

Cone Beam CT Software Toolkit (CST)

- Full CT reconstruction backend with state-of-the-art algorithms to correct for scatter, detector blur, beam hardening, lag, metal artifacts, and ring artifacts.
- Efficient filtered back projection (FDK) and iterative reconstruction algorithms.
- Workbench R&D application to construct and optimize easily deployable pipelines.
- Full geometric calibration suite.
- Stable easy-to-use API supporting .NET and C++ host applications.

OVERVIEW

Varex Imaging has developed an easy-to-use, highly configurable Cone Beam CT Software Toolkit (CST) to speed up development times and produce high-quality 2D images or 3D reconstructions for medical applications.

The toolkit consists of:

1. State-of-the-art algorithms to correct for scatter, detector blur, beam hardening, lag, metal artifacts, and ring artifacts.
2. Efficient filtered back projection (FDK) and iterative reconstruction algorithms.
3. A complete geometry calibration and correction suite.

CST runs on Windows and is designed for use with all Varex Imaging X-ray flat panel detectors.

CST's pipeline provides an interface for OEM host applications to execute image processing and reconstruction algorithms. The algorithms are delivered as separate plugins, and a host application can use any or all of the plugins provided. OEMs can also create custom plugins that integrate with the pipeline in the same way as CST-provided processing steps.

2-D AND 3D IMAGE PROCESSING PLUGINS

2D VSHARP Scatter Correction

Deconvolves scatter from the raw projection data using a model that is customized to the user's CBCT system.

3D VSHARP™ Scatter Correction

Estimates and corrects for scatter by rapidly simulating X-ray transport through a volumetric model of the scanned object. It is generally more accurate than 2D VSHARP but slower.

Beam Hardening Correction

Corrects for hardening of the X-ray spectrum as the beam passes through the object.

Lag Correction

Corrects for the lag, or residual signal on the detector, from one frame to the next.

Resolution Enhancement (REA)

Reduces the impact of scintillator light spread on MTF.

Ring Correction

Corrects for ring artifacts caused by small gain linearity differences across the detector.

Hounsfield Unit Adjustment

Scales the output image to calibrated Hounsfield units

Metal Artifact Reduction

Reduces shading and streaking artifacts that arise from highly attenuating metal objects.

RECONSTRUCTION PLUGINS

Normalization

Log-normalizes the data based on a previous static or dynamic air calibration scan and optional norm chamber.

Filtering

Highly configurable module that can selectively apply the FDK ramp filter, Parker and cosine weighting, and anti-aliasing noise reduction.

CPU and GPU Back Projection

Both highly optimized. The GPU back projector supports 12-DOF geometries and projection matrices.

Statistical Reconstruction

Performs GPU-based iterative reconstruction supporting both ART and maximum-likelihood estimation, with ordered subset and momentum accelerations, multiple regularization options, and configurable noise models.

GPU Forward Projection

Generates 2D Projections from 3D Images.

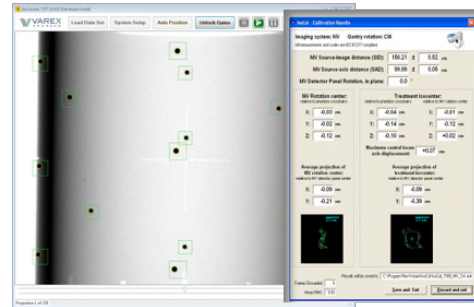
CBCT SOFTWARE TOOLS

GEOMETRIC CALIBRATION AND OPTIMIZATION

CST's geometric calibration package includes both calibration software and precisely machined phantoms.

- The phantoms are available in small and medium sizes as appropriate for the geometry of the CBCT system.
- The software measures both "static" and "dynamic" geometric information by analyzing projection data obtained over a range of rotation angles.
- The 9-DOF dynamic geometry information can be used to correct for repeatable gantry wobble and jitter.

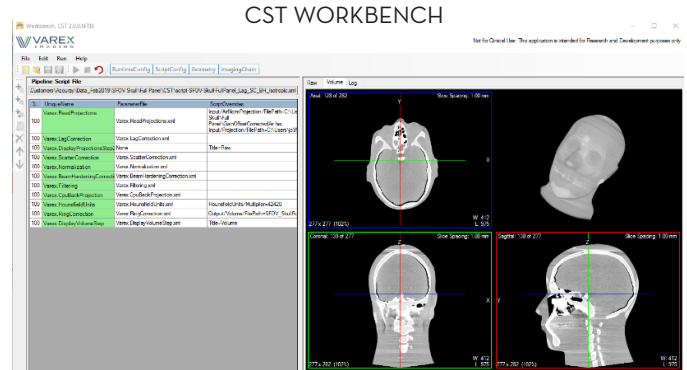
GEOMETRY CALIBRATION PHANTOM AND SOFTWARE



CST WORKBENCH

The CST Workbench application (not intended for system use) is an R&D tool that allows OEMs to easily set up and run the CST pipeline. It provides:

- A flexible platform to experiment with the pipeline and optimize it for customer applications.
- 2D and 3D visualization of images.
- An interface to easily examine log files.



The CST PipelineRunner application is a similar tool that allows the user to run a pipeline directly from the command line.

APPLICATION PROGRAMMING INTERFACE (API)

A host application can integrate CST using just two *Pipeline API* calls. A wide range of additional calls provide extensive control over the algorithms and pipeline, including status reports and callbacks, passing data in-memory, or customizing parameters on-the-fly.

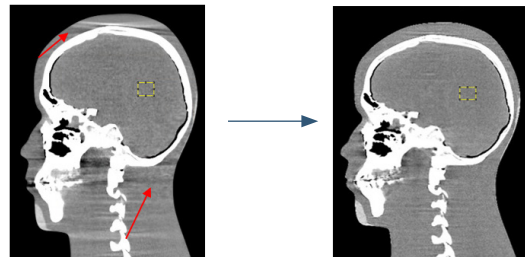
The *Plugin API* allows OEMs to write their own custom processing steps to replace or augment CST-provided plugins or to introduce novel customer-specific features or algorithms.

DOCUMENTATION

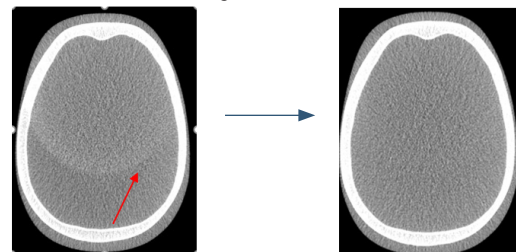
All aspects of CST are fully documented. The Workbench contains context-based help for each parameter, including a link to the appropriate section in the HTML reference manuals. There is a hands-on tutorial to enable users to get started quickly, and additional reference manuals are provided for the APIs and other components of CST. Example pipeline scripts demonstrate how to configure various algorithms, and source code examples (in both C# and C++) demonstrate how to use the APIs.

EXAMPLE CST CORRECTIONS

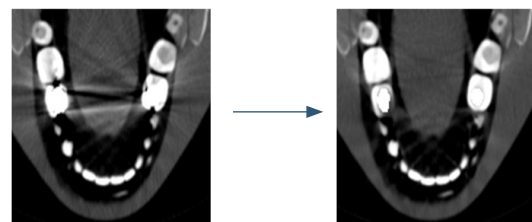
Cone Beam Artifact Reduction



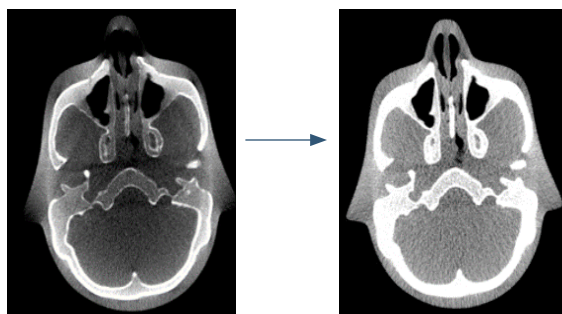
Lag Correction



Metal Artifact Reduction



Example of CST Scatter and Beam Hardening Correction



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