Performance of DREAM for First Science

Report for Diffraction STAP, Werner Schweika, Oct 17 2023

In 2013 at the time of the DREAM proposal, an ESS power of 5 MW at 2 GeV has been considered for the evaluation of the instrument DREAM to compare with the instruments WISH and POWGEN.
Later, with scope setting the detector coverage was reduced from 6 sr to 2 sr.
In 2015, the performance was rescaled for the butterfly moderator by 2.57 and 3.4 for the thermal and cold spectra, see Ref. [1], with a calculated performance ratio (PR) with respect to WISH/POWGEN of two orders of magnitude. The results of this paper are based on the final power and detector scope as originally proposed.
In the meantime, POWGEN increased the solid angle of detection and SNS has increased power from 1 to 1.7 MW. For WISH the actual measured flux is 1.3 times higher than 2013 in the simulations. On average, the relative performance of POWGEN and WISH is ~2.5 better than estimated before.
The performance of DREAM at HC and SOUP is determined by the power ramp up of the ESS accelerator and the detector coverage of DREAM, current scope ~2sr. There is a performance impact roughly estimated to lower 70% efficiency due to the lower proton energy and the not yet optimal first butterfly moderator.
At 571MeV, the performance ratio with respect to WISH and POWGEN will scale with proton power as PR_{HC} ~ 100 *0.4**6sr/2sr * 0.7 * (p/5MW) as shown in the table below.
At SOUP, DREAM will be similarly performing like POWGEN and WISH.

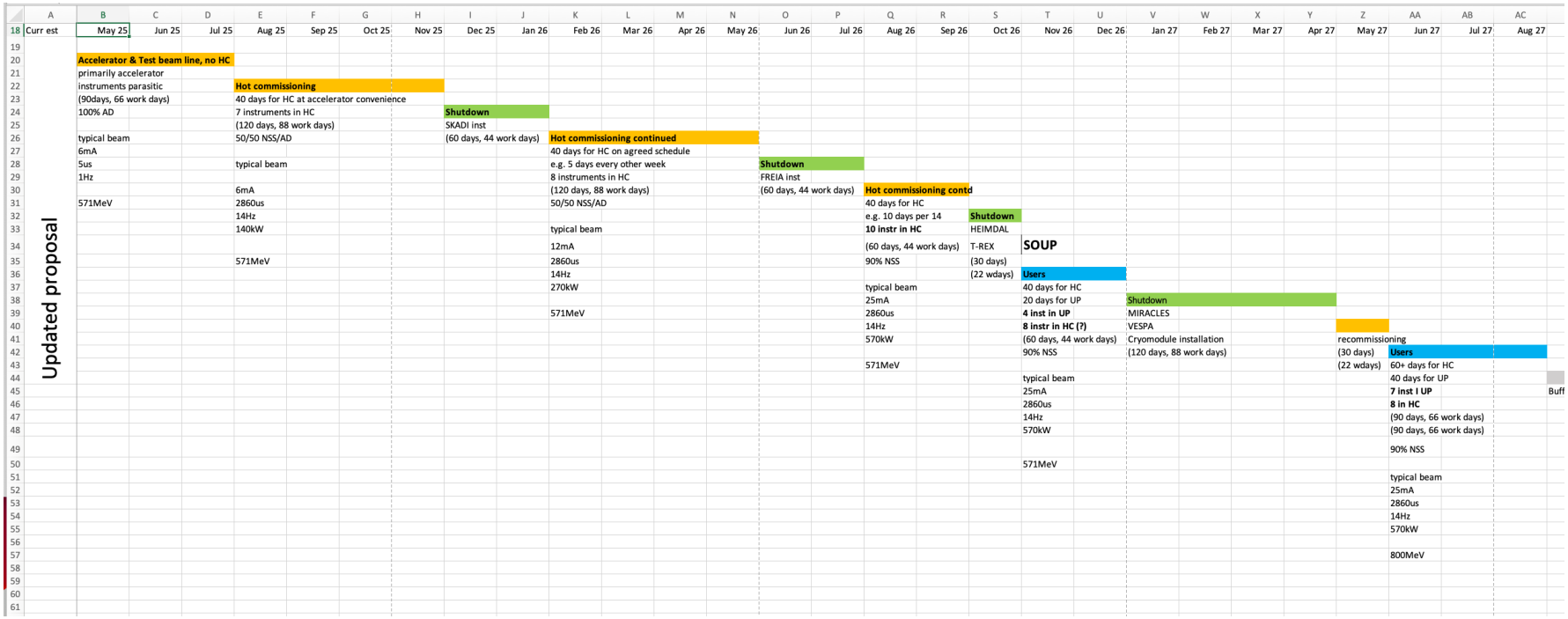
Estimated performance based on the integrated plan for ramp up power at ESS

Date current estimate baseline +0.5y	PR	Power MW	energy MeV	Current mA	Pulse Length	Freq. [Hz]
May-July ‘25		0.01	571	6	5µs	1
Aug-Nov ’25 HC 40d (AC)	0.26	0.14	571	6	2860µs	14
Feb-May ’26 HC 40d	0.52	0.27	571	12	2860µs	14
Aug-Sep ’26 HC 40d	1	0.57	571	25	2860µs	14
Nov-Dec ’26 SOUP / HC 20d/40d	1	0.57	571	25	2860µs	14
Jun-Aug ’27 User / HC 40d/60d	1.6	0.80	800	25	2860µs	14

Conclusions

First science on DREAM should try to benefit on its unique instrument characteristic, the possibility of very high resolution, the large Q range.
The power ramp up could also try to maximize the proton peak current at a shorter pulse length. A peak current of 30 to 40 mA at shorter pulse length of 50 to 200 µs could be feasible even for early HC. This option could be of particular interest for first experiments in HC yielding a PR of ~2.
For the time beyond 2027, apart from further a power upgrade, higher detector coverage with a recovered gain of 3 is needed to be world leading. Considering the time of production, it seems feasible if the decision is taken now. For example, the proposed WISH-2 instrument will have 10 times more detector coverage than WISH, which we used for comparison to DREAM.

[1] https://iopscience.iop.org/article/10.1088/1742-6596/746/1/012013/pdf


Updated proposal
Curr est
May 25
Jun 25
Jul 25
Aug 25
Sep 25
Oct 25
Nov 25
Dec 25
Jan 26
Feb 26
Mar 26
Apr 26
May 26
Jun 26
Jul 26
Aug 26
Sep 26
Oct 26
Nov 26
Dec 26
Jan 27
Feb 27
Mar 27
Apr 27
May 27
Jun 27
Jul 27
Aug 27
Accelerator & Test beam line, no HC
primarily accelerator
instruments parasitic
(90days, 66 work days)
100% AD
typical beam
6mA
5us
1Hz
571MeV
Hot commissioning
40 days for HC at accelerator convenience
7 instruments in HC
(120 days, 88 work days)
50/50 NSS/AD
6mA
2860us
14Hz
140kW
571MeV
Shutdown
SKADI inst
(60 days, 44 work days)
Hot commissioning continued
40 days for HC on agreed schedule
e.g. 5 days every other week
8 instruments in HC
(120 days, 88 work days)
50/50 NSS/AD
typical beam
12mA
2860us
14Hz
270kW
571MeV
Shutdown
FREIA inst
(60 days, 44 work days)
Hot commissioning contd
40 days for HC
e.g. 10 days per 14
10 instr in HC
(60 days, 44 work days)
90% NSS
typical beam
25mA
2860us
14Hz
570kW
571MeV
Shutdown
HEIMDAL
T-REX
(30 days)
(22 wdays)
SOUP
Users
40 days for HC
20 days for UP
4 inst in UP
8 instr in HC (?)
(60 days, 44 work days)
90% NSS
typical beam
25mA
2860us
14Hz
570kW
571MeV
Shutdown
MIRACLES
VESPA
Cryomodule installation
(120 days, 88 work days)
recommissioning
(30 days)
(22 wdays)
Users
60+ days for HC
40 days for UP
7 inst I UP
8 in HC
(90 days, 66 work days)
(90 days, 66 work days)
90% NSS
typical beam
25mA
2860us
14Hz
570kW
800MeV
Buff