

VELO Safety system (VSS)



Old VSS
New VSS
BCM
Vacuum
Motion
Cooling
Infrastructure
CIBU
Sector valves
Module T
Em. buttons

- Task of VSS: generate relevant actions on occurrence of unwanted events to prevent damage to the equipment.

New VSS based on following concepts:

- Is organized hierarchical.
- All signals are implemented failsafe.

In this presentation only safety matrix items which have a relation to LHC will be presented

Has a hybrid structure due to lack of time and manpower in the past and distributed responsibilities. Has three main components:

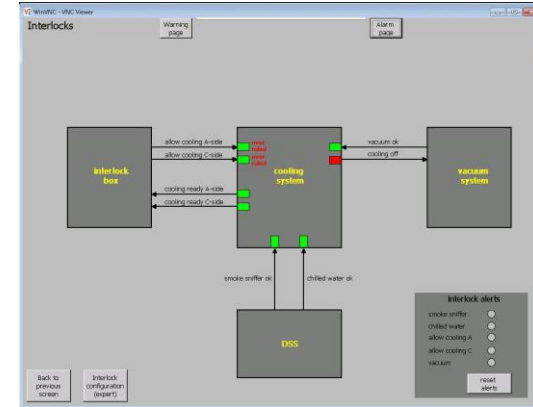
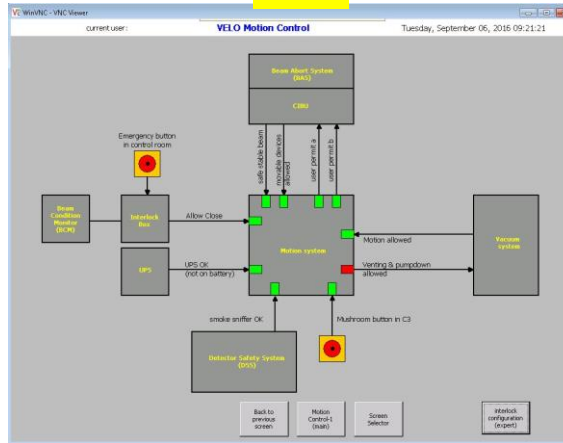
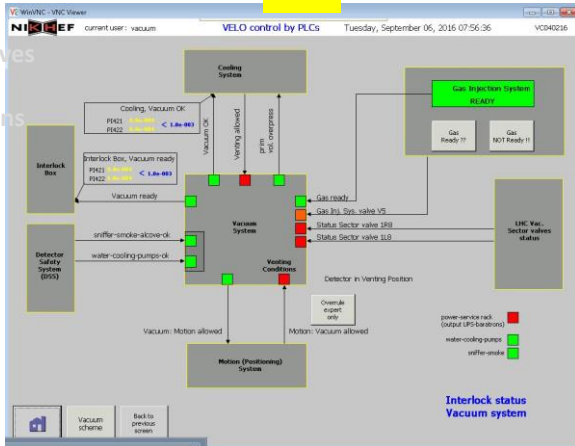
- Via signals running directly between the PLCs for vacuum, motion and cooling.

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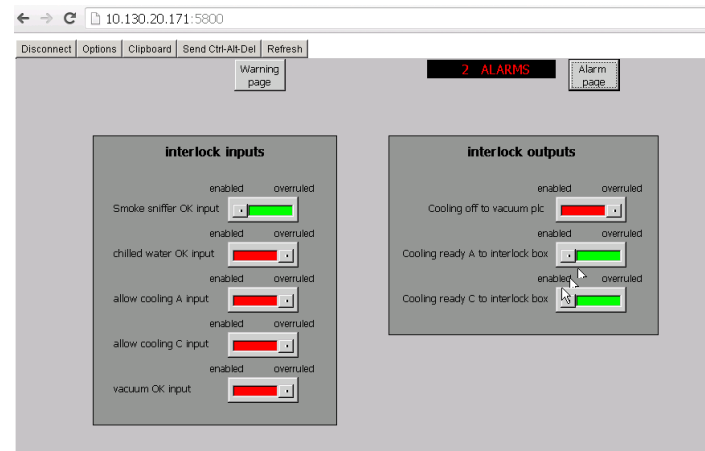
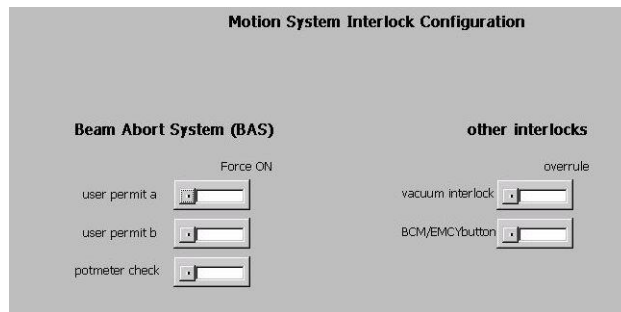
V

M

C



- Special pages to manipulate conditions related to the motion and cooling



Old VELO safety system (2)

- Via the **Interlock Box** = a stand-alone FPGA that can inhibit (parts of) the LV and HV systems

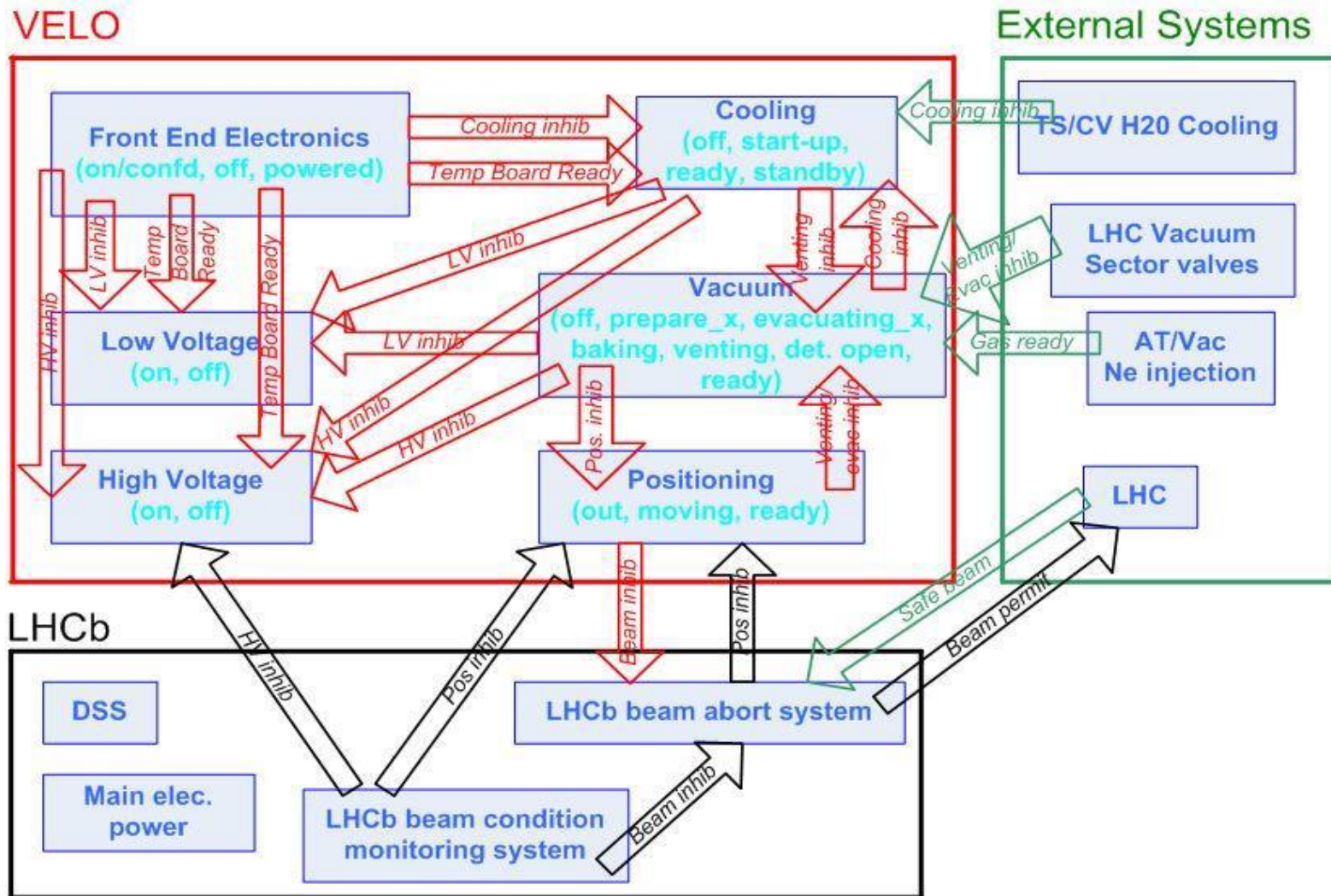


Old VELO safety system (3)

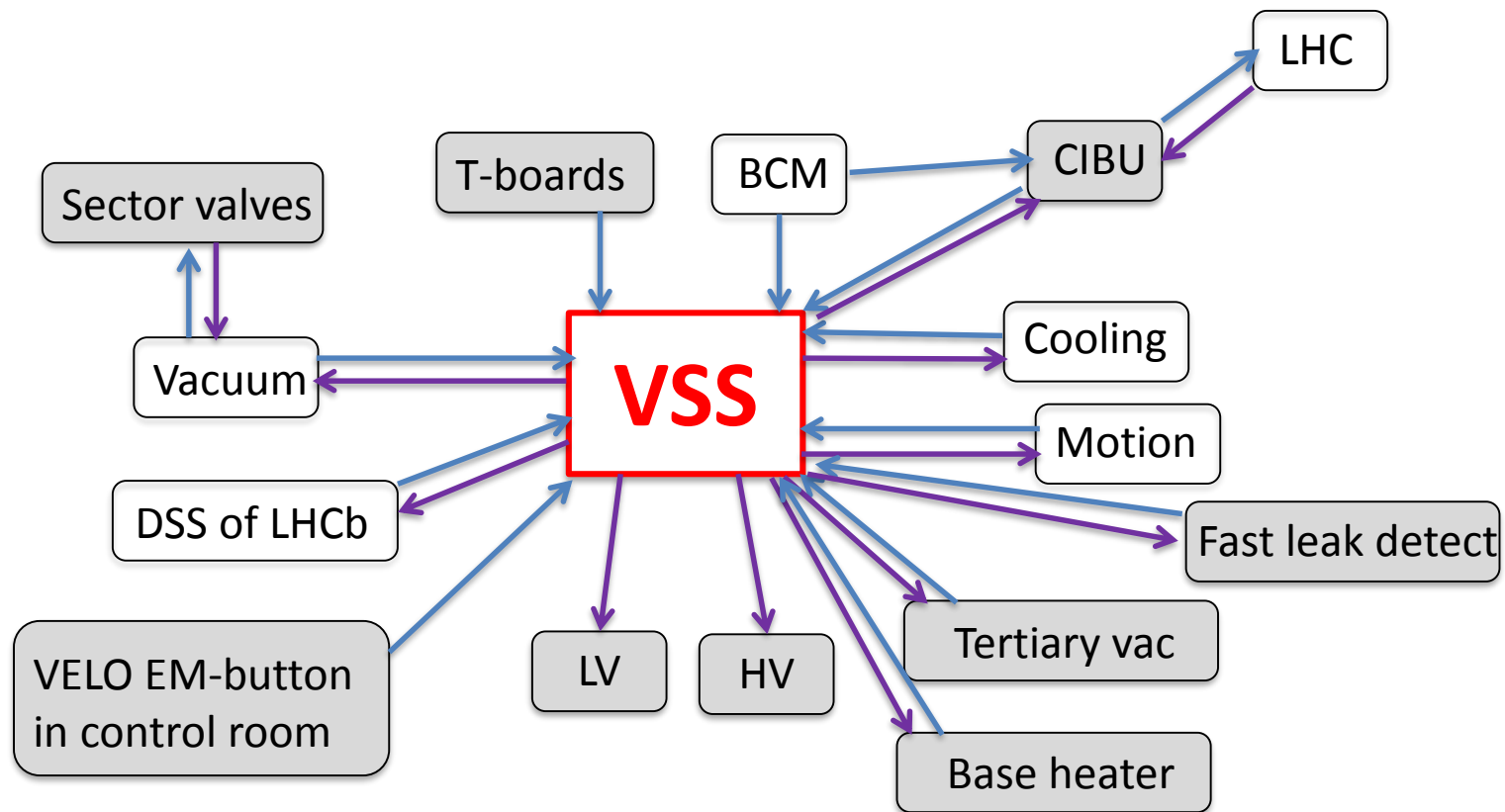
All sub-systems and their mutual dependencies

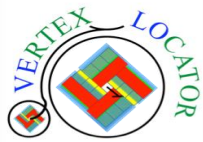
Old VSS

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Consists of one central node where all inputs and outputs will come together.





Actions on inputs to VSS – overview



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line#	from device to VELO safety system (VSS)	index	#	signal	good state	LV modules	LV A/C side	LV all	HV A/C side	HV all	sector valves	CIBU	vacuum system	motion system	cooling system
1	BCM	1	1	BCM OK	TRUE					Off				move out	
2	VELO-vacuum	1	1	VELO vacuum OK	TRUE					Off	do not open			no move	go to warm
3		2	1	NEON OK	TRUE										
4		3	1	≥1 ion pump(s) ON (could stay inside vac-ctrl *)	TRUE						not open or not close				
4b (new)	(tertiary vac controlled by VSS)	3b	1	tertiary vac ok	TRUE			Off							go to warm
4c		4	1	pressure sensors detects NO leak in secondary	TRUE			Off		Off					Close safety valves on circuits
5	VELO-motion	1	2	VELO A/C is OUT	TRUE							no beam injection			
6		2	2	VELO A/C is CLOSED	TRUE								no vent/evacuate		
7	VELO-cooling	1	1	pre-operation	TRUE										
7b (new)		1b	1	not on backup mode (both UT and VELO on its own plant)	TRUE										
8		2	1	full cooling power available (not on backup chiller)	TRUE			Off		Off					
9		3	1	cooling A-side ready	TRUE		Off		Off						
10		4	1	cooling C-side ready	TRUE		Off		Off						
11	LHCb infrastructure	1	1	chilled water OK	TRUE										
12		2	1	sniffer alcove OK (or emergency button @ctrlroom)	TRUE			Off		Off				move out	
13	CIBU	1	1	Stable Beams (SSB) OK	TRUE							dump beam, if VELO A/C is not OUT		move out	
14		2	1	MDA (OR of stable and unstable beam) signal OK	TRUE										
15	sector valves	1	2	both sector valves are closed (could stay inside vac-ctrl *)	TRUE								no vent/evacuate		
16	valve V5 of GIS (start/stop of Ne flow for VELO/BP)	1	1	V5 is open (could stay inside vac-ctrl *)	TRUE								no vent/evacuate		
17		2	1	manual switch to start Ne venting: Gas Ready (could stay inside vac-ctrl *)	TRUE								no vent/evacuate		
18	Module/pipes temperatures	1	86	CO2 temperature sensors OK	TRUE		Off		Off						
19		2	16	foil temperature sensors OK	TRUE				Off	Off		dump beam			
20		3	24	Hybrid NTCs HIGH OK	TRUE	Off			Off						
21		4	24	Hybrid NTCs LOW OK											
22	Emergency button Control Room	1	1	EM-button DSS NOT pressed	TRUE			Off		Off				move out	
		2	1	EM-button interlock box NOT pressed	TRUE			Off		Off				move out	
23	Water cooling for Turbo pump	1	1	pump running OK (could stay inside vac-ctrl *)	TRUE										
24 (new)	ctrl of heater on VELO base (T-sensors & PSU)	1		Base T not ok	TRUE										go to warm

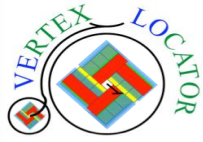


Output (actions) lines of VSS – overview



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line#	from VELO safety system to device	index	#	signal	good state
1	VELO-vacuum	1	1	Venting allowed	TRUE
2		2	1	Pumping allowed	TRUE
3	VELO-motion	1	2	Staying closed allowed	TRUE
4		2	2	Movement allowed	TRUE
5	VELO-cooling	1	1	Cooling cold allowed	TRUE
5b (new)		1b	1	Cooling plant running allowed	TRUE
6		2	1	Cooling flow allowed	TRUE
7	LHCb infrastructure	1	1	keep VELO racks powered	TRUE
8	CIBU	1	1	USER permit A (for circulating beam A) given	TRUE
9				USER permit B (for circulating beam B) given	TRUE
10	LV system	1	1	inhibit not activated	TRUE
11	HV system	1	1	inhibit not activated	TRUE



Actions on inputs to VSS - Vacuum



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1.) VELO Vac not OK .and. NEON not OK:

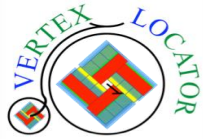
means air inside

Actions:

- Switch cooling to warm
- Interlock HV
- Interlock LV
- No Move
- Do not open sector valves (done inside vac ctrl system)

Remarks:

- VELO no movement: since with Ne or air inside movement could produce pressure difference between beam- and detector volume.
- Normally in this case VELO is always open.



Actions on inputs to VSS - Vacuum



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2.) VELO Vac not OK .and. NEON OK:

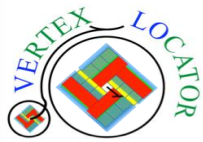
means Neon inside

Actions:

- No Movement
- Do not open sector valves (done inside the vac ctrl system)
- Interlock HV

Remarks:

- VELO no movement, since with Ne or air inside movement could produce pressure difference between beam- and detector volume.
- Normally in Ne case VELO is always open.
- Not sure that Neon inside is good for HV? (Martin v. B.), maybe need a PVSS overrule button for this interlock for commissioning purposes.



Actions on inputs to VSS - Vacuum



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3.) no ion pump ON:

Actions:

- Do not open and do not close sector valves (done inside vac ctrl system)

Remarks:

- Don't open sector valves (LHC wants us to pump with at least one ion pump on the beam volume before they will allow the sector valves to be opened).
- If they are open, don't close automatically (to permit SMOG-operation).

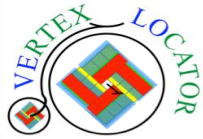
4.) Instant CO₂ leak detection system detects leak in secondary vacuum:

Actions:

- Close safety cooling valves and open bypass cooling valve
- Interlock HV
- Interlock LV

Remarks:

- VSS is giving signals to pressured air system to shut down individually 26 safety valves (+1 valve to be opened for bypass) via valve relays.
- Individual manual control needed for commissioning & if we have a constant leak inside one circuit.
- What else do we do: sector valves? (this will have other issues e.g. if there is beam).
- Fast leak detection system will use several inputs.



Actions on inputs to VSS - Motion



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1.) VELO A/C side is NOT out:

Actions:

- NO beam injection

Remarks:

- Inhibit beam a&b injection if VELO is NOT out.

2.) VELO A/C side NOT closed:

Actions:

- Inhibit venting or evacuating

Remarks:

- No venting and no evacuating. (Martin Doets wants to have the 2 RF foils closed when venting/evacuating. Two touching foils are reducing the risk of bursting in case of a higher pressure inside detector volume.)
- if system stops during pumping/evacuating, it switches to “balancing mode”: it regulates ΔP to be $[-5,+2]$ mbar. To do so, it needs to pump at beam volume or add Ne to beam volume.

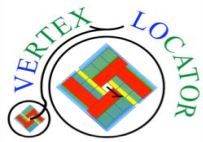
1.) Stable Beam Flag (SSB) NOT OK:

Actions:

- Dump beam if VELO A/C side is not OUT
- Move VELO out

Remarks:

- If SSB not ok (means: Adjust or Unstable Beams (state will be in future discarded?)) .AND .if VELO A/C is not completely OUT, then move VELO out and dump beam.
- In old VELO:
 - if Unstable Beams (MDA ok, SSB not ok, this state has never been seen): if VELO not completely out, move out.
 - if Adjust (MDA not ok, SSB not ok): if VELO not completely out, move VELO out and dump beam.



Actions on inputs to VSS - CIBU



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2.) Movable Devices Allowed Flag (MDA) NOT OK:

Actions:

Remarks:

- No more used in new VSS matrix (see before).
- Change logic as well in closing manager.

Actions on inputs to VSS – Sector Valves

1.) Not both sector valves are closed:

Actions:

- Inhibit venting and evacuation (done inside vac ctrl system)

Remarks:

- Info about this signal should be visible in VSS for monitoring.

Actions on inputs to VSS – Valves

1.) valve V5 of GIS (start/stop of Ne flow for VELO) is CLOSED:

Actions:

- Inhibit venting and evacuation (done inside vac ctrl system)

Remarks:

- If V5 is CLOSED, do not start venting procedure (anyway not possible!)
- If V5 is CLOSED, do not pump, since if system stops during pumping, it switches to “balancing mode”: it regulates deltaP to be [-5,+2] mbar. To do so, it needs to be able to pump at beam volume or add Ne to beam volume.
- Info about this signal should be visible in VSS for monitoring.

Actions on inputs to VSS – Valves

2.) s/w switch of GIS to start Ne venting is OFF: GIS NOT Ready

Actions:

- Inhibit venting and evacuation (done inside vac ctrl system)

Remarks:

- Switch is there to prevent venting/evacuation, if GIS is NOT READY, although V5 is OPEN.
- If GIS is not READY, do not start venting procedure (anyway not possible!)
- If GIS is not READY, do not pump, since if pump/evacuate procedure stops, system switches to “balancing mode”: it regulates deltaP to be [-5,+2] mbar. To do so, it needs to pump at beam volume or add Ne to beam volume.
- Info about this signal should be visible in VSS for monitoring.

Actions on inputs to VSS – VELO-Temperature

2.) One of the 16 temperature of T-sensors at RF-foils not OK:

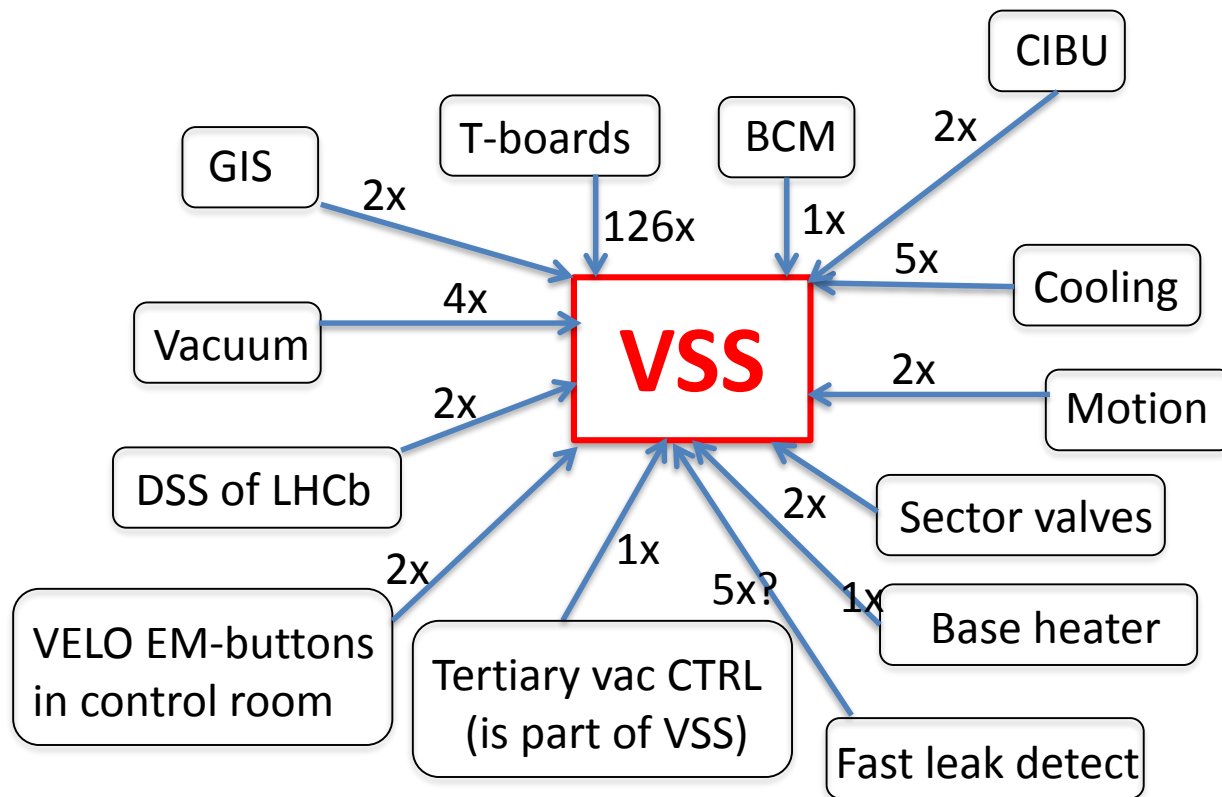
Actions:

- Interlock LV
- Interlock HV
- Dump beam

Remarks:

- Granularity tbd.
- Could move VELO in since T is higher when VELO is out (Eddy's presentation 2/8/2013), but best is dump beam.

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- For the logic, VSS is almost a direct of copy of the old VELO safety system.
- What stays vacuum-internal control has been agreed “(done inside vac ctrl system)” (need official statement).
- Implementation details in the next+ talks.