CLIC Accelerating structure and PETS testing and conditioning Some reflections

Summary of a couple of meetings with:
G. Riddone, P. Lebrun, R. Corsini, S. Doebert,
W. Wuensch, A. Grudiev, I. Syratchev

CLIC Accelerating structure and PETS testing and conditioning

Some reflections

What do we know today:

- We will need 142812 structures and 71406 PETS
- Construction time is 7-10 years
- One year has 7000 'conditioning' hours
- ~ 50-60 MW needed per structure
- We can buy 50 MW klystrons
- Accelerating structures need ~ 1000h at 60 Hz of conditioning to get to target performance (let's say 200h conditioning and 800h breakdown rate reduction)
- No clear experience for PETS conditioning, likely 200 h sufficient
- Not really clear to which extend pre-conditioned structures keep their memory (some final in situ conditioning will most likely be needed)
- I believe structures (PETS ?) need to be high power tested before final installation

1. Precondition all structures with klystrons

•1 klystron + pulse compressor → 150 MW good to test two structures
(70 MW klystron could test 3 structures in parallel)
Let's say 200 h at 60 Hz = 4.32 10^7 pulses
Use klystrons at 100 Hz → 120 h conditioning
→ 100 structures per klystron/year (140h turn around)

500 GeV machine: 23802 structures → 34 klystrons for 7 years (50k hours/klystron)

3 TeV machine: 142812 structures → 142 klystrons for 10 years
Or using 500 GeV drive beam for the upgrade

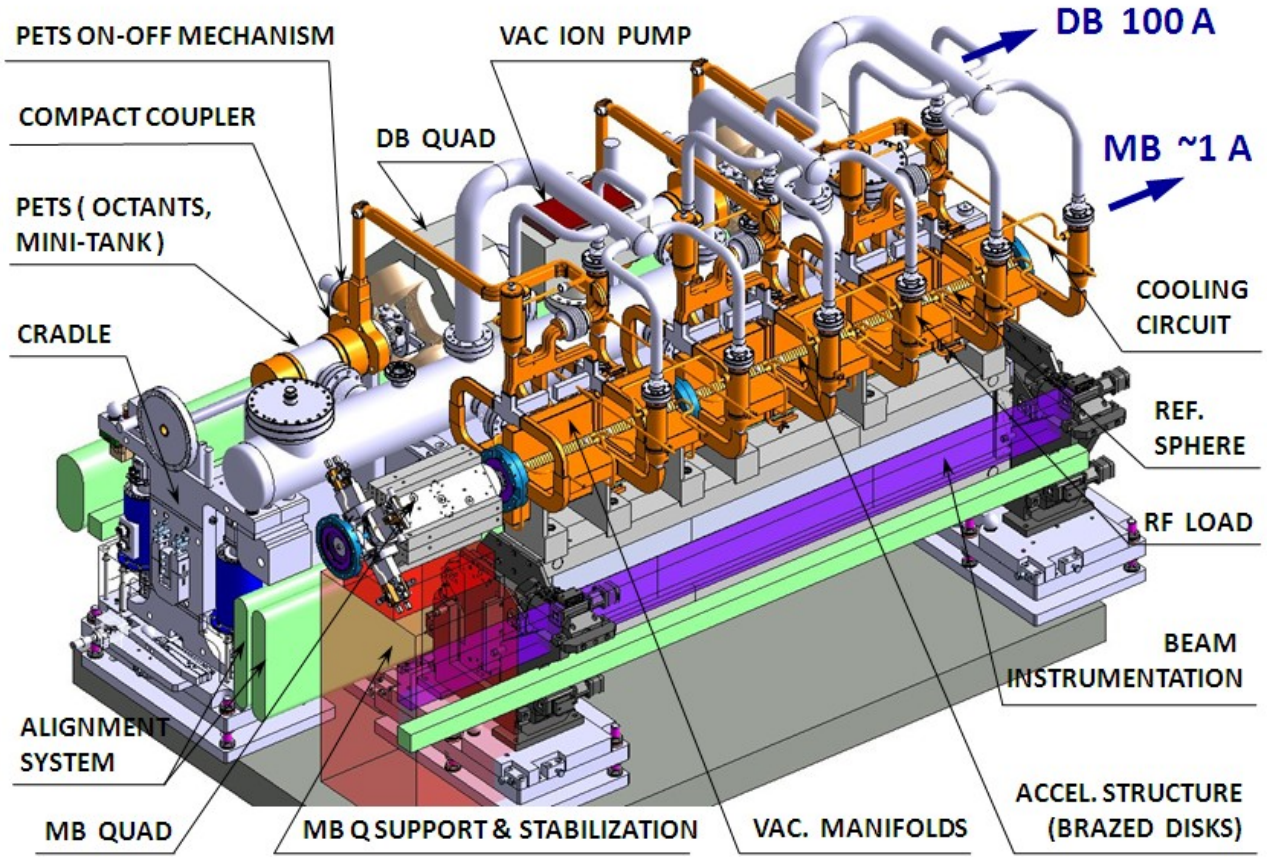
Plan to test rf units: 1 pets feeding one superstructure including waveguide circuit and loads. A sort of input coupler is needed for this assumption !

Conditioning for 120h would be the acceptance test,
I believe a yield of 95 % is realistic after some learning time
(which means 66 % for full modules)

~540 MW needed for full module test

Cost: 150 test stations, 2 MCHF each + infrastructure (can be distributed)

CLIC highlights
Module design



CLIC at 500 GeV (4248 modules)
26312 Accelerating structures
13156 PETS
~ 70000 RF components

CLIC at 3 TeV (20924 modules)
142812 Accelerating structures
71406 PETS
~ 400000 RF components

A. Samoshkin

2. Precondition all structures with drive beam in a dedicated facility

Some general reflections:

- What do we order from industry ? Structures, PETS and components or full modules ?
- Different industry for component fabrication and assembly ?
- Pre-conditioned structures would have to be assembled in clean-room environment to preserve effect
- Testing, conditioning and rejecting full modules would be best (more expensive ?)
- Need to define rejection criteria (average gradient per module)
- Beam test would be the most complete testing method, PETS, Acc-Structures and all components together

2. Precondition all structures with drive beam in a dedicated facility

- Assumption of testing full assembled modules
- Faulty modules have to be reassembled and retested

- Use CLIC0 or CLIC drive beam facility for full module testing.
  Available 5 years after construction ?
- 100 m facility to test string of 50 modules in one go, shielded assembly beam line in parallel,
  facility runs at 50 Hz, 4000 h available per year, 240 h conditioning
  → 15 strings per year, 10 days to remove and assemble 100 m beam line

19278 modules to test:
5 years for conditioning, 3856 modules/year → 77 strings to test

500 GeV, 3213 modules, 2 years of conditioning → 32 strings per year

→Facility earlier, longer strings ?

Cost: 100 m beam facility (bunker) for 100 A drive beam at the end of the drive beam

Timing critical, can we assume CLIC0 is available before starting construction

3. Precondition all structures with drive beam in the final CLIC tunnel

- In theory 1000 h of beam time with special trip protection needed, in reality probably several 1000 hours, let's say at least 6 month
- Defect parts have to be changed in the tunnel after final assembly
- Can start only when machine is finished

Probably not realistic for preconditioning, needed anyway to get to final breakdown rate specs.

Open questions

- Production scenario, who does what in parts production and assembly (Industry, CERN)
- What objects we test, 1 PETS + 2 Structures, How ? Should study a scenario
- Production yield, what to assume, what to aim for, how bad are the failures
  Define a set of module performance parameters ?
- How much conditioning time is sufficient to make a decision on performance
- Do pre-conditioned structures keep there performance, how much degradation ?
- Recovery scenario of a single component, whole modules ?

X-FEL model:
Fabricate cavities in industry (risk at client), some vertical tests, assemble in Saclay, full model test in dedicated test facility at DESY, installation.

Conclusion

- Conditioning R&D has do be done with both klystrons (stand alone source) and beams (TBL+) in any case to get better input for this questions

- A klystron based testing plant, to test individual components or full modules before final installation would be the safest option
  No doubt that such a scenario would be technically credible, we can start early and follow production all along
- Is it affordable ? 100 klystrons → rough guess > 150 MCHF facility
- For time being we plan to use ~96 klystrons for the final bunch compressors at the beginning of the linacs.

- CLIC0 based facility gives the most complete test for modules, timing is critical and CLIC0 would be needed early otherwise it is difficult to cope with production

- A sizeable klystron facility will be needed anyway for R&D and early and quick production evaluation

- Klystron development for higher power, higher rep. rate should start tomorrow

What do we propose for the CDR

Of course for time being we can choose many parameters freely (yield, conditioning time needed,..) and describe a scenario based on this assumptions.

I personally feel more comfortable with a klystron based scenario
Main drawback cost and many klystrons needed for a two beam machine

However there is a feeling that something like CLIC0 will be needed anyway and therefore should be used for module testing

<u>Proposal for CDR :</u>
Condition most modules with beam based facility, state nevertheless the necessity of a klystron based facility for the initial stage and for R&D
The size of this facility could be 20-30 klystron like for a 500 GeV machine
Once more experience and the beam facility is available one would switch to module testing with beam