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"*

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