150804
Nu in J WS @ Tokai

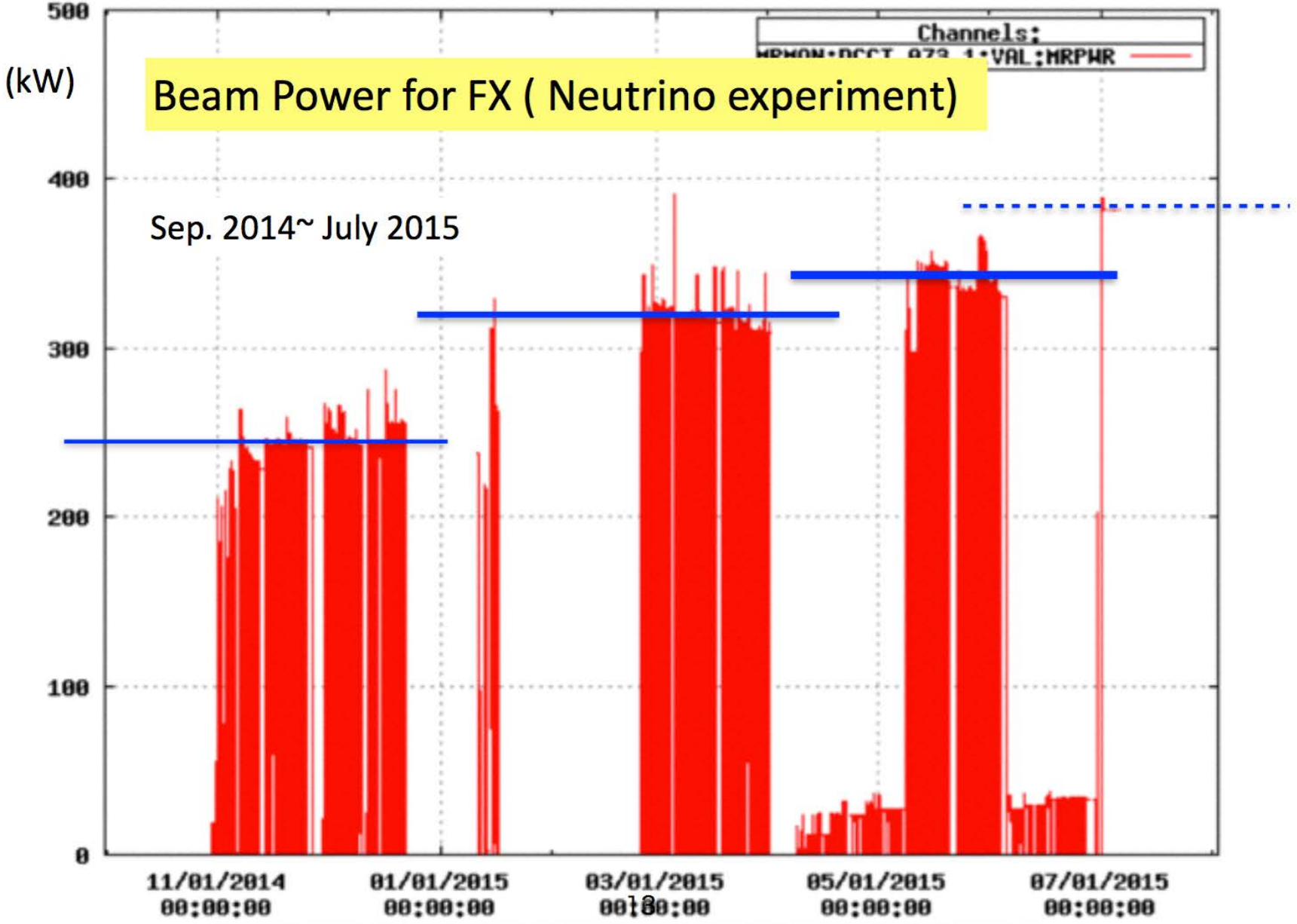
Potential J-PARC beam power improvement and beam delivery before 2026

Working assumption for this workshop and future studies

T. Kobayashi

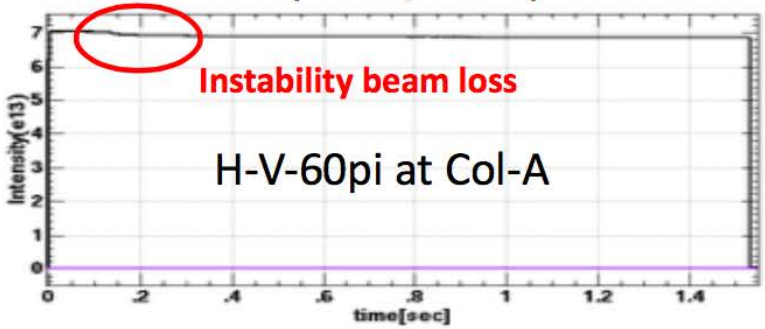
IPNS/KEK & J-PARC

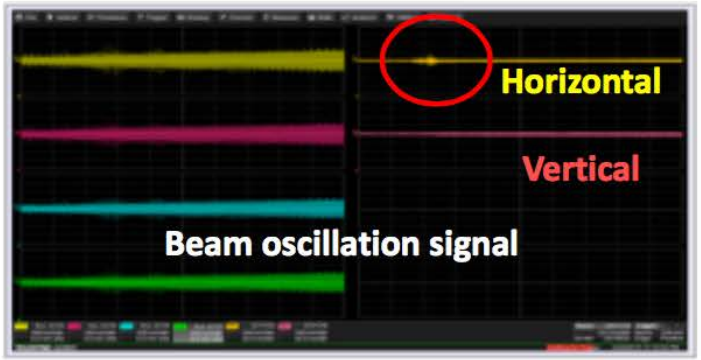
MR (30GeV)


(kW)
Beam Power for FX (Neutrino experiment)
Sep. 2014~ July 2015
Channels:
MRMON:DCCT_873_1:VAL:MRPWR
500
400
300
200
100
0
11/01/2014 00:00:00
01/01/2015 00:00:00
03/01/2015 00:00:00
05/01/2015 00:00:00
07/01/2015 00:00:00

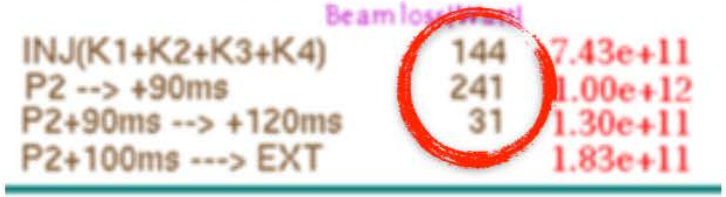
30GeV Acceleration by new operation point with two bunches

(21.239, 21.310)





Peak:40mA, Macro:0.5ms, Chop:489ns, Thining:32/32
2bunches, Trim-Qs:ON, Trim-Ss:ON, Inj.KM: (K1,K2,K2,K2)
Chrom. Corr. of 75% DC for reduction of instability



MR Power 131.93 kW

Tunable knobs:
Injection kicker, BxB feed-back,
2nd harmonic cavity, VHF cavity

	Bunch number	repetition period (sec)	Beam power (kW)	Beam loss (kW)	Notes
1	***2***	***2.48***	***132***	***0.42***	***measurement***
2	8	2.48	530	*1.7*	estimation
3	8	1.3	1000	*3.2*	estimation

Mid-term plan of MR

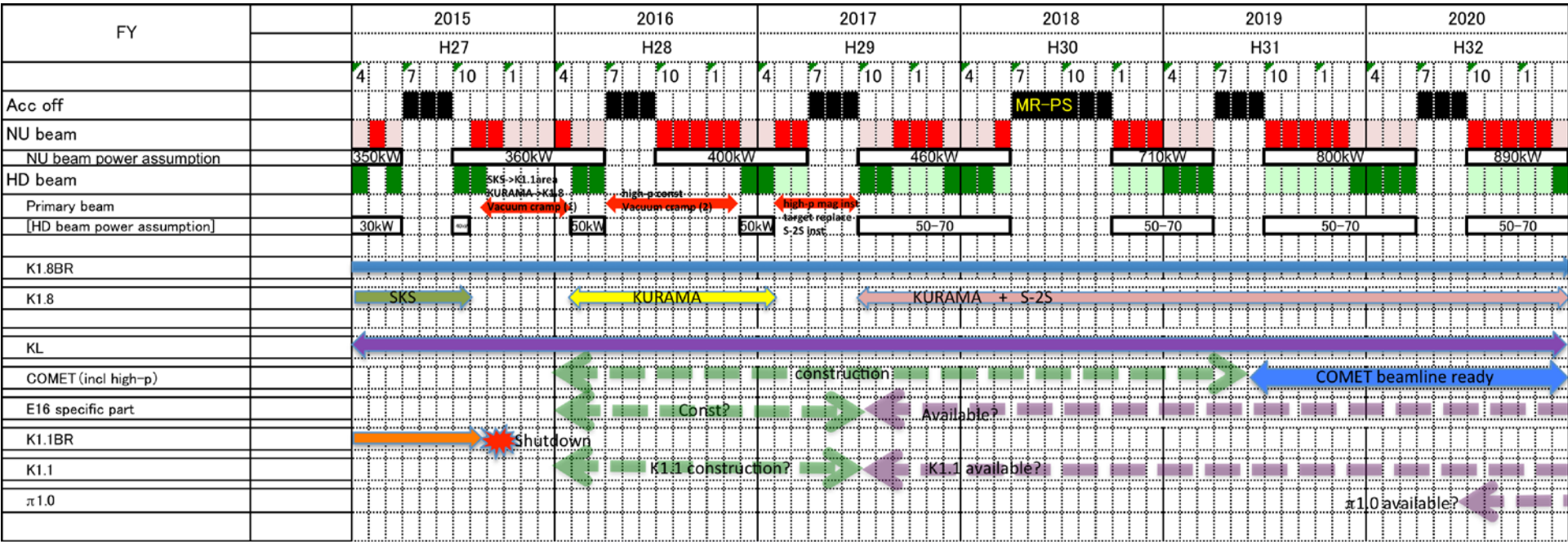
FX: The high rep. rate scheme is adopted to achieve the design beam intensity, 750 kW.
Rep. rate will be increased from ~ 0.4 Hz to ~1 Hz by replacing magnet PS's and RF cavities.
SX: Titanium ducts & chamber to reduce the residual radiation are required for 50 kW operation.
Beam power will be gradually increased toward 100 kW carefully watching the residual activity.

JFY	2014	2015	2016	2017	2018	2019	2020
Event	Li. current 30 -> 50		New PS Buildings		New power projection		
FX [kW] (study/trial) SX [kW] (study/trial)	240-320 -	>360 30~40	400 50	450 50~70	700 50~70	800 100	900 100
Period of magnet PS New magnet PS	2.48 s R&D	Large prototype	Mass production		1.3 s	1.3 s	1.25 s
Present RF system High grad. rf system 2nd harmonic cavity VHF cavity	Manufacture, installation & test						
Ring collimators	Back to JFY2012 (2kW)	Add. colli. C,D	Add. colli. E,F				
Injection system FX system	Kicker PS improve., Septa manufac. /test Kicker PS improve., LF & HF septa manufac. /test						
SX collimator / Local shields			Local shields				
Ti ducts Ti chamber for SX	Beam ducts	ESS					

7/15 PAC

PAC on Jul16,2015
T.Kobayashi

New middle term plan

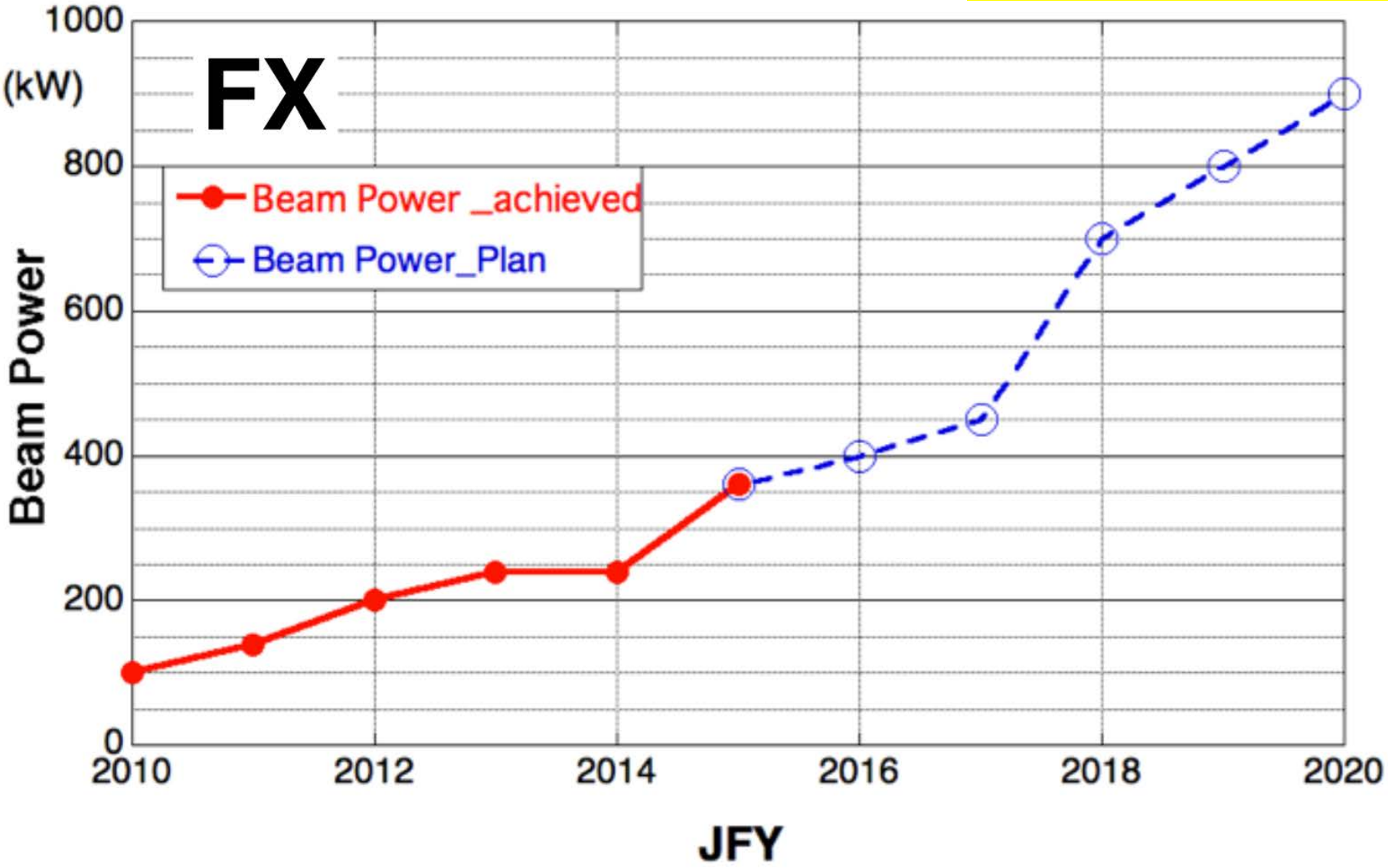


Assuming

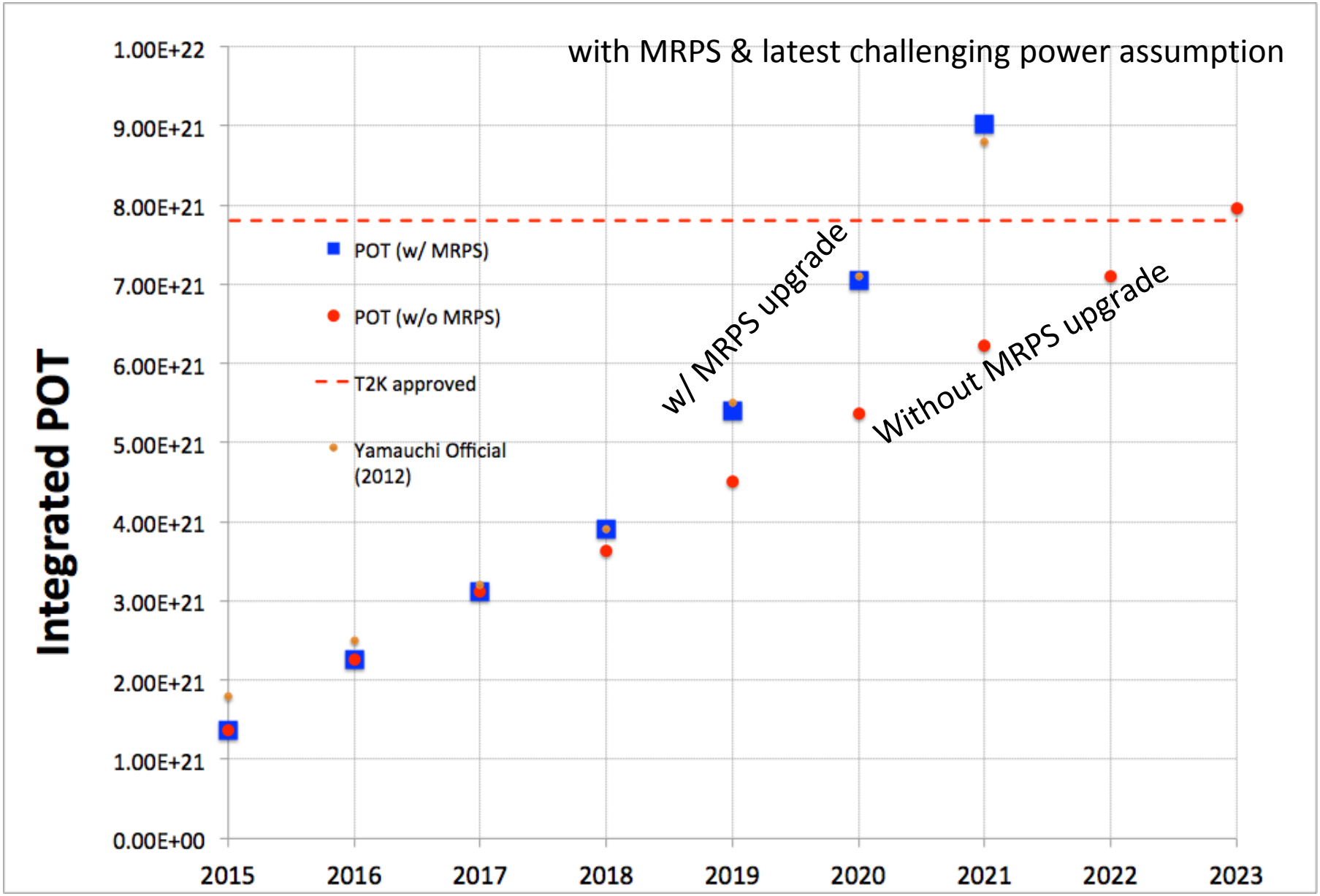
- Main ring power supply upgrade is funded as we desire during FY2016-2018
- Operating budget is constant at “6.5 cycle” during FY2016-2020
- Vacuum cramp replacement work of hadron primary line is decided to be done
- SX >100kW target strategy need to be discussed and fund need to be found

Mid-term plan of MR

New power projection



T2K expected POT projection



Longer term projection (1)

FY	2015		2016		2017		2018		2019		2020	
	4 7 10 1		4 7 10 1		4 7 10 1		4 7 10 1		4 7 10 1		4 7 10 1	
Acc off							MR-PS					
Neutrino												
Month	1	2	1	5	0	5	0	3	0	5	0	5
Days/Month	22	22	22	23	23	23	23	23	23	23	23	23
Days	22	44	22	115	0	115	0	69	0	115	0	115
Live days	19.8	39.6	19.8	103.5	0.0	103.5	0.0	62.1	0.0	103.5	0.0	103.5
Hours	475.2	950.4	475.2	2484.0	0.0	2484.0	0.0	1490.4	0.0	2484.0	0.0	2484.0
Rep rate	2.48	2.48	2.48		2.48			1.30			1.25	
ppb	2.10E+13	2.35E+13	2.60E+13		3.00E+13		2.40E+13		2.70E+13		2.90E+13	
ppp	1.68E+14	1.88E+14	2.08E+14		2.40E+14		1.92E+14		2.16E+14		2.32E+14	
Power(kW)	325.6	364.4	403.1		465.1		709.9		798.6		892.1	
pot	1.16E+20	2.59E+20	1.30E+20	7.50E+20	0.00E+00	8.65E+20	0.00E+00	7.92E+20	0.00E+00	1.49E+21	0.00E+00	1.66E+21
Integ. POT	1.11E+21	1.37E+21	1.50E+21	2.25E+21	2.25E+21	3.12E+21	3.12E+21	3.91E+21	3.91E+21	5.40E+21	5.40E+21	7.06E+21
Integ. POT	1.37E+21		2.25E+21		3.12E+21		3.91E+21		5.40E+21		7.06E+21	
MW.1e7s	0.66		1.08		1.50		1.88		2.59		3.39	
T2K experiment side improvements												
Horn Fac	1.00	1.00	1.00	1.00	1.00	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Fid vol	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.20	1.20	1.20	1.20	1.20
SK ev smple	1.00	1.00	1.00	1.00	1.00	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Overall impro	1.00	1.00	1.00	1.00	1.00	1.21	1.21	1.45	1.45	1.45	1.45	1.45
Eff Integ POT	1.11E+21	1.37E+21	1.50E+21	2.25E+21	2.25E+21	3.30E+21	3.30E+21	4.45E+21	4.45E+21	6.61E+21	6.61E+21	9.02E+21
Eff Integ POT	1.37E+21		2.25E+21		3.30E+21		4.45E+21		6.61E+21		9.02E+21	
Eff MW.1e7s	0.66		1.08		1.59		2.14		3.18		4.33	

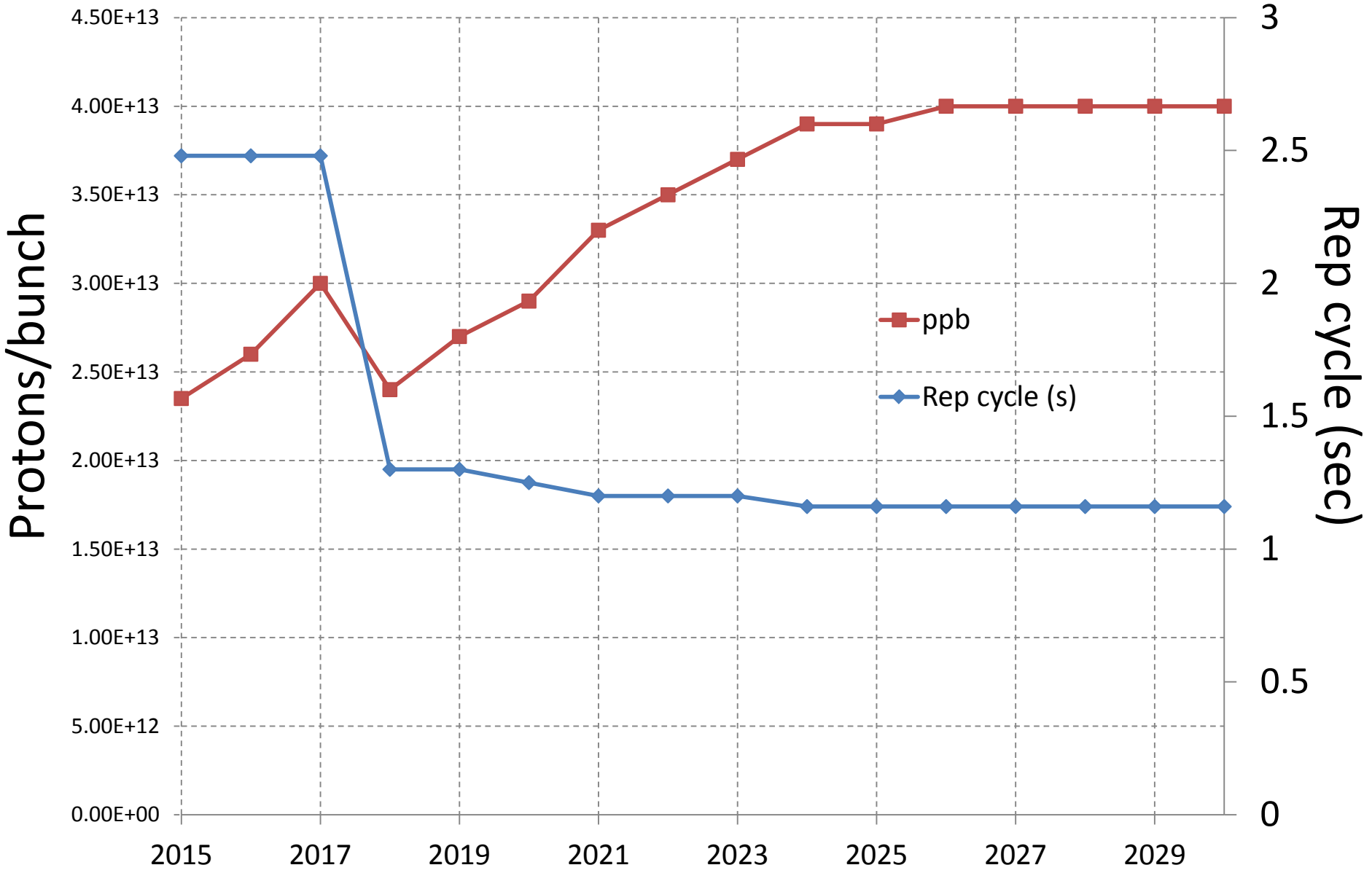
Longer term projection (2)

FY	2021		2022		2023		2024		2025		2026	
Acc off												
Neutrino												
Month	0	5	0	5	0	5	0	5	0	5	0	5
Days/Month	23	23	23	23	23	23	23	23	23	23	23	23
Days	0	115	0	115	0	115	0	115	0	115	0	115
Live days	0.0	103.5	0.0	103.5	0.0	103.5	0.0	103.5	0.0	103.5	0.0	103.5
Hours	0.0	2484.0	0.0	2484.0	0.0	2484.0	0.0	2484.0	0.0	2484.0	0.0	2484.0
Rep rate	1.20		1.20		1.20		1.16		1.16		1.16	
ppb	3.30E+13		3.50E+13		3.70E+13		3.90E+13		3.90E+13		4.00E+13	
ppp	2.64E+14		2.80E+14		2.96E+14		3.12E+14		3.12E+14		3.20E+14	
Power(kW)	1057.4		1121.5		1185.6		1292.8		1292.8		1325.9	
pot	0.00E+00	1.97E+21	0.00E+00	2.09E+21	0.00E+00	2.21E+21	0.00E+00	2.41E+21	0.00E+00	2.41E+21	0.00E+00	2.47E+21
Integ. POT	7.06E+21	9.02E+21	9.02E+21	1.11E+22	1.11E+22	1.33E+22	1.33E+22	1.57E+22	1.57E+22	1.81E+22	1.81E+22	2.06E+22
Integ. POT	9.02E+21		1.11E+22		1.33E+22		1.57E+22		1.81E+22		2.06E+22	
MW.1e7s	4.34		5.34		6.40		7.56		8.71		9.90	
T2K experiment												
Horn Fac	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Fid vol	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
SK ev smple	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Overall impro	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
Eff Integ POT	9.02E+21	1.19E+22	1.19E+22	1.49E+22	1.49E+22	1.81E+22	1.81E+22	2.16E+22	2.16E+22	2.51E+22	2.51E+22	2.87E+22
Eff Integ POT	1.19E+22		1.49E+22		1.81E+22		2.16E+22		2.51E+22		2.87E+22	
Eff MW.1e7s	5.71		7.16		8.70		10.38		12.06		13.78	

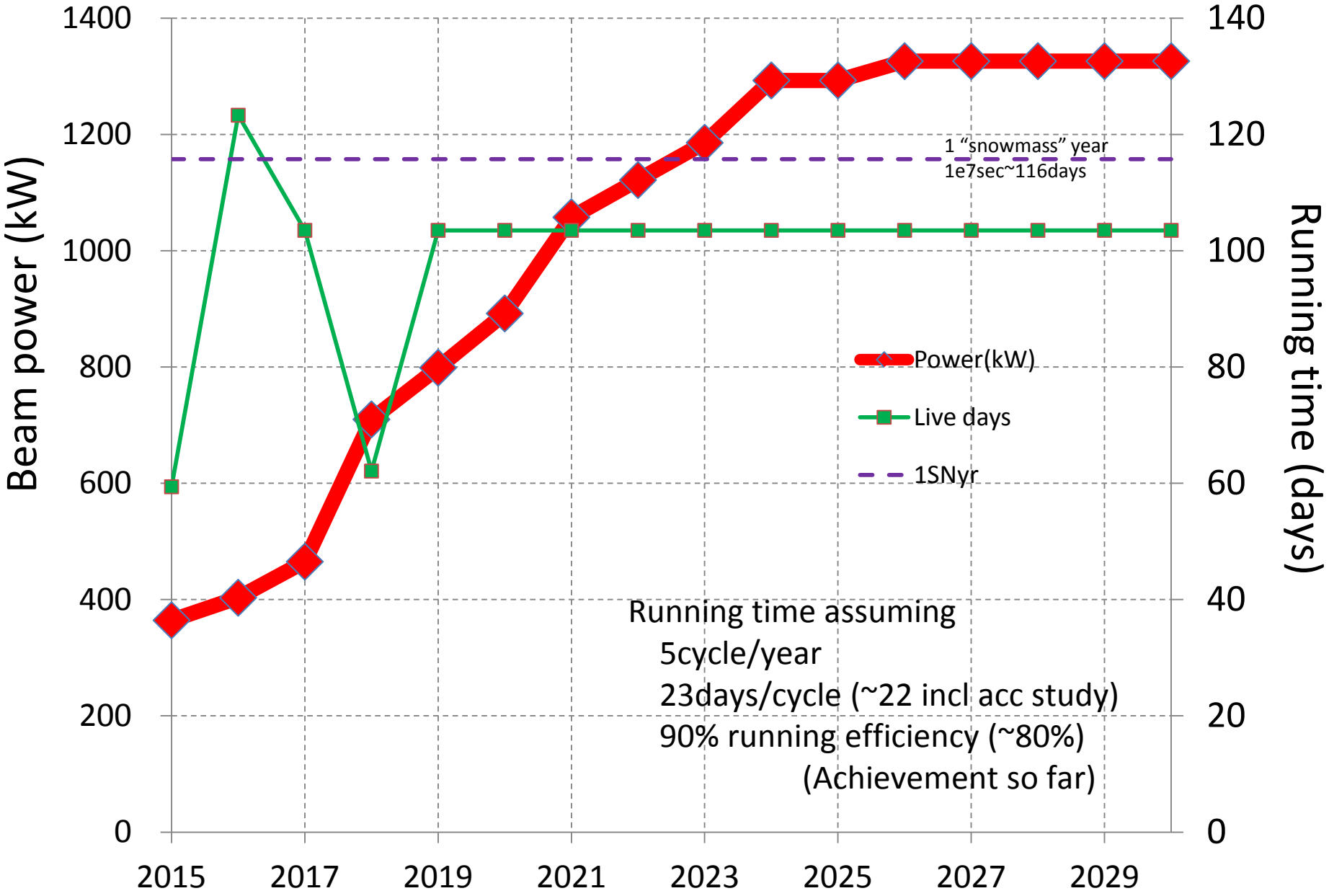
Longer term projection (3)

FY	2025		2026		2027		2028		2029		2030	
	7 10 1		4 7 10 1		4 7 10 1		4 7 10 1		4 7 10 1		4 7 10 1	
Acc off												
Neutrino												
Month	0	5	0	5	0	5	0	5	0	5	0	5
Days/Month	23	23	23	23	23	23	23	23	23	23	23	23
Days	0	115	0	115	0	115	0	115	0	115	0	115
Live days	0.0	103.5	0.0	103.5	0.0	103.5	0.0	103.5	0.0	103.5	0.0	103.5
Hours	0.0	2484.0	0.0	2484.0	0.0	2484.0	0.0	2484.0	0.0	2484.0	0.0	2484.0
Rep rate	1.16		1.16		1.16		1.16		1.16		1.16	
ppb		3.90E+13		4.00E+13		4.00E+13		4.00E+13		4.00E+13		4.00E+13
ppp		3.12E+14		3.20E+14		3.20E+14		3.20E+14		3.20E+14		3.20E+14
Power(kW)		1292.8		1325.9		1325.9		1325.9		1325.9		1325.9
pot	0.00E+00	2.41E+21	0.00E+00	2.47E+21	0.00E+00	2.47E+21	0.00E+00	2.47E+21	0.00E+00	2.47E+21	0.00E+00	2.47E+21
Integ. POT	1.57E+22	1.81E+22	1.81E+22	2.06E+22	2.06E+22	2.31E+22	2.31E+22	2.55E+22	2.55E+22	2.80E+22	2.80E+22	3.05E+22
Integ. POT	1.81E+22		2.06E+22		2.31E+22		2.55E+22		2.80E+22		3.05E+22	
MW.1e7s	8.71		9.90		11.08		12.27		13.45		14.64	
T2K experiment												
Horn Fac	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Fid vol	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20	1.20
SK ev smple	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10	1.10
Overall impro	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45	1.45
Eff Integ POT	2.16E+22	2.51E+22	2.51E+22	2.87E+22	2.87E+22	3.23E+22	3.23E+22	3.58E+22	3.58E+22	3.94E+22	3.94E+22	4.30E+22
Eff Integ POT	2.51E+22		2.87E+22		3.23E+22		3.58E+22		3.94E+22		4.30E+22	
Eff MW.1e7s	12.06		13.78		15.50		17.22		18.95		20.67	

Assumed ppb & rep cycle



Assumed beam power and running time



Hardware Improvement (Assumption)

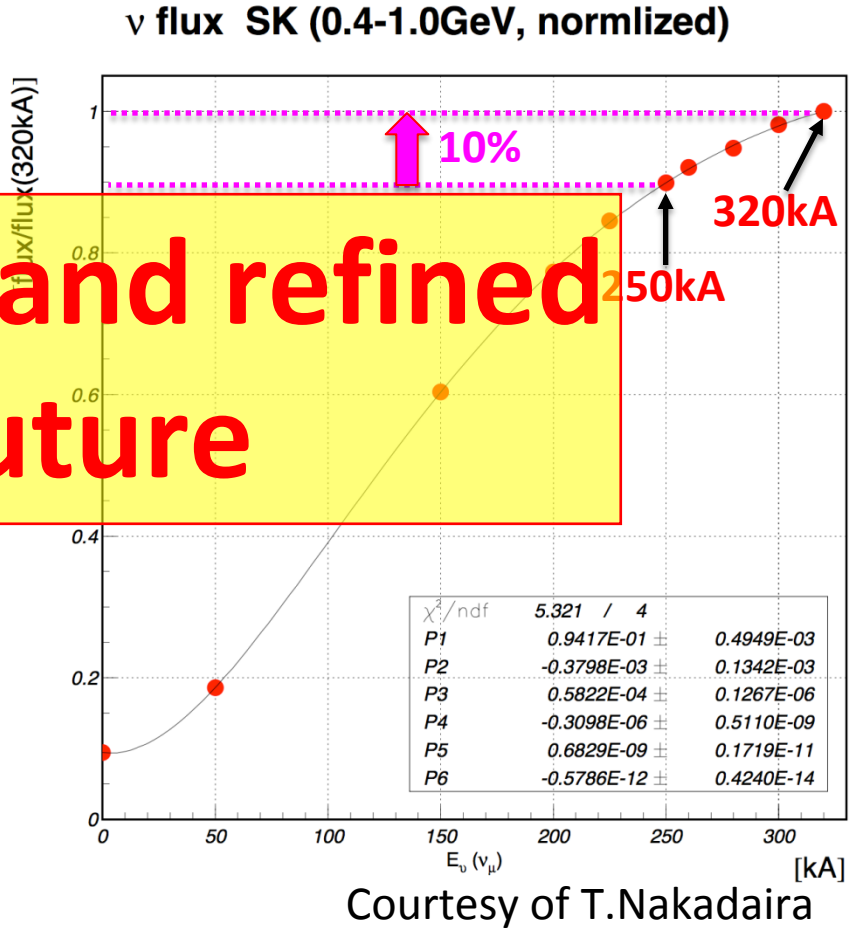
Flux gain by Horn current 250kA → 320kA

- 10% flux gain with 320kA

Implementation plan

- Three power supplies for three horns
  - Two of three already produced.
  - Two new transformers (one currently being produced).
- Aiming to start 320kA operation from 2017 fall.
  - Timely budget approval is necessary.

To be discussed and refined in this WS and future



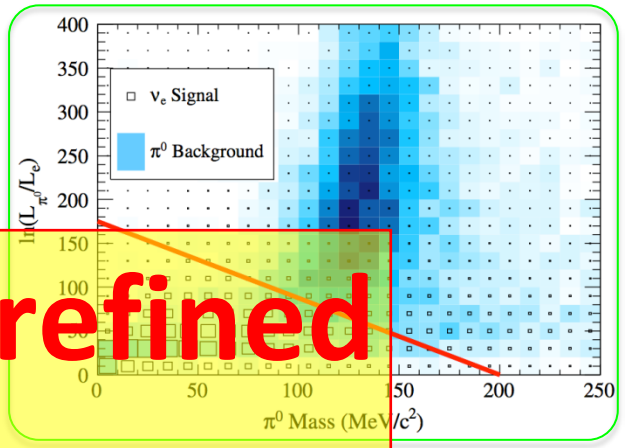
Courtesy of T.Nakadaira

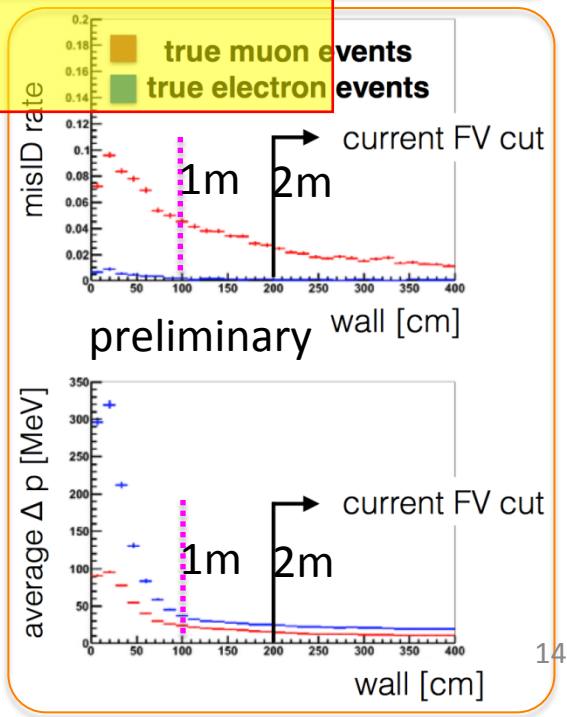
Analysis Improvement **(Assumption)**

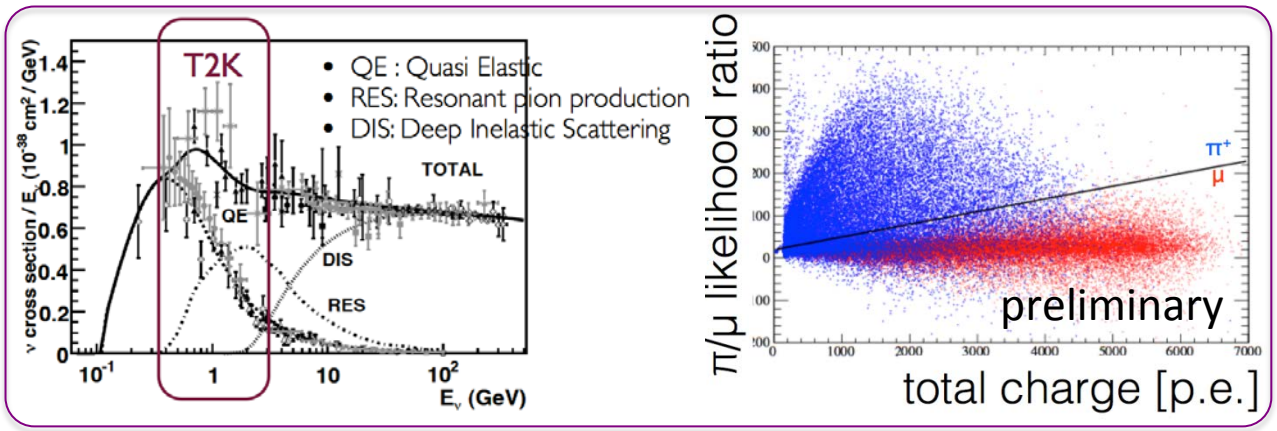
Development of new event reconstruction algorithm for SK

- Better π^0 rejection (done)
- Better vertex resolution:
  - Fid. vol. cut from ID wall
    - 2m → 1m (being studied)
      - ~20% gain
- Better PID → π/μ separation in SK:
  - Exclusive CC1π sample (being studied)
    - ~10% gain by using the sample.

To be discussed and refined in this WS and future







Integrated POT projection

(working assumption)