The Slow Extraction Survey

Institution:	Institute for High Energy Physics (IHEP) of NRC “Kurchatov Institute”	
Machine:	Proton synchrotron U-70	
Machine acceptance:	230 mm·mrad (on-momentum)	
Beta function at the septum:	50 m after applying dedicated trim quads in the CF machine. Otherwise, 22 m.	
Type of Beam:	Protons	Carbon nuclei
Energy/nucleon:	50–70 GeV	25–35 GeV per nucleon
Current in machine (A):	0.3 A	
Beam emittances	1.4–2 mm·mrad, 95%, both planes	
Momentum spread dp/p:	$\pm(0.8–1)\cdot10^{-3}$	
Incoherent tune shift		
Beam bunched/unbunched:	Unbunched at flattop extraction	
Resonance used:	$3Q_x$ = 29 with WP Q_x = 9.7–9.9	
Chromaticity correction:	Available, correction coils in the CF bending magnets	
Feedback system:	Beam feedback, Low-pass (DC and AC coupled). Closed via a CO bump or a Noise amplitude, depending upon feeding option.	
Other control schemes used:	No feed forward inputs (found redundant)	
Extracted intensity (N/S):	$(2–10)\cdot10^{12}$ in 1.0–2.5 sec, on user demand	
Slow Extraction Efficiency %	90–94%, best values	
Beam loss at the septum %:	Not recorded specifically	
Beam loss: Rest of the machine %	4% through entire ramp cycle with transition crossing	
Slow Extraction length (s):	1.0–2.5 sec	
Micro Spill quality:	Stochastic extraction. Diffusion in momentum with anintermediate non-random “chimney” layer of empty auxiliary RF buckets overlapping the resonance. No lines of 50 Hz and multiples in amplitude spectrum. No cut-offs. Ratio min : average : max = ½:1:2 ca. Best reduced σ^2 = ¼ ca. Beyond external active control at about > 100 Hz.	
Spill variations:	In DC – operationally, $(2–10)\cdot10^{12}$ protons per a spill under sequential beam sharing	
Required spill quality:		

Required spill stability:	
Notes, observations:	