Phase-3 Commissioning Road Map

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B2GM 2018.10.15

Luminosity Target for Early Phase-3

- Until 2019.06
  - (1) 1.06 x 10^{34} $cm^{-2}s^{-1}$ (conservative ξy ~ 0.026)
    - βy* ~ 3mm collision with I ~ 1.2 x 1.0A
    - Increase beam current from phase-2 collision operation.
  - (1ex) 1.46 x 10^{34} $cm^{-2}s^{-1}$ (aggressive ξy ~ 0.033)
    - βy* ~ 3mm / σ*y ~ 670 x 830nm / I ~ 1.4 x 1.0A

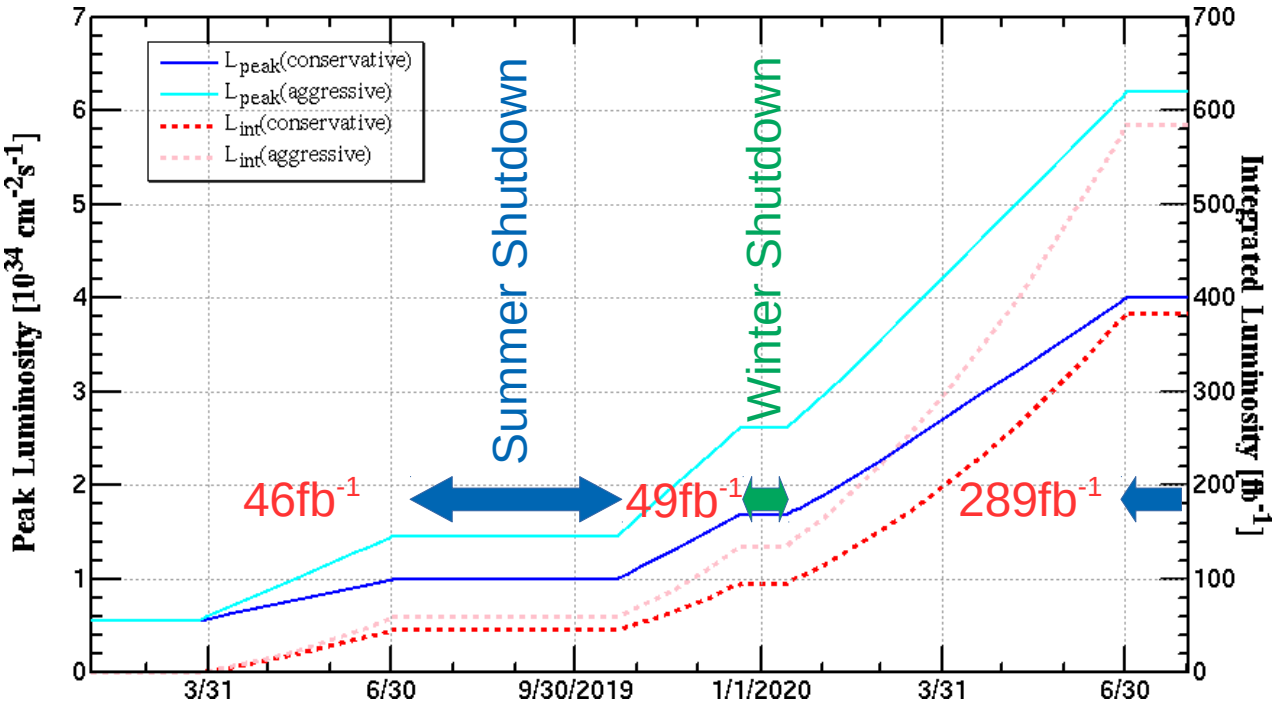
Note: ξy ~ 0.021 is achieved in phase-2.

- Around 2019.12 ~ 2020.02
  - (2) 2.08 x 10^{34} $cm^{-2}s^{-1}$ (conservative ξy ~ 0.028)
    - βy* ~ 2mm / σ*y ~ 525nm / I ~ 1.4 x 1.0A
    - Single beam & low current operation of βy* = 2mm optics is confirmed in phase-2.
  - (2ex) 3.14 x 10^{34} $cm^{-2}s^{-1}$ (aggressive ξy ~ 0.035)
    - βy* ~ 2mm / σ*y ~ 510nm / I ~ 1.7 x 1.2A
- Until 2020.06
  - (3) 4.00 x 10^{34} $cm^{-2}s^{-1}$ (conservative ξy ~ 0.030)
    - βy* ~ 1.4mm / σ*y ~ 440nm / I ~ 1.8 x 1.3A
  - (3ex) 6.20 x 10^{34} $cm^{-2}s^{-1}$ (aggressive ξy ~ 0.037)
    - βy* ~ 1.2mm / σ*y ~ 350nm / I ~ 2.0 x 1.4A

Luminosity Projection

L_{int} Assumptions

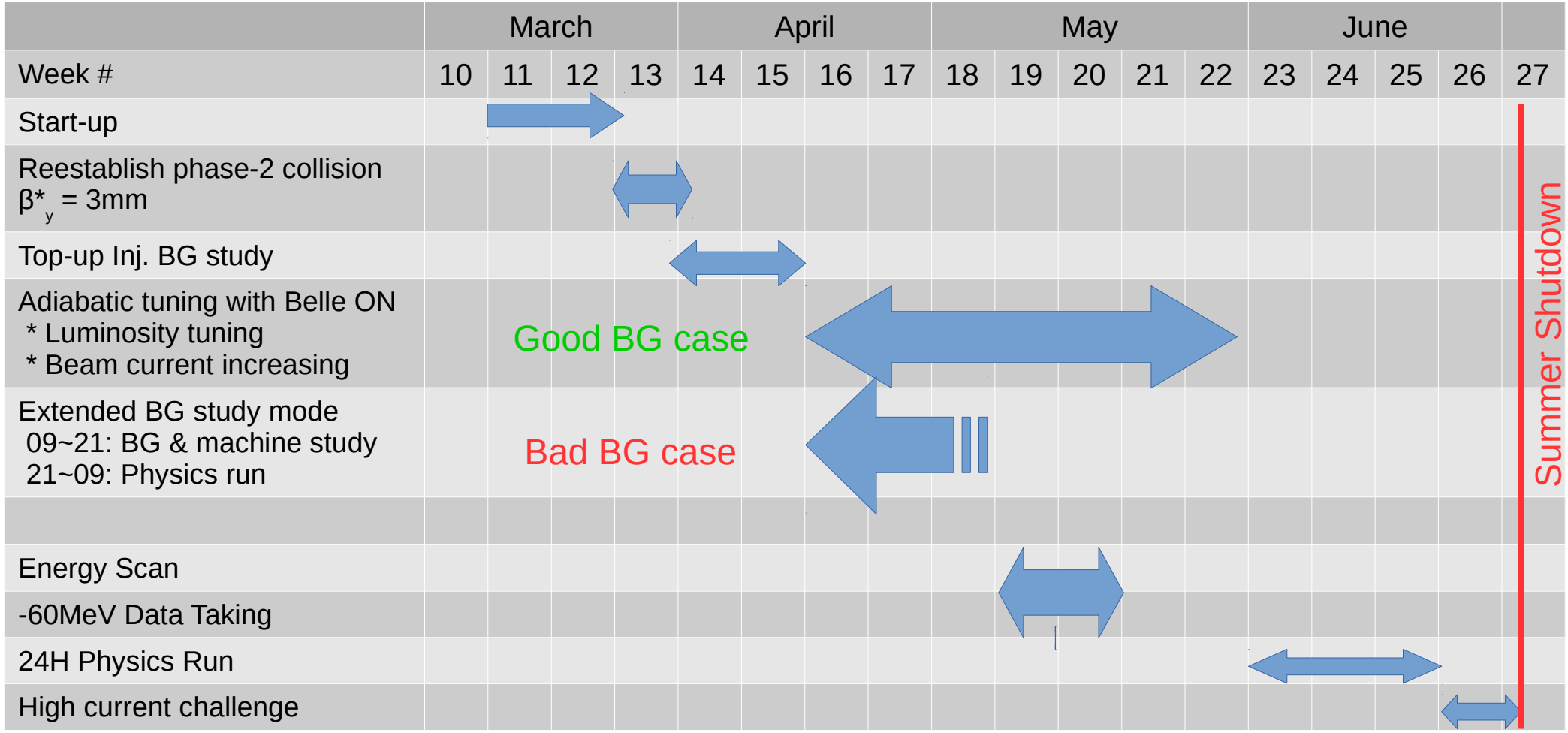
- L_{peak} increases linearly during beam operation.
- Efficiency L_{avg} / L_{peak} ~ 70%
- Belle works 24H during beam operation.(98days for 2019 spring run)
- Belle CAN take data with high beam current operation.(No BG limit)



Bad BG case

- No improvements from Phase-2.
- Beam current is limited by BG.
- Sample from 2019.07.01 morning
- $L_{peak\ limit}$ ~ 0.2 x 10^{34} cm^{-2}s^{-1}
- I ~ 290 x 270 mA
  → L_{int} in 2019 Spring ~ 11.8 fb^{-1}

Timeline: 2019.03 ~ 2019.06



Rough plan after 2019.10

- 2019.10
  - Start-up + Reestablish collision: 2~3weeks
- 2019.11
  - Adiabatic tuning
  - β*y = 2 mm collision trial?
- 2019.12 ~ 2020.01
  - Adiabatic tuning
  - Winter Shutdown: 2.5~3weeks
  - Restart collision: 1.5~2weeks
- 2020.02 ~ 2020.06
  - Adiabatic tuning
  - Adiabatic β*y squeezing trial down to 1.x mm & collision trial
- 2020.07 ~ 2020.12 or 2012.01
  - Extended summer shutdown for Belle II detector works.

Issues from Phase-2 Operation

- QCS Quench
  - New H & V beam collimators are installed. It would be useful to protect QCS.
  - Additional W shield for QCS is considering for protecting QCS and reducing beam background.
- High Current Beam Operation
  - Longitudinal coupled bunch instability is observed in LER I > 850mA.
    - Preparing longitudinal feedback system.
  - Need hardware commissioning & tuning to increase beam current beyond 1 A. (RF system/vacuum components/monitor/feedback)
    - Maximum operated beam current: LER 1010mA / 858mA (Phase-1/Phase-2) HER 870mA / 788mA (Phase-1/Phase-2)
- Beam-Beam Parameter Limit
  - Achieved ξy in phase-2 is about 0.021.
  - IP linear coupling is adjusted in phase-2.
  - This limitation would be caused by IP non-linear coupling, however, source term is not identified.
    - Simulation study and examination of measurement method are started.
    - Consider to activate LER sextupole rotator to adjust chromatic IP coupling.
      - New skew sextupole for HER is under consideration. (KEKB's skew sextupoles are already removed & reused by ATF.)
    - Consider to activate non-linear QCS correctors.

Tentative Target Parameter(1)

	LER	HER
ε_x[nm]	2.0	4.6
$\varepsilon_y/\varepsilon_x$[%]	8.0	8.0
β^*_x[mm]	100	100
β^*_y[mm]	3	3
σ_z[mm]	6	6
I[A]	1.2	1.0
nb	1576	
Bunch Current[mA]	0.761	.635
σ^*_y[nm]	693	1051
ξ_y	0.0262	0.0272
L[$cm^{-2}\,s^{-1}$]	1.06×10^{34}	

Tentative Target Parameter(1ex)

	LER	HER
ε_x[nm]	2.0	4.6
$\varepsilon_y/\varepsilon_x$[%]	7.5	5.0
β^*_x[mm]	100	100
β^*_y[mm]	3	3
σ_z[mm]	6	6
I[A]	1.4	1.0
nb	1576	
Bunch Current[mA]	0.888	.635
σ^*_y[nm]	670	830
ξ_y	0.0331	0.0328
L[$cm^{-2}\,s^{-1}$]	1.46×10^{34}	

Tentative Target Parameter(2)

	LER	HER
ε_x[nm]	2.0	4.6
$\varepsilon_y/\varepsilon_x$[%]	7.0	3.0
β^*_x[mm]	100	100
β^*_y[mm]	2	2
σ_z[mm]	6	6
I[A]	1.4	1.0
nb	1576	
Bunch Current[mA]	0.888	.635
σ^*_y[nm]	529	525
ξ_y	0.0351	0.0278
L[$cm^{-2}\,s^{-1}$]	2.08×10^{34}	

Tentative Target Parameter(2ex)

	LER	HER
ε_x[nm]	2.0	4.6
$\varepsilon_y/\varepsilon_x$[%]	6.5	2.8
β^*_x[mm]	100	100
β^*_y[mm]	2	2
σ_z[mm]	6	6
I[A]	1.7	1.2
nb	1576	
Bunch Current[mA]	1.079	.761
σ^*_y[nm]	510	508
ξ_y	0.0436	0.0351
L[$cm^{-2}\,s^{-1}$]	3.14×10^{34}	

Tentative Target Parameter(3)

	LER	HER
ε_x[nm]	2.0	4.6
$\varepsilon_y/\varepsilon_x$[%]	7.0	3.0
β^*_x[mm]	100	100
β^*_y[mm]	1.4	1.4
σ_z[mm]	6	6
I[A]	1.8	1.3
nb	1576	
Bunch Current[mA]	1.142	.824
σ^*_y[nm]	442	439
ξ_y	0.0387	0.0302
L[$cm^{-2}\,s^{-1}$]	4.11×10^{34}	

Tentative Target Parameter(3')

	LER	HER
ε_x[nm]	2.0	4.6
$\varepsilon_y/\varepsilon_x$[%]	5.0	2.2
β^*_x[mm]	100	100
β^*_y[mm]	1.25	1.25
σ_z[mm]	6	6
I[A]	1.6	1.15
nb	1576	
Bunch Current[mA]	1.015	.730
σ^*_y[nm]	354	356
ξ_y	0.0397	0.0301
L[$cm^{-2}\,s^{-1}$]	4.00×10^{34}	

Tentative Target Parameter(3ex)

	LER	HER
ε_x[nm]	2.0	4.6
$\varepsilon_y/\varepsilon_x$[%]	5.0	2.2
β^*_x[mm]	100	100
β^*_y[mm]	1.2	1.2
σ_z[mm]	6	6
I[A]	2.0	1.4
nb	1576	
Bunch Current[mA]	1.142	.824
σ^*_y[nm]	346	348
ξ_y	0.0453	0.0369
L[$cm^{-2}\,s^{-1}$]	6.20×10^{34}	