Characteristics of the breast CT protocol @ SYRMEP

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Elettra – Sincrotrone Trieste

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Trieste

Beam:

Available energy range: 9 - 42 keV (**32 - 40 keV** for breast CT)

Horizontal size at patient position (7 mrad horiz. opening): **21 cm**

Vertical size @ patient position:

- presently defined by the patients slits system ≅ **3.4 mm**

- with an adequate beam expander ≅ **5 - 6 mm** (depending on beam energy)

Distances:

Source-to patient: 30.2 m

Patient-to-detector distance: 1 - 1.8 m

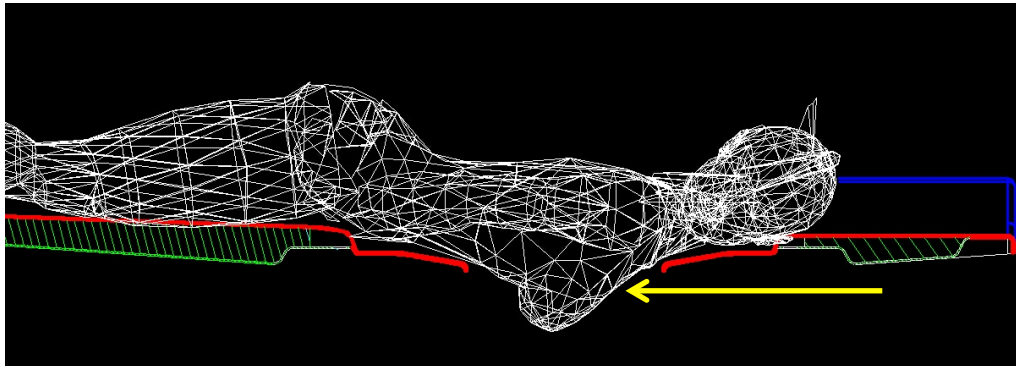**Typical Pixirad working conditions**:

Rate: 30 Frame/s (FPS)

Number of projections: 600 – 1200?

Possible doses goals:

Mean Glandular Dose: 5 mGy (or less?)

Patient support

Rotation for projection selection and tomography

Rotation

Vertical scanning

Δy : 20 cm
v_y : 0.5 - 4 cm/s
Stability v_y : 1%
Resolution : ~100 μm

ϑ: ±Nx360°
v_ϑ : ?-60 °/s
Resolution < 1°

Horizontal adjustment

Δx : 40 cm
Resolution : ~1mm
v_x : ≈5 cm/s

SAFETY and Supervision systems

Personnel Access Control System (PACS)

Dose Control System (DCS)

Patient imaging

Beamline Control system (BCS)

Supervision and Human Machine Interface (SHMI)

Data reconstruction and visualization

Personnel Access Control System (PACS)

- It determines access conditions to the patient hutch

- Based on Pilz PS 3000 PLC with high safety standard

- Operating modes: experiment and patient
  - **Experiment mode** (i.e. standard beamline: door locked, standard search procedure required to open beamstoppers, etc.)

  - **Patient mode**: 'Radiologist' key inserted, door unlocked, modified search inspection)

CPU & I/O

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It is active in **patient mode,** during the acquisitions of **flats** without the patient and during the **multiple CT scans of** the exam

Aims:

to prevent **over-exposure** and **useless exposure** to the patient
to monitor the correct working conditions of all the components before and during a scan

Alarm states:

Malfunction of dose monitors
Malfunction of detector
Mismatch of monochromator energy
Malfunction of monochromator
Overcome of skin doserate threshold
Overcome of integrated dose threshold

Actions:

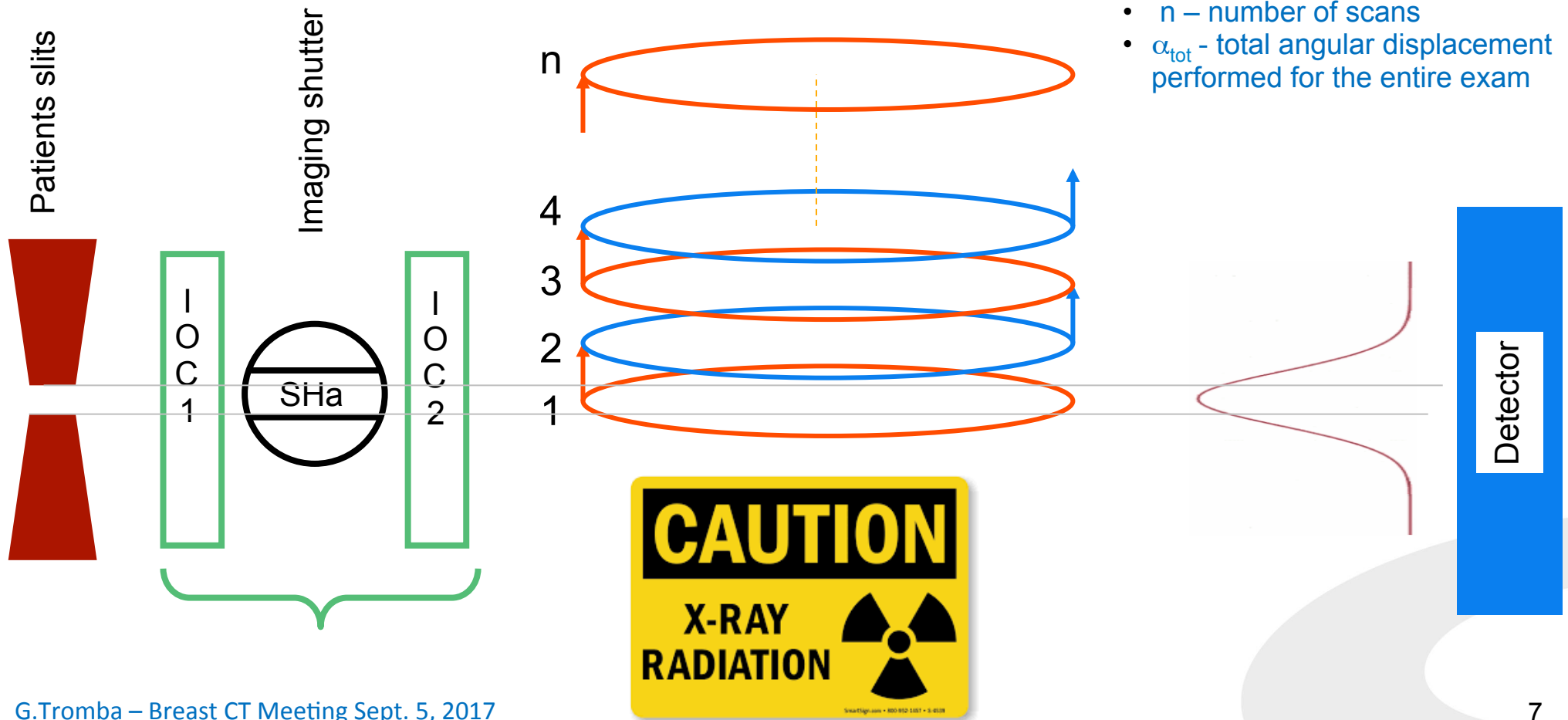Abort of exam: closure of safety and imaging shutters
Acoustic alarm

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- Continuous rotation at constant angular speed (with SHa open)
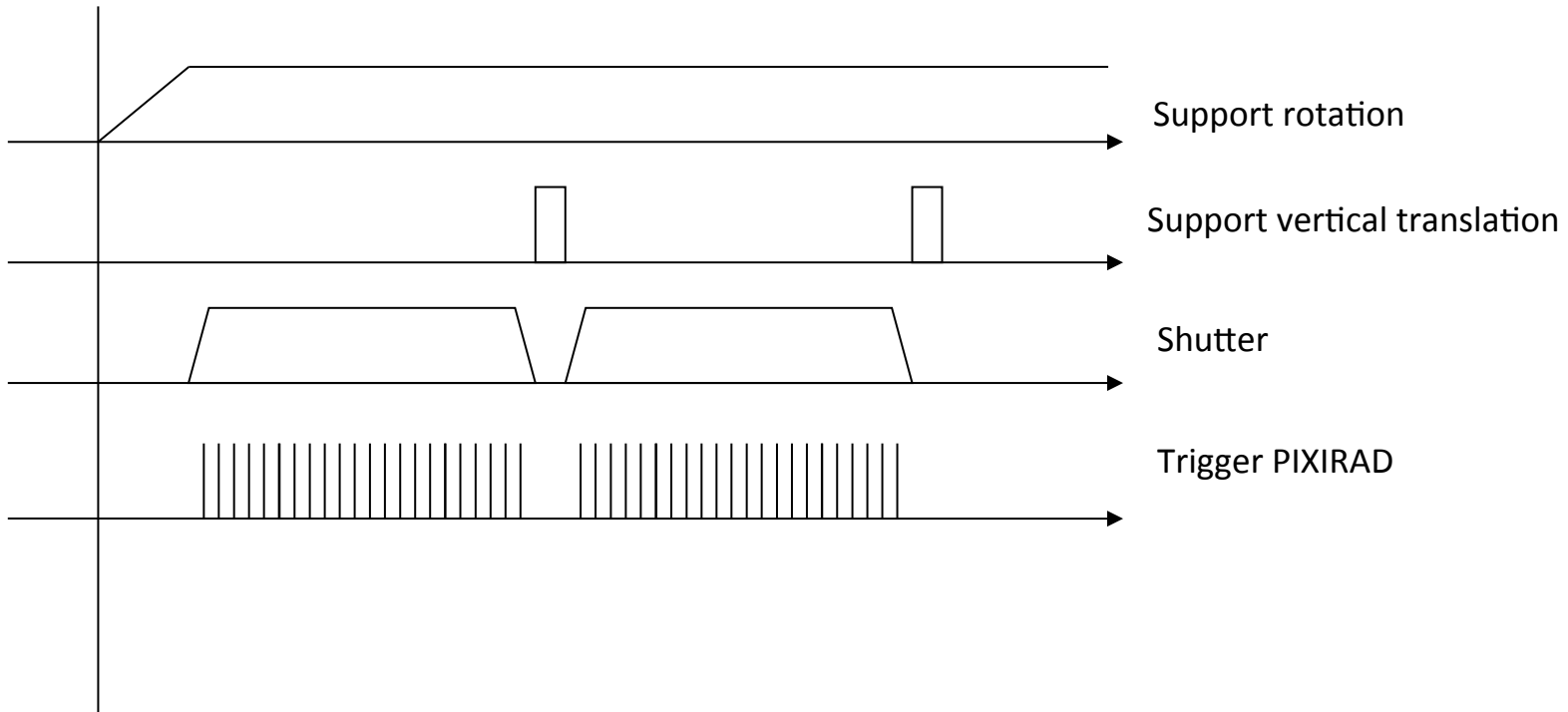- Vertical displacement after completing each 180° turn (SHa closed)

$$\alpha_{tot} = n \times (180^o + \beta)$$

- β - angle performed during each vertical displacement (with no beam)
- n – number of scans
- α_{tot} - total angular displacement performed for the entire exam

Patients slits

Imaging shutter

IOC 1

SHa

IOC 2

n

4

3

2

1

Detector

CAUTION
X-RAY
RADIATION

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Sincrotrone
Trieste

Support rotation

Support vertical translation

Shutter

Trigger PIXIRAD

Required time each exam
- using Pixirad at 30 FPS → needed time one scan with 600 projections = 20 s
- Vertical displacement, Pixirad switch off/on : 5 s → 25 s each slab
- For a required scan area 3.4 cm with 3.4 mm beam height → 10 slabs

Time required per exam = 250 s !!!

Energy selection

Breast sizes

Per definire la taglia del *reggiseno*

1 - Giro Seno
Indossando un reggiseno, senza imbottiture, misura la circonferenza all'altezza del seno e senza stringere.

2 - Sotto Seno
Misura la circonferenza del torace al di sotto del seno e senza stringere.

Taglia Internaz.	Taglia Italiana	Sotto Seno da - a	coppa A Giro Seno da - a	coppa B Giro Seno da - a	coppa C Giro Seno da - a	coppa D Giro Seno da - a	coppa E Giro Seno da - a
XS	1	63 - 67	77 - 79	79 - 81	81 - 83	83 - 85	85 - 87
S	2	68 - 72	82 - 84	84 - 86	86 - 88	88 - 90	90 - 92
M	3	73 - 77	87 - 89	89 - 91	91 - 93	93 - 95	95 - 97
L	4	78 - 82	92 - 94	94 - 96	96 - 98	98 - 100	100 - 102
XL	5	83 - 87	97 - 99	99 - 101	101 - 103	103 - 105	105 - 107
XXL	6	88 - 92	102 - 104	104 - 106	106 - 108	108 - 110	110 - 112
XXXL	7	93 - 97	107 - 109	109 - 111	111 - 113	113 - 115	115 - 117

Breast Immobilizer (BI) has to be used to prevent motion artifacts and reduce the breast thickness crossed by the beam

BI size

⇕
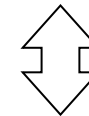
Energy

Note: It has still to be decided if in the energy selection there is the need to differentiate for different breast densities (glandularity class), i.e. "low", "medium" or "high"....

- Patient is selected for PHC breast CT
- Assumption: conventional exams performed at the Hospital (MX, tomosynthesis, MRI,...) are available before the patient arrives at Elettra BI size is known (in case, also an estimate of glandularity class is available)
- PACS key is turned to **patient mode**
- Patients' parameters are input to SHMI
- The correct X-ray energy is selected by SHMI and beam is optimized
- Flats images are taken at the patient's entrance at Elettra
- Patient is positioned with BI
- The radiologist decides for the scanning range (laser pointers)
- The radiologist exits from the patient area (search)
- **SHMI performs the final check on parameters correctness and automatically starts the entire CT exam**
- A check on CT data consistency is made at the end of each scan
- A first reconstruction of a CT slice is performed before the patient leaves Elettra

CAUTION X-RAY RADIATION

Thanks for your attention !

Layout

BEAM PREPARATION
Energy, flux, geometry

PATIENT EXPOSURE

Patient
Slits

Vacuum
slits

Beam stopper   Al filters

Fast
shutters

Mammographic station

Monochromator

Air Slits

Ionization
chambers

BEAM

Detector

Safety elements
Control elements
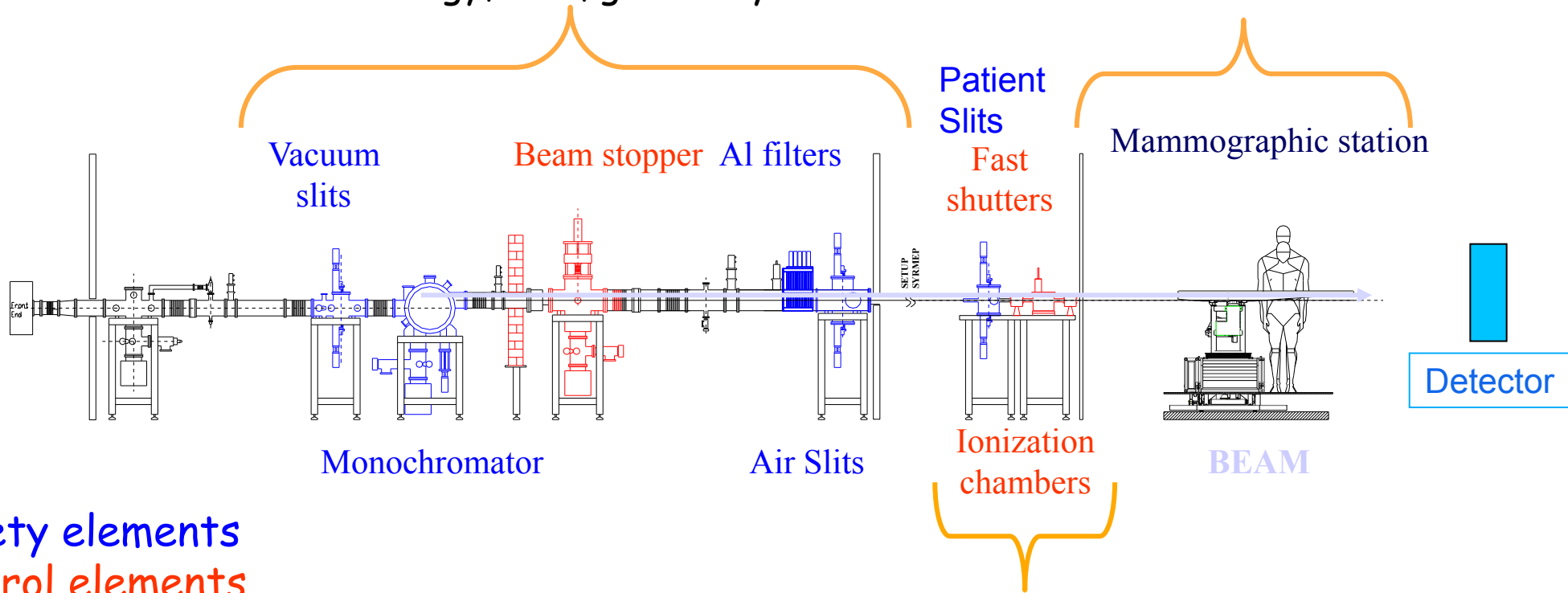
BEAM MONITORING
Dose, exposure time
Safety system

Inclusion criteria (to be discussed)

Patients candidates for quadrantectomy

- Lobular lesions

- Lesions unvisible with MRI

- Cancer stadiation

Possible use of Contrast agents ?

Interest in breast density measurements ?

Use of SR breast CT slices for refining the therapeutic approach?