射束复制调试过程：

直接复制计划到新的 CT，会提示
Error: The given plan key is not unique

新建计划，直接复制 Beamset，即
patient.TreatmentPlans['Copiedplan'].BeamSets=patient.TreatmentPlans['9F-SMLC'].BeamSets
或
patient.TreatmentPlans['Copiedplan'].BeamSets=patient.TreatmentPlans['9F-SMLC'].BeamSets[0]
均提示 SystemError:Member BeamSets cannot be mutated directly
访问 patient.TreatmentPlans['Copiedplan'].BeamSets[0]提示 ValueError：Index was out of range.
说明 BeamSet 为空

新建 Beamset，并用 new 来访问，即 new 指向 patient.TreatmentPlans['Copiedplan'].BeamSets[0]
直接复制
patient.TreatmentPlans['Copiedplan'].BeamSets[0]=patient.TreatmentPlans['9F-SMLC'].BeamSets
或
patient.TreatmentPlans['Copiedplan'].BeamSets[0]=patient.TreatmentPlans['9F-SMLC'].BeamSets[0]
均提示 TypeError:'ScriptObjiectCollection' object does not support item assignment

new.Beams 也为空
新建光子束后，直接复制
new.Beams=patient.TreatmentPlans['9F-SMLC'].BeamSets[0].Beams
new.Beams[0]=patient.TreatmentPlans['9F-SMLC'].BeamSets[0].Beams[0]
均报错

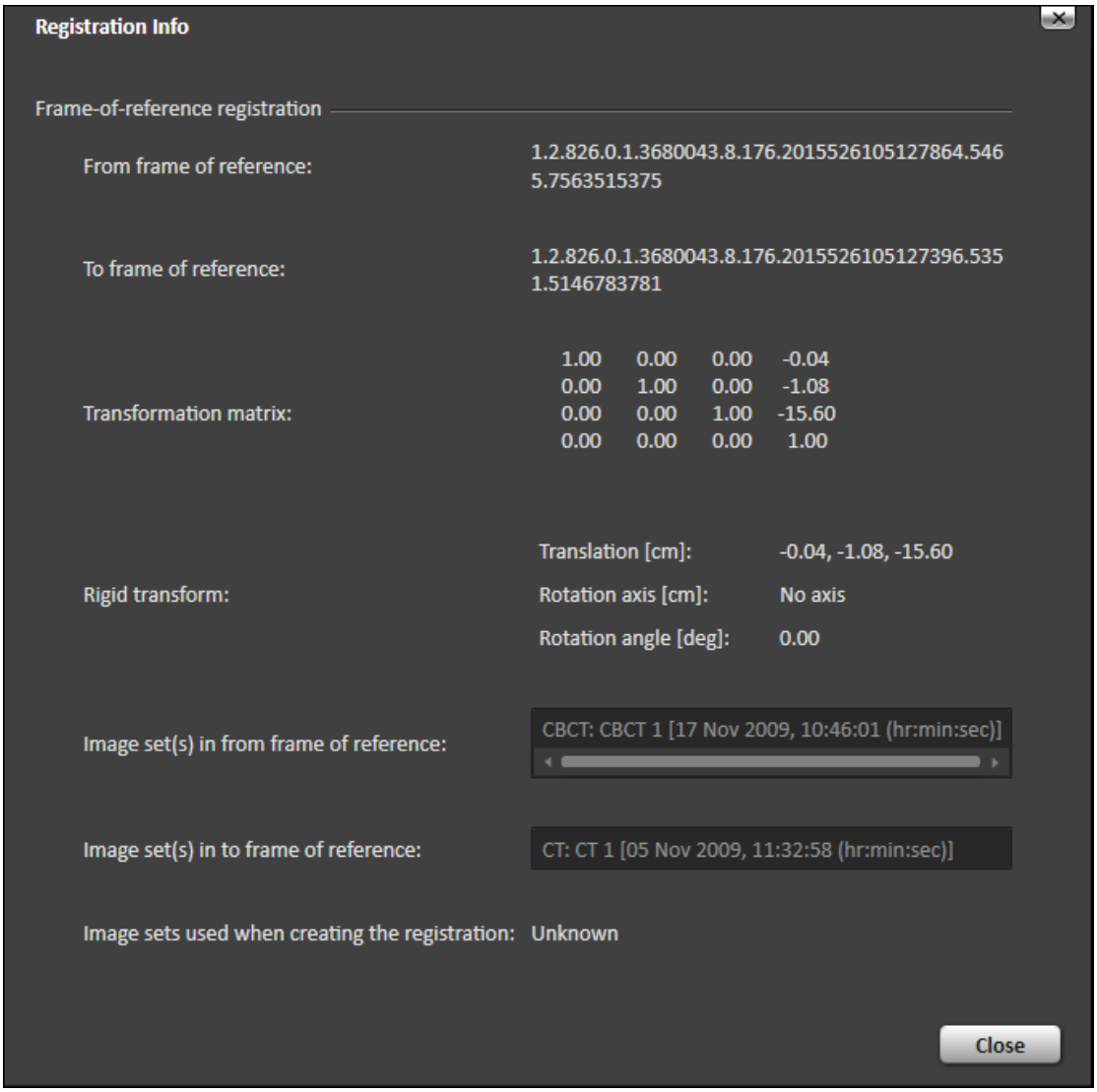
每运行一次 CreateRectangularField(),Beam 中 Segments 就会增加一个元素

new.Beams[0].Segments=patient.TreatmentPlans['9F-SMLC'].BeamSets[0].Beams[0].Segments
new.Beams[0].Segments[0]=patient.TreatmentPlans['9F-SMLC'].BeamSets[0].Beams[0].Segments[0]
均报错

结论：**只能一个一个 Segment 复制，对于每一个 Segment，新建一个方形野，复制 Jaw 位置、MLC 位置、权重系数**

CBCT treatment position alignment & rigid registraion 调试

在 CBCT 和 CT 中心对齐时，CBCT isocenter 设为 0,0,0（CT 中 plan 等中心位置为-0.04,-1.08,-15.60）
系统提示 registered by treatment position alignment
RayStation 中的配准信息



State Tree 中显示的配准信息，与 RayStation 中显示的一致（注意坐标变换）

Patient.Registrations[0].RigidTransformationMatrix

- RigidTransformationMatrix
  - RigidTransformationMatrix[0]: 1
  - RigidTransformationMatrix[1]: 0
  - RigidTransformationMatrix[2]: 0
  - RigidTransformationMatrix[3]: -0.0375919944
  - RigidTransformationMatrix[4]: 0
  - RigidTransformationMatrix[5]: 1
  - RigidTransformationMatrix[6]: 0
  - RigidTransformationMatrix[7]: 15.599158107
  - RigidTransformationMatrix[8]: 0
  - RigidTransformationMatrix[9]: 0
  - RigidTransformationMatrix[10]: 1
  - RigidTransformationMatrix[11]: -1.079911845
  - RigidTransformationMatrix[12]: 0
  - RigidTransformationMatrix[13]: 0
  - RigidTransformationMatrix[14]: 0
  - RigidTransformationMatrix[15]: 1

scripting 获取配准信息

```
x=patient.Examinations['CT 1'].EquipmentInfo.FrameOfReference
y=patient.Examinations['CBCT 1'].EquipmentInfo.FrameOfReference
a=patient.GetTransform(FromFrameOfReference=y,ToFrameOfReference=x)
```

```
Array[float]((1.0, 0.0, 0.0, -0.037591994400000002, 0.0, 1.0, 0.0, 15.599158107,
 0.0, 0.0, 1.0, -1.079911845, 0.0, 0.0, 0.0, 1.0))
```

等价于

```
Patient.GetTransformForExaminations(FromExamination='CBCT 1',ToExamination='CT 1')
```

```
Array[float]((1.0, 0.0, 0.0, -0.037591994400000002, 0.0, 1.0, 0.0, 15.599158107,
 0.0, 0.0, 1.0, -1.079911845, 0.0, 0.0, 0.0, 1.0))
```

因为不存在额外的刚性配准，又等价于

```
Patient.GetTotalTransformForExaminations(FromExamination='CBCT 1',ToExamination='CT 1')
```

```
Array[float]((1.0, 0.0, 0.0, -0.037591994400000002, 0.0, 1.0, 0.0, 15.599158107,
 0.0, 0.0, 1.0, -1.079911845, 0.0, 0.0, 0.0, 1.0))
```

在对 POI 进行刚性映射前，需要注意一下 RayStation 中的坐标系

患者坐标系，也就是在 RayStation 视图中横断面中的坐标系，点坐标为(x ,y ,z)

2.1 THE PATIENT COORDINATE SYSTEM

The patient coordinate system is oriented with the positive x-axis towards the patient's left arm, the positive y-axis towards the patient head and the positive z-axis towards the patient breast. The coordinate system follows the patient orientation: head first or feet first, supine or prone. In the hierarchy of IEC 61217 coordinate systems, the patient coordinate system has the table top coordinate system as its mother system.

The RayStation 4.7 dose and the dose difference distributions are all visualized in the patient coordinate system. In general, in RayStation 4.7 the patient coordinates are reported as **Right-Left**, **R-L** (right-left = x -/+), **Inf-Sup**, **I-S** (inferior-superior = y -/+) and **Post-Ant**, **P-A** (posterior-anterior = z -/+).

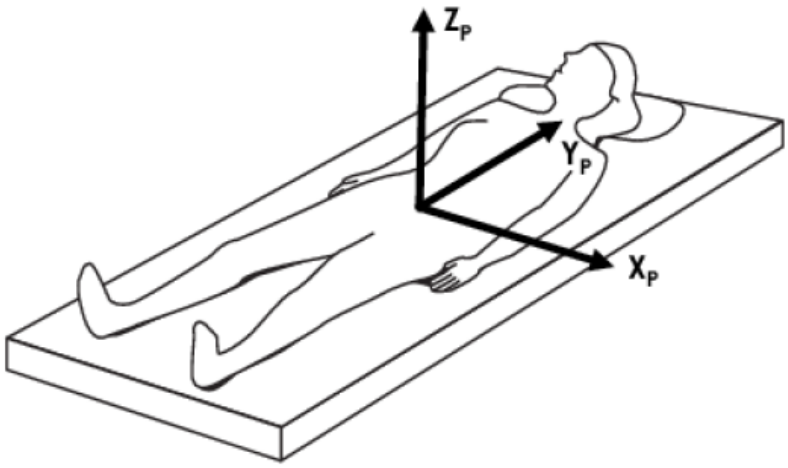


Figure 3. The patient coordinate system.

Note: *Patient positions Head First Supine (HFS), Head First Prone (HFP), Feet First Supine (FFS) and FFP (Feet First Prone) are supported by RayStation 4.7.*

DICOM（3.0）坐标系，与 RayStation 中的患者坐标系 y 和 z 不同，变换关系为 $x_{dicom}=x$, $y_{dicom}=-z$, $z_{dicom}=y$,反之 $x_{patient}=x$, $y_{patient}=z$, $z_{patient}=-y$

2.2 PATIENT COORDINATE SYSTEM IN THE DICOM EXPORT

Patient coordinates in DICOM exported datasets follow the DICOM standard, with the positive x-axis towards the patients left arm, the positive z-axis towards the patient head and the positive y-axis towards the patient back. The coordinate system follows the patient orientation: head first or feet first, supine or prone.

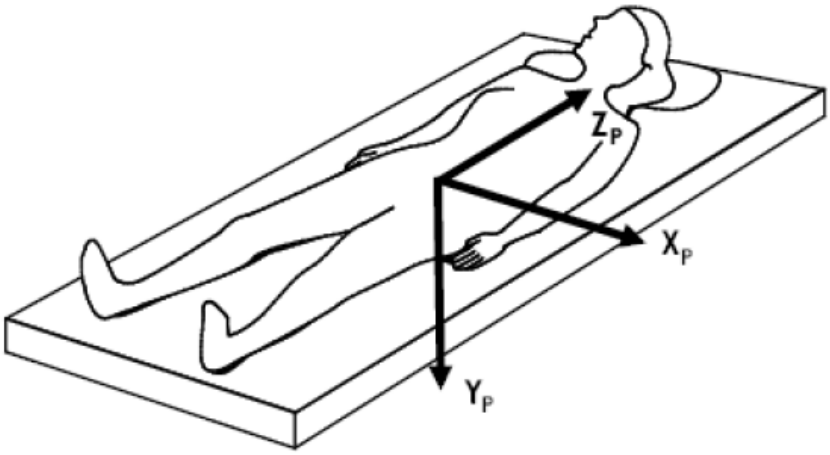


Figure 4. The patient coordinate system in the DICOM export follows the DICOM standard.

注意：scripting 中的输出的坐标都是基于 DICOM 坐标系！

POI 刚性映射

Patient.TransformPointFromExaminationToExamination(FromExamination='CBCT 1',ToExamination='CT 1',Point= {'x':0, 'y':0, 'z':0})

```
<System.Dynamic.ExpandoObject object at 0x000000000000002C [System.Dynamic.Expan
doObject]>
>>> a.x
-0.037591994400000002
>>> a.y
15.599158107
>>> a.z
-1.079911845
```

变化为 RayStation 患者坐标系为 x=-0.04,y=-1.08,z=-15.60，正好是 CT 计划等中心

另外也可以用

Patient.TransformPointFromExaminationToExaminationUsingTotalTransform(...)

Patient.TransformPointFromFoRToFoR(FromFrameOfReference='', ToFrameOfReference='',Point={})

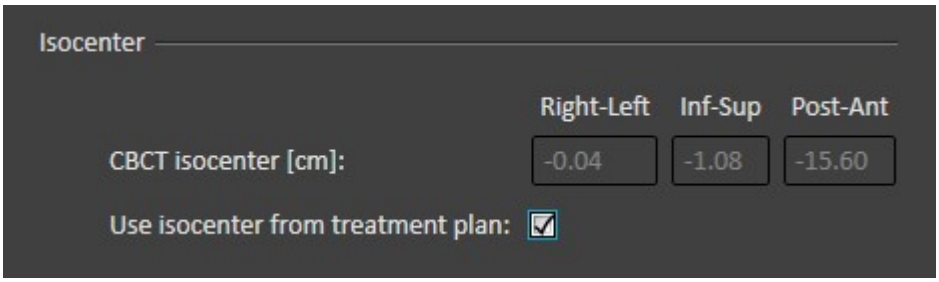
用 CT 中的 plan 射野等中心位置(-0.04,-1.08,-15.60)测试，结果是 CBCT 中心(0,0,0)

Patient.TransformPointFromExaminationToExamination(FromExamination='CT 1',ToExamination='CBCT 1',Point= {'x':-0.04, 'y':15.60, 'z':-1.08})

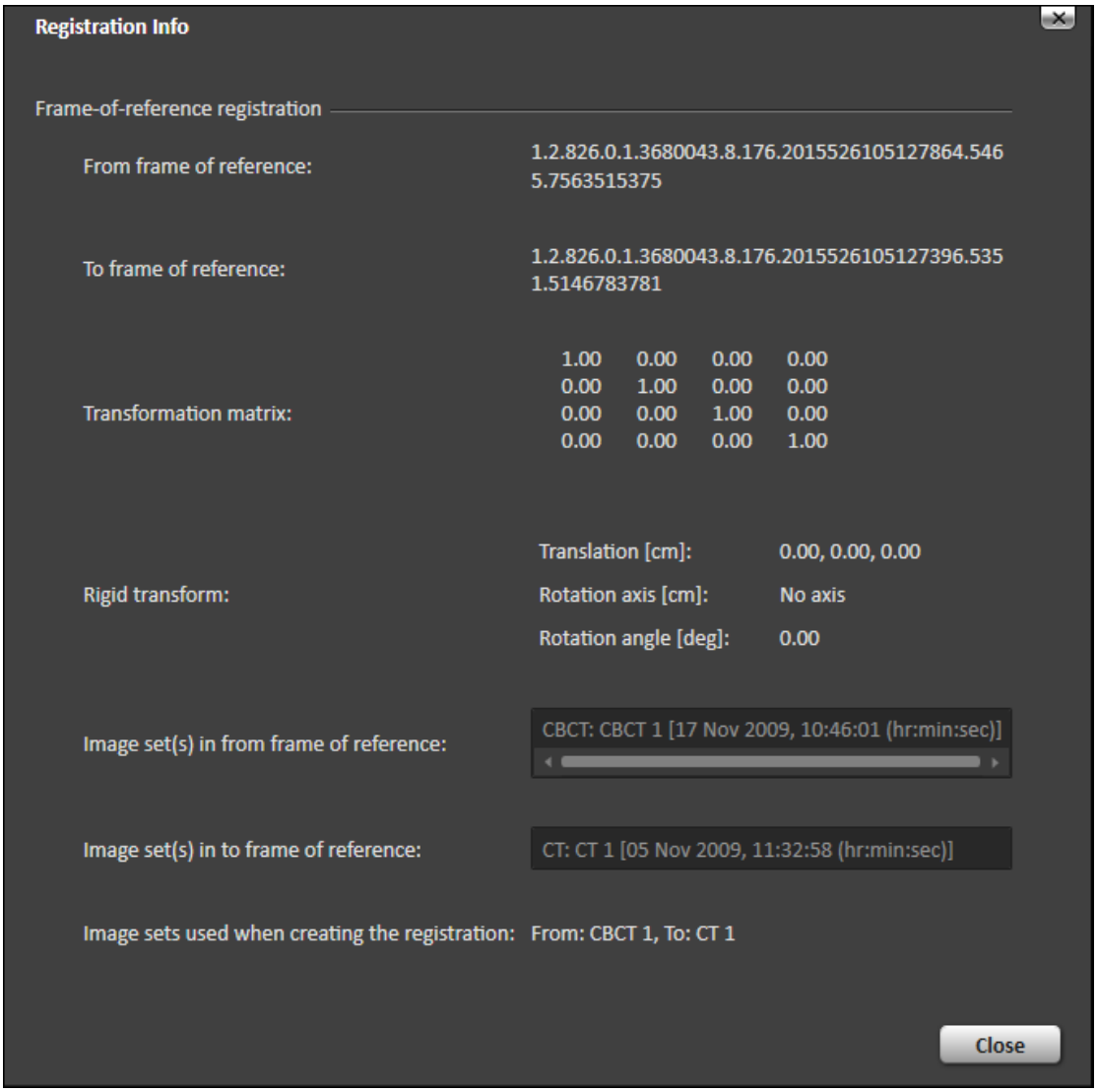
```
<System.Dynamic.ExpandoObject object at 0x000000000000002B [System.Dynamic.Expan
doObject]>
>>> a.x
-0.0024080055999999989
>>> a.y
0.00084189300000048206
>>> a.z
-8.8155000000034178e-05
```

注意：FromExamination 等价于 Reference image set，ToExamination 等价于 Target image set
FromExamination 等价于 ToFrameOfReference，ToExamination 等价于 FromFrameOfReference

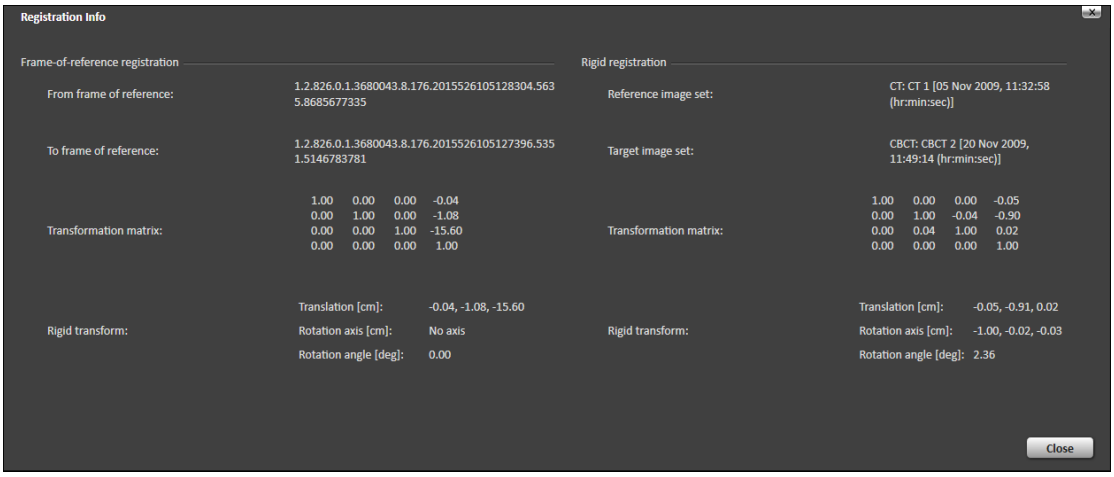
如果在设置中将 CBCT 的中心设为计划等中心



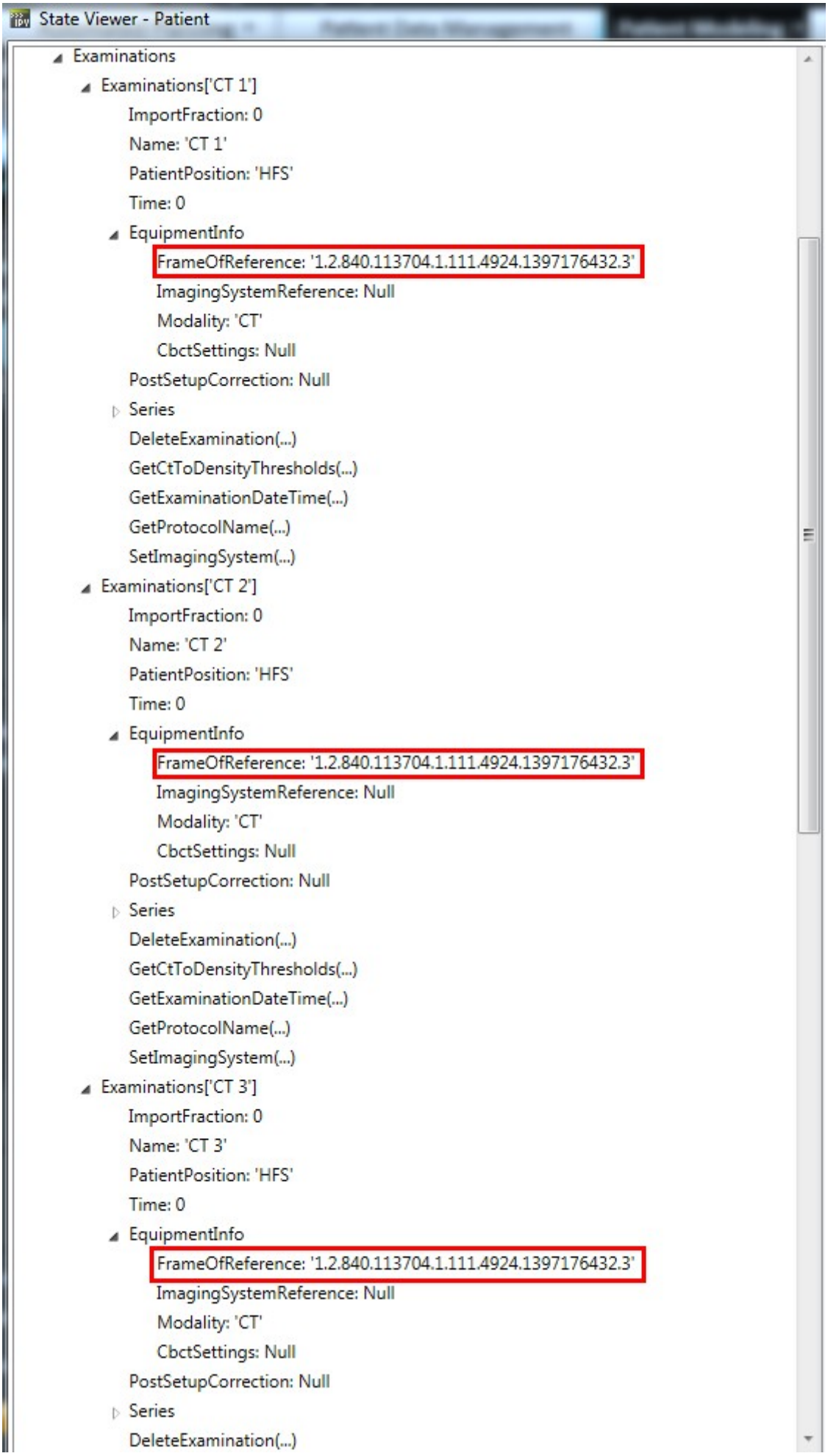
那么中心对齐的变换为 0,0,0



既有中心对齐，又有额外刚性变换的情形



4D-CT 所有时相的 CT 具有相同的参考系 Frame Of Reference，它们之间的配准会提示“The images are defined in the same frame of reference. No registration can be performed.”


State Viewer - Patient
Examinations
Examinations['CT 1']
ImportFraction: 0
Name: 'CT 1'
PatientPosition: 'HFS'
Time: 0
EquipmentInfo
FrameOfReference: '1.2.840.113704.1.111.4924.1397176432.3'
ImagingSystemReference: Null
Modality: 'CT'
CbctSettings: Null
PostSetupCorrection: Null
Series
DeleteExamination(...)
GetCtToDensityThresholds(...)
GetExaminationDateTime(...)
GetProtocolName(...)
SetImagingSystem(...)
Examinations['CT 2']
ImportFraction: 0
Name: 'CT 2'
PatientPosition: 'HFS'
Time: 0
EquipmentInfo
FrameOfReference: '1.2.840.113704.1.111.4924.1397176432.3'
ImagingSystemReference: Null
Modality: 'CT'
CbctSettings: Null
PostSetupCorrection: Null
Series
DeleteExamination(...)
GetCtToDensityThresholds(...)
GetExaminationDateTime(...)
GetProtocolName(...)
SetImagingSystem(...)
Examinations['CT 3']
ImportFraction: 0
Name: 'CT 3'
PatientPosition: 'HFS'
Time: 0
EquipmentInfo
FrameOfReference: '1.2.840.113704.1.111.4924.1397176432.3'
ImagingSystemReference: Null
Modality: 'CT'
CbctSettings: Null
PostSetupCorrection: Null
Series
DeleteExamination(...)

以多 CT 的病例来探索 Matrix 的应用，详见 word 文档 A example of rigid registration between multi-CTs