Options for G- or P-switch in prep. region

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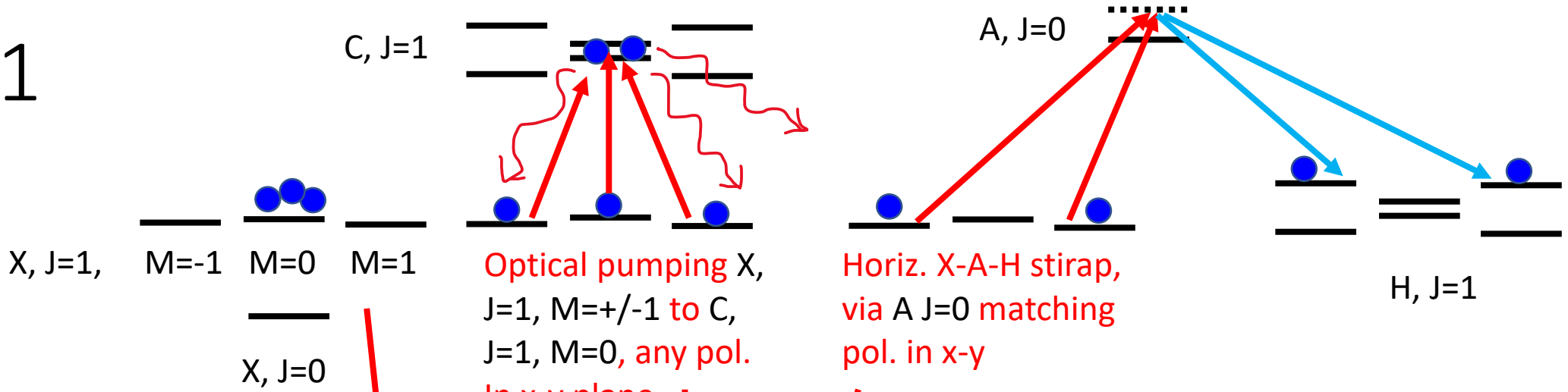
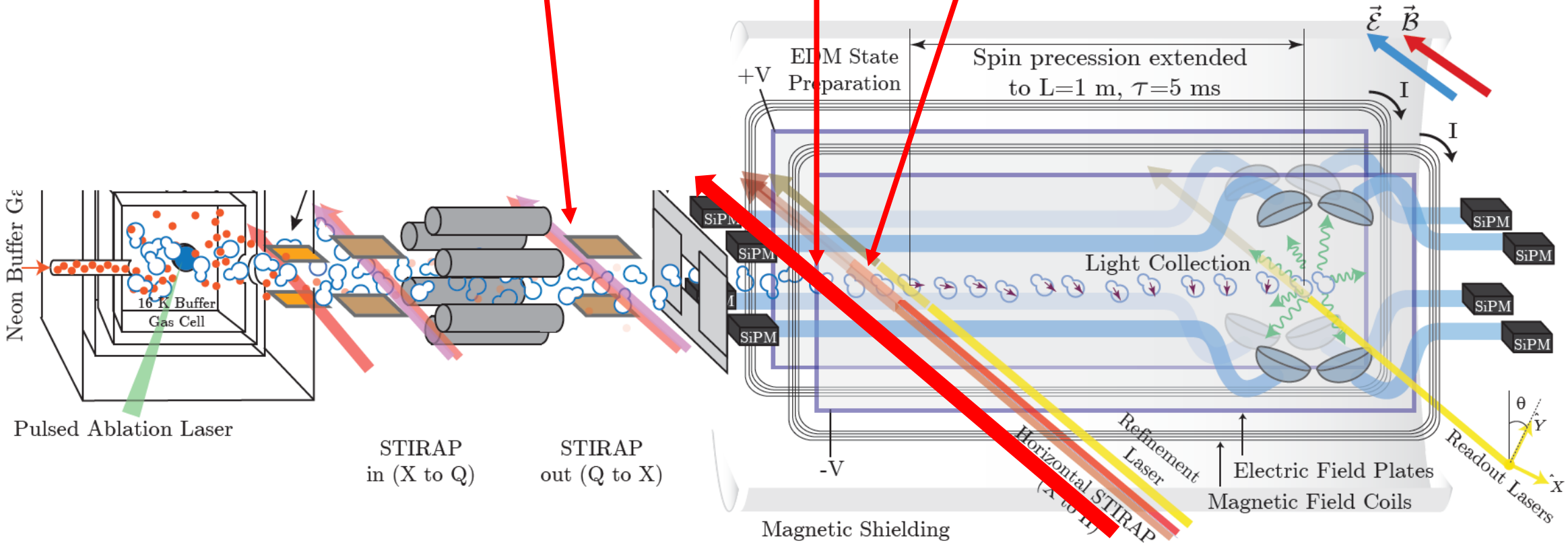
#	action @ Lens exit (on Q |JM=2,2>)	State after Lens	E-field Lens-to-IR	1st prep. in Interaction Region (IR)	state after IR prep 1	2nd prep. in IR (to H |JM=1,±1> coher.)	Intermed. state	G	P
1	Q-C-X stirap; Q-C pol: σ-, 22-->11 C-X pol: σ+, 11-->10	X, J=1, M incoher. (mixed by ext. field)	N	X-C horiz. opt. pump; X-C pol.: any x-y, 1,±1-->10 & 10-->1,±1	X J=1, M=±1 (coher.)	X-A(00)-H horiz. stirap X-A pol.: same as 1st prep A-H pol.: any x-y	A,J=0	Y	N
2	Q-C-X stirap; Q-C pol: σ-, 22-->11 C-X pol: σ+, 11-->00	X, J=0	N	X-C(10)-X vertical stirap; X-C pol.: z, 00 --> 10 C-X pol.: x, 10 --> 2,±1	X J=2, M=±1 (coher.)	X-A(1,0)-H horiz. stirap X-A pol.: x A-H pol.: any x-y	A, J=1, M=0	Y	N
3	Q-C-X stirap; Q-C pol: σ-, 22-->11 C-X pol: σ+, 11-->00	X, J=0	N	X-C-Q vertical stirap; X-C pol.: z, 00 --> 10 C-Q pol: x, 10 --> 2,±1	Q J=2, M=±1 (coher.)	Q-C(1,0)-H vertical stirap Q-C pol.: x C-H pol.: x	C, J=1, M=0, either P	N	Y
4	Q-C-X stirap; Q-C pol: σ-, 22-->11 C-X pol: σ+, 11-->00	X, J=0	N	As in 3	Q J=2, M=±1 (coher.)	Q-I(1,0)-H vertical stirap Q-I pol.: x I-H pol.: x	I, J=1, M=0, either P	N	Y
5	No action	Q, J=2, M=2	Y	Q-C-Q vertical stirap; Q-C pol.: x, 22-->11 C-Q pol.; z, 11-->21; red detuned vs C, JM=11	Q J=2, M=1	Q-C(1,0)-H vertical stirap Q-C pol.: x I-H pol.: x	C, J=1, M=0, either P	N	Y
6	No action	Q, J=2, M=2	Y	as in 5	Q J=2, M=1	Q-I(1,0)-H vertical stirap Q-I pol.: x I-H pol.: x	I, J=1, M=0, either P	N	Y

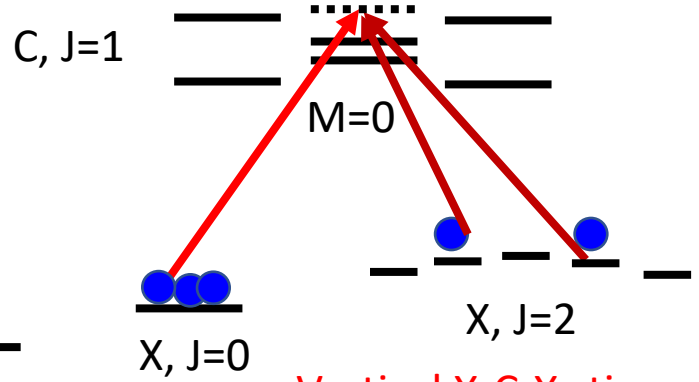
#	action @ Lens exit	1st prep. IR	2nd prep. IR	Advantage	Disadvantage	likely problems, unknonwn risks	problems considered	new costs	Total new cost
1	Q-C-X stirap; State after: X, JM=10	X-C horiz. opt. pump	X-A-H horiz. stirap	Opt. pump. @ 1st prep. (less sensitive to misalign vs. stirap); Arbitrary pol./initial phase	Loss at opt. pump in 1st prep. loss (>25%); New lasers for X-A & H-A, and ULE cavity locks; Time to set up new stirap	X-A-H stirap; stirap thru ITO? New vendor for 1892nm laser, no user experience	scatter of 690 (X-C) laser on ITO: not worse than clean-up (703)	943 TA (X-A): ~60k; 1892 fiber laser (H-A): ~40k new ULE cavity: ~40k 1x 690 TA (X-C): ~60k Optical switching: ~6k	~206k
2	Q-C-X stirap; State after: X, JM=00	X-C-X vertical stirap	X-A-H horiz. stirap	No sponta. decay loss from opt. pump.; Strongest stirap transit.; Arbitrary pol./initial phase	x pol. in X-A & arbitrary pol. In H-A, hard to prep.; New lasers for X-A & H-A, and ULE cavity locks; Time to set up new stirap	X-A-H stirap; stirap thru ITO? New vendor for 1892nm laser, no user experience		943 TA (X-A): ~60k; 1892 fiber laser (H-A): ~40k new ULE cavity: ~40k 2x 690 TA (X-C): ~120k	~260k
3	Q-C-X stirap; State after: X, JM=00	X-C-Q vertical stirap	Q-C-H vertical stirap	All steps demonstrated; No stirap thru ITO; Only need freq.-switch ~100 MHz for P-switch, clean to implement		set up vertical stirap on new beamline?	remote alignment w/ piezo-controlled steering mirror	1090 amplifier (H-C), >15W: ~24k; 1x 690 TA (X-C): ~60k; 1196 DL pro (Q-C): ~36k; piezo-control + optics: ~10k	~130k
4	Q-C-X stirap; State after: X, JM=00	As in 3	Q-I-H vertical stirap	all transitions are known or now have access to; Q-I-H much more balanced strengths vs. Q-C-H;	Expensive new TiS laser or RFA or SFG for Q-I (746nm) and I-H (703nm); Time to setup new stirap		more powerful solution @ 703nm? split for stirap + cleanup + probe	TiS: ~200k; RFA: ~100k; New ULE cavity: ~40k; 1x 690 TA (X-C): ~60k; 1196 DL pro (Q-C): ~36k	~436k (could save~100k if do it smartly)
5	No action State after: Q, JM=22	Q-C-Q vertical stirap	Q-C-H vertical stirap	One stirap fewer to do; Min. optic resources; All steps demonstrated or known to be easy	Rely on contin. E-field Lens-to-IR to suppress spin flip from Q, JM=22.	concerns on spin flip of Q, JM=22	spin flip at collimator: solved by new design, test w/ COMSOL sim.;	1090 fiber amplifier (H-C), >15W: ~24k; Q-C (1196) DL Pro: ~36k piezo-control + optics: ~10k	~70k
6	No action State after: Q, JM=22	as in 5	Q-I-H vertical stirap	4 & 5 combined	4 & 5 combined Time to setup new stirap	concerns on spin flip of Q, JM=22	4 & 5 combined	TiS + RFA + locking cavity: ~340k; 1196 DL pro (Q-C): ~36k	~380k

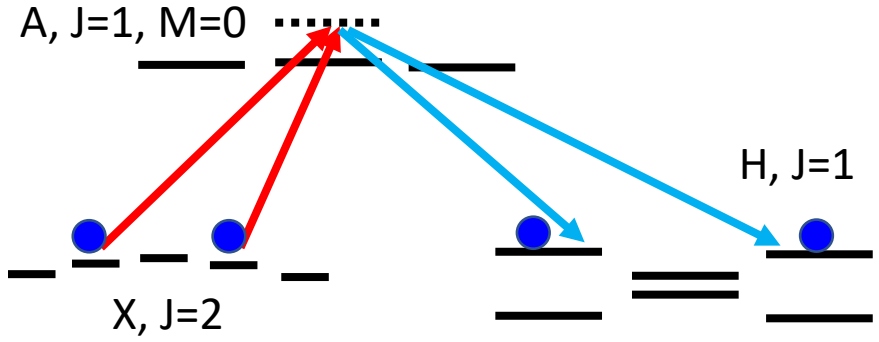
Method 1

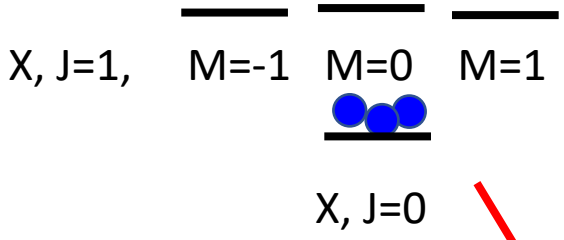

C, J=1
A, J=0
X, J=1,
M=-1
M=0
M=1
X, J=0
H, J=1
Optical pumping X, J=1, M=+/-1 to C, J=1, M=0, any pol. In x-y plane
Horiz. X-A-H stirap, via A J=0 matching pol. in x-y


Neon Buffer Gas
16 K Buffer Gas Cell
Pulsed Ablation Laser
STIRAP in (X to Q)
STIRAP out (Q to X)
EDM State Preparation
+V
-V
Spin precession extended to L=1 m, τ=5 ms
Light Collection
SiPM
Magnetic Shielding
Refinement Laser
Horizontal STIRAP
Electric Field Plates
Magnetic Field Coils
Readout Lasers
θ
Y
X

Method 2

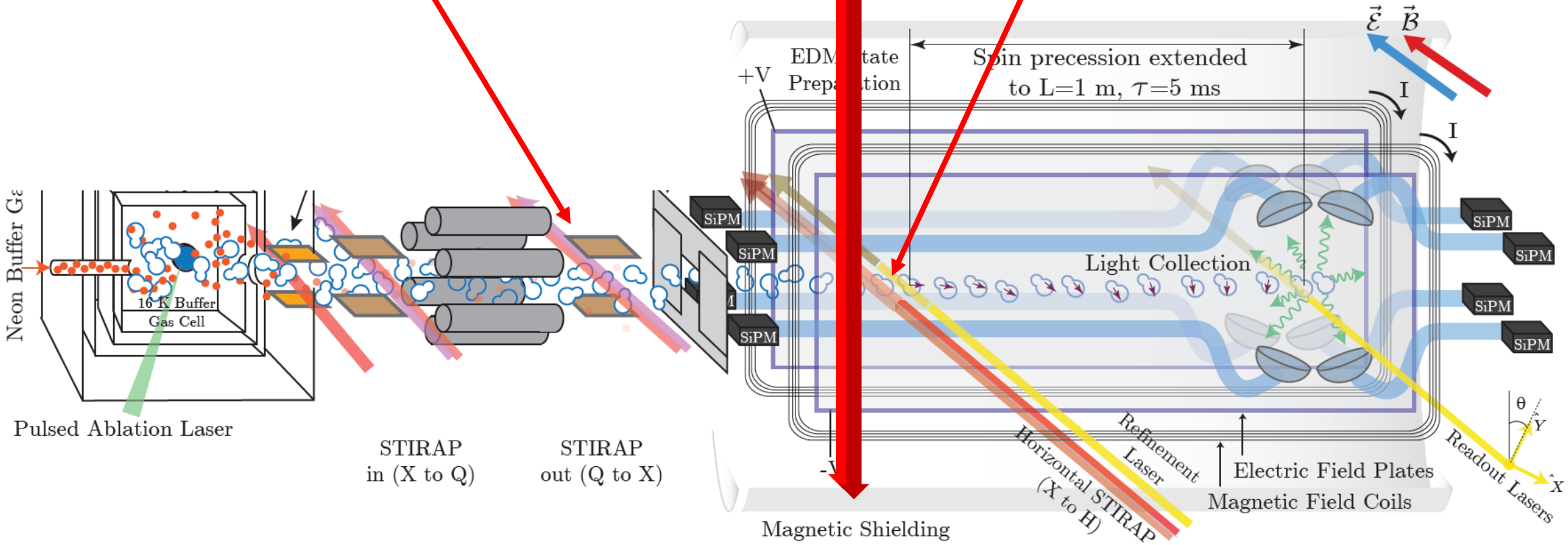




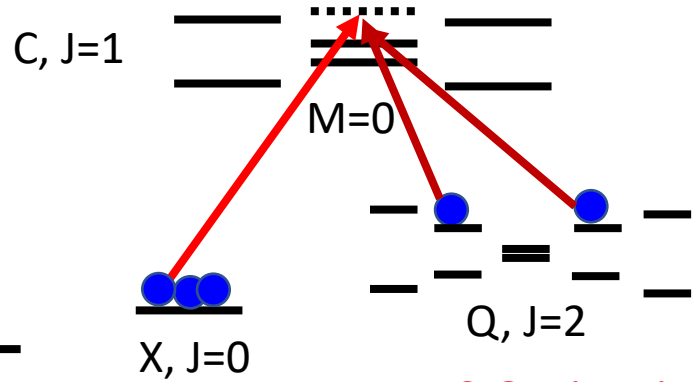


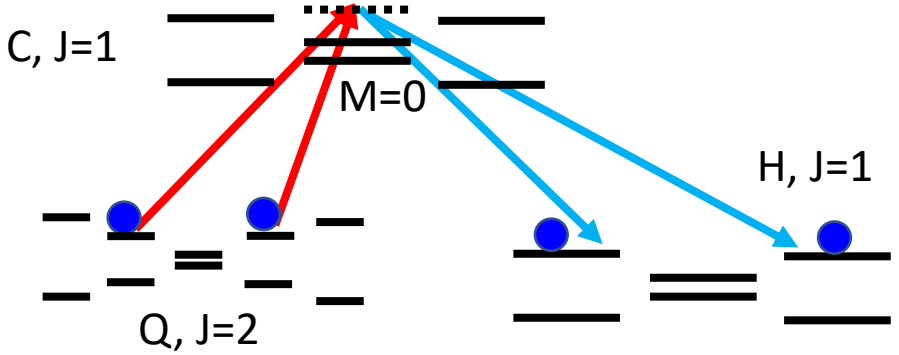
Vertical X-C-X stirap into X, J=2, M= +/-1 state

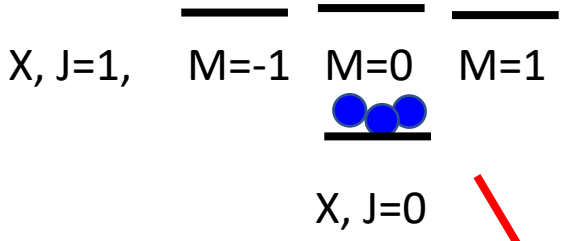
Horiz. X-A-H stirap, via A, J=1, M=0
X-A in x-pol., A-H in any pol. x-y



Method 3

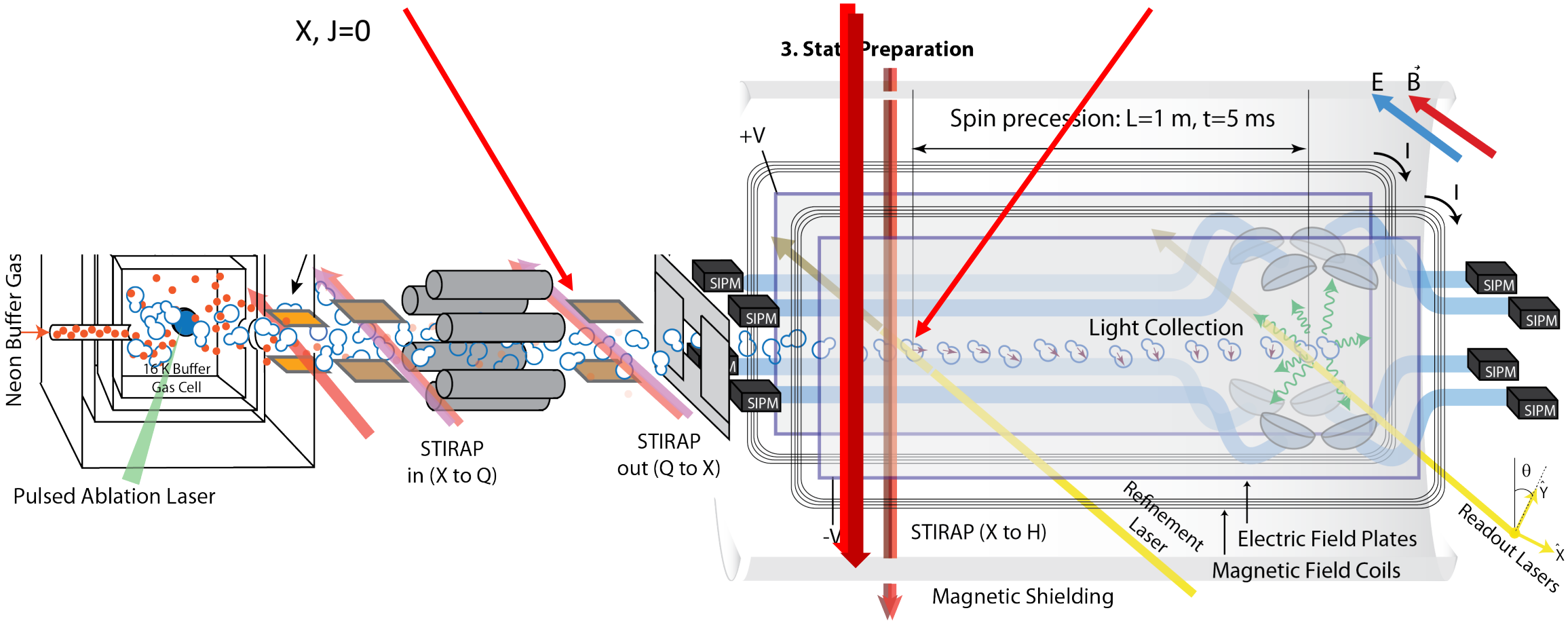




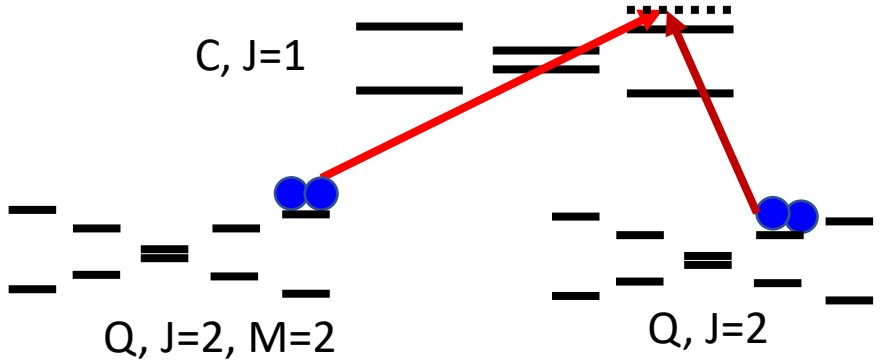


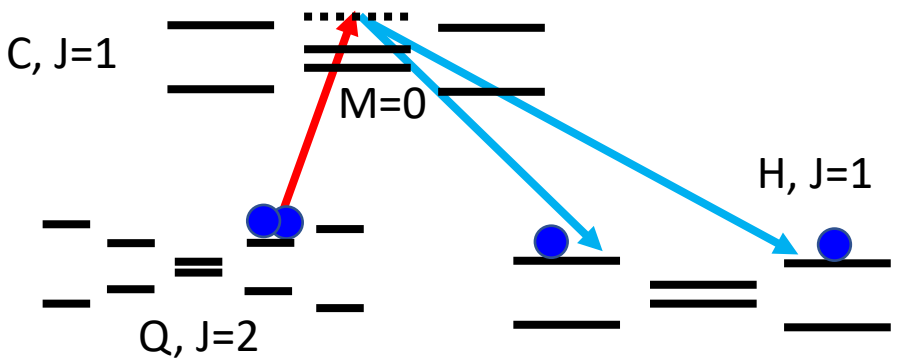
Vert. X-C-Q stirap into Q, J=2, M= +/-1 state

Vert. Q-C-H stirap, via C, J=1, M=0. x-pol, but can use P-switch of C doublet



Method 5

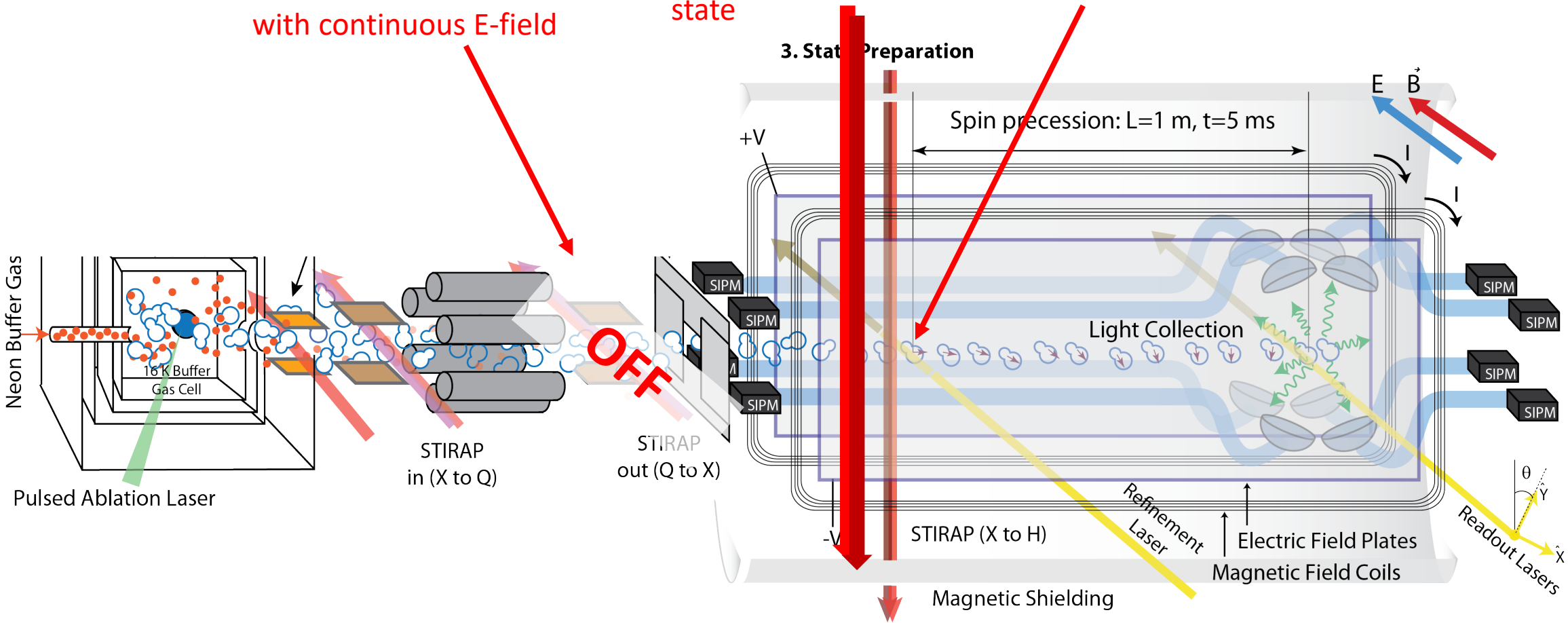




NO stirap after lens. Keep molecules in Q, J=2, M=2 with continuous E-field

Vert. Q-C-Q stirap into Q, J=2, M= 1 state

Vert. Q-C-H stirap, via C, J=1, M=0. x-pol, but can use P-switch of C doublet



Method 4 & 6

- Similar to 3 & 5
- Except replace the last stirap of Q-C-H with Q-I-H

- Q-C-H stirap
  - Q-C: 1196nm, strong transition
  - C-H: 1090nm, weak transition

- Everything is known about these 2 transitions
- Lasers are readily available

- Q-I-H stirap
  - Q-I: 746nm, intermediate strength
  - I-H: 703nm, intermediate strength

- Transitions strength more balanced, more symmetric 2-photon lineshape
- Might require 2 extra TiS Lasers

>15 W solution driving 1090nm C-H transition

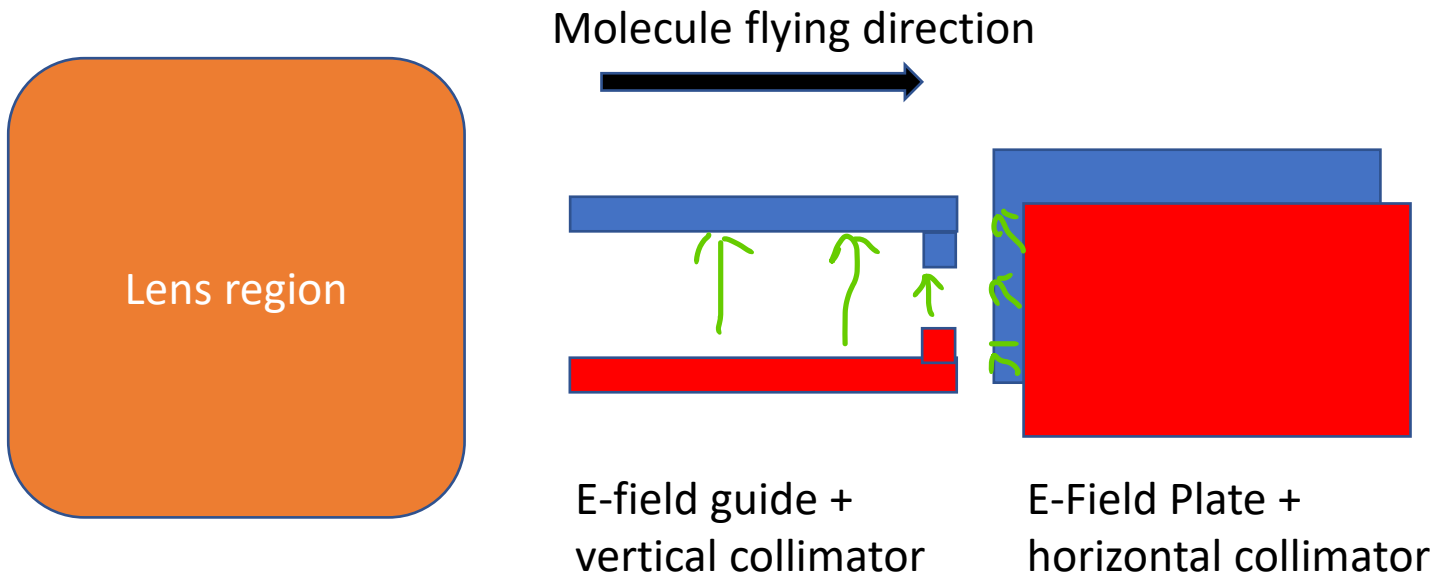
precilasers 频准激光

Details:

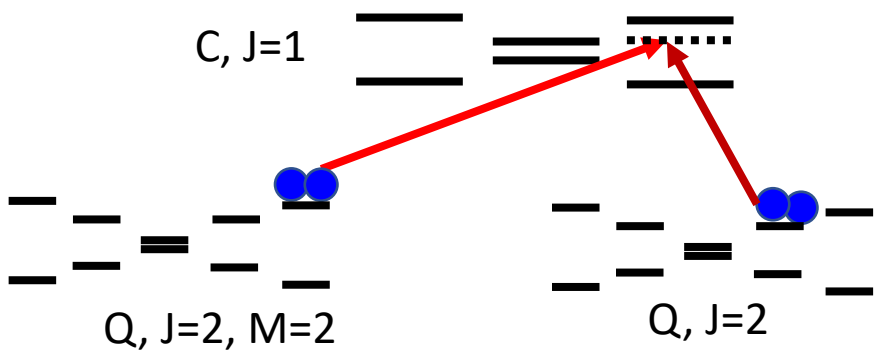
Item	Model	Descriptions	QTY	Unit Price (USD)	Total Price (USD)	Delivery Time
1	YFA-SF-1090-15-CW	1090 nm Fiber amplifier Central wavelength: 1090 nm; Amplification Wavelength Range: 1060-1095 nm; Power after isolator:>15 W ; RMS Power stability:<0.5% for 3 hours; RIN: <0.05% integration from 10Hz-10MHz; Polarization: Linear-polarized, PER>23dB; Output Cable Length: Over 1.5m; Adjustable Power Range (%): 2-100%; Output Beam quality : M2< 1.1; Control way: 7 inch touch screen/Computer software with a USB line. The software and line are included.	1	US$20,000.00	US$20,000.00	8-10 Weeks
2	Shipping	Express delivery by Fedex.	1	US$500.00	US$500.00	
		Total USD Price			US$20,500.00	

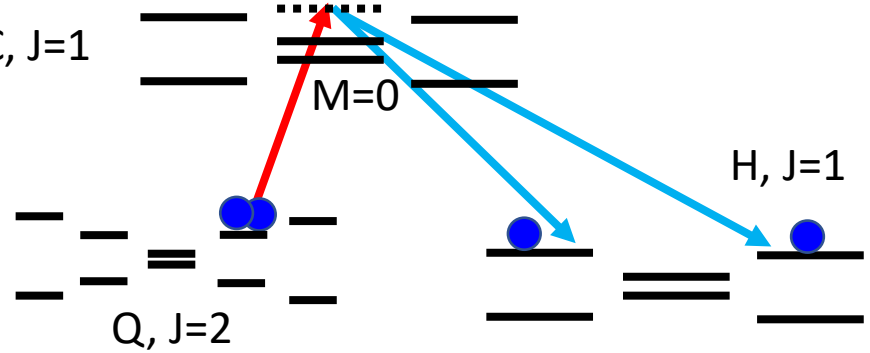
#	action @ Lens exit (on Q |JM=2,2>)	State after Lens	E-field Lens-to-IR	1st prep. in Interaction Region (IR)	state after IR prep 1	2nd prep. in IR (to H |JM=1,±1> coher.)	Intermed. state	G	P
1	Q-C-X stirap; Q-C pol: σ-, 22-->11 C-X pol: σ+, 11-->10	X, J=1, M incoher. (mixed by ext. field)	N	X-C horiz. opt. pump; X-C pol.: any x-y, 1,±1-->10 & 10-->1,±1	X J=1, M=±1 (coher.)	X-A(00)-H horiz. stirap X-A pol.: same as 1st prep A-H pol.: any x-y	A,J=0	Y	N
2	Q-C-X stirap; Q-C pol: σ-, 22-->11 C-X pol: σ+, 11-->00	X, J=0	N	X-C(10)-X vertical stirap; X-C pol.: z, 00 --> 10 C-X pol.: x, 10 --> 2,±1	X J=2, M=±1 (coher.)	X-A(1,0)-H horiz. stirap X-A pol.: x A-H pol.: any x-y	A, J=1, M=0	Y	N
3	Q-C-X stirap; Q-C pol: σ-, 22-->11 C-X pol: σ+, 11-->00	X, J=0	N	X-C-Q vertical stirap; X-C pol.: z, 00 --> 10 C-Q pol: x, 10 --> 2,±1	Q J=2, M=±1 (coher.)	Q-C(1,0)-H vertical stirap Q-C pol.: x C-H pol.: x	C, J=1, M=0, either P	N	Y
4	Q-C-X stirap; Q-C pol: σ-, 22-->11 C-X pol: σ+, 11-->00	X, J=0	N	As in 3	Q J=2, M=±1 (coher.)	Q-I(1,0)-H vertical stirap Q-I pol.: x I-H pol.: x	I, J=1, M=0, either P	N	Y
5	No action	Q, J=2, M=2	Y	Q-C-Q vertical stirap; Q-C pol.: x, 22-->11 C-Q pol.; z, 11-->21; red detuned vs C, JM=11	Q J=2, M=1	Q-C(1,0)-H vertical stirap Q-C pol.: x I-H pol.: x	C, J=1, M=0, either P	N	Y
6	No action	Q, J=2, M=2	Y	as in 5	Q J=2, M=1	Q-I(1,0)-H vertical stirap Q-I pol.: x I-H pol.: x	I, J=1, M=0, either P	N	Y

Possible solution to E-field issue of the guiding: slow rotation of ‘dipole-field’ by 90°



Method 4’ (red detune pre-stirap)





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Vert. Q-C-Q stirap into Q, J=2, M= 1 state

Vert. Q-C-H stirap, via C, J=1, M=0. x-pol, but can use P-switch of C doublet