cherenkov telescope array

CTA Power Concept Review

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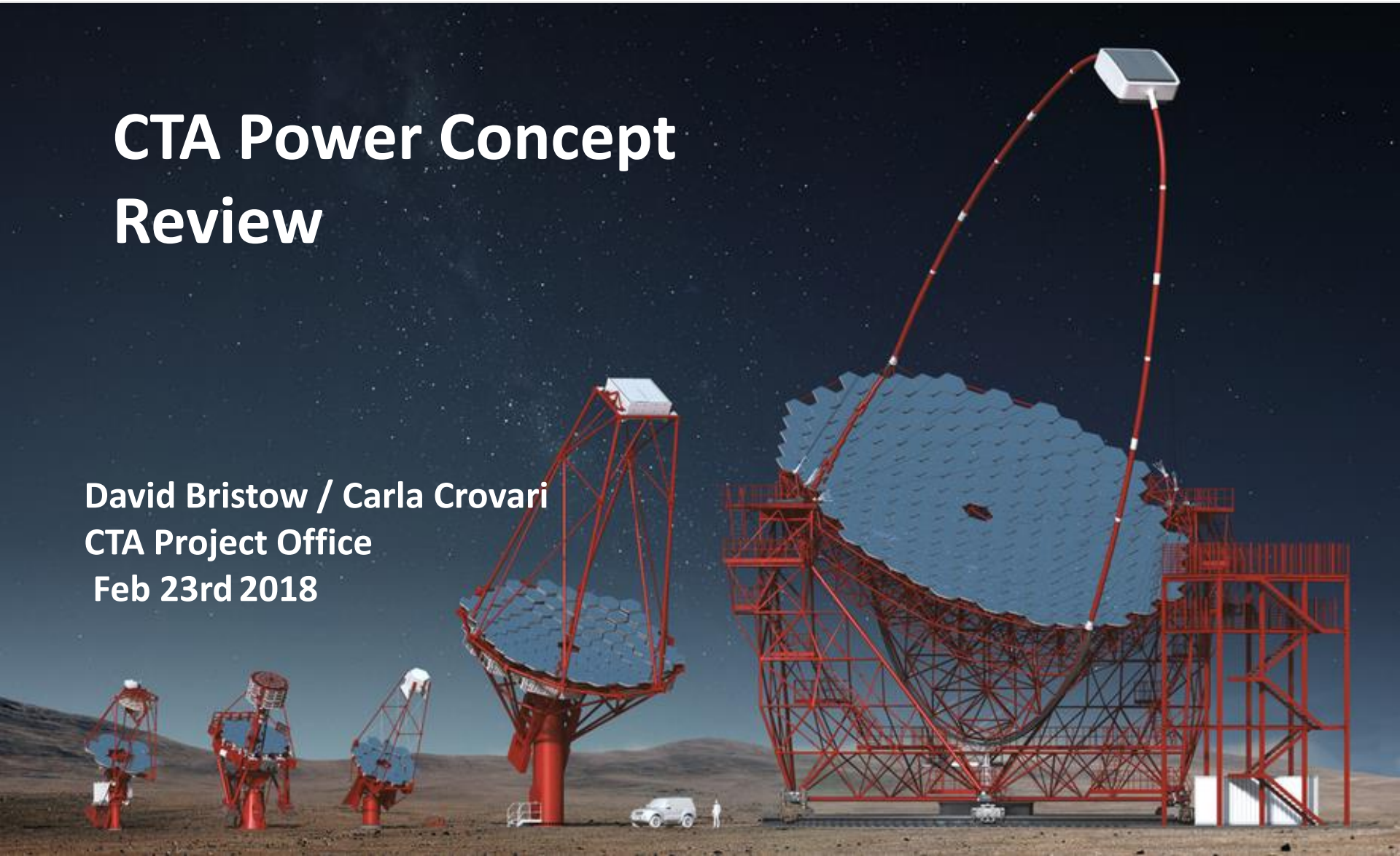

Introduction to the Panel Discussion

- Part 1
  - Review and discuss the Questions and Recommendations sent by the Reviewers that didn´t end in an “ok” state.
- Part 2
  - Discuss the answer for the questions of the Review plan

- Minutes with the Conclusions will be prepared.

Review items – Power Requirements, document PowerNote v0.2 (1)

a/a	Doc. reference (page, chapter)	Question or Comment	Answers	Reviewer Rejoinders
2	Page 5, Table 2.1	Table 2.1 defines the peak demand of LST (Structure+Camera) to 48 kW. Table 8 of design study defines as peak demand of 4 LSTs 240 kW, which is 60 kW per LST. Documents harmonization as regards power requirements should be possibly required	it is expected that the peak power required (from the power distribution system) to load the fly wheels do not occur at same time as fast repositioning. Values are under review	During the review of the values, please consider that coincidence would lower the 4 LSTs demand (reported in Table 8 as 240 kW) to something lower than 4 x 1 LST value (reported in Table 2.1 as 4x48 kW = 192 kW)
4	Page 6, Table 2.4	It shall be clear that from the values given in Table 2.4 the only critical for the electrical system design is the peak demand (or Peak power consumption), which is referred as 1 MW for CTA North. All equipment capacities and cable lines design shall be based on this value. **It is advisable to have a good margin on this peak demand figure**, because in case it is underestimated the installation would not be capable to serve the loads, within the defined power quality. The other values of Annual energy consumption and (mean?) power required during Observations, are just for information, mainly to calculate estimated energy consumption and related cost	OK - a statement will be added to the final version of the Power Requirements document. (buffer is already > 10% of expected peak)	OK, if CTA considers a 10% peak demand margin as adequate
6		Is anywhere defined the required power quality for the CTA North?	There is a qualitative requirement on voltage and frequency stabilisation that is expected to be achieved with the use of UPS in the design. Feedback from the reviewers is expected, in case additionally, a standard or ESO power quality document is needed.	ESO general power quality specification "GEN-SPE-ESO-50000-5044_iss2" is attached

Review items – Power Requirements, document PowerNote v0.2 (2)

a/a	Doc. reference (page, chapter)	Question or Comment	Answers	Reviewer Rejoinders
7	Page 6, requirement B-INFRA-0520 / 0550 Annual Energy Consumption	The statement "The southern/northern site infrastructure must be capable of providing an annual electric energy supply of X GWh" should probably become just informative, since the defined (15 min) power demand allows the calculation of the possible max energy consumption. Normally real consumed energy per year is just a fraction of the max energy that can be consumed based on power demand. Estimated energy consumption could influence the project economics, but not the pure electrical design	Yes - will be reviewed, rephrase to "the annual supply must be at least?" or rather "must not exceed".	To the reviewer opinion a less biding phrase, like e.g. "the annual electricit consumption is expected to be …" might be preferable
11	Page 8, requirement B-INFRA-0605 Backup power control	The statement "The Power Provision System must incorporate a backup solution, capable of **compensating for variations in the supply** of power from the grid" is expected to result to a central backup system incorporating flywheels or online UPS near the grid connection point. In case just a backup generation is required, statement would be better rephrased.	This is up to the design solution. Maybe remove "from the grid"	To the reviewers opinion, if just backup generation is required the sentence shall be rephrased to something like "The Power Provision System must incorporate a backup solution, capable to provide power when grid power supply is
12	Page 8, requirement B-INFRA-0610 Power Cable	The statement "Telescopes and OES Controllable Systems **must be provided with a cable power supply, which must be protected against damage for the entire cable length** …" means that armoured cables are required?	This is up to the design solution.	The question is about what CTA is requiring to be designed
14	Page 8, requirement B-INFRA-0640 Power frequency stabilisation	The requirement "Voltage and frequency stabilisation must be considered in Power supply design, such that even on millisecond timescales, no disturbances may cause damage to the instruments" is expected to result to the use of a flywheels or online UPS system within the power supply system. Is that the intention of the requirements writer?	Yes - this is a power quality related requirement	So, the existence of a central flywheels or online UPS system within the power supply system is required, in addition to what exists in LSTs? Why there is not any relevant description?

Review items – Concept design, document “Study for Electrical Power distrib. CTAN” (1)

a/a	Doc. reference (page, chapter)	Question or Comment	Answers	Reviewer Rejoinders
16	Page 0-3, clause 0.4.2	The reviewer thinks as too optimistic reliability assumption for Substations and cable cabinets that "no outage should be expected during the target lifetime of the telescope array"	This sentence is only an abstract of Chapter 8.2 and reflects the statistical reliability.	OK, but the reviewers continues to consider this statement as too optimistic
19	Page 0-5, clause 0.9.1 UPS system comparison, General Page 11-1, clause	Stating only the rated power of a UPS system is not adequate. The required energy storage capacity (e.g. kWh, or Ah, etc.) shall also stated. You can have 30 kW UPS with 150 Ah batteries or with 1500 Ah batteries. What is required?	The UPS battery must be able to deliver rated kW for 6 minutes as telescopes are required to be able to go to safe state in not more than 5 minutes.The Ah value will be defined during detail design.	The reviewer has the opinion that the general requirement "The UPS battery must be able to deliver rated kW for 6 minutes" shall be inserted in this report
25	Page 2-2, clause 2.1.3 Technical conditions	The reviewer just notes that according to EN 50160 the allowed frequency variation for systems with no synchronous connection to an interconnected system (e.g. supply systems on certain islands) is: 50 Hz ± 2 % (i.e. 49 Hz... 51 Hz) during 95 % of a week; 50 Hz ± 15 % (i.e. 42,5 Hz... 57,5 Hz) during 100 % of the time.	As all critical consumers will by supplied via UPS systems the power quality of the grid is inessential.	OK, supposing that all UPSs would have continuous AC-DC-AC conversion (on-line UPSs) to be able to continuously feed the loads with corrected frequency
29	Page 4-1, clause 4.1 Base configuration	The 4th paragraph of the clause 4.1 states "A transformer of 630 kVA rated size will be installed together with the LST1 prototype. For emergency reasons a 600 kVA stand-by generator set is foreseen. The derating due to altitude leads to an available power of 446 kW at power factor 0.9" 600 kVA x 0.9 = 540 kW 446/540 = 0.826 (or 17.5%) de-rating factor for 2300 m ASL The reviewer notes that this derating factor seems to be reasonable for Diesel gensets where a 2% to 3% de-rating every 1000ft ASL is usually considered, but is not reasonable for transformers where 0.3 % de-rating every 330 ft. above the 1100 ft. ASL is usually considered	The figures come from the EDG supplier (see General Note above)	OK, but values shall be verified during detailed design

Review items – Concept design, document "Study for Electrical Power distrib. CTAN" (2)

a/a	Doc. reference (page, chapter)	Question or Comment	Answers	Reviewer Rejoinders
30	Page 5-1, Figure 1 20kV Substation 1 Page 5-4, Figure 3 20kV Substations 1 and 2 Page 5-6, Figure 4 20kV Substation 1 Page 5-8, Figure 5 20kV Substations 1 and 2 Page 5-10, Figure 6 20kV Substation 1 Page 5-12, Figure 7 20kV Substation 1 Page 5-13, Figure 8 20kV Substation 2 Page 5-14, Figure 9 20kV Substation 1 Page 5-16, Figure 10 20kV Substations 1 and 2	The two incoming feeders of each S/S shall have Circuit breakers as shown in the diagrams, or just load switches as it is common in ring distribution systems? In case of load switches, shall they be manual or motor operated? A bus tie is indicated on the diagrams, when the usual standardised solution of distribution companies to feed 630 kVA transformers is to use an isolator- circuit breaker panel having also measuring facility (to measure the consumption to be billed). Is this 20 kV distribution switchgear for ring system: - to be bought by CTA and approved by Endesa, or - to be supplied by Endesa and charged to CTA (usual case in distribution systems)? In any case it is usual that Endesa would have the exclusive right to operate the switches of the two incoming feeders and CTA would have the right to operate only the CB of the transformer feeders	The connection will be done in the same way as in other IAC ring main units. Bus tie shall be used to isolate the CTA system for maintenance without interrupting the IAC ring structure. Not known. Noted	Is this "same way" known to CTA, or not? This isolation is usually offered by the "isolator" which normally exist before the CB in transformer protection panels, see attached "Page 29 from Ormazabal ca-112-en-1611" brochure
33	Page 5-3, Clause 5.2.3 Energy storage system for LST	The reviewer absolutely agrees to the last paragraph of this clause stating "This energy storage device acts also as UPS for the LST. Therefore no separate UPS will be foreseen", but it is noted that for the flywheels system to be able to provide power for the time required by the separate stand by generator to resume supply (20-30 sec as stated in page 5-2, clause 5.2.1 of this study) or longer, the system shall either: - have adequate big mechanical energy storage - be supported by batteries energy storage - be supported by incorporated in the flywheels diesel generator	A flywheel solution of 400 kW for 10 sec should be able to support a mean power of 22 kW for the required time.	OK, but please verify with the supplier

Review items – Concept design, document “Study for Electrical Power distrib. CTAN” (3)

a/a	Doc. reference (page, chapter)	Question or Comment	Answers	Reviewer Rejoinders
37	Page 5-17, clause 5.9.1, Substations Page 6-1, clause 6, Protection concept	Last sentence of clause 5.9.1 states "These feeders will be equipped with load break fuses" and 7th paragraph of clause 6 states "All outgoing feeders from the 0.4 kV busbars will normally be equipped with fused load break switches" The reviewer notes that specific personal protection equipment and specially trained personnel is required to really operate under load the "load break fuses" or "fused load break switches". A previous interruption of the feeding system by a Load switch or CB simplifies drastically (and makes safer) the connecting/disconnecting operation	Switching actions are in any case restricted to special trained personnel. Nevertheless the usage of CBs increases personal safety during the connecting/disconnecting prozess. Using CBs instead of fuses will increase the investment costs and is finally an economic decision.	OK, but please note that it can be just a safety procedure to interrupt/reconnect a circuit using the existing upstream CBs that feed relevant circuit
38	Page 5-17, clause 5.10.1 Variant 1 and 2 Page 5-18, clause 5.10.2 Variant 1 and 2 Page 5-18, clause 5.10.3 Variant 1 and 2	It is stated "No fast tracking possible for MST" What causes this limitation? The capacity of the backup generator or the capacity of the transformer (which could possibly increased)?	The capacity of the backup generator. In the three mentioned failures the transformer is always out of service.	Has been evaluated if it is worth to increase backup generator capacity to keep available MSTs fast tracking in such cases, or if a certain percentage (e.g. 50% of MSTs) can follow the fast tracking?
40	Page 5-20, clause 5.10.7 Variant 2 and 3 Page 8-1, close 8.2 Reliability, 8th paragraph Page 8-2, clause 8.3 Recommendation	"**Damage of equipment** due to sudden power cut **possible**" is reported. Is this risk acceptable or variants 2 and 3 should be rejected?	To be answered by MST providers.	This answer would become critical in case variant 2 or 3 are to be promoted
46	Page 13-1, clause 13.2 Consumers	Last paragraph of the clause states "The converters used in the **LSTs** have also **high harmonic contribution but they will be provided with line filters** to minimize the influence on the 20 kV voltage profile" Since there will be a flywheels system in each LST, which is expected to drastically reduce harmonics, the need of use line filters shall be probably verified after all characteristics of the LST flywheels are well known	This statement comes from the LST supplier.	LST supplier provided this statement before or after the flywheels system definition?

Review items – Concept design, document “Study for Electrical Power distrib. CTAN” (4)

a/a	Doc. reference (page, chapter)	Question or Comment	Answers	Reviewer Rejoinders
47	Page 13-2, clause 13.4 Solution for CTA site	Regarding the statement of the 4th paragraph of this clause "The available short circuit power cannot be influenced by CTA" please note that the Flywheels of the LSTs will somehow contribute to the short circuit current, increasing it. The need to use harmonic filters shall be evaluated when all characteristics of the LST flywheels system are well known	As the flywheel system is connected via converter to the supply system, no short circuit contribution will occur.	The reviewer has the opinion that, despite the inductance towards the feeding system that is part of the flywheels, the flywheels system would contribute increasing the short circuit level of the feeding system. Please verify during detailed design with the supplier
53	Annex 2 Study of Electrical Power Distribution	it is listed the standards applicable as per the IAC hosting agreement; could we have an equivalent list of what are the standards that would apply to the southern site?. Maybe some of those would be convenient to consider for the northern site?	Reviewers can comment, in case they see any particular additional standards that may be helpful to be considered.	To be double checked
54	4.1 Base configuration, page 4-1	Since the time that the study was prepared and now some months have passed, could you update what is the current status of the LST1 project with regard the technical solution being implemented? (e.g. power and data network topology and if that could affect the different variants being analized or if it puts constrains for the detailed design of the selected variant option)	LST1 prototype has already installed a 630 KVA transformer, a 650 KVA Diesel Generator and ATS. The power lines to the LST1, IT Container and Control Container for LST1 is also in installation.	Thanks, I assume this will show up in the discussions
55	8 Concept evaluation, page 8-1 General question	In order to visualize the implementation and assess eventual risks, can you share your plan of the remaining key activities once the concept design is finished? Is there any significant difference in the schedule depending on the variant selected?	After one of the four Variants is selected, the Detailed design will be prepared, for expansion stage 1 and then 2.	Maybe a high level schedule you could share to visualize when stage 1 and stage 2?

Questions from the Review Plan

1. Have the system performance requirements, concerning the power system, been defined? Are they complete?
2. Have all interface requirements been captured? Is the operational environment taken into account?
3. Have system utilization requirements been defined? Number of operating hours? Life time?
4. Has the anticipated concept of maintenance been identified?
5. Are all requirements verifiable?
6. Do system requirements all trace to upper level requirements?
7. Have RAM requirements been defined?
8. Have hazards been identified and ESH (Environment, Safety & Health) requirements been defined?
9. Has the architecture of the system been defined?
10. Do the Variants proposed in the Conceptual study: Variant 1, 2, 3 and 4, comply with the power system requirements? If not, please comment which Variant and in what sense may not comply with which requirement.
11. Besides requirements, do you foresee any risk of the following, to any of the 4 Variants. Considering both implementation and operation & maintenance: Risk in Schedule, Risk in Cost, Risk in Quality, Risk in scope. If so, please comment which Variant has what kind of Risk.
12. Based on your experience, in case you see clear advantages for any of the four Variants, please comment which one it is and which are the advantages you identify.

cherenkov telescope array

Thanks for your participation!