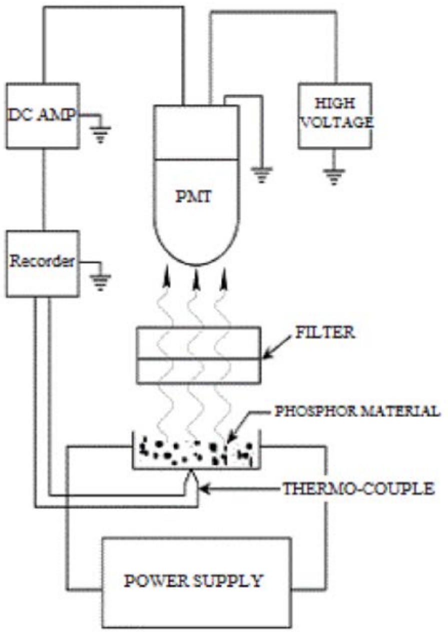
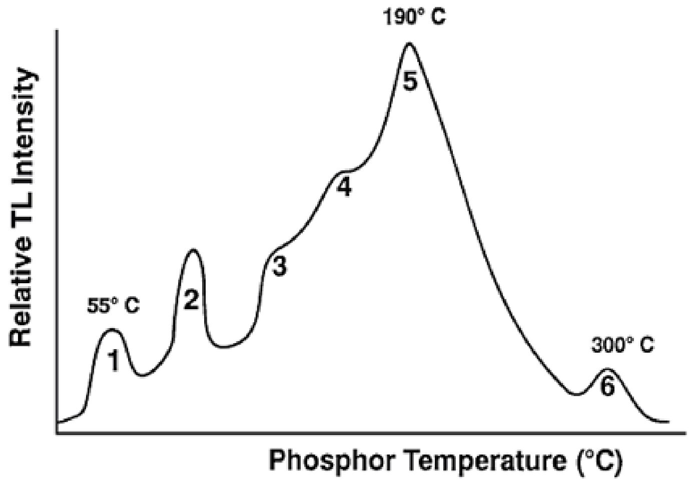
Describe the images below;





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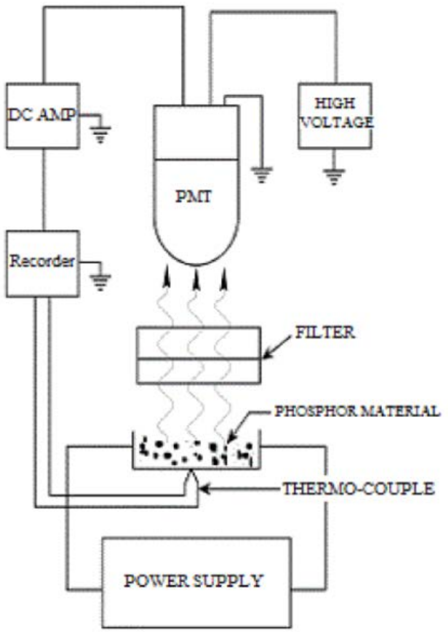

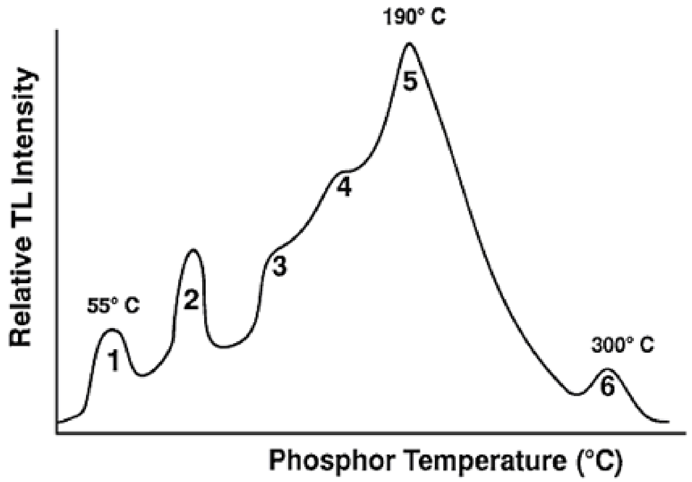

This is a schematic of a thermoluminescence dosimeter (TLD) reader which is used to measure the amount of energy stored in the sample crystal and correlate that to an absorbed dose.

A basic TLD reader system includes:

- Planchet - for placing and heating the TLD,
- PMT - to detect the thermoluminescence light emission and convert it into an electrical signal linearly proportional to the detected photon fluence and
- Electrometer - to record the PMT signal as a charge or current

- A plot of thermoluminescence signal vs. temperature (or incubation time) is called a glow curve.
- In most TL materials, there is more than 1 trap type. These traps have different energy gaps to the conduction band and will therefore empty at different temperatures.
- As the temperature of the TL material exposed to radiation is increased, the probability of releasing trapped electrons increases.
- The light emitted (TL) first increases, reaches a maximum value, and falls again to zero. Because most phosphors contain a number of traps at various energy levels in the forbidden band, the glow curve may consist of a number of glow peaks as shown in above. The different peaks correspond to different “trapped” energy levels.

Describe the calibration method for TLDs

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- Prior to exposure for measurement purposes, TLDs must be annealed (baked and cooled according to protocol) to bring the electrons to ground state.

- TLD samples are irradiated to various known doses and the relative light output graphed to produce a dose curve which is used to determine the dose from unknown sources.

What is annealing and what is its purpose?

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- Because the response of the TLD materials is affected by their previous radiation history and thermal history, the material must be suitably annealed to remove residual effects.
- The standard **preirradiation annealing procedure** for LiF is 1 hour of heating at 400C and then 24 h at 80C.
- The heating to 400C (the degree corresponding to the max wavelength in light) is to release any remaining charges from deeper traps (Attix p401).
- The slow heating, namely 24 hours at 80C, removes peaks 1 and 2 of the glow curve (Fig. 8.12) by decreasing the "trapping efficiency".
- Peaks 1 and 2 can also be eliminated by **postirradiation annealing** for 10 minutes at 100C.
- The need for **eliminating peaks 1 and 2** arises from the fact that the magnitude of these peaks **decreases relativelyfast with time** after irradiation. By removing these peaks by annealing, the **glow curve becomes more stable andtherefore predictable.**

Is TLD energy dependent?

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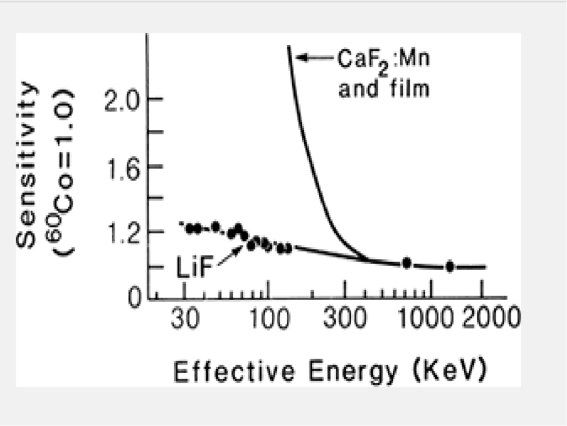
- The TLD response is defined as TL output per unit absorbed dose in the phosphor. Figure below gives the energy response curve for LiF (TLD-100) for photon energies below megavoltage range. 20% over response at low E (30keV), and 5% under-response for linac energy range, normalized to Co60.
- So very small energy sensitivity in our linac energy range



$Z_{water} = 7.4$; $Z_{Al_2O_3} \sim 11.28$

Advantages and Disadvantages of TLDs?

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Advantages:

- Accuracy 3%
- Small size: 3 mm Area x 1 mm thick
- Wide useful dose range;
  - $5 \times 10^{-5} – 10^{3}$ Gy range.
- Dose-rate independence
- Reusability so reduce the cost

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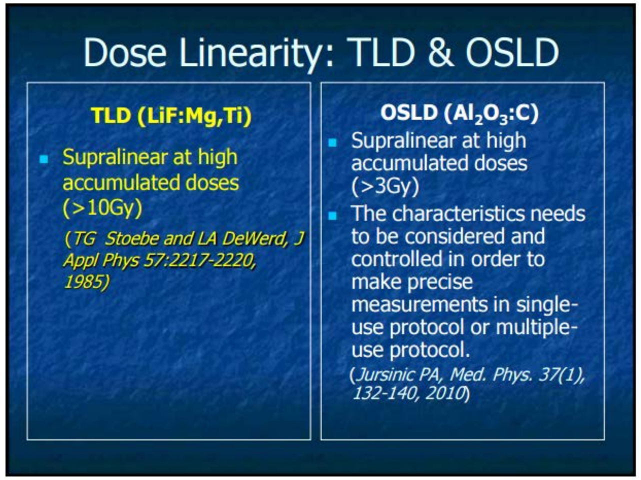
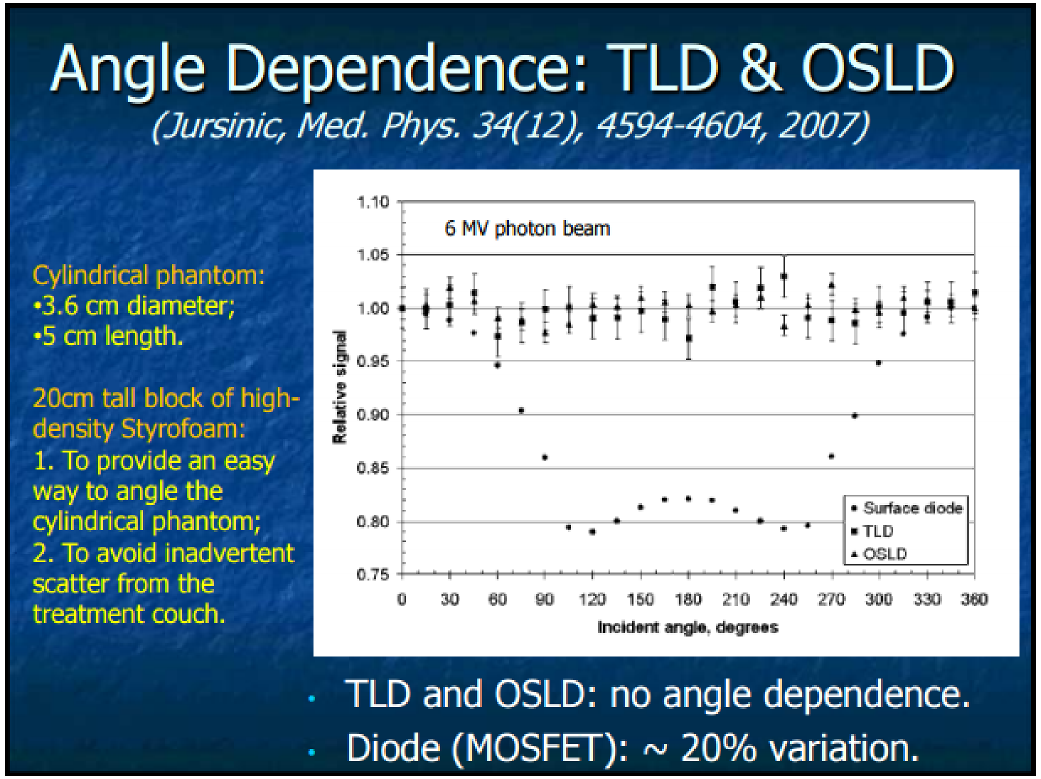


Disadvantages:

- Fading: Irradiated dosimeters do not permanently retain 100% of their trapped charge carriers, LiF fades ~1% per month.
- Results are not instantly available
- Labor intensive (annealing, calibration, reading)
- Memory of radiation & thermal history
- Light sensitivity: TLDs all show some sensitivity to light. This can cause accelerated fading or leakage of filled traps.

What is the advantage of TLD over diode?

- Less energy dependence compared to diode
- No angular dependence
- No dose rate dependence



Follow up Questions

- Describe the properties of luminescence materials, as relate to dosimetry.
- Describe the method for calibration of TLD’s.
- Describe a glow curve and why it is important.
- What are some of the practical advantages and disadvantages of TLD’s?
- How do TLDs differ from OSL?