

High Performance Image Processing: from PowerPC to Cell and GPU

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XLR8 Team

- 4 Researchers, 2 labs (IEF= Electronics Engineering, LRI=Computer Science)
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 - Lionel Lacassagne, assistant Professor
- 2 PhD students and 2 engineers
 - Tarik Saidani, PhD student IEF
 - Stéphane Piskorski, PhD student LRI
 - Joël Falcou, post-doct / engineer IEF
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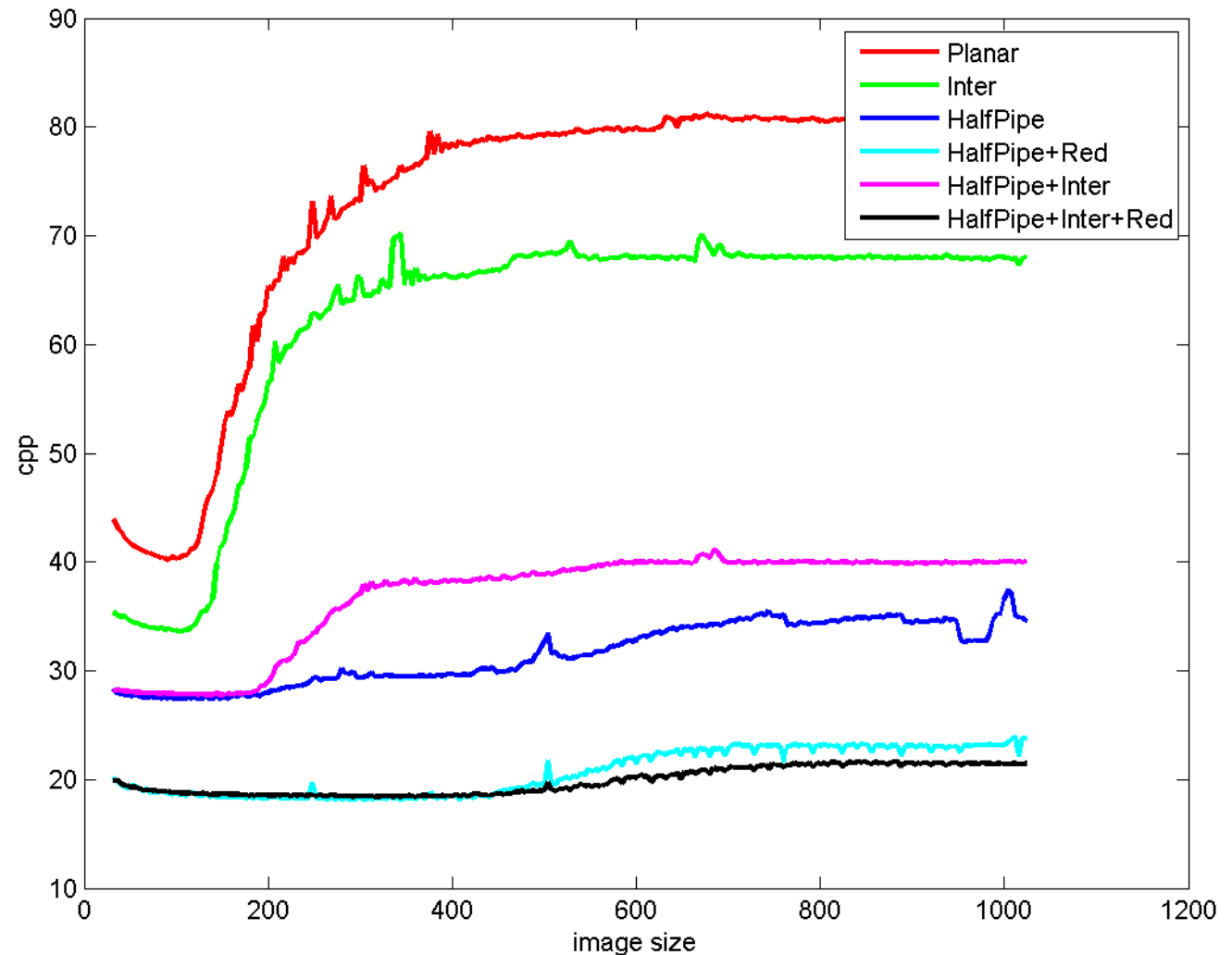
Harris Corner Detector

- Harris: Points of Interest (corner detection)
 - For autonomous robot
 - For UAV (drone)
- Architectural point of view
 - Many schemes of parallelization
 - Representative of image processing algorithms with:
 - point to point operation
 - Convolutions kernel
- Real Time constraint
 - 40 ms to process camera stream
- Right Now:
 - No real time implementation in scala
 - SIMD (AltiVec or SSE) required



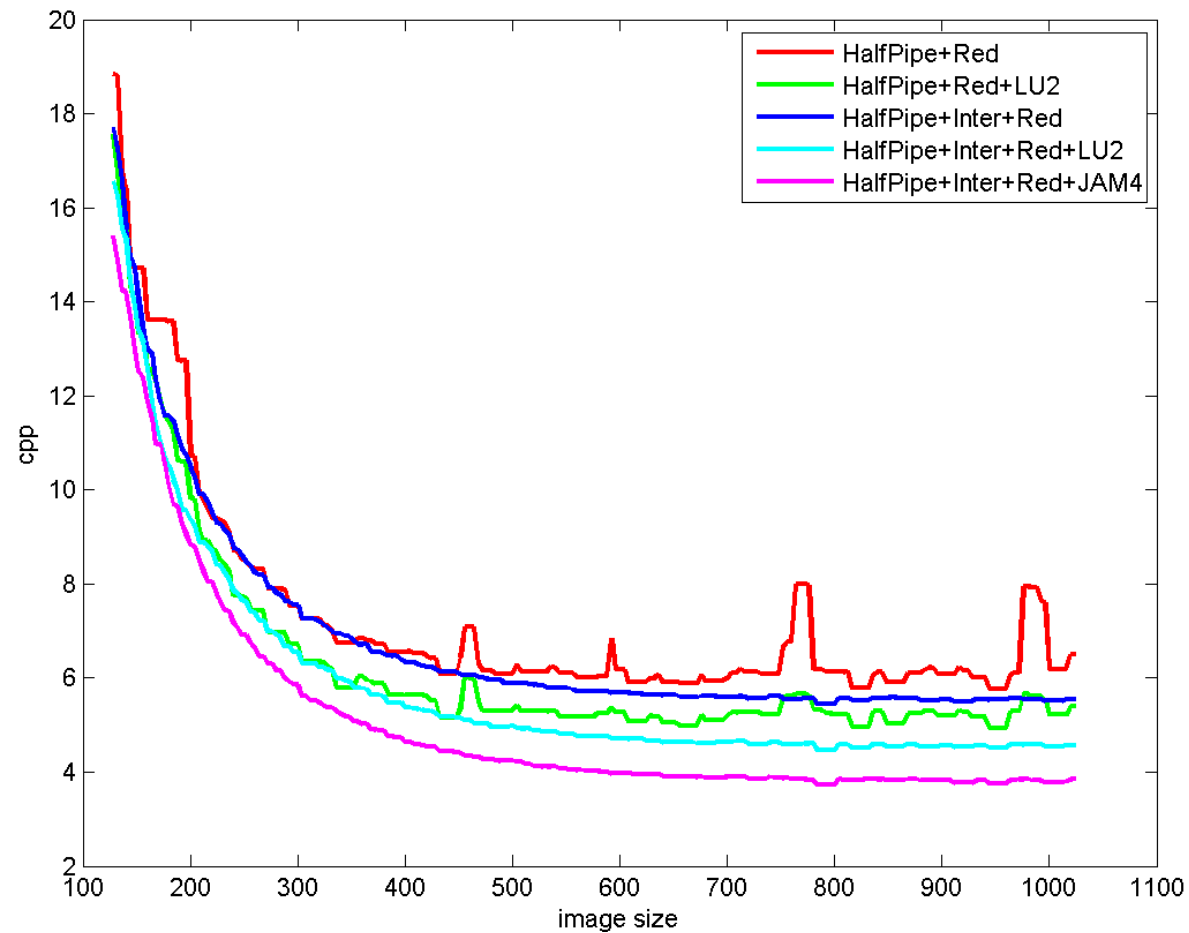
Harris on Macintosh G5: impact of SW transformations

- PowerPC 970 MP (2.5GHz)
 - Computation time: from 80 to 20 cycles per point
 - Image size: from 128x128 to 1024x1024



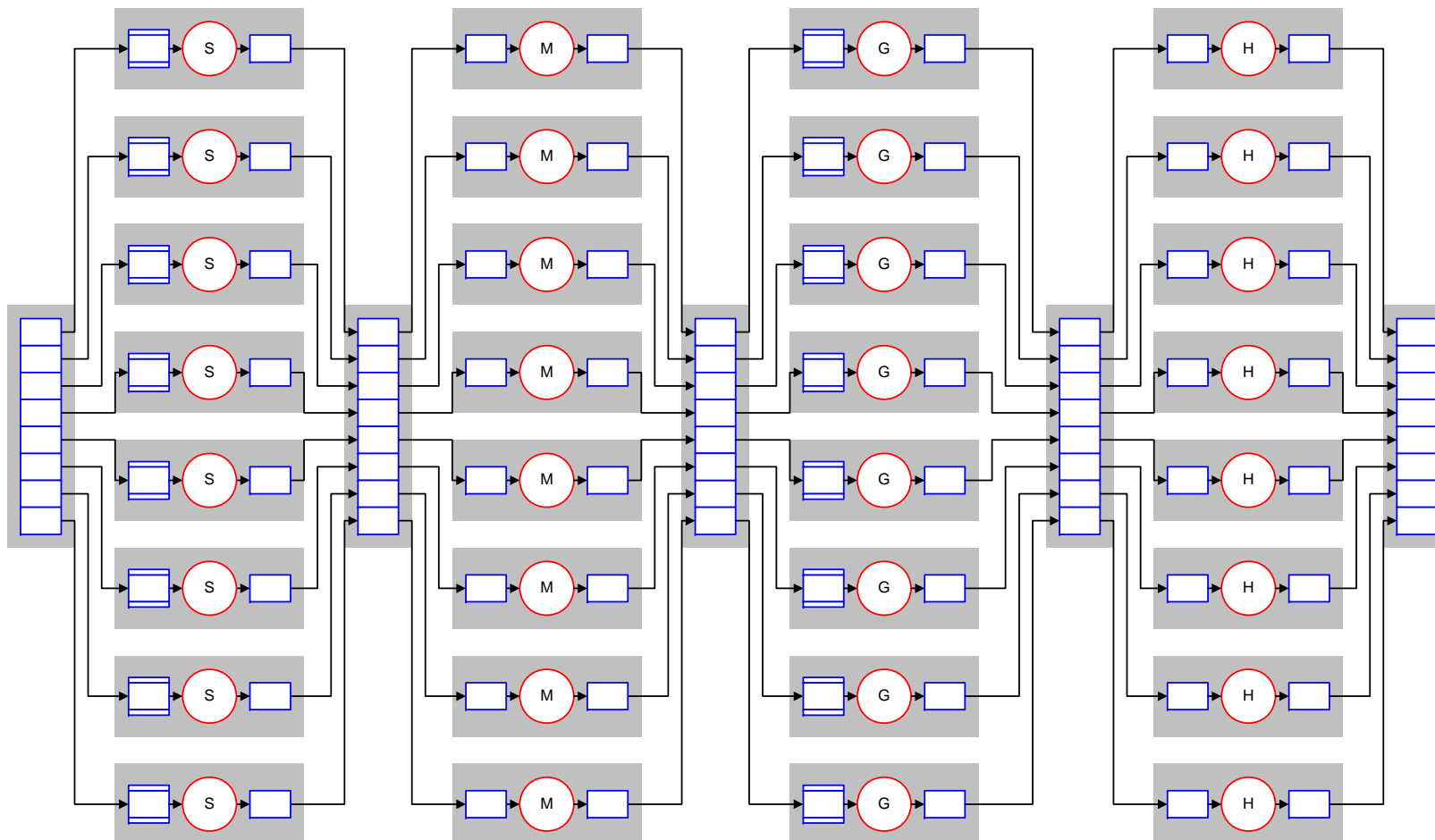
Harris: multithread on Macintosh Quad G5

- Speedup = x3.8 (compared to mono CPU)
- Cpp drops to 5 cycles per point (4 with unroll and jam)



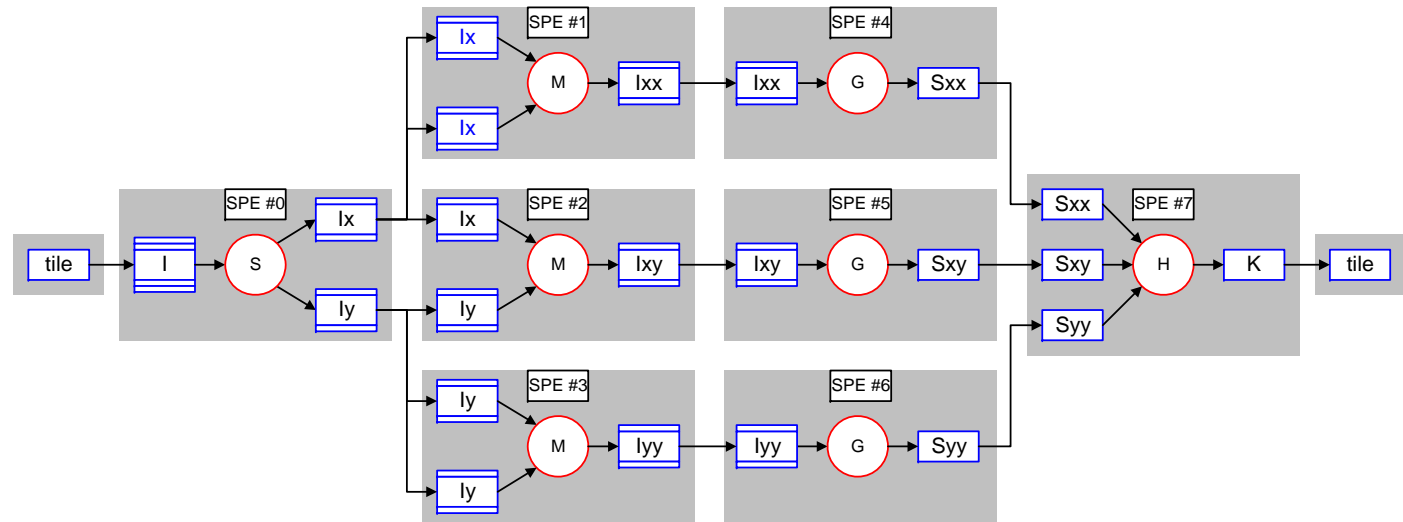
Harris on Cell: SIMD implementation

- 8 processors (each with 1/8 of the data)

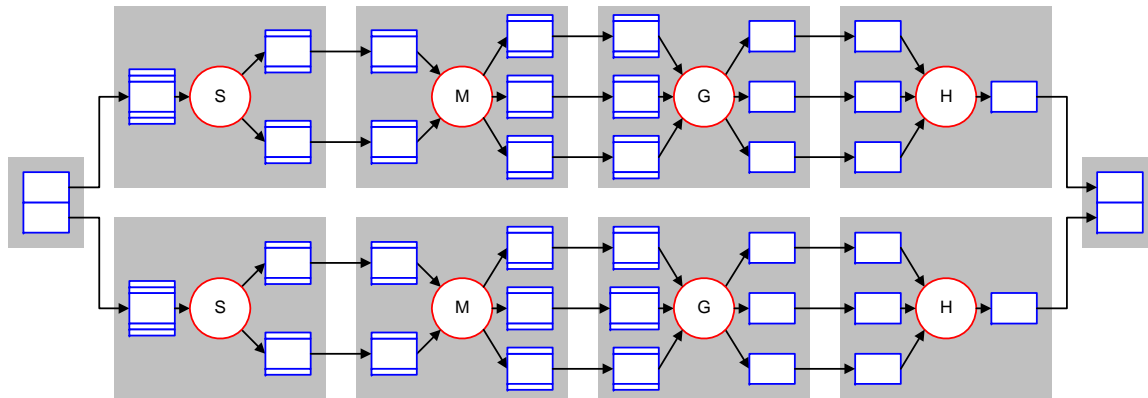


Harris on Cell: Pipeline Implementation

– By operator

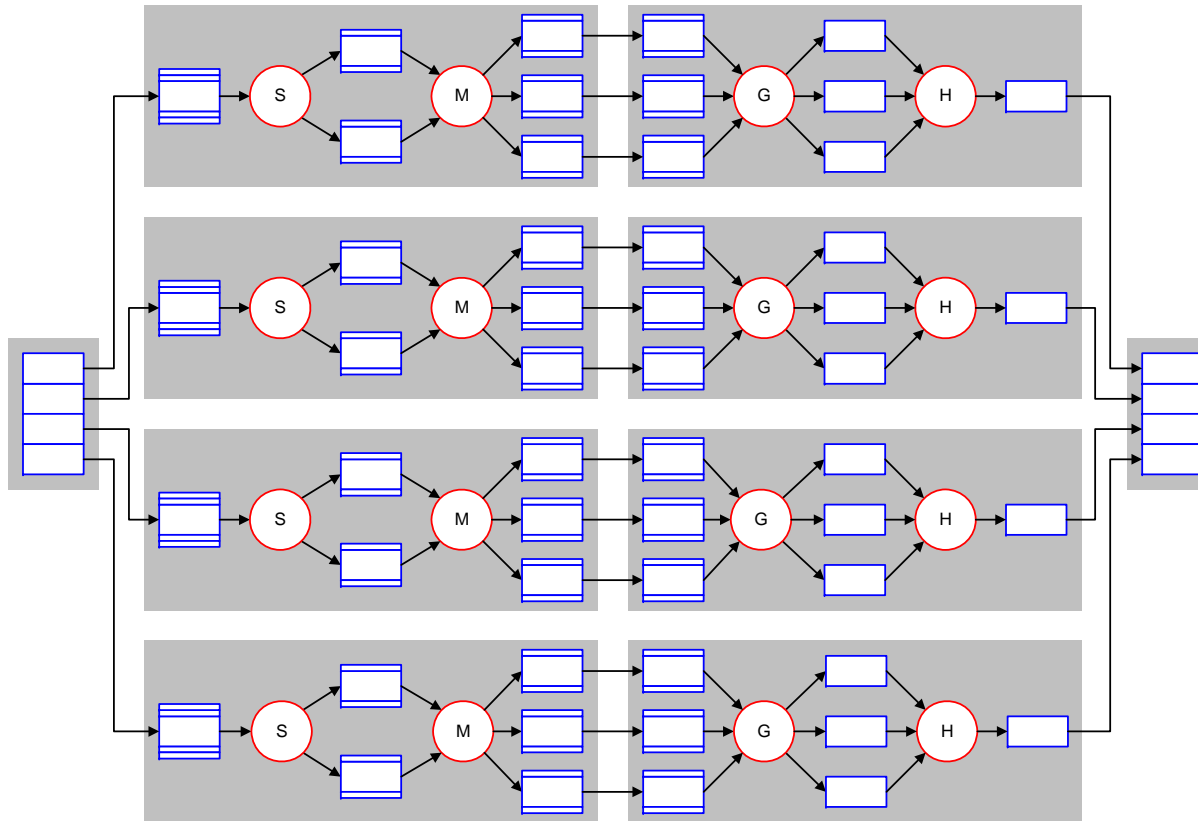


– By stream



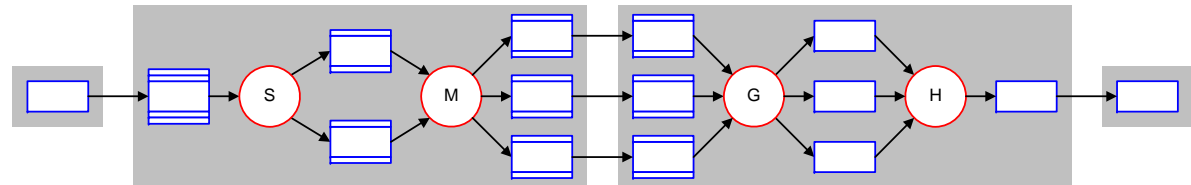
Harris on Cell: "half-chain » implementation

- Pipeline by stream with better locality
 - **operator chaining** : 2 operators / processor



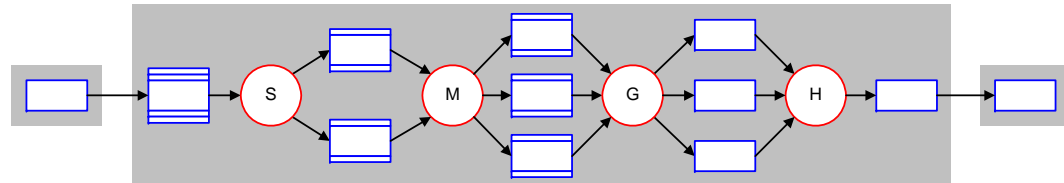
Harris on Cell: "half-pipe" implementation

- "half-chain"

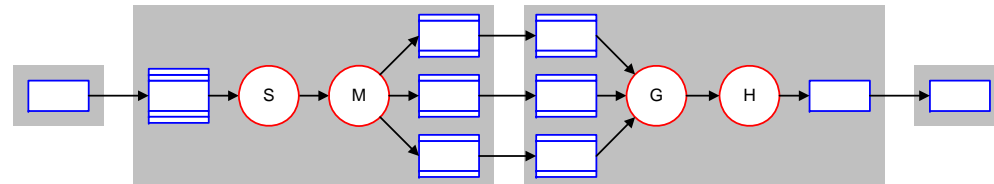


- 2 possibilities

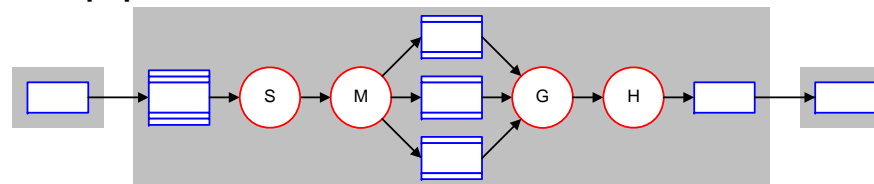
- 4 operators per processor: **increase chaining** : "full chain"



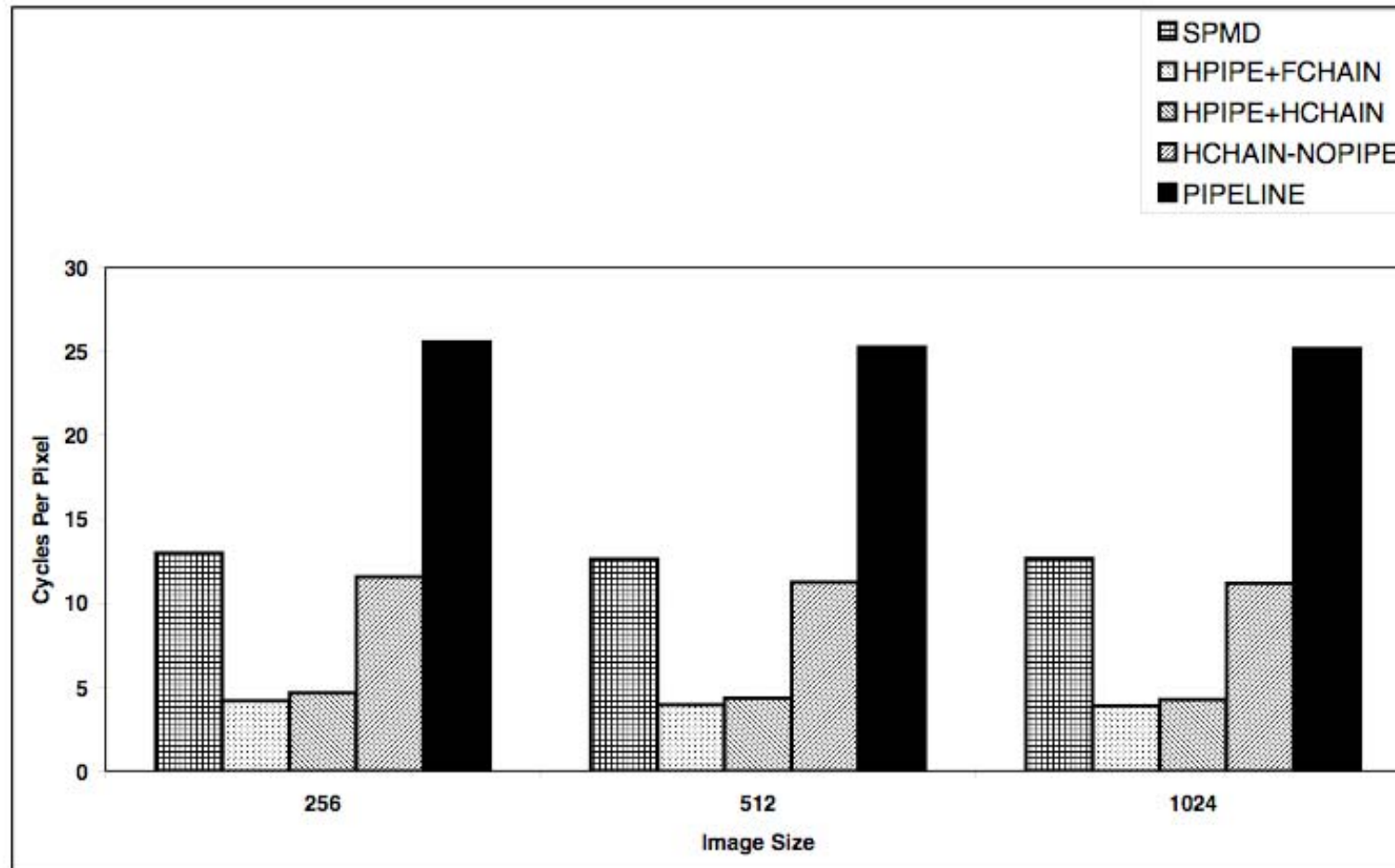
- Remove memory accesses suppression: **operators fusion** "half chain"



- Combination: "full-chain + half-pipe"



Harris on Cell: Models Comparison (2008)



Harris on Cell and GPU

- PowerPC altivec
 - From 80 cycles to 20 cycles
 - Down to 4 cycles
- Cell by hand on 8 SPEs
 - SWAR on 8 SPEs: from 13 cycles down to 4 cycles per point
- Cell with automatic parallelization (Skell BE skeleton meta-programming)
 - Same results, with only less than 5% of overhead
- Open MP vs mono-processing on PPE
 - PPE: about 600 cycles per points
 - PPE+OpenMP : 430 -> speedup = X1.4
- Harris on GPU (preliminary results)
 - 20 cycles on FX1700 (32 CPU)
 - 10 cycles on 8800 Ultra
 - Algorithm does not scale