

## Module Fabrication Working Group Meeting

01/09/2020 11:00 CET

### Attendees:

Carlo Rossi	CR	(Presenter)
Steinar Stapnes	SS	(Chair)
Markus Aicheler	MA	
Philip Burrows	PB	
Nuria Catalan Lasheras	NCL	
Steffen Doeber	SD	
Hélène Durand	HD	
Andrea Latina	AL	
Alexej Grudiev	AG	
Igor Syrathev	IS	
Walter Wuensch	WW	
Matthew Capstick	MC	(Minutes)

### Minutes:

1. **CR:** Introduction
  - 1.1. How can we advance the CLIC module work?
  - 1.2. Can we work on a module near the CLIC specification?
  - 1.3. Can we afford a module?
  - 1.4. How can we find resources?
  - 1.5. What purpose would the module have?
    - 1.5.1. It would be nice if the module could serve a practical purpose.
  - 1.6. **SS:** We have approximately 1MCHF over 5 years: This is probably not enough alone
  - 1.7. **CR:** Aiming to have 4 or 5 meetings over the next 2 or 3 months
2. **CR:** The advantages of producing a module:
  - 2.1. Introduction to the fabrication required
  - 2.2. What are the requirements for effective module integration?
    - 2.2.1. Start from the design presented at the project implementation plan for the klystron-based module ( + some improvements)
    - 2.2.2. The new positioning and alignment approach
    - 2.2.3. Consider the current CLIC power levels in the design
3. **CR:** We should agree the following CLIC K-Module Requirements, with some additions if needed, and see if they can be fulfilled by other machines, e.g. eSPS, FLASH, AWAKE etc. Requirements have been grouped by areas as follows:
  - 3.1. RF
  - 3.2. Module
    - 3.2.1. Thermomechanical
    - 3.2.2. Stability and alignment
  - 3.3. Beam dynamics and instrumentation
    - 3.3.1. Current Klystron baseline relies on wakefield monitors for beam-based alignment. Experience gained so far suggests that further studies are required for a proper specification.
  - 3.4. A module allows the studies at the intersection between different aspects of the design e.g. the interface between the vacuum, cooling, and the RF performance.
    - 3.4.1. Provides several benefits:
      - 3.4.1.1. Exploring industrialisation
      - 3.4.1.2. Description of the interfaces

- 3.4.1.3. Allowing deeper studies of assembly and alignment
- 3.5. **CR:** The current proposal is to write-up a document describing the interfaces, the deliverables for each of the work packages, including details like budgets, possible collaborations and external contributions.
- 4. **CR:** Module Type
  - 4.1. To compare several different machines (e.g. eSPS, FLASH, AWAKE), having considered that:
    - 4.1.1. The alignment requirements for CLIC are particularly strict
    - 4.1.2. The average dissipated power for CLIC is much higher than the others
  - 4.2. However, there may be synergies with other machines
  - 4.3. We should probably avoid duplicating other existing module developments e.g. Compact Light at Frascati
  - 4.4. Even if the alignment tolerances for CLIC are much stricter than the others, we can still study this on different modules
  - 4.5. RF and vacuum design is likely to be similar, in particular for FLASH
  - 4.6. To compare average power dissipation: eSPS is 60% of CLIC, FLASH is 80%,
  - 4.7. No other project is adopting comparable acceleration gradients and RF power
- 5. **CR:** Resources required:
  - 5.1. We will need an RF engineer
  - 5.2. We currently have a mechanical engineer and will need one in the future
  - 5.3. We will need a draftsman
  - 5.4. We will need input from the SMM and Vacuum groups throughout
  - 5.5. We should consider using existing test stands
  - 5.6. A new RF system complying with CLIC requirements would be very expensive
    - 5.6.1. It could be possible to use a single klystron and power half a module for some studies
    - 5.6.2. Or we could combine a new system with one of the existing XBoxes
- 6. **CR:** Project Organisation
  - 6.1. We should carry out four or five meetings
  - 6.2. Produce a specification by the end of the year
  - 6.3. Assign work packages between technical design and fabrication
  - 6.4. Each group will hold responsibility for its deliverables and associated budget
  - 6.5. Aim is to complete design and fabrication in three years
- 7. **Discussion**
  - 7.1. **CR:** Key points for discussion:
    - 7.1.1. Which CLIC requirements do we want to achieve?
    - 7.1.2. With which other development programs can we align?
    - 7.1.3. To determine the benefits of testing and check which of the other proposed projects have the same goals.
  - 7.2. **NCL:** Firstly, what and why are we doing this? We must know what we know and what we don't know, and we should define what needs to be found.
  - 7.3. **NCL:** We need to involve people from CV, vacuum, and alignment throughout the project
  - 7.4. **HD:** We would not be interested in only performing the measurements
  - 7.5. **NCL:** A full RF system would be very expensive: what would we want to achieve with it?
    - 7.5.1. It seems like we need collaboration with other projects for the budget, have we approached any other projects about this?
  - 7.6. **CR:** This is to be a CLIC module, built to the CLIC requirements, not an eSPS, FLASH or AWAKE module. This is to make sure we keep the knowledge of how to build a module within the team over the next five years and developing the knowledge about operating a full CLIC module.
  - 7.7. **NCL:** Are we determining how to make the modules for someone in the future?

- 7.8. **CR**: In five to seven years, we don't know about the state of FCC, but we will have the specialist knowledge of how to build a module. In this time, CLIC might be considered a candidate. If we have a tested module that is something interesting to bring in the discussion.
- 7.9. **SS**: Thinking about how we can convert this project for funding:
- 7.9.1. CLIC and AWAKE are very different
  - 7.9.2. XLS at 1GeV is also very different. We don't want to do exactly the same as Frascati
  - 7.9.3. Building a FLASH module would likely require extra funding
  - 7.9.4. eSPS is unlikely to have extra funding
  - 7.9.5. A CLIC demo module is better for the verification of the specification
- 7.10. **SS**: It is unknown whether we can afford a mechanical and XBand test stand for structures
- 7.10.1. We don't know what CERN will do in the future
  - 7.10.2. We are not currently building modules
  - 7.10.3. The study of FCC pushes the CLIC decision back a few years
  - 7.10.4. We should determine how best we can use the next five years. A CLIC-like module would be very useful
- 7.11. **IS**: This is not a CLIC module: it doesn't have a drive beam. Klystron-based CLIC module is not CLIC
- 7.11.1. If we build a demonstrator we will need collaborators
- 7.12. **SS**: We could build a two-beam module, but why?
- 7.13. **WW**: We can build a two-beam module, this can be discussed
- 7.14. **SD**: Many of the developments are applicable to both K-mode and Two-Beam CLIC
- 7.14.1. E.g. stabilisation, alignment, integration
  - 7.14.2. There's a lot of overlap and this keeps the knowledge in the team. A TBM would not necessarily be more useful
- 7.15. **IS**: A TBM would be useful
- 7.16. **SS**: The K-module could also be useful: Useful for others, useful as a demonstrator for other machines. We could have a Klystron-based module by 2024 which could be used in the XBox or in CLEAR
- 7.17. **CR**: If we wanted to operate with beam, yes.
- 7.18. **IS**: It would not be useful for CLEAR; the aperture etc. would need modifying.
- 7.19. **SS**: It would demonstrate the mechanical requirements of CLIC
- 7.20. **HD**: For alignment etc.
- 7.21. **NCL**: We want to keep the knowledge within the RF group however it seems like it would be relying on external fellows and we would lose the knowledge in two or three years. If we build something in CLEAR or the XBOXs we have more scope for knowledge
- 7.22. **NCL**: It also seems like 1.5MCHF budget was all on procurement, not personnel?
- 7.23. **NCL**: Was the previous module design, development, assembly not useful?
- 7.24. **SS**: Why was this not useful?
- 7.25. **SD**: It was useful: It showed that it didn't meet the alignment requirements, so we have worked on new versions. We have developed new hardware based on this.
- 7.26. **NCL**: We are technical people perhaps it would be better to discuss this in technical terms
- 7.27. **CR**: That is why we have the list of requirements
- 7.28. **SS**: OK next meeting we should have a summary of the previous Two-Beam module program
- 7.28.1. Igor claims we already have a perfect module
- 7.29. **CR**: we have a presentation of the limits of previous designs that was given by Steffen at one of the CLIC Main Linac Hardware Baseline meetings
- 7.30. **IS**: We have not discussed gradient etc. This could be tested in the XBOXs, and alignment can probably be tested in other ways. This allows many more variables to be tested.
- 7.31. **CR**: agreed, but four accelerating structures have never been conditioned together before, and collective vacuum design has not been done, therefore conditioning four structures in this way will likely take some more work and understanding
- 7.32. **IS**: module is not needed for this, it can be done in the XBox
- 7.33. **SS**: A single klystron does not recreate a CLIC module
- 7.34. **NCL**: we can still do testing in the XBOXs, but that is not CLIC, there are a lot of other parameters

- 7.35. **WW**: If it is necessary to power an entire module, then two klystrons are needed.
- 7.36. **SS**: if we do everything this should include mechanical testing
- 7.37. **NCL**: This can also be done including more RF power
- 7.38. **SS**: that is the interesting part. We know we can build one or two structures, but can we build thousands of modules?
- 7.39. **NCL**: This would require industrialization to find out about
- 7.40. **SS**: that is the next step
- 7.41. **MA**: The project is over the next five years; we have time to develop more structures
- 7.42. **NCL**: We have time but we don't have the money.
- 7.43. **IS**: As said, a module is not necessarily interesting without the integrated RF
- 7.44. **CR**: Can we combine XBOX 1 and XBOX 2 ?
- 7.45. **NCL**: XBOX 1 has been promised to several different groups
- 7.46. **SS**: It seems we have an avenue to proceed:
- 7.46.1. Developing 1 module for combined studies within the XBOXs
- 7.47. **IS**: It will still not be a true CLIC module
- 7.48. **SS**: We can build a K-mode module, and use this to develop the integration
- 7.49. **MA**: Surely better than doing nothing
- 7.50. **SS**: This must be better than nothing
- 7.51. **IS**: If we have half the power, we would need dummy modules, and this would not be CLIC. Do we need the XBOXs for the testing?
- 7.52. **CR**: Yes, for the combined thermomechanical testing
- 7.53. **IS**: So we would need the RF for this?
- 7.54. **SS**: Yes, now he is interested. A detailed module presentation would be useful, summarising the achievements and the developments of the module group would be useful.
- 7.55. **NCL**: Considering the different module requirements will require more time.
- 7.56. **CR**: Yes, if anyone wants to provide feedback in the next few days, please get in touch.
- 7.57. **CR**: We will arrange further meetings, every two weeks on Tuesdays.

#### **Actions:**

	<b><u>Deadline</u></b>	<b><u>Required</u></b>
1. Provide feedback on the module requirements to Carlo	08/09/2020	All
2. Arrange another meeting in two weeks	15/09/2020	Carlo Rossi