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Eclipse Scripting API Reference Guide

Eclipse

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Legal Information

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Eclipse Scripting API Reference Guide

Abstract
This document provides reference information and procedures for Eclipse Scripting API version 18.0.
This publication is the English-language original.

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ISO 13485
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MD

Basic Unique Device Identification

The Basic Unique Device Identification (Basic UDI-DI) for Eclipse is 089947500200107PN.

IEC 62083

Eclipse™ Treatment Planning System is IEC 62083 compliant.
BrachyVision™ Treatment Planning System is IEC 62083 compliant.

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Introduction

Introduction

Eclipse™ is used to plan radiotherapy treatments for patients with malignant or benign diseases. The users of Eclipse are medical professionals who have been trained in radiation dosimetry. After an oncologist has decided that radiotherapy is the suitable treatment for a patient, the medical professionals use Eclipse to plan the treatment for the patient. Eclipse can be used to plan external beam irradiation with photon, electron, and proton beams, as well as for internal irradiation (brachytherapy) treatments. Eclipse is part of Varian's integrated oncology environment.

The Eclipse Scripting Application Programming Interface (Eclipse Scripting API or ESAPI) is a programming interface and a software library for Eclipse. It allows software developers to write scripts to access the treatment planning information in Eclipse. The scripts can be integrated into the Eclipse user interface, or they can be run as stand-alone executables.

Who Should Read This Guide

This guide is written mainly for medical/technical personnel who wish to write custom scripts to be used in Eclipse. It is assumed that you are familiar with:

- Eclipse Treatment Planning System
- Radiation oncology domain and concepts
- DICOM
- Software engineering practices
- Microsoft® Visual Studio® development environment
- Microsoft Visual C#® programming language and object-oriented development

Related Publications

- *RT Administration Reference Guide*
- *Beam Configuration Reference Guide*
- *BrachyVision Instructions for Use*
- *BrachyVision Reference Guide*
- *BrachyVision Algorithms Reference Guide*
- *Eclipse Photon and Electron Instructions for Use*
- *Eclipse Photon and Electron Reference Guide*
- *Eclipse Photon and Electron Algorithms Reference Guide*
- *Eclipse Cone Planning Online Help*
- *Eclipse Proton Instructions for Use*
- *Eclipse Proton Reference Guide*
- *Eclipse Proton Algorithms Reference Guide*
- *Eclipse Scripting API Online Help*

- *Varian Service Portal User Rights Reference Guide*
- *Varian Service Portal Administration Reference Guide*
- *DICOM Import and Export Reference Guide*
- *Varian Medical Systems Backup Guidelines (CTB-GE-936)*

Visual Cues

This publication uses the following visual cues to help you find information:

WARNING: A warning describes actions or conditions that can result in serious injury or death.

CAUTION: A caution describes hazardous actions or conditions that can result in minor or moderate injury.

NOTICE: A notice describes actions or conditions that can result in damage to equipment or loss of data.

Note: A note describes information that may pertain to only some conditions, readers, or sites.

Tip: A tip describes useful but optional information such as a shortcut, reminder, or suggestion, to help get optimal performance from the equipment or software.

Eclipse Scripting API

About Eclipse Scripting API

The Eclipse Scripting API is a Microsoft .NET® class library that gives you access to the treatment planning data of Eclipse. It allows you to create scripts that leverage the functionality of Eclipse, and lets you retrieve plan, image, dose, structure, and DVH information from the Varian System database. The data is retrieved from the Varian System database also in stand-alone Eclipse installations. You can integrate the scripts into Eclipse, or you can run them as stand-alone executables.

With Eclipse Automation feature, you can also create scripts that allow you to create and modify structure and plan data, and execute dose calculation and optimization algorithms. These scripts are first created and tested in a non-clinical development environment, but can then be approved for clinical use.

WARNING: The authors of custom scripts are responsible for verifying the accuracy and correctness of the scripts after developing a new script or after system upgrade for the existing scripts.

Features

By using the Eclipse Scripting API, you can:

- Write custom scripts and integrate them into the Eclipse user interface.
- Write stand-alone executable applications that leverage the Eclipse Scripting API.

You can access the following information with ESAPI scripts:

- Image and structure models, including their volumetric representations.
- Plans, fields, and accessories.
- Predecessor plans.
- Plan protocol information.
- IMRT optimization objectives and parameters.
- Clinical goals.
- Doses, including their volumetric representations.
- Dose volume histograms.
- Optimal fluences.
- DVH estimates.
- Plan uncertainty information.
- Prescription Information.
- Treatment session information.

With Eclipse Automation, you can also create scripts that:

- Create and modify structures and structure sets.
- Create and modify plans and fields.

- Create and modify verification plans and copy images from another patient for those plans (for example, copy a scanned phantom image from a designated case).
- Create artificial phantom images.
- Generate DRRs.
- Create evaluation doses to evaluate dose calculated outside of Eclipse.
- Optimize plans by using the Eclipse optimization algorithms.
- Calculate leaf motions by using the Eclipse leaf motion calculation algorithms.
- Calculate the dose by using the Eclipse external beam and BrachyVision TG-43 dose calculation algorithms.
- Set field and plan uncertainty parameters and calculate plan uncertainty doses.
- Execute DVH estimation.
- Modify raw and final scan spot lists for proton plans.

The Eclipse Scripting API provides you also the following:

- Possibility to use visual scripting.
- A wizard that makes it simple to create new scripts.
- Patient data protection that complies with HIPAA.
- Support for user authorization used in Eclipse and ARIA® Radiation Therapy Management (RTM).
- API documentation.
- Example applications.
- Full 64-bit support.

System Requirements

The basic system requirements of the Eclipse Scripting API are the same as those of Eclipse. For more information, refer to *Eclipse Customer Release Note*.

Note: Microsoft Visual Studio is not needed for creating scripts. However, some features described in this document assume that Microsoft Visual Studio 2013 has been installed.

Clinical Environment

To run read-only ESAPI scripts in a clinical environment, you need the following:

- Eclipse 15.1 or later.
- A license for the Eclipse Scripting API 15.1 or later.

To approve and run ESAPI scripts created for Eclipse Automation, you need:

- Eclipse 15.1.1 or later.
- A license for the Eclipse Scripting API 15.1.1 or later.
- A license for Eclipse Automation 15.1.1 or later.

Development / Research Environment

To develop ESAPI scripts in a non-clinical development (research) environment, you need the following:

- Eclipse 15.1 or later (optional for creating scripts, mandatory for running them).
- A non-clinical Varian System database configured for research use.
- Eclipse Scripting API license.
- Eclipse Scripting API for Research Users license.

Version Compatibility

Note: If you use an obsoleted type, property, field, or method, the compiler shows a warning. In this case, the compilation of a single-file plug-in fails. If the script is a binary plug-in or a standalone executable, the compiler shows an error. This happens only if the “Treat warnings as errors” project setting is turned on in Microsoft Visual Studio.

ESAPI 18.0

The Eclipse Scripting API 18.0 is compatible with Eclipse 18.0.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

The target framework for the scripts must be Microsoft .NET Framework 4.8.

ESAPI 17.0

The Eclipse Scripting API 17.0 is compatible with Eclipse 17.0.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

The target framework for the scripts must be Microsoft .NET Framework 4.8.

ESAPI 16.1

The Eclipse Scripting API 16.1 is compatible with Eclipse 16.1.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

The target framework for the scripts must be Microsoft .NET Framework 4.6.1.

ESAPI 16.0

The Eclipse Scripting API 16.0 is compatible with Eclipse 16.0.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

The target framework for the scripts must be Microsoft .NET Framework 4.6.1.

ESAPI 15.5

The Eclipse Scripting API 15.5 is compatible with Eclipse 15.5.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

The target framework for the scripts must be Microsoft .NET Framework 4.5.

ESAPI 15.1.1

The Eclipse Scripting API 15.1.1 is compatible with Eclipse 15.1.1.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

ESAPI 15.1

The Eclipse Scripting API 15.1 is compatible with Eclipse 15.1.

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ESAPI 15.0

The Eclipse Scripting API 15.0 is compatible with Eclipse 15.0.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

Incompatibilities between ESAPI 15.0 and ESAPI 13.7:

- In prior versions, for stand-alone executables, the method `Application.CreateApplication` took two parameters, `userid` and `password` to identify a user. In Eclipse Treatment Planning System 15.0, a new security framework is introduced, and the logged-in user is automatically identified.
- The `Fractionation` class has been removed, and its properties and methods have been moved to the `PlanSetup` class.
- The `OptimizationSetup.AddStructurePointCloudParameter()` method and the `Beam.ExternalBeam` property that were previously marked as obsolete are now removed (the latter one is replaced by `Beam.TreatmentUnit`).

ESAPI 13.7

The Eclipse Scripting API 13.7 is compatible with Eclipse 13.7.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

Incompatibilities between ESAPI 13.7 and ESAPI 13.6:

- In prior versions, proton plans were represented as `ExternalPlanSetup` types. In version 13.7, a new class hierarchy for proton plans (`IonPlanSetup`) has been added. The consequence of this is that methods with return type `ExternalPlanSetup` that used to return proton plans now do not. The following methods and properties have been changed to return only photon external beam plans:
  - `ScriptContext.ExternalPlansInScope`
  - `ScriptContext.ExternalPlanSetup`
  - `Course.ExternalPlanSetups`

The corresponding methods of `ScriptContext` and `Course` returning `PlanSetup` types continue to return external beam plans, brachytherapy plans, and proton plans as previously.

ESAPI 13.6

The Eclipse Scripting API 13.6 is compatible with Eclipse 13.6.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

ESAPI 13.5

The Eclipse Scripting API 13.5 is compatible with Eclipse 13.5.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

ESAPI 13.0

The Eclipse Scripting API 13.0 is compatible with Eclipse 13.0.

Varian Medical Systems provides no guarantee that scripts written with this version of the Eclipse Scripting API will be compatible with future releases.

Incompatibilities between ESAPI 13.0 and ESAPI 11.0:

- The type `VMS.TPS.Common.Model.Types.VRect` has been changed to immutable. Scripts that use the set accessors of `VRect` properties are incompatible with the Eclipse Scripting API 13.0.
- The type `VMS.TPS.Common.Model.ExternalBeam` has been marked as obsolete. It is replaced by the `VMS.TPS.Common.Model.ExternalBeamTreatmentUnit` type.
- The property `VMS.TPS.Common.Model.Beam.ExternalBeam` has been marked as obsolete. It is replaced by the `VMS.TPS.Common.Model.Beam.TreatmentUnit` property.

ESAPI 11.0

The Eclipse Scripting API 11.0 is compatible with Eclipse 11.0.

Assembly Version Numbers

The Eclipse Scripting API is a Microsoft .NET class library that is also called an assembly. The .NET assembly can have several different version numbers. The three version numbers that are used in ESAPI are:

- AssemblyVersion: this is used by Visual Studio and .NET framework during building and at runtime to locate, link, and load the assemblies. The assembly version is visible, for example, in Visual Studio, in the properties of the assembly reference.
- AssemblyFileVersion: this is the version number of the file. It is displayed in Windows®, Explorer, in the file properties dialog of the assembly.
- AssemblyInformationalVersion: the product version of the assembly. It is displayed in Windows Explorer, in the file properties dialog of the assembly. Product version number is also visible in *Eclipse Scripting API Online Help*.

Starting from ESAPI release 15.0, assemblies have used the .NET strong naming. The strong (or full) name of the assembly consists of name, version, culture, and public key token. Originally, these three version numbers have been the same in ESAPI, but starting from the ESAPI release 15.1, the AssemblyVersion is different. This enables changing the AssemblyVersion based on changes in ESAPI, in comparison to the file and product versions that are automatically updated based on the Eclipse release.

The following table contains the version numbers per release starting from ESAPI 15.1 release:

ESAPI Release	AssemblyVersion	AssemblyFileVersion	AssemblyInforma-tionVersion
18.0	1.0.600	18.0	18.0
17.0	1.0.500	17.0	17.0
16.1	1.0.450	16.1	16.1
16.0	1.0.400	16.0	16.0
15.5 MR1	1.0.200	15.5	15.5
15.5	1.0.100	15.5	15.5
15.1.1	1.0.7	15.1	15.1
15.1	1.0.7	15.1	15.1

Upgrade to ESAPI 18.0

Binary plug-in scripts and stand-alone executable scripts that have been compiled using versions 15.5 and later of Eclipse Scripting API will work after upgrading to the Eclipse Scripting API 18.0 without recompilation. The major version of the API has not been changed, there are no breaking changes, just additions to the API.

Stand-alone scripts that have been compiled using versions older than 15.5 of Eclipse Scripting API do not work after upgrading to the Eclipse Scripting API 18.0. Additionally, binary plug-ins for older versions do not compile after the upgrade.

To make the scripts work with ESAPI 18.0, you need to update the Visual Studio projects to reference the new ESAPI 18.0 assemblies.

1. Open the Eclipse Script Visual Studio project.
2. Expand the **References** item in the **Solution Explorer**. You should see the existing references to `VMS.TPS.Common.Model.API` and `VMS.TPS.Common.Model.Types`.
3. Remove both references from the project.
4. Add new references to the ESAPI 18.0 assemblies. In the **Add Reference** dialog box, select the **Browse** tab. The assemblies are located under the installation directory of the Eclipse Scripting API, in the API sub-directory.
5. Add references to both `VMS.TPS.Common.Model.API.dll` and `VMS.TPS.Common.Model.Types.dll`.
6. In the properties of the solution, make sure that the Target Framework is NET 4.8.
7. Recompile the project.

If you are using a script provided as a part of an earlier Eclipse version and you have copied the script to another location, you need to re-fetch the script from the same location of the new Eclipse version.

What Is New in Eclipse Scripting API 18.0

Many new properties, functions, and classes have been added or changed in ESAPI 18.0. See the detailed documentation in *Eclipse Scripting API Online Help*. The following lists most significant changes and additions.

Plan Checker

You can now run a **Plan Checker** script that contains over 30 predefined plan checks for a preliminary (dosimetric) check. **Plan Checker** has a user interface that displays the checks done and their results. You need to go through the findings and take appropriate actions. You can also run a PDF report of the information provided by **Plan Checker**.

For a faster access to **Plan Checker**, a menu commands are added to the **Tools** menu in **External Beam Planning**.

New templates for Plan Checker script and Plan Checker extension are now available in the **Script Wizard**.

More information: Launching a Plan Checker Script on page 76 and Showing Plan Checker Reports on page 78.

Custom Logging

You can now use the following methods in the `Globals` class to write custom messages into log files. These messages are generated during a script execution.

```
Globals.AddCustomLogEntry("TEST LOG MESSAGE");
```

```
Globals.AddCustomLogEntry("TEST LOG MESSAGE2", LogSeverity.Info);
```

Log files are saved under the VMSOS folder: `VMSOS\Log\Application\RTM\TpsScriptingApi\ScriptCustomLog`.

Optimization

The following optimization features were added to Eclipse Scripting API:

Normal Tissue Objective

- It is now possible to use the Stereotactic Body Radiation Therapy Normal Tissue Objective (SBRT NTO) using function `OptimizationSetup.AddAutomaticSbrtNormalTissueObjective`.
- Two new properties were added to `OptimizationNormalTissueParameter` to determine the selected NTO mode.

Proton Planning

The following proton planning features have been added to Eclipse Scripting API.

Plans

- It is now possible to evaluate the deliverability and delivery time of ProBeam modulated scanning plans using the `IonPlanSetup.CalculateDeliveryDynamics` method.

IonBeam Properties

- It is now possible to get Proton Delivery Time Status using the `IonBeam.GetDeliveryTimeStatusByRoomId` method.
- It is now possible to get field delivery time using the `IonBeam.GetProtonDeliveryTimeByRoomIdAsNumber` method.

General Improvements

The following improvements have been made to ESAPI:

- It is now possible to add reference points to existing plans, also within plugin scripts. It is now also possible to remove reference points from plans (`Patient.ReferencePoints`, `PlanSetup.ReferencePoints`, `PlanSetup.PrimaryReferencePoint`).
- It is now possible to get information of plan's status with the property `PlanSetup.IsInTreatment`.
- It is now possible to define the block outline with the property setter `Block.Outline`.
- It is now possible to get information of the structure set's series with the property `StructureSet.Series` (and `StructureSet.SeriesUID`).

- It is now possible to move a plan to a new course maintaining the old plan UID with the `PlanSetup.MoveToCourse` method.
- It is now possible to access and modify the beam set up note with the `Beam.SetupNote` property.
- It is now possible to add and remove the bolus to a field: `Beam.AddBolus` and `Beam.RemoveBolus`.
- It is now possible to access and modify the treatment order of a field with `PlanSetup.BeamsInTreatmentOrder` property and `PlanSetup.SetTreatmentOrder` method.
- It is now possible to recreate a VMAT beam by adjusting the gantry angles and meterset weights in control points with `ControlPoint.GantryAngle` and `ControlPoint.MetersetWeight`.

Supported Script Types

Eclipse supports the script types listed below.

Plug-Ins

Plug-ins are launched from the Eclipse user interface. After the launch, the plug-in gains access to the data of the currently open patient.

Eclipse supports three types of plug-ins:

- A single-file plug-in: A source code file that Eclipse reads, compiles on the fly, and connects to the data model of the running Eclipse instance.
- A binary plug-in: A compiled .NET assembly that Eclipse loads and connects to the data model of the running Eclipse instance.
- An approval extension plug-in: A binary plug-in that is executed during plan approval wizard operation. More information: Creating Approval Extension Plug-In Scripts on page 35.

Software Add-Ons

Software add-ons are features that can be downloaded from Varian Download Center. More information: Getting Software Add-Ons on page 33 and Launch a Software Add-On on page 75.

Executable Applications

A stand-alone executable is a .NET application that references the Eclipse Scripting API class library. It can be launched just like any Windows® application.

Stand-alone executables can be either command-line applications, or they can leverage any .NET user interface technology available on the Windows platform.

While the plug-in scripts are restricted to work for one single patient opened in Eclipse, the stand-alone executable can scan the database and open any patient.

Read-Only and Write-Enabled Scripts

Binary plug-ins and executables can be either read-only or write-enabled. Read-only scripts have only read access to the treatment planning data of Eclipse. Write-enabled scripts can be used for changing Eclipse objects.

Visual Scripts

Visual scripts are created in Visual Scripting Workbench and executed in Eclipse as single-file plug-in scripts. They can be either read-only or write-enabled. Visual scripts are launched from the Visual Scripting Workbench, or from Eclipse in the same way as ordinary single-file plug-in scripts.

Eclipse Scripting API Object Model

About Eclipse Scripting API Object Model

The Eclipse data model is presented in the Eclipse Scripting API as a collection of .NET classes with properties and methods. The class hierarchy is an abstraction over the Varian Radiation Therapy Management (RTM) data model and uses similar terminology as the DICOM object model.

The classes of the object model hide all the details of interacting with the database and creating the in-memory representations of the Eclipse data. Because the Scripting API is a .NET class library, all details of managing the memory and other low-level resources are also transparent to you when you create scripts.

Eclipse Scripting API Concepts

The following describes the most important concepts of the Eclipse Scripting API.

Coordinate System and Units of Measurement

The Eclipse Scripting API uses the following coordinate systems and units of measurement.

Distances and Positions

In all methods and properties that work with distances and positions, the unit of measurement is millimeters. The positions in 3D space are returned using the DICOM coordinate system. Note that this differs from the Planning Coordinate system used in the Eclipse user interface, where the unit of measurement is centimeters. In addition, when the coordinate values are displayed in the Eclipse user interface, the following are taken into account:

- The possible user-defined origin of an image.
- The treatment orientation of the plan.
- The axis definition of the planning coordinate system.

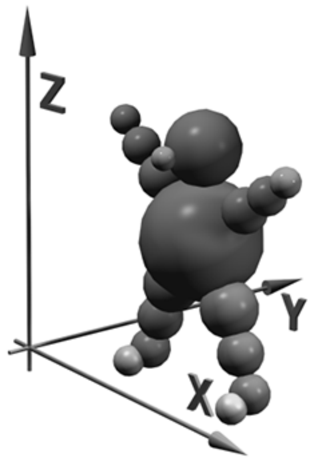


Figure 1 DICOM Coordinate System

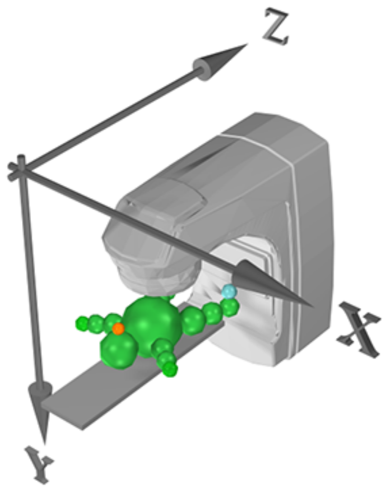


Figure 2 Standard Planning Coordinate System

The Eclipse Scripting API has methods that convert values from the DICOM coordinate system to the same representation that is used in the Eclipse user interface.

More information on the display of 3D coordinates in the Eclipse user interface: *Eclipse Photon and Electron Reference Guide*. More information on the DICOM coordinate system: *DICOM standard*.

Dose Values

In the Eclipse Scripting API, dose values are always represented with the separate `VMS.TPS.Common.Model.Types.DoseValue` type. In addition to the actual floating point value of the variable, this type also holds the measurement unit of the dose. The measurement unit can be Gy or cGy, depending on the selected clinical configuration. It can also be a percentage if the relative dose is used.

Treatment Unit Scales

All methods and properties of the Eclipse Scripting API return the treatment unit and accessory properties in the IEC61217 scale. This feature allows you to create scripts despite the scale interpretation differences between treatment unit vendors.

User Rights and HIPAA

The Eclipse Scripting API uses the same user rights and HIPAA logging features as Eclipse. When a plug-in script is executed, the script applies the same user rights as were used to log into Eclipse.

When you execute a stand-alone executable script, the user name and password are automatically passed via the new single sign-on technology implemented in the Eclipse release. No additional dialogs are required to authenticate the user to the system.

According to HIPAA rules, a log entry is made for each patient opened by a standalone script. Additionally, the Eclipse Scripting API follows the rules of department categorization of ARIA RTM.

Working with Several Patients

The context of the running Eclipse instance is passed to plug-in scripts. They work only for the one patient that is selected in that context. In contrast, stand-alone executables can open any patient in the database. However, only the object model of a single patient is available at a time. The previous patient data must be explicitly closed before another patient is opened. If you try to access the data of a patient that has been closed, an access violation exception is generated.

Overview of the Object Model

The following diagram gives an overview of the `Image`-related objects in the Eclipse Scripting API.

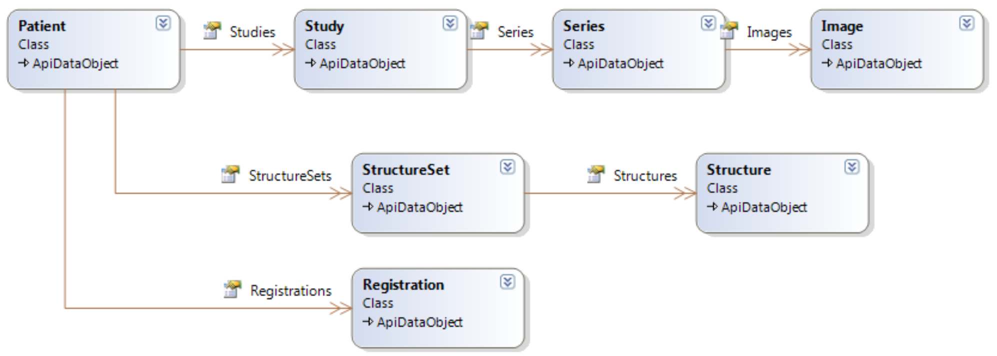


Figure 3 Image Data Model

The Image Data Model diagram contains the following objects:

- A `Patient` that has a collection of `Study`, `StructureSet`, and `Registration` objects.
- A `Study` that has a collection of `Series` objects.
- A `Series` that has a collection of `Image` objects.

- A `StructureSet` that has a collection of `Structure` objects.

Another important section of the Eclipse Scripting API is the model of `Plan`-related objects shown in the following diagram.

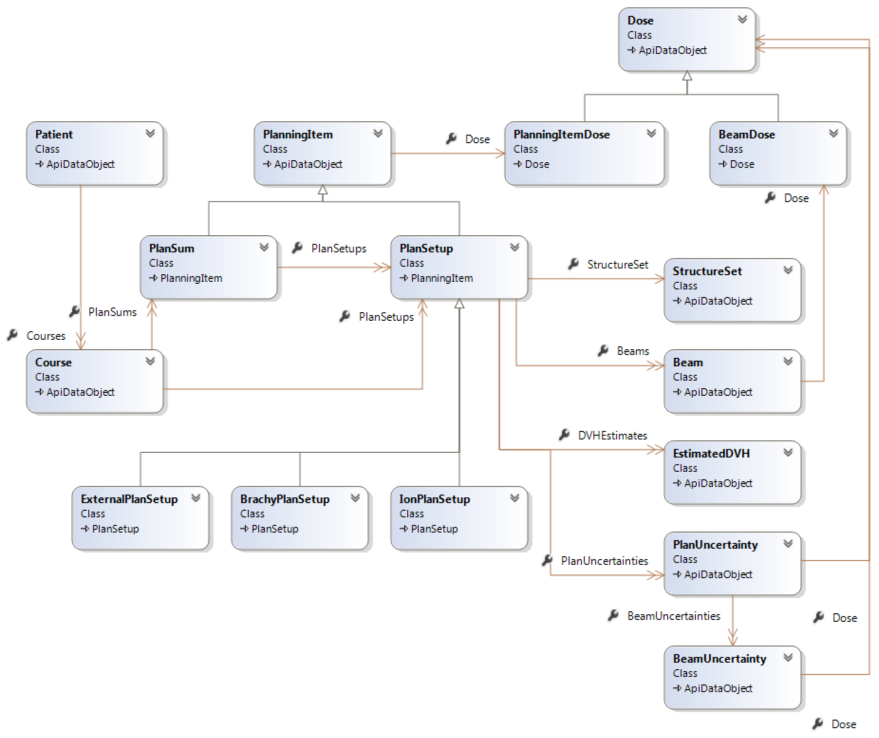


Figure 4 Plan Data Model

The Plan Data Model diagram contains the following objects:

- A `Patient` that has a collection of `Course` objects.
- A `Course` that has a collection of `PlanSetup` and `PlanSum` objects. Each of them is derived from the common `PlanningItem` base class. Each `PlanSetup` object is an `ExternalPlanSetup`, a `BrachyPlanSetup`, or an `IonPlanSetup`.
- A `PlanningItem` class that has a direct (but nullable) relationship with a `PlanningItemDose` class.
- A `PlanSetup` that has a collection of `Beam` objects. A `Beam` has a direct (but nullable) relationship with a `BeamDose` class.
- A `PlanSetup` that has a direct (but nullable) relationship with `StructureSet` and `EstimatedDVH` objects.
- A `PlanSetup` that has a collection of `PlanUncertainty` objects.
- A `PlanUncertainty` has a collection of `BeamUncertainty` objects, and a direct (but nullable) relationship with a `Dose` class.
- A `BeamUncertainty` has a direct (but nullable) relationship with a `Dose` class.

The object model related to Plan optimization is visualized in the following figure:

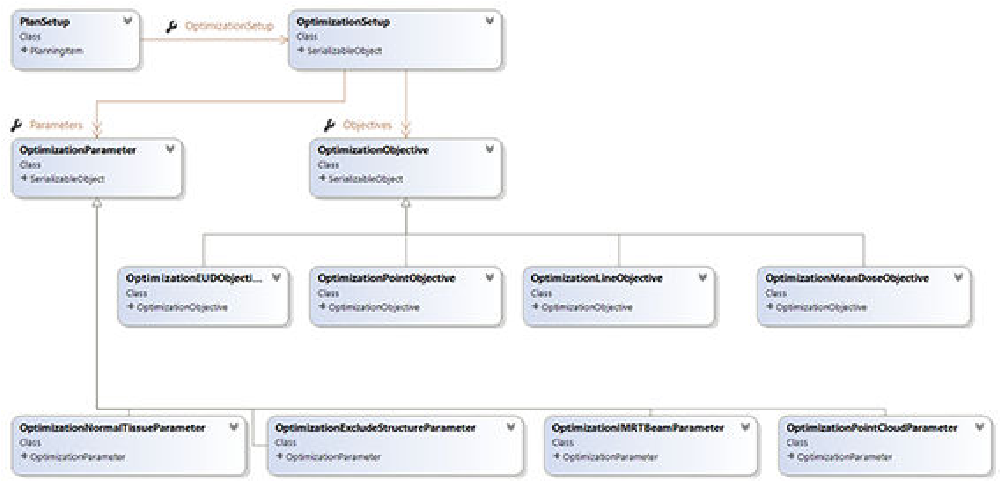


Figure 5 Plan Optimization Data Model

The Plan Optimization Data Model diagram contains the following objects:

- A `PlanSetup` that has an association to the `OptimizationSetup`.
- An `OptimizationSetup` that has a collection of `OptimizationParameter` objects. Each `OptimizationParameter` object is an `OptimizationNormalTissueParameter`, `OptimizationExcludeStructureParameter`, `OptimizationIMRTBeamParameter`, or `OptimizationPointCloudParameter`.
- An `OptimizationSetup` that has a collection of `OptimizationObjective` objects. Each object is an `OptimizationPointObjective`, `OptimizationEUDObjective`, `OptimizationLineObjective`, or `OptimizationMeanDoseObjective`.

The following diagram shows the objects related to an individual `Beam`:

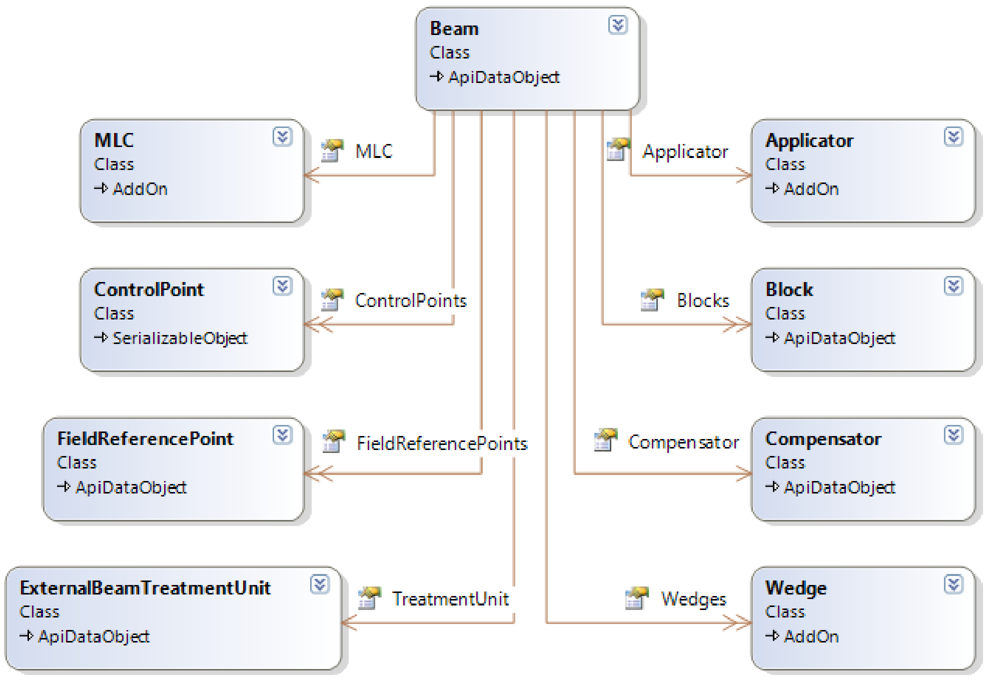


Figure 6 Beam Data Model

The Beam Data Model diagram contains the following objects:

- An `MLC` and a `ControlPoint` collection of the `Beam`.
- An `Applicator`, a `Compensator`, and a collection of `Blocks` and `Wedges` if defined for the `Beam`.
- A collection of `FieldReferencePoint` objects for the `Beam`.
- An `ExternalBeamTreatmentUnit` object that represents the treatment unit.

The following diagram shows the data model for brachytherapy plans:

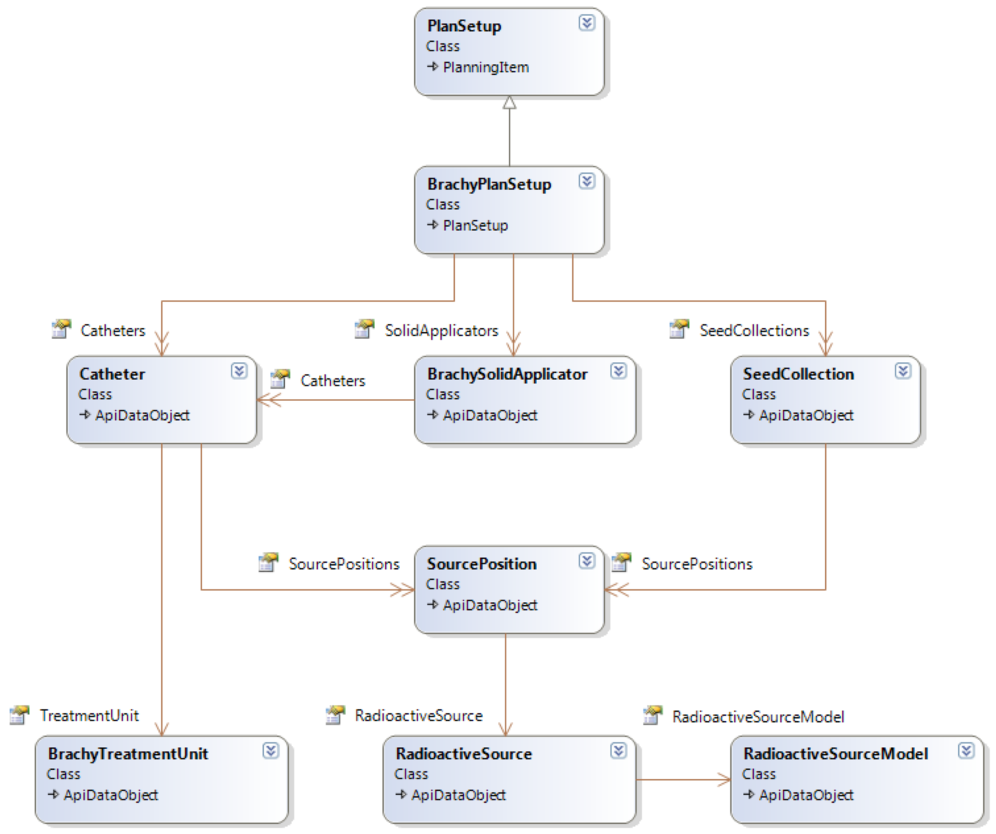


Figure 7 Brachytherapy Data Model

The Brachytherapy data Model diagram contains the following objects:

- A `BrachyPlanSetup` is derived from `PlanSetup`. The `BrachyPlanSetup` has a collection of `Catheters`, `BrachySolidApplicators`, and `SeedCollections`. Note that `BrachyPlanSetups` can be accessed through the `Course` in the same way as `PlanSetups`.
- A `BrachySolidApplicator` has a collection of `Catheters`.
- A `Catheter` (applicator channel central line or needle) has a `BrachyTreatmentUnit` and a collection of `SourcePositions`.
- A `SeedCollection` has a collection of `SourcePositions`.
- A `SourcePosition` has a `RadioactiveSource`.
- A `RadioactiveSource` has a `RadioactiveSourceModel`.

The following diagram details the proton plan data model:

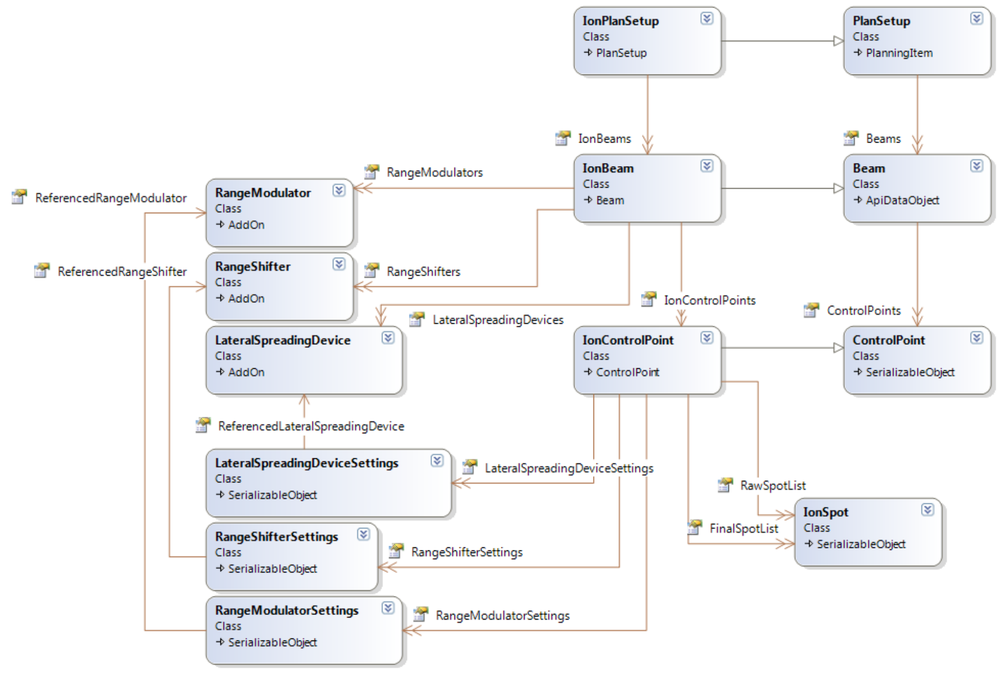


Figure 8 Proton Plan Data Model

The Proton Plan Data Model diagram contains the following objects:

- An `IonPlanSetup` is derived from `PlanSetup`. The `IonPlanSetup` has a collection of `IonBeams`.
- An `IonBeam` is derived from `Beam`. The `IonBeam` has collections of `IonControlPoints`, `RangeModulators`, `RangeShifters`, and `LateralSpreadingDevices`.
- The `IonControlPoint` is derived from `ControlPoint`. It provides access to the raw spot list `IonSpot` objects through property `RawSpotList`, and access to the final spot list through property `FinalSpotList`.
- An `IonControlPoint` has collections of `LateralSpreadingDeviceSettings`, `RangeShifterSettings`, and `RangeModulatorSettings`.
- A `LateralSpreadingDeviceSettings` contains control-point-level settings for a `LateralSpreadingDevice` owned by the `IonBeam`. A `RangeShifterSettings` contains control-point-level settings for a `RangeShifter` owned by the `IonBeam`. A `RangeModulatorSettings` contains control-point-level settings for a `RangeModulator` object owned by the `IonBeam`.

The properties of each object are described in detail in the *Eclipse Scripting API Online Help*.

Eclipse Scripting API in a Developer Environment

Installing the Eclipse Scripting API in a Developer Environment

You can install Eclipse Scripting API libraries and components in a separate Windows developer environment with the Eclipse Scripting API installer. The ESAPI installer installs the Eclipse Script Wizard, Eclipse Scripting API Online Help, and the DLL files needed for creating and compiling scripts. Once these components are installed, you can create and compile standalone and plug-in scripts without having the Eclipse treatment planning system installed. Executing scripts in this developer environment requires Eclipse to be installed.

Note: Do not use this installer for updating the installed Eclipse Scripting API on any clinical system. Varian prohibits the use of the installer for this purpose. Only authorized Varian service personnel are allowed to change the installation on clinical systems.

Note: ESAPI scripts only run on computers that have Eclipse installed.

Installing the Eclipse Scripting API in a developer environment has the following benefits:

- Provides easier access to the Eclipse Script Wizard and Eclipse Scripting API Online Help.
- Allows you to preview new ESAPI releases.
- Allows you to create and compile scripts on workstations that do not have Eclipse installed (as is the case with local workstations in Citrix environments).

Install the Eclipse Scripting API

1. Save the installer (`Varian_Eclipse_Scripting.msi`) on your local computer.
2. To start the installation process, double click `Varian_Eclipse_Scripting.msi`.
3. Click **Next** and follow the instructions in the wizard to complete the installation.

   A folder called Varian is added to the desktop and to the Windows Start menu. This folder contains the sub-folder Eclipse Scripting API, which includes a shortcut to the **Eclipse Script Wizard** and to *Eclipse Scripting API Online Help*.

   The installer also adds libraries needed for running the **Eclipse Script Wizard** and for compiling ESAPI plug-in and stand-alone executable scripts.

   The **Eclipse Script Wizard** creates Visual Studio project files that reference these libraries so that ESAPI projects can be compiled on the developer workstation where the Eclipse Scripting API is installed.

Getting Started with The Eclipse Scripting API

Start the Eclipse Scripting API

To get quickly started with the Eclipse Scripting API, you can:

1. Copy the example code shown below to a file.
2. Save the file with a .cs extension on the hard disk of your workstation.

```
using System;
using System.Text;
using System.Windows;
using VMS.TPS.Common.Model.API;

namespace VMS.TPS
{
  class Script
  {
    public Script()
    {
    }
    public void Execute(ScriptContext context)
    {
      if (context.Patient != null)
      {
        MessageBox.Show("Patient id is " + context.Patient.Id);
      }
      else
      {
        MessageBox.Show("No patient selected");
      }
    }
  }
}
```

3. In Eclipse, select **Tools** > **Scripts**.
4. Select the `Directory: [path_to_your_own_scripts]` option.
5. To locate the script that you created, click **Change Directory**.
6. In the **Scripts** dialog box, select the script from the list and click **Run**. The script displays a message box that contains the ID of the patient that is open in Eclipse.

Using Example Scripts

The Eclipse Scripting API includes example scripts for a few of the supported script types. You can first copy the example scripts by using the Script Wizard, and then compile them by using Visual Studio.

If you do not have Visual Studio available, you can compile the examples with the MSBuild program, which is included in the Microsoft .NET framework.

Copy Example Scripts

1. From the **Start** menu, select **Varian** > **Eclipse Scripting API** > **Eclipse Script Wizard**.
2. Click the **Copy Example Scripts** tab.
3. To select a location for copying the example scripts, click **Browse**.
4. Click **Copy**.

   The example scripts are copied to the specified location.

Compile Example Scripts

You can compile the examples in Visual Studio. If you do not have Visual Studio available, you can compile the examples with the MSBuild program, which is included in the Microsoft .NET framework and the Microsoft Build Tools package.

1. Compile the examples by using Visual Studio:
   a. Open the Visual Studio project files.
   b. Compile the examples.
   c. Launch the example scripts.
2. To compile the examples by using MSBuild:
   a. In the file browser, go to the directory where you copied the example scripts.
   b. Open **Command Prompt**.
   c. Enter the following information on the command line:
      - The path to the directory where MSBuild.exe is located.
      - The name of the project file.
      - Platform specification for x64.

      For example: `C:\Windows\Microsoft.NET \Framework64\v4.0.30319\MSBuild.exe Example_DVH.csproj /p:Platform=x64`
3. To compile the example, press **ENTER**.

Using Custom Messages in Script Execution

You can use the following methods in the `Globals` class to write custom messages into log files. These messages are generated during a script execution.

```
Globals.AddCustomLogEntry("TEST LOG MESSAGE");
```

```
Globals.AddCustomLogEntry("TEST LOG MESSAGE2", LogSeverity.Info);
```

Log files are saved under the VMSOS folder: `VMSOS\Log\Application\RTM \TpsScriptingApi\ScriptCustomLog`.

Creating Scripts

About Creating Scripts

You can create scripts manually or by using the Script Wizard.

Creating Plug-In Scripts

The following sections give you step-by-step instructions on creating different types of plug-in scripts supported by the Eclipse Scripting API.

Create a Single-File Plug-In with the Script Wizard

1. From the **Start** menu, choose **Varian** > **Eclipse Scripting API** > **Eclipse Script Wizard**.
2. Enter a name for the new script.
3. Select the **Single-file plug-in** option.
4. To select the location for storing the script, click **Browse**. By default, the script is stored in the user-specific **Documents** folder.
5. Click **Create**.

   The Script Wizard creates the following folders in the location that you selected:

   - Project folder: Contains a script-specific subfolder where the Microsoft Visual Studio project file is stored.
   - Plugins folder: Contains the source code file for the single-file plug-in.

   The Script Wizard launches Visual Studio.
6. Edit the source code file according to your needs. You can use Visual Studio and its IntelliSense® support for editing the file, but they are not required. You do not have to compile the plug-in, because Eclipse compiles it automatically on the fly.

Create a Binary Plug-In with the Script Wizard

1. From the **Start** menu, choose **Varian** > **Eclipse Scripting API** > **Eclipse Script Wizard**.
2. Enter a name for the new script.
3. Select the **Binary plug-in** option.
4. To select the location for storing the script, click **Browse**. By default, the script is stored in the user-specific **Documents** folder.
5. Click **Create**.

   The Script Wizard creates the following folders in the location that you selected:

   - Project folder: Contains a script-specific subfolder where the Microsoft Visual Studio project file and source code file are stored.
   - Plugins folder: Contains the compiled plug-in dlls. From this folder, the dll can be loaded into Eclipse.

   The Script Wizard launches Visual Studio.

6. Edit the source code file according to your needs.
7. Compile the plug-in, for example, by using Visual Studio. The resulting plug-in dll is saved into the **Plugins** folder. Note that you can also use the MSBuild tool to compile the binary plug-in (see example: Compile Example Scripts on page 30). More information about MSBuild: Refer to Microsoft documentation.

Create a Single-File Plug-In Manually

If you want to create a single-file plug-in without the Script Wizard, follow these guidelines. An example of a source code file: Start the Eclipse Scripting API on page 29.

1. Create an empty C# source code file.
2. Add the using statements for the `System` and `System.Windows` namespaces.
3. Add the using statements for the following namespaces:
   - `VMS.TPS.Common.Model.API`
   - `VMS.TPS.Common.Model.Types`
4. Add a namespace called `VMS.TPS`.
5. To the `VMS.TPS` namespace, add a public class called `Script`.
6. To the `Script` class, add a constructor without parameters, and a method called `Execute`.
7. Define the return type of the `Execute` method as `void`.
8. To the `Execute` method, add the following parameters:
   - The context of the running Eclipse instance. The parameter type is `VMS.TPS.Common.Model.API.ScriptContext`.
   - A reference to the child window that Eclipse creates for the user interface components (optional). The parameter type is `System.Windows.Window`.

   You do not have to compile the plug-in, because Eclipse compiles it automatically on the fly.

Create a Binary Plug-In Manually

If you want to create a binary plug-in without the Script Wizard, follow these guidelines.

1. In Microsoft Visual Studio, create a new Class Library project. Select x64 as the Solution Platform.
2. Create the source code in the same way as for a single-file plug-in. Instructions: Create a Single-File Plug-In Manually on page 32.
3. Use the following file name extension for the dll: `.esapi.dll`. In this way, Eclipse recognizes the plug-in and can load it.
4. Add references to the following class libraries of the Eclipse Scripting API:
   - `VMS.TPS.Common.Model.API.dll`
   - `VMS.TPS.Common.Model.Types.dll`

   On the basis of this information, the dll can access the Eclipse Scripting API. The assemblies are located under the installation directory of the Eclipse Scripting API, in the API sub-directory.

5. Compile the plug-in into a .NET assembly (a dll), for example, by using Visual Studio. For more information on how to create a .NET assembly and add references to class libraries, refer to Microsoft documentation.

Storing Plug-In Scripts

If you want to make the created scripts available for all workstations, store them into the **System Scripts** directory. The **System Scripts** directory is a shared directory on the Varian System server.

You can access the **System Scripts** directory by clicking the **Open Directory** button in the **Scripts** dialog box.

Approval extension scripts must always be stored in the **System Scripts** directory. For cloud packages, the **Script Administration Wizard** takes care of installing the extension in the correct directory. When installing locally developed extensions, use the following steps:

1. Place the approval extension in a sub-directory of the `Extensions\PACKAGE` under **System Scripts**, where `PACKAGE` is the combination of extension name and version.

   For example, approval extension MyExtension.dll would be placed in directory `Extensions\MyExtension1.0.0.0` under **System Scripts**.
2. Register the extension using **Script Administration Wizard**.

Note: Installed approval extensions must be separately taken into use in **RT Administration**.

Getting Software Add-Ons

1. To open the ESAPI Script Administration, choose **Tools** > **Scripts**.
2. In the **Script Administration**, click the **Varian Download Center** tab.

   The tab displays configuration information on the script portal.
3. Click **Connect**.

   The list of available software add-ons is displayed.
4. Click **Download** to get a software add-on.

   After downloading the software add-on, it is unzipped and all the needed DLLs are saved to the server and registered automatically in the database. The saving location is: `\\[SERVER_NAME]\VA_DATA\ProgramData\Vision\PublishedScripts\VarianProvidedScripts`.

Creating Stand-Alone Executable Applications

The following sections give you step-by-step instructions on creating stand-alone executables supported by the Eclipse Scripting API.

Create a Stand-Alone Executable with the Script Wizard

1. From the Start menu, select **Varian** > **Eclipse Scripting API** > **Eclipse Script Wizard**.
2. Enter a name for the new script.
3. Select the **Standalone executable** option.
4. To select the location for storing the script, click **Browse**.
5. Click **Create**.

   The Script Wizard creates a **Projects** folder in the location that you selected. The folder contains a script-specific sub-folder where the Microsoft Visual Studio project file and source code file are stored. The Script Wizard launches Visual Studio.
6. Edit the source code file according to your needs.

Create a Stand-Alone Executable Manually

If you want to create stand-alone executables without the Script Wizard, follow these guidelines.

1. In Microsoft Visual Studio, create a new project file for the executable. Select x64 as the Solution Platform.
2. Add references to the following class libraries of the Eclipse Scripting API:

   - `VMS.TPS.Common.Model.API.dll`
   - `VMS.TPS.Common.Model.Types.dll`

   On the basis of this information, the executable can access the Eclipse Scripting API. The assemblies are located under the installation directory of the Eclipse Scripting API, in the API sub-directory.
3. In the main method of the executable file, use the static `CreateApplication` method to create an instance of the `VMS.TPS.Common.Model.API.Application` class. This class represents the root object of the data model. The `CreateApplication` method also initializes the Eclipse Scripting API.
4. Dispose of the instance when the stand-alone executable exits to free the unmanaged resources in the Eclipse Scripting API. For more information on disposing of objects, refer to Microsoft documentation of the IDisposable interface.
5. Use a single-threaded apartment (STA) as the COM threading model of the executable. The Eclipse Scripting API must only be accessed from a single thread that runs in the default application domain. For more information about threading and application domains, refer to Microsoft documentation.

   The following is the code for a sample stand-alone executable in C# language:

```
using System;
using System.Linq;
using System.Text;
using System.Collections.Generic;
using VMS.TPS.Common.Model.API;
using VMS.TPS.Common.Model.Types;

namespace StandaloneExample
{
  class Program
  {
    [STAThread]
    static void Main(string[] args)
    {
      try
      {
        using (Application app = Application.CreateApplication())
        {
          Execute(app);
        }
      }
      catch (Exception e)
      {
        Console.Error.WriteLine(e.ToString());
      }
    }
    static void Execute(Application app)
    {
      string message =
        "Current user is " + app.CurrentUser.Id + "\n\n" +
        "The number of patients in the database is " +
        app.PatientSummaries.Count() + "\n\n" +
        "Press enter to quit...\n";
      Console.WriteLine(message);
      Console.ReadLine();
    }
  }
}
```

6. Compile the project. The stand-alone executable is ready to be run.

   For more information on creating and compiling .NET applications, refer to Microsoft documentation.

Creating Approval Extension Plug-In Scripts

Approval extensions are binary plug-in scripts that are executed by the plan approval wizard of Eclipse and BrachyVision. The extensions are invoked right before the approval wizard opens and they can produce information, warning and error messages that are shown to the user. Note that producing an error message from your approval extension will block the plan approval in the same way as happens for errors detected by the plan validation checks of Eclipse. The approval extensions are called the second time immediately after the plan has been approved. At this step, the approval extension receives the same list of warnings and information messages that the approval wizard displayed to the user.

The approval extensions can also show a dialog box for interacting with the user. Be sure to call `ShowDialog()` rather than `Show()` method and create an `WindowInteropHelper` object as explained in Approval Extension Plug-In Methods on page 36.

All approval extensions plug-ins must be approved before they can be used in a clinical system and they must additionally be selected for use in **RT Administration** (unapproved extensions may be used when the system is configured for non-clinical use).

While your approval extension can be write-enabled it cannot make any dosimetric changes to the plan: if Eclipse detects a dosimetrically relevant change, the approval operation is stopped and modifications are discarded. In order to accomplish this, Eclipse saves all modifications to the database before starting the approval wizard execution if there are approval extensions configured in the system.

The approval extensions are invoked when moving a plan to Planning Approved or Reviewed state in Eclipse and BrachyVision. **Plan Parameters** does not support execution of custom approval extensions.

Approval Extension Plug-In Methods

Your approval extension plug-in must declare a public class named `VMS.TPS.ApprovalExtension` that has either a constructor with no parameters, or a constructor with the following signature:

```
public ApprovalExtension(User user, IntPtr parentWindowHandle)
```

The parameter user represents the currently logged in user of Eclipse and `parentWindowHandle` is the HWND handle that the approval extension must set as the `Owner` property of `System.Windows.Interop.WindowInteropHelper` object it creates for the modal dialog in case it wants to show a user interface:

```
WindowInteropHelper wih = new WindowInteropHelper(myDialog);
wih.Owner = parentWindowHandle;
myDialog.ShowDialog();
```

The method that is called before approval is executed must have this signature:

```
public PlanValidationResult PrePromote(PlanSetupApprovalStatus
newStatus, IEnumerable<PlanSetup> plans)
```

The parameter `newStatus` describes the state to which the plan is about to be promoted and the second parameter is the collection of plans to be promoted (the collection contains more than one plan in case of plan sum approval). The plans in the collection can have different statuses; some could be Unapproved while others can be Reviewed. The method should return a `PlanValidationResult` object that contains validation details (null can be returned if there is nothing to report).

A method with the following signature is called right after the plan has been saved to the database with the new state:

```
public void PostPromote(PlanSetupApprovalStatus newStatus,
IEnumerable<PlanSetup> plans, PlanValidationResult results)
```

The first two parameters are the same as for the `PrePromote` method and the optional third one contains all the warnings and information messages of the approval wizard. The extension state is retained between the `PrePromote` and `PostPromote` calls. The list of plans might be different in `PostPromote` in case a plan had IMRT fields that were split as part of the approval.

Creating an Extension Plug-In with the Script Wizard

1. From the **Start** menu, select **Varian** > **Eclipse Scripting API** > **Eclipse Script Wizard**.
2. Enter a name for the new script.
3. Select the **Approval extension** option.

4. To select the location for storing the script, click **Browse**. By default, the script is stored in the user-specific **Documents** folder.
5. Click **Create**.

   The Script Wizard creates the following folders in the location that you selected:

   - Project folder: Contains a script-specific sub-folder where the Microsoft Visual Studio project file and source code file are stored.
   - Plugins folder: Contains the compiled plug-in dlls.

   The Script Wizard launches Visual Studio.
6. Edit the source code file according to your needs.
7. Compile the plug-in, for example, by using Visual Studio. The resulting plug-in dll is saved into the **Plugins** folder. Note that you can also use the MSBuild tool to compile the binary plug-in. For an example, see Compile Example Scripts on page 30. For more information about MSBuild, refer to Microsoft documentation.
8. Register and approve the extension plug-in dll in Eclipse or BrachyVision by selecting **Tools** > **Script Administration**.

   - The script .dll files must be copied to folder **Extensions\PACKAGE** under **System Scripts**, where PACKAGE is the combination of extension name and version. For example, approval extension MyExtension.dll would be placed in directory `Extensions\MyExtension1.0.0.0` under **System Scripts**.
   - The tool will not register the extension if it is not in the correct location (and will also indicate what the correct location is.)
   - To approve for a limited evaluation, choose **Approve for Evaluation Testing**.
   - To approve for full clinical use for all clinical users, choose **Approve**. Unapproved extensions can be used if the system is configured for non-clinical use. This may be useful during extension development.
   - To close the **Script Administration** dialog box, choose **Close**.
   - To save changes, choose **File** > **Save All**.
9. In **RT Administration**, choose **Tools** > **Approval Extensions** for selecting the approval extension plug-in for use.

   - Click **Add** and select your extension from the list.
   - Specify the order of execution of the approval extensions by clicking **Invoke Earlier** or **Invoke Later**.
   - To remove your approval extension plug-in, select it from the list of **Extensions in Use** and click **Remove**.

Changing Scripts to Be Write-Enabled

You can create and save write-enabled scripts as described below when your installation includes the Eclipse Automation license.

1. Create a script with the Eclipse Script Wizard as described in sections Create a Binary Plug-In with the Script Wizard on page 31 and Create a Stand-Alone Executable with the Script Wizard on page 34.
2. Add the following line of code above the namespace declaration:

```
[assembly: ESAPIScript(IsWriteable = true)]
```

3. Add a call to the `BeginModifications` method of the `Patient` class as shown in the following code example:

```
[assembly: ESAPIScript(IsWriteable = true)]
namespace VMS.TPS
{
  class Script
  {
    public Script()
    {
    }

    public void Execute(ScriptContext context, System.Windows.Window window)
    {
      Patient patient = context.Patient;
      // BeginModifications will throw an exception if the system is not
      // configured for research use or system is a clinical system and
      // the script is not approved.
      patient.BeginModifications();

      // After calling BeginModifications successfully it is possible
      // to modifiy patient data.
      if (patient.CanAddCourse())
      {
        // E.g. the script adds a new course
        Course newCourse = patient.AddCourse();
        // Continue with other changes
      }
    }
  }
}
```

4. Save or discard modifications as follows:
   - In a stand-alone executable script, use the `Application` class:
     - To save the modifications to the database, call the `SaveModifications` method.
     - To discard the modifications, close the patient by calling the `ClosePatient` method. You can then open the patient again if the script still needs to access the patient data.
   - A plug-in script (single-file or binary) modifies the current data context of the Eclipse Treatment Planning application:
     - After the script has been executed, save or discard the modifications in the Eclipse Treatment Planning user interface in the same way as any other change.

Creating Visual Scripts

About Creating Visual Scripts

Using Visual Scripting Workbench you can create ESAPI scripts with a visual programming method, without the need to know how to program C# code.

Visual Scripting Workbench

The Visual Scripting Workbench is used to create and manage visual scripts. You can create, save, open, delete, export, and immediately run visual scripts in Eclipse. You can also import visual scripts from other users who have exported visual scripts for sharing. Advanced users can generate ESAPI script code with the Visual Scripting Workbench, which they can use as a basis for their own custom ESAPI script. You can open and modify only such scripts in the Visual Scripting Workbench that have been originally created there.

The Visual Scripting Workbench contains three types of script elements: context items, flow control, and action packs. They are dragged to the canvas to create a script.

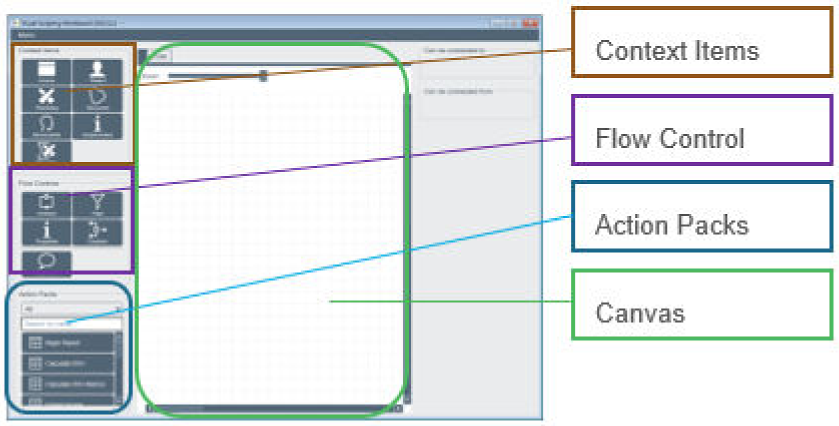


Figure 9 Overview of the Visual Scripting Workbench

Action Packs

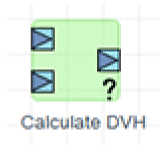
Action packs are modules that perform a single function. They are similar to macros found in other scripting tools. Action packs accept input data, use the input data to perform a function on that data or in Eclipse, and then send output data to the next action pack in line in the flow. The data that flows between action packs are high-level radiotherapy objects like *patients*, *plans*, and *structures*.

Action packs contain also a few helper objects like a *table* that is useful in reporting, export, and presenting logical listings of data; and a *report*, which represents an electronic report that is used in visual scripting reporting flows.

Visual Scripting Workbench contains a number of ready-made action packs, and programmers can also create their own action packs to extend the functionality of Visual Scripting. The ready-made action packs are all read-only, but customized action packs created by programmers can be write-enabled.

You can manually load custom action packs, or choose which custom action packs to load every time that Visual Scripting is started by choosing the **Load Action Packs** menu command.

Examples of an action pack:



Calculates the DVH of all input structures.

Formats input information to a table format. Can be used in reporting, export, and in presenting logical listings of data.

Flow Controls

Using flow controls you can combine action packs into a series of functions. A flow connects the input and output of an action pack. Flow control elements can be used to filter and combine inputs and outputs, and to loop over lists.

The **ForEach** flow control loops over all items in the passed input list and performs the action pack flow contained within it. Note that looping is normally not required in visual scripting flows since most action packs are capable of taking both single context items and lists of items as input.

When inserted between action packs, the **Filter** control filters the context items, such as structures, according to the selected criteria.

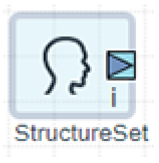
The **Properties** control changes the item flowing in a visual script to the selected sub-item. This is used to expose items and properties that are present in the Eclipse Scripting API but are not otherwise exposed by context items.

You can use the **Combine** control to combine multiple lists into a single list for further processing in a visual scripting flow.

The **Comment** control is used for adding documentation to visual scripts.

Context Items

Context items pass active Eclipse data, such as plan and structure data, to a flow. Context items may include sub-items (for example, `PlanSetup` may include `StructureSets`) that you can also use in a flow.



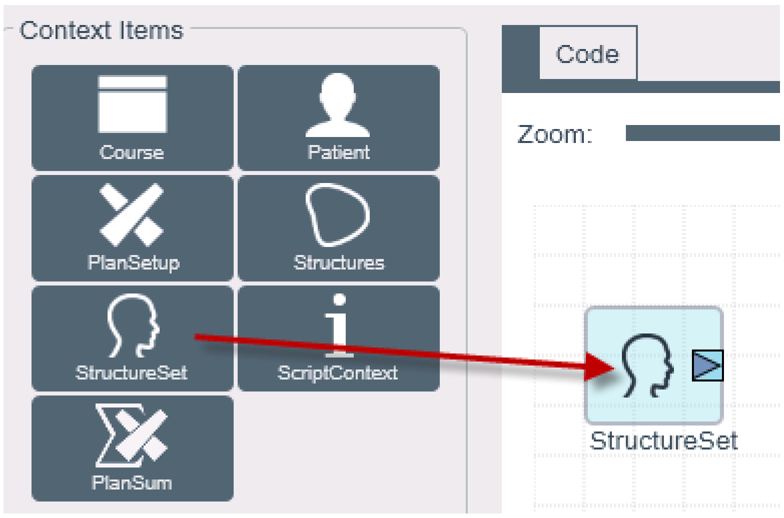
Retrieves the structure set information from the currently active plan.

Canvas

Canvas is an area in the user interface, to which you drag the selected script elements, action packs, context items, and flow controls, to form flows. Use the following functions to select the elements and create connections between them.

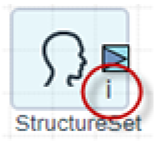
Drag a Script Element to Canvas

Select an element and drag it to canvas:

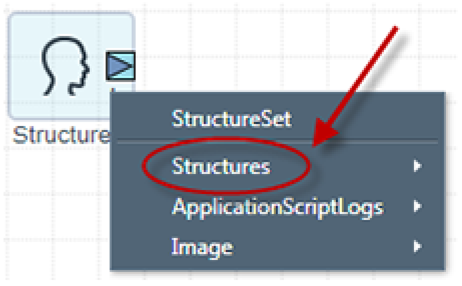


Open the Menu of a Context Item

Click the **i** icon in the item:

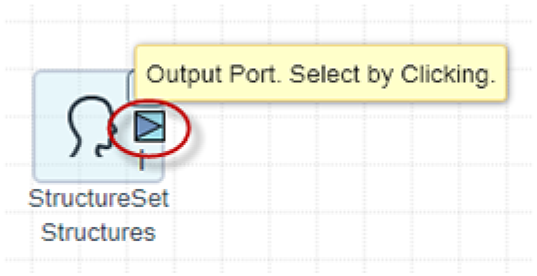


Select a sub-item, if you wish:

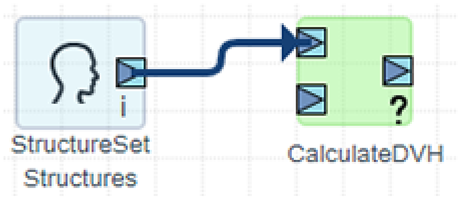


Create Connection Between Elements

Each context item contains an **Output Port** to connect the item into other objects. To draw a connection, click the **Output Port** of the context item:



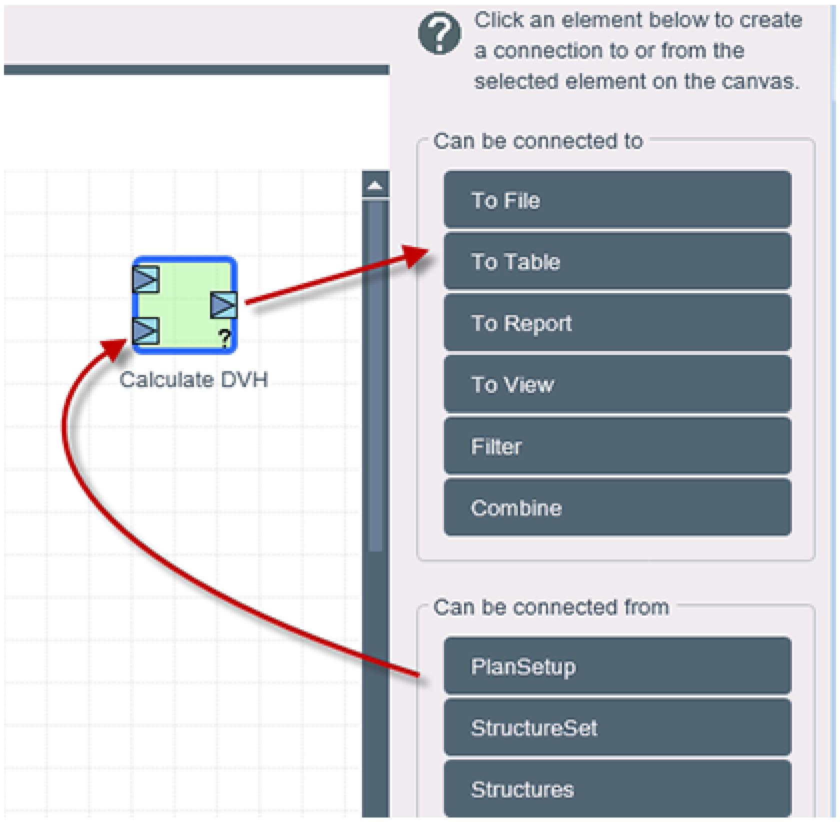
Each action pack contains **Input Ports** and **Output Ports** to connect the action packs into other elements. Drag an **Input Port** to an **Output Port** to make a connection.



If the line turns orange, the created connection is invalid, or, the validity of the connection depends on the previous input elements in the flow. You can remove an invalid connection by hovering over the middle part of the line, and clicking the **X** button.

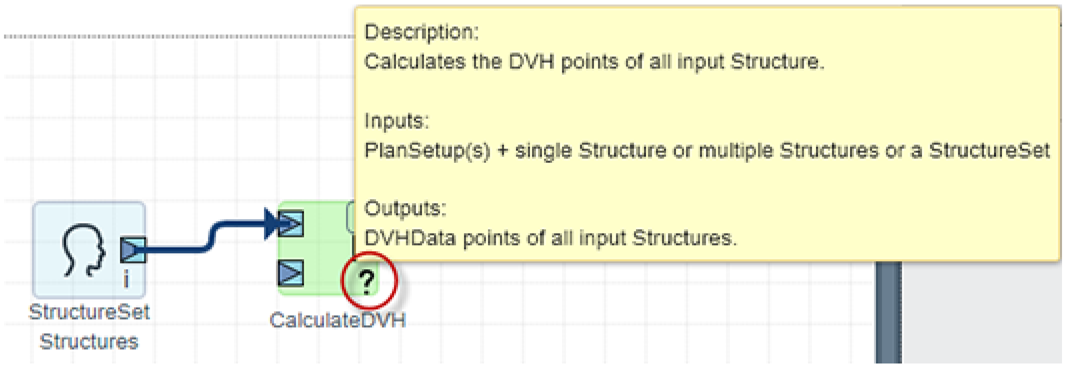
Use Connection Pane for Creating the Connection

The connection pane shows the script elements that can be used as inputs or outputs of the selected element:



View Accepted Inputs and Outputs of an Action Pack

Hover over the question mark in an action pack to view what kind of inputs and outputs it accepts:



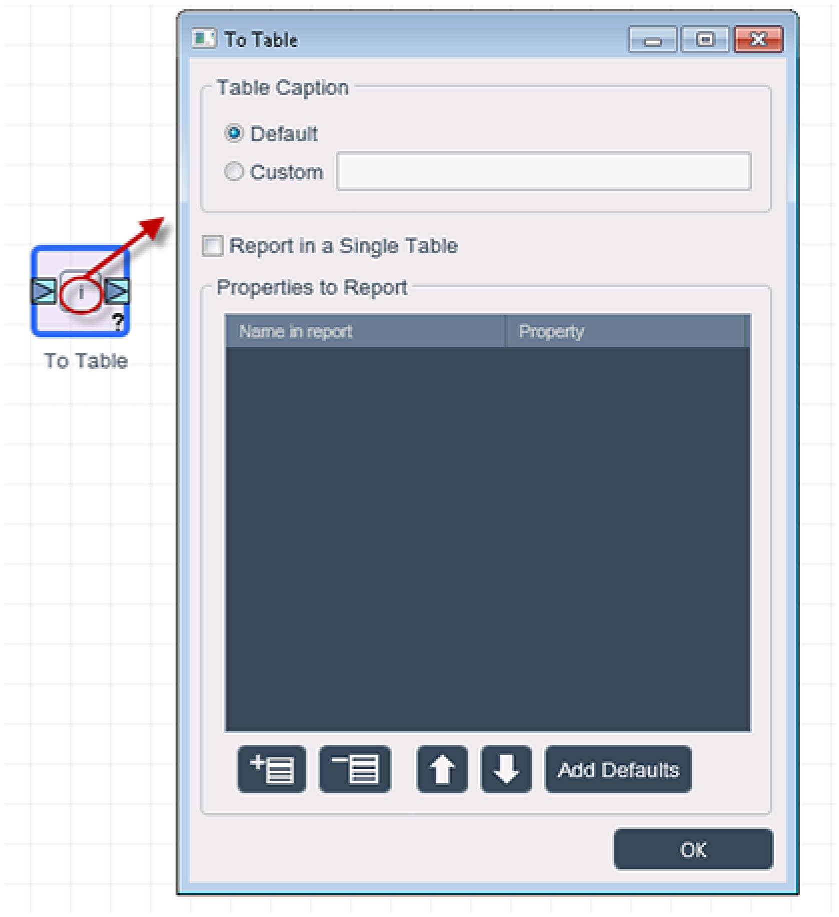
Description:
Calculates the DVH points of all input Structure.

Inputs:
PlanSetup(s) + single Structure or multiple Structures or a StructureSet

Outputs:
DVHData points of all input Structures.

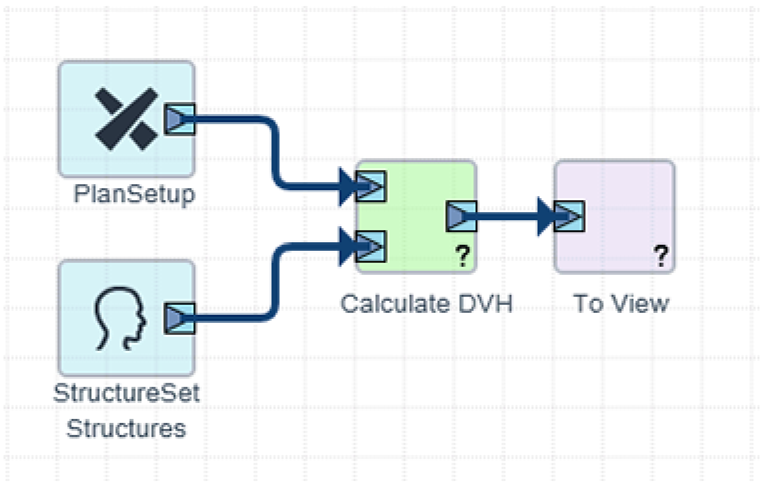
View Action Pack Settings

Some action packs may need additional settings configured in order to execute properly in a visual script. For example, the **ToFile** action pack needs to know the path to the file where data will be saved. You can view and edit action pack settings by clicking the **i** in the element.



Example: Visual Script for Calculating DVHs

The simple visual script below calculates dose volume histograms (DVHs) for all structures of the active patient and displays them. The **CalculateDVH** action pack has two inputs and one output. Its function is to calculate the DVH for all structures passed to it for the specified plan and output those DVHs. Inputs to this action pack are the active **PlanSetup** and the active structure set (**StructureSet** > **Structures**) in Eclipse. The output is a DVH object, which is the input of the **ToView** action pack.



Create and Test a Visual Script

You can access the Visual Scripting Workbench in Eclipse External Beam Planning and BrachyVision™.

1. In Eclipse, choose **Tools** > **Visual Scripting**.

   The main window of the Visual Scripting Workbench appears.
2. Select an action pack to start your flow and drag it onto the canvas.
3. Add other necessary action packs and context items to the canvas and connect them by using the following options:
   - Click the **Output Port** triangle in an element. The application suggests an element to which to connect by showing a dotted line to the **Input Port** of the element. To confirm the connection, click the triangle again. To remove the connection, hover over the middle part of the line, and click the **X** button.
   - Click the element and choose another element to which you want to connect in the upper right corner under **Can be connected to** or **Can be connected from**.

   For some of the action packs and context items, you can further define what kind of information is retrieved and how. To view additional options, click the **i** button in the element. To remove an added element from the canvas, hover over the right upper corner of the element, and click the **X** button.

   Tip: You can use flow controls as an aid if you wish.
4. When all inputs have been defined, test the visual script in Eclipse by choosing **Menu** > **Save and Execute in Eclipse**.

Run a Visual Script

- To run a visual script in Eclipse, choose **Menu** > **Save and Execute in Eclipse**.

Save a Visual Script

- To save a visual script, choose **Menu** > **Save**, or **Menu** > **Save As**.

The script is stored in a user-specific folder on the server.

Add a Visual Script as a Favorite

1. To add the script to the **Eclipse Tools** menu as a favorite, choose **Menu** > **Add to Favorites**.
2. To remove a script from the **Eclipse Tools** menu, choose **Menu** > **Delete from Favorites**.

Export and Import a Visual Script

1. To export a script, choose **Menu** > **Export**.
2. To import a script, choose **Menu** > **Import**.

Create or Delete Scripts

1. To close the current script and create another script, choose **Menu** > **New Script**.
2. To delete a script, choose **Menu** > **Delete**.

Example: Create a Visual Script for Calculating DVHs

Follow the steps below to create the example visual script illustrated in Example: Visual Script for Calculating DVHs on page 44.

1. In Visual Scripting Workbench, drag the **CalculateDVH** action pack onto the canvas.
2. While the **CalculateDVH** action pack is selected, click on the **ToView** action pack in the **Can be connected to** section on the top right.
3. Select the **CalculateDVH** action pack again, and click the **PlanSetup** context item in the **Can be connected from** section on the middle right.
4. Click the **StructureSet** > **Structures** context item to finish the flow.

Example Visual Scripting Flows

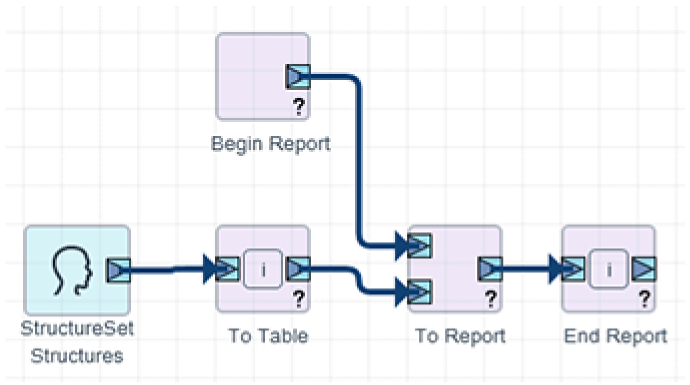
This section describes how to achieve a few typical activities with visual scripting.

Create a Custom Treatment Planning Report

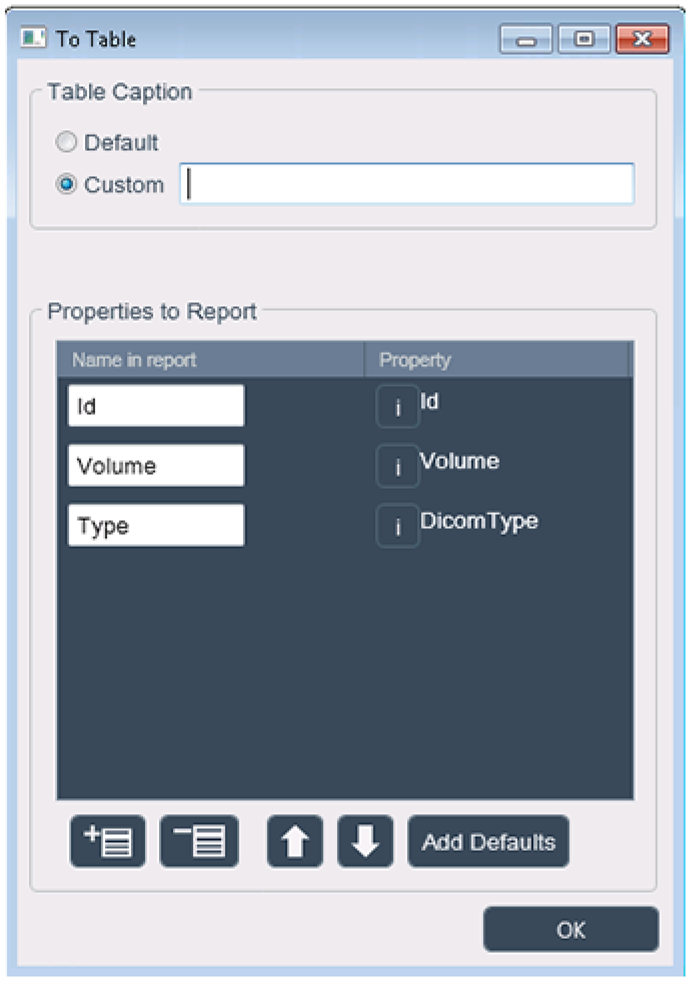
You can create customized treatment planning reports that display only the selected properties, for example, of a structure set.

The following flow creates a PDF report that includes a table with the ID, volume, and type information of all structures. The PDF is created when the script is executed in Eclipse.

1. In Visual Scripting Workbench, drag the **BeginReport** action pack onto the canvas.
2. Add reporting elements as desired. For example, to report on the properties of loaded structures, send the **StructureSet** > **Structures** context item to the **ToTable** action pack and flow that to the **ToReport** action pack. Finish the flow with **EndReport**.



3. Configure the **ToTable** action pack to select the desired properties from the structures and put them in a table. In this case, select the structure ID, the type, and the volume.



To Table

Table Caption

( ) Default
(●) Custom

Properties to Report

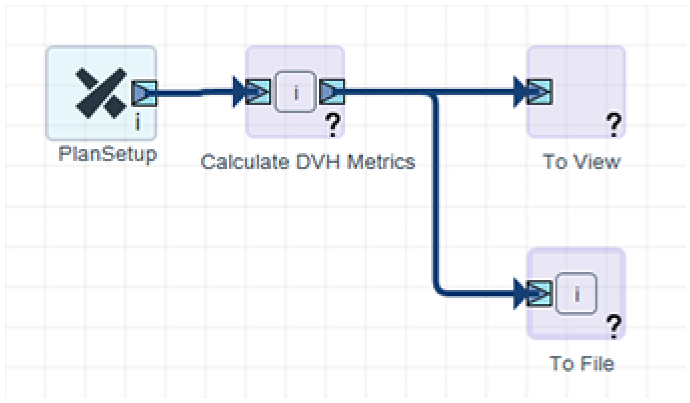
Name in report	Property
Id	Id
Volume	Volume
Type	DicomType

Evaluate DVH Metrics

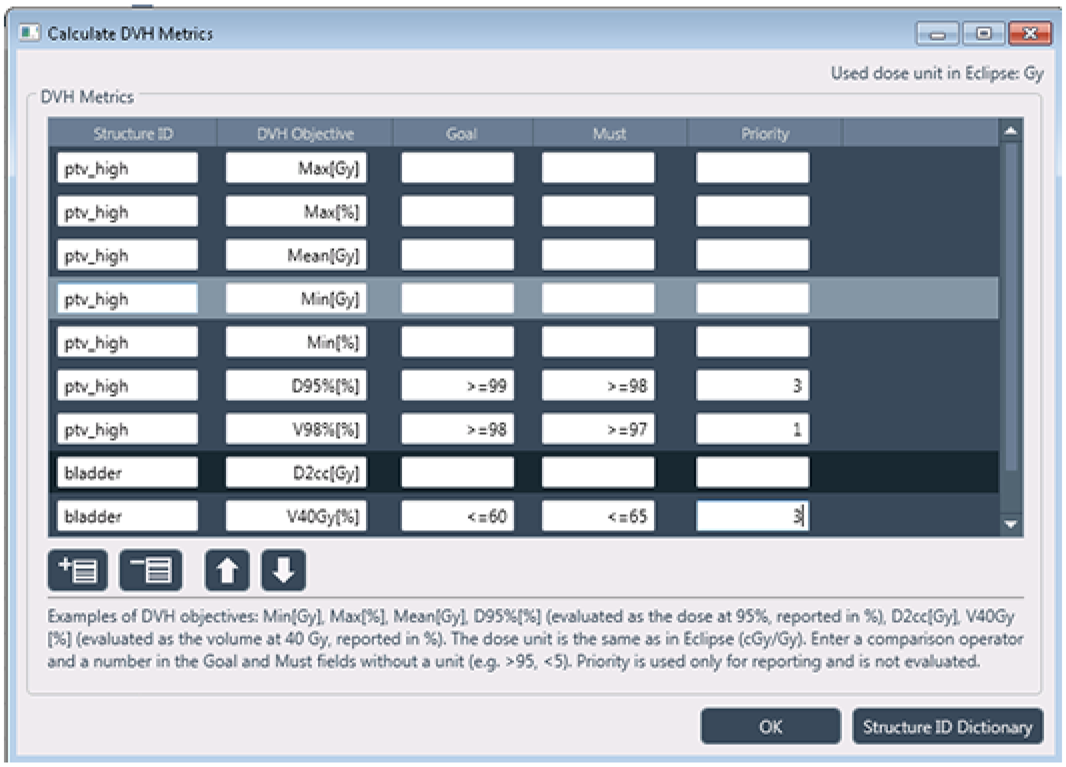
You can evaluate customized DVH metrics using the syntax defined by Mayo, et al. in *Establishment of practice standards in nomenclature and prescription to enable construction of software and databases for knowledge-based practice review* (Pract Radiat Oncol. 2016 Jul-Aug; 6(4):e117–26. doi: 10.1016/j.prro.2015.11.001. Epub 2016 Jan 26).

The following flow evaluates user-defined metrics, exports them to a CSV file, and also shows the metrics to the user in a table.

1. In Visual Scripting Workbench, drag the **Calculate DVH Metrics** action pack onto the canvas.
2. Add the **ToView** action pack and connect it.
3. Add the **ToFile** action pack and connect it.



4. To define the file to export to, click the **i** on the **ToFile** action pack and enter a file name.
5. Define the metrics by clicking the **i** on the **Calculate DVH Metrics** action pack.
6. Use the syntax defined in the Mayo paper for the **DVH Objective** column.
7. You can define an **Evaluator** by defining **Goal** and **Must** criteria, if necessary. If an **Evaluator** is not defined, the metric will be calculated and reported, but not evaluated.
8. To add user-defined priority information to generated reports and tables, enter a value in the **Priority** column. The entered priority has no effect on processing or evaluation.
9. To map multiple structure IDs back to a single ID, use the **Structure ID Dictionary**. You can, for example, map “Femoral Head Rt” and “Femoral Head Right” to the alias id “fem_head_rt”.



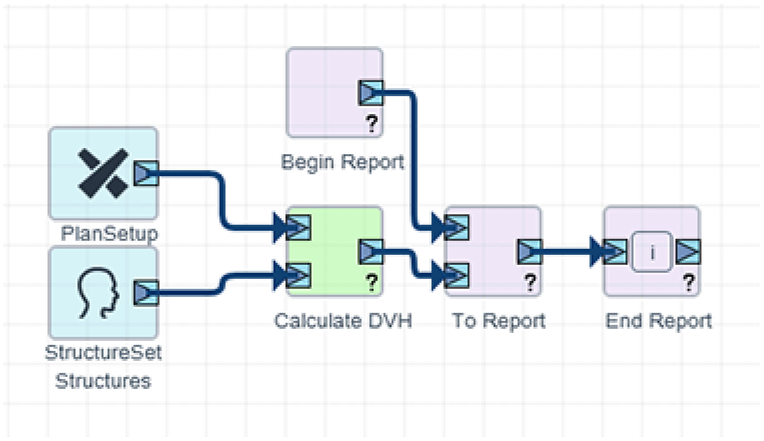
Used dose unit in Eclipse: Gy

Structure ID	DVH Objective	Goal	Must	Priority
ptv_high	Max[Gy]			
ptv_high	Max[%]			
ptv_high	Mean[Gy]			
ptv_high	Min[Gy]			
ptv_high	Min[%]			
ptv_high	D95%[%]	>=99	>=98	3
ptv_high	V98%[%]	>=98	>=97	1
bladder	D2cc[Gy]			
bladder	V40Gy[%]	<=60	<=65	3

Examples of DVH objectives: Min[Gy], Max[%], Mean[Gy], D95%[%] (evaluated as the dose at 95%, reported in %), D2cc[Gy], V40Gy [%] (evaluated as the volume at 40 Gy, reported in %). The dose unit is the same as in Eclipse (cGy/Gy). Enter a comparison operator and a number in the Goal and Must fields without a unit (e.g. >95, <5). Priority is used only for reporting and is not evaluated.

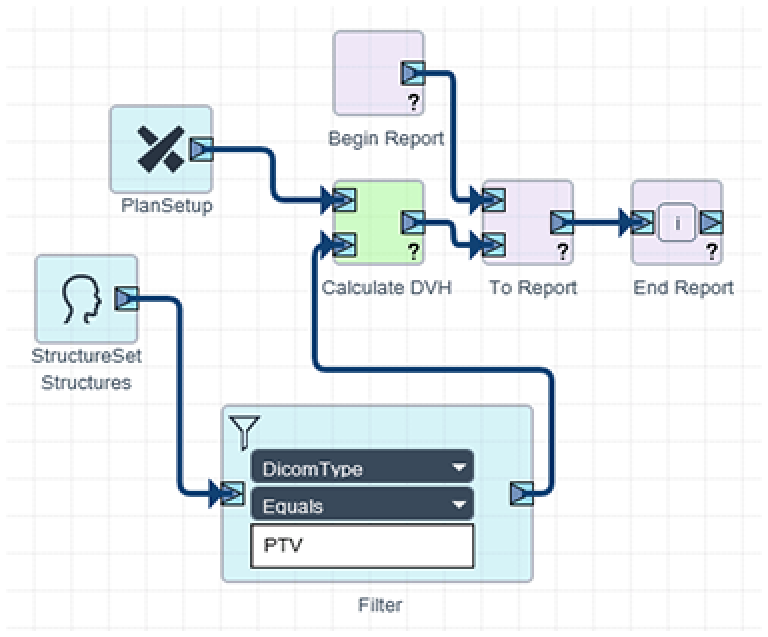
Filter Structures Based on DICOM Type

The following example flow sends DVH data for all structures in the active **StructureSet** to a report.



You can limit the flow so that DVH data for PTV type structures only is sent to the report by using the **Filter** flow control between the **Structures** context item and **CalculateDVH** action pack.

1. In Visual Scripting Workbench, drag all the action packs and context items illustrated in the image below to the canvas.
2. Add the required connections: Drag a **Filter** control between **Structures** and **CalculateDVH**.
3. Select **DICOM Type** and **Equals**, and type `PTV` into the filter.

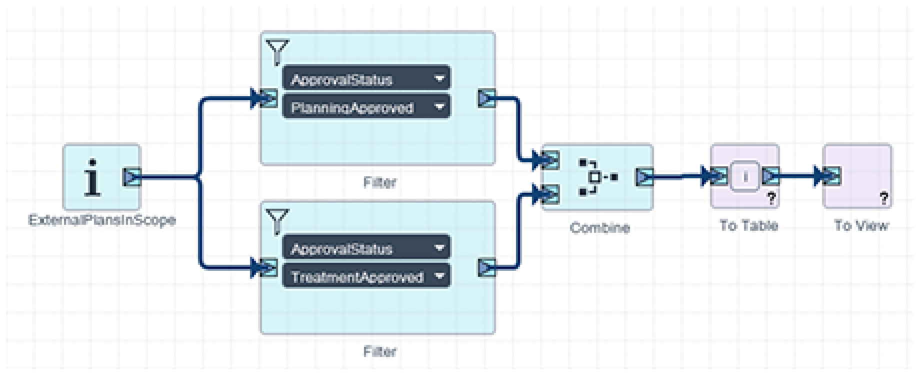


Filter and Combine Plans by Status

It is possible to use the **Filter** and **Combine** flow controls together to create more complex visual script flows. You can do this, for example, to create a script that shows a list of all external beam plans with Planning Approved or Treatment Approved status. First you filter the plans to show only plans with Planning Approved or Treatment Approved status. Then you combine the filtered plans into a single table to view or report.

1. Drag the **ScriptContext** context item to the canvas and choose the sub-type **ExternalPlansInScope**.
2. Drag the **Filter** control to the canvas and for **ApprovalStatus**, select the value **PlanningApproved**. A list of Planning Approved plans is created on the **Output Port**.
3. Add another filter for **ApprovalStatus** with the value **TreatmentApproved**. A list of Treatment Approved plans is created on the **Output Port**.
4. Connect **ScriptContext** to the **Filter** controls.
5. Add the **Combine** control and connect it to the **Filter** controls.

   Two plans lists are combined.
6. Connect the **Combine** control to a new **ToTable** action pack. The combined plan list is sent from the **Combine** control to the **ToTable** action pack.
7. Configure the **ToTable** action pack by choosing properties of the plans you wish to display in a table (ID, for example) by clicking the **i**.
8. Add the **ToView** action pack. The selected properties from the plans are put into a table that is flowed to the **ToView** action pack where the plans list is shown to the user.



Developing Custom Action Packs for Visual Scripting

You can create your own custom action packs to be used in Visual Scripting. The action packs can be either read-only or write-enabled. Write-enabled action packs must be approved in Eclipse prior use in a clinical environment. Before using an action pack in a clinical system, you must follow the same professional software engineering and clinical development practices that you use for developing other scripts.

WARNING: The authors of custom scripts are responsible for verifying the accuracy and correctness of the scripts after developing a new script or after system upgrade for the existing scripts.

Create a Custom Action Pack with the Script Wizard

1. From the **Start** menu, select **Varian** > **Eclipse Scripting API** > **Eclipse Script Wizard**.
2. Enter a name for the new action pack.
3. Select the **Visual Scripting Action Pack** option.
4. To select the location for storing the script, click **Browse**. By default, the action pack project is stored in the user-specific **Documents** folder.
5. Click **Create**.
6. The Script Wizard creates the following folder in the location that you selected if it does not already exist:

   - Project folder: Contains a script-specific sub-folder where the Microsoft Visual Studio project file and source code file are stored.

   The Script Wizard launches Visual Studio.
7. Edit the source code as you wish.
8. Compile the plug-in by using Visual Studio (or MSBuild as described in Compile Example Scripts on page 30).

   The resulting action pack DLL is created in the **Plugins** folder.
9. Copy the custom action pack to the Visual Scripting Action Pack directory in `\\server\va_data$\ProgramData\Vision\VisualScripting\CustomActionPacks`.
10. If necessary, approve the action pack for use in Eclipse.
11. In the Visual Scripting Workbench, load the newly created custom action pack and create a flow that uses the new action pack.

To run the new script in Eclipse, choose **Menu** > **Save and Execute in Eclipse**.

Creating Scripts for Eclipse Automation

About Creating Scripts for Eclipse Automation

You can use the Eclipse Automation features in the Eclipse Scripting API for the tasks listed in this chapter.

Adding and Removing Structures

Use the `StructureSet` class to add and remove structures:

- Add structures with the `AddStructure` method. You can use the `CanAddStructure` method to check if the script is able to add a new structure to the structure set.

  To specify the type of structure to add, give the string representation of the DICOM type as a parameter to the `AddStructure` method. Example values are EXTERNAL, ORGAN, and PTV. For a complete list of allowed values, refer to *Eclipse Scripting API Online Help*.
- Add structure code information with `AddStructure(StructureCodeInfo)`.

  To construct `StructureCodeInfo`, you need to pass coding scheme and structure code, for example:

```
StructureCodeInfo scInfo = new
StructureCodeInfo("99VMS_STRUCTCODE", "Support");
```

- Remove structures with the `RemoveStructure` method.
- You can convert an isodose surface to a structure. See `Structure.ConvertDoseLevelToStructure`.

Modifying Structures

Use the `Structure` class to modify structures:

- Add contours to a structure with the `AddContourOnImagePlane` method.

  Input parameters: a list of points defining the contour, and the index of the image plane where the contours are to be added.
- Subtract contours with the `SubtractContourOnImagePlane` method.

  Input parameters: a list of points defining the contour, and the index of the image plane where the contours are to be subtracted.
- Clear all contours for a structure with the `ClearAllContoursOnImagePlane` method.
- Set a structure to the result of a Boolean operation with the `And`, `Or`, `Not`, and `Xor` methods. These methods are available also on the `SegmentVolume` class, which allows you to execute a combination of Boolean operations with an intermediate variable of the `SegmentVolume` type before assigning the final result to a `Structure` object. For more information, see the `SegmentVolume` property getter and setter of the `Structure` class.
- Set a three-dimensional symmetric or asymmetric margin around a structure. First call the `Margin` or `AsymmetricMargin` method. Then set the resulting `SegmentVolume` object to

the `Structure` object using the `SegmentVolume` property. For more information, see the get and set accessors of the `SegmentVolume` property of the `Structure` class.

Adding and Removing Artificial Phantom Images

Use the `Patient` class to add and remove artificial phantom images:

- Add a phantom image with the `AddEmptyPhantom` method.

  Input parameters: patient orientation, the size of the image set in X- and Y-directions in pixels and in millimeters, the number of planes, and the separation between the planes in millimeters.

  The image is created to a new `Study`. The return value of the `AddEmptyPhantom` is a new `StructureSet` where you can add structures and their contours. You can access the created Image using the `Image` property of the `StructureSet` class.
- Remove a phantom image and associated `StructureSet` with the `RemoveEmptyPhantom` method.

  Input parameter: `StructureSet`. The `StructureSet` must not contain any `Structures`. Before removing the phantom, you can use the `CanRemoveEmptyPhantom` method to check if the script is able to remove the phantom image.

Copying an Image from Another Patient

Use the `Patient` class to copy a 3D image from another patient. This must only be used when creating verification plans with a script.

- Specify the identifiers of the other patient, the study of the other patient, and the 3D image of the other patient. Validate the identifiers using the method `CanCopyImageFromOtherPatient`. Copy the image using the method `CopyImageFromOtherPatient`.

  Input parameters: the identifier of the other patient, the identifier of the study of the other patient, the identifier of the 3D image of the other patient.

Creating and Modifying Plans and Fields

You can create and modify external beam photon plans and fields, as well as brachytherapy plans and applicators by using the classes described below. For brachytherapy plans, no additions or modifications are supported for solid applicators or seed collections.

Adding and Removing Plans

Use the `Course` class to add and remove plans:

- Add a new external beam photon plan with the `AddExternalPlanSetup` method.

  Input parameter: `StructureSet`. A new primary reference point without a location is automatically created for the plan, or alternatively you can specify an existing reference point that will be used as primary. You can use the `CanAddPlanSetup` method to check if the script is able to add a new plan to the course.
- Add a new external beam photon plan as a verification plan with the `AddExternalPlanSetupAsVerificationPlan` method.

  Input parameters: structure set, the verified plan.
- Use `AddIonPlanSetup` for creating a proton treatment plan.
- Use `AddIonPlanSetupAsVerificationPlan` for creating a proton verification plan.
- Remove a plan with the `RemovePlanSetup` method.

  Input parameter: `PlanSetup`. You can use `CanRemovePlanSetup` to check if the script is able to remove the plan from the course.
- Copy an external beam plan with `CopyPlanSetup` to create a plan in another image that is not registered.
- Add a new brachytherapy plan with the `AddBrachyPlanSetup` method.

  Input parameters:
  - `StructureSet`. A valid structure set to be connected to the brachytherapy plan.

    A new primary reference point without a location is automatically created for the plan.

    Additionally, you can also specify `targetStructure` to be set as the target structure of the plan, and `primaryReferencePoint` to set an existing reference point to be used as the primary reference point instead of creating a new one.
  - `dosePerFraction`: Dose per fraction.
  - `brachyTreatmentTechnique`: Brachytherapy treatment technique.

  The `CanAddPlanSetup` method can be used to check if the script is able to add a new plan to the course.
- Copy a brachytherapy plan to another image with `CopyBrachyPlanSetup`.

Modifying Brachytherapy Plan Properties

- Treatment time: Define the treatment time of the plan by setting the `BrachyPlanSetup.TreatmentDateTime` property.
- Treatment technique: Define the treatment technique of the plan by setting the `BrachyPlanSetup.BrachyTreatmentTechnique` property. The type of the property is `BrachyTreatmentTechniqueType`.
- Fractions (property `PlanSetup.NumberOfFractions`): Set `NumberOfFractions` together with properties `DosePerFraction` and `TreatmentPercentage`, using the `SetPrescription` method.
- Dose (property `PlanSetup.DosePerFraction`): Set `DosePerFraction` together with properties `NumberOfFractions` and `TreatmentPercentage`, using the `SetPrescription` method.
- Treatment percentage (property `PlanSetup.TreatmentPercentage`): Set `TreatmentPercentage` together with properties `NumberOfFractions` and `DosePerFraction`, using the `SetPrescription` method.

Adding Reference Points in Brachytherapy Plans

Use the `BrachyPlanSetup` class to add reference points:

- Add a new location to an existing reference point with the `AddLocationToExistingReferencePoint` method.

  Input parameters:

  `location`: The location of the reference point.

  `id`: The identifier of the reference point.
- Add a new reference point to a brachytherapy plan with the `AddReferencePoint` method.

  Input parameters:

  `target`: Indicates whether the reference point tracks treatment target (true) or organ at risk (false).

  `id`: The identifier of the reference point.

Copying a Brachytherapy Plan to a New Image

Use the `Course` class to copy a brachytherapy plan to a new image:

- Copy a brachytherapy plan with `Course.CopyBrachyPlanSetup`. The target image must be registered with the primary image of the source plan.

Adding Reference Lines

- Add a new reference line to a structure set using the `StructureSet.AddReferenceLine` method.

  Input parameters:

  `name`: The name of the reference line.

  `id`: The identifier of the reference line.

  `referenceLinePoints`: The points of the reference line. The number of points is between 1 and 500.

Adding Fields

Use the `ExternalPlanSetup` class to add photon fields:

- Add a new static open field to the plan with the `AddStaticBeam` method.
- Add a new arc field to the plan with the `AddArcBeam` method.
- Add a field with static MLC shape with the `AddMLCBeam` or `AddMLCArcBeam` method.
- Add an arc field with dynamic MLC shape using the `AddConformalArcBeam` method.
- Add an IMRT field with the Multiple Static Segment delivery method using the `AddMultipleStaticSegmentBeam` method.
- Add an IMRT field with the Sliding Windows delivery method using the `AddSlidingWindowBeam` method.

- Add a VMAT field with the `AddVMATBeam` method.

Define the `TreatmentMachine` configuration for added fields:

- Create an `ExternalBeamMachineParameters` object and use it as input for the above mentioned beam adding methods of the `ExternalPlanSetup` class.
- Input parameters for the `ExternalBeamMachineParameters` object: The treatment machine identifier, energy mode identifier, field technique identifier, dose rate, and optionally, the primary fluence mode identifier.

For information about other input parameters for the beam adding methods of the `ExternalPlanSetup` class: *Eclipse Scripting API Online Help*.

Use the `IonPlanSetup.AddModulatedScanningBeam` to add modulated scanning fields to a proton plan.

Modifying Photon Fields

Use the `BeamParameters` class to modify a Beam:

- Call the `GetEditableParameters` method. Modify the returned `BeamParameters` object. Call `ApplyParameters`. If the call succeeds, the beam data is updated.
- Set the optimal fluence of an IMRT field with the `SetOptimalFluence` method.
- Modify `ControlPoints` using the `ControlPoints` property of the `BeamParameters` class. Each `ControlPoint` has one `ControlPointParameters` object. Call `ApplyParameters`. If the call succeeds, the beam data is updated.
- Methods to perform MLC fitting are available. See `Beam.FitMLCToStructure` and `Beam.FitMLCToOutline`.

Modifying Proton Fields

The following can be adjusted in a proton field:

- Proximal target margin `IonBeam.ProximalTargetMargin`.
- Distal target margin `IonBeam.DistalTargetMargin`.
- Lateral margins `IonBeam.ProximalTargetMargin`.

Modifying Proton Scanning Spots

Use the `IonBeamParameters` class to modify the scanning spots of an `IonBeam`:

- Call the `IonBeam.GetEditableParameters` method.
- With the returned `IonBeamParameters` object, call property `IonControlPointPairs` to get a list of editable control point pairs.
- Iterate over the list of control point pairs and get the editable spot lists using method `IonControlPointPair.RawSpotList` or `IonControlPointPair.FinalSpotList`.
- Iterate over the scanning spot list and set the position or weight of each spot using setter properties `IonSpotParameters.Weight`, `IonSpotParameters.X`, or `IonSpotParameters.Y`.

- When the scanning spots have been changed as desired, call `IonBeam.ApplyParameters(IonBeamParameters)`. If the call succeeds, the proton beam / control point / scanning spot data resident in Eclipse memory has been updated.

  The following illustrates a sample script code for editing raw scanning spots:

```
// unrealistic example shows how to edit the raw scanning spot lists
foreach (IonBeam ionBeam in context.IonPlanSetup.IonBeams)
{
  IonBeamParameters beamParams = ionBeam.GetEditableParameters();
  IonControlPointPairCollection cpList = beamParams.IonControlPointPairs;
  foreach (IonControlPointPair icpp in cpList)
  {
    IonSpotParametersCollection rawSpotList = icpp.RawSpotList;
    foreach (IonSpotParameters spot in rawSpotList)
    {
      spot.Weight = 1;  // set weight to desired
      spot.X = 1;       // set X position of scanning spot
      spot.Y = 1;       // set Y position of scanning spot
    }
  }
  // apply scan spot changes to Eclipse
  ionBeam.ApplyParameters(beamParams);
}
```

- Methods `IonControlPointPair.ResizeFinalSpotList` and `IonControlPointPair.ResizeRawSpotList` allow resizing the proton raw and final scanning spot lists.

Modifying Proton Range Shifter Settings

Use the `IonBeamParameters` class to modify the range shifter settings of an `IonBeam`:

- Call the `IonBeam.GetEditableParameters` method.
- With the returned `IonBeamParameters` object, call property `PreSelectedRangeShifter1Id/PreSelectedRangeShifter2Id` to set the range shifter IDs and property `PreSelectedRangeShifter1Id/ PreSelectedRangeShifter2Id` to set the range shifter settings.

When the range shifter settings have been changed as desired, call `IonBeam.ApplyParameters(IonBeamParameters)`. If the call succeeds, range shifter beam line modifier settings have been updated.

DECT Features for Proton Plans

You can use the following Dual-Energy CT (DECT) specific methods:

- `Image.CalculateDectProtonStoppingPowers`, that calculates the pixel-wise proton stopping powers from the planning CT and DECT Rho (relative electron density) and Z (effective atomic number) images.
- `IonPlanSetup.CreateDectVerificationPlan`, that can be used to evaluate the dose distribution of a proton treatment plan using DECT stopping power information.
- Use `Image.GetProtonStoppingPowerCurve` method for reading the proton stopping power curve of the CT scanner associated with an image.

Adding Field and Plan Uncertainty for Photon and Proton Plans

You can add new plan or field uncertainties with parameters. Supported uncertainty types are:

- `IsocenterShiftUncertainty` (photon-specific)
- `BaselineShiftUncertainty` (photon-specific)
- `RangeUncertainty` (proton-specific)
- `RobustOptimizationUncertainty` (=Perturbation, proton-specific)

Field-specific plan uncertainty dose can be used only for `RobustOptimizationUncertainty`. In case of field-specific uncertainty, `HUConversionError` is overwritten to be always zero. In case of `BaselineShiftUncertainty`, the `isocenterShift` parameter is actually the target shift.

Functions to call to set plan or field uncertainties with parameters:

`PlanSetup.AddPlanUncertaintyWithParameters(PlanUncertaintyType planUncertaintyType, bool planSpecificUncertainty, double HUConversionError, VVector isocenterShift)`

For protons:

`IonPlanSetup.AddPlanUncertaintyWithParameters(PlanUncertaintyType planUncertaintyType, bool planSpecificUncertainty, double HUConversionError, VVector isocenterShift)`

Parameters example:

`planUncertaintyType = PlanUncertaintyType.RangeUncertainty`

`planSpecificUncertainty = true` The plan uncertainty dose is either plan-specific (true) or field-specific (false).

`HUConversionError = 3.0`. Unit is %.

`isocenterShift = new VVector(0.3, 0.4, 0.5)`. The unit is cm.

Adding Brachytherapy Applicators and Seeds

Use the `BrachyPlanSetup` class to add brachytherapy applicators:

- Add a new applicator to the brachytherapy plan with the `AddCatheter` method.

  Input parameters:

  `catheterId`: a string defining the ID of the new applicator.

  `treatmentUnit`: an object defining the brachytherapy treatment unit for the applicator.

  `outputDiagnostics`: A list of messages populated by the system to inform about the possible consequences of adding the applicator.

  `appendChannelNumToId`: If true, the channel number is appended to the applicator ID. If false, the channel number is not included in the applicator ID.

`channelNum`: sets the channel number of the applicator with the given number. The accepted range is from 1 to the maximum number of channels defined for the brachytherapy treatment unit in **RT Administration**. If the provided channel number is 0, the next available free channel number is assigned to the applicator. If the provided channel number is −1, the channel number is left empty.

- Adding new solid applicator or seed collection is not supported yet. Applicators with different treatment units cannot be added in the same plan.

Modifying Brachytherapy Applicators

Use the `Catheter` class to modify brachytherapy applicators.

- The applicator length can be defined by setting the `Catheter.ApplicatorLength` property.
- The length of the applicator dead space can be defined by setting the `Catheter.DeadSpaceLength` property. This property is not supported for solid applicators.
- The applicator step size (property `Catheter.StepSize`), first source position (property `Catheter.FirstSourcePosition`), and last source position (property `Catheter.LastSourcePosition`) can be defined with the `Catheter.SetSourcePositions` method. Calling this method will also automatically recalculate the source positions.
- The applicator channel number can be defined with the `ChannelNumber` property.
- The treatment unit of all applicators of a brachytherapy plan can be changed with the `BrachyPlanSetup.ChangeTreatmentUnit` method. A list of the available brachytherapy treatment units can be obtained through the new `Equipment` class, with the `Equipment.GetBrachyTreatmentUnits` method.
- The applicator geometry can be defined by setting the `Catheter.Shape` property. This property is not supported for solid applicators.
- The `ID` property of class `Catheter` can now be set with the `Catheter.SetID` method. The `ID` must be unique within the plan. If not, the `ID` is not changed.
- An existing reference line can be linked to an applicator in a brachytherapy plan using the `Catheter.LinkRefLine` method.

  Input parameter: `refLine` (reference line to link with an applicator).
- A linked reference line can be unlinked from an applicator in a brachytherapy plan using the `Catheter.UnlinkRefLine` method.
- An existing reference point can be linked to an applicator in a brachytherapy plan using the `Catheter.LinkRefPoint` method.

  Input parameter: `refPoint` (reference point to link with an applicator).
- A linked reference point can be unlinked from an applicator in a brachytherapy plan using the `Catheter.UnlinkRefPoint` method.
- The nominal dwell time for each dwell position can be get/set using the `SourcePosition.NominalDwellTime` property.
- The dwell time lock for each dwell position can be get/set using the `SourcePosition.DwellTimeLock` property.

Adding Prescriptions

Set the prescription with the `SetPrescription` method of the `PlanSetup` object.

Input parameters for the method: the number of fractions, the prescribed dose per fraction (using the dose unit defined for your system in the Varian Service Portal, and prescribed percentage.

Using External Beam Calculation Algorithms

You can use the classes described below for IMRT and VMAT optimization, leaf motion calculation, and dose calculation.

Setting Calculation Models

Use the `PlanSetup` class to set the calculation models:

- Set the calculation model with the `SetCalculationModel` method.

  Input parameters: calculation type and calculation model name.

  The current calculation model can be retrieved with the `GetCalculationModel` method.

  All available models can be read with the `GetModelsForCalculationType` method of the `ExternalPlanSetup` class.
- Set the calculation options using the `SetCalculationOption` method. The available options and their allowed values depend on the calculation model. Before setting the calculation options, set the calculation model.
- Clear the calculation model of a plan with the `ClearCalculationModel` method.

Viewing Calculation Logs

Use the following classes to read the messages from the algorithms:

- `Beam`

  Access the calculation logs after calculation with the `CalculationLogs` property. It returns a collection of `BeamCalculationLog` objects that can be filtered using the `Category` property. The category for the optimization log is, for example `Optimization`.
- `System.Diagnostics.Trace`

  Use the `Trace` class of the .NET framework to receive messages from the algorithms during the calculation. For more information about how to use `Trace Listeners`, consult the Microsoft Developer Network (MSDN) documentation.

Executing DVH Estimation

Use the `ExternalPlanSetup` class or `IonPlanSetup` class for executing DVH estimation.

- Run DVH estimation with the `CalculateDVHEstimates` method.

Input parameters: the identifier of the DVH estimation model, the dose level for target structure(s) and the mapping between the structures of the estimation model, and the structure set of the plan. Use the `Success` property of `OptimizerResult` to check if the algorithm executed without errors.

Optimizing IMRT and VMAT Plans

Use the following classes for optimizing IMRT and VMAT plans.

Setting Up the Plan

- Before starting the optimization, create open fields for the plan with the `AddStaticBeam` or `AddArcBeam` method of the `ExternalPlanSetup` class.
- Use the `OptimizationSetup` property of the `PlanSetup` class to access the `OptimizationSetup` object.

Adding and Modifying Optimization Objectives

Use the `OptimizationSetup` object to add and modify optimization objectives:

- Add point objectives with the `AddPointObjective` method.
- Add mean dose or gEUD objectives with the `AddMeanDoseObjective` or `AddEUDObjective` methods.
- Add beam-specific parameters with the `AddBeamSpecificParameter` method.
- Add a Normal Tissue Objective with the `AddNormalTissueObjective`, `AddAutomaticNormalTissueObjective`, or `AddAutomaticSbrtNormalTissueObjective` method.
- Remove optimization objectives with the `RemoveObjective` method.
- Remove optimization parameters with the `RemoveParameter` method.

Optimizing an IMRT Plan

Use the `ExternalPlanSetup` class to optimize an IMRT plan:

- Run the IMRT optimization algorithm with the `Optimize` method.

  Input parameter: the number of needed iterations. All existing optimal fluences are removed. As a result of `Optimize`, the `OptimizerResult` object is returned. Use the `Success` property of `OptimizerResult` to check if the algorithm executed without errors.
- You can continue IMRT optimization with the overloaded version of the `Optimize` method, for which you can give the `OptimizationOption` as a parameter. To continue optimization with existing optimal fluences, use the `OptimizationOption.ContinueOptimization` as a parameter.
- You can continue IMRT optimization with the existing plan dose as an intermediate dose. To do this, use the overloaded version of the `Optimize` method, and define the `OptimizationOption.ContinueOptimizationWithPlanDoseAsIntermediateDose` as a parameter.

- You can terminate IMRT optimization upon convergence. To do this, use the `Optimize` method that does not take any input parameters, or the overloaded version of the `Optimize` method that takes an `OptimizationOptionsIMRT` object as an input. Construct the `OptimizationOptionsIMRT` object using the `OptimizationConvergenceOption.TerminateIfConverged` option. After optimization, you can read the actual number of iterations from `OptimizerResult.NumberOfIMRTOptimizerIterations`.
- You can use intermediate dose calculation during IMRT optimization. To do this, create an `OptimizationOptionsIMRT` object and specify the `numberOfStepsBeforeIntermediateDose`. Then use the overloaded version of `Optimize` method that takes an `OptimizationOptionsIMRT` object as an input.

Optimizing a VMAT Plan

Use the `ExternalPlanSetup` class to optimize a VMAT plan:

- Run the VMAT optimization algorithm with the `OptimizeVMAT` method. As a result of `Optimize`, the `OptimizerResult` object is returned. Use the `Success` property of `OptimizerResult` to check if the algorithm executed without errors.
- You can use intermediate dose calculation during VMAT optimization. To do this, create an `OptimizationOptionsVMAT` object by specifying either the option `OptimizationIntermediateDoseOption.UseIntermediateDose` or the number of optimization cycles. Then use the overloaded version of method `OptimizeVMAT` that takes an `OptimizationOptionsVMAT` object as an input parameter.

Accessing Dose Volume Histograms

Use the `OptimizerResult` class to access the results of the optimization:

- Use the `StructureDVHs` property to access the Dose Volume Histograms after optimization. The returned collection contains an `OptimizerDVH` object for each `Structure` that had optimization objectives defined. Use the `CurveData` property of the `OptimizerDVH` class to access the points of the Dose Volume Histogram.

Accessing Optimal Fluences After IMRT Optimization

Use the `Beam` class to access the optimal fluence information:

- Read the optimal fluence matrix after optimization with the `GetOptimalFluence` method.

Using Trade-Off Exploration

Use the `TradeoffExplorationContext` class and its methods and properties for exploring trade-offs in plans:

1. Start from an optimized and calculated plan by using the `TradeoffExplorationContext` class.
2. Select the trade-off objectives by using the `AddTradeoffObjective(Structure)` method. At least one objective is needed.

3. Query if all pre-conditions to generate the plan collection are met by calling the `CanCreatePlanCollection` property.
4. If `CanCreatePlanCollection` is true, generate the plan collection by calling the `CreatePlanCollection` method.
5. If the plan collection is generated successfully, the `HasPlanCollection` property is set to true. The class is now ready for exploring different trade-offs.
6. To evaluate the current trade-off, use the `GetObjectiveCost`, `CurrentDose`, and `GetStructureDvh` methods.
7. To explore different trade-offs:
   - Use the `SetObjectiveCost` method to reduce the cost of any objective.
   - Use the `SetObjectiveUpperRestrictor` method to prevent the cost of an objective from exceeding a specified limit.
8. Save the trade-off exploration results by calling the `ApplyTradeoffExplorationResult` method. The method also applies the trade-off exploration result to the plan setup for IMRT plans.
9. In case of a VMAT plan, call the `CreateDeliverableVmatPlan` method to apply the trade-off exploration result to the plan setup.
10. To resume the trade-off exploration from a saved plan collection, call the `LoadSavedPlanCollection` method.

Calculating Leaf Motions After IMRT Optimization

Use the `ExternalPlanSetup` class to execute the leaf motion calculation algorithm:

- Calculate leaf motions with the `CalculateLeafMotions` method. The method uses the default calculation options of the leaf motion calculation model set in the plan. The method returns a `CalculationResult` object. This object has a `Success` property, which you can use to check if the algorithm executed without errors.
- To run the Varian Leaf Motion Calculator algorithm, use the overloaded `CalculateLeafMotions` method.

  Input parameter: an `LMCVOptions` object. In `LMCVOptions`, you can specify the usage of fixed jaws. Check that the leaf motion calculation model of the plan is Varian Leaf Motion Calculator.
- To run the Varian Smart LMC algorithm, use the overloaded `CalculateLeafMotions` method.

  Input parameter: a `SmartLMCOptions` object. In `SmartLMCOptions`, you can specify the usage of fixed field borders and jaw tracking. Check that the leaf motion calculation model of the plan is Varian Smart LMC.
- To run the non-Varian MSS Leaf Motion Calculator algorithm, use the overloaded `CalculateLeafMotions` method.

  Input parameter: an `LMCMSSOptions` object. In `LMCMSSOptions`, you can specify the number of calculation iterations. Check that the leaf motion calculation model of the plan is MSS Leaf Motion Calculator.

Calculating Photon Plan Dose

Use the `ExternalPlanSetup` class for dose calculation:

- Calculate the volume dose using the `CalculateDose` method. The method returns a `CalculationResult` object. This object has a `Success` property that you can use to check if the algorithm executed without errors.
- Calculate the volume dose with preset MUs using the `CalculateDoseWithPresetValues` method.

  Input parameter: a list of `Beam` identifier and `MeterSetValue` pairs.
- Calculate all plan uncertainty doses that are not calculated already using `CalculatePlanUncertaintyDoses`.

Calculating Proton Plan Dose

Use the `IonPlanSetup` class for proton dose calculation:

- Calculate DVH Estimates and generate optimization objectives based on a proton DVH Estimation model with the `IonPlanSetup.CalculateDVHEstimates` method.
- Calculate the beamline with the `IonPlanSetup.CalculateBeamLine` method.
- Optimize a proton modulated scanning plan with the `IonPlanSetup.OptimizeIMPT` method. PCS optimization is not supported with Eclipse Scripting API.
- Calculate the volume dose using the `CalculateDose` method. The method returns a `CalculationResult` object. This object has a `Success` property that you can use to check if the algorithm executed without errors.
- Calculate all plan uncertainty doses that are not calculated already using `IonPlanSetup.CalculatePlanUncertaintyDoses`.

Additionally, the proton plan has the following new methods:

- `IonPlanSetup.SetNormalization` for modifying plan normalization mode.
- `IonPlanSetup.SetOptimizationMode` for changing plan normalization mode (Multi-field/single field optimization).
- `IonPlanSetup.PatientSupportDevice` for retrieving details of the patient support device.

Calculating Proton Delivery Dynamics

Use the `IonPlanSetup` class for proton delivery dynamics calculation:

- Create a final spot list for a ProBeam modulated scanning `IonPlanSetup` following the instructions in Calculating Proton Plan Dose on page 65. Check that the delivery dynamics calculation model of the plan is Nonlinear Universal Proton Optimizer (NUPO).
- Calculate delivery dynamics for the `IonPlanSetup` using the `CalculateDeliveryDynamics` method.

  Delivery dynamics are calculated for all treatment fields and all rooms enabled in beam data.

Additionally, the proton plan has the following new methods:

- `IonBeam.GetDeliveryTimeStatusByRoomId` for retrieving the deliverability status (Deliverable/Undeliverable/NotCalculated).
- `IonBeam.GetProtonDeliveryTimeByRoomIdAsNumber` for retrieving the delivery time in seconds.

  Input parameters: The identifier of the room.

Creating an Evaluation Dose

Use the `ExternalPlanSetup` or `IonPlanSetup` class:

- Create a new `EvaluationDose` using the `CreateEvaluationDose` method. The method returns an `EvaluationDose` object. This object has a `SetVoxels` method that is called to set the content of the dose grid.
- Create a new `EvaluationDose` using the `CopyEvaluationDose` method. The method copies an existing `Dose` and returns it as an `EvaluationDose` object. Use the `SetVoxels` method to change the content of the dose grid.

Creating Halcyon Plans

Halcyon plans have additional requirements beyond standard photon plans before they can be approved. Halcyon plans need to have imaging setups and couch structures attached before they can be considered valid. To create a Halcyon plan with ESAPI automation, first create a plan with `Course.AddExternalPlanSetup`, then add an imaging setup with `ExternalPlanSetup.AddExternalPlanSetup`, and insert a couch with `StructureSet.AddCouchStructures`. Check the validity of the plan with `ExternalPlanSetup.IsValidForPlanApproval`. See the code sample below:

```
public void Execute(ScriptContext context)
   {
       context.Patient.BeginModifications();
       Course c = context.Patient.AddCourse();
       c.Id = "halcyon";
       var ptv = context.StructureSet.Structures.First(s => s.DicomType ==
"PTV");
       var eps = c.AddExternalPlanSetup(context.StructureSet, ptv, ptv, "refpt1");
       var machineparameters = new ExternalBeamMachineParameters("Hal2_SX2_D5");
       var flat = eps.AddFixedSequenceBeam(machineparameters, 20, 45, new VVector(0, 0,
0));
       var imagingparameters = new
ImagingBeamSetupParameters(ImagingSetup.MVCBCT_Low_Dose, 0, 0, 0, 0, 140, 140);
       eps.AddImagingSetup(machineparameters, imagingparameters, ptv);
       IReadOnlyList<Structure> addedStructures;
       bool imageResized;
context.StructureSet.AddCouchStructures("RDS_Couch_Top",
PatientOrientation.HeadFirstSupine,
RailPosition.In, RailPosition.In, null, null, null, out addedStructures, out
imageResized, out error);
       eps.CalculateDose();

       IEnumerable<PlanValidationResultDetail> reasons;
       if (!eps.IsValidForPlanApproval(out reasons))
       {
           string message = "";
```

```
            foreach (PlanValidationResultDetail pvrd in reasons)
            {
                message += pvrd.MessageForUser + "\n";
            }
            MessageBox.Show("Halcyon plan is not valid for
            approval.  Messages = \n" + message);
        }
        else
        {
            MessageBox.Show("Halcyon plan is valid for approval");
        }
    }
```

Using Brachytherapy Calculation Algorithms

You can use the methods described below for the dose calculation of brachytherapy plans.

Calculating Brachytherapy Plan Dose

The TG-43 dose can be calculated for brachytherapy plans.

- The `BrachyPlanSetup.CalculateTG43Dose` method calculates the dose for the brachytherapy plan. The dose is calculated using the TG-43 dose calculation algorithm.
- The `CalculateTG43Dose` method returns a `CalculateBrachy3DDoseResult` object that indicates if the operation was successful or not in the `Success` property.
- For a successful dose calculation, the `RoundedDwellTimeAdjustRatio` property indicates how the much the dwell times where adjusted. A value of zero (0.0) indicates that dwell times where not adjusted.
- If the dose calculation was not successful, the reason(s) for the failure is included in the `Errors` property.

Approving Scripts for Clinical Use

About Approving Scripts for Clinical Use

This chapter describes how you can use script administration in Eclipse to support the script development at your clinic.

Script approval makes sure that all ESAPI scripts used clinically have been validated and approved by senior clinical personnel.

You can define that Varian-provided software add-ons are approved automatically. If a Varian-priovided software add-on is marked for automatic approval, all the necessary DLLs will be approved for execution during database registration and are immediately accessible in the **Add-Ons** window.

Approve a Script for Clinical Use

Write-enabled scripts must be approved before they can be used in a clinical system. A responsible senior level staff member can approve them in Eclipse (**External Beam Planning** and **Plan Evaluation**) and BrachyVision (**Brachytherapy Planning** and **Brachytherapy 2D Entry**). After the script has been properly coded and tested according to your script development process, do the following:

1. In Eclipse or BrachyVision, choose **Tools** > **Script Administration** to open the **ESAPI Script Administration** window.
2. Copy the script to the clinical system and click **Register New Script** to register it in the system.

   Tip: You can sort the scripts by their status to reduce the number of scrips visible on the screen at once. The filtering options are saved separately for each user.

3. To approve for a limited evaluation, choose **Approve for Evaluation Testing**.
4. To approve for full clinical use for all clinical users, choose **Approve**.
5. Close the **Script Administration** dialog box.
6. Select **File** > **Save All** to save changes.

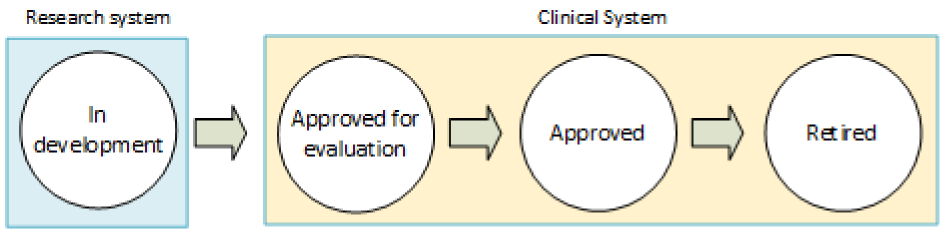
Script Development Process

Scripts are developed and tested in a non-clinical development system that allows running both read-only and write-enabled scripts without any approval process. When development is completed, scripts are moved to the clinical system, and to allow their use, scripts must be approved.

Script approval is mandatory for all Approval Extension plug-ins and write-enabled scripts that use the Eclipse Automation features. For read-only scripts, approval is optional. Script approval is possible for binary plug-in scripts, stand-alone executables, and for read-only scripts (if the optional approval is activated). Any write-enabled custom action pack used in a visual script must be approved separately.

It is possible to first approve the script for evaluation use so that a group of users with specific evaluation rights can use the script for a limited time period in a clinical environment.

The following diagram illustrates the suggested steps in script development:



The system provides logging so that the QA responsible person can always find all plans and structure sets that have been modified by a write-enabled script.

Modifications made by a script to plans and structure sets are shown in the **Plan Approval Wizard**. The planner must acknowledge and approve the changes during the plan approval process.

More information on configuration: Configuring a Non-Clinical Development System on page 71 and Configure a Clinical System to Require Approval for All Scripts on page 72.

Example Script Development Process

The following sections illustrate how script approval can be used to support the script development process in a radiotherapy clinic.

Initial Phase

- The lead clinical physicist in the radiotherapy department asks a programmer to develop a new script.
- The programmer starts creating the script following professional software engineering practices and the software development lifecycle in use at the institution.

Development in a Non-Clinical System

To develop the script, the programmer does the following work on the non-clinical development system:

- Works with the clinical physicist to develop the user story and document the intended clinical use for the script.
- Writes testable user and system requirements for the script and reviews those with the clinical physicist and other stakeholders.
- Analyzes potential risks and hazards with colleagues and documents a risk and hazards analysis for the script along with mitigators for identified potential hazards.
- Creates and documents a design for the script, if the script is large enough to warrant a design, and reviews that with stakeholders.
- Programs the script source code and reviews the source code with other programmers.
- Uses a software configuration management system to version and archive source code.
- Creates automated unit tests and verifies that near 100% code coverage is possible.

- Releases the script to the clinical physicist and copies it to the release directory on the non-clinical development system.

Commissioning and Validation

The clinical physicist does the following:

- Works with the programmer to create a commissioning and validation plan for the script.
- Validates and commissions the script for its intended clinical use and environment.
- After confirming that the script satisfies requirements and works as intended, creates a validation and commissioning report.
- Copies the script to the **System Scripts** directory on the clinical system.

Evaluation in a Clinical System

The clinical physicist does the following:

- Signs in to the clinical system and opens the **ESAPI Script Administration** window.
- Chooses the newly developed script and sets the status to **Approved for Evaluation**.
- In Varian Service Portal, gives **Run Script in Evaluation State** user rights to two senior treatment planners, and notifies them that the script is available for evaluation.

Treatment planners do the following:

- At the clinical physicist's instruction, evaluate the script in the clinical system by shadowing actual clinical cases they are working on.
- Create evaluation courses with evaluation plans that are created with the script, and compare the evaluation plans against the actual clinical plans they have manually created.
- Complete the evaluation phase of the script, when they have successfully planned a number of different types of cases for different sites as defined in the validation and commission plan.

The clinical physicist does the following:

- Reviews the results of the evaluation phase, and then finalizes the validation and commissioning report.

Approval for Clinical Use

The clinical physicist does the following:

- Signs in to the clinical system and opens the **ESAPI Script Administration** window. Chooses the script and sets its status to **Approved**.
- The script is now available for routine clinical use by all treatment planners in the department.

Differences Between Clinical and Non-Clinical Environments

Non-clinical environments (also called research environments) are different from clinical environments in that:

- Users cannot treatment approve plans, which prevents treating from a research environment database.
- The title bars in Eclipse workspaces note that the system is running in a research environment.

- All Eclipse printouts generated from this environment note that they were created in a research environment.
- **Beam Configuration** warns that changes should only be made if the DCF environment is dedicated for research.
- All plans created or modified through the Eclipse Scripting API have their intent set to “Research”.
- Users can execute unapproved scripts for debugging and testing purposes.

Configuring a Non-Clinical Development System

When Eclipse is configured as a non-clinical development system (also called research system), additional API features are available for non-clinical research and development use.

A development environment has an Eclipse Scripting API research license installed, and the Varian System database has been configured for research use. The configuration is typically done by Varian service personnel at time of installation.

Configure Eclipse for Non-Clinical Use

You can configure an Eclipse system for non-clinical development use if you have the proper user rights and the Eclipse Scripting API for Research Users license.

1. Open **RT Administration** using a system administrator account.
2. Click **System and Facilities**.
3. Click **System Properties**.
4. Select the **Database in Research Mode** check box.
5. Select **File** > **Save All** to save changes.

Tip: You can use the following script to test whether write-enabled scripts can be run on the system.

```
using System;
using VMS.TPS.Common.Model.API;
using VMS.TPS.Common.Model.Types;
using System.Windows;
[assembly: ESAPIScript(IsWriteable = true)]
namespace VMS.TPS
{
  public class Script
  {
    public void Execute(ScriptContext context)
    {
      if (context.Patient == null)
      {
        MessageBox.Show("Please load a patient before running this script.");
        return;
      }
      try
      {
        // throws an exception if writable scripting not enabled.
        context.Patient.BeginModifications();
        MessageBox.Show("SUCCESS!  Writable scripting is enabled.");
      }
      catch (Exception e)
```

```
        { string Message = "Test FAILED!  Writable scripting is not enabled.\n";
          Message += "Message:\n" + e.Message;
          MessageBox.Show(Message);
        }
      }
    }
  }
```

Configure a Clinical System to Require Approval for All Scripts

The Eclipse system can be configured to enforce script approvals for all script types, read-only and write-enabled. By system design, approval is mandatory for write-enabled scripts. For read-only scripts, you can decide whether to make the approval mandatory or not.

To configure the system to require approvals for all script types, both read-only and write-enabled:

1. Open **RT Administration** using a system administrator account.
2. Click **System and Facilities**.
3. Click **System Properties**.
4. Select the **Approval required for read-only scripts** check box.
5. Select **File** > **Save All** to save changes.

Release a New Version of a Script That Is in Clinical Use

Before releasing a new version of a script that is in clinical use, retire the current version of the script.

1. In the **Script Administration** dialog box, select the current version of the script and click **Retire**.
2. Enter your user name and password, and click **Retire**.
3. Approve the new version of the script following instructions in the prior section.
4. Close the **Script Administration** dialog box.
5. Select **File** > **Save All** to save changes.

   You can delete scripts in that are in the **Retired** status if such scripts have no history of plan/ structure set modifications.

Find All Plans and Structure Sets Changed by a Script

You may find, for example, that a write-enabled script you created and approved produces erroneous results due to a coding defect, and the script has been approved and used clinically for some time.

To evaluate the impact of the defect, you can create a stand-alone executable script that uses the API methods `PlanSetup.ApplicationScriptLogs` and `StructureSet.ApplicationScriptLogs` to find all plans and structure sets that the script has changed in the system. The following code sample shows an implementation of a stand-alone executable `Execute` method that could do this. Note that a stand-alone executable script like this opens every patient in the database and should only be run after-hours when no other users are working.

```
static void Execute(Application app)
{
  const string MyScript = "MyScript.esapi";
  // look for objects created since April 1st 2016 since script was
  // approved then.
  DateTime searchSince = new DateTime(2016, 4, 1);
  double searchDays = (DateTime.Now - searchSince).TotalDays;

  foreach (PatientSummary summary in app.PatientSummaries)
  {
    Patient p = app.OpenPatient(summary);
    // find all plans touched by the script
    foreach (Course course in p.Courses)
    {
      foreach (PlanSetup plan in
          course.PlanSetups.Where
          (ps => (DateTime.Now-ps.HistoryDateTime).TotalDays <= searchDays))
      {
        var scriptLogs = plan.ApplicationScriptLogs;
        foreach (ApplicationScriptLog log in
            scriptLogs.Where(s => s.ScriptFullName == MyScript))
        {
          Console.WriteLine("Plan \"{0}/{1}/{2}\" touched by " +
                            "script {3} on {4}.",
              p.Id, course.Id, plan.Id,
          log.ScriptFullName, log.HistoryDateTime);
        }
      }
    }
    // find all structure sets touched by the script
    foreach (StructureSet structSet in
        p.StructureSets.Where
        (ss => (DateTime.Now - ss.HistoryDateTime).TotalDays <= searchDays))
    {
      var scriptLogs = structSet.ApplicationScriptLogs;
      foreach (ApplicationScriptLog log in
          scriptLogs.Where(s => s.ScriptFullName == MyScript))
      {
        Console.WriteLine("Structure set \"{0}/{1}\" touched by " +
                          "script {2} on {3}.",
            p.Id, structSet.Id,
            log.ScriptFullName, log.HistoryDateTime);
      }
    }
    app.ClosePatient();
  }
}
```

Information About Used Scripts in Plan Approval

The **Plan Approval Wizard** contains the following information about the script that has been used to modify the plan or its structure set:

- The name of the script.
- The version of the script.
- The time when the plan or structure set was first saved after the modifications.

If you copy a plan or structure set that has been modified by a script, the same modification information is also transferred to the copied plan or structure set, and shown in the **Plan Approval Wizard**.

However, in this case, the time when you first saved the copied plan or structure set is shown instead of the time when the original plan or structure set was saved.

Scripts and Software Add-Ons in Eclipse

Using Scripts and Software Add-Ons in Eclipse

You can launch plug-in scripts from the **Tools** menu in Eclipse (**External Beam Planning**, **Plan Evaluation**) and BrachyVision (**Brachytherapy Planning**, **Brachytherapy 2D Entry**). You can also store scripts as favorites in the same menu.

You can launch software add-ons via the **Tools** > **Add-Ons** menu in Eclipse (**External Beam Planning**, **Plan Evaluation**) and BrachyVision (**Brachytherapy Planning**, **Brachytherapy 2D Entry**).

Stand-alone executables can be launched as any Windows application.

Approval extensions are executed automatically as part of the Plan Approval Wizard.

Launch a Plug-In Script

1. Choose **Tools** > **Scripts**.

   The **Scripts** dialog box opens.
2. To locate the script that you want to run, select one of the following options:
   - System Scripts: The scripts that are available for all users are shown on the list.
   - Directory: [`path_to_your_own_scripts`]. Click **Change Directory** and select a folder. All files with the .cs or .esapi.dll file name extension become available on the list.
3. In the **Scripts** dialog box, select the script file on the list.
4. Click **Run**.
5. If the execution of the script takes a very long time, you can click the **Abort** button. The execution of the script is aborted the next time the script accesses a property or method of the Eclipse Scripting API.

   Note: This procedure is meant only for recovering from programming errors and should not be considered a normal practice.

Launch a Software Add-On

1. Choose **Tools** > **Add-Ons**.

   The **Add-Ons** dialog box opens showing the available add-ons.
2. Click an add-on to execute the scripts for that add-on.

Launching a Stand-Alone Executable Application

You can launch a stand-alone executable like any Windows application on the workstation where Eclipse is installed. You can also debug the stand-alone executable using normal Windows debugging tools.

Adding and Removing Favorite Scripts

You can add favorite scripts to the **Tools** menu and define keyboard shortcuts for them.

Add a Favorite Script to the Tools Menu

1. In Eclipse, choose **Tools** > **Scripts**.

   The **Scripts** dialog box opens.
2. Select the script that you want to add to the menu.
3. Click **Add**.

   A dialog box is opened. You can define a keyboard shortcut for the favorite script.
4. Click **OK**.

Remove a Favorite Script from the Tools Menu

1. In Eclipse, choose **Tools** > **Scripts**.

   The **Scripts** dialog box opens.
2. Select a favorite script.
3. Click **Remove**.

Launching a Visual Script

Visual scripts can be run from within the Visual Scripting Workbench. You can also store scripts as favorites there. More information: Create and Test a Visual Script on page 45.

In addition, visual scripts can be run in Eclipse like any other plug-in script. More information: Launch a Plug-In Script on page 75. You can also store visual scripts as favorites in the **Tools** menu.

The system requires that all write-enabled action packs used in a visual script must be approved for use before script execution.

Launching a Plan Checker Script

Plan Checker is a script that supports automated plan checking. The script contains additional checks to enable fast plan approval process. You can use it to check the plan before it is planning approved. The script checks the plan against predefined checks (rules) and records the results. **Plan Checker** is available for Eclipse photon and electron plans. It is not available for proton or brachytherapy plans.

You start the **Plan Checker** script in **External Beam Planning** by choosing **Tools** > **Plan Checker** > **Run Plan Checker**. It is not possible to fix errors in Eclipse while **Plan Checker** is open. However, you can show a Plan Checker Report and have the PDF open while fixing errors in Eclipse.

Plan Checker script contains approximately 30 predefined checks. In addition to automated checks, the script contains an optional manual checklist for confirming most common causes for errors in a treatment plan. The script only reads data from Eclipse, it does not write any new data to the database. You can also create your own custom checks and use them in your own **Plan Checker** scripts. You are allowed to use all ESAPI features in your own **Plan Checker** scripts, including those changing data. The **Script Wizard** can be used to create a new plan check from the template.

The **Plan Checker** output contains the following types of data:

- Information – a simple informational text. Checked by default.
- Question – a simple question to the user. Requires the user to select the check box.
- Success – a success mark. Checked by default.
- Alert – an alert mark. Requires the user to enter some justification into the input field, to select the check box and ignore the error. There may be more than one alert.
- SuccessCollection – a collection of results. Displayed in a separate window.
- InformationCollection – same as SuccessCollection but uses the information icons. Displayed in a separate window.

Varian Plan Checker script contains manual checks that are simple Yes/No questions, and Varian provided automatic checks that have the Pass/Fail status.

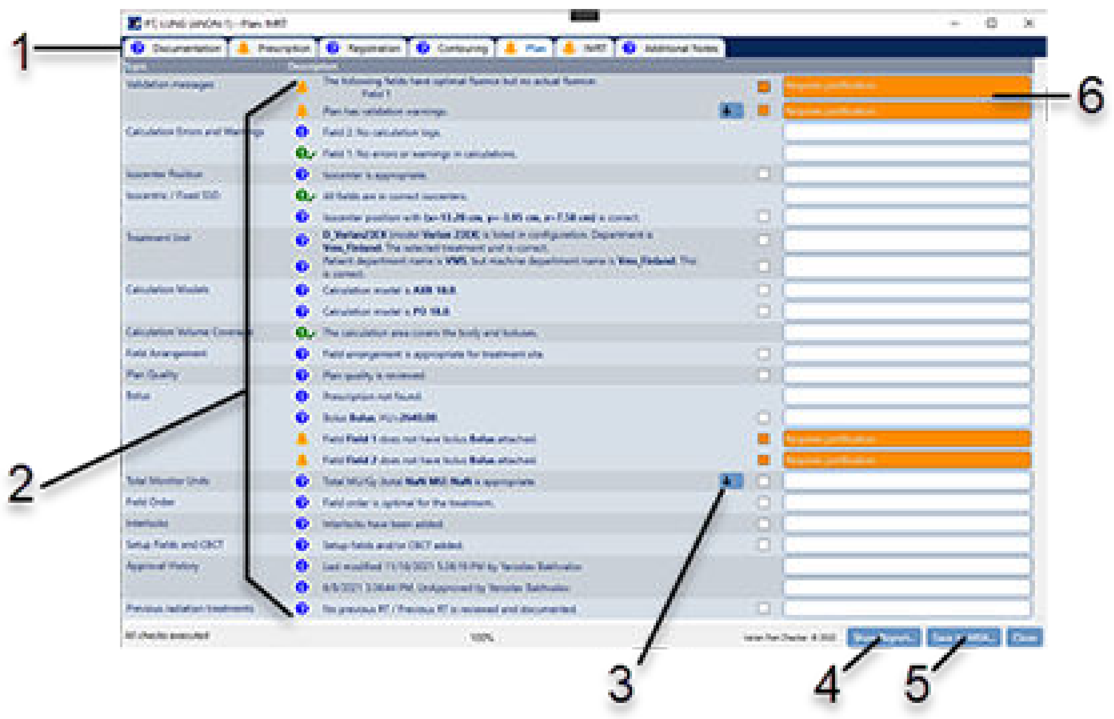


Figure 10 Plan Checker

1. Tabs for checks on different areas in the plan.
2. List of checks for all data types.
3. Click to show additional information.
4. Click to show a PDF report of the findings.
5. Click to save the report to the ARIA document server.
6. Errors can be overridden by selecting the check box and writing a justification in the text box. Mandatory fields are highlighted in orange.

You can display a description for each check by hovering over the check name in the Topic column.

Showing Plan Checker Reports

You can show a PDF report to verify information provided by **Plan Checker** and fix any existing errors. It is not possible to fix errors in Eclipse while **Plan Checker** is open.

Display a PDF report by clicking **Show Report** in **Plan Checker**, or directly from **Tools** > **Plan Checker** > **Run Status Report** menu item in Eclipse. You can save the report to ARIA document server by clicking **Save to ARIA** in **Plan Checker**.

If the report contains failed checks or unanswered questions, “This document contains failed checks or unanswered questions” text will be printed on every page of the report.

You can modify the look of the reportby customizing or creating your own header, footer ads style files. Template files for the report are installed to `\\[SERVER_NAME]\VA_DATA$\ProgramData\Vision\PlanChecker\ReportTemplates`. Currently supported page sizes are A4 and Letter.

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