International Cancer Expert Corps
Partnering to transform global cancer care

CERN

R&D Areas missing in the present portfolio plus prototyping/testing

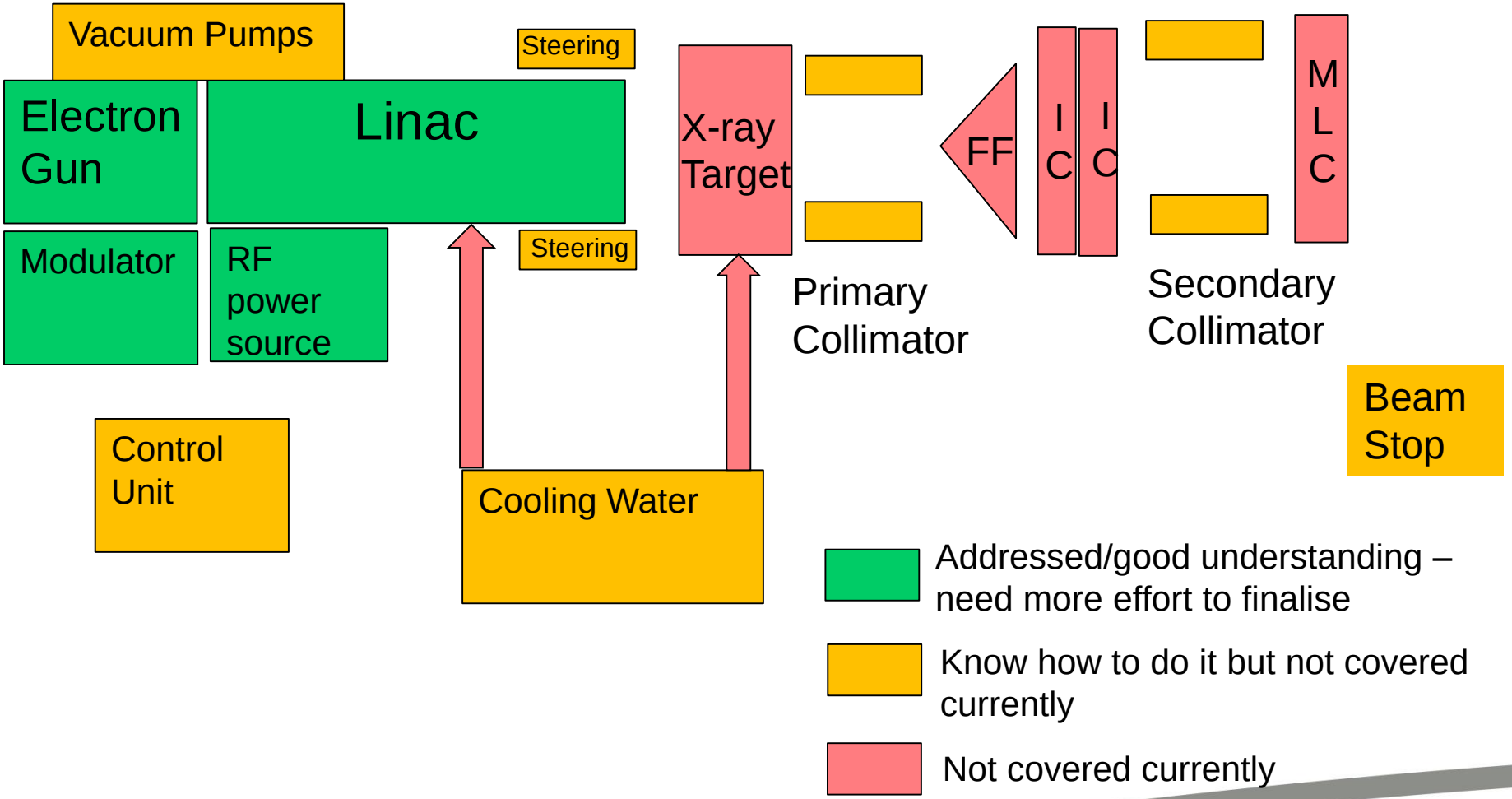
Deepa Angal-Kalinin
UKRI STFC ASTeC, Daresbury Laboratory, UK

CERN-ICEC-STFC Workshop, Gaborone, Botswana
20-22nd March 2019

Science & Technology Facilities Council

UK Research and Innovation

Minimum Viable RTT System



Parameter	MVP	Comment
Fixed vs rotating gantry	gantry	type tbd
With or without rotating couch	without	
Beam energy or energies	single	4 to 10
Photon(s) only or also electrons	only	
With or without flattening filter		tbd, factor 10 current overhead needed
With or without MLC		tbd, design study needed
With or without bending magnet	straight ahead	may return
Combined gun-accelerator	no	
Vacuum sealed?	no	see above, modularity issue, may return
Travelling vs standing wave		tbd
Frequency		3, 6, 9 or 12 GHz (dimensions, pulse energy)
Klystron or magnetron or solid state	klystron or magnetron	
rf wave guide joints	not need with ring	avoid bending cables
Redundant RF source		later (depends on source type)
Expected dose rate	400	cGy/min
Expected field size	35	cm
Minimum/maximum electron spot size	3 to 5	mm diameter FWHM, depends on MV imaging
Electro or permanent magnet		tbd, focusing and bending
All RF in gantry?	yes, objective	
RF cavity, Cu or Al?	tbd	
Beam stop	yes	
isocenter	125 cm	
Other important issues/sub-systems to remember		
mains stabilization		
digital readout		
dose monitoring and control		
Air/water cooling		
Shielding		
Record and verify		

R & D Items Missing From Present Portfolio

Not included and not in the schematic

- Radiation shielding
- Dosimetry and QA
- CT imaging
- Remote accelerator diagnostics
- Machine integration
- Cooling requirements
- Gantry
- Treatment planning

- Industralisation

Prototyping and Testing

- Integrated Gun + Linac + (X-ray target?)
- Beam commissioning and characterisation
  - Shielded enclosure
  - HV / RF infrastructure
  - Beam diagnostics (macropulse and micropulse charge, beam energy and energy spread, beam profile, pulse length, beam position repeatability)
  - Control system
  - Vacuum system (Pumps, gauges)
  - Cooling
  - X-ray target : Characterisation of X-ray spatial and spectral distribution
- How well other parts are understood? Do we need to include some of the following in prototyping?
  - Collimators
  - MLC
  - Detectors and imaging

Develop detailed task list and next steps for each subsystem e.g. Tasks and Status of Development of the Gun

Item	Contents	Current status
Beam parameters specifications	- Derived from earlier workshops. Can be changed if different as project progresses.	In progress – 50% completed
Beam dynamics simulation in the electron gun	To chose optimal: - Gun operation mode (pulsed or train-pulsed) - Gun modulation frequency - Gun voltage - Cathode parameters (bunch charge, bias and modulation voltage)	In progress – 25% completed
Start-to-End beam dynamics simulation in the accelerator	- Beam parameters at the entrance of the accelerating structure - Geometry	In progress – 25% completed
Vacuum design of the electron gun	- Specification of the vacuum requirements for electron source - Selection of the pumping technology used in the electron source - Selection of the pump	In progress – 25% completed
Mechanical design of the electron gun prototype	- Mechanical design of a modular electron source - Integration of the source into diagnostic facility	Not started
Construction and characterisation of the prototype	- Characterisation of the beam parameters at the entrance of the accelerator structure (beam profile, bunch length etc.)	Not started

Suggestions for Next Steps

- Source of funding
- Finalise specifications and justification for MVP
  - Prepare a document so that we do not go around in loops
  - Revise the spreadsheet to identify which requirements are absolutely necessary!
  - Define criterion to take decision where there are number of options
- Define criterion for robustness of system components
- Prototypes of systems
- Engagement with industry
- Cost vs performance
- Detailed project plan