Ion source operation and interventions during the Reliability Run

- Linac4 H^- sources:
  - IS03a (6.5 mm, Einzel 30 kV): 50 mA but poor transfer through LEBT and too large emittance. RFQ trans ~80% peak.
  - IS03b (5.5 mm, Einzel 43 kV): 35 mA, LEBT transfer Ok, emittance up to 27 mA Ok but Hollow beam.
  - IS03c (AlN, 6.5 mm, 43 kV, reduced filter field strength) being assembled, in its Al_2O_3 version faced challenging Helicoflex leaks. Not tested yet but should be ready by end of HST.
- L4IS Expectations form R^2 :
  a) Test of the Autopilot regulations (must be tuned to each IS-prototype)
  b) Test of Autopilot-restart procedures (HV and RF)
  c) Measure Availability via Autopilot logs
  d) Starting with IS03c: 3 prototypes at 2-3 month intervals including 2 weeks start up + 2 days dedicated RFQ transmission measurements

Monitoring of the Linac4 H⁻ source availability / reliability

Autopilot test cases

FAILURE CATALOGUE				Access	0.5	h	Reliability
SECTION: **Linac4**	FAILURE MODE	LOCATION OF BEAM LOSSES	SEVERITY (** *mitigation*)	Beam time : 330 J/y Maintenance: 25 J/y Cesiation: 3h/month			97.9%
1) SOURCE	H- beam not available or below nominal intensity	Source / LEBT	Low ?	MTTR [h]	Mean down time	period [y]	162.7
1.1) Hydrogen	Hydrogen delivery system	Plasma generator		3	3.5	3	1.2
	Hydrogen pulser	Plasma generator		3	3.5	1	3.5
1.2) RF- source	LLRF controller	Plasma generator		2	2	2	1.0
	RF-amplifier	Plasma generator		6	6	1	6.0
	Matching network connection	Plasma generator		1	1.5	3	0.5
	RF-antenna - air ionization	Source	** New PG	24	24.5	3	8.2
1.3) Plasma Generator	plasma generator leak	Plasma generator		24	24.5	2	12.3
	Plasma electrode Bias power supply		** short circuit Bias	1	1.5	2	0.8
	permanent magnets			24	24.5	3	8.2
	Vis ceramique			24	24.5	3	8.2
1.4) Source High Voltage	10 kV Puller-dump transformer	Source		3	3.5	3	1.2
	45 kV HV transformer	Source		3	3.5	3	1.2
	25/45 kV Einzel Lens transformer	Source		3	3.5	3	1.2
	Fron-end insulator	Source		72	72.5	3	24.2
	10/25/45 kV converter	Source		3	3.5	1	3.5

FAILURE CATALOGUE				Access	0.5	h	Reliability
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1) SOURCE	H- beam not available or below nominal intensity	Source / LEBT	Low ?	MTTR [h]	Mean down time	period [y]	162.7
1.5) Cesiation source	Cs-heating system			1	1.5	2	0.8
	Air cooling system			1	1.5	2	0.8
	Cs-valve motorization		** Manual open/close	1	1.5	1	1.5
1.5) Source vessels	Flange leak	Source		24	24.5	3	8.2
	Front-end leak	Source		72	72.5	3	24.2
1.6) Source vacuum	TM pump			3	3.5	2	1.8
	Roughing pump			3	3.5	3	1.2
	Vacuum gauge		** use a different gauge	1	1.5	1	1.5
	Vacuum valve			24	24.5	3	8.2
	Vac-Interlock	Source	** use a different gauge	3	3.5	1	3.5
1.7) Source Controls	BCT-LEBT			3	3.5	1	3.5
	PLC-Hardware / software			8	8	1	8.0
	FESA-software			8	8	1	8.0
	Autopilot software		** Manual operation	8	8	1	8.0
1.8) FC access system	PLC	Source		3	3.5	3	1.2
	doors Micro-switches	Source	** Manual operation	3	3.5	2	1.8

Status, Conclusion, Outlook

- The source beam intensity is close to what was announced as nominal for the cesiated surface prototype.
- The emittance suffers form the LEBT and from a hollow beam, there is no evidence that the RMS value of 0.25 π·mm·mrad can be achieved.
  - The test stand today delivers an emittance, the positive signals is dominated by SEY, its linearity is questionable. The grids cannot be used besides beam centring.
- Precision measurement is mandatory to measure the impact of hardware "improvement" on beam emittance
  - Impaired by inhomogeneity of wire response, unknown SEY. Major temperature variation in the hall that cannot be compensated lead to instability even at the 1 hour meas.-duration scale.
- The tool for monitoring the availability and reliability of components (HV, RF) will be ready for the Reliability-run.
- Organisation of Interventions:
  - The list of possible interventions exists, reaction time to failure and down time measurement shall provide feed back

- What will be the beam intensity and pulse length during the run?
  - 30-40 mA, 200 μs SCC followed by 600 μs beam
- What will be the schedule (technical stops, shutdown, etc.)?
  - 3 periods separated by 2-3 weeks IS exchange
  - 3-6 cesiations per running period
- Who will check the beam parameters, which ones need to be controlled, and what will be the threshold to declare a fault?
  - Autopilot + Timber, warning for beam below 90% nominal, fault below 80%
- What will happen when a fault is declared?
  - Reduced intensity triggers decision meeting, no beam triggers intervention.
- Who will come to Linac4 and when if the machine is «on fault»?
  - There is no IS piquet. All actions by Autopilot or operators. IS-team during working hours.
- Who will do the «post-mortem» of the faults, how the information will be structured and communicated, and who will decide/implement actions?
  - IS team will present the result of each period to the Commissioning team. Actions will be proposed by the IS-team, decision by the com-team.