GPU BASED ITERATIVE CBCT FOR PROSPECTIVE MOTION COMPENSATED ALGORITHM FOR RADIATION THERAPY

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Index

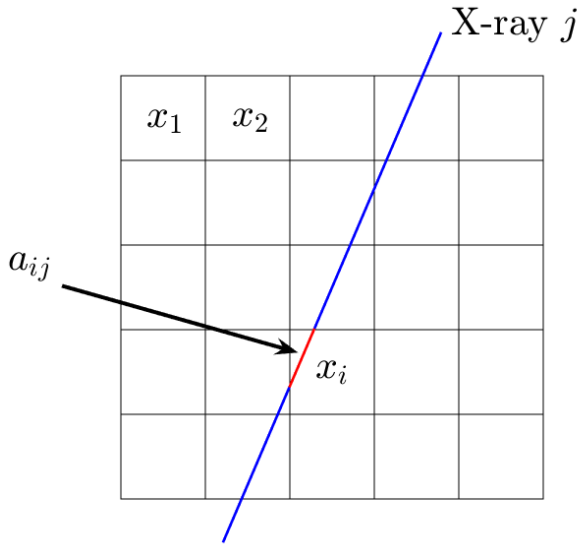
- CBCT for lung IGRT
  - A GPU toolbox for CBCT
    - Performance
    - Features
  - Choice of algorithm matters: Few projections
  - Motion on CBCT (4D imaging):
    From accelerator physics to medical imaging

A GPU toolbox for CBCT

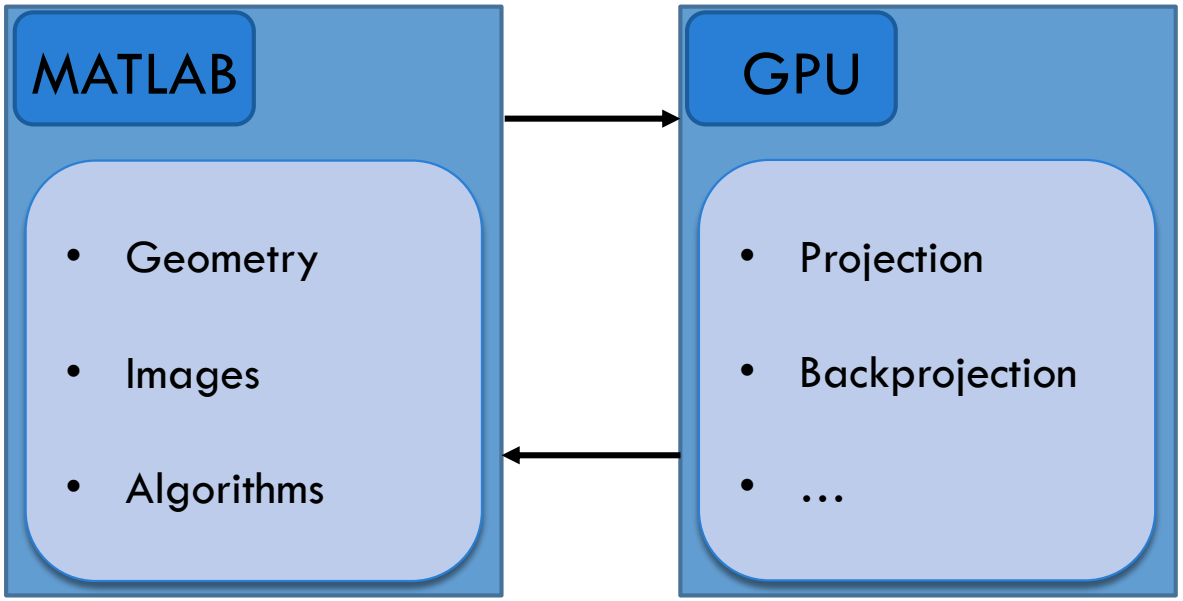
$$\arg\min_{x} \|Ax - b\|_2^2 + J(x)$$

- A: For 512^3 image, 512^2 detector, ~320Gb of memory
- Matrix "free" :
  Replace matrix [A·x , A^T·b] by operator → [A(x) , A^T(b)]

- GPU:
  - Multiple processors (60K> in a TESLA k40)
  - Optimized memory
  - Hardware accelerated interpolation



A GPU toolbox for CBCT



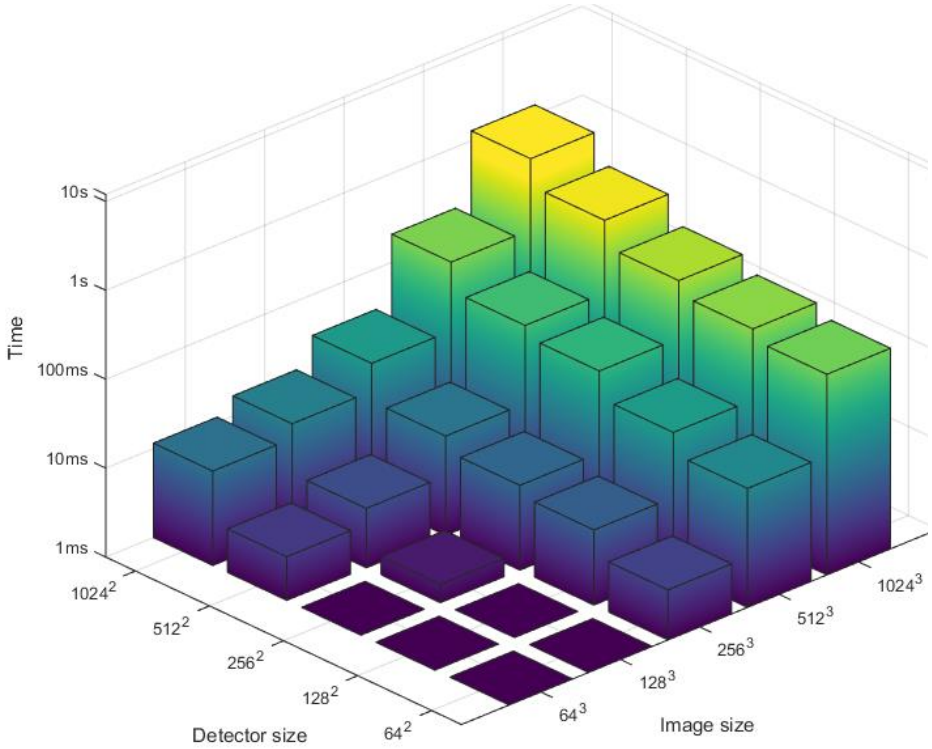
SIRT

GPU

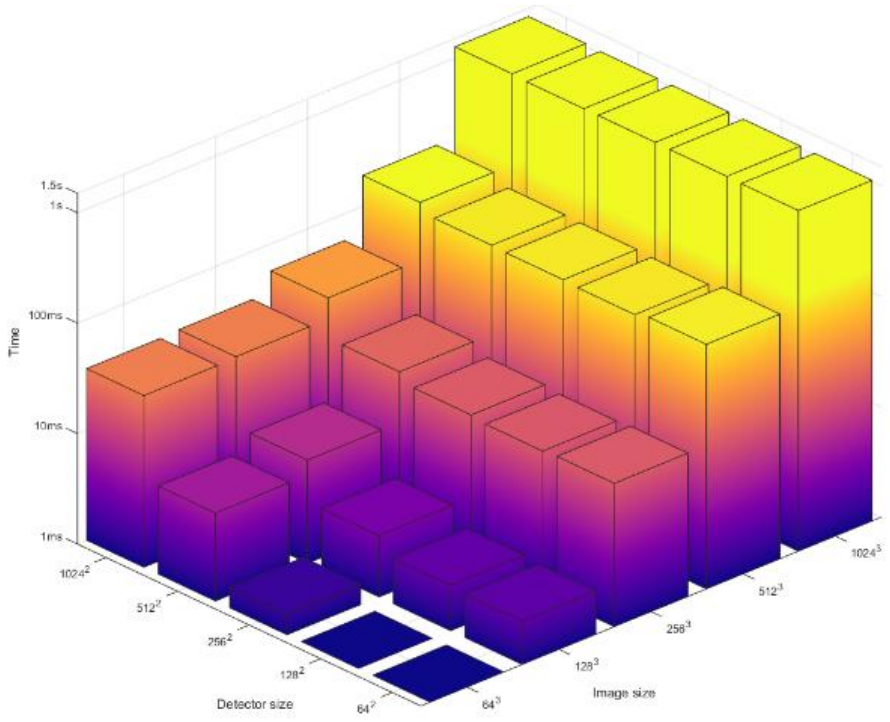
```
for ii=1:niter
    proj_err=proj-Ax(res,geo,alpha);
    weighted_err=W.*proj_err;
    backprj=Atb(weighted_err,geo,alpha);
    weigth_backprj=bsxfun(@times,1./V,backprj);
    res=res+lambda*weigth_backprj;
end
```

A GPU toolbox for CBCT

- Performance



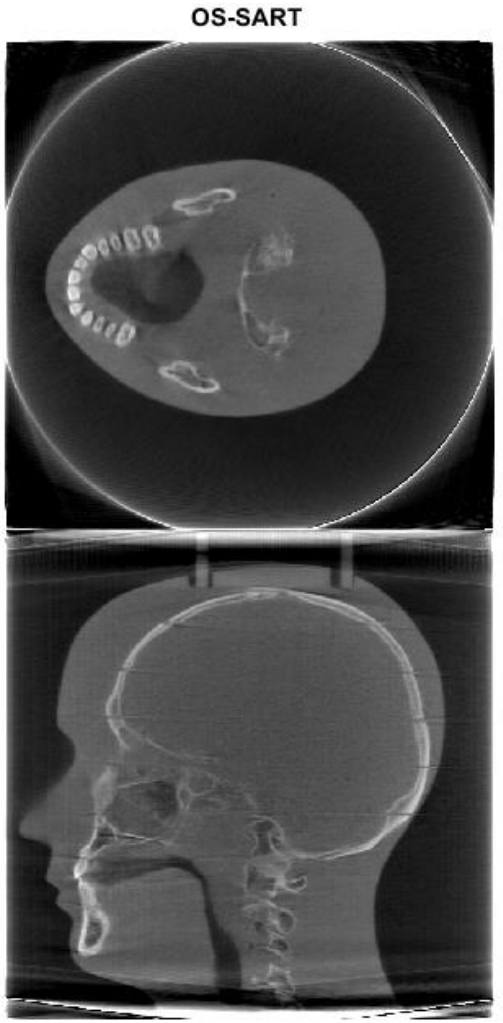
Projection



Backprojection

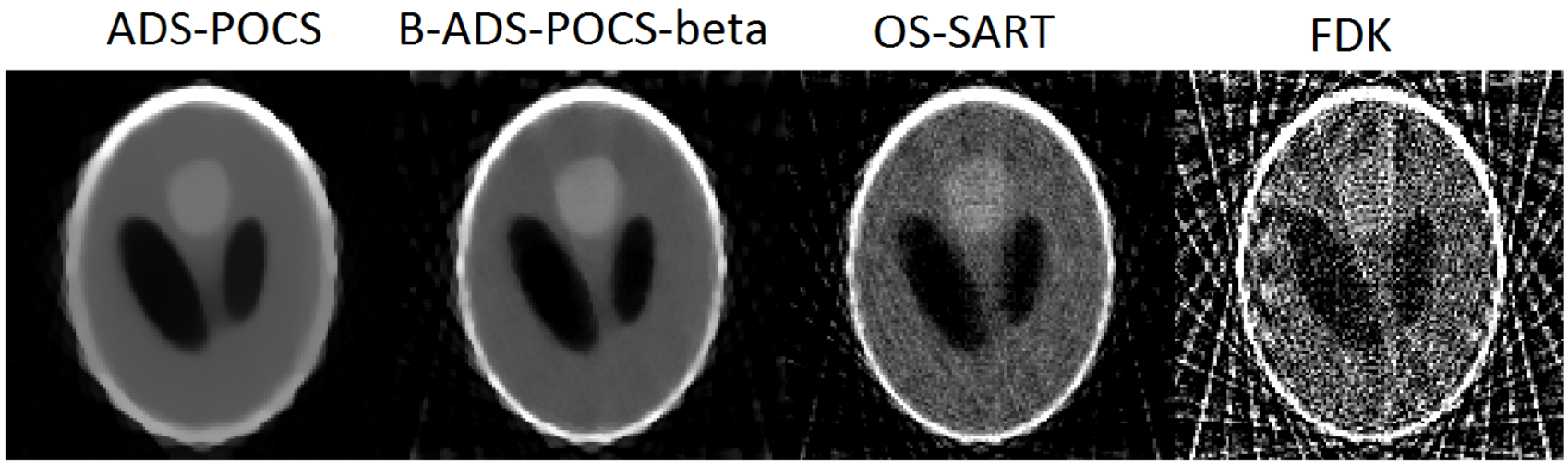
A GPU toolbox for CBCT

- Algorithms:
  - FDK
  - SART, OS-SART, SIRT (with multiple initialization)
  - CGLS
  - POCS-TV, OSC-TV, B-POCS-TV-β, SART-TV
- Pre and post processing tools
- Visualization Tools



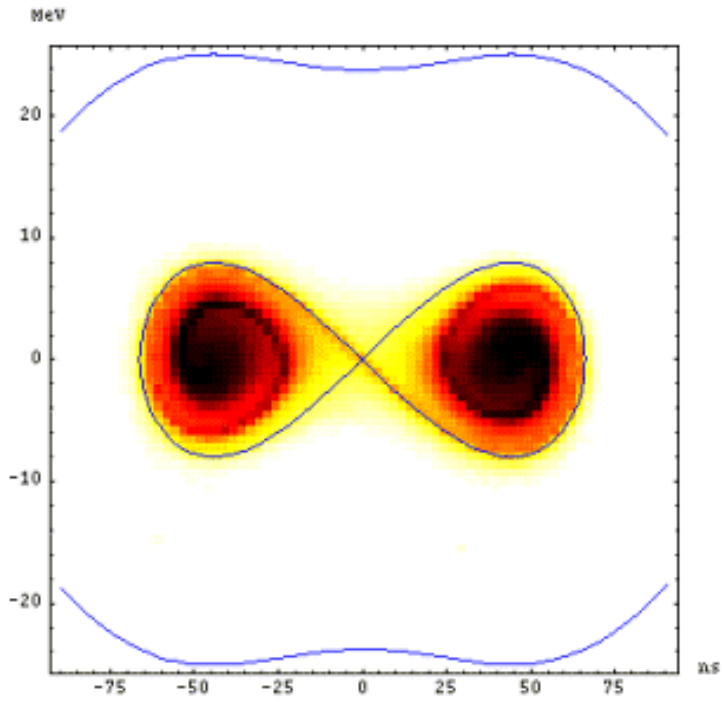
Choice of algorithm matters: Few projections

- 20 equidistant projections



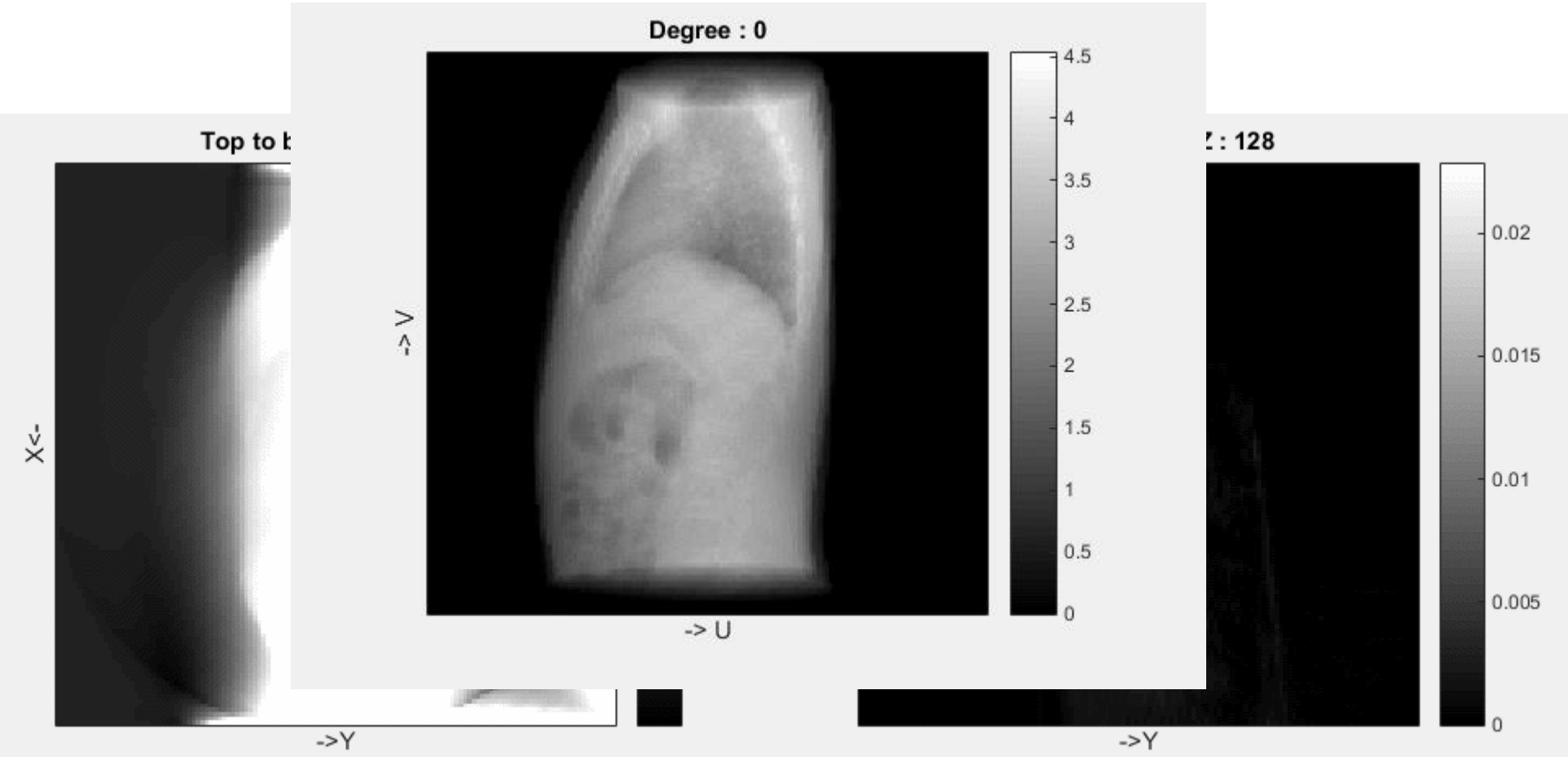
Motion on CBCT (4D imaging):
From accelerator physics to medical imaging

- Phase Space tomography:
  - Particles “move” between projections.
  - “Motion” information is measured and encoded system matrix (A)
  - Images are reconstructed at arbitrary time using SART



Motion on CBCT (4D imaging): From CERN to medicine

- Preliminary results:

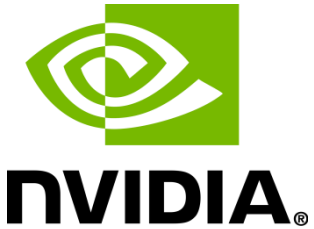


Conclusions and future work

- Fast, complete MATLAB-CUDA CBCT toolbox
  - Includes most of the common algorithms
  - Includes tools for research: post/pre processing, visualization, quality measurements, …
- Choice of algorithm matters
- CERN to medicine: on the fly computation of operators A(x) , A^T(b) allows to introduce motion knowledge. Full 4D imaging is the next step

Thanks

- CERN and EPSRC
- The Christie Hospital
- Manjit Dosanjh
  Steven Hancock
  Imanol Luengo
  Manucherh Soleimani
- NVIDIA



Questions