Fluoroscopy units come in many different physical configurations but all consist of the main components shown in this slide.
Fluoroscopy units used in angiographic and cardiac applications are normally configured as shown in this slide. This physical arrangement allows for easy positioning for multiple viewing angles around the patient.
“Conventional” fluoroscopy units do not provide for three dimensional positioning around the patient and thus are used for exams with little need for oblique or lateral imaging views.
Fluoroscopy units can be configured such that they are easily mobile within a facility. This is especially useful for use in surgical and emergency departments where x-ray image guidance is needed for certain procedures.

Mobile Fluoro Systems

Mobile C-arm

"Mini" C-arm
A fluoroscopy unit called the "O-arm" allows for conventional fluoroscopic imaging but also can acquire computed tomographic images for use in invasive procedures. The dose rates are similar to conventional c-arm fluoroscopy and CT scanning. However, the images acquired with this unit can then be used to perform procedures using image guidance without the need for continuous x-ray exposure. Thus, when used properly, this unit can perform certain exams at much lower overall radiation dose.

Source: Breakaway Imaging, Inc.
Every fluoroscopy system has controls which can affect the dose rate to the patient, and thus to staff. It is the responsibility of each fluoroscopy operator to be familiar with these controls and their affect on patient dose.

Fluoroscopy Equipment Operation

- Be familiar with the safe operation of the particular system and each mode to be used.
- For further information about specific machines consult:
  - Radiology Technologist
  - Medical Physicist
  - Vendor apps representative
Most fluoroscopy systems have several or all of these features that the operator can utilize to manage patient doses during exams.

**Fluoro Equipment Controls (that can affect dose)**

- Field of View (magnification mode)
- Fluoro Dose Rate Modes
- Pulsed Modes
- Last Image Hold
In almost all cases, imaging with a smaller field of view (magnification mode) results in a higher dose rate to the patient. In this real-life example, the choice of a different field of view can affect dose rate by almost a factor of 2. Thus, the magnification mode should not be overused.

### Fluoro Equipment Controls (that can affect dose)

**Field Of View**
(smaller FOV usually increases dose rate)

<table>
<thead>
<tr>
<th>FOV</th>
<th>48 cm</th>
<th>42 cm</th>
<th>31 cm</th>
<th>22 cm</th>
<th>19 cm</th>
<th>15 cm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Dose</td>
<td>1.00</td>
<td>1.15</td>
<td>1.24</td>
<td>1.58</td>
<td>1.74</td>
<td>1.87</td>
</tr>
</tbody>
</table>
This data is from a modern angiographic fluoroscopic unit and allows the operator to choose between three fluoro dose rates. Large differences in patient doses could result from performing an exam in these different dose rate modes. The lowest dose rate should be used, consistent with the image quality required to achieve the clinical goal of the exam.

<table>
<thead>
<tr>
<th>Dose Rate Setting</th>
<th>I</th>
<th>II</th>
<th>III</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Dose Index</td>
<td>0.50</td>
<td>1.0</td>
<td>2.0</td>
</tr>
</tbody>
</table>
Pulsed mode operation is another powerful tool that can be used to limit patient dose. This feature is available with many units in either fluoroscopic mode, archival (cine) mode, or both. The dose savings is typically directly proportional to the frame rate of the pulsed mode. Thus, operating in 15 frames per second would result in about half the dose as 30 frames per second.

### Fluoro Equipment Controls (that can affect dose)

#### Pulsed Fluoro; Pulsed Archival

Pulsed modes turn the x-ray beam on and off rapidly a specified number of times per second.

<table>
<thead>
<tr>
<th>Pulse Setting</th>
<th>30 fr/s</th>
<th>15 fr/s</th>
<th>7.5 fr/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relative Dose Index</td>
<td>1.0</td>
<td>0.5</td>
<td>0.25</td>
</tr>
</tbody>
</table>
Use of the Last Image Hold feature is an effective method for limiting the total fluoroscopy exposure time. This allows the operator to view the last fluoro image statically rather than using continuous x-ray exposure to the patient. In some systems, the last several fluoro image frames are summed, resulting in a lower noise, superior quality image for viewing. Last Image Hold should be used extensively by fluoroscopy operators when the exam does not require frequent updating of the image.

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**Fluoro Equipment Controls (that can affect dose)**

**Last Image Hold**

All modern equipment offers Last Image Hold (LIH)

The last fluoro frame is held on the monitor, limiting the amount of live fluoro required

On many systems, this is not the default mode and must be selected
A very common mobile c-arm unit is made by GE/OEC. The main display and control panel is shown here.

OEC C-Arm Console Controls

- **Fluoroscopy Time Per Case (should be recorded)**
- **kVp** (directly related to energy and penetration of the x-ray beam)
- **mA** (directly related to # of x-rays and patient dose)
Magnification modes for the OEC c-arm are controlled by toggling the button shown.

- Image Intensifier Electronic Magnification Control
- Toggle Green Button to change magnification mode
- For most cases it should be set to “Norm”
A closer view of the magnification mode display. Higher magnification equals higher patient dose.

**OEC Magnification Modes**

- **Norm** – non magnified image. Should be default setting.
- **Mag 1** – magnified image, larger patient dose
- **Mag 2** – more magnified, more patient dose
- Magnification increases the detail of the image.
Two dose rate modes are available to the operator. The high rate mode should be used sparingly as it is capable of exposure rates that are twice as high as those in “normal” mode. This high rate mode can deliver 20 R/minute or more to thicker patients and can thus result in serious doses to the patient’s skin in relatively short times.

### OEC Exposure Foot Pedals

- The normal fluoroscopy foot pedal will not have a plus sign next to the eye. **This foot pedal should be used for most applications.**

- The high rate / digital acquisition beam-on foot pedal uses a higher patient dose and should only be used for recording special digital images that will require digital processing.
The operator can control the size of the exposed skin further by using collimation controls. Use of smaller collimation reduces dose to patient and staff and improves image quality.

- Collimation controls the x-ray field size to the object of interest
- Increases the x-ray field size
- Decreases the x-ray field size
- Decreasing the field size decreases dose and increases image quality
Most OEC models provide a low dose mode. Use of this mode will reduce the patient dose rate to half of what the “normal” mode would deliver. Image noise will be somewhat higher, but may be acceptable to achieve the clinical goal of the exam.

**OEC Low Dose Mode**

- Pushing this button turns on the fluoroscopy low dose mode.
- The LED beside this button will light when it is activated.
In summary, fluoroscopy units come in many configurations. Most of them offer several methods for the operator to control patient dose. It is important for fluoroscopy operators to understand how these dose control features can be used to limit patient dose.