# A Novel Approach for Online Monitoring for High Data-Rate Image-Based Instrumentation

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*Imaging techniques are widely used in science and industry. The performance cameras are generating large data-sets in the order of 40 GB per 3D Image at high repetition rates. The required realtime or near realtime monitoring can be achieved by utilizing standard graphics adapters for image reconstruction.*

## Approach

➤ Heavily multiprocessor architecture exploiting data parallelism



➤ CUDA = C + Extensions

```
__global__ void gpuMatrixAdd(float **A, float **B, float **C) {
    int i = threadIdx.x, j = threadIdx.y;
    C[i][j] = A[i][j] + B[i][j];
}
....
gpuMatrixAdd<<<M,N>>>(A,B,C)
```

➤ Upcoming generalized approach

*AMD & NVidia GPU, IBM CELL, Multicore CPU*

### OpenCL
(Open Computing Language)

Programming standard for general-purpose computations on heterogeneous systems. OpenCL allows programmers to preserve their expensive source code investment and easily target both multi-core CPUs and the latest GPUs

## Hardware

### Standard Graphic Cards

**NVidia GTX280**

| Number of streaming processors: | 240 |
| Frequency of processor cores: | 1.3 GHz |
| Peak performance (single precision): | 933 GFlops |
| Peak performance (double precision): | 78 GFlops |
| Memory Size: | 1 GB |
| Memory Bandwidth: | 102 GB/s |

**ATI Radeon HD 4870**

| Number of streaming processors: | 800 |
| Frequency of processor cores: | 750 MHz |
| Peak performance (single precision): | 1.2 TFlops |
| Peak performance (double precision): | 240 GFlops |
| Memory Size: | 1 GB |
| Memory Bandwidth: | 115 GB/s |

### GPU Super-computers

| Number of streaming processors: | 960 |
| Frequency of processor cores: | 1.44 GHz |
| Peak performance (single precision): | 4.14 TFlops |
| Peak performance (double precision): | 345 GFlops |
| Memory Size: | 16 GB |
| Memory Bandwidth: | 408 GB/s |

**NVidia Tesla S1070**

### Approach · Hardware · Projects

## GPU Computing
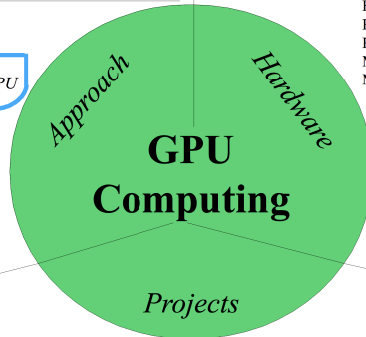
## Projects
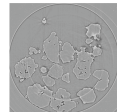
### Synchrotron Light Sources

Imaging Detectors at modern synchrotron light sources create large data-sets in the order of 40 GB per 3D Image at high repetition rates. The image reconstruction from projections is extremely computational intensive and takes up to 12 hours on actual desktop computers.



Polyethylene grains in the conical plastic holder

**PyHST CPU & GPU performance**
(Software was developed by ESRF, France)
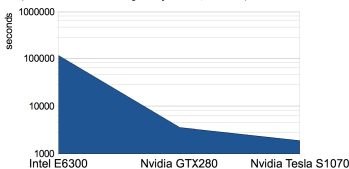


### Precise Strain Measurements

Measuring strain in samples which are too small, big, compliant, soft or hot are typical scenarios where non-contact techniques are needed. A technique which can cover all that and also can deal with complicated strain fields in structures or structural materials is the Digital Image Correlation.
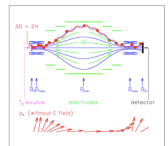


400 μm
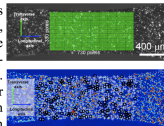
**Acceleration by NVidia GTX280 GPU**
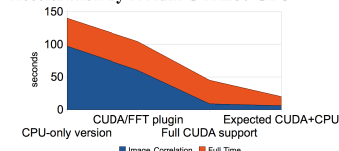


### Planed Projects

**Simulation code for KATRIN**

Simulation and visualization of magnetic fields for Karlsruhe Tritium Neutrino (KATRIN) experiment is another compute intensive task which can benefit from parallelization using modern GPU's.



**Classification of primary cosmic rays**

Neural networks and Bayes classifiers are used at Aragats Space Environmental Center to determine characteristics of primary cosmic rays. These algorithms can be easy parallelized and accelerated using GPU computing.

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