If a fluoroscopic examination is indicated,

- **PAUSE** - to ensure that this is the correct examination, performed for the correct reason, and to plan the examination
- **PULSE** - Use pulsed fluoroscopy - use a grid-controlled, variable rate pulsed fluoroscopic (GCPFL) unit to perform this examination rather than using a continuous fluoroscopy (CFL) unit.
- Removal of the anti-scatter grid (different from the negatively charged grid in grid-controlled fluoroscopy) in small patients can also effect a significant dose savings [1]

- **Additional Steps:** If possible, collaborate with your medical physicist and fluoroscope manufacturer to additionally modify the unit to pediatric specifications. Modifications of a GCPFL unit have been shown to deliver at least 8-times lower radiation exposures to children than a CFL unit during the performance of VCUG, while maintaining anatomic detail and diagnostic image quality. [2]

Fluoroscope design features that can be modified by the manufacturer in collaboration with your medical physicist are

- **spectral beam filtration** (adding filters in the x-ray beam path),
- **automatic brightness control** (ABC) system should be optimized as a function of the child’s size with proper selection of tube current and voltage
- **reduction in pulse rates** (= number of radiation beam pulses per second)
- **reduction in pulse widths** (= duration of each pulse).

A narrower pulse width actually results in improved image quality when evaluating moving structures (less motion blur). The many available reduced pulse rates and
widths allow the fluoroscope operator (radiologist) to make real-time adjustments while performing a fluoroscopic examination

• **Refine and optimize technique:** Minimize the number of actual recorded images obtained during the performance of a study.
  - **Use Fluoro-grab.** These images record the fluoroscopic image already on the monitor) without additional radiation exposure. This has the added advantage of allowing recording of multiple images and thus recording of temporal information.
  - **Minimize Exposures:** Exposed images require additional radiation to obtain the exposure; they offer better detail, but should be used judiciously, e.g., when mucosal detail is important.
  - **Magnification:** Use lowest magnification needed
  - **II Tower:** Keep Image Intensifier tower as close to the patient as possible
  - **Collimate** ("cone in") on the anatomic area of interest
    - Position tower over area of interest before beginning. In other words, use your eyes, not the fluoroscope, to arrive at area of interest
    - Pre-set collimators to area of interest before beginning fluoroscopy as much as possible.

• **Keep track of radiation exposure delivered to patient**
  - Instantaneous entrance skin dose can be measured with an accurately calibrated monitor, e.g., patient exposure monitoring network (PMNET, Clinical Microsystems, Arlington VA)
  - Reset timer before each case, and pay attention when timer alerts

• **Keep track of radiation exposure delivered to personnel**
  - Ensure that all staff are wearing film badges
  - Make available and encourage use of thyroid shields, lead glasses, gloves, wrap-around aprons when needed
  - Ensure appropriate care of aprons: hung suspended, not folded; check regularly for damage/cracks

• **Quality Assurance**
  - Application specialists should train radiologists and technologists in low dose features of equipment
    - Ensure expertise of technologists who operate this equipment
  - Consider holding regular refresher sessions to review “knobs and switches – ‘buttonology’”
  - Participate in radiation safety committees throughout hospital
  - Have equipment inspected regularly by qualified physicists
Encourage radiation physics training for non-radiologists who use fluoroscopic equipment
Teach and supervise residents in optimal fluoroscopy techniques


SUMMARY:

- **PAUSE** to properly plan and prepare for study
- **Activate** dose saving features of equipment
- **No** exposures unless necessary
- **Depress** last image hold and last image grab instead
- **PULSE** at lowest possible rate