



Brainstorming meeting on a possible biomedical facility at CERN - LEIR Overview

Contributions from many people: D. Abler, C. Carli, S. Damjanovic, M. Dosanjh,
A. Garonna, D. Küchler, J. Stafford-Haworth ...

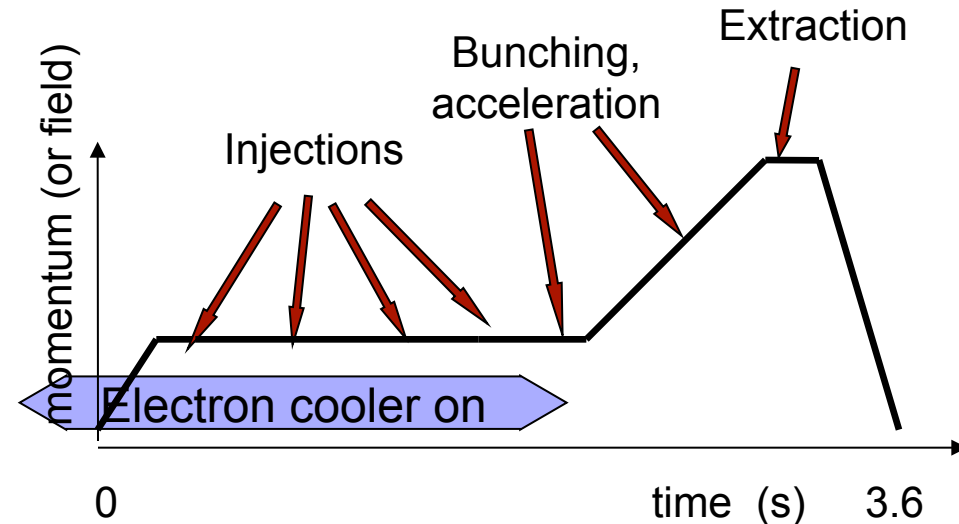
- Present LEIR Ring
- Biomedical facility at LEIR
- Present Ideas, Studies and Status

Present LEIR Ring



LEIR for LHC:

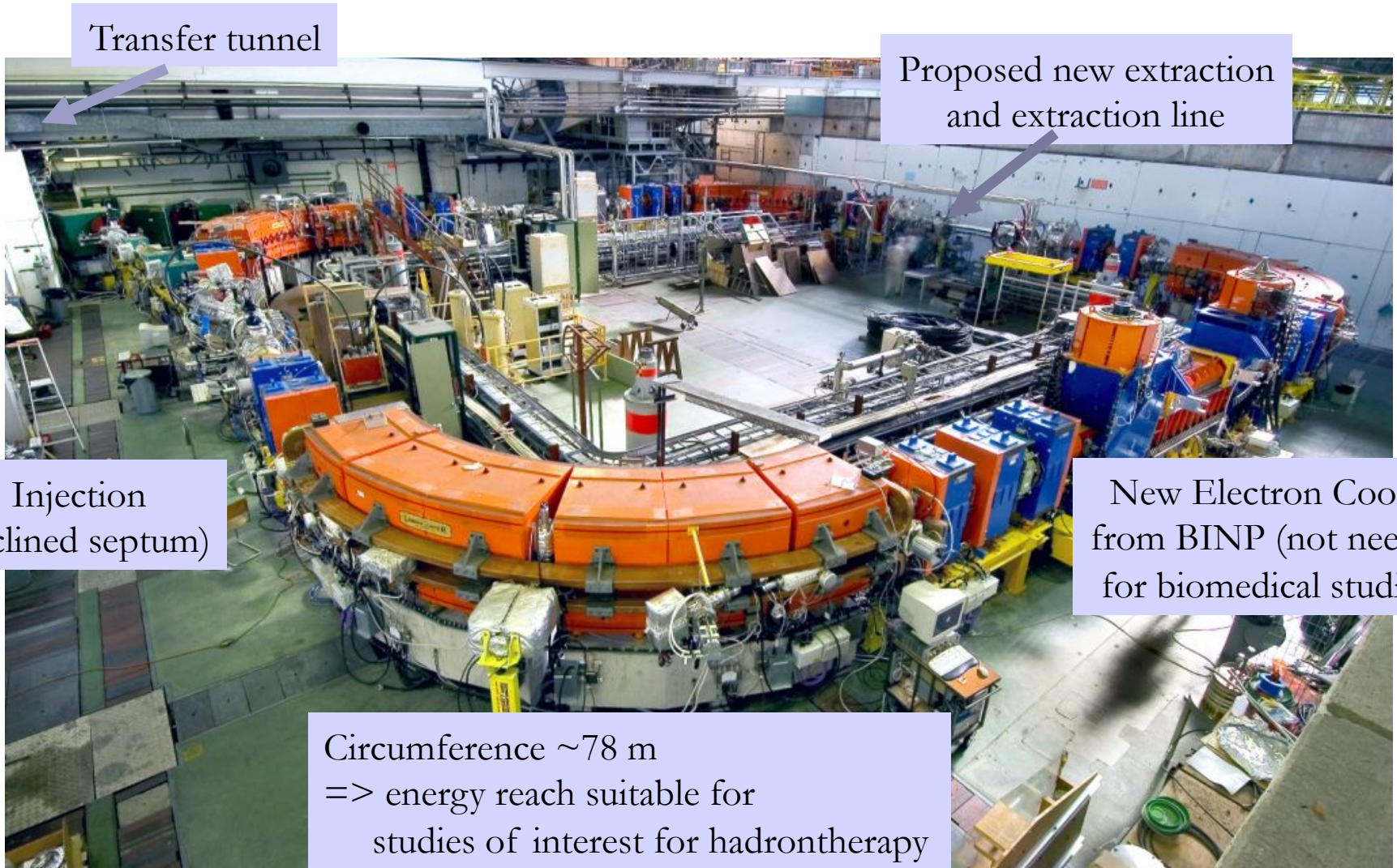
- Low energy heavy ion (Pb^{54+} in LEIR, later stripped to Pb^{82+})
- Transforms several long low density Linac3 pulses from LHC into dense bunches useful for LHC
- Ion chain of pre-LHC (for fixed target SPS experiments) not suitable for LHC
- Proof of principle experiments in 1990ies
- Commissioned in 2005 and 2006
- In between plans for “lighter” ions (Ar and Xe) in SPS (possibly LHC)
- Successful operation for LHC and fixed target SPS ion physics in 2010 and 2011



Nominal LEIR cycle lasting 3.6 s :

- Bring machine in a state suitable for beam,
- Accumulation alternating :
 - Multiturn injection with horizontal, vertical and longitudinal stacking : 70 turns ($\sim 200 \mu\text{s}$) with $>50\%$ efficiency,
 - Fast (~ 200 to 400 ms) electron cooling with a new state-of-the-art cooler
- Bunching ($h=2$) and acceleration during ~ 1 s and (fast) extraction

Present LEIR Ring



Transfer tunnel

Proposed new extraction
and extraction line

Injection
(inclined septum)

New Electron Cooler
from BINP (not needed
for biomedical studies)

Circumference ~ 78 m
 \Rightarrow energy reach suitable for
studies of interest for hadrontherapy

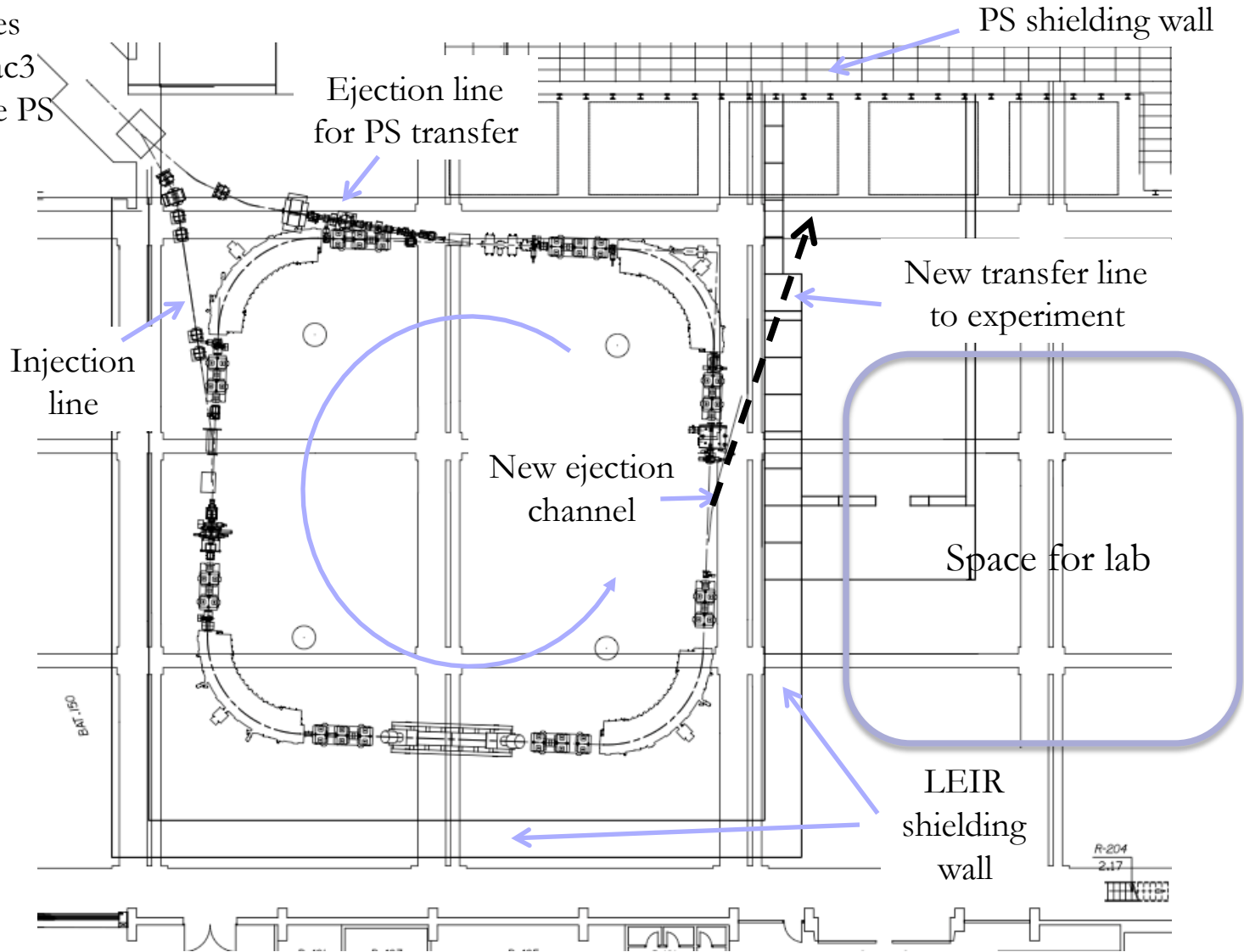
Biomedical facility at LEIR



- First discussed at the “Physics for Health in Europe Workshop” at CERN in February 2010 and again early this year
 - Provide beams for experiments in support of treatment centers
 - Radiobiology, investigations with different ion species (up to O ... or even higher atomic numbers)
 - Fragmentation studies, dosimetry
- LEIR well suited for such an installation
 - Not (yet?) used all the time
 - Additional proposals coming up for LEIR, scheduling a likely issue
 - Additional Linac3 source (and RFQ) to allow radiobiology between LHC fills
 - Additional Linac3 source preferable to provide beams during LHC ion “coasts”
 - No other machines (PS) required ... minimum impact on other CERN programs
 - Energy reach of LEIR appropriate for such experiments
 - Fully stripped 12C or 16O up to 240 MeV/n with present main power supply
 - Up to 430 MeV/n (magnet limit) with a new main power supply
 - Limitations from radio-protection (higher energy with higher Z/A for light ions) likely, very first study to be completed with updated input
- Infrastructure to be provided

Biomedical facility at LEIR

Transfer lines
- from Linac3
- towards the PS



Present Ideas, Studies and Status



- Ion species and intensities per cycle (2.4 or 3.6 s)
 - based on Linac3 source proposal (7.5 keV/n at RFQ entrance and injection of 5 efficient turns in LEIR, no cooling)
 - He: LEIR limitation lower than Linac3 limit $\approx 8.5E10$ ions

Species	C	N	O	Ne
Intensity	$1.4 \cdot 10^9$	$0.4 \cdot 10^9$	$1.1 \cdot 10^9$	$0.25 \cdot 10^9$
 - Protons not trivial ... may-be either H_3^+ from Linac3 and stripping (with very low magnetic fields in LEIR) or at 50 MeV from Linac2 or Linac4?
- Linac3: options for another source
 - Source proper
 - Impact on beam dynamics
 - Implementation (timescale, installation work) might be an issue
- Extraction
 - Slow extraction easier to implement than fast one ... and more interesting for experiments
 - Details studied at present: 3rd order resonance excited by sextupoles, apertures in ring and extraction channel, methods to obtain spill (variation of quadrupole currents, longitudinal or transverse excitation),
- Transfer line: about to be started, may-be a vertical low energy line plus a horizontal line, large field at experiment
- Next step once requirements clear: discussions with hardware experts