BTL Buncher Options

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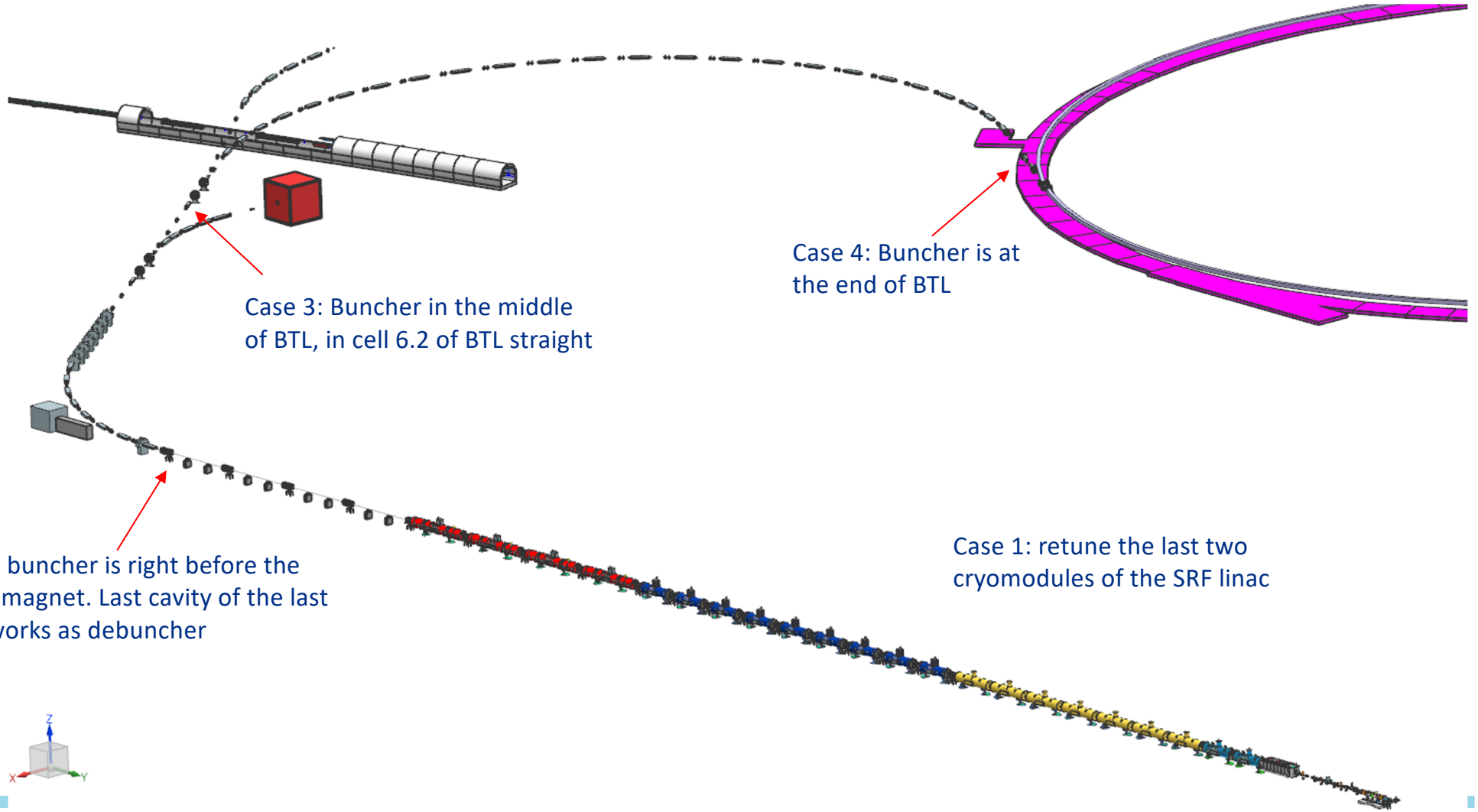
A Partnership of:
- US/DOE
- India/DAE
- Italy/INFN
- UK/STFC-UKRI
- France/CEA, CNRS/IN2P3
- Poland/WUST

Linac and BTL Layout with Buncher Options



Case 1: HB650 CMs Retuning

- Not recommended as the main option
  - Large tails, possible losses in BTL
  - Small energy spread reduction factor, up to 2
- But can be tried if nothing else is available
- Might not remove energy jitter

Case 2B: Buncher Before BTL

- Advantages
  - Can be added later without modifications (see comment about SRF)
- Disadvantages
  - Takes space of the beam switch yard/RF separator, requires higher voltage, benefits from retuning of the last HB cavity as a buncher, might not work well if two more HB CM added
- Voltage:
  - 5.5 MV with debunching last HB cavity,
  - 7.1 MV without
- Acceptable cavity type:
  - SRF, 650 MHz (HB650) or 1.3 GHz (LCLS)
    - SSA amplifiers 10-20 kW, requires cryogenic, long field rampup/rampdown time
    - This is not a particulate free area although the voltage is low
  - RT, 1%-2%, pulsed, 650MHz CCL or 1.3 GHz (?), two cavities
    - Requires Klystron, ~0.5-1MW total (Klystrons will be expensive one-item production)

Case 3: Buncher In the Middle of BTL

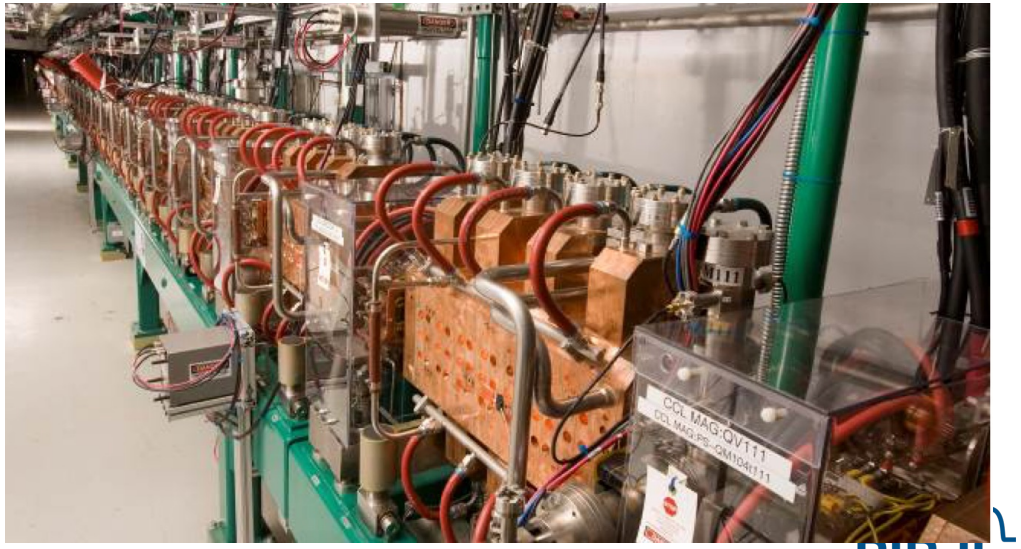
- The most optimal solution from the physics point of view, there is space in the beam line
- Disadvantages:
  - need to provide requirements to CF now, situated close to BAL and 25 kW dump
- Voltage: 2.3 MV @ 650 MHz
- Acceptable cavity type:
  - RT, pulsed 1% or 2%, 650MHz CCL or decoupled cell cavities (see Timergali's presentation), two 1m long cavities, 6-7 cells each
    - Requires SSA amplifiers (~40-50 kW per cavity), ~2 total for CCL or 14 5 kW units for induvial cell cavities

CCL Cavity Design

- CCL is a typical structure choice for semi-relativistic proton beams
  - Fermilab, SNS, Los Alamos (805 MHz)
- Advantages
  - Single coupler, low loss coax line, probe, control system per cavity – can be beneficial in case of limited space
- Disadvantage
  - A bit more complicated cavity, ~30% lower shunt impedance than individual cells

Fermilab CCL
1/4 of cavity with coupling cell

SNS CCL



Case 4: Buncher at the End of BTL

- Can require 325 MHz. 650 MHz still might be acceptable but can start producing nonlinearities in the beam distribution.
- Advantages
  - Requires lowest voltage, might have access to Booster facilities, can produce the smallest energy spread
- Disadvantages:
  - Might need 325 MHz cavity, requiring additional studies
- Voltage: 2 MV @ 325 MHz or 1 MV @ 650 MHz
- Acceptable cavity type:
  - RT, pulsed 1% or 2%, 650MHz CCL or decoupled cell cavities (see Timergali's presentation), one 1m long cavity, 6-7 cells
    - Requires 1 SSA amplifier (~40-50 kW) for CCL or seven 5 kW units for induvial cell cavities
  - Design 325 MHz cavities needs to be developed

Buncher Locations and Options Summary

	Case 1	Case 2B	Case 3	Case 4
Location	HB650 CM retuning	Buncher before BTL	Buncher in BTL around BAL	Buncher at the end of BTL
Frequency	N/A	650 MHz 1300 MHz	650 MHz 1300 MHz (maybe)	325 MHz 650 MHz (maybe)
Buncher Voltage	N/A	5.5 MV with debuncher 7 MV without @650 MHz	2.3 MV @650 MHz	~2 MV @325 MHz
Cavity Type	N/A	SRF RT	RT	RT
RF systems	N/A	SSA (SRF) Klystron (RT)	SSA	SSA