

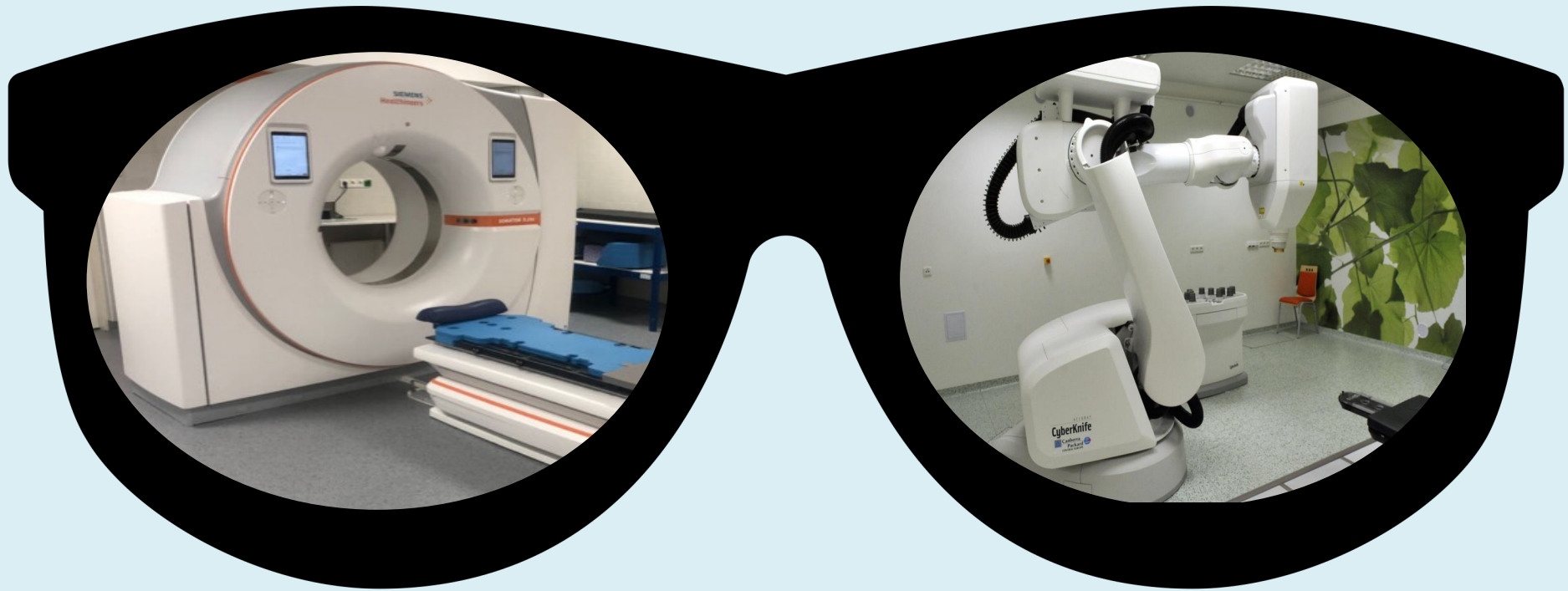


CyberKnife – pohledem radiologického asistenta

Mgr. Adam Chlopčík

CK ↔ CT

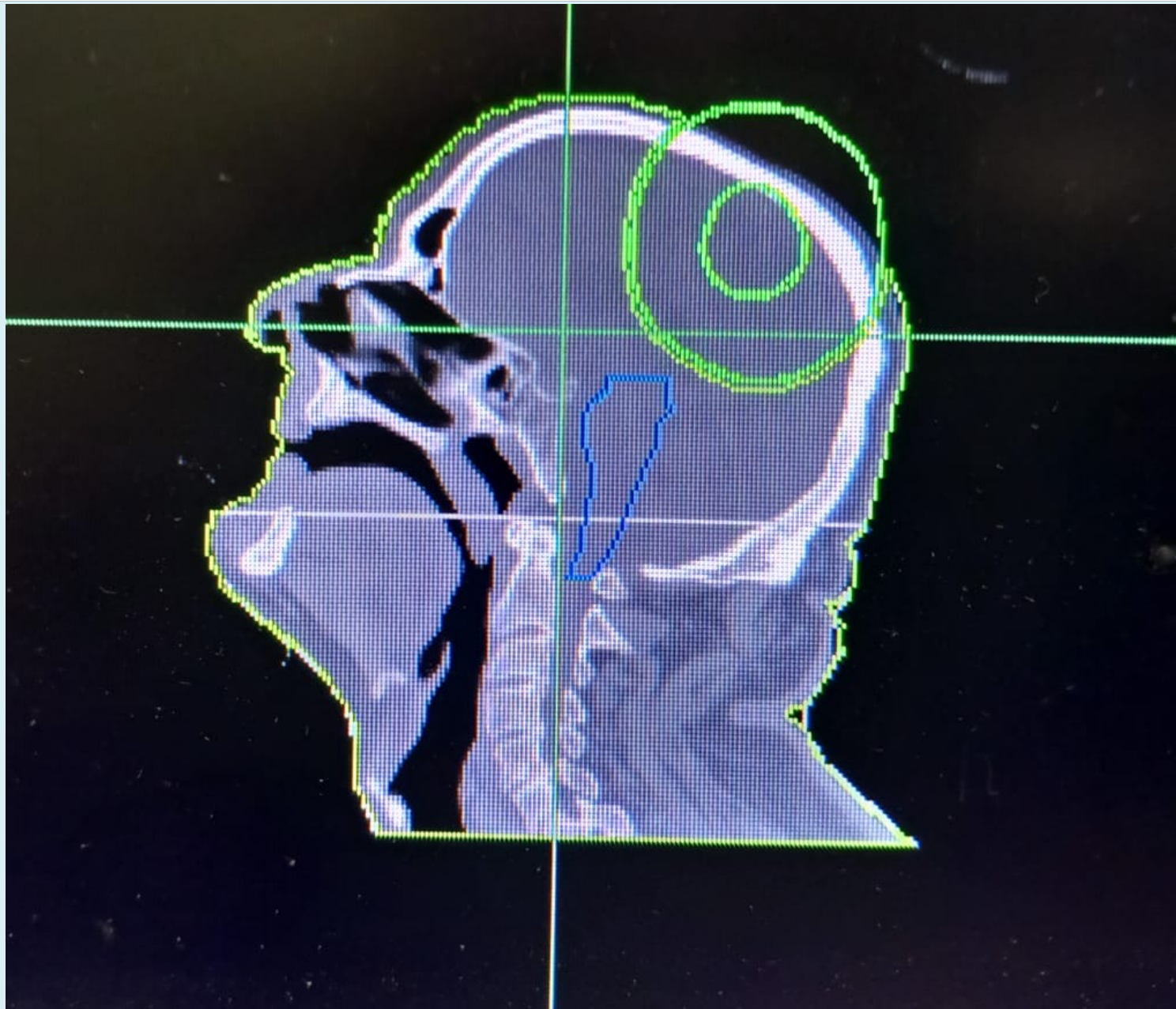
- bez kvalitních snímků nelze kvalitně plánovat + ozářit



CT pro CK – hlava, krk

- výroba fixační masky
- rovina uložení
- pohodlí pacienta
- zubní protézy





CT pro CK – hrudník

- poučení pacienta – nádech x výdech
- zkouška nanečisto
- dýchání do břicha x hrudníku
- umístění RPM krabičky

CT pro CK – břicho

- analogické problémy jako u hrudníku - nádech x výdech
- použití KL per os

CT pro CK – pánev

- použití KL per os
- příprava pro pacienty s c61 – plný MM x prázdné rektum



CK – zaměřovací režimy



6D skull

Overview Alignment Readiness Delivery

Couch Technique Align

115 kV 100 mA 100 ms **B**

115 kV 100 mA 100 ms **A**

Axis	Calculated	Applied
↓	-12.5 mm	-
→	-9.5 mm	-
↗	7.2 mm	-
↻	4.3 deg	-
↺	5.1 deg	-
↻	1.8 deg	-

☒ Rotational Bounds Checking Enabled

Acquire Image

Couch Position (mm)

↓ → ↗

-13.2 -6.7 -25.4

Couch Rotation (deg)

↻ 0.0 ↺ 0.0 ↻ 0.2

0.0 0.0 0.0

Images

Acquired 6 Expected 632

Estimated Imaging Dose (cGy)

Exposed 0.1 Expected 9.3

dxAB (mm) 1.2 2.5

Brightness (%) 1.0 5.0

Gradient (%) 7.8 15.0

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6D skull

No Photo Available

First Name:
 Last Name:
 Medical ID:

Plan Name: 27Gy_3fr_Iris_2023
 MU: 0.00 / 28153.06
 Treatment Site: CNS

Orientation: Head First Supine
 Tracking Method: 6D Skull
 Mode: Treatment

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Image History

Id	Brightness A	Brightness B	Gradient A	Gradient B	dxAB (mm)
1	1.02	1.22	0.97	1.10	4.9
2	1.00	1.01	1.08	1.09	5.4
3	0.99	1.01	1.06	1.08	1.2

Acquisition Details

Time (HH:MM:SS): 17:50:43 Imaging Interval (sec): 5

XRS A

kV 115
mA 100
ms 100

Calculated Translation (mm)

↓ -12.5 → -9.5 ↗ 7.2

Calculated Rotation (deg)

↶ 4.3 ↷ 5.1 ↻ 1.8

dxAB (mm)

1.2

XRS B

kV 115
mA 100
ms 100

Absolute Couch Position (mm)

↓ 7.6 → 13.9 ↗ -161.6

Absolute Couch Rotation (deg)

↶ 0.0 ↷ 0.0 ↻ 0.2

Brightness (%)

1.0

Gradient (%)

7.8

Workflow Guide

```

graph TD
    A[Analyze Results] --> B[Adjust Parameters]
    B --> C[Acquire Image]
    C --> D[Readiness]
    D --> A
    
```

Move to Readiness phase.

Alignment > Align Screen

The goal of the **Alignment > Align** phase for 6D Skull Tracking mode is to make sure the patient is aligned within acceptable bounds for treatment delivery.

The existing Live X-ray images from the **Alignment > Technique** phase are automatically correlated with the DRR images. Start by reviewing the calculated **Offset** values to determine if you need to move the couch.

This phase has the following steps:

- [Analyze imaging results](#)
- [Move the couch](#)
- [Adjust algorithm parameters as needed](#)
- [Acquire a Live X-ray image](#)
- [Analyze the Image History](#)
- [Proceed to the next treatment phase](#)

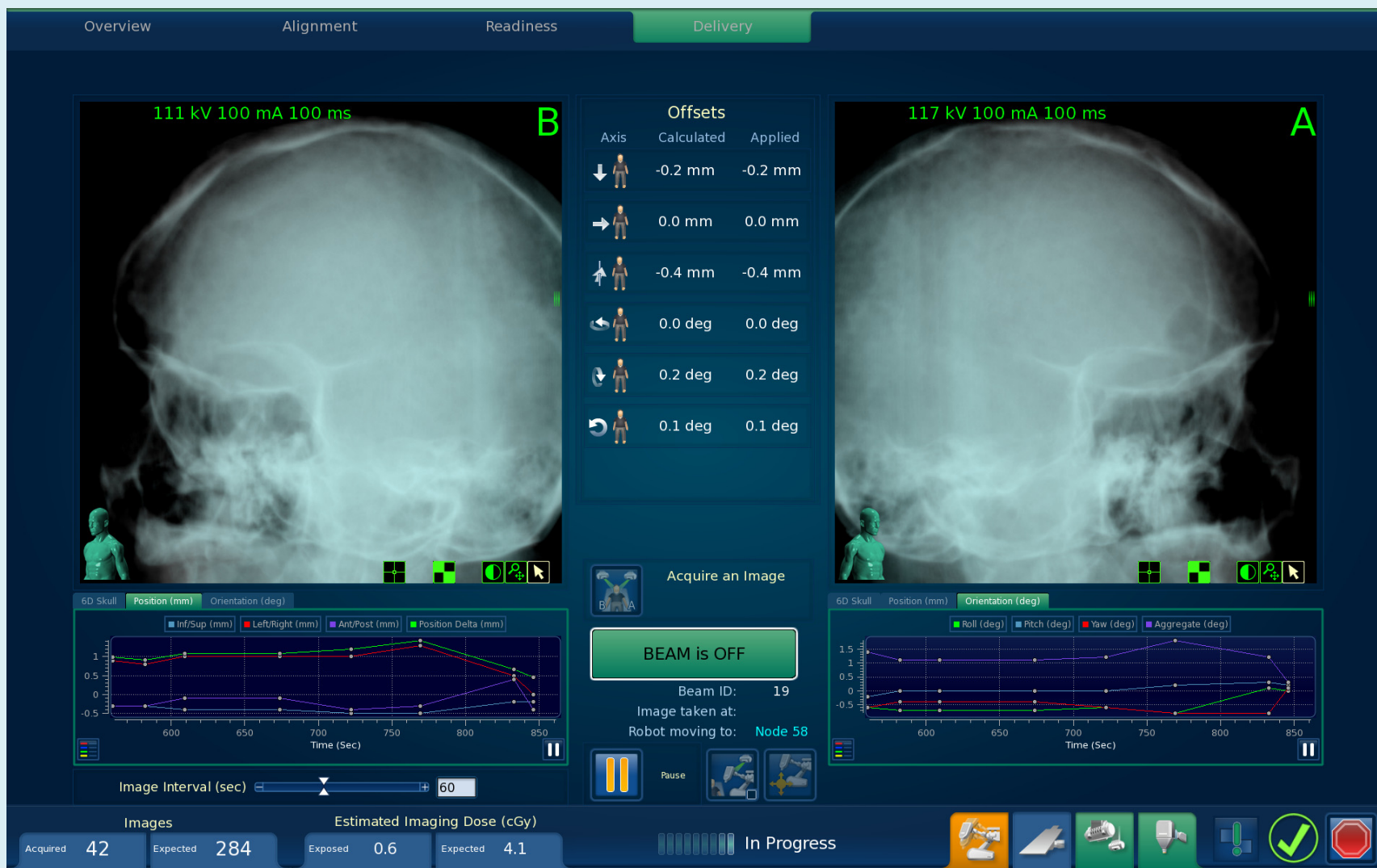
Analyze imaging results

The left screen displays the Live X-ray image in a teal color scale overlaid on the DRR image in grayscale for Camera B and Camera A of the imaging system.

WARNING: Visually compare the Live X-ray and DRR images to ensure that features are similar in both. Ensure that the skeletal features to be tracked are correctly identified in the Live X-ray images for the tracking procedure.

Time (HH:MM:SS): 18 Apr 2023 17:51:29

6D skull



6D skull



XST – Xsight Spine Tracking

Overview Alignment Readiness Delivery

Couch Technique Align

140 kV 100 mA 100 ms

Offsets

Axis	Calculated	Applied
↓	0.3 mm	-
→	-0.1 mm	-
↗	-0.2 mm	-
↖	-0.2 deg	-
↘	0.1 deg	-
↙	-0.2 deg	-

☒ Rotational Bounds Checking Enabled

Acquire Image

Couch Position (mm)

↓ → ↗

-1.0 -4.5 18.8

Couch Rotation (deg)

↖ ↘ ↙

1.7 0.1 2.1

0.0 0.0 0.0

Tracking Range (mm)

4.0

ROI Width (mm)

77.0

☒ From Planning

dxAB (mm)

0.0 2.5

False Nodes (%)

25.0 50.0

drAB (deg)

0.0 2.0

Images

Acquired 40 Expected 372

Estimated Imaging Dose (cGy)

Exposed 0.8 Expected 7.7

XST – Xsight Spine Tracking

Overview Alignment Readiness Delivery

Couch Technique Align

140 kV 100 mA 100 ms B

140 kV 100 mA 100 ms A

Axis	Calculated	Applied
↓	0.3 mm	-
→	-0.1 mm	-
↗	-0.2 mm	-
↖	-0.2 deg	-
↘	0.1 deg	-
↙	-0.2 deg	-

☒ Rotational Bounds Checking Enabled

Acquire Image

Couch Position (mm): ↓ -1.0 → -4.5 ↗ 18.8

Couch Rotation (deg): ↻ 1.7 ↺ 0.1 ↻ 2.1

Tracking Range (mm): 4.0

ROI Width (mm): 77.0

☒ From Planning

dxAB (mm): 0.0 2.5

False Nodes (%): 25.0 50.0

drAB (deg): 0.0 2.0

Images: Acquired 40 Expected 372

Estimated Imaging Dose (cGy): Exposed 0.8 Expected 7.7

XST – Xsight Spine Tracking

No Photo Available

First Name:
 Last Name:
 Medical ID:

Plan Name: 3625cGy_5fr_Iris_PTV3_4
 MU: 4781.70 / 54182.46
 Treatment Site: Other

Orientation: Head First Supine
 Tracking Method: Xsight Spine
 Mode: Treatment

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Image History

Id	dxAB (mm)	drAB (deg)	False Nodes A	False Nodes B	Tracking Range (mm)	ROI Width (mm)	Histogram A	Histogram B
14	0.2	0.3	22	11	4.0	77.0		
15	0.1	0.2	30	9	4.0	77.0		
16	0.3	0.4	21	12	4.0	77.0		
17	0.9	0.4	25	9	4.0	77.0		
18	0.2	0.3	28	4	4.0	77.0		
19	0.4	0.0	28	10	4.0	77.0		
20	0.0	0.0	25	5	4.0	77.0		

Workflow Guide

```

graph LR
    A[Analyze Results] --> B[Adjust Parameters]
    B --> C[Acquire Image]
    C --> D[Readiness]
    D --> E[Move to Readiness phase]
    
```

Acquisition Details
Images

Acquisition Details

Time (HH:MM:SS): 14:56:20
Imaging Interval (s): 5

XRS A

kV 140
mA 100
ms 100

Calculated Translation (mm)

↓ 0.3

→ -0.1

↗ -0.2

Calculated Rotation (deg)

↶ -0.2

↷ 0.1

↻ -0.2

Absolute Couch Position (mm)

↓ -476.1

→ -9.2

↗ -95.6

Absolute Couch Rotation (deg)

↶ 1.6

↷ 0.1

↻ 2.1

dxAB (mm)
0.0

drAB (deg)
0.0

False Nodes (%)
25.0

Tracking Range (mm): 4 mm

ROI Width (mm): 77 mm

Alignment > Align Screen

The goal of the **Alignment > Align** phase is to make sure the patient is aligned within acceptable bounds for treatment delivery using Xsight Spine Tracking mode or Xsight Spine Prone. For Xsight Lung Tracking mode, the goal is to determine the rotational offsets to be used in the **Align > Lung** phase and during treatment delivery.

The existing Live X-ray images from the **Alignment > Technique** phase are automatically correlated with the DRR images. Start by reviewing the calculated **Offset** values to determine if you need to move the couch.

This phase has the following steps:

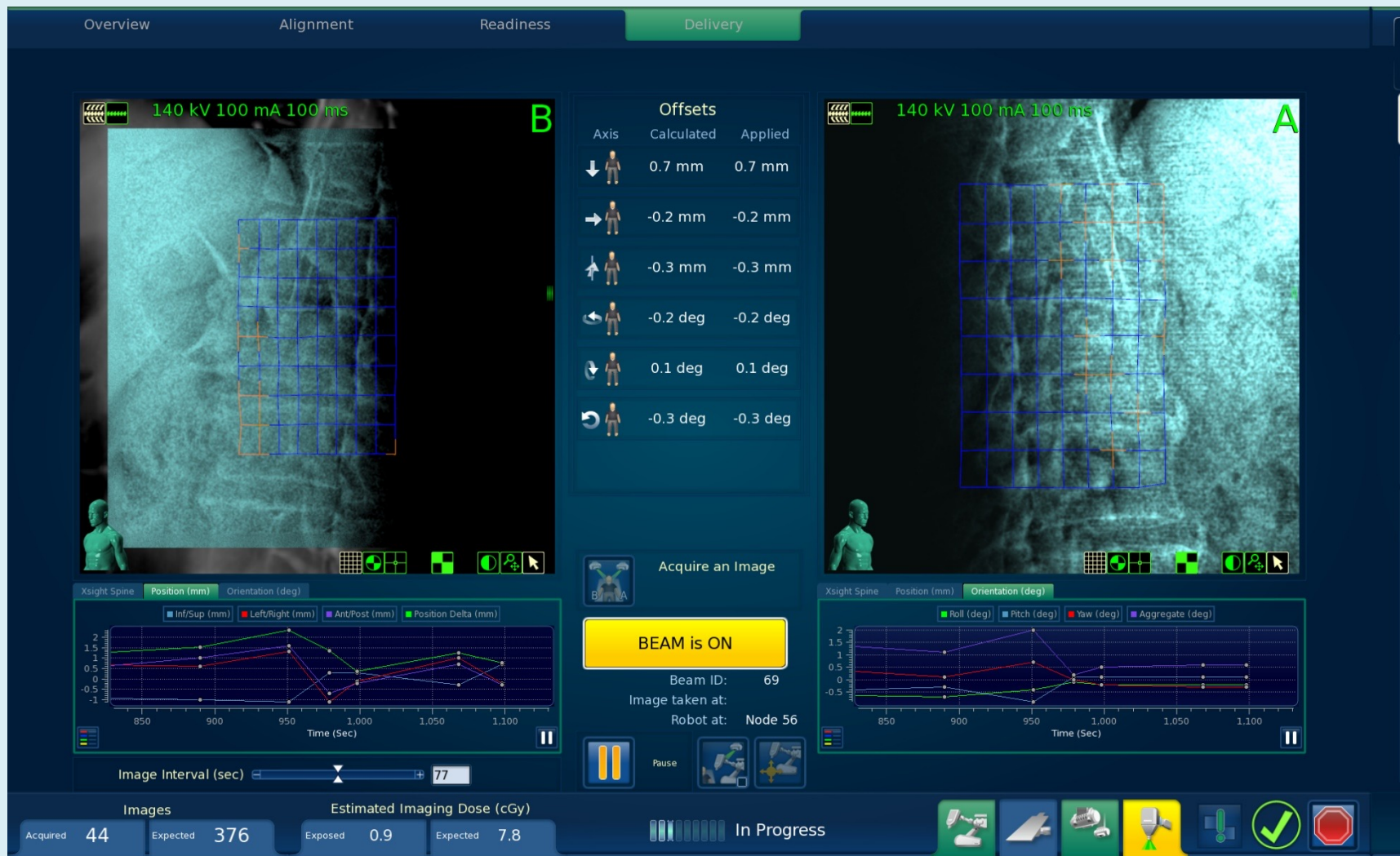
- [Analyze imaging results](#)
- [Move the couch](#)
- [Adjust algorithm parameters as needed](#)
- [Acquire a Live X-ray image](#)
- [Analyze the Image History](#)
- [Proceed to the next treatment phase](#)

Analyze imaging results

The left screen displays the Enhanced Live X-ray image in a teal color scale overlaid on the DRR image in grayscale for Camera B and Camera A of the imaging system.

Time (HH:MM:SS): 17 Apr 2023 14:57:13

XST – Xsight Spine Tracking



XST – Xsight Spine Tracking



XLT – Xsight Lung Tracking



XLT + synchrony model

Overview Alignment Readiness Delivery

Couch Technique Align Lung Technique Synchrony

120 kV 100 mA 64 ms

Synchrony Model (mm)

0.1	-1.1	0.5	0.9
0.1	-1.0	0.7	0.7
0.0	-0.6	0.7	0.7
0.1	-0.5	0.7	0.7
0.3	-1.0	0.7	1.1
0.2	-1.4	0.5	0.9
0.0	-1.4	0.7	0.7

Alignment Rotation Correction (deg)

0.3	-0.1	0.1
-----	------	-----

Model Information

Avg Std Err (mm): 0.2
Max Std Err (mm): 0.2
Model State: Sub-Optimal

120 kV 100 mA 64 ms

Automatic Setup Manual Setup

Acquire Image

Couch Position (mm)

Couch Rotation (deg)

Tracking Range X (mm) 12.0

Tracking Range Y (mm) 12.0

dxAB (mm) 0.3 2.5

Uncertainty (%) 5.7 40.0

Preferred Projection (ON)

Rotational Bounds Checking Enabled

Skip Synchrony

Images

Estimated Imaging Dose (cGy)

Acquired 28 Expected 1458 Exposed 0.4 Expected 15.3

XLT + synchrony model

No Photo Available

First Name: Last Name: Medical ID:

Plan Name: 40Gy_5fr_Iris
MU: 0.00 / 32444.52
Treatment Site: Lung

Orientation: Head First Supine
Tracking Method: Xsight Lung Synchrony
Mode: Treatment

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Image History

Model Point	Phase	Age	Used
-		1:51	
-		1:29	
7		1:10	
3		1:00	
2		0:41	
5		0:31	
4		0:20	
6		0:10	
1		0:01	

Coronal View Grid: 2 mm Sagittal View Grid: 2 mm

Vertical(1 mm) Horizontal(4 s)

Workflow Guide

Synchrony Model → Analyze Model

Adjust Parameters

Readiness
Move to Readiness phase.

Acquisition Details Synchrony Details Images

☒ Marker 1
☒ Marker 2
☒ Marker 3

Coverage (%)
75.2

Model Points
7

INF(+) / SUP(-)
Grid: 2 mm r(Marker)

LFT(+) / RGT(-)
Grid: 2 mm r(Marker)

ANT(+) / POS(-)
Grid: 2 mm r(Marker)

Linear Linear Linear

Markers
☒ Marker 1
☒ Marker 2
☒ Marker 3

Horizontal(1 s) Vertical(1 mm)

Alignment > Synchrony Screen

The goal of the **Alignment > Synchrony** phase for Xsight Lung Tracking mode and 1-View tracking is to build a Synchrony model.

In this phase, you do the following:

- [Build a Synchrony model](#)
- [Analyze the Synchrony model](#)
- [Adjust algorithm parameters as needed](#)
- [Analyze the Image History](#)
- [Proceed to the next treatment phase](#)

Build a Synchrony model

You build a Synchrony model using **Manual Synchrony Setup** or the optional **Automatic Synchrony Setup**.

- [Enable/disable Synchrony Tracking Markers](#)
- [Use Manual Synchrony Setup](#)
- [Use Automatic Synchrony Setup \(Option\)](#)
- [Monitor Synchrony modeling](#)

Enable/disable Synchrony Tracking Markers

Time (HH:MM:SS): 11 Apr 2023 12:28:56

XLT + synchrony model



XLT + synchrony model



Fiducials

Overview Alignment Readiness Delivery

Couch Technique Align

120 kV 100 mA 100 ms

Offsets

Axis	Calculated	Applied
↓	-1.2 mm	-
→	0.2 mm	-
↗	0.3 mm	-
↶	1.6 deg	-
↷	-2.2 deg	-
↻	0.0 deg	-

☒ Rotational Bounds Checking Enabled

Acquire Image

Tracking Range (mm) 10.0 dxAB (mm) 0.2 2.5 Uncertainty (%) 25.8 40.0

Rigid Body (mm) 2.3 2.5 Collinearity (deg) 78.1 15.0 Fiducial Spacing (mm) 24.5 16.0

Fiducials ☒ F 1 ☒ F 2 ☒ F 3 ☒ F 4

Couch Position (mm) ↓ → ↗ ↶ ↷ ↻

Couch Rotation (deg) -0.3 0.2 3.5

Images Acquired 188 Expected 334

Estimated Imaging Dose (cGy) Exposed 3.0 Expected 5.3

Fiducials - In tempo

No Photo Available

First Name: Last Name: Medical ID:

Plan Name: 3625cGy_5fr_Iris
MU: 15902.49 / 38738.26
Treatment Site: C61

Orientation: Head First Supine
Tracking Method: Fiducial
Mode: Treatment

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Image History

Id	dxAB (mm)	Rigid Body Error (mm)	Uncertainty (%)	Tracking Range (mm)	Fiducial Count
2	0.5	1.0	25.5	10.0	4
3	0.5	1.3	25.7	10.0	4
4	0.6	1.4	24.2	10.0	4
5	0.5	1.3	24.6	10.0	4
6	0.5	1.2	25.2	10.0	4
7	0.5	2.3	27.9	10.0	4
8	0.2	2.3	25.8	10.0	4

Acquisition Details

Images

Location / Uncertainty

Algorithm Details

Acquisition Details

Time (HH:MM:SS): 14:05:31

Imaging Interval (sec): 5

XRS A

kV 120
mA 100
ms 100

Calculated Translation (mm)
↓ 1.2 → 0.2 ↗ 0.3
Absolute Couch Position (mm)
↓ -795.2 → -39.3 ↗ -112.0
Calculated Rotation (deg)
↻ 1.6 ↺ -2.2 ↻ 0.0
Absolute Couch Rotation (deg)
↻ -0.3 ↺ 0.2 ↻ 3.5

XRS B

kV 120
mA 100
ms 100

Fiducials
☒ F1 ☒ F2 ☒ F3 ☒ F4
Tracking Range (mm): 10 mm

dxAB (mm)
0.2
Rigid Body Error (mm)
2.3
Uncertainty (%)
25.8
Fiducial Spacing (mm)
24.5
Collinearity (deg)
78.1

Workflow Guide

Analyze Results → Adjust Parameters
Acquire Image
Readiness
Move to Readiness phase.

Alignment > Align Screen

The goal of the **Alignment > Align** phase for fiducial tracking mode is to make sure the patient is aligned within acceptable bounds for treatment delivery or Synchrony modeling if the Synchrony System will be used.

The existing Live X-ray images from the **Alignment > Technique** phase are automatically correlated with the DRR images. Start by reviewing the calculated **Offset** values to determine if you need to move the couch.

This phase has the following steps:

[Analyze imaging results](#)
[Move the couch](#)
[Adjust algorithm parameters as needed](#)
[Acquire a Live X-ray image](#)
[Analyze the Image History](#)
[Proceed to the next treatment phase](#)

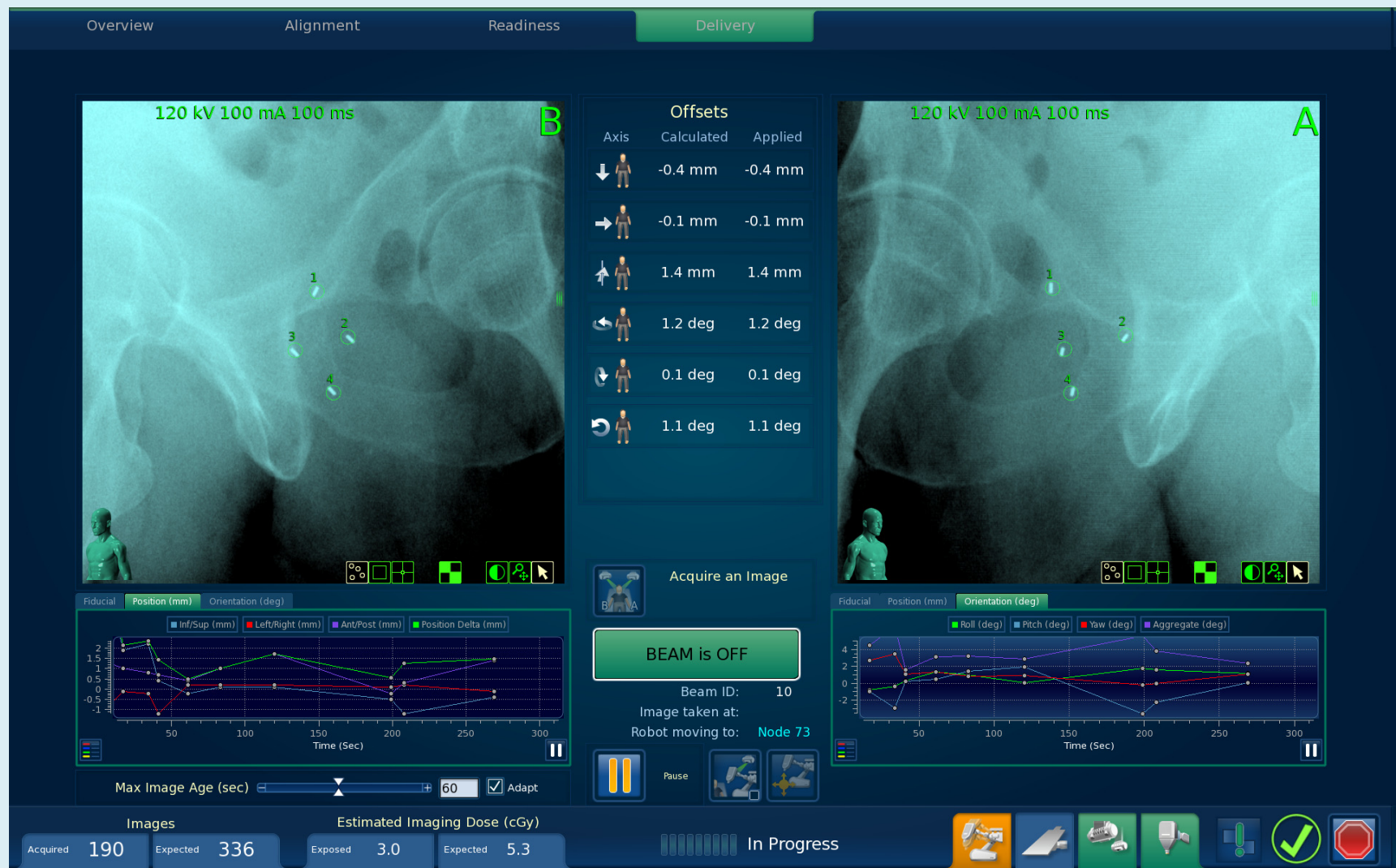
Analyze imaging results

The left screen displays the Enhanced Live X-ray image in a teal color scale overlaid on the DRR image in grayscale for Camera B and Camera A of the imaging system.

WARNING: Visually compare the Live X-ray and DRR images to ensure that features are similar in both. Ensure that the fiducials selected are correctly identified in the Live X-ray.

Time (HH:MM:SS): 17 Apr 2023 14:06:00

Fiducials



Fiducials



Fiducials + synchrony

- měkké tkáně v oblasti břicha (fiducials)
- kompenzace dýchacích pohybů (synchrony model)

Závěr

- pro RA je důležité znát praxi jak na CK, tak na CT
- spolupráce s pacientem
- preciznost - vzhledem k aplikovaným dávkám a bezpečnostním leům
- orientace v parametrech a anatomii
- schopnost najít nejlepší řešení problému

D Ě K U J I Z A
P O Z O R N O S T !!!