDisk eMMC chip



Page layout



Error Correction Code(ECC)



ECC algorithms

- Hamming code (OLD)
- Reed-Solomon code (OLD)
- BCH
- LDPC

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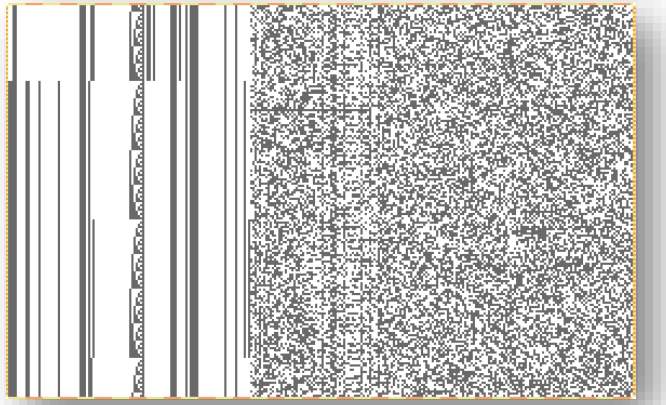
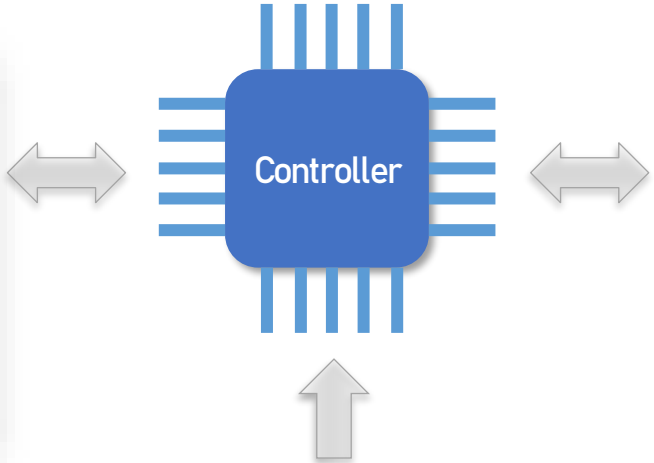
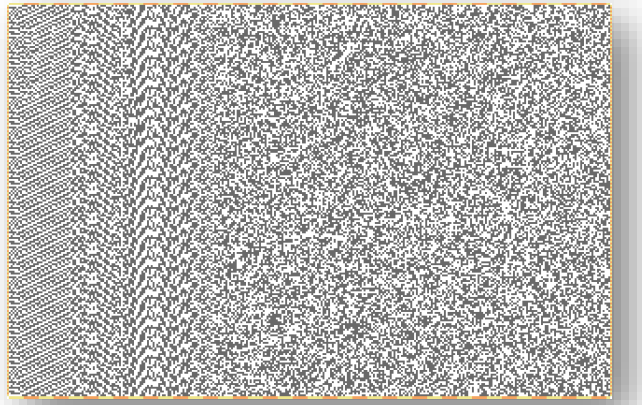
Scrambler XOR key

DATA

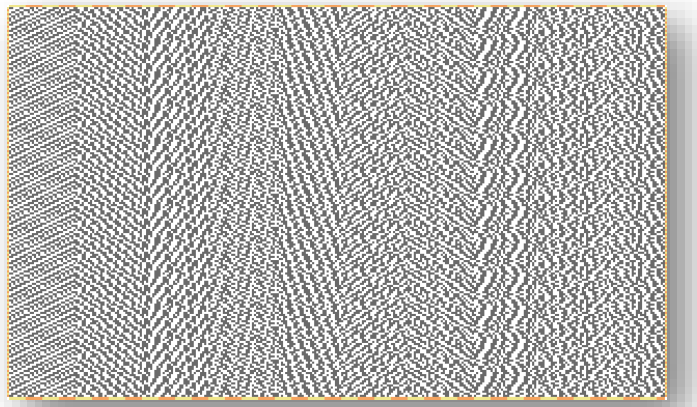




SCRAMBLED DATA

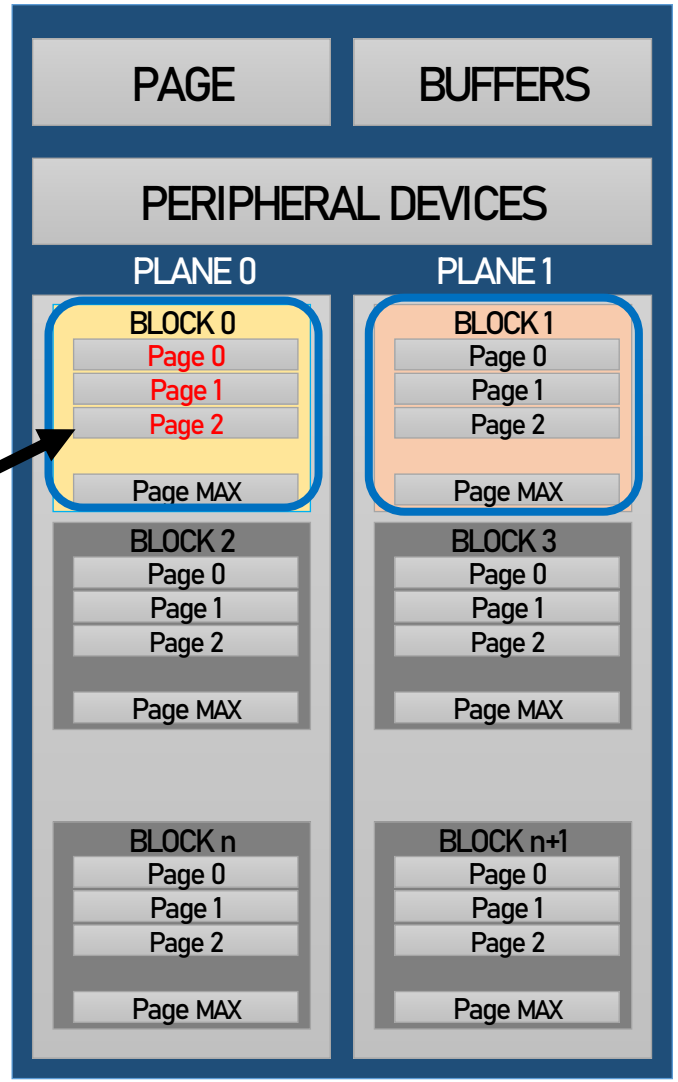


XOR key



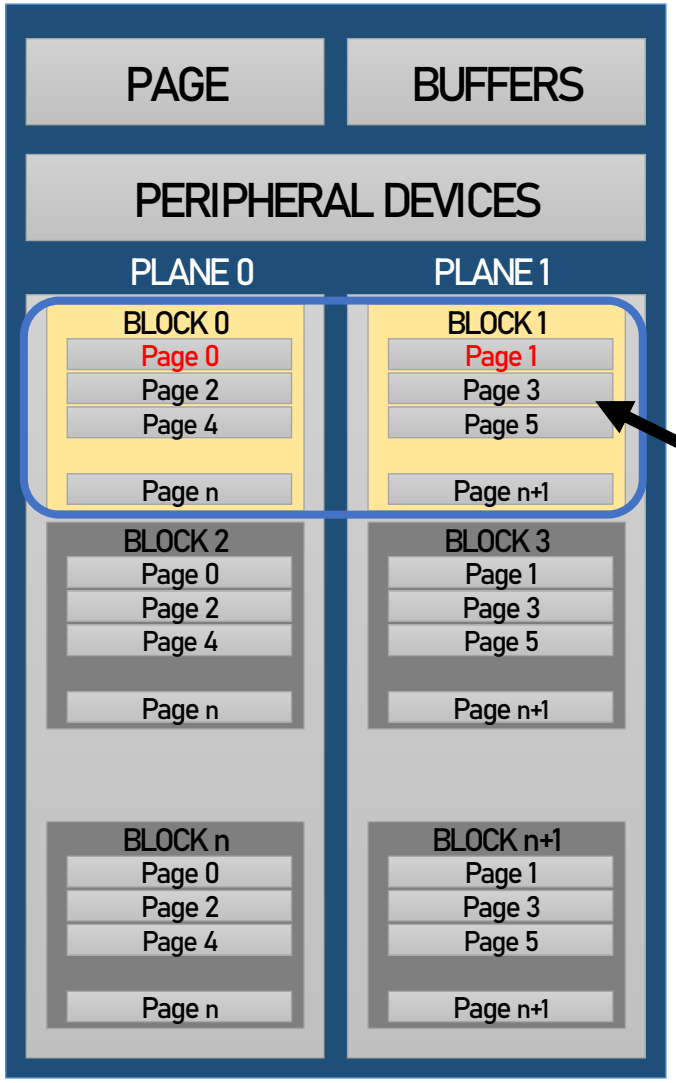
Page allocation modes

SINGLE-PLANE PAGE ALLOCATION



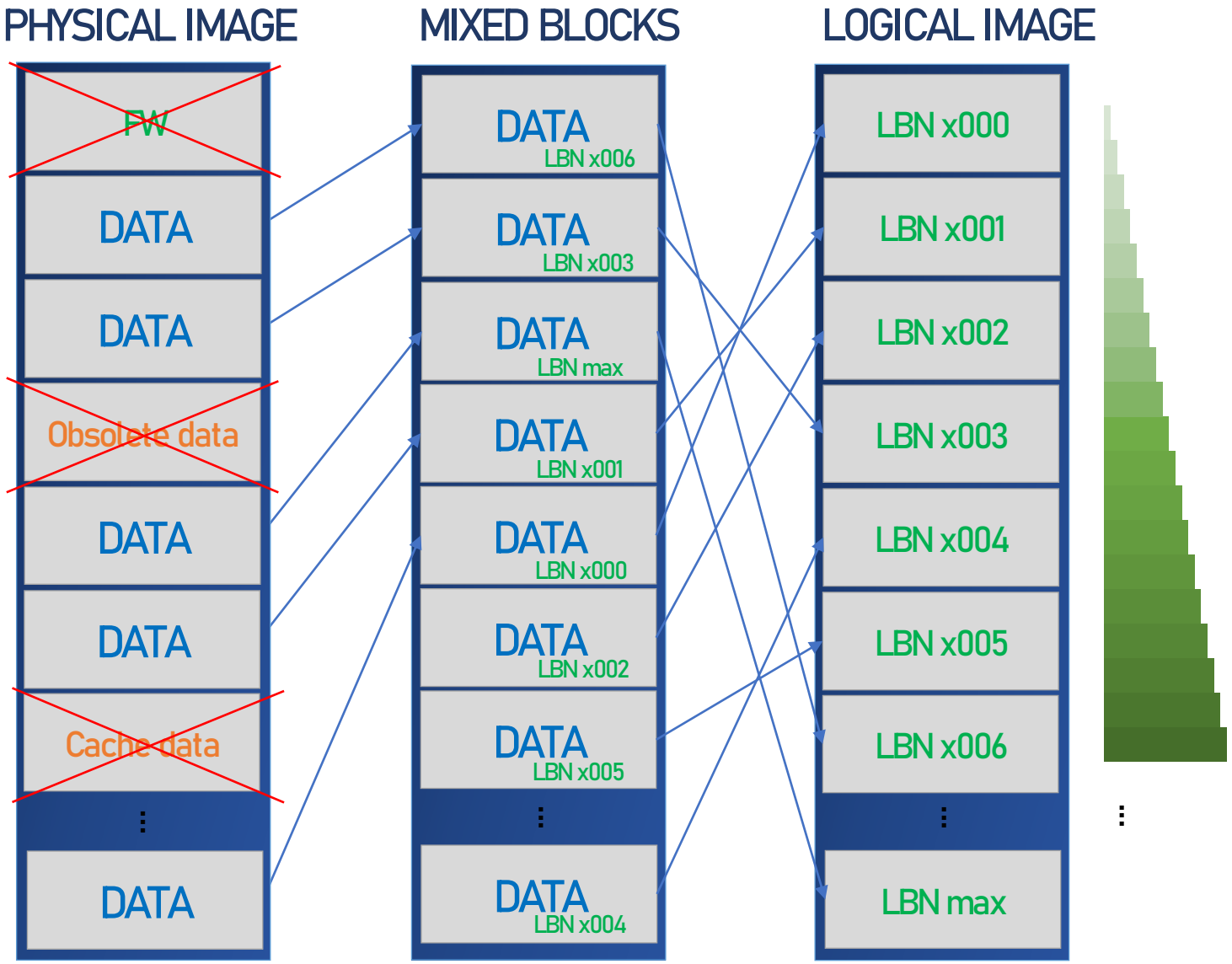
Logical block = 1 Physical block

MULTI-PLANE PAGE ALLOCATION



Logical block = 2 Physical blocks

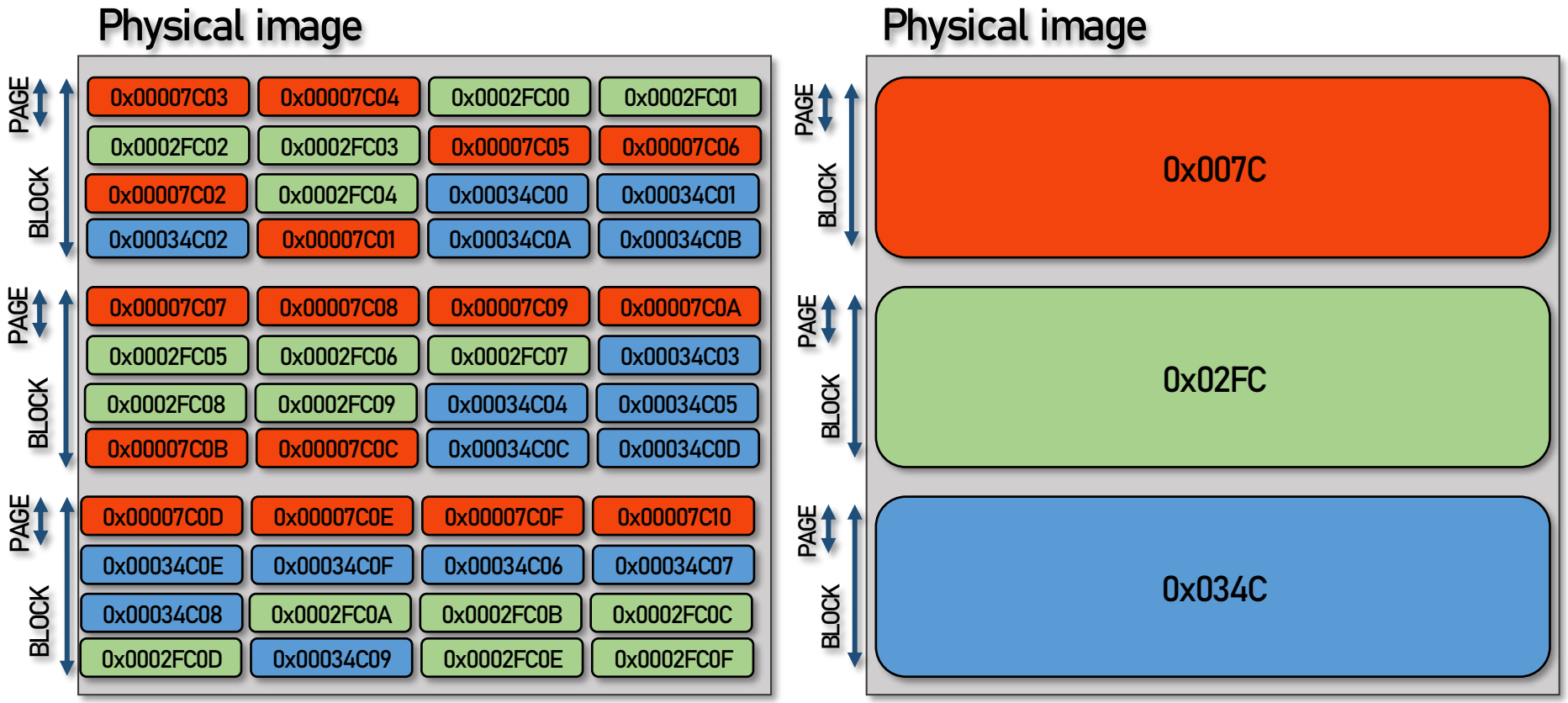
Block management



Block management

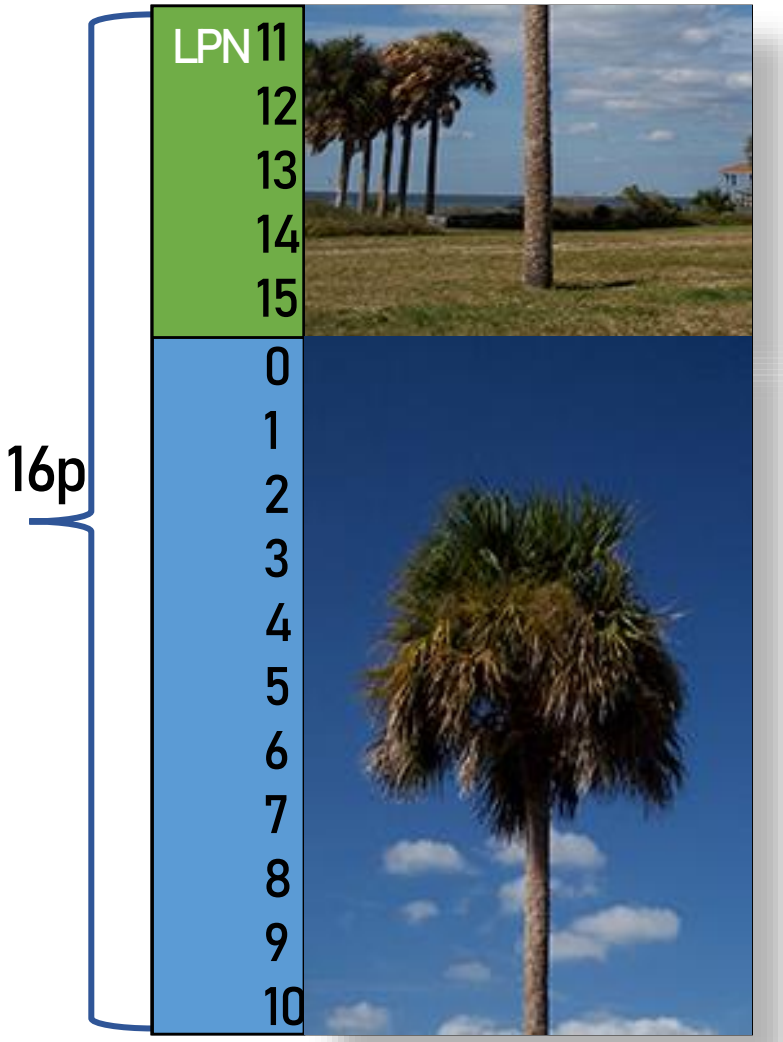
Controller allocates data using 4KB chunks.

The controller allocates the data inside the logical blocks. Avg. log. Block size = 4096KB



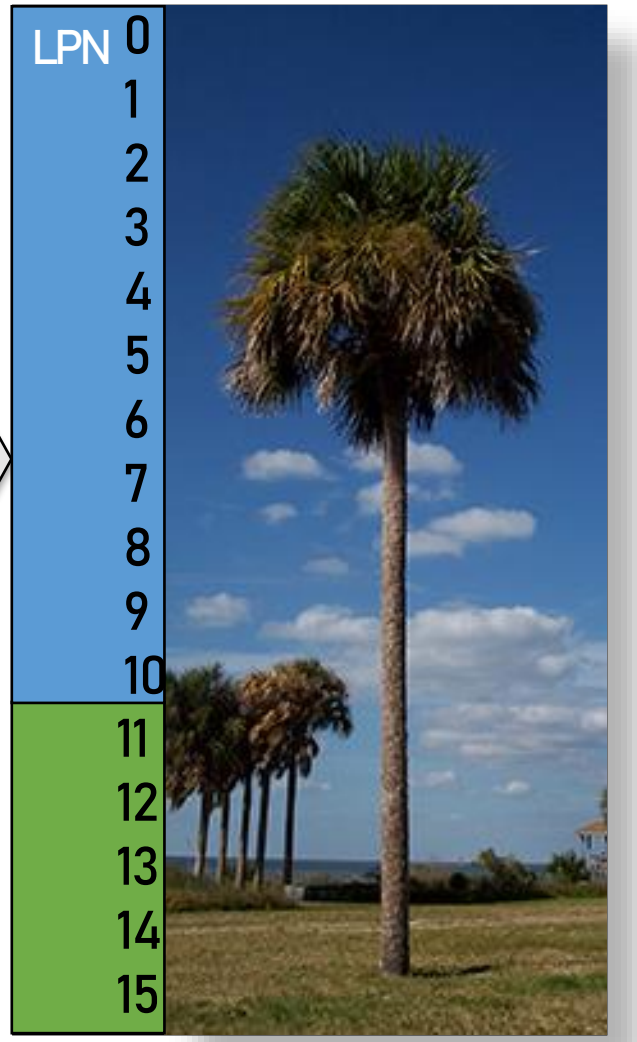
Block rotation

Block in Physical dump



BLOCK ROTATION

Same block after rotation



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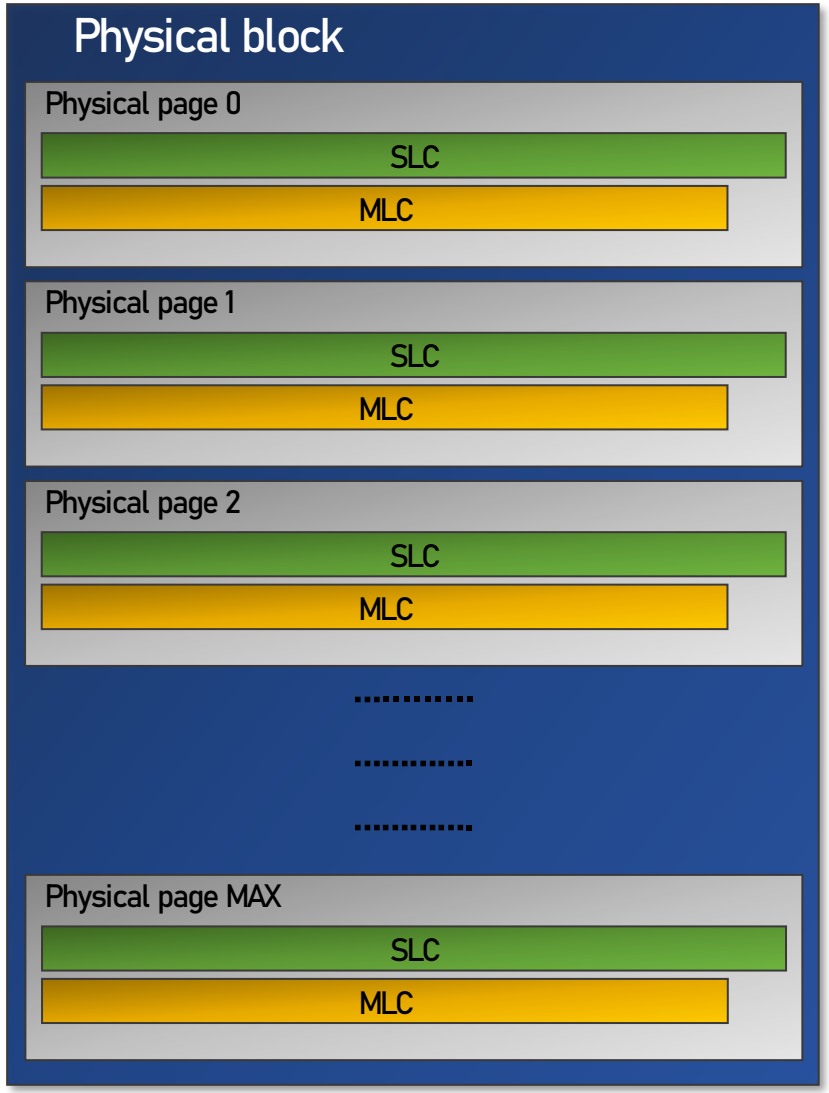
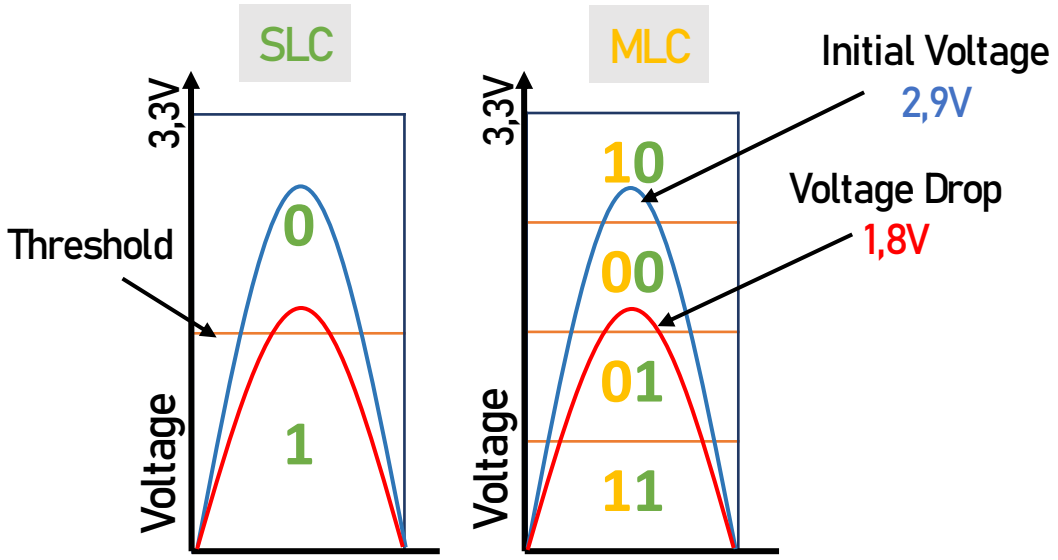
Pattern of SLC Block in MLC memory

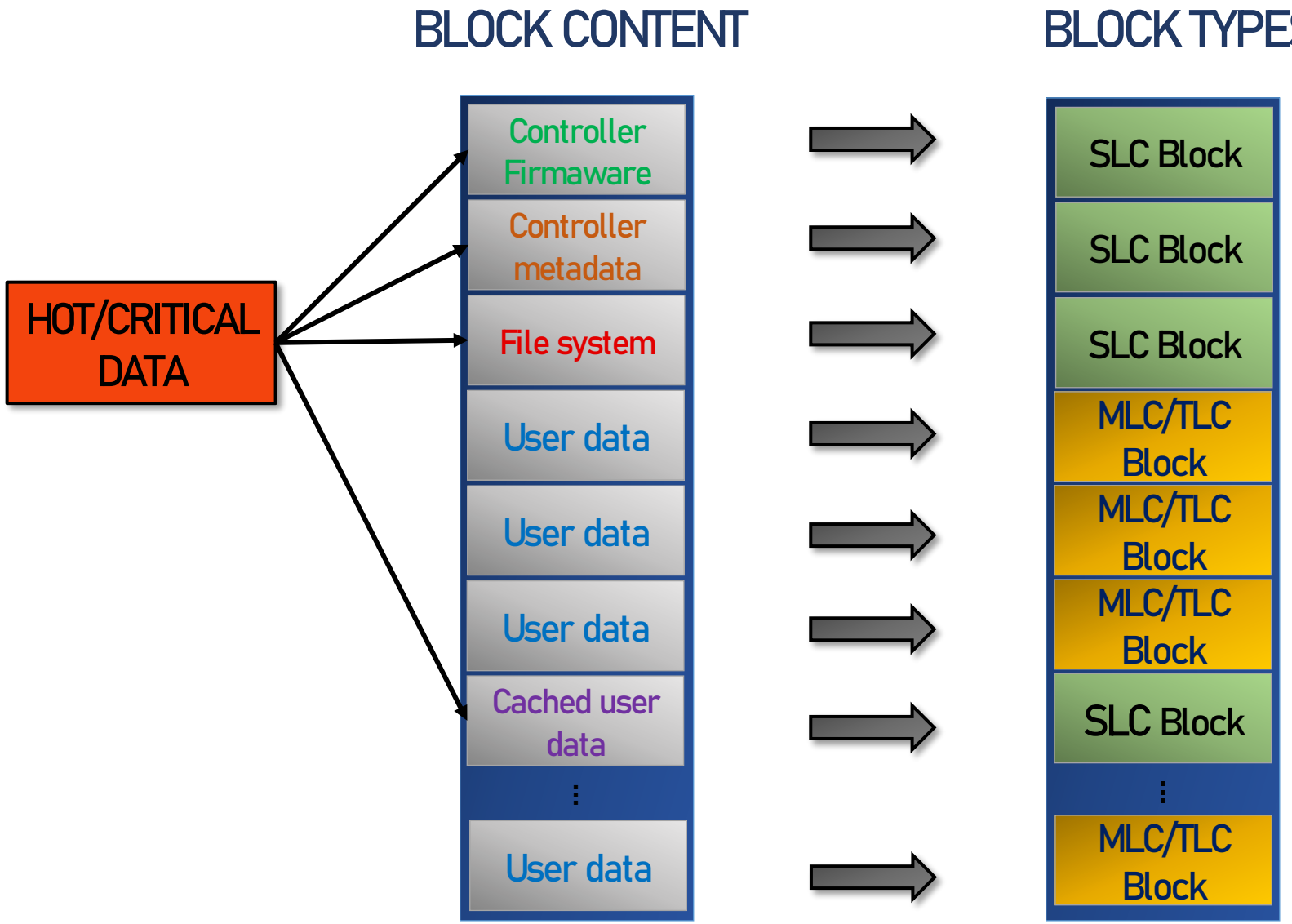
SLC Block in MLC NAND Memory



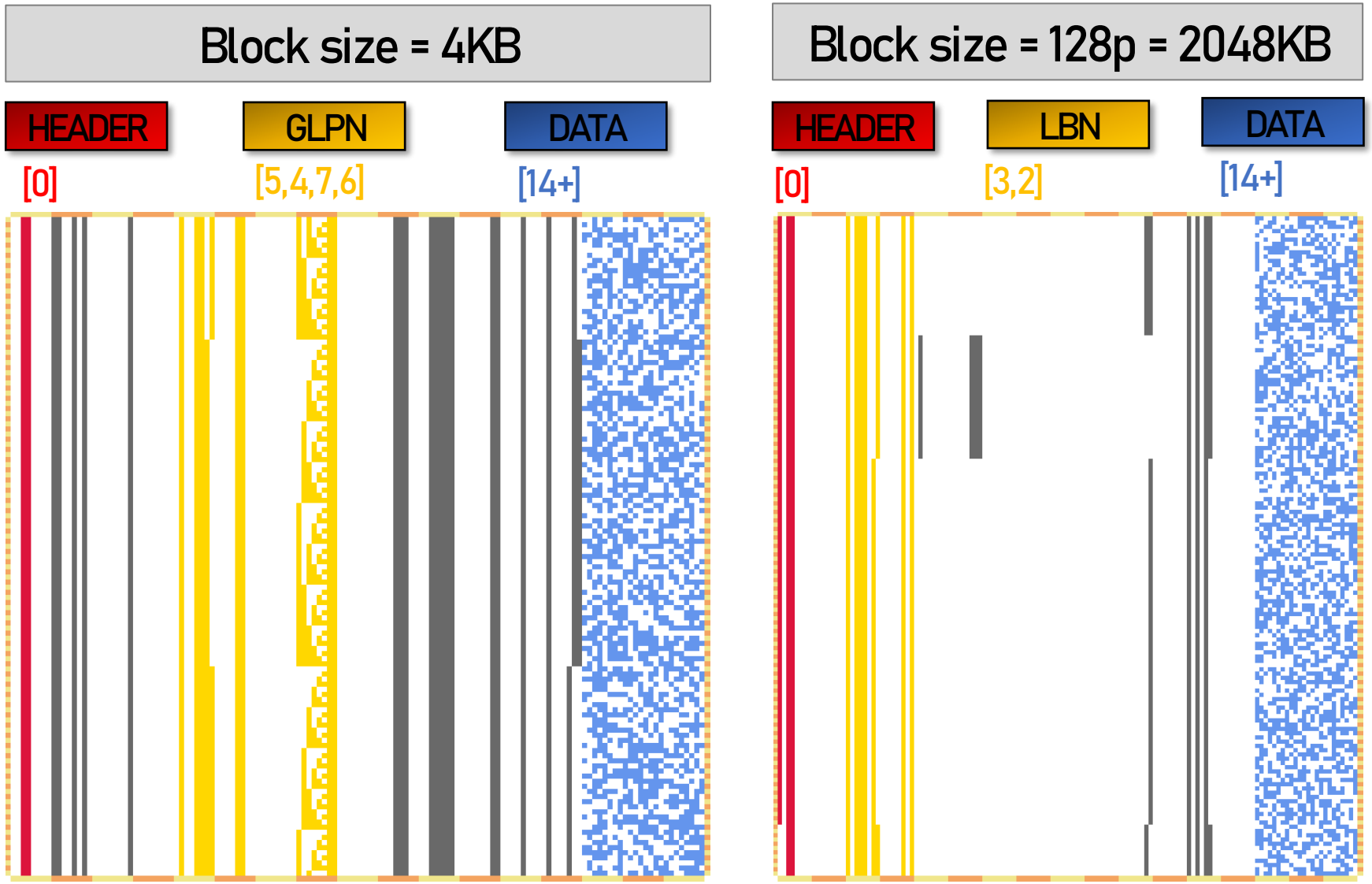


CELL	2,9V	1,8V	ECC MAP
SLC	0	0	No error
MLC	10	00	Bit error

Usage of SLC Blocks



SanDisk Service Areas



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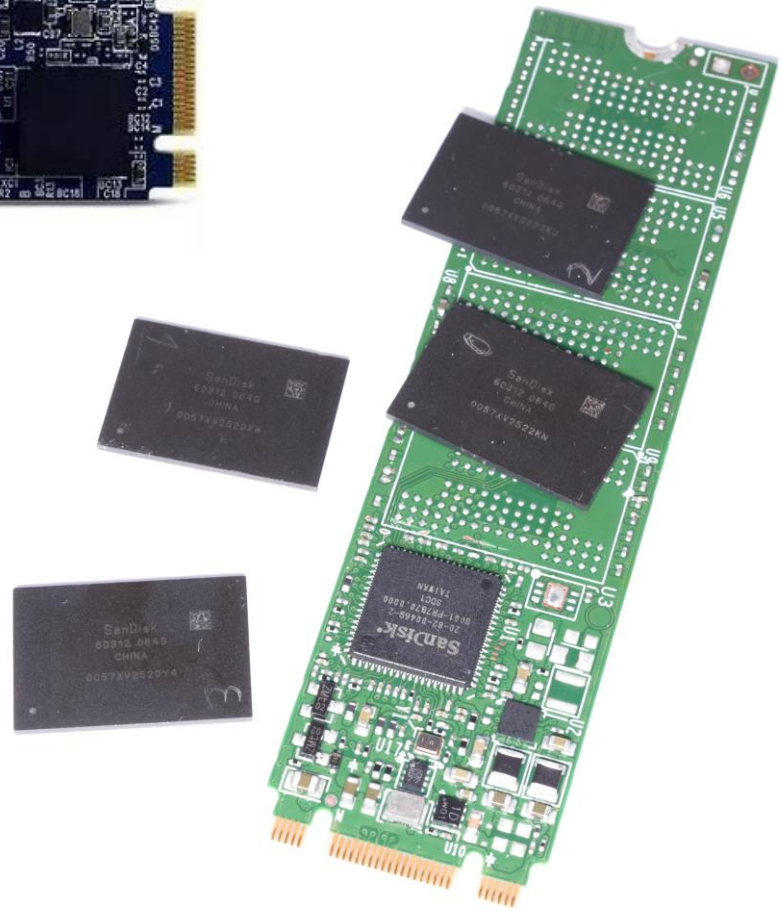
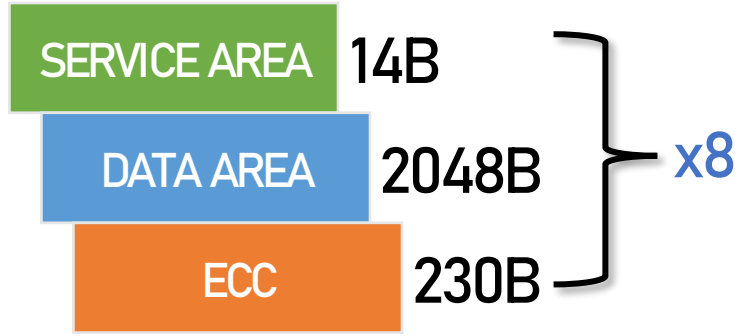
Western Digital Green SSD

Sandisk 20-82-00469-2



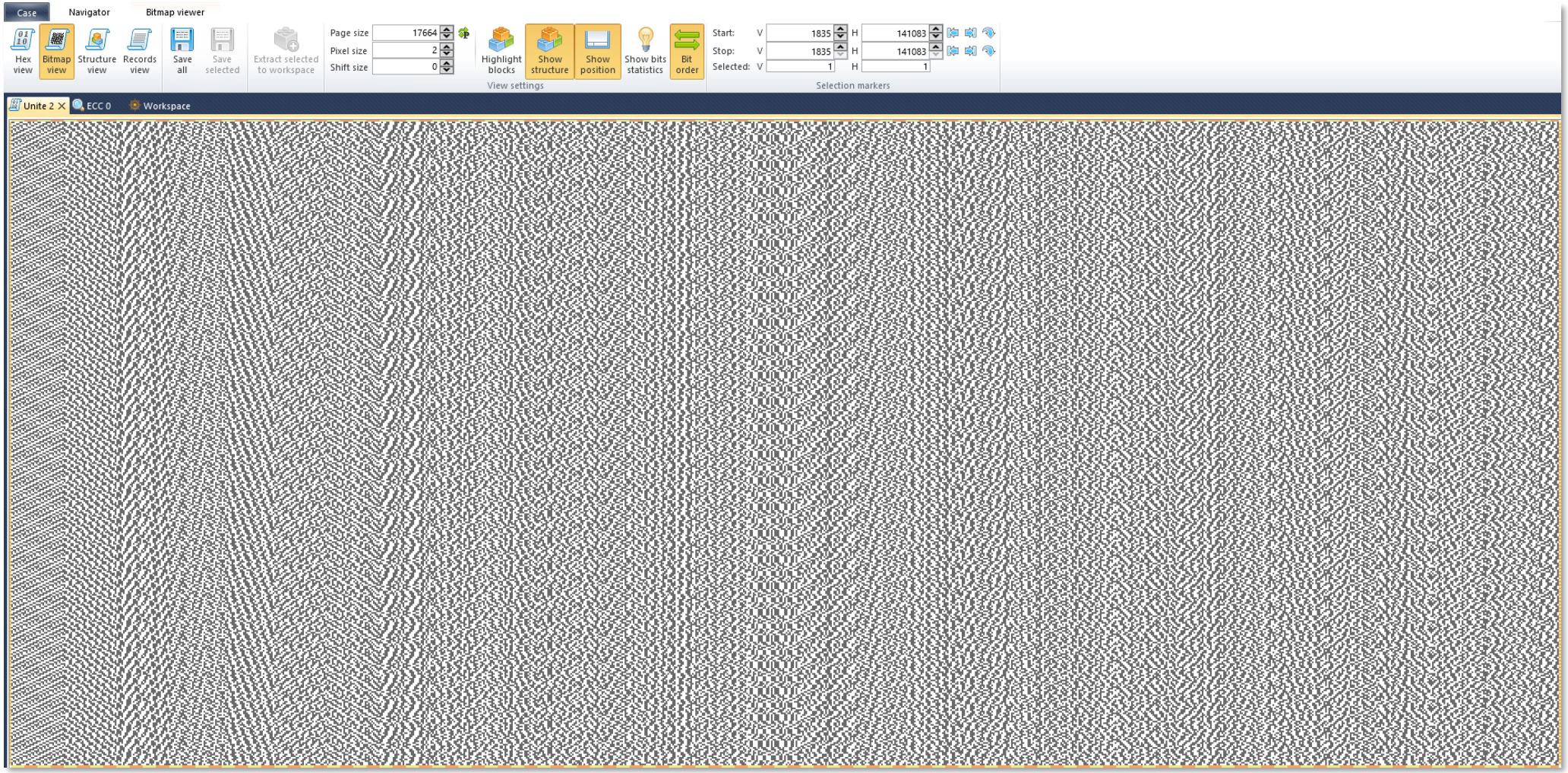
Sandisk 20-82-00469-2

Page structure



Sandisk 20-82-00469-2

Scrambler XOR key



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Sandisk 20-82-00469-2

Block management

Block size
4KB

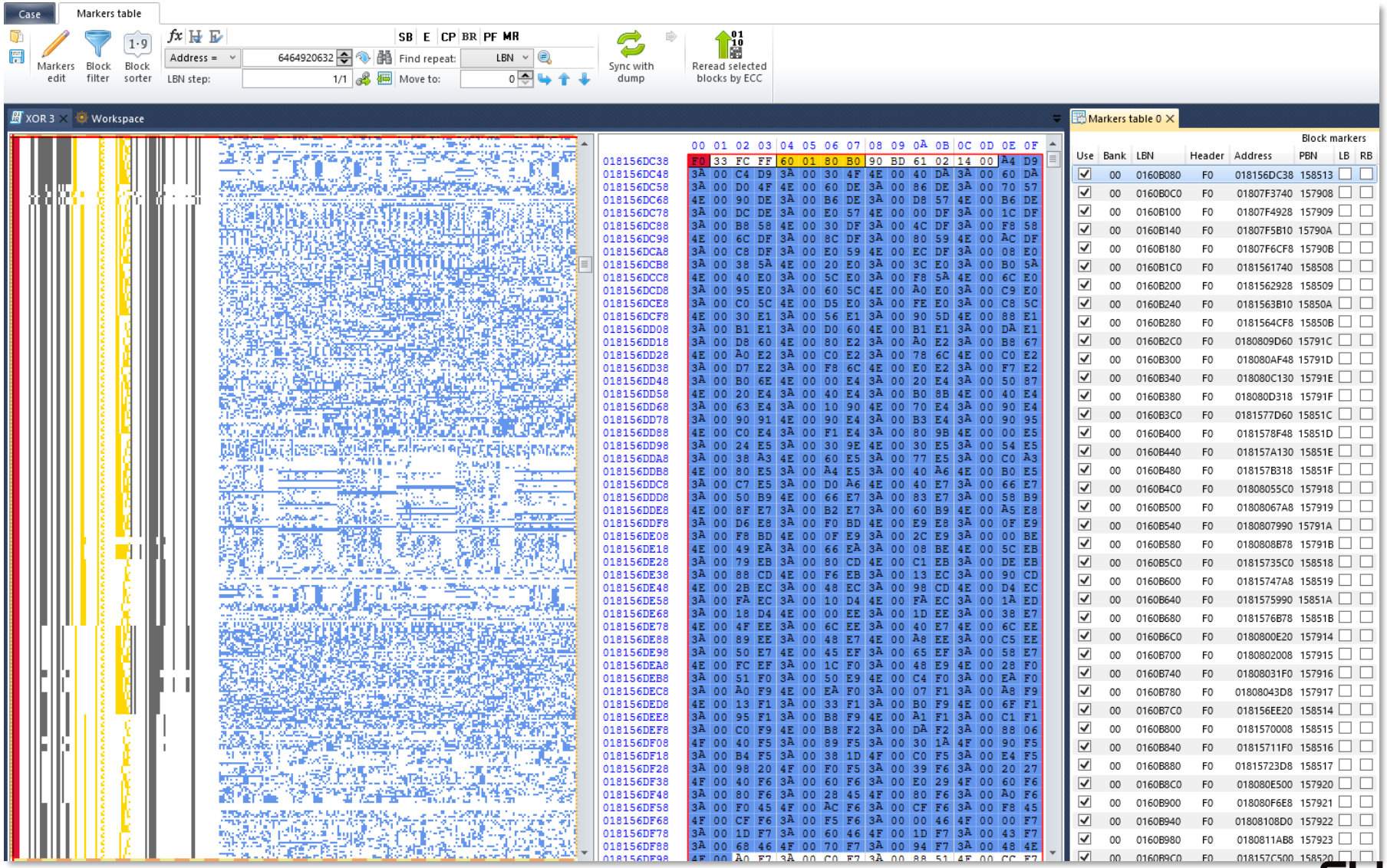
SERVICE AREA

HEADER

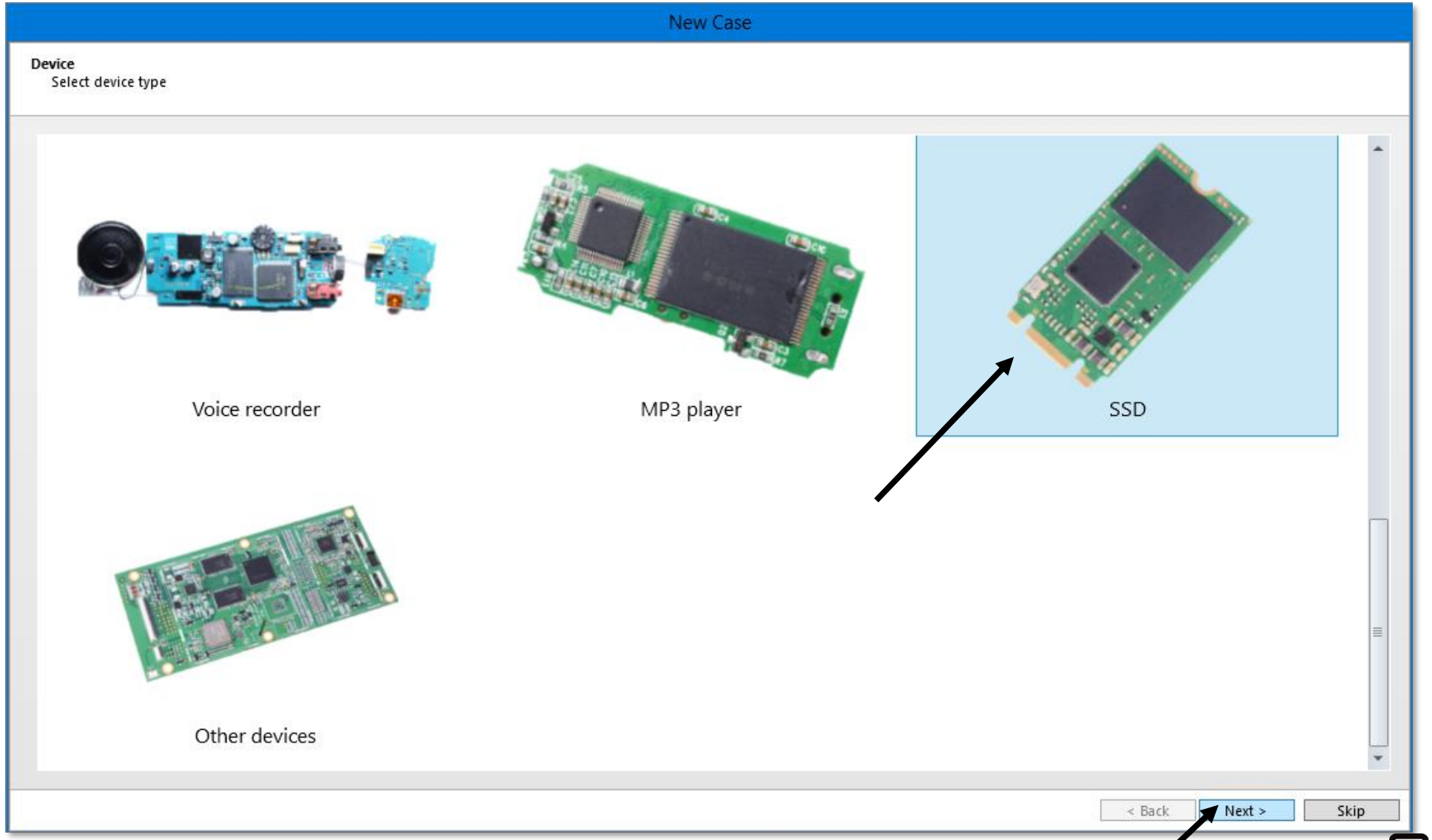
[0]

GLPN

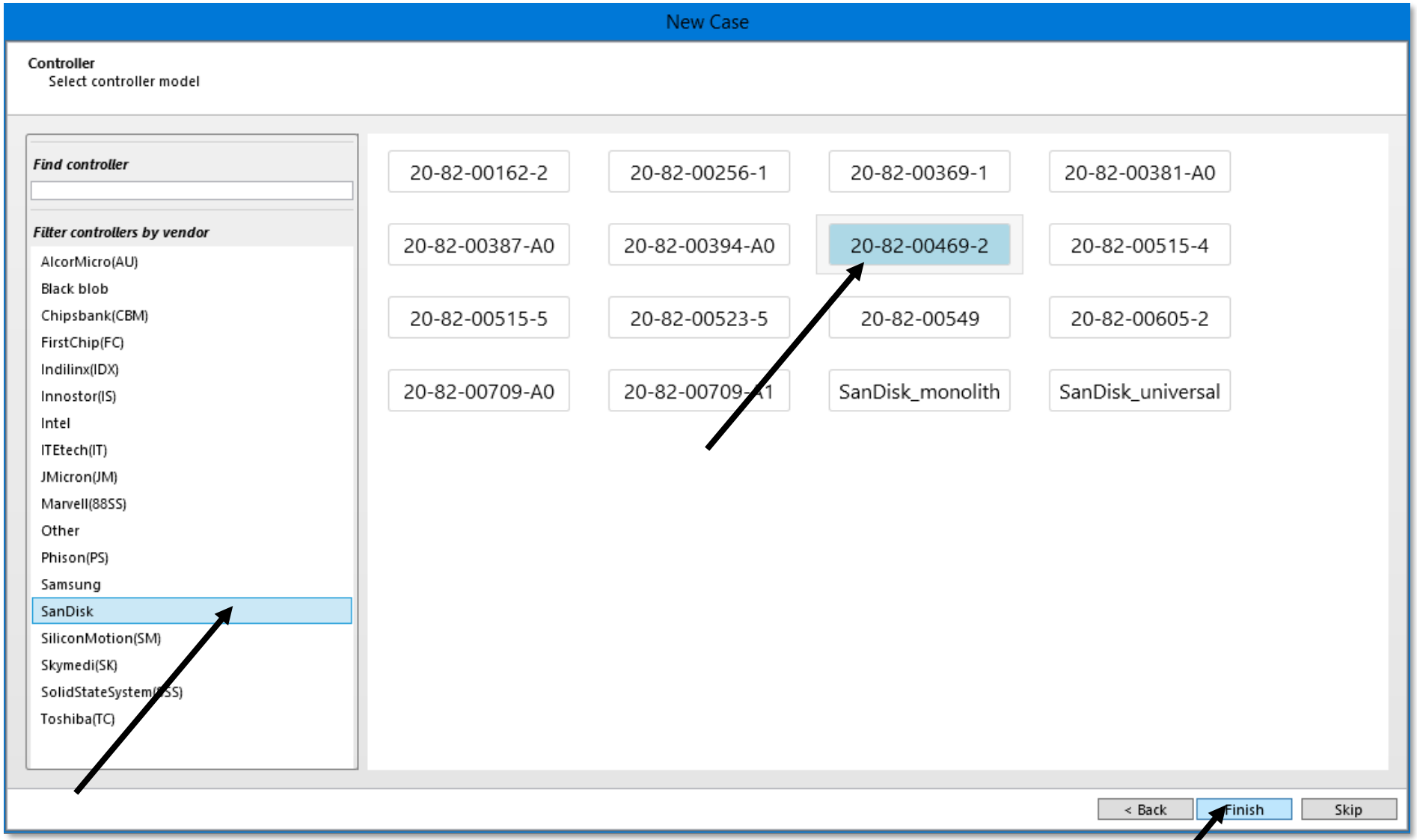
[5,4,7,6]



Western Digital Green SSD



Western Digital Green SSD



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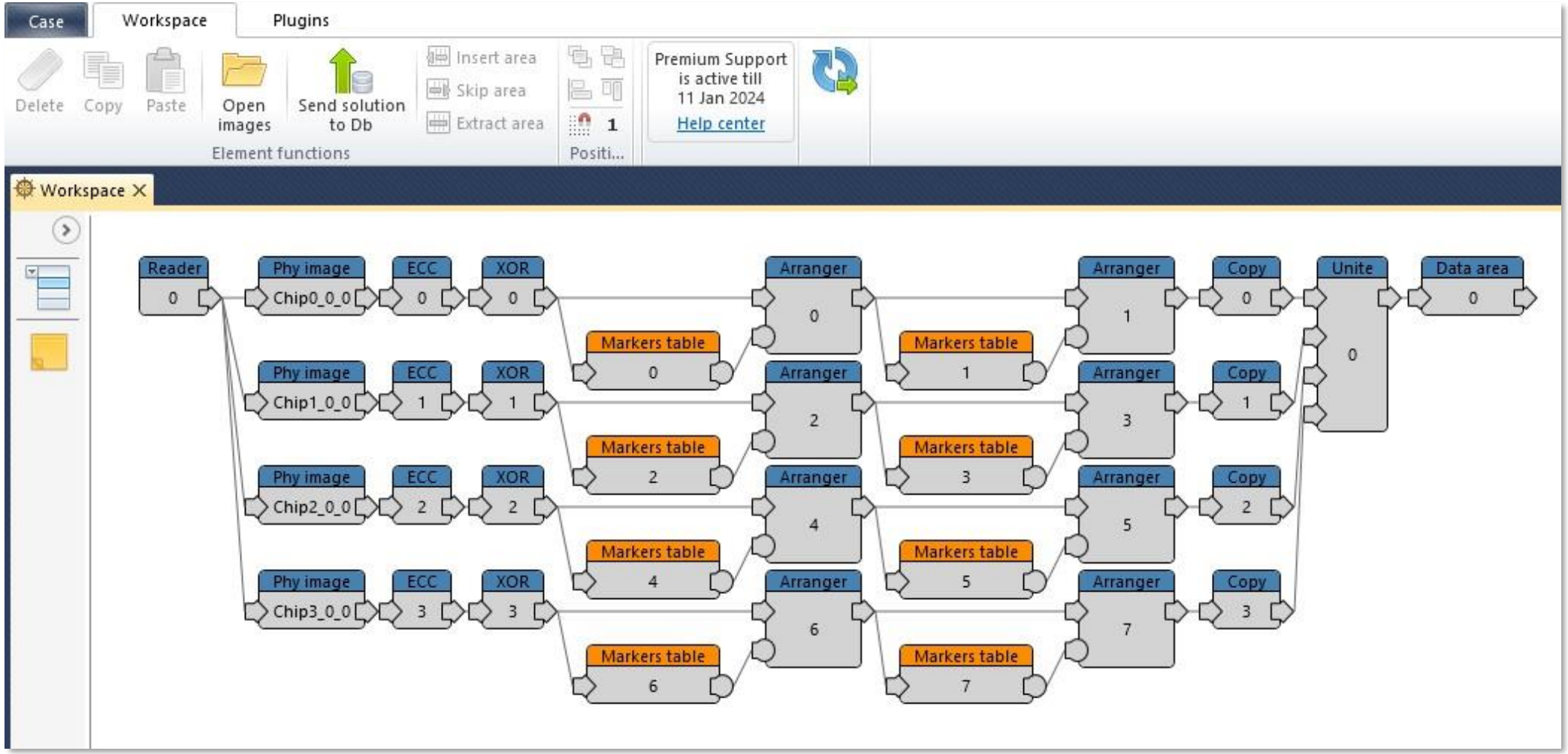
Full-Solution will be loaded to the workspace if all conditions are met.



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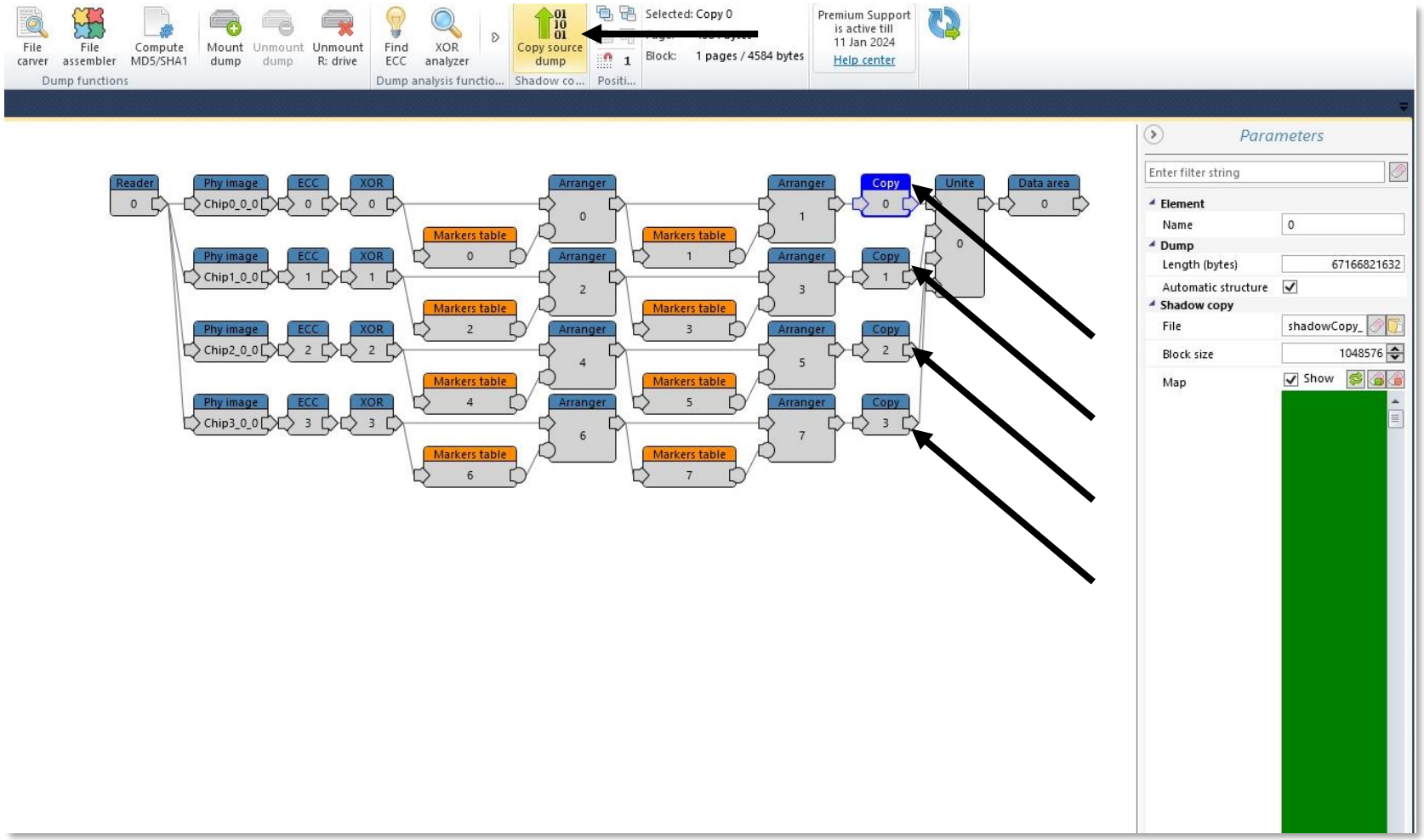
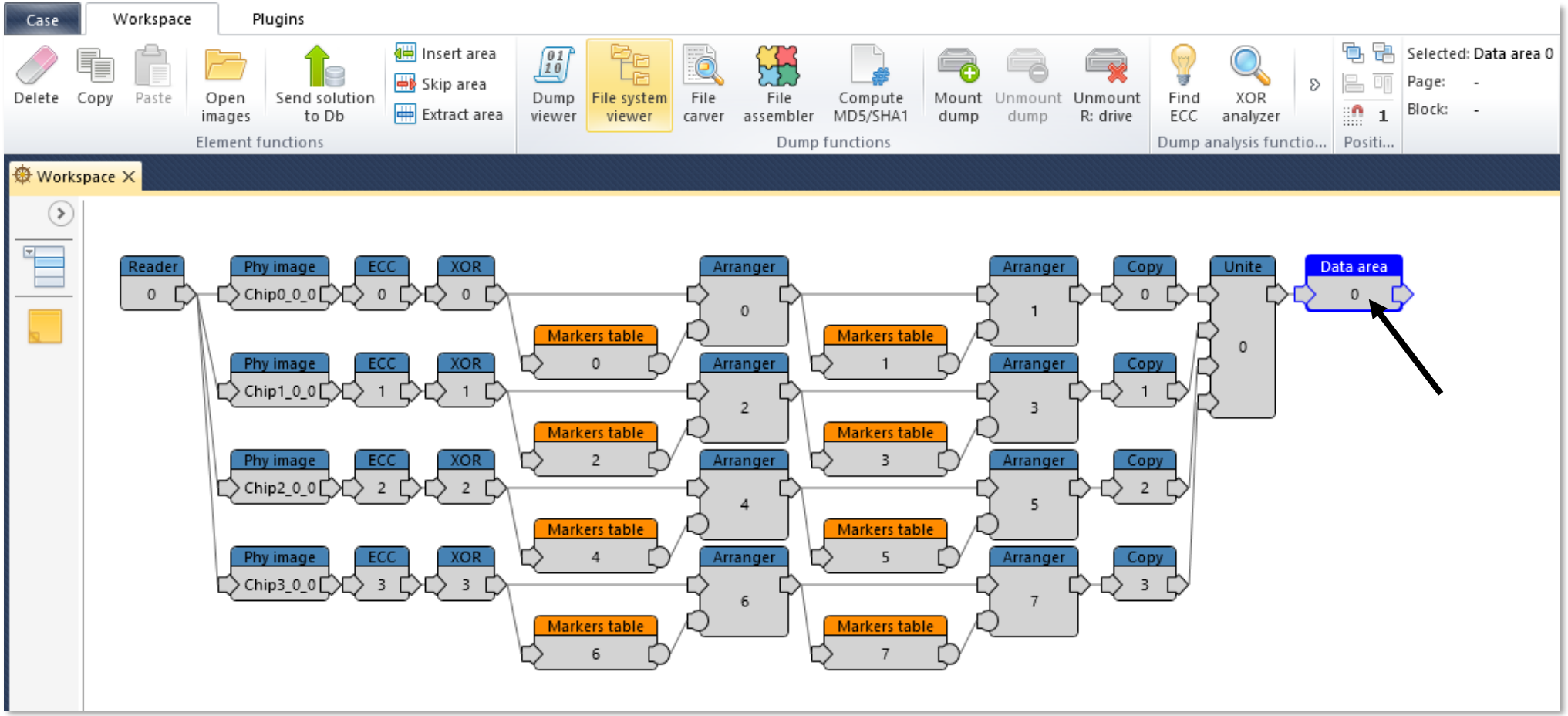
Western Digital Green SSD

Save the content of each Virtual Image on the Shadow copy element.



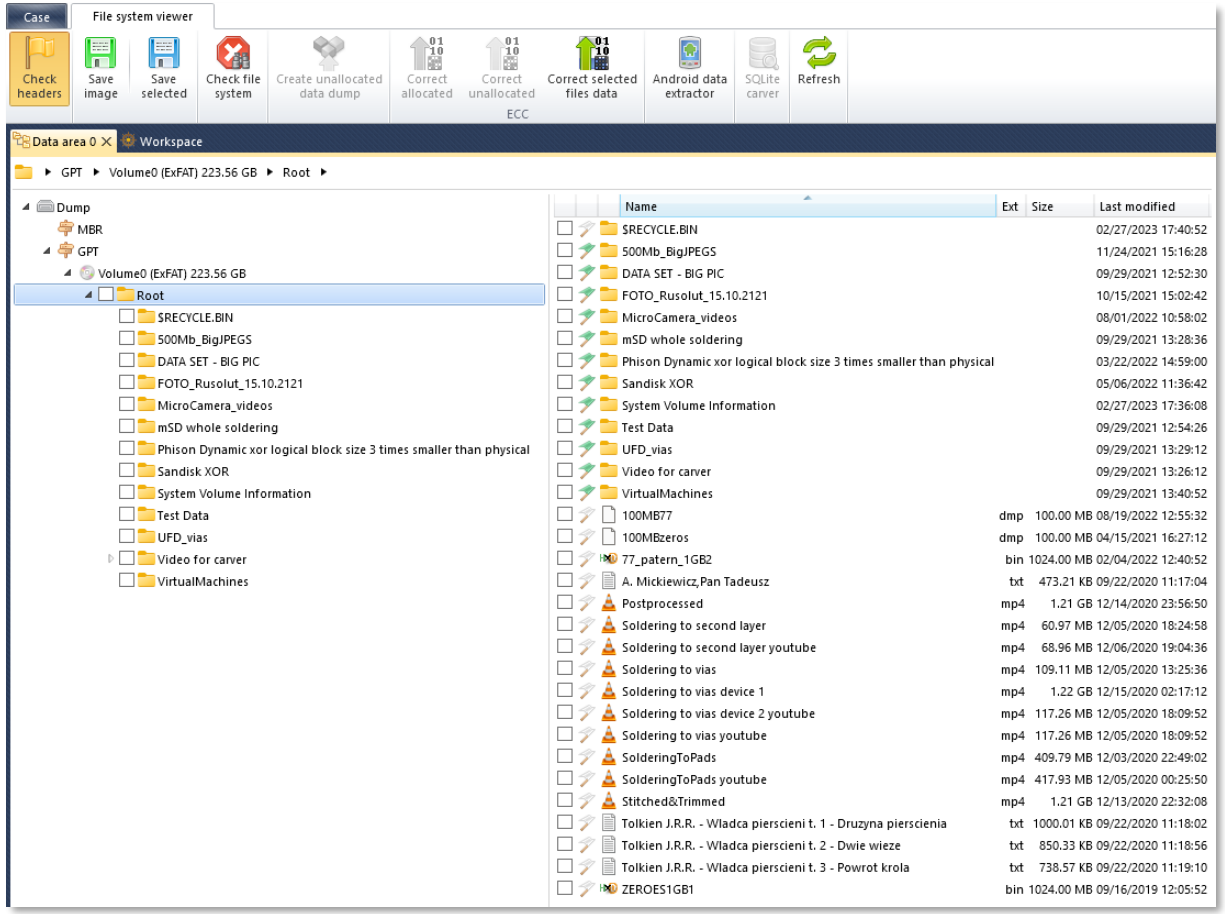
Western Digital Green SSD

A logical image is available on the data area element. Now it's possible to run a file system viewer/ file assembler or file carver to extract the data.

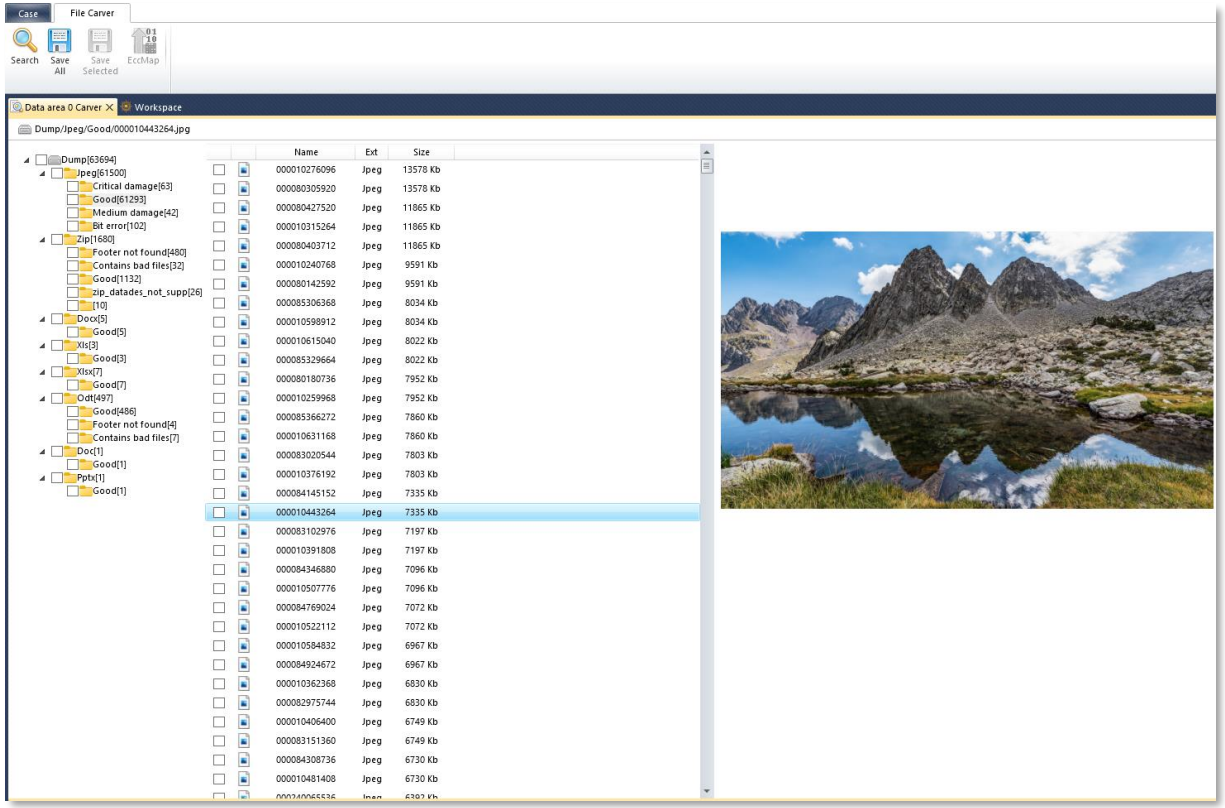


Western Digital Green SSD

FILE SYSTEM VIEWER



FILE CARVER



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