Preliminary cost estimates

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- **Phase 1 (preliminary)**
- **Phase 2 (very preliminary…)**

Phase 1
("Test phase")

Phase 1: description*

* For details, look at the other contributions to this workshop

- "Global" crab scheme
- 1 cavity per ring in P4, at a location reserved for ACN (200 MHz) cavities or for spare damper(s)
- Infrastructure requirement (per cavity):
  - RF:
    - ~ 50 kW CW at 800 MHz (IOT-based unit, as foreseen for the SPS upgrade) installed in a technical gallery
    - Cavity interlocks + Tuning loop + Low Level RF for amplitude and phase stabilization + Controls
  - Cryogenics:
    - Preferably 2 K temperature (He volume < 50 liters)
    - 50 Watt @ 2 K per cavity (or 500 W at 4.6 K)

Phase 1: cost estimate (1 cavity)

RF	**High power amplifier (including power supplies) and circulator**	**380**	**kCHF**
	Infrastructure (civil engineering, cables and pipes)	**330**	**kCHF**
	Low Level RF, interlocks and control system	**200**	**kCHF**
	Installation	**90**	**kCHF**
Cryogenics	**Option 1**: 2 K with new QRL service module [requiring removal and reinstallation of an ACS cryomodule + cuts and welds on QRL headers + global pressure tests for a complete sector (34 or 45)]	>500	kCHF
	Option 2: 4.6 K with modification of supply and return lines of QRL extension to an ACS cryomodule	80	kCHF

Total cost (1 cavity) – excluding cavity: **> 1.5 MCHF (2 K – option 1) or 1.08 MCHF (4.6 K – option 2)**

Reminder

1rst cavity module: **4 M$**

2nd cavity module: **2 M$**

Phase 2 ("Implementation phase")

Phase 2: attempt at a description*

* For more details, look at the other contributions to this workshop

- "Local" crab scheme at IR1 and IR5
- 1 (or 2 ?) cavity(ies) / ring on both sides of IP1 and IP5 [= 4 (8?) cavities / IP]
- Cavity type:
  - Either "Compact" at 800 MHz to fit within the 19cm separation between rings,
  - Or more probably at 400 MHz with a dogleg increasing the distance between beam pipes and ≥ 2 cavities / ring on each side of the IP…
- Infrastructure requirement:
  - Civil Engineering for hosting RF amplifiers and their power supplies
  - RF:
    - 8 (16 ?) x 50 kW CW at 800 (400 ?) MHz
    - Cavity interlocks + Tuning loop + Low Level RF for amplitude and phase stabilization + Controls
  - Cryogenics:
    - 2 (4.5 ?) K temperature

Phase 2: cost estimate (2 IPs)

Civil Engineering	**Include space for the CC systems in the new technical galleries for phase 2 of the LHC IR upgrade**	**?**	**MCHF**
RF	**8 (16 ?)x High power amplifiers (including power supplies) and circulators**	**3 (6 ?)**	**MCHF**
	Infrastructure (cables and pipes)	**2.4 (4.8 ?)**	**MCHF**
	Low Level RF, interlocks and control system	**1.4 (2.8 ?)**	**MCHF**
	Installation	**0.4 (0.8 ?)**	**MCHF**
Cryogenics	Include capability to cool the CC's into the new phase 2 cryogenics cooling systems of IR1 and IR5	?	MCHF

Total cost excluding cavities (very preliminary – certainly dominated by civil engineering which requires a detailed study): >> 10 MCHF

Cavities (guess…):

R & D for module hosting

2 (4?) compact 800 MHz cavities: 6 M$

Production of 4 modules (2 cavities/module): 12 M$

Phase 2: more (private) comments

- Planning and impact on physics data taking is likely to be more important than cost of construction:

⇒ **focus on being ready for Phase 2 of the LHC upgrade (2019?)**

⇒ **start asap the R & D for Phase 2 cavities**

- The cavities developed for Phase 1 cannot be used for Phase 2:

⇒ **why not start immediately with the R & D for Phase 2 cavities?**

- Civil Engineering is the cost driver:

⇒ **Invest enough in the Civil Engineering detailed study…**