



Operation plans and Luminosity projections: - near-term and middle-term -

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- Some results of Phase-3 2019c run at a glance
Details were covered by Ohnishi-san
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 - Middle term (~2023/March=FY2022)
- Summaries



Some results of Phase-3 2019c run



Operation plan: near term

- Expected luminosities in Base plan

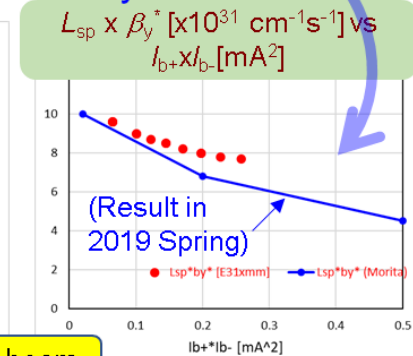
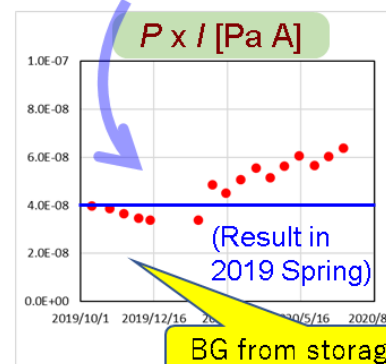
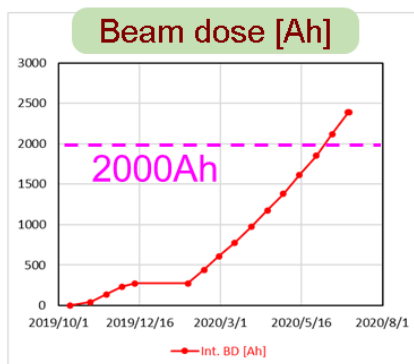
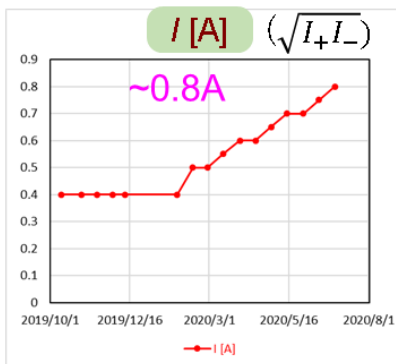
Assumptions:

Similar beam-beam effects as 2019 Spring, with slightly improvement by 20%.

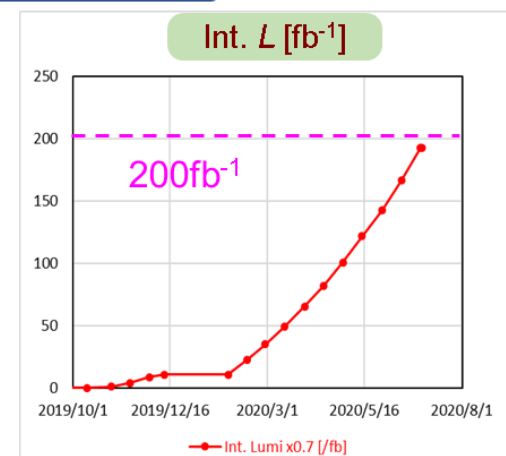
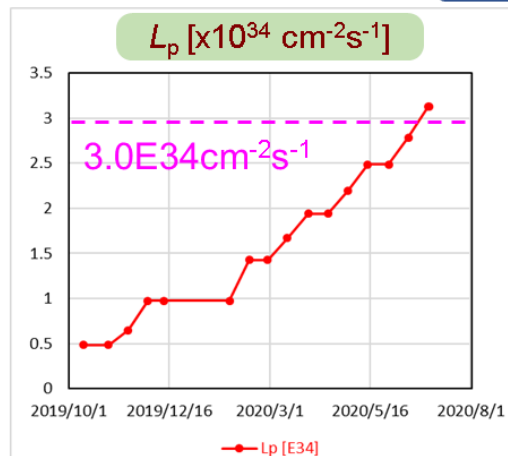
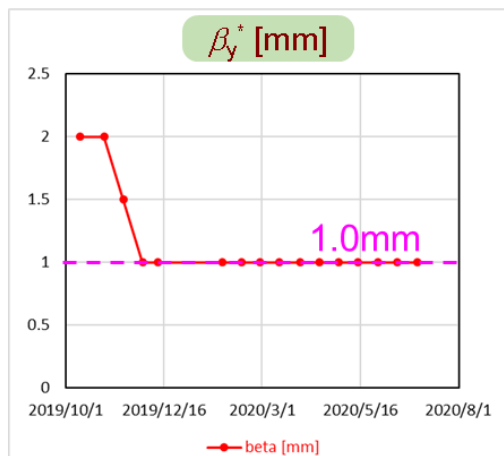
Similar background level as 2019 Spring, with slightly improvement by 50%.

Luminosity plan presented in 2019/10/27 BPAC

● Cal, Assumption



BG from storage beam

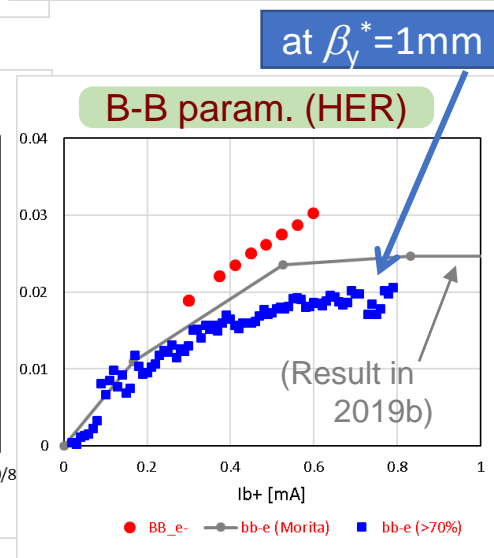
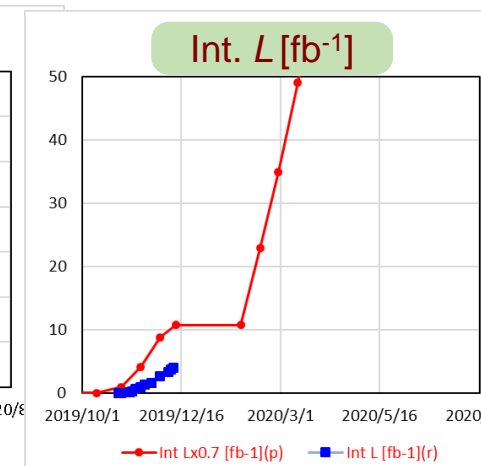
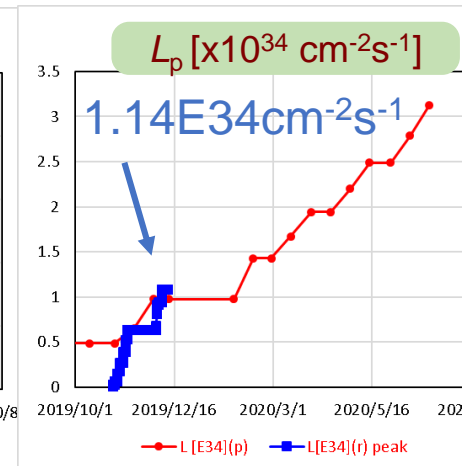
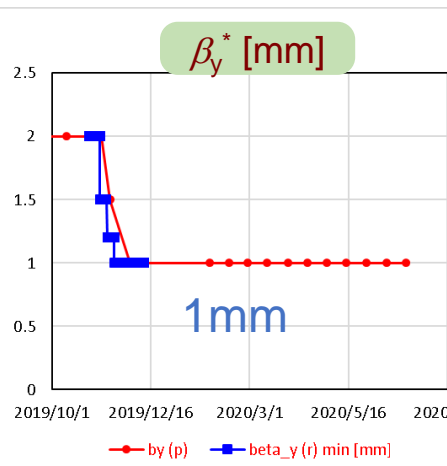
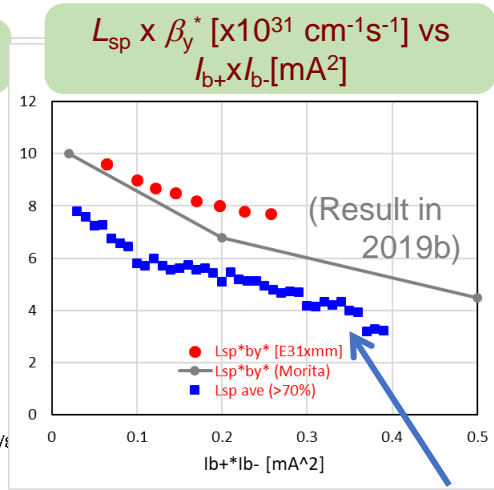
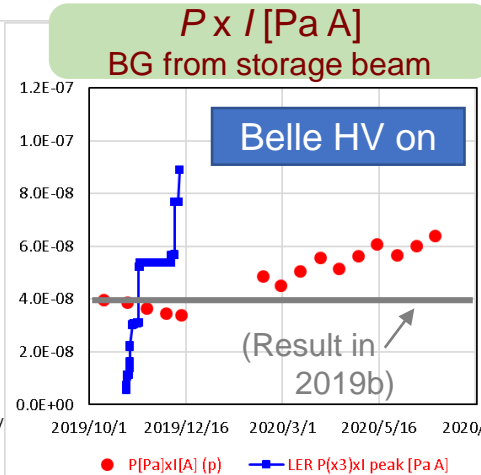
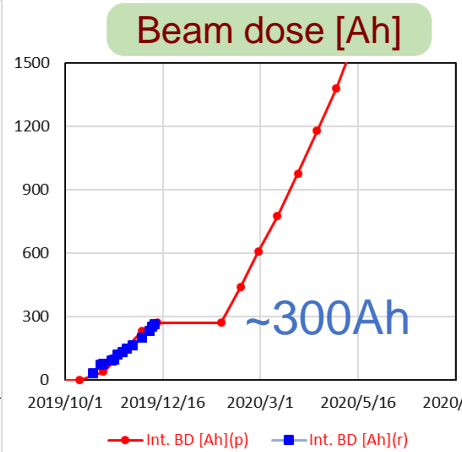
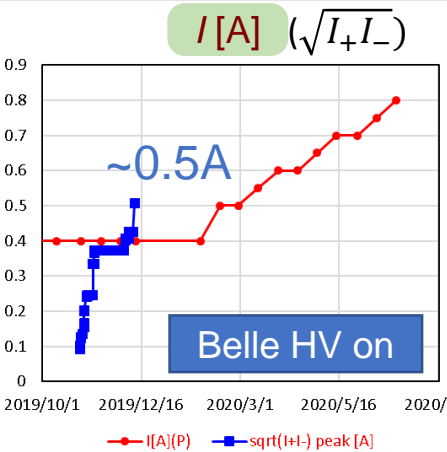




Some results of Phase-3 2019c run



- Cal., Assumption
- Result in 2019c

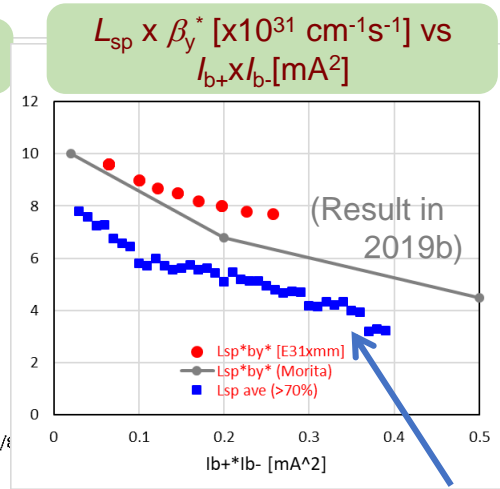
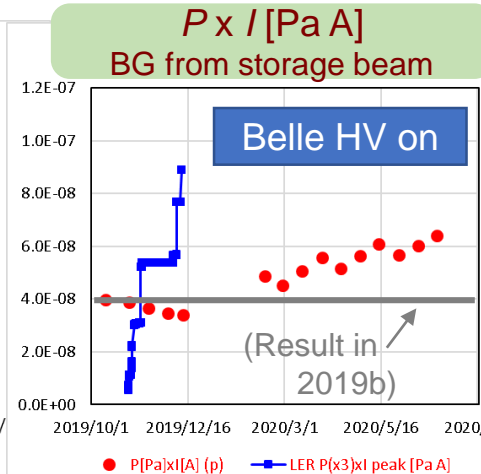
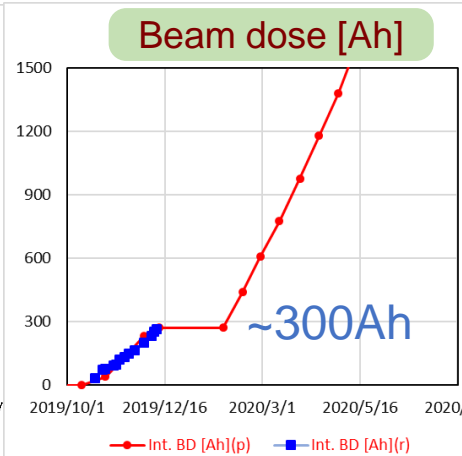
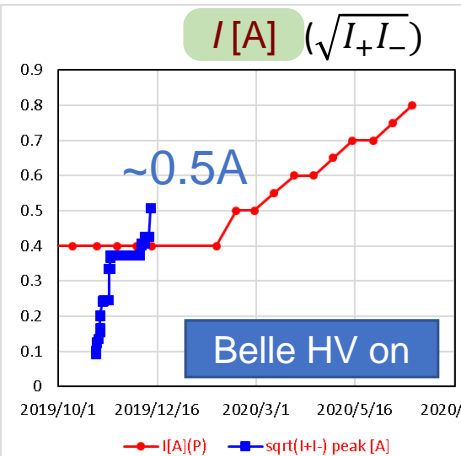




Some results of Phase-3 2019c run



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at $\beta_y^* = 1\text{mm}$

Beam currents	Beam dose	$P \times I$ (a measure of BG from storage beam)	$L_{sp} \times \beta_y^*$ (a measure of BB effect)
Almost achieved	Achieved	Higher than expected	70~80% of expectation
		Collimator tuning Baking of collimators Vacuum scrubbing	

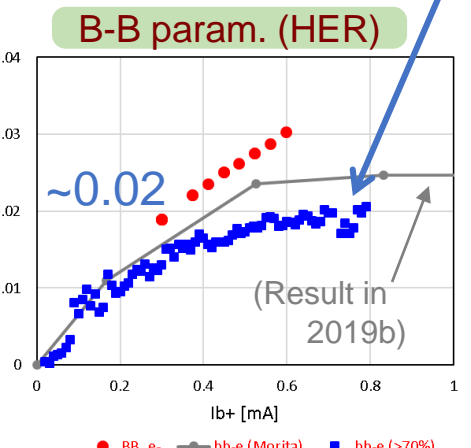
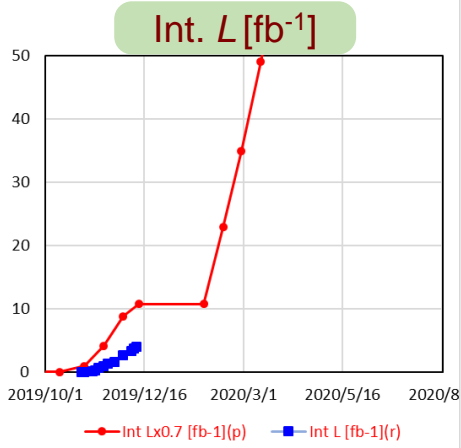
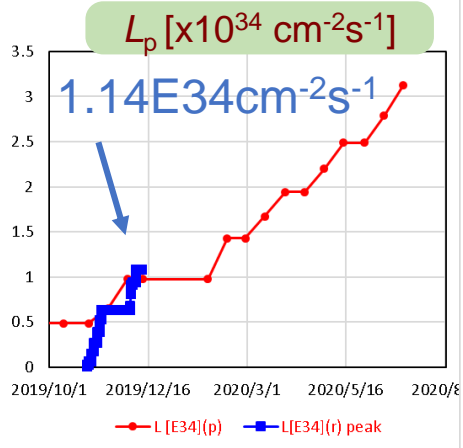
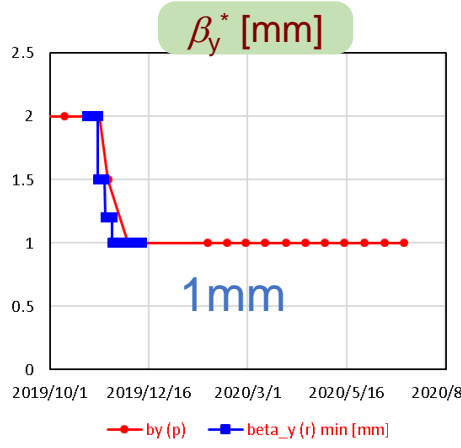


Some results of Phase-3 2019c run



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at $\beta_y^* = 1\text{mm}$



β_y^*	Luminosity	Integrated luminosity	Beam-Beam parameter (HER)
Achieved	Achieved	~50 %	70~80% of expectation
		Low currents during phys. run Short time for phys. run	Need more study and tuning



Operation plans and luminosity projections

1. Near term-1 (~2020/June)

- Here the luminosity projection was re-evaluated based on the 2019c result and operation plan.

(1) Base (conservative) plan

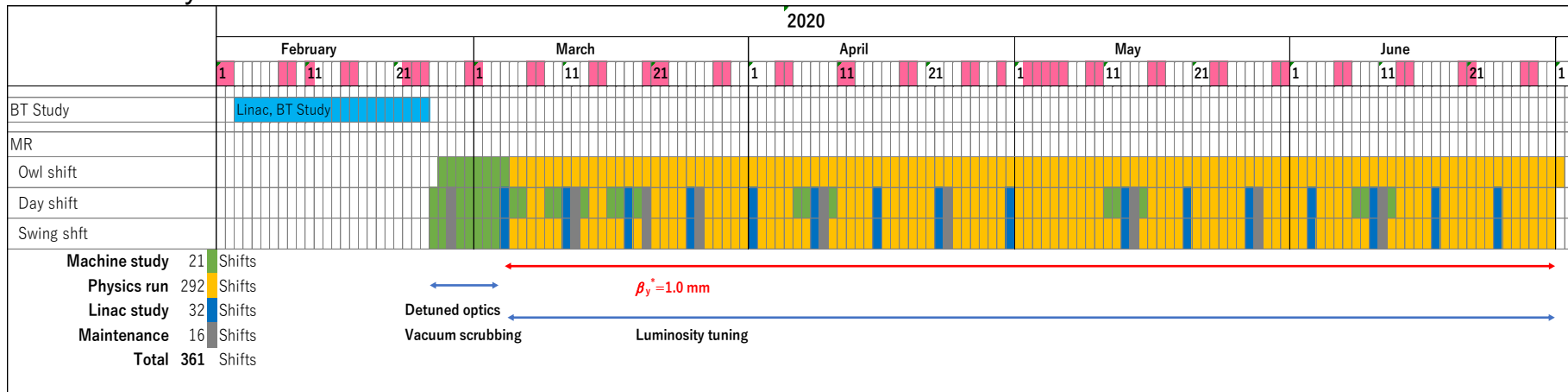
Assumptions:

1) 2020a run starts from 2020/3/2.

LER starts 2020/2/25 for vac. scrubbing and tuning.

2) 2020a and b runs are basically dedicated to physics run. (~100 days for physics run)

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Note: Details of the commissioning plan was reported by Ohnishi-san.



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4) **BG from injection beams is improved. (stable injection, low emittance)**

An essential point in the future commissioning!



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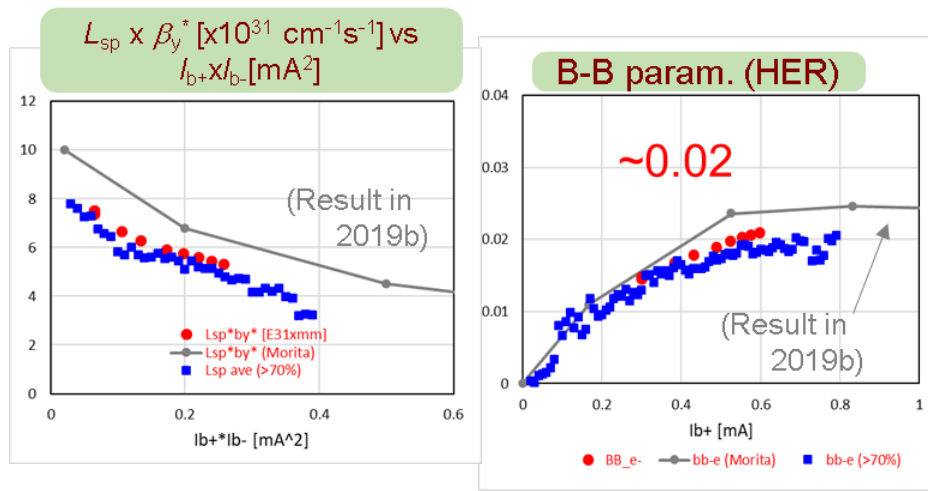
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- 6) Similar background level (storage beam) as 2019c.
- 7) Expecting vacuum scrubbing of LER (Decrease in dP/dI is proportional to $1/BD$). → **Increase in beam currents.**
- 8) Efficiency of integrated luminosity is 70% of peak luminosity.
- 9) 1576 bunches



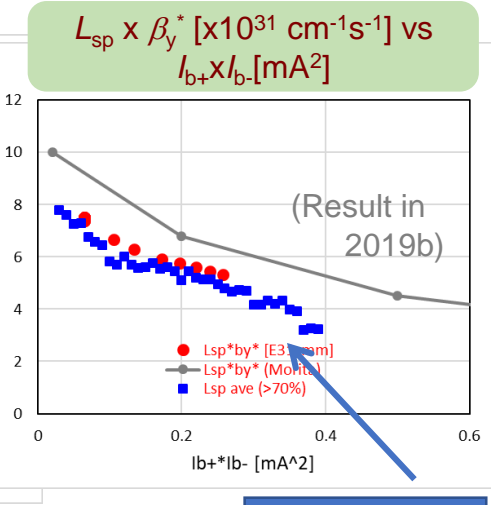
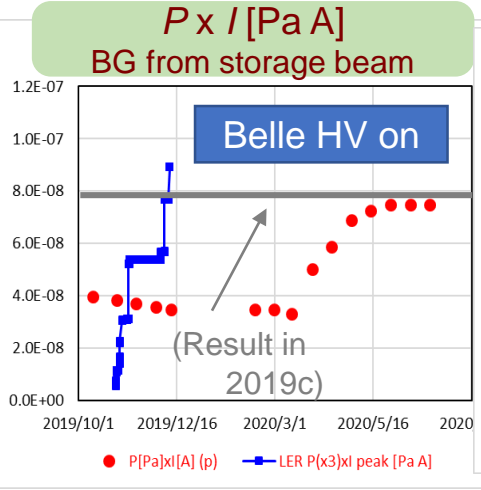
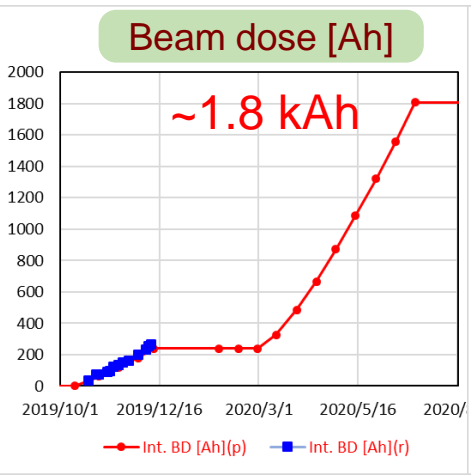
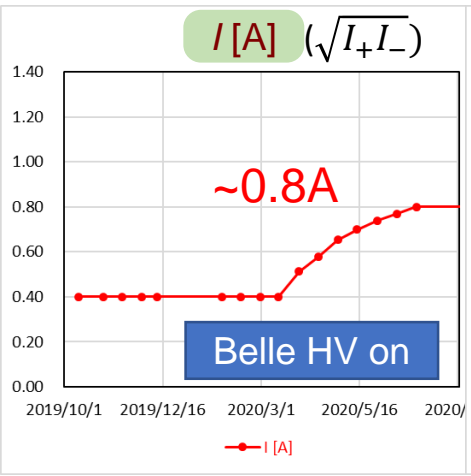
Operation plans and luminosity projections



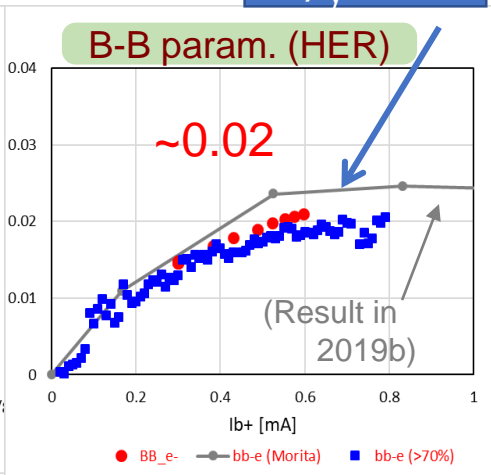
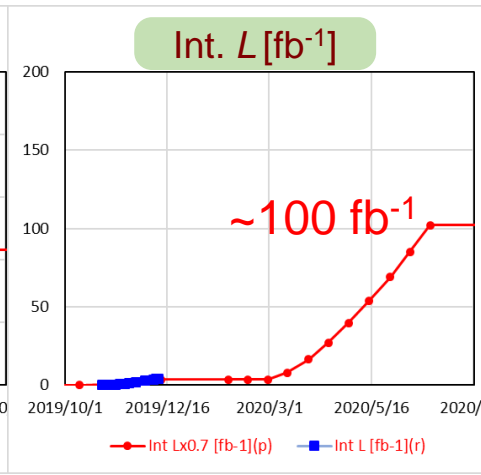
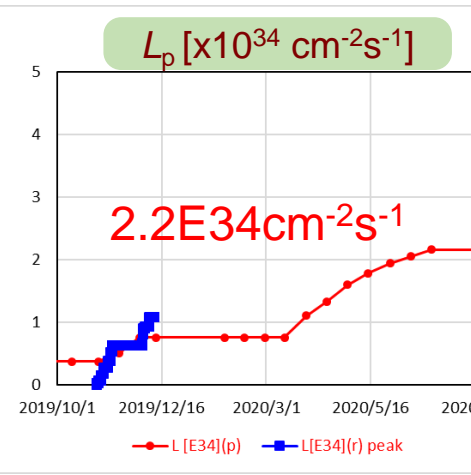
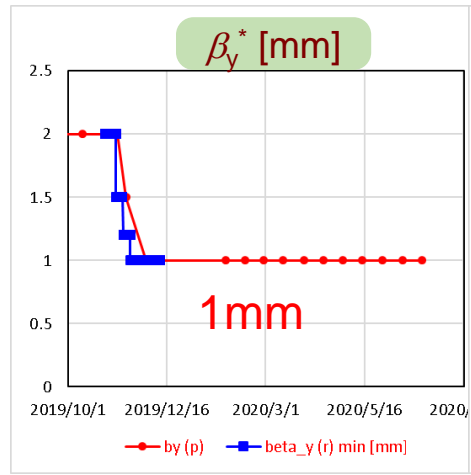
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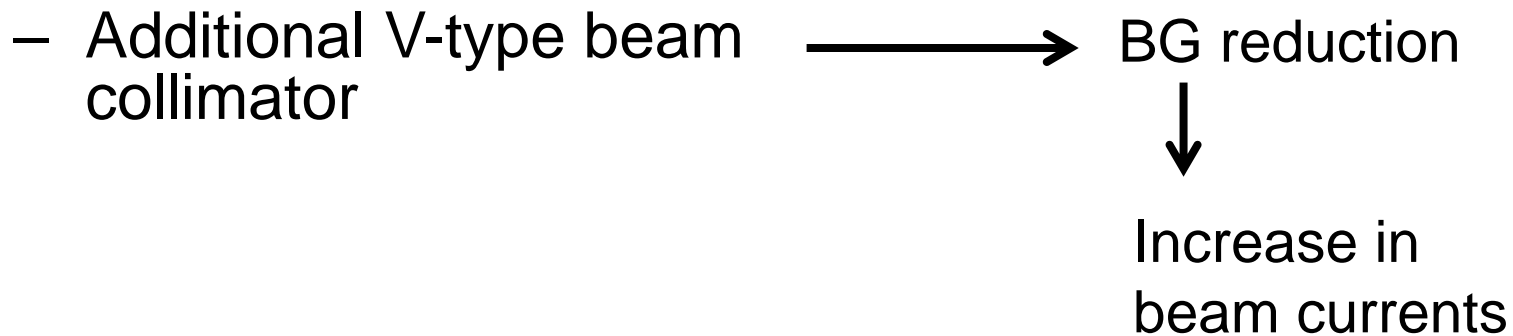
at $\beta_y^* = 1\text{mm}$





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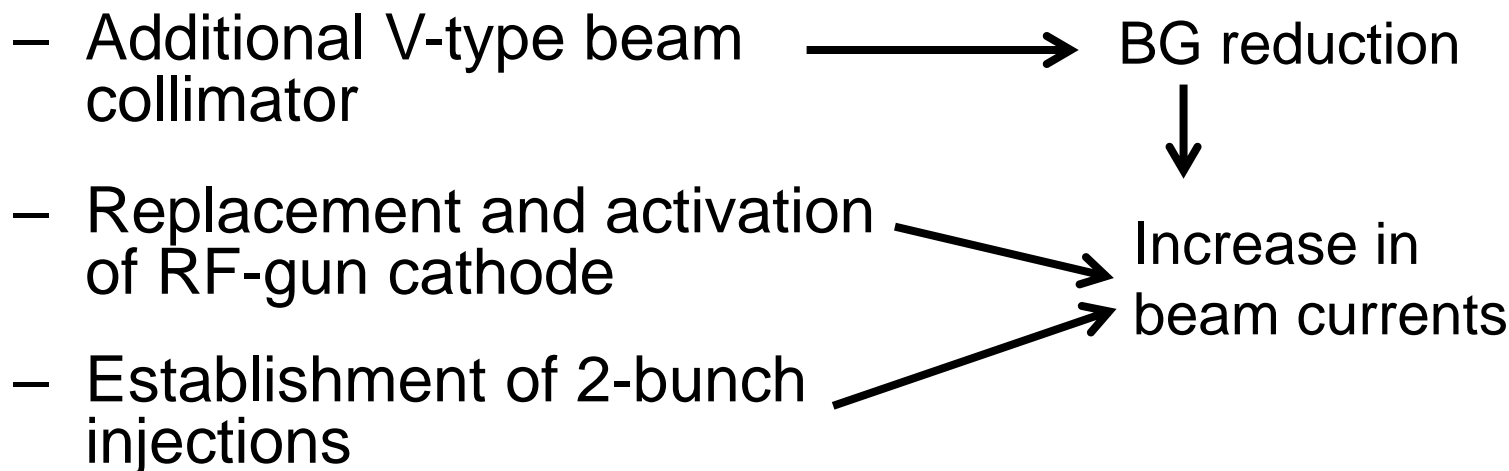
- Hardware improvements during winter shutdown and their expected effects





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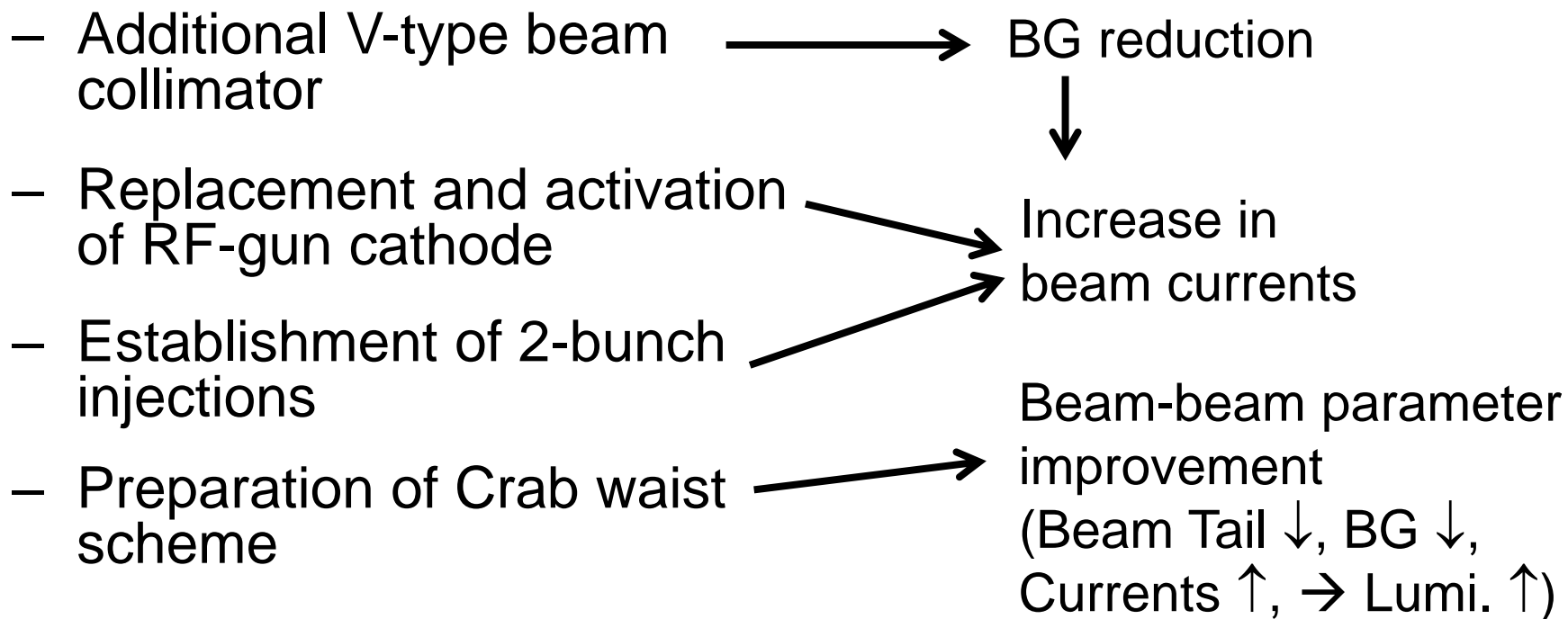
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1. Near term-1 (~2020/June)

- Hardware improvements during winter shutdown and their expected effects



- Improvements in BG, optics and beam dynamics issues are also expected by machine studies during beam operation.



1. Near term-1 (~2020/June)

(2) Possible (expected) plan

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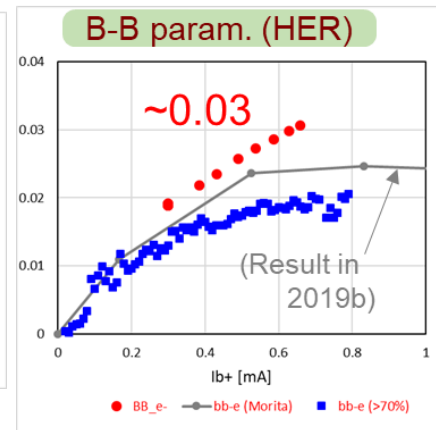
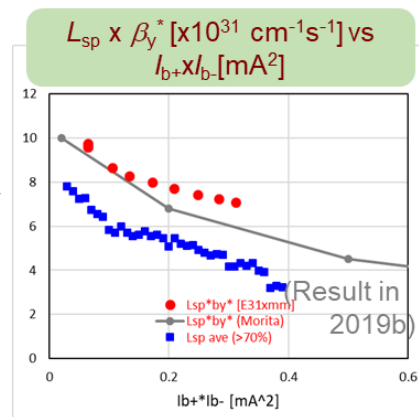
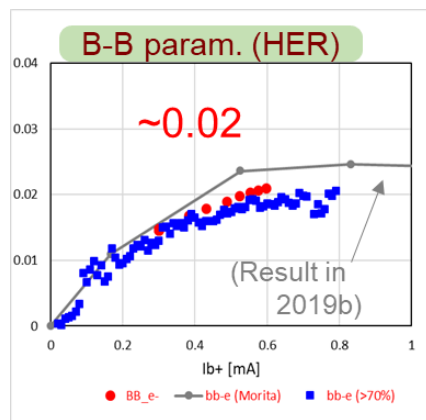
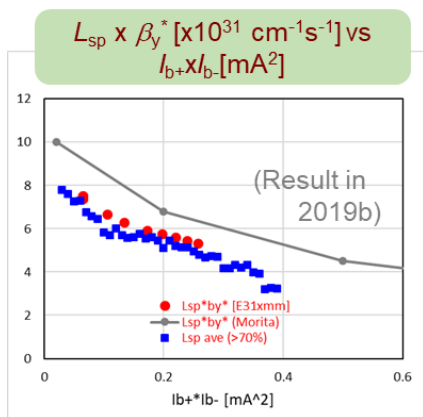
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5) **Similar beam-beam effect as 2019c, but still expecting some improvement by 30~50%.**





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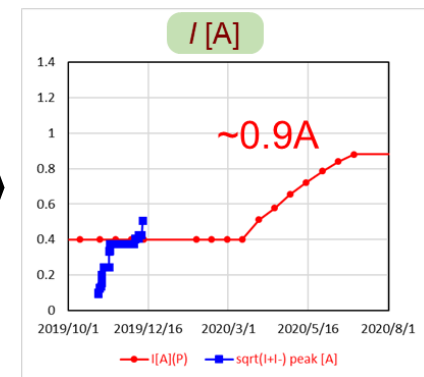
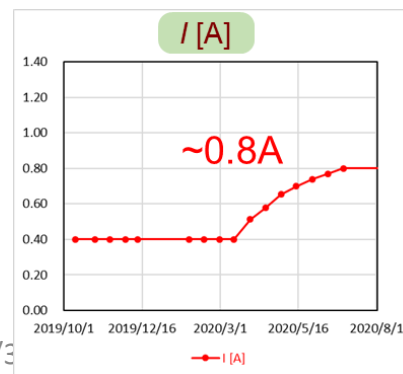
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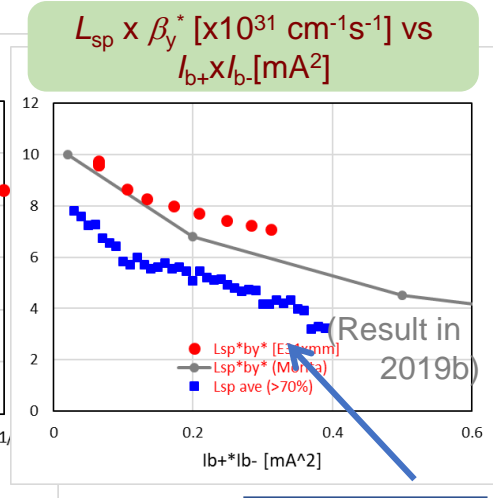
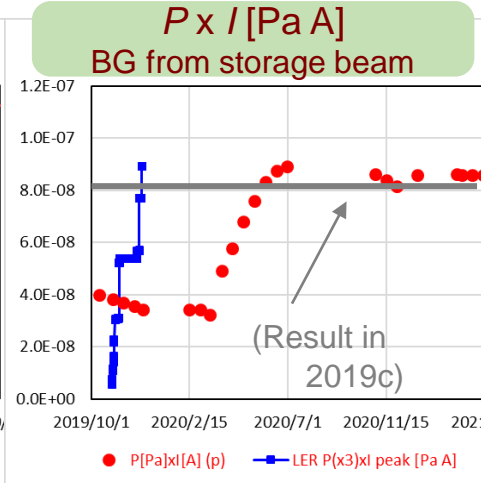
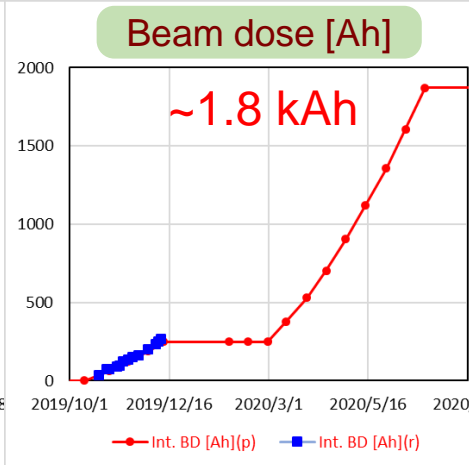
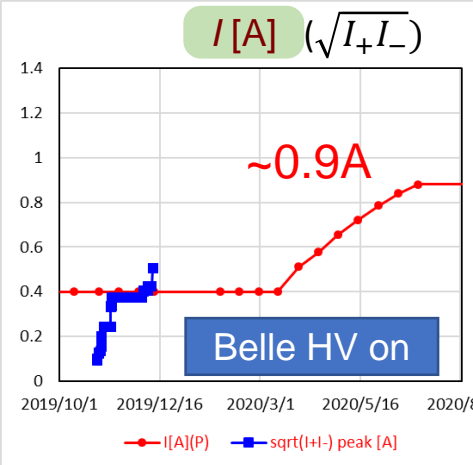
Operation plans and luminosity projections



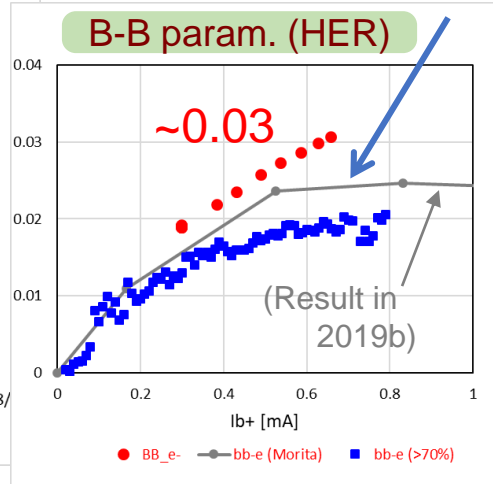
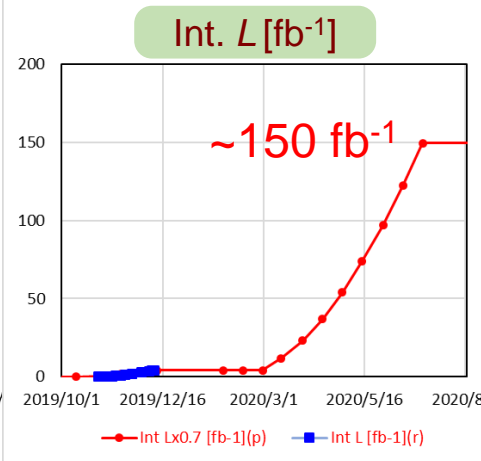
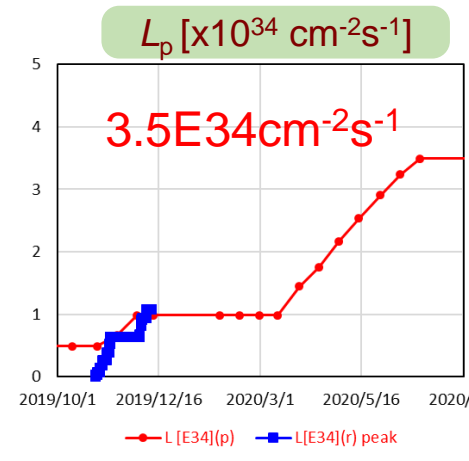
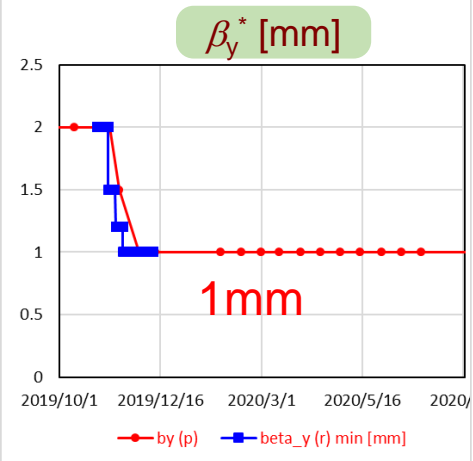
1. Near term-1 (~2020/June)

(2) Possible (expected) plan

● Cal., Assumption
 ■ Result in 2019c



at $\beta_y^* = 1 \text{ mm}$





1. Near term-1 (~2020/June)

Interim summary

	Until 2020/7/1			
	Int. L [fb^{-1}]	L_p [E34]	I_{max} [A]	β_y^* [mm]
Base (conservative) plan	100	2.2	0.8	1
Possible (expected) plan	150	3.5	0.9	1



1. Near term-2 (~2021/March=FY2020)

Operation plan

- FY2020 Budget for SuperKEKB project

As reported by Ushiroda-san

- Assuming the average unit cost of electricity to be kept, we can operate for 5.4 months with FY2020 project budget alone.
- We aim to add 1.1 months (= 6.5 months in total) (cost cut here and there, hope for world peace and stable electricity cost, and extra budget from DG).
- Here we considered two cases;
 - (1) Case N1: 6.5 months operation in FY2020
 - (2) Case N2: 5.4 months operation in FY2020



Operation plans and luminosity projections



1. Near term-2 (~2021/March=FY2020)

Assumptions:

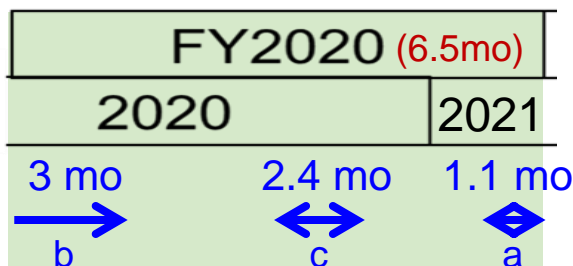
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4/1~7/1 (3 mo), 10/13~12/25 (~2.4 mo), 2/22~3/31 (~1.1 mo)

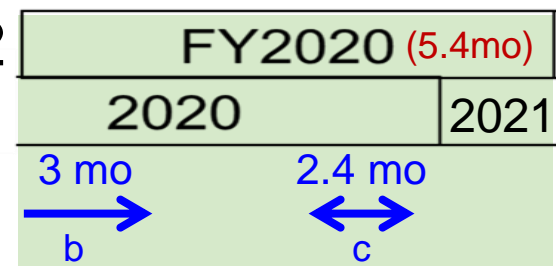
5.4 months operation.

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Case N1



Case N2





Operation plans and luminosity projections



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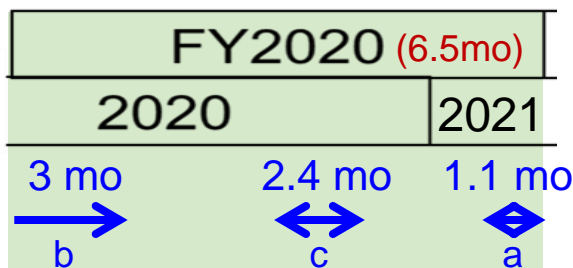
4/1~7/1 (3 mo), 10/13~12/25 (~2.4 mo)

2) 2020c is dedicated to squeeze β_y^* . (as in the case of 2019c)

$\beta_y^* = 1.0 \text{ mm} \rightarrow 0.7 \text{ mm} \rightarrow 0.5 \text{ mm}$ in 1 month

2021a is dedicated to physics run (Case N1)

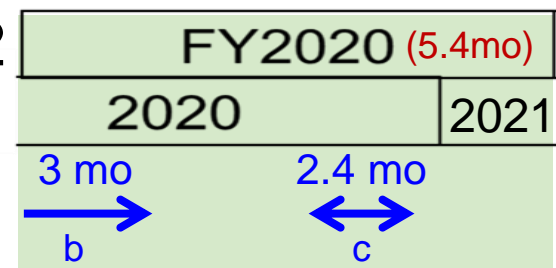
Case N1



$\beta_y^* \rightarrow 0.5 \text{ mm}$

Physics run

Case N2



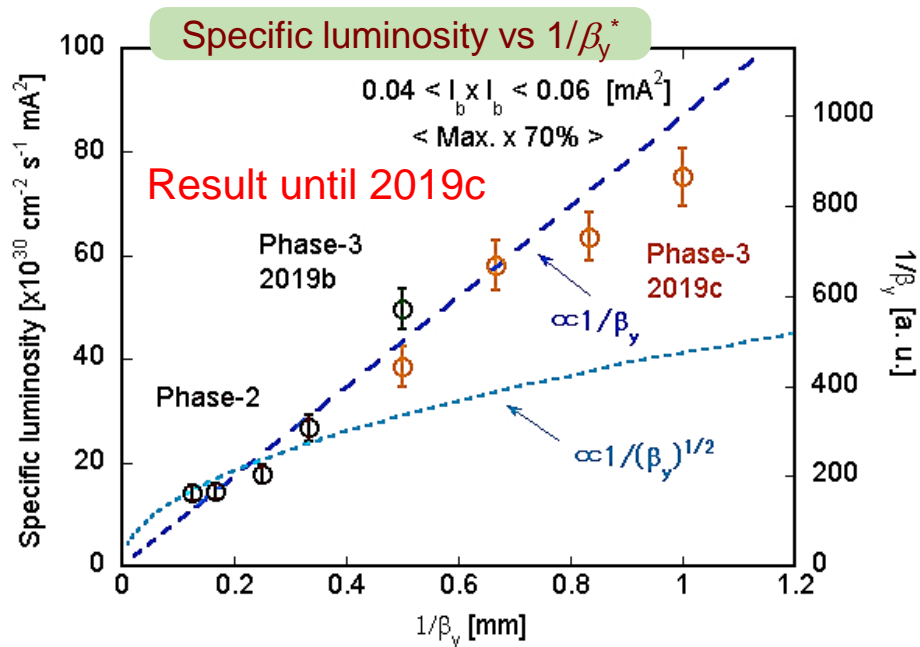
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- 3) Specific luminosity at low bunch currents is proportional to $1/\beta_y^*$.





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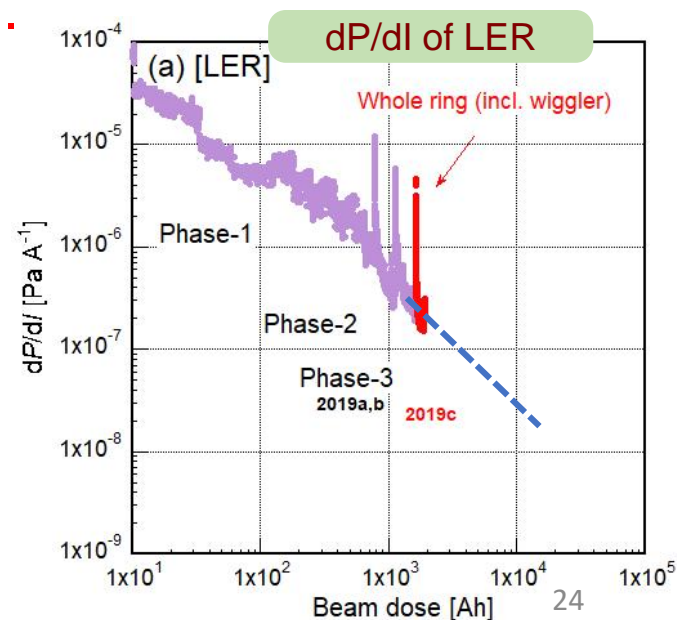
Also a key point in the future commissioning!



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1. Near term-2 (~2021/March=FY2020)

- Hardware improvements during 2020 summer shutdown and their possible effects

– Additional V-type beam collimator



BG reduction



Increase in
beam currents



1. Near term-2 (~2021/March=FY2020)

- Hardware improvements during 2020 summer shutdown and their possible effects
 - Additional V-type beam collimator → BG reduction
 - 50Hz injection from Linac → Increase in beam currents
 - e^+ charge increase (FC power up) → Increase in beam currents
- Improvements in BG, optics and beam dynamics issues are also expected by machine studies during beam operation.



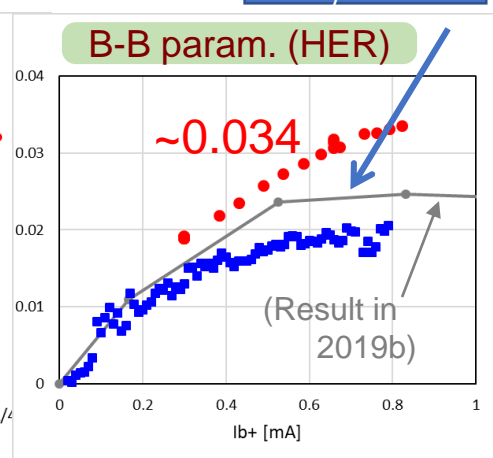
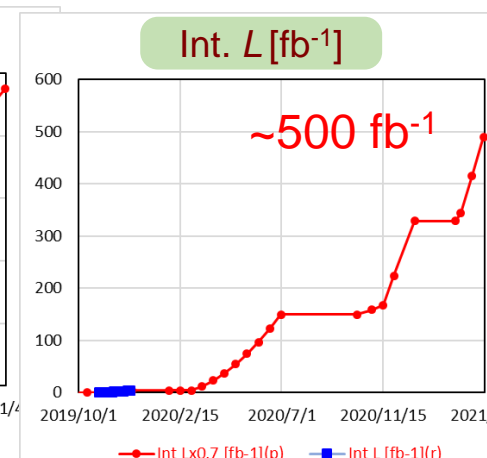
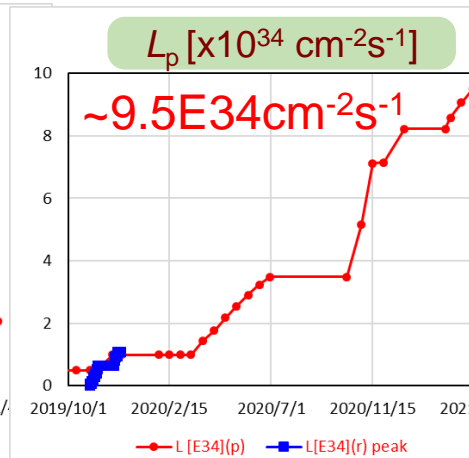
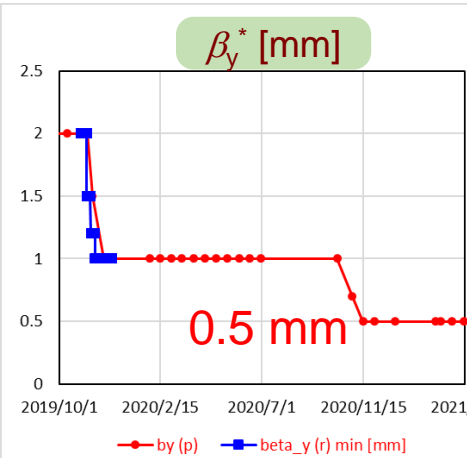
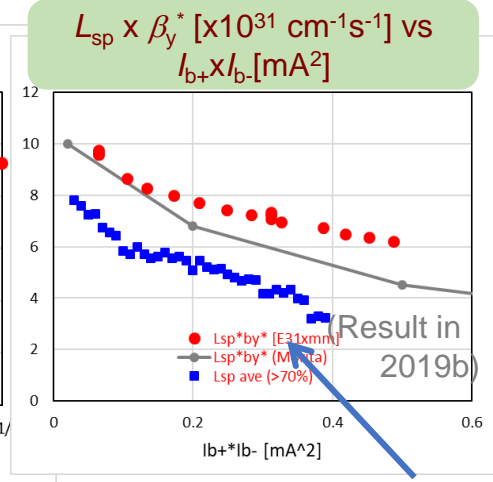
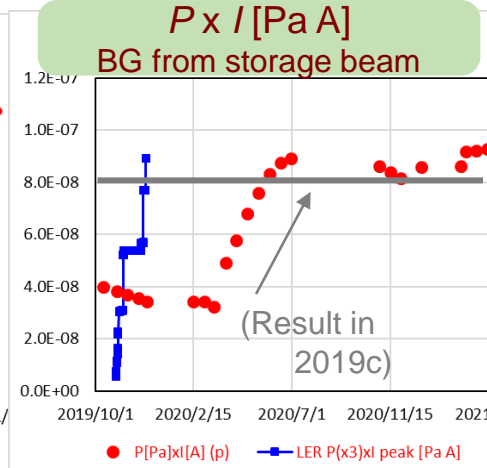
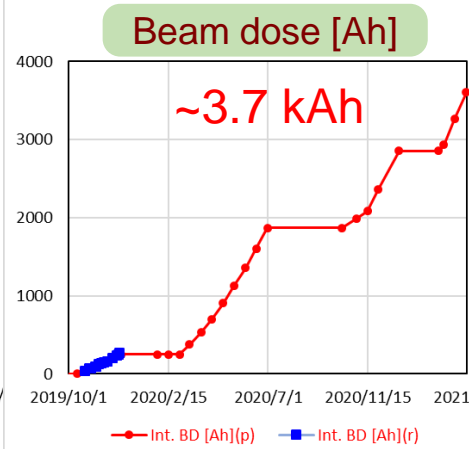
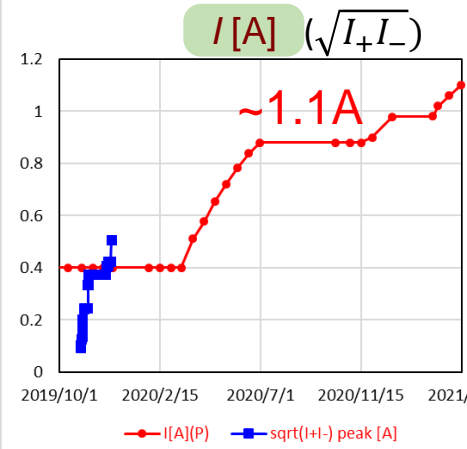
Operation plans and luminosity projections



1. Near term-2 (~2021/March=FY2020)

(1) Case N1: 6.5 months operation

● Cal., Assumption
■ Result in 2019c





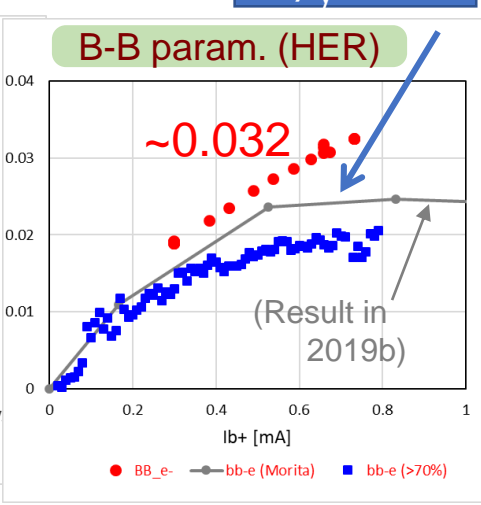
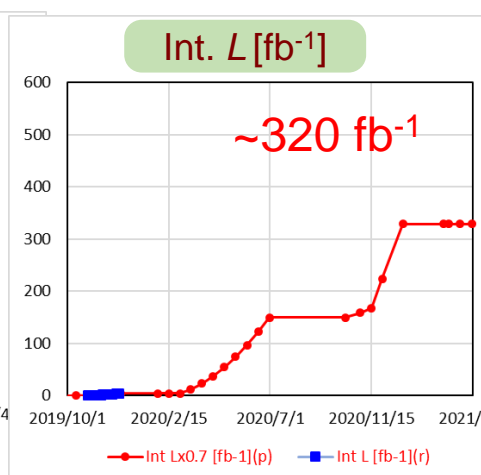
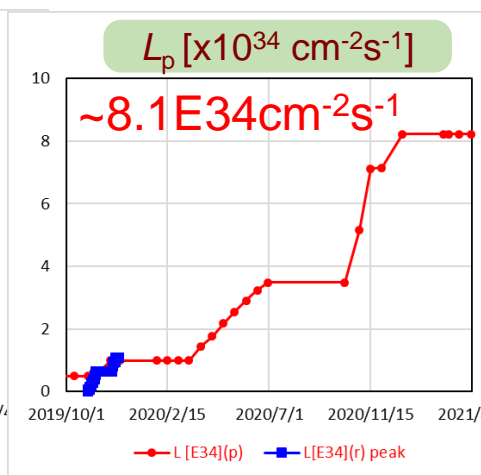
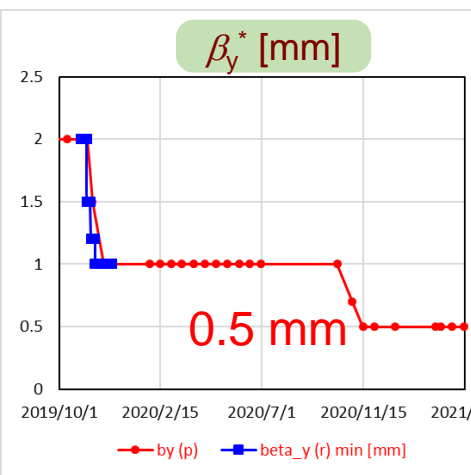
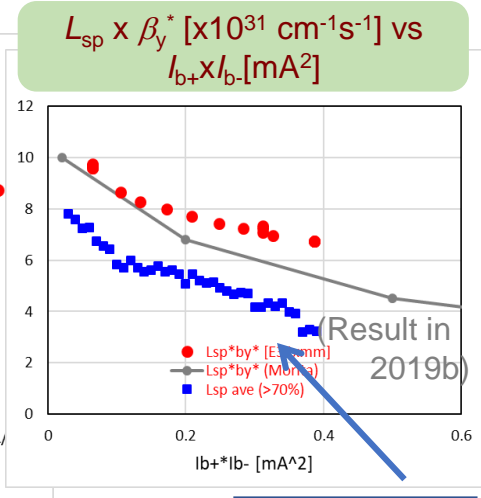
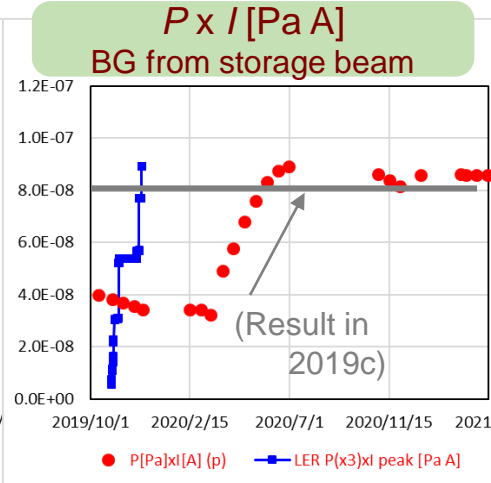
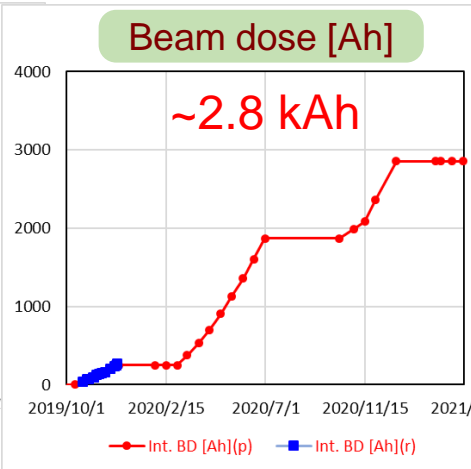
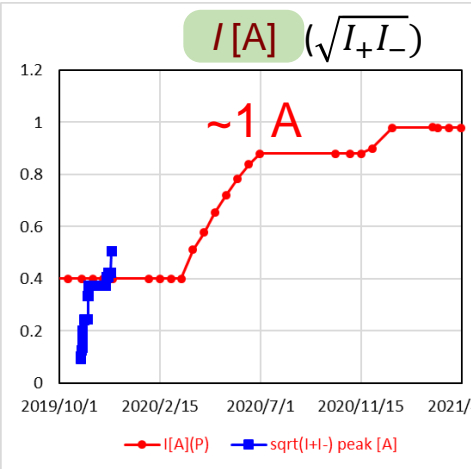
Operation plans and luminosity projections

1. Near term-2 (~2021/March=FY2020)



(2) Case N2: 5.4 months operation

● Cal., Assumption
■ Result in 2019c





Operation plans and luminosity projections



1. Near term-2 (~2021/March=FY2020)

Interim summary

	Until 2020/7/1				Until 2021/3/31			
	Int. L [fb ⁻¹]	L_p [E34]	I_{\max} [A]	β_y^* [mm]	Int. L [fb ⁻¹]	L_p [E34]	I_{\max} [A]	β_y^* [mm]
Base (conservative) plan	100	2.2	0.8	1				
Possible (expected) plan	150	3.5	0.9	1				
Case N1: 6.5 months operation	150	3.5	0.9	1	500	9.5	1.1	0.5
Case N2: 5.4 months operation	150	3.5	0.9	1	320	8.1	1	0.5



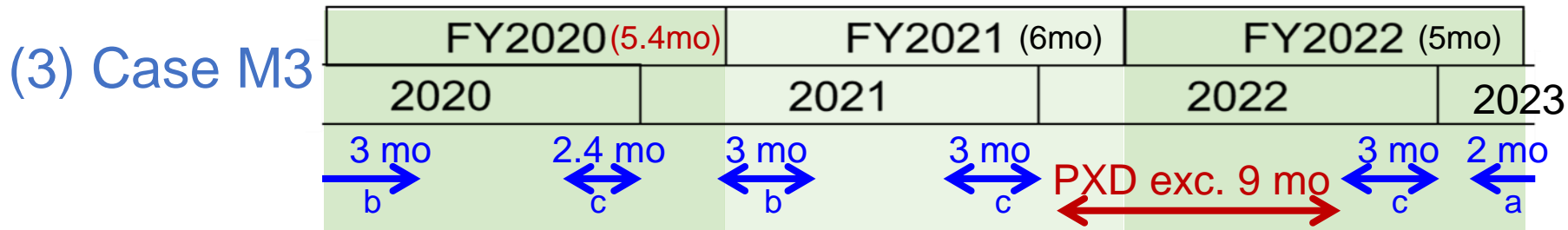
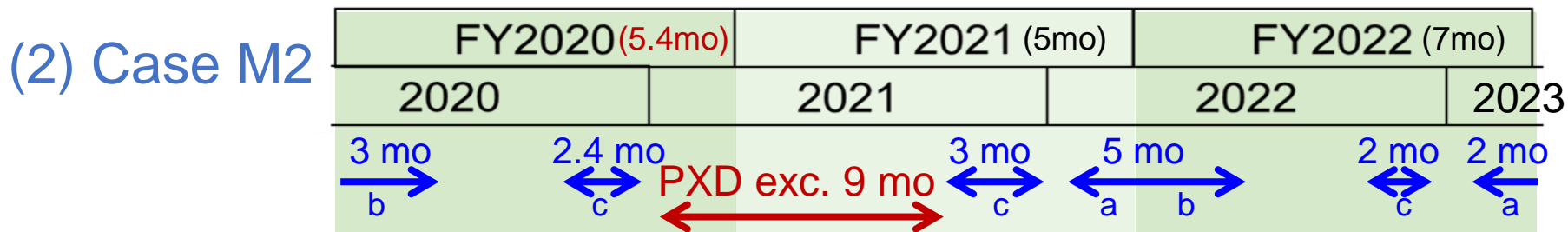
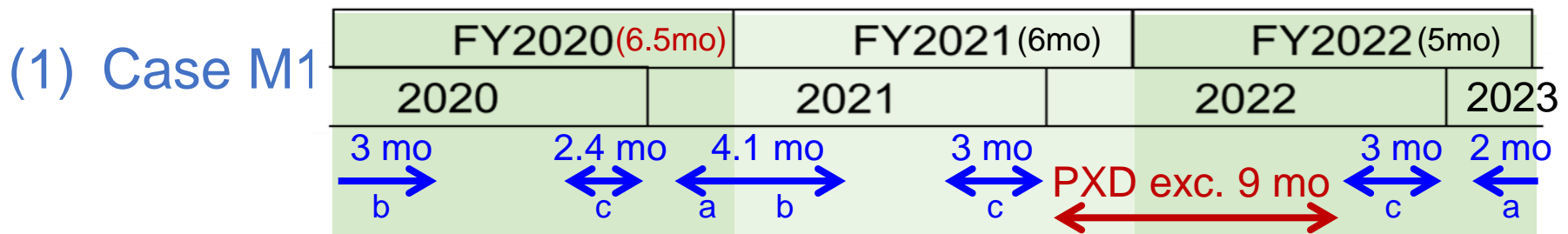
Operation plans and luminosity projections

2. Middle term (~2023/March=~FY2022)



Operation plans

Here we considered three cases:





Operation plans and luminosity projections

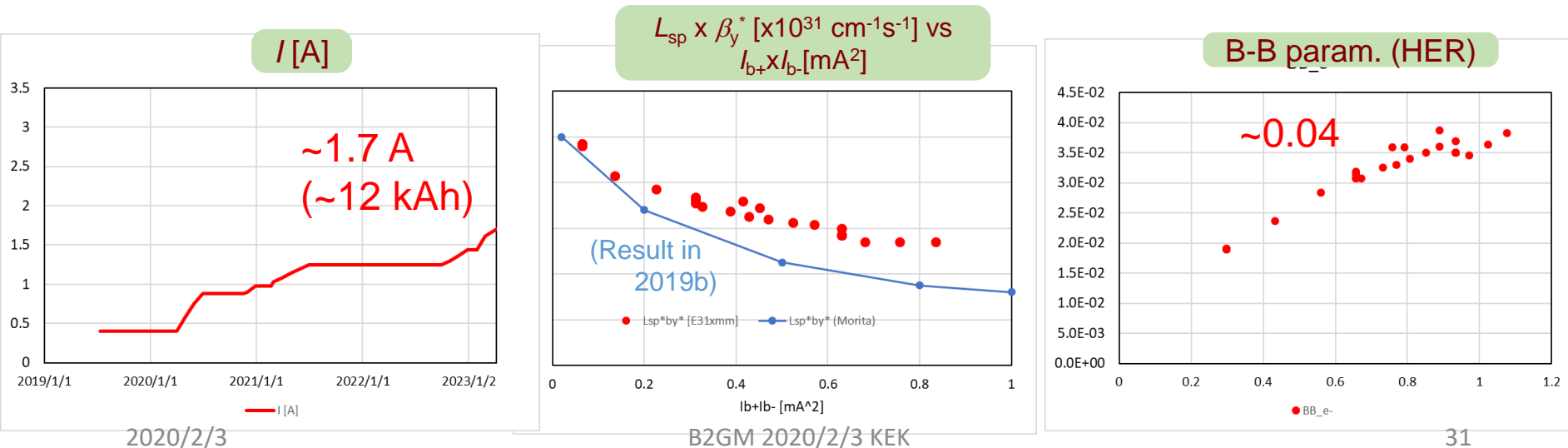
2. Middle term (~2023/March=~FY2022)



Assumptions:

- 1) We basically aim 7 months operation/year (~2022).
(more operation budget and further cost down!)
- 2) 2021c is dedicated to squeeze β_y^* . (as in the case of 2020c)
 $\beta_y^* = 0.5 \text{ mm} \rightarrow 0.4 \text{ mm} \rightarrow 0.3 \text{ mm}$ (Still Specific Lumi. $\propto 1/\beta_y^*$)
- 3) Bunch number is increased to from 1576 to 2500 from 2023a.
- 4) Further improvement in BG, beam-beam effect and so on.
- 5) Other assumptions are the same as before.

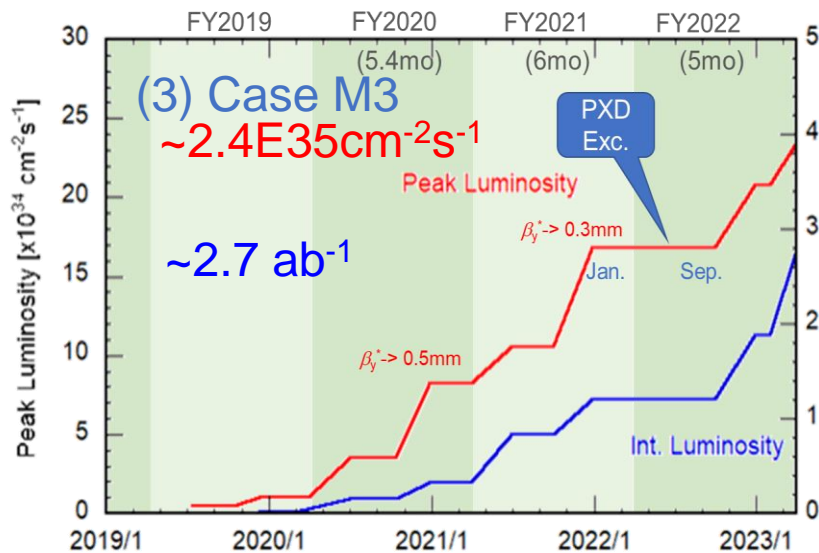
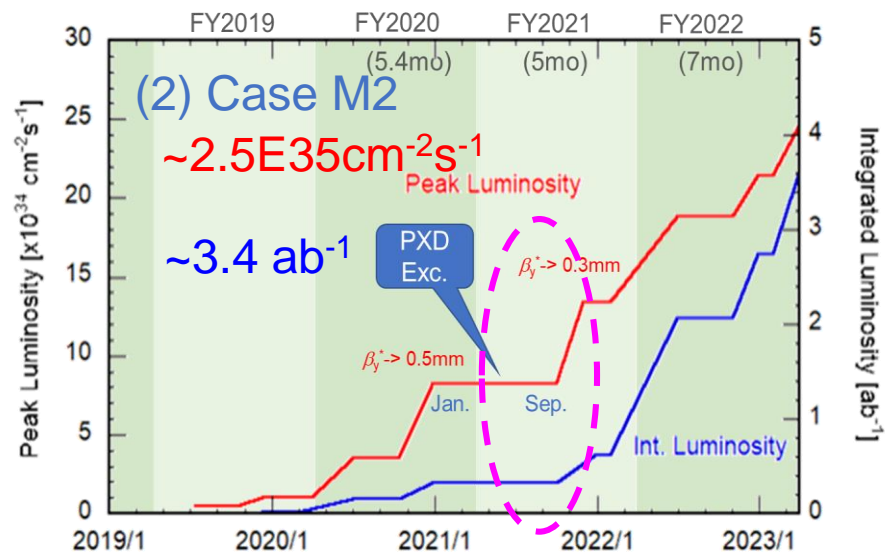
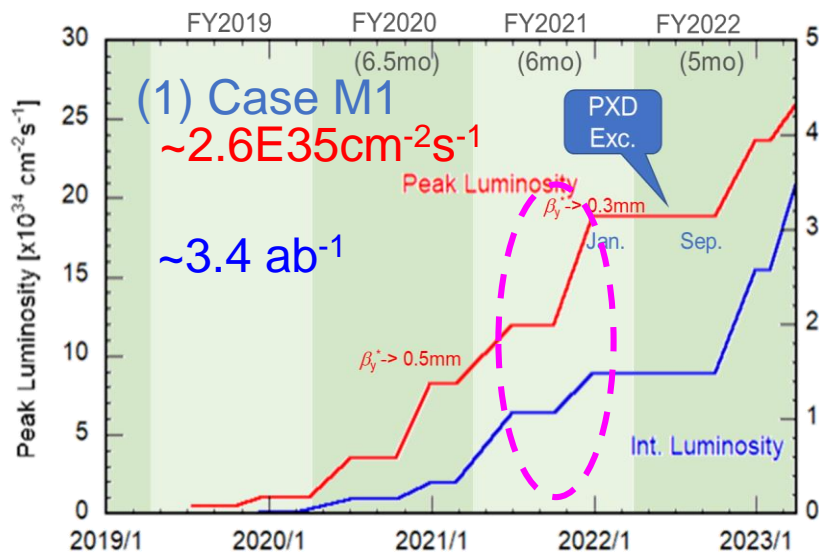
For Case 1 (typical)





Operation plans and luminosity projections

2. Middle term (~2023/March=~FY2022)

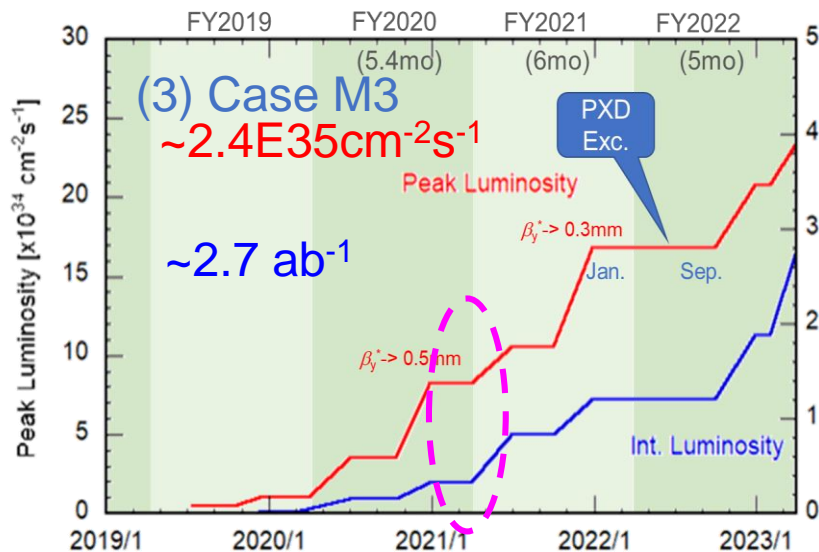
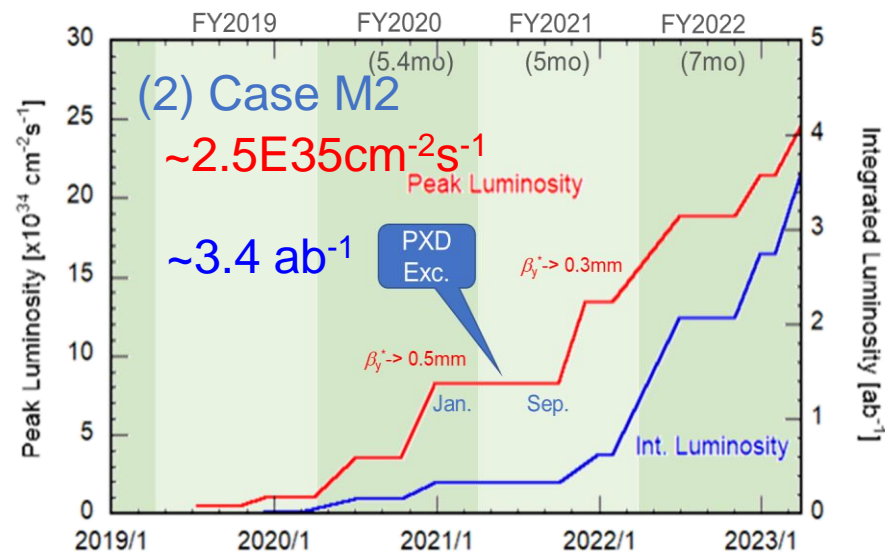
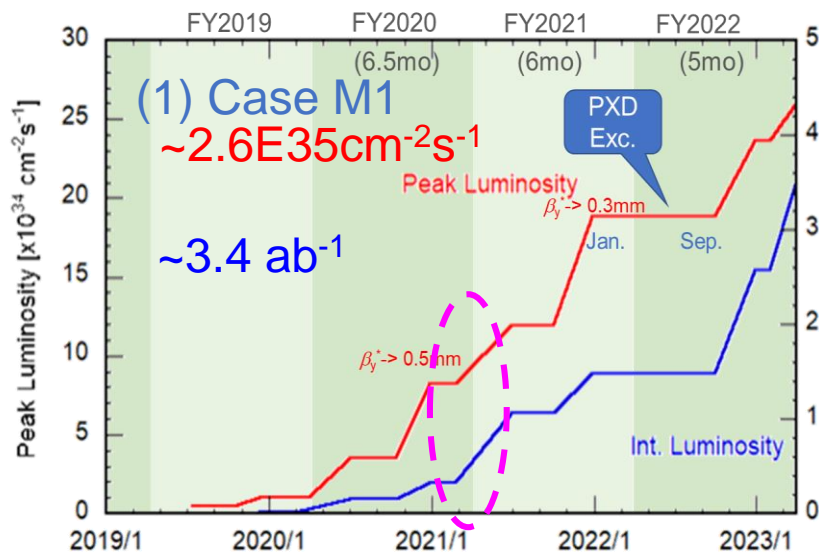


- Case M1 and M2
 - L_p and $Int. L$ are finally almost the same, but the difference around 2021 is large.



Operation plans and luminosity projections

2. Middle term (~2023/March=~FY2022)



- Case M1 and M2
 - L_p and $Int. L$ are finally almost the same, but the difference around 2021 is large.
- Case M1 and M3
 - L_p and $Int. L$ of M3 are lower than those in M1 due to short run time (low beam currents).



Operation plans and luminosity projections

2. Middle term (~2023/March=~FY2022)



Interim summary

	Until 2022/3/1				Until 2023/3/31			
	Int. L [ab ⁻¹]	L_p [E34]	I_{\max} [A]	β_y^* [mm]	Int. L [ab ⁻¹]	L_p [E34]	I_{\max} [A]	β_y^* [mm]
Case M1: FY2020 6.5 months PXD exc. 2022	1.5	19	1.3	0.3	3.4	26	1.7	0.3
Case M2: FY2020 5.4 months PXD exc. 2021	0.6	16	1.1	0.3	3.4	25	1.6	0.3
Case M3: FY2020 5.4 months PXD exc. 2022	1.2	17	1.2	0.3	2.7	24	1.6	0.3



Summaries



- Operation plans and luminosity projections were re-evaluated based on the recent results
 - Near term plans
 - ~100 fb⁻¹(conservative) ~ ~150 fb⁻¹ (expected) by 2020/June
 - ~500 fb⁻¹(6.5 mo.) ~ ~320 fb⁻¹ (5.4 mo.) by 2021/March (expected)
 - Middle term plan
 - ~2.7 ~ ~3.4 ab⁻¹ by 2023/March (expected)
 - Depend on the operation plan.
 - Long term plan (~2029)
 - Under consideration
- It might be nothing to say that these luminosity projections include lots of (expected) assumptions.
- We are now struggling to solve various challenges step by step and to provide higher luminosities.
- Now we have to recognize again that securing sufficient operation time is an essential issue as a factory machine.
- We greatly appreciate your continued support.

Thank you for your attention.