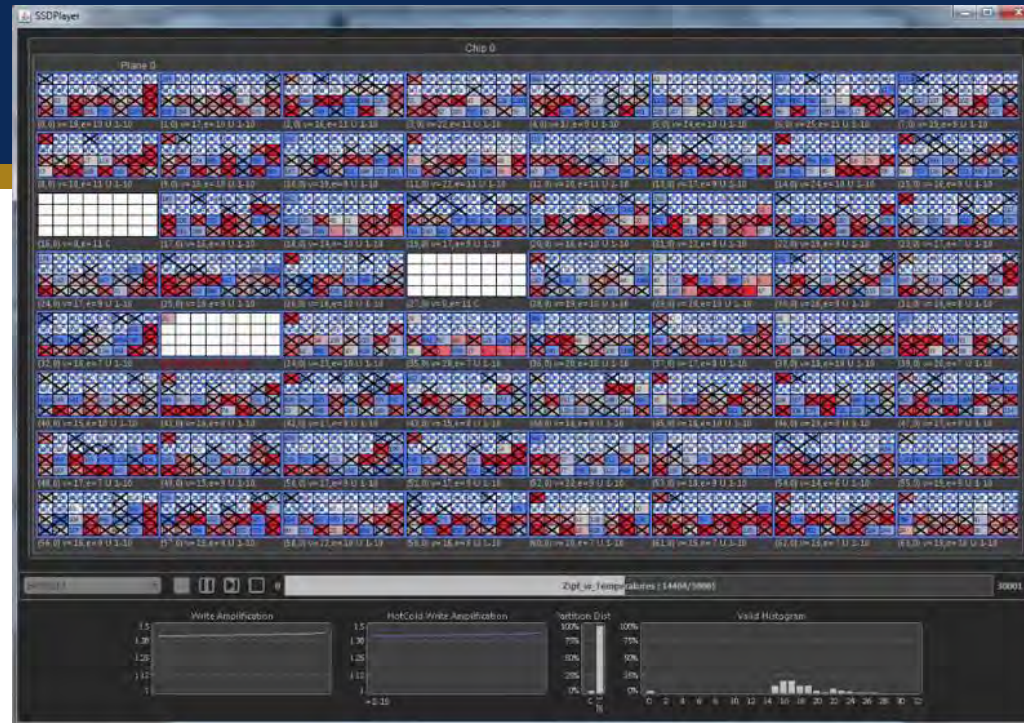


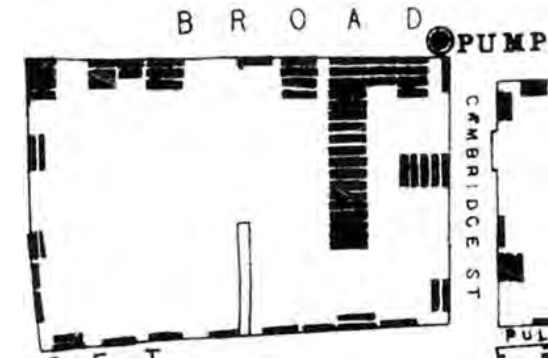
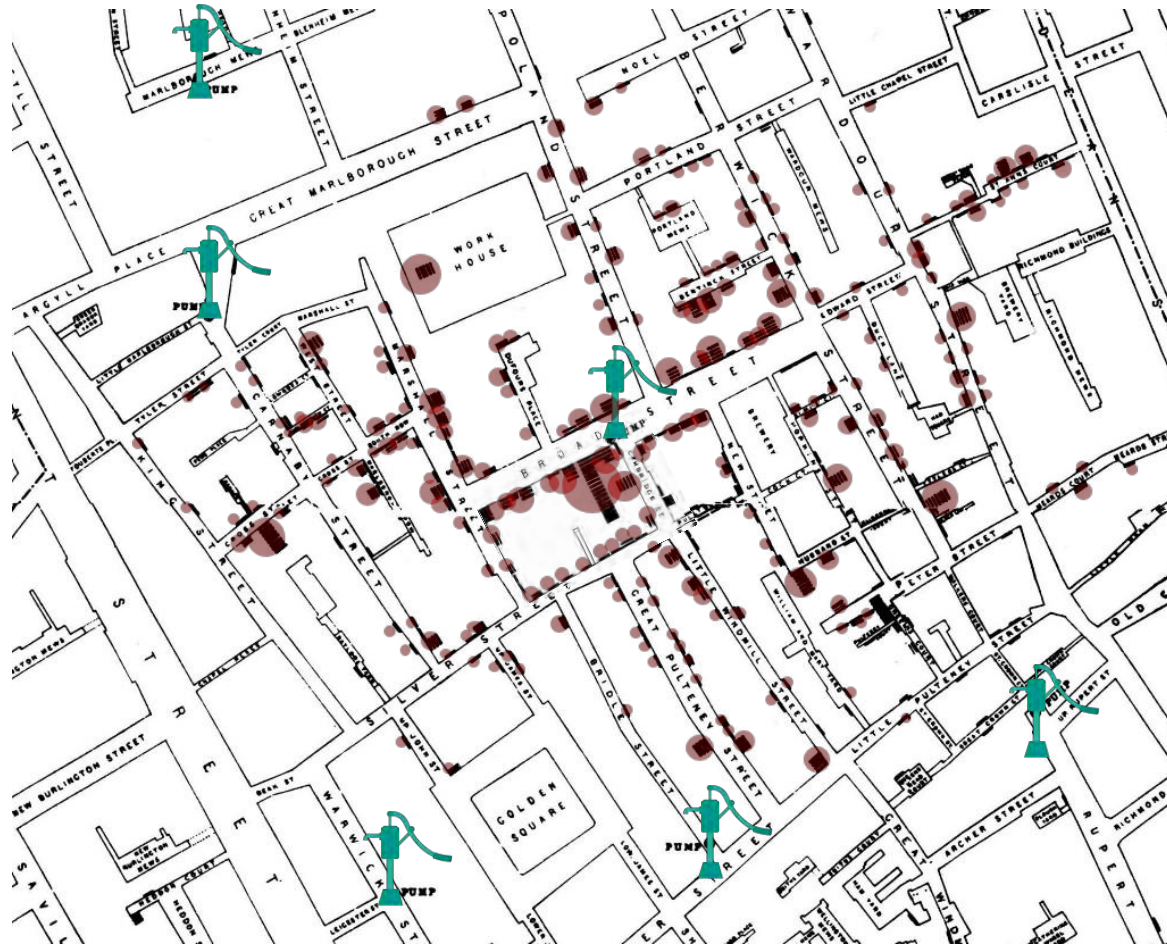
Experience from Two Years of Visualizing Flash with SSDPlayer

Gala Yadgar
Roman Shor

Computer Science
Technion



1854 Broad Street cholera outbreak



Benefits of visualization

- Comprehend complex situations.
- Spot aspects that may otherwise go unnoticed.
- Explain abstract concepts.

Storage visualization use cases

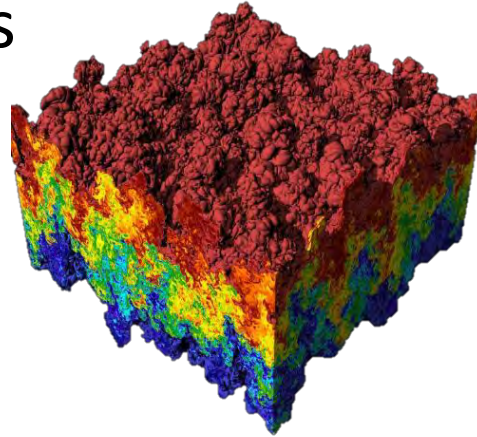
- Education
- Presentation
- Research
- Collaboration



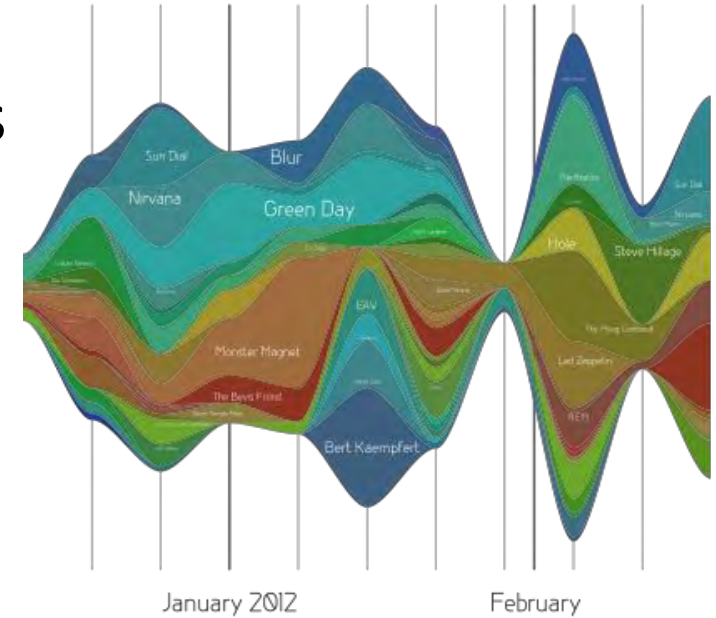
Scientific Visualization



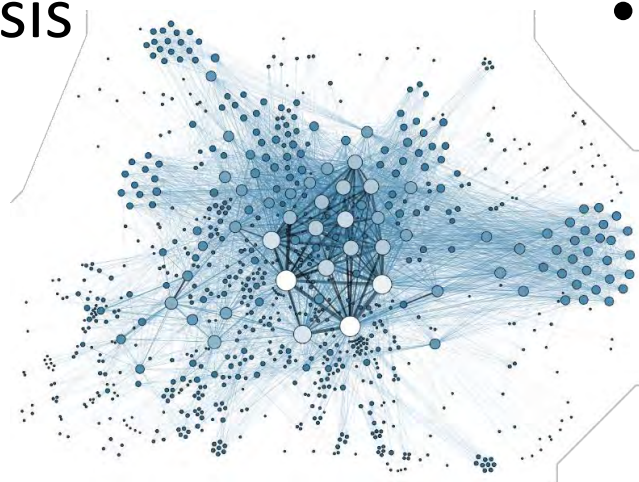
- Natural sciences



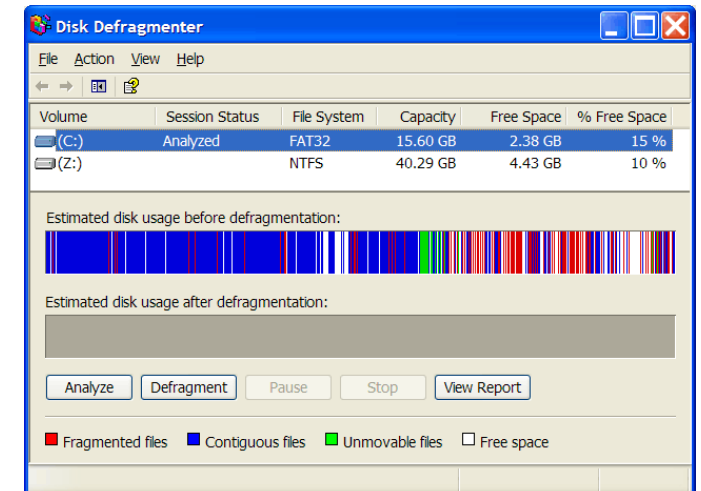
- Data analysis



- Network Analysis



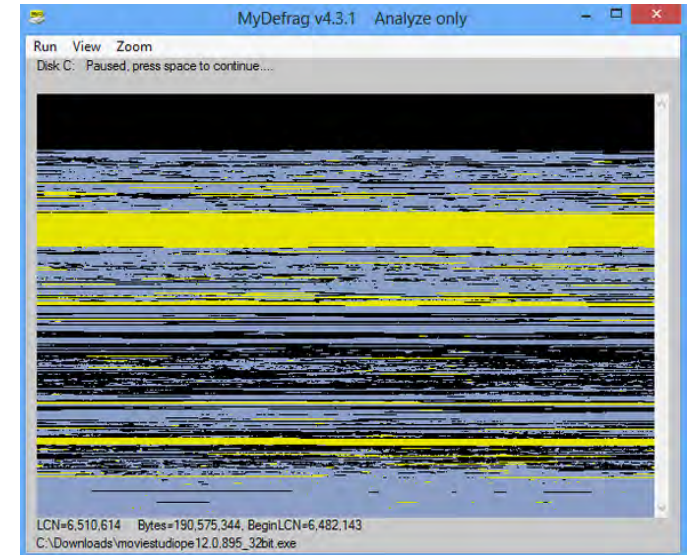
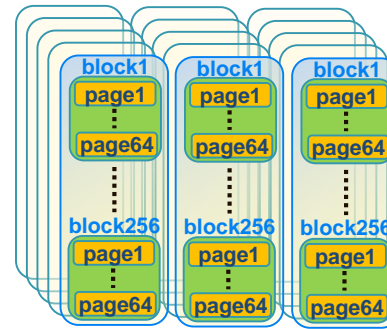
- Storage systems



Visualizing SSD

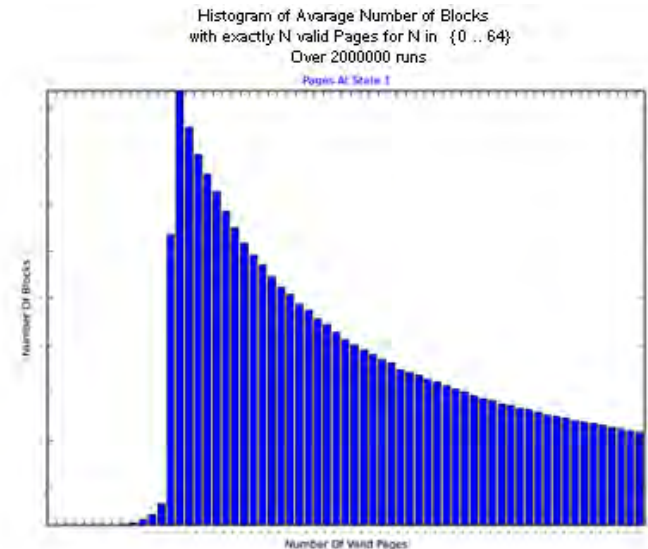


- Where Is The Data? Static data representation is not good enough for flash based SSD.

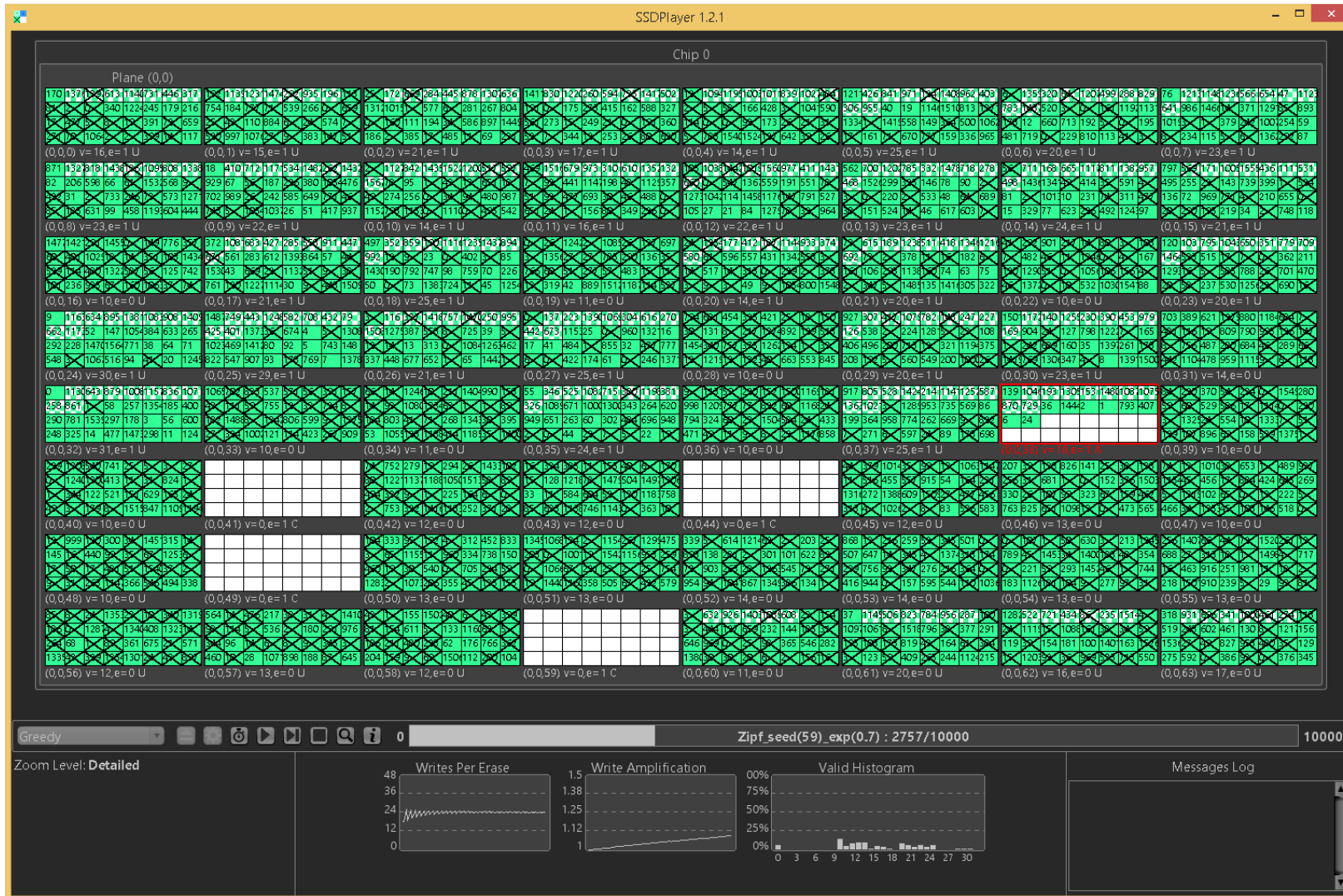


- Histograms show us overall statistics and momentary state.

Chip 0 Plane 0										
Block 0:	94	53	85	42	61	86	62	16	2	...
Block 1:	26	37	79	22	30	17	48	94	4	...
Block 2:	28	63	44	70	26	46	42	51	47	...
Block 3:	75	67	45	12	72	88	90	37	19	...
Block 4:	91	80	18	34	91	91	45	51	45	...
Block 5:	54	56	70	34	49	87	59	54	82	...
...										
Chip 0 Plane 1										
Block 0:	97	81	42	75	13	12	84	69	86	...
Block 1:	94	70	48	22	81	48	89	24	100	...
Block 2:	69	28	86	42	58	88	16	38	68	...



Education use case: Write Amplification

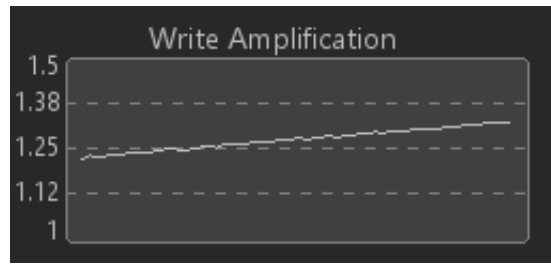
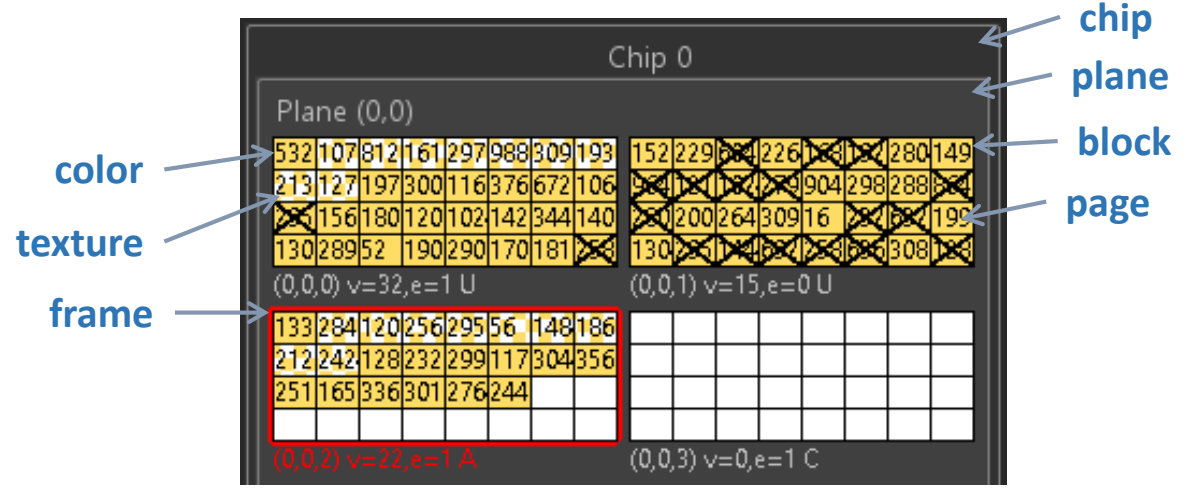


<http://ssdplayer.cswp.cs.technion.ac.il/demos/greedy-zipf/>

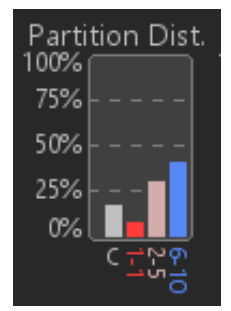


Education use case: SSDPlayer Design

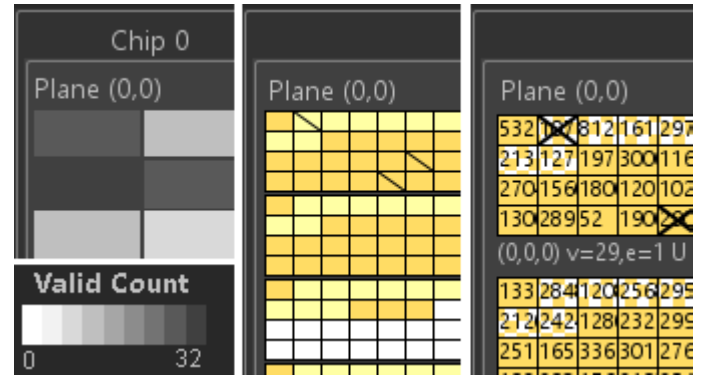
- General
- Simple
 - *No timing*
 - *Write-only workloads*
- Flexible
 - *Appearance*
 - *Input*
 - *Features*



continuous histograms



states and stats



zoom levels and details

• Java open source project

Collaboration use case



Skewed workload with temperature tags

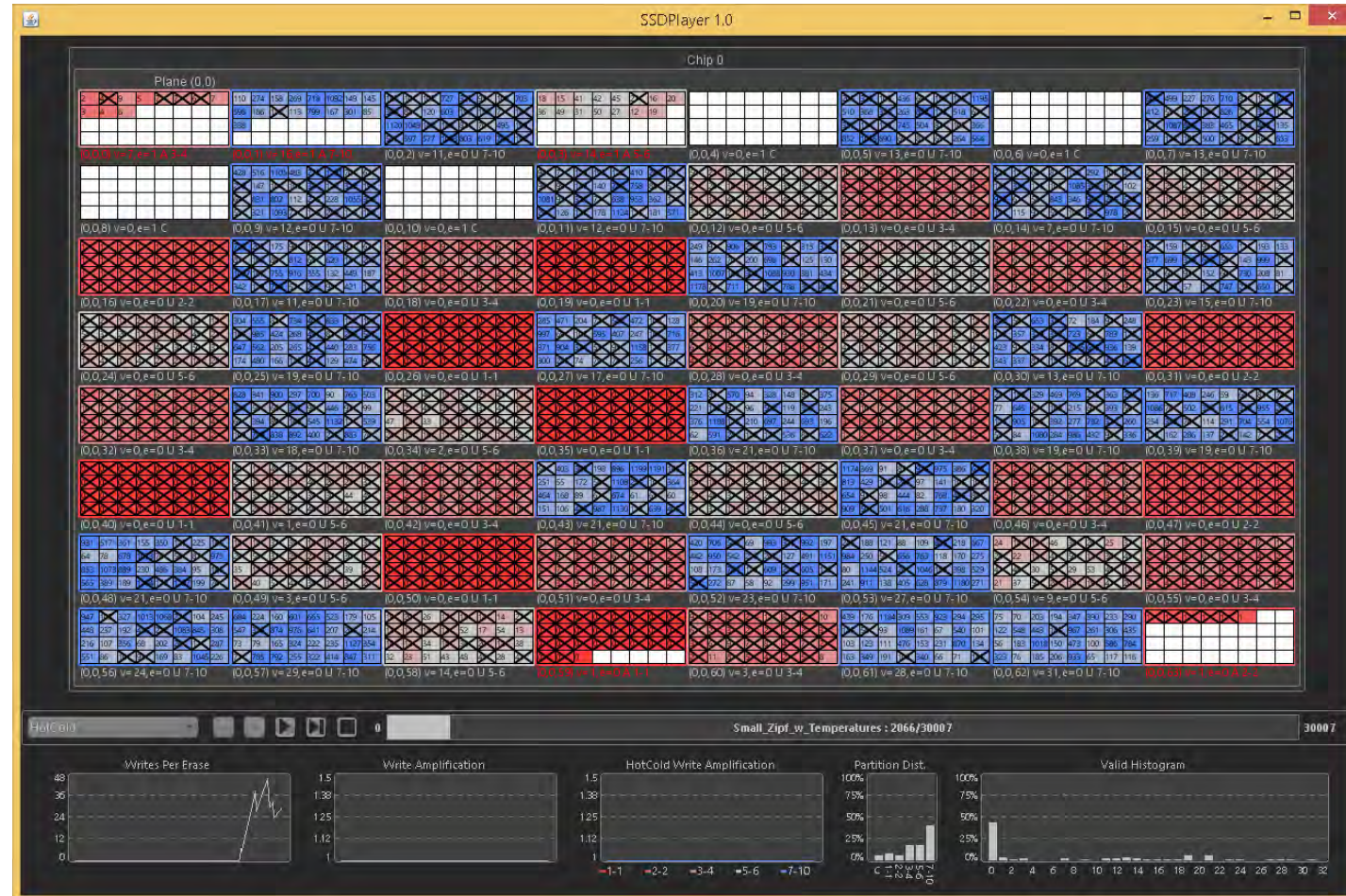


<http://ssdplayer.cswp.cs.technion.ac.il/sample-page/hotcold-1/>

Collaboration use case



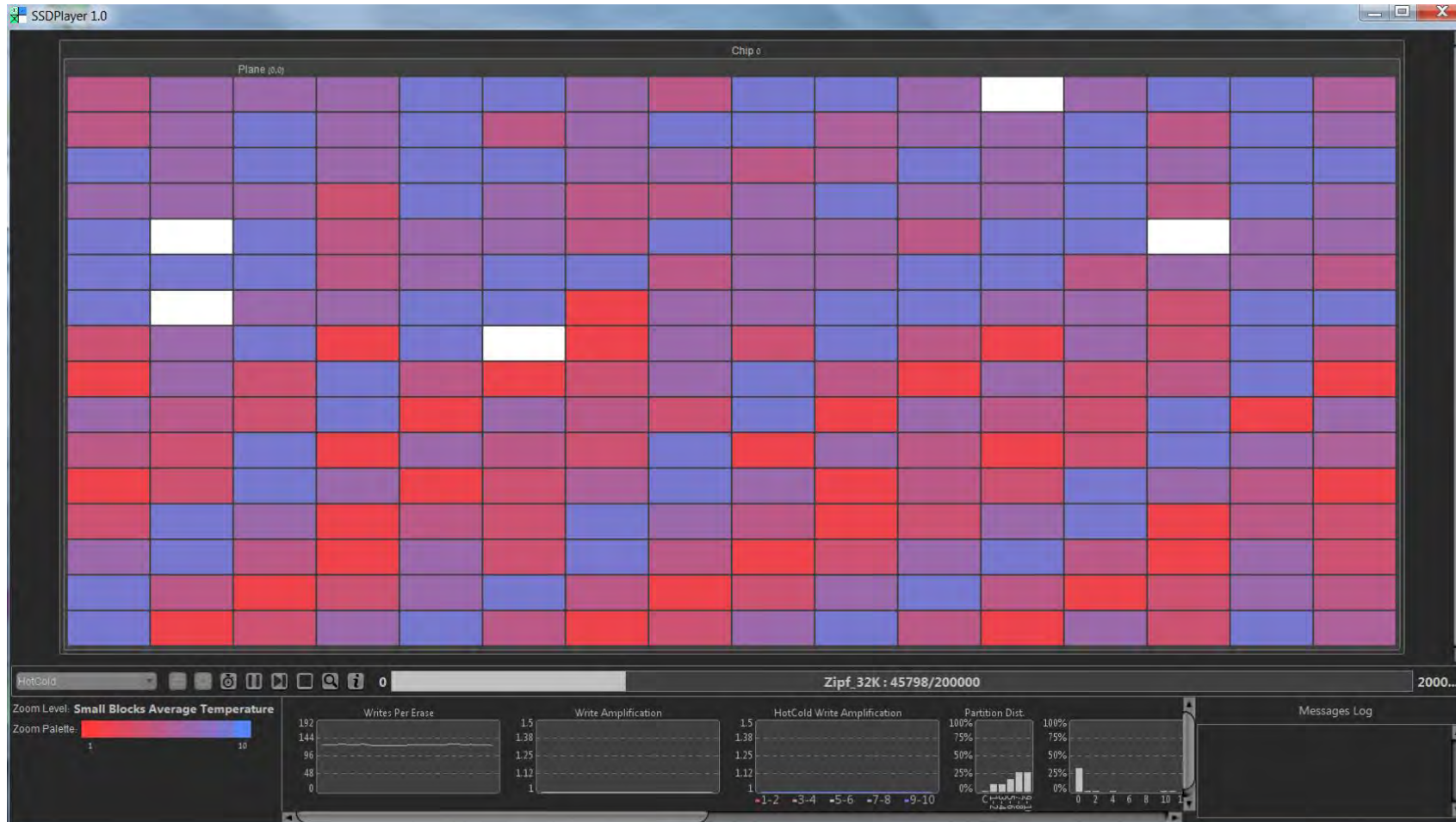
Analyzing Hot and cold data separation



Collaboration use case



Visualizing large scale devices, zoom in and out of 32K pages device



<http://ssdplayer.cswp.cs.technion.ac.il/demos/large-hotcold-5/>

Presentation with SSDPlayer



Visualization mode: your own data and platform.



Replay of FTL with reusable pages, implemented on OpenSSD board. Presented at FAST'16

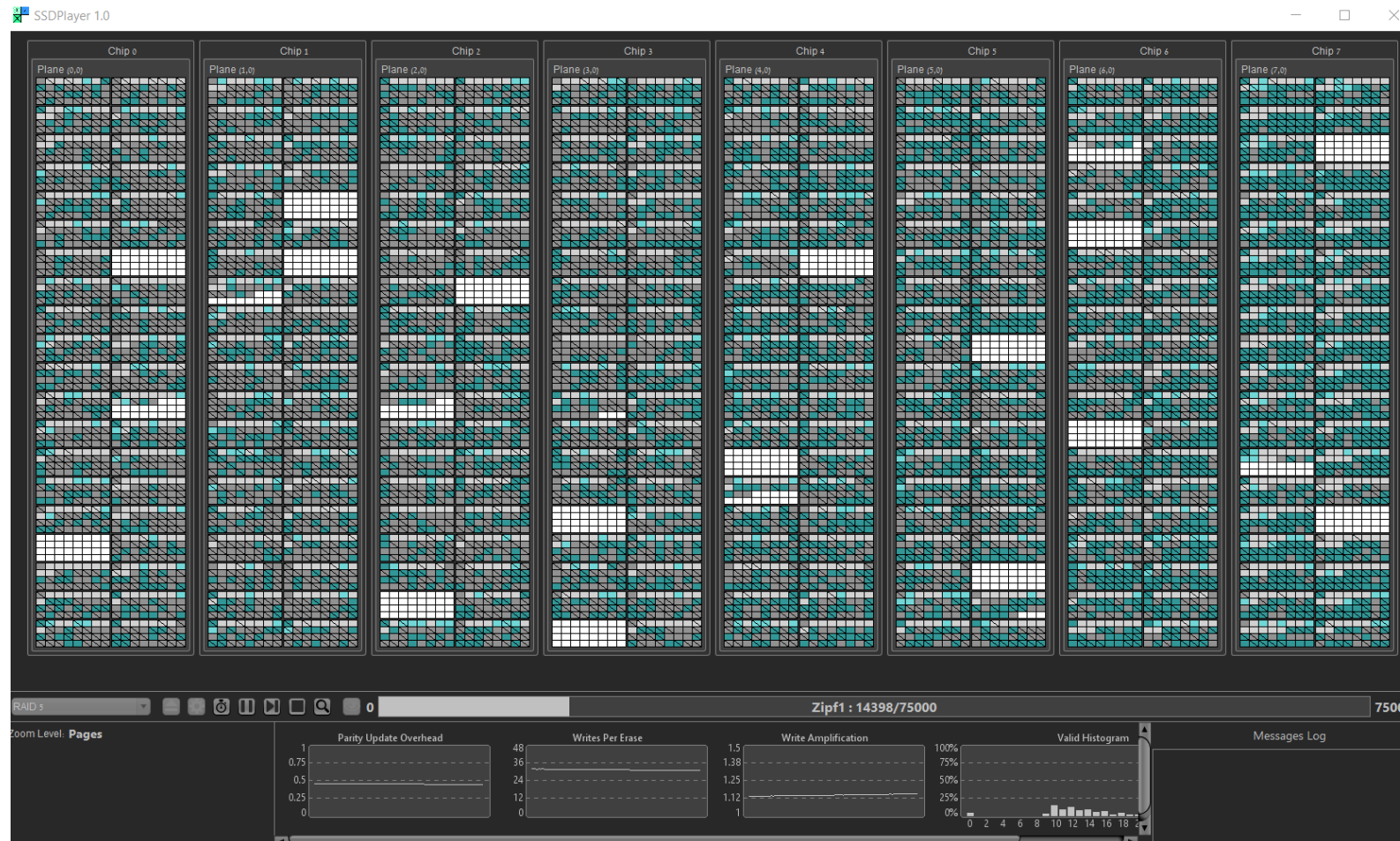
“The Devil Is in the Details: Implementing Flash Page Reuse with WOM Codes” [Margaglia, Yadgar, Yaakobi, Li, Schuster, Brinkmann]

<http://ssdplayer.cswp.cs.technion.ac.il/demos/llh-ftl-msr/>

Research use case: internal RAID



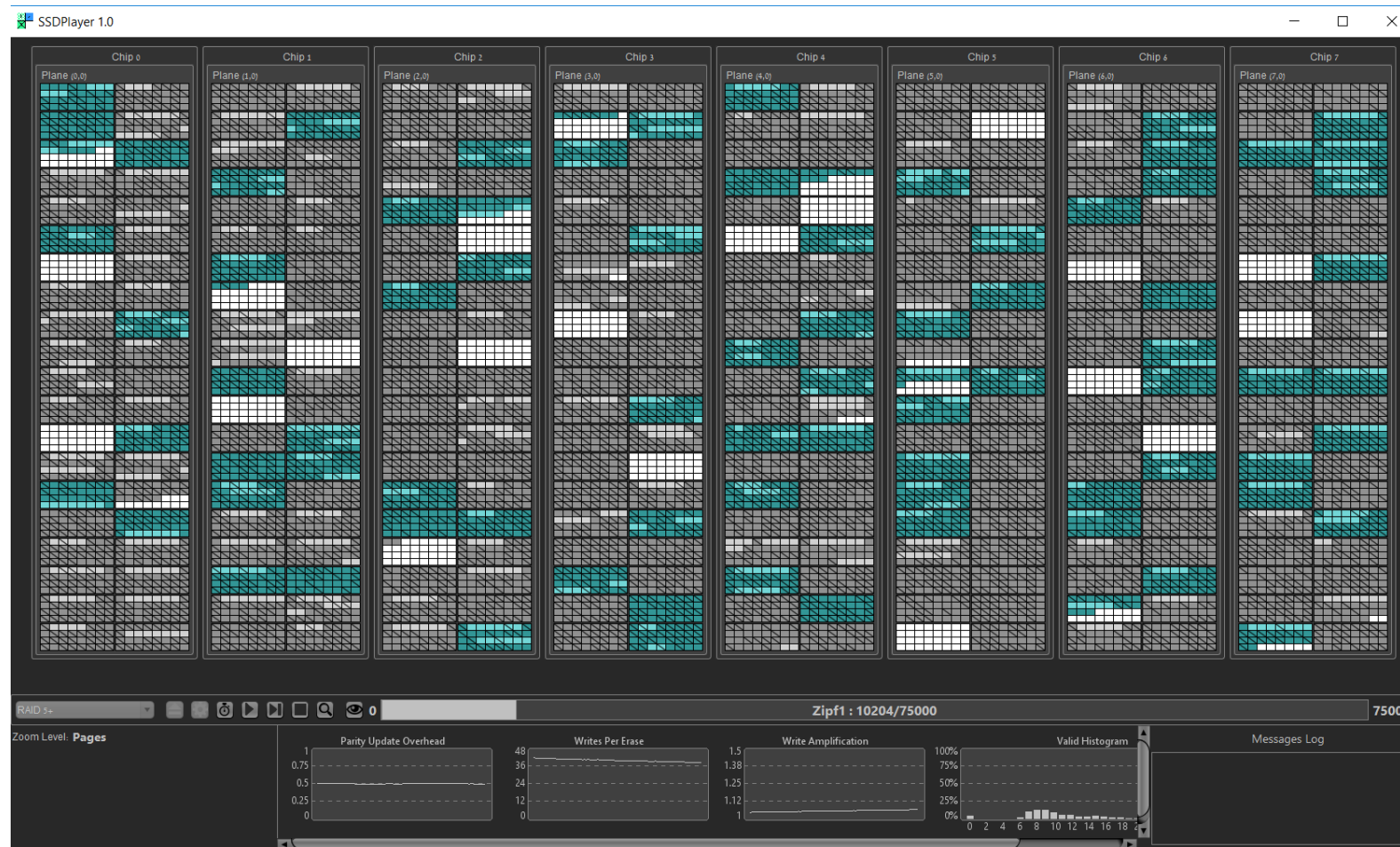
- Enhancing flash reliability with internal RAID



Research use case: internal RAID

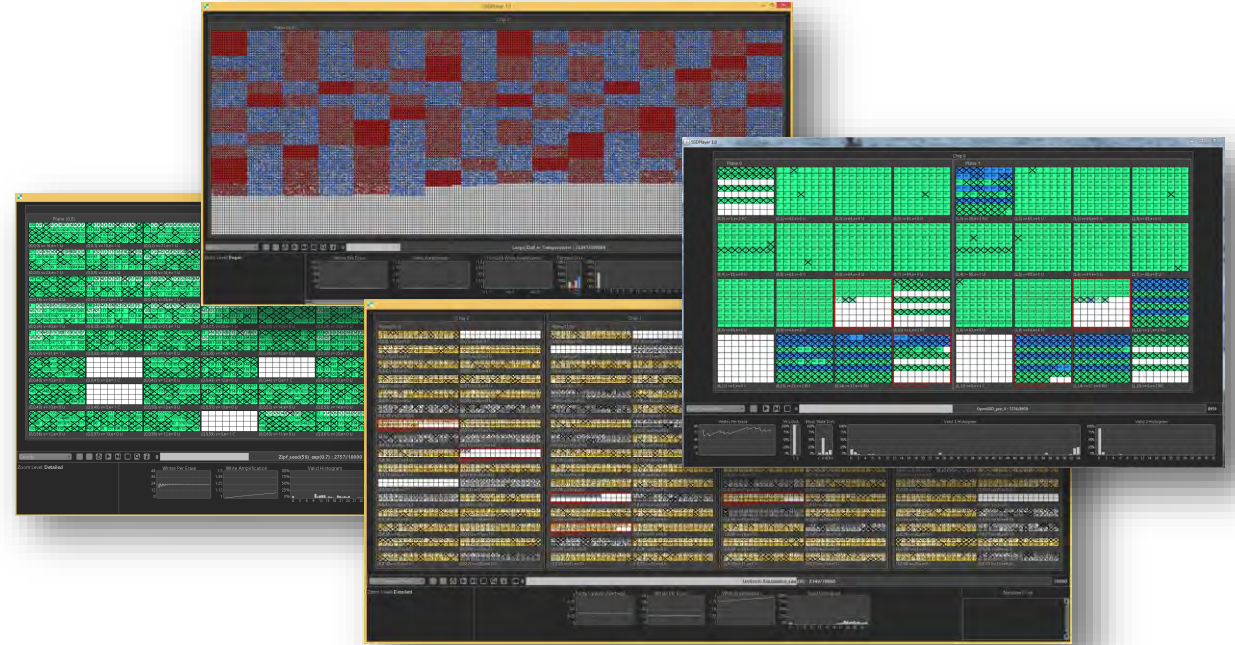


- Decreasing write amplification by separating data from parity






Benefits of visualization

- Education
- Presentation
- Research
- Collaboration



Using SSDPlayer

- Watch the demos 
- Download executable 
- Develop and Contribute 

Thank You!