Alternative bridge concept: **from LHC to μCollider**

Some tentative thoughts before discussions/toward White Paper

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Preamble

- HL-LHC stops in 2041 (or later) and there is **no real need** to decide now very long-term future of CERN
- **In 10 years** (or more) one can make proper decision
- However, *Phase One* LHeC at 20 GeV should be decided **very soon**, and that is compatible with **both** "bridge scenarios" – towards FCC or μCollider
- LHμC as "demonstrator" for μCollider/**part of its infrastructure** (with LHeC)

LHeC *vs.* LHμC: Physics and Detector Aspects

LHμC

- **Much larger Center-of-Mass Energy**, but non-negligible event pileup (peak $\mu \lesssim 1$)
- **Multi-TeV muon precision** detectors required, but at much **lower** collision rate
- **Symmetric** detector design (à la Atlas/CMS)
- **Large backgrounds** from muon beam decays but **negligible SR**
- (No beam polarization?)

LHeC *vs.* LHμC: Physics Case

from Laurent

Proton energy, E_p	7 TeV			
Electron energy, E_e	50 GeV		20 GeV	
Electron polarisation, P_e	0	−0.8	0	−0.8
$\sigma(e^- p \to H\nu_l + \text{jet} + \text{X})$ [fb]	73	164	21	52
$\sigma(e^- p \to e^- H + \text{jet} + \text{X})$ [fb]	14	19	3.4	5.6
$\sigma(e^- p \to e^- t\bar{t} + \text{X})$ [fb]	26	28	0.93	0.99
$\sigma(e^- p \to \nu_l \bar{t} + \text{X})$ [pb]	1.7	3.1	0.28	0.51

Proton energy, E_p	7 TeV	
Muon energy, E_μ	1 TeV	2 TeV
Muon polarisation, P_μ	0	
$\sigma(\mu^+ p \to H\bar{\nu}_l + \text{jet} + \text{X})$ [pb]	0.7*	1.1*
$\sigma(\mu^+ p \to \mu^+ H + \text{jet} + \text{X})$ [pb]	0.1*	0.1*
$\sigma(\mu^+ p \to \mu^+ t\bar{t} + \text{X})$ [pb]	4.7	10.3
$\sigma(\mu^+ p \to \bar{\nu}_l \bar{t} + \text{X})$ [pb]	57.6	100.5

+ strong **γγ case** → Hamzeh's talk

&

ν Factory, with associated "ν–flux problem"

LHeC *vs.* LHμC: Collider Aspects

LHμC

1. Could CERN/Europe/EU strengthen ultra-cold μ^+ effort at J-PARC?
2. Further optimization to maximize performance, also by **adding components**
   ⇒ aim at luminosity towards **$10^{34}\,cm^{-2}s^{-1}$**
   - **Larger *p* bunch charges** possible thanks to 4 MHz collision rate?
   - (Stronger *p* focusing with crossing angle/shorter bunches?)
   - Booster, thanks to some extra cavities ⇒ about 30 GeV per pass
     ⇒ **larger colliding μ-bunch charge**
   - Ultra-cold source ⇒ #bunches ×2 = 80 ⇒ 2 MW RCS at 3 GeV and **25 Hz**

LHeC + LHμC: Next steps

Two urgent questions for last session today

- Do we start preparing (asap) *White Paper* on very powerful synergy and numerous merits of combined LHeC and LHμC projects? It is important to make together **common case** towards HEP community – new results are not so much needed at this stage, but we could outline various exciting and significant possibilities

  ⇒ *High energy lepton-hadron collisions at CERN?*

- Once we (very?) soon release it – to still have some impact on ESPPU – we call for proper **kick-off meeting?** When?