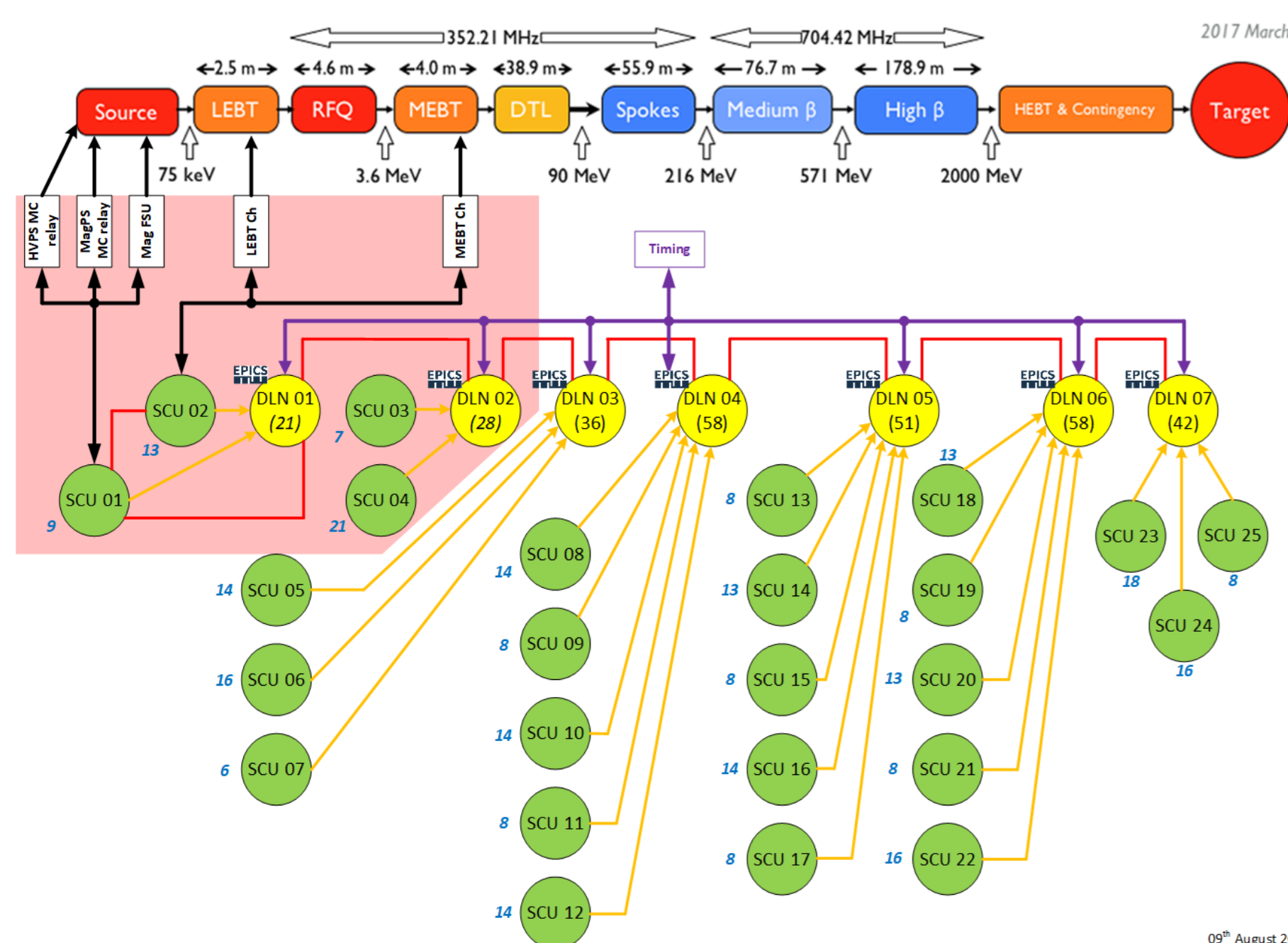


The ESS Fast Beam Interlock System - Design, Deployment and Commissioning of the Normal Conducting Linac



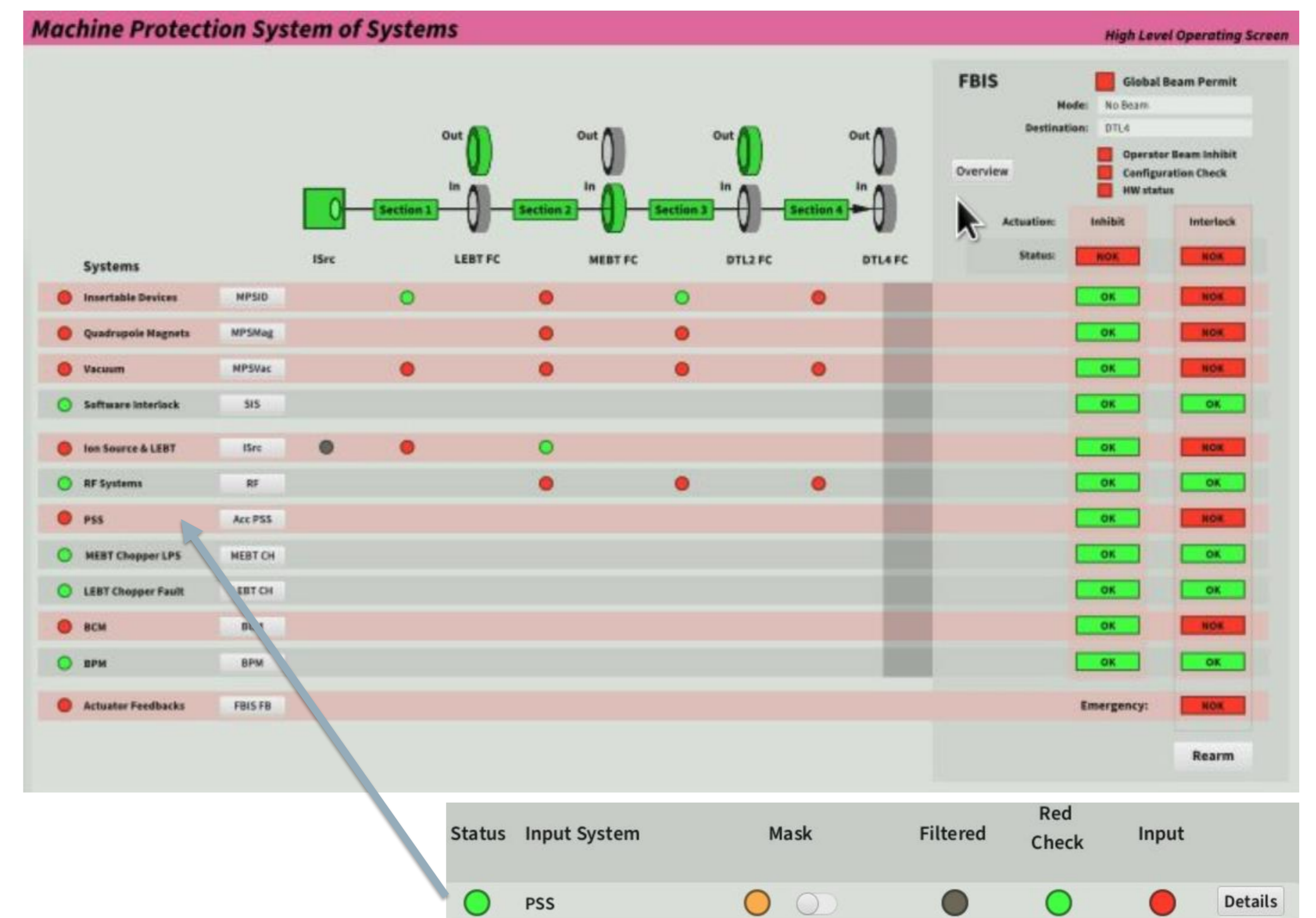
S. Pavinato, M. Carroll, S. Gabourin, A. Gorzawski, A. Nordt
European Spallation Source, Lund, Sweden



The FBIS for the full Linac is constituted of 7 mTCA DLNs and 25 cPCI SCUs. For the Normal Conducting Linac (NCL) commissioning phase to DTL4 Faraday Cup (FC), a subset of 2 DLNs and 4 SCUs was installed.

FBIS full deployment with DTL4 FC installation highlighted.

The High level OPI has been designed following a matrix approach composed by a set of rows (corresponding to the inputs to FBIS represented as round LEDs) and columns (corresponding to the outputs from FBIS represented as square LEDs).

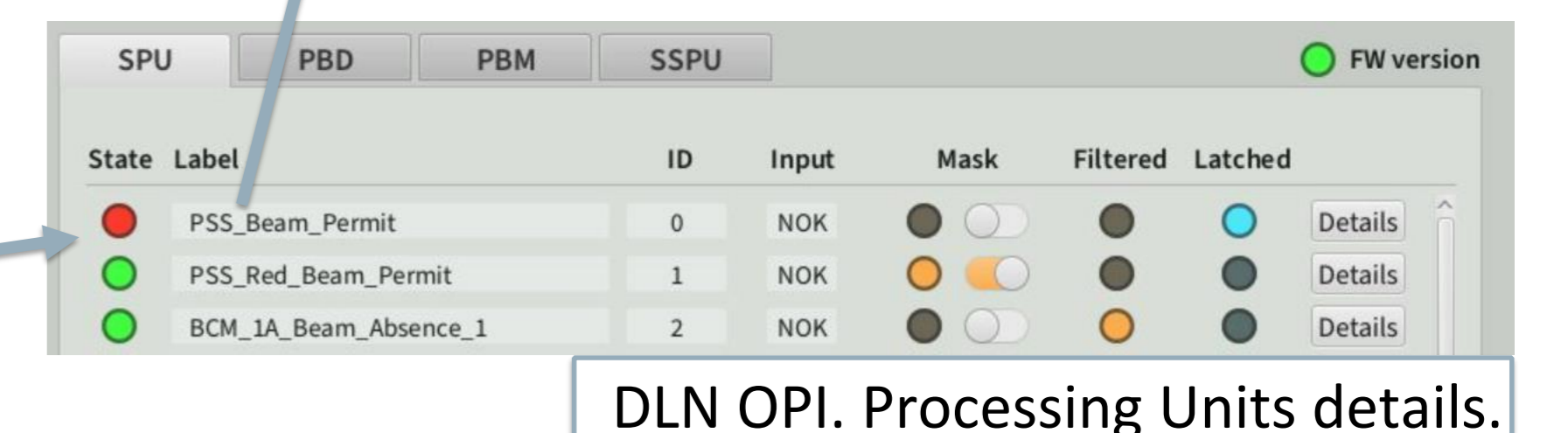


Rolling History Buffer (HB) of the latest 1023 events that occurred. To understand the sequence of events during particular situation, especially after unclear Beam Stops or during commissioning.

Date	ns	SuperType	GBP	EBI	RBI	BI	Type	SubType	Signal
2023-06-26 13:54:26	710,000,623.6	BSO	●	●	●	●	GBP	OK	
2023-06-26 13:57:59	843,698,577.4	PU DLV out	●	●	●	●	SPU	4	NOK
2023-06-26 13:57:59	843,698,577.4	PU DLV out	●	●	●	●	SPU	5	NOK
2023-06-26 13:57:59	843,698,585.6	BSO	●	●	●	●	Local BI	NOK	
2023-06-26 13:57:59	843,698,593.8	BSO	●	●	●	●	Local RBI	NOK	
2023-06-26 13:57:59	843,698,602.0	BSO	●	●	●	●	GBP	NOK	
2023-06-26 14:02:06	716,866,002.9	PU DLV out	●	●	●	●	SPU	4	OK
2023-06-26 14:02:06	716,867,387.4	PU DLV out	●	●	●	●	SPU	5	OK
2023-06-26 14:02:06	716,867,395.6	BSO	●	●	●	●	Local BI	OK	
2023-06-26 14:02:06	716,867,395.6	BSO	●	●	●	●	Local RBI	OK	
2023-06-26 14:02:06	716,870,475.8	BSO	●	●	●	●	GBP	OK	

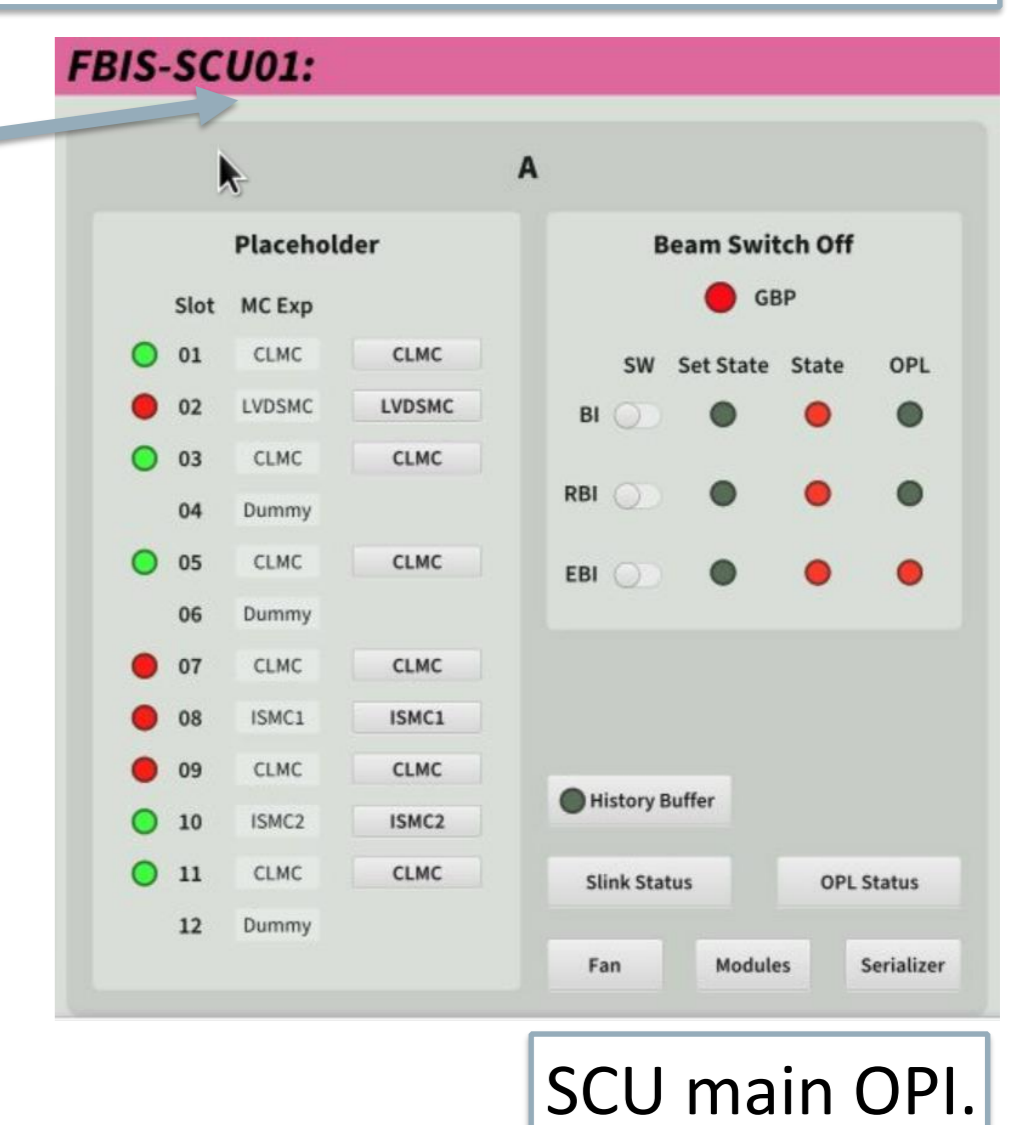
FBIS OPI. Details about an input system.

DLN is responsible for implementing the protection logic utilized by the FBIS. It is built upon the mTCA standard and employs a 3U chassis to accommodate the redundant IFC1410 Intelligent FMC Carrier which serves as the core component for FBIS functionality.



DLN OPI. Processing Units details.

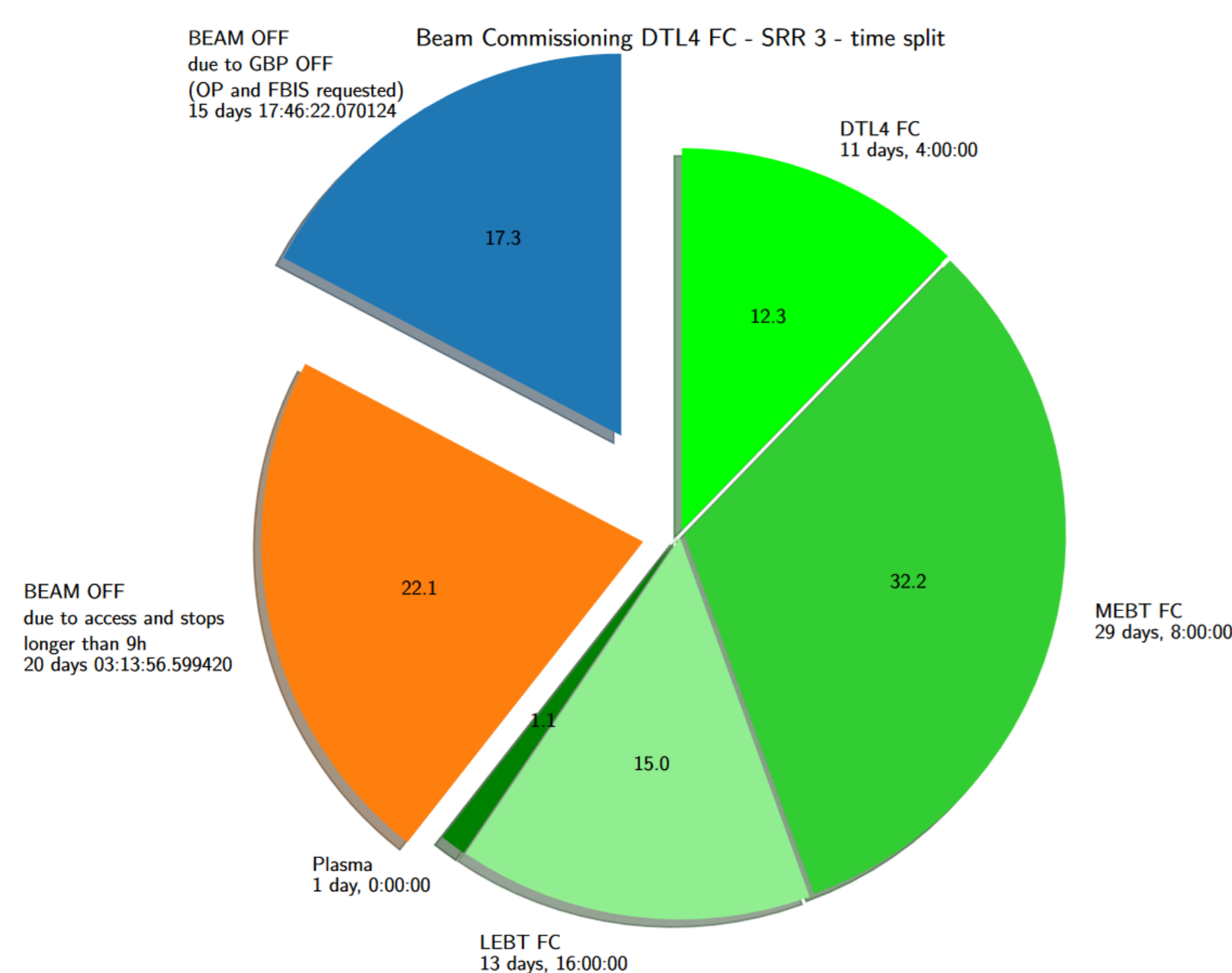
SCU is a concentrator for Sensor Systems connections. It is based on a cPCI standard chassis with custom electronic cards. An SCU hosts up to 12 Mezzanine Cards (MC) on which Sensor Systems connect. Two more cards, called Serializers, host a MPSoc Zynq Ultrascale+.



SCU main OPI.

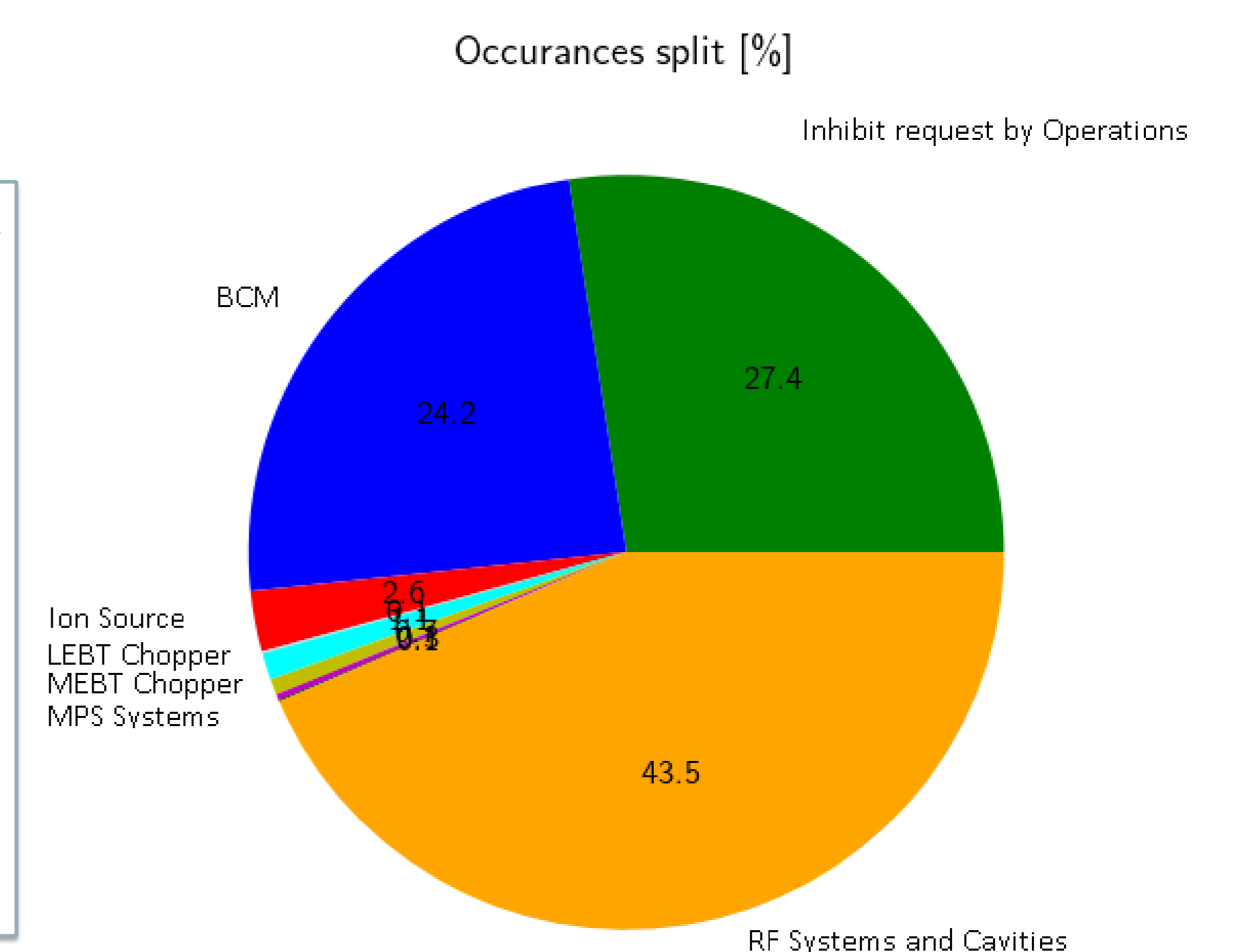
Input systems: PSS, BCMs, BPMs, RF LPS, MPS systems ...

Actuators: LEBT & MEBT Chopper, Magnatron, HV Power Supply



The percentage of available beam time w.r.t the time when the beam was off due to the FBIS (and/or) operator request. The intended stops were counted for planned accesses and scheduled stops. The time with Beam ON represents time spent with studies on various destinations in the ESS linac.

ESS NCL commissioning trips split by the FBIS input. The dominant part is intended by operations usually used for machine configuration adjustments. The next three players are inputs related to the RF systems, Beam Current Monitor, and Ion Source. The remaining < 6% covers all other active inputs.



Conclusions

The FBIS has been fully operational for the NCL commissioning to the DTL4 Faraday Cup. Beam stops were triggered when necessary for machine protection purpose, but also in many more circumstances. A rough minimum availability of the machine can be estimated around 60% the ratio between the Beam Off (22.1% + 17.3% of total time) and the total time of the commissioning. When running in full operation, the machine availability is foreseen to be above 95%. This will be achievable by reducing drastically access time, by reducing the time to restart beam thanks to more advanced post-mortem analysis tools, and by making more use of the inhibit feature of the FBIS that allows automatic recovery of the GBP, in particular for the RF systems.

Acknowledgements

Zurich University of Applied Sciences for their contributions to the development of the Fast Beam Interlock system.