Overarching concepts  
*Italics are “concepts”*

**Disclaimer - personal opinion of presenter**

**Term**
- Short term - fixing what we now use
  - And *Boxcare concept*
- Medium term – make a much better linac - 3-7 years
- Long term - new ways of doing what linac does - 7-? years

**Modularity**
- For function - *Mars-Mission* - fixable by reasonably skilled non-expert
- For complexity - upgrade head to more complex MLC, etc, not need
  - New machine

**Fits in cobalt room**
- Utilize what now exists
- Replace cobalt “*Treatment, not Terror*”, engage NNSA (DOE), IAEA, Politicians and public support
- Medium term may require different construction

**Must be and appear to be first class - eye-rolling index**
- Machines useable in Upper and Middle income countries
- Critical for recruitment and retention of expertise; and market

**Bury the complexity - iphone**
- Remote upgrades
- Remote monitoring
- Anticipate failure
- Centralized oversight - QA, help,

**But maintain simplicity - clinical oncologist in very high volume**
- Able to do clinical set ups and treatment
- Contouring-based use but not required for palliative or simple treatments

**Robust (forever) vs inexpensive replacement**
- Consider stuff that already exists for availability, cost, replacement

**Cluster concept**
- Available replacement parts- modular can be stored regionally
- Repair can be finished in 24 hours (1 day loss of function at most)

- Cluster of machines and Suite of machines in center or in region – some workhorse and some more specialized (energy and capability such as electrons, whole body, SRS, etc)

**Potential market share**
- LMIC need =’s current world use
- Consider global market
- Fits within quality and reporting requirements of UICs
Specifications - requirements
Parameters clear - but upgradeable capability - don’t lock out future options

Open-source
- But - IP protected so open source possible
- Interoperability among parts manufacturing

Cost - consider purchase, service, durability in the price
- Clear explanation of what is included along full machine life for right calculation (e.g. cobalt disposal often not considered)

Interoperable
- Treatment planning
- Contouring 3D, IMRT, IGRT
- Image acquisition

Environment - tolerant and friendly
- Heat, cooling: Humidity
- Sealed sources -

Safety and redundancy
- Redundancy
- Redundancy

**Expertise - is essential** *ICEC global approach*
- Build with on-the-ground expertise and community
- ***MUST own time beyond routine*** service for overarching goals

- Sustainable mentorship and education not “hit and run” visits
- Global standards of care and global partnerships *world peace*
- Academic career - opportunity for new knowledge and advancement
- Economic considerations - capturing expertise now lost

**Not discussed here**
Nigel Crisp - “Turning the world upside down” - LMICs teach UICs to manage volume

Clay Christensen - Innovators Prescription (same person who wrote Innovator’s DNA - disruptive and catalytic innovation) - move task down to “lowest” capable level (technicians, nurses do tasks often relegated to physicists and physicians)

Mohammed Yunus - social business model - reinvest profits after fair return on investment
Specific components
Power supply- conditioned, stable, essential “power on” be limited so that backup isn’t major energy user
Recognize that medium term solutions will likely be in improved power settings

Moving parts-
Limited- use jaws, and some MLC- and software- “RaySearch”

Modularity- “color coded” swap in-
Potential to use new technology as easy swap in- klystrom, magnetron, solid state printer-cartridge

Dual utility
Can linac do both simulation and treatment- or is this poor use of linac

Beam energy? - range or workhorse vs specialty (complex)
Flattening filter, beamlets

Electrons? (required)

Magnets vs not- or where- bending vs not
Targets
Power supply
Info on chip- printed stuff
Things too hard for an MD...

Gantry- ? Beam needs to move. Issue relates to beam energy, quality assurance, patient mobilization

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Next steps
**Need “team” to carry the ball- CERN-ICEC-STFC

A. What are critical next steps for STFC consideration- and ready for next project

1. Defining requirements and also criteria for specific parts- robust vs cheap
Build on section reports from this workshop

2. What parts need to be better- electronics? Power issues?

3. What parts need to be less expensive

4. What- or do all parts- need to be made into “color code” modularity

Engineering versus invention
What needs to be made better versus what needs more conceptualization
Somewhat latter considerations
B. Manufacturing
   Distribution and maintenance (service)

C. Education and training (start asap to gather what exists).

D. Treatment system approach- first call to long-term followup

Future workshops
E. Long-term

F. Link to NCI “Shades of Gy” concept of radiation as a “drug”- “accurate, precision radiation medicine”

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Linac guts
Linac brochure

Kathmandu wiring
Woodstock, Vermont (underground)
Closing thoughts

Reminder from “Hidden Figures”  
*President Kennedy Moon Speech*  12 Sept 1962

**MUST apply this now to global cancer care** including indigenous and geographically isolated populations in UICs.

This is “Mars Landing and back”- beyond Moonshot as it must work!

“We choose to go to the moon. We choose to go to the moon in this decade (and do the other things), not because they are easy, but because they are hard, because that goal will serve to organize and measure the best of our energies and skills, because that challenge is one that we are willing to accept, one we are unwilling to postpone, and one which we intend to win, and the others, too.”

**Thank you**- CERN, STFC, ICEC, especially participants