LPSPL options for delivering ~1.4 GeV protons to the ISOLDE area

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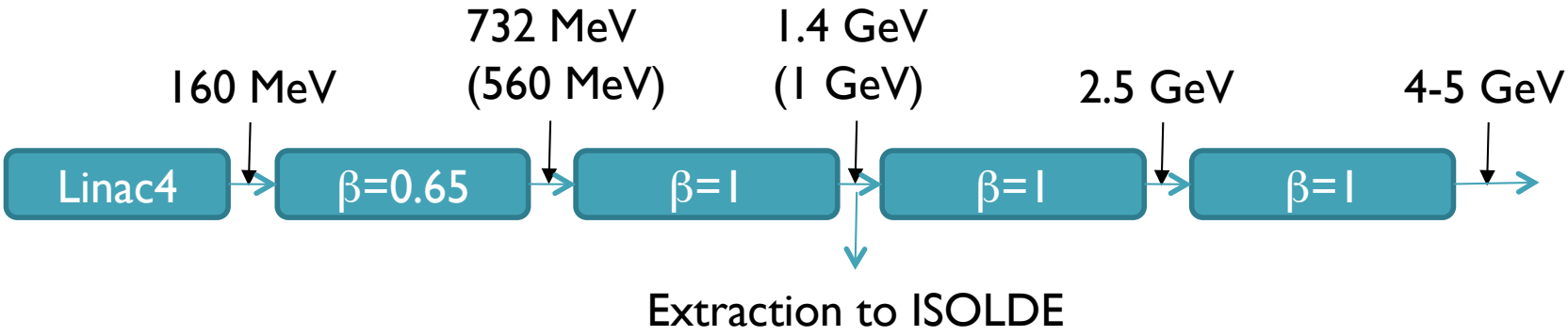
Analysis

- **SPL block diagram**



- **Main impact of faster cycling rate: klystron modulators (SPL + Linac4)**

Limited $P_{average}$ + technology limited cycling rate (~ 15 Hz)

$P_{average} \propto$ Modulator pulse length x Rep. rate

$P_{average} \propto$ (Modulator rise + Cavity fill + Beam pulse) x Rep. rate

200 μs

$\propto E_{acc}^2$

- Other consequences of faster cycling rate:
  - Magnets power supplies
  - Beam instrumentation
  - Controls…

Minimum cost options

⇒ LP-SPL type modulators ($P_{nominal}$ ≡ 0.35 % duty cycle)

*** Basic period : 600 ms – PS2 cycling time: 2.4 s**

Beam energy (GeV)	Max. pulse duration (ms)	Max. current during pulse (mA)	Cycling rate* (Hz)	Max. protons /pulse ($x10^{13}$)	Max. beam power (kW)
1.4	1.2	20	1.25 (3 out of 4 pulses)	15	42
1.4	0.15	20	2.92 (7 out of 8 pulses)	1.9	12
1	0.5	28	2.92 (7 out of 8 pulses)	8.75	41
1	0.15	28	4.58 (11 out of 12 pulses)	2.6	19

Baseline solution

Low cost improvement

Same average RF power

Need for wide range high power RF phase shifters… => Cost!

ISOLDE preferences

Medium cost options with higher cycling rate

- ⇒ Need for higher power klystron modulators
- ⇒ But no change of modulator technology (cycling rate ≤ 15 Hz and average power ≤ 3 x $P_{nominal}$ ≡ 1.05 % duty cycle)

Beam energy (GeV)	Max. pulse duration (ms)	Max. current during pulse (mA)	Cycling rate* (Hz)	Max. protons /pulse (x10^{13})	Max. beam power (kW)
1.4	0.15	20	~ 10 (23 out of 24 pulses)	1.9	42
1	0.5	28	~ 10 (23 out of 24 pulses)	8.75	140
1	0.15	28	~ 15 (35 pulses out of 36)	2.6	63

3 x $P_{nominal}$ Same technology

Need for wide range high power RF phase shifters… => Cost!

ISOLDE preference

High cycling rate

- ⇒ Need for different klystron modulator technology (50 Hz cycling rate and higher power) both in Linac4 and low energy part of SPL
- ⇒ 10 x $P_{nominal}$ ≡ 3.5 % duty cycle
- ⇒ 33 x $P_{nominal}$ ≡ 10.5 % duty cycle

Need for wide range high power RF phase shifters… => Cost!

Beam energy (GeV)	Max. pulse duration (ms)	Max. current during pulse (mA)	Cycling rate* (Hz)	Max. protons /pulse ($x10^{13}$)	Max. beam power (kW)
1	0.15	28	~ 50	2.6	210
1.4	0.27	20	~30	3.4	227
1.4	1.2	20	~ 50	15	1680

10 x $P_{nominal}$ High rate technology

33 x $P_{nominal}$ High Power SPL

Requested feedback

It is economically important to implement the proper cycling rate at the time of design/construction of the LP-SPL (too late for Linac4…):

⇒ How much is it worth? (Upgrading the ISOLDE facility to 100-200 kW capability will already be costly: how much additional cost is acceptable?)

⇒ Interest for higher cycling rate with shorter beam pulse?

⇒ Which set of beam parameters make sense?