Commissioning Procedure for bKAGRA Phase 1

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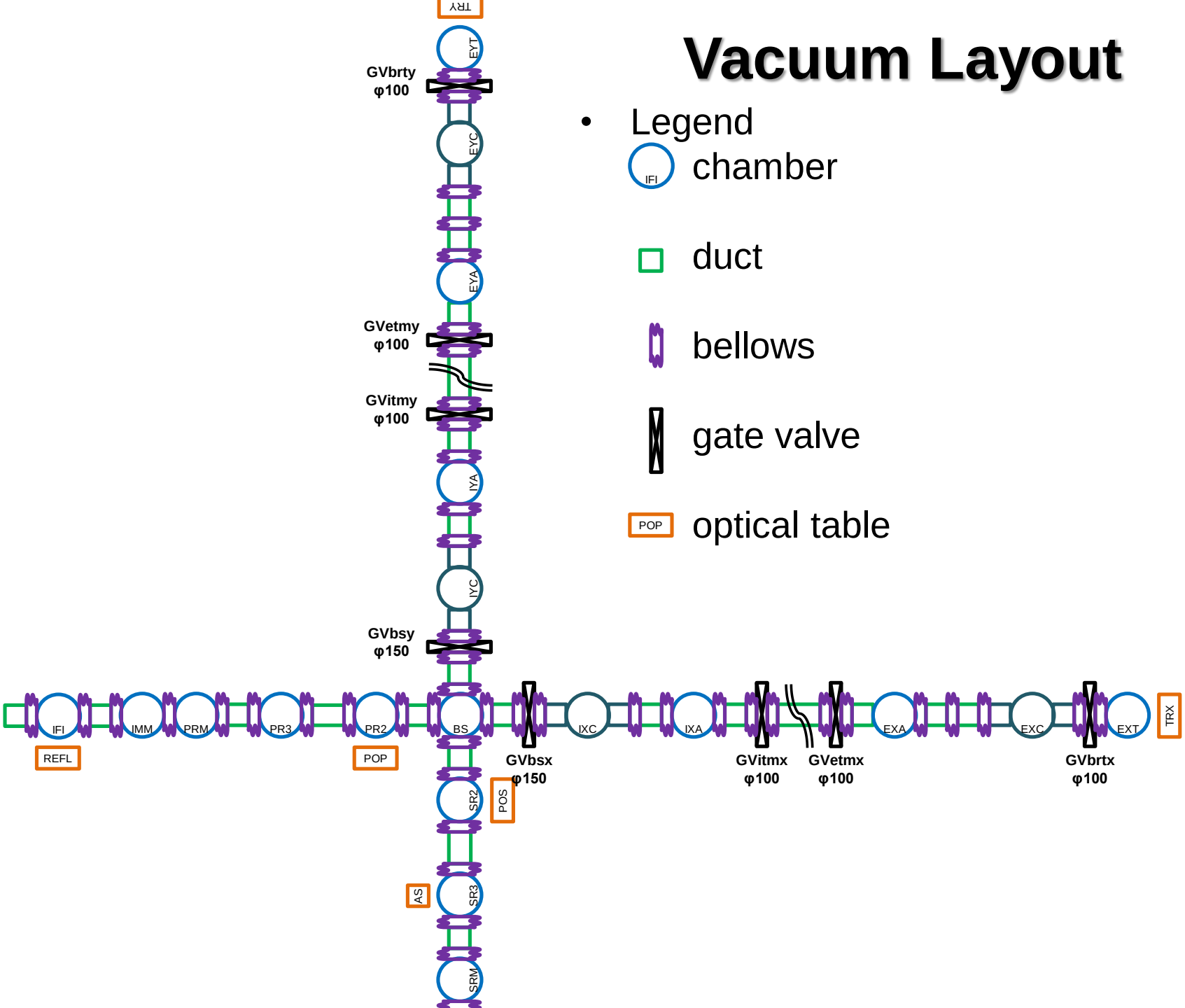
see, also, JGW-T1605595
for interferometer design and commissioning schedule

Vacuum Layout

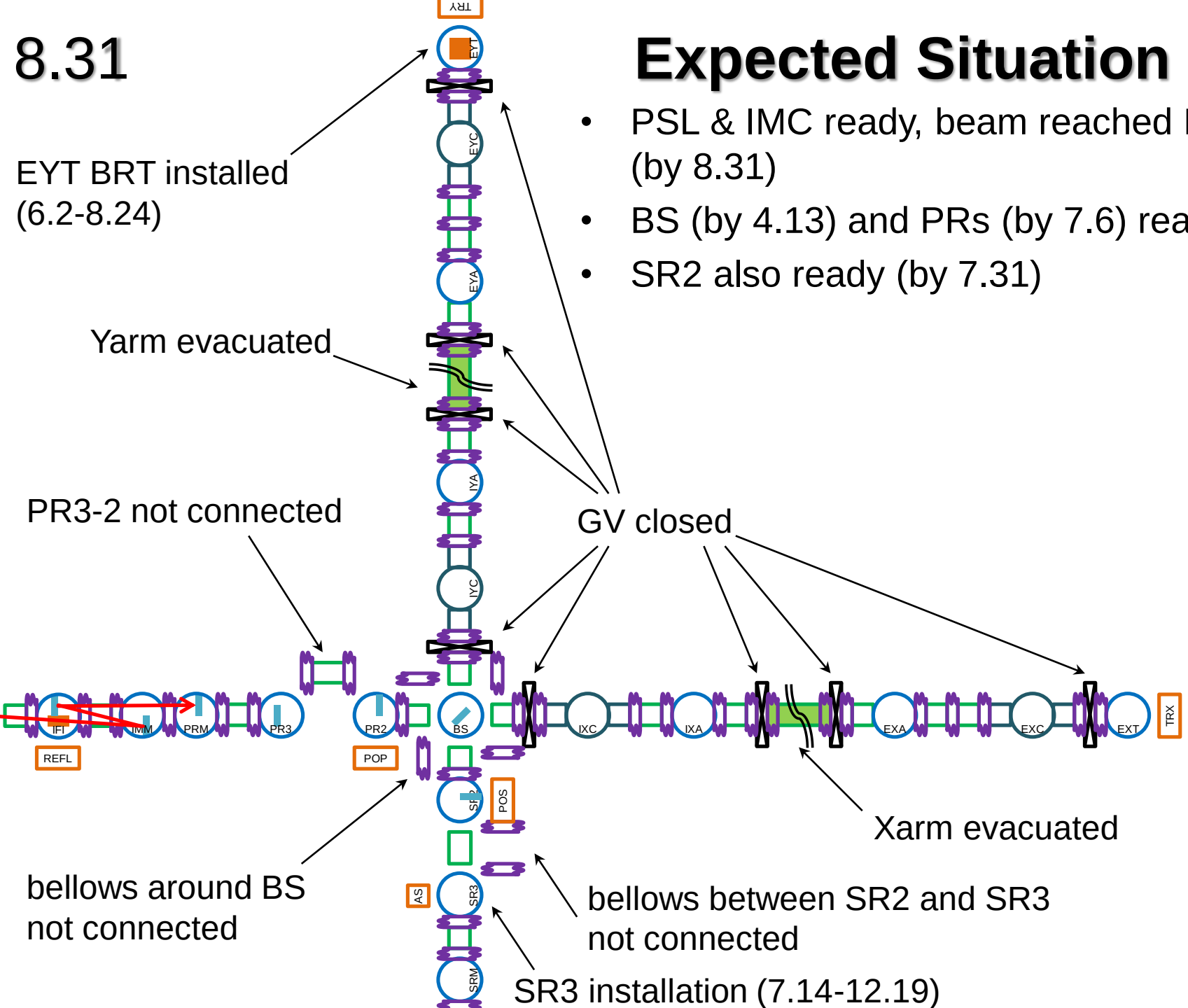
- Legend
  - chamber
  - duct
  - bellows
  - gate valve
  - optical table



8.31

Expected Situation

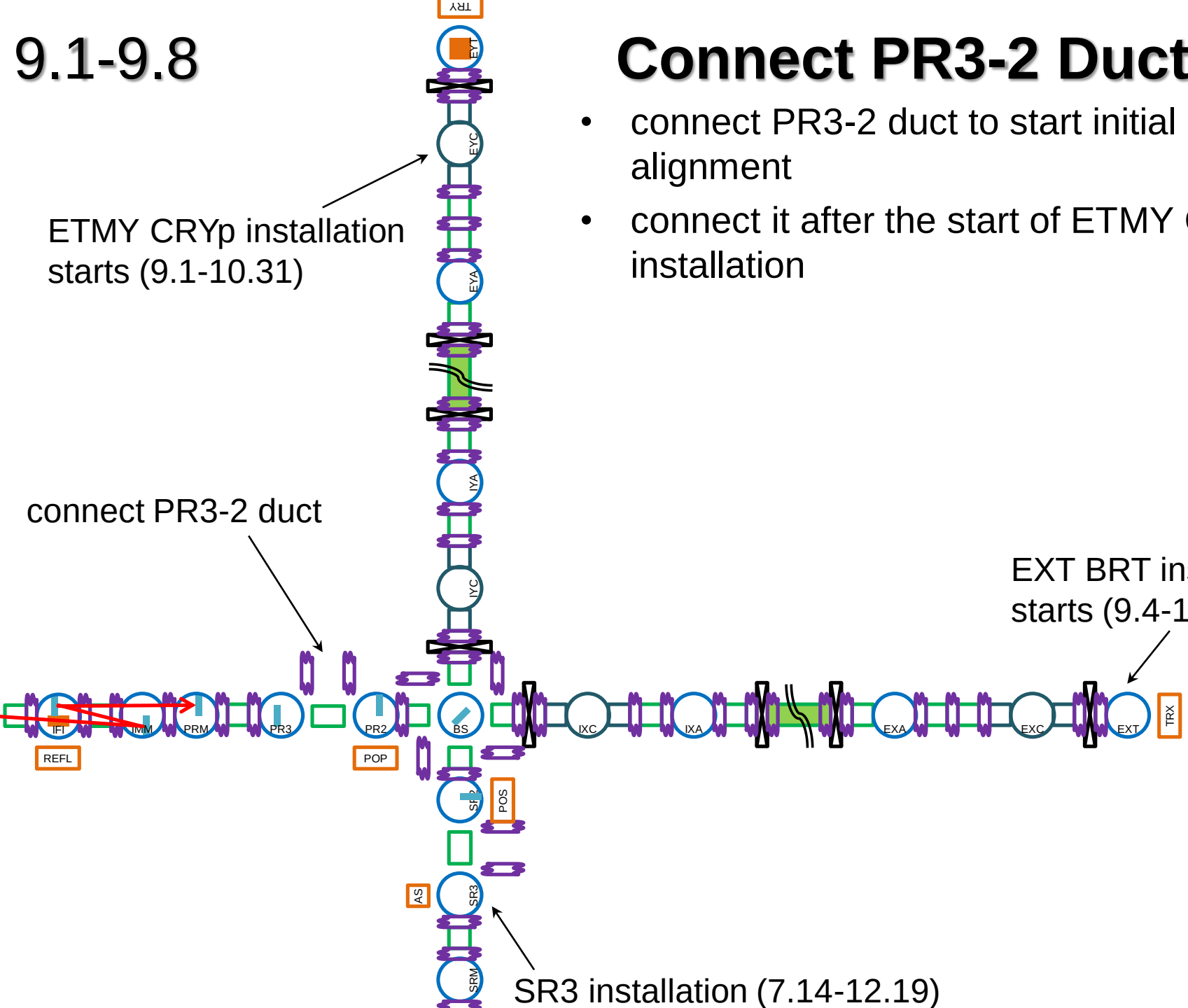
- PSL & IMC ready, beam reached PRM (by 8.31)
- BS (by 4.13) and PRs (by 7.6) ready
- SR2 also ready (by 7.31)



9.1-9.8

Connect PR3-2 Duct

- connect PR3-2 duct to start initial alignment
- connect it after the start of ETMY CRYp installation



9.11-9.15 Alignment from IMMT to PR3

- beam spot on PR3 has to be off the center by -5 mm in Y, since there's no ITM wedge

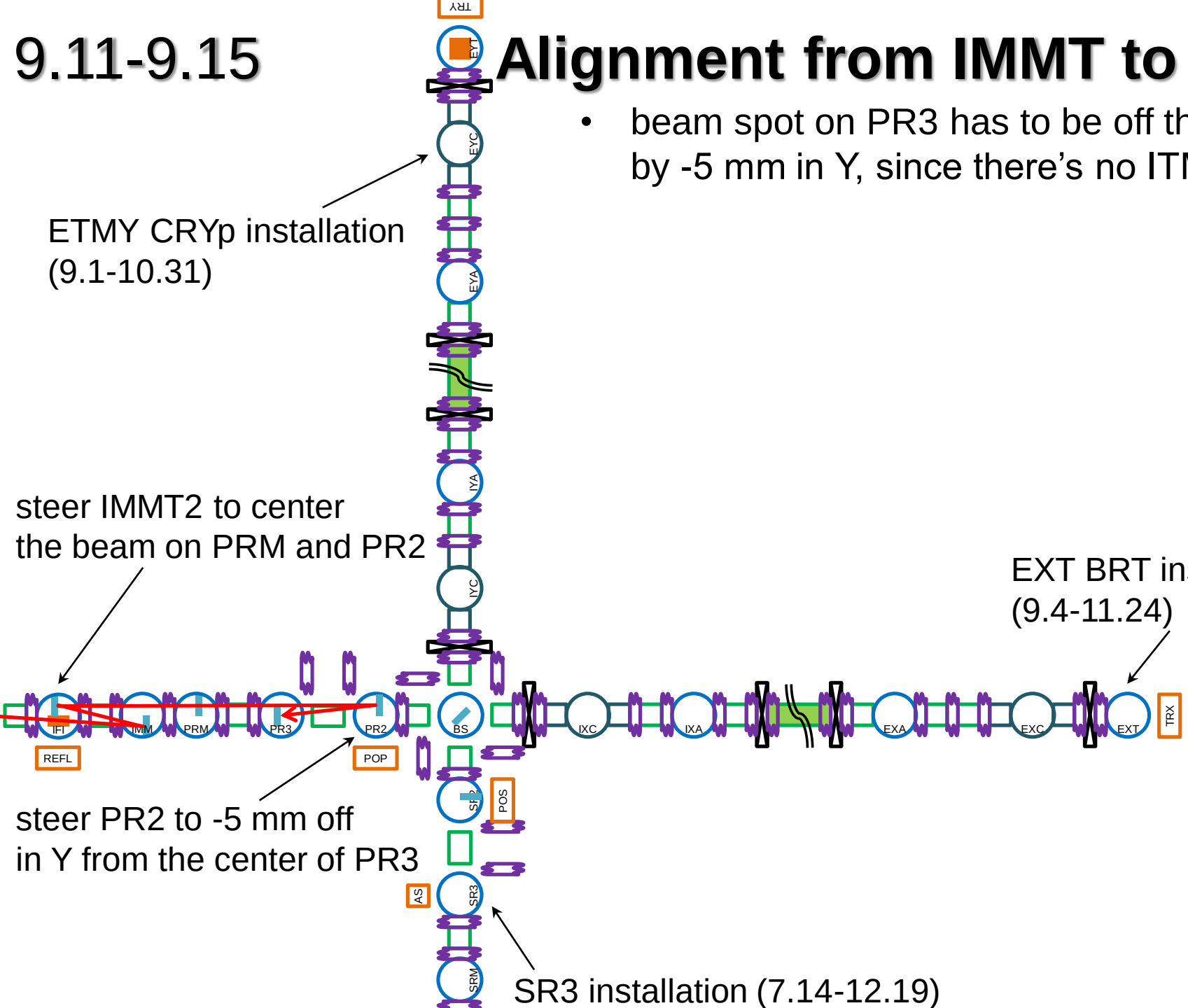
ETMY CRYp installation (9.1-10.31)

steer IMMT2 to center the beam on PRM and PR2

EXT BRT installation (9.4-11.24)

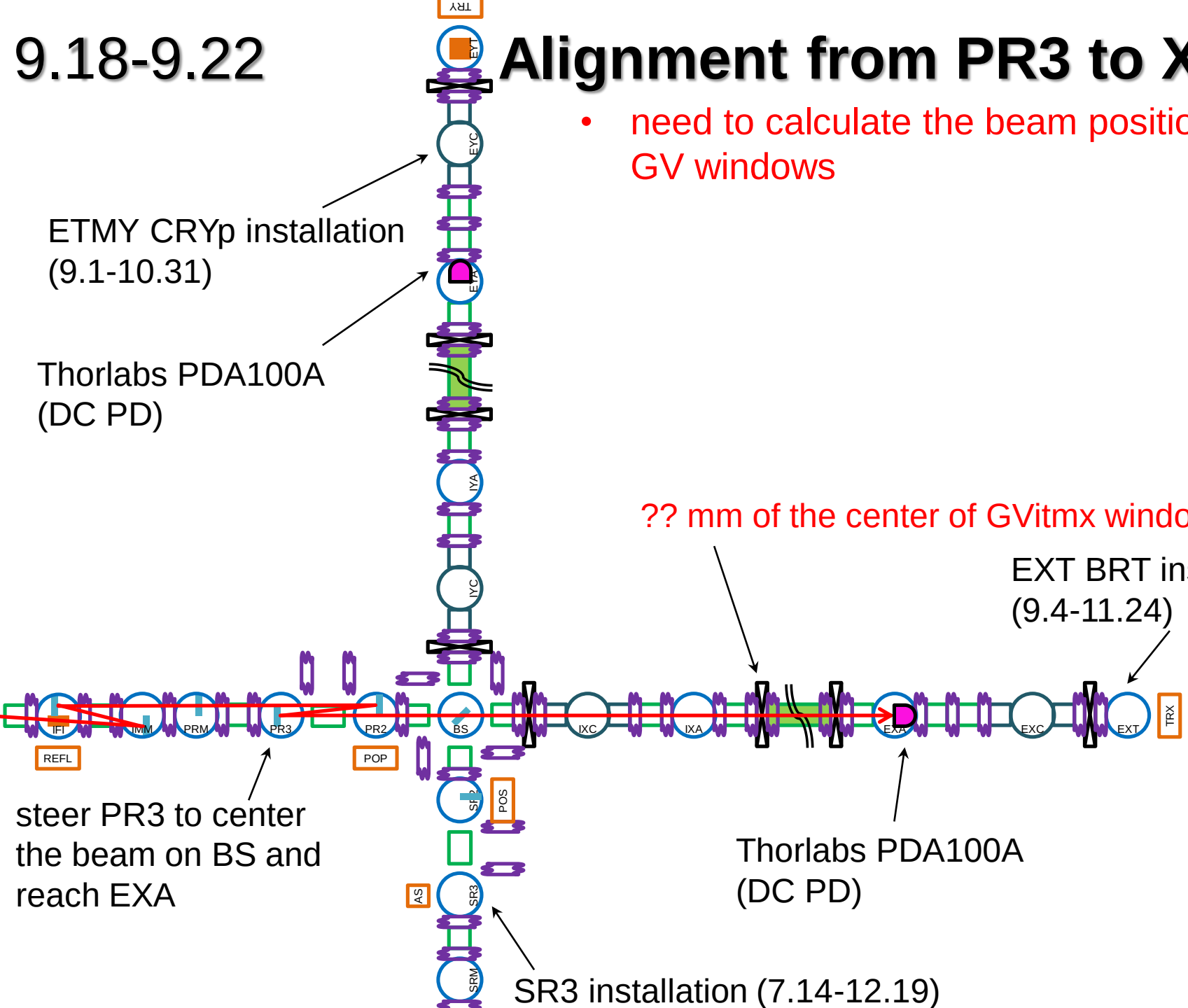
steer PR2 to -5 mm off in Y from the center of PR3

SR3 installation (7.14-12.19)



9.18-9.22 Alignment from PR3 to Xend

- need to calculate the beam position on GV windows



9.25-9.29

Alignment from BS to Yend

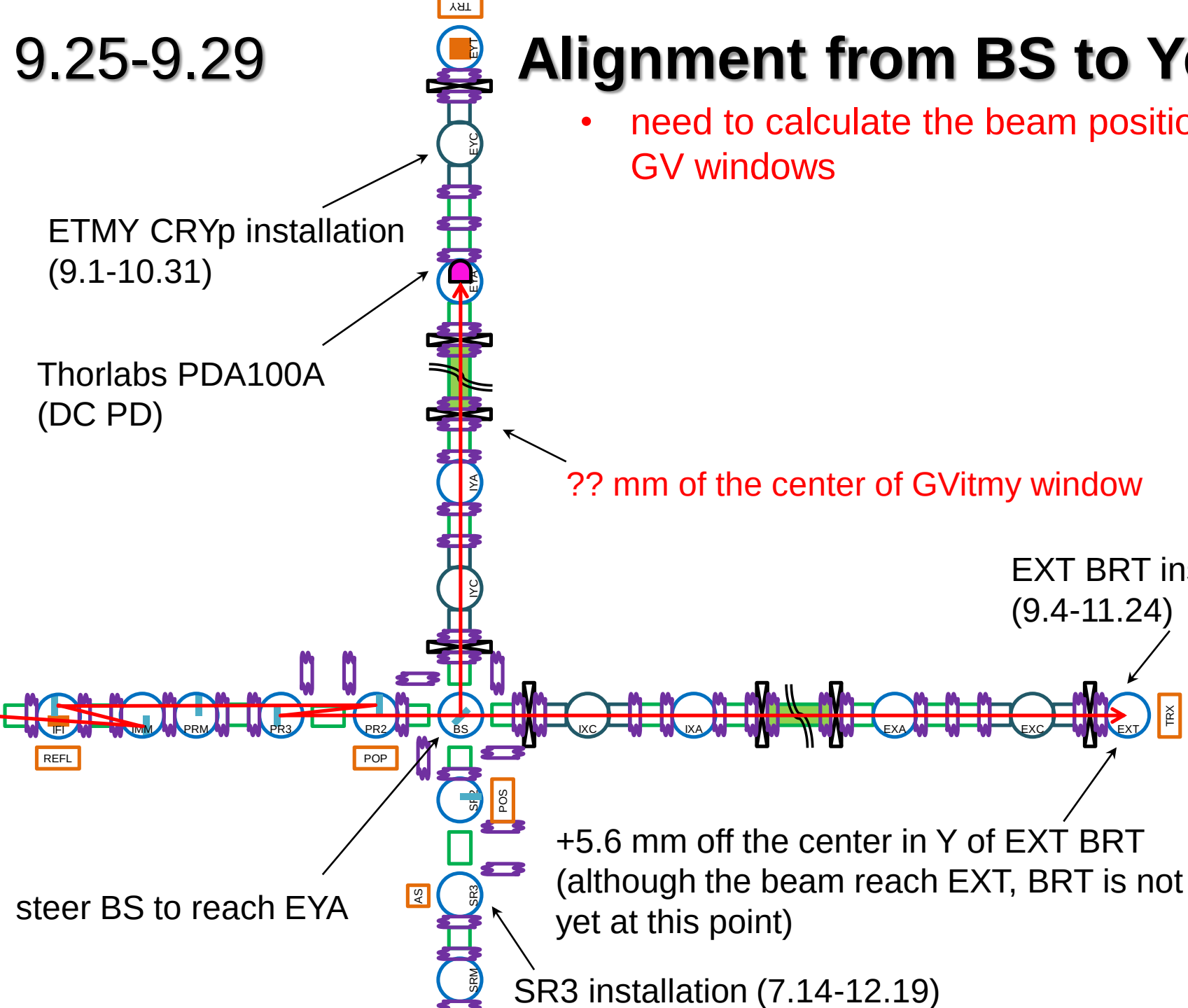
- need to calculate the beam position on GV windows

ETMY CRYp installation
(9.1-10.31)

Thorlabs PDA100A
(DC PD)

?? mm of the center of GVitmy window

EXT BRT installation
(9.4-11.24)



+5.6 mm off the center in Y of EXT BRT
(although the beam reach EXT, BRT is not ready yet at this point)

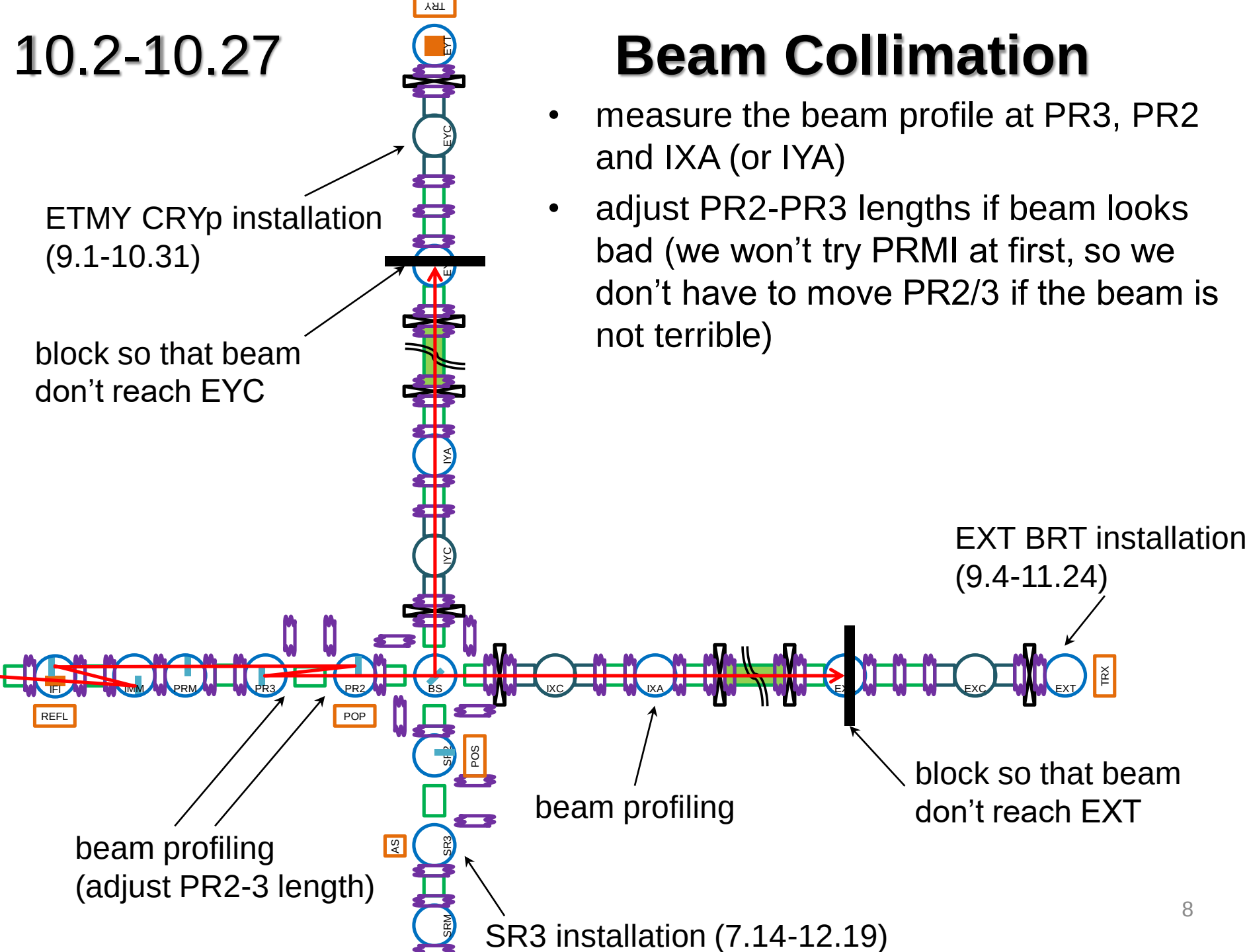
steer BS to reach EYA

SR3 installation (7.14-12.19)

10.2-10.27

Beam Collimation

- measure the beam profile at PR3, PR2 and IXA (or IYA)
- adjust PR2-PR3 lengths if beam looks bad (we won't try PRMI at first, so we don't have to move PR2/3 if the beam is not terrible)



11.1-11.7

Align ETMY

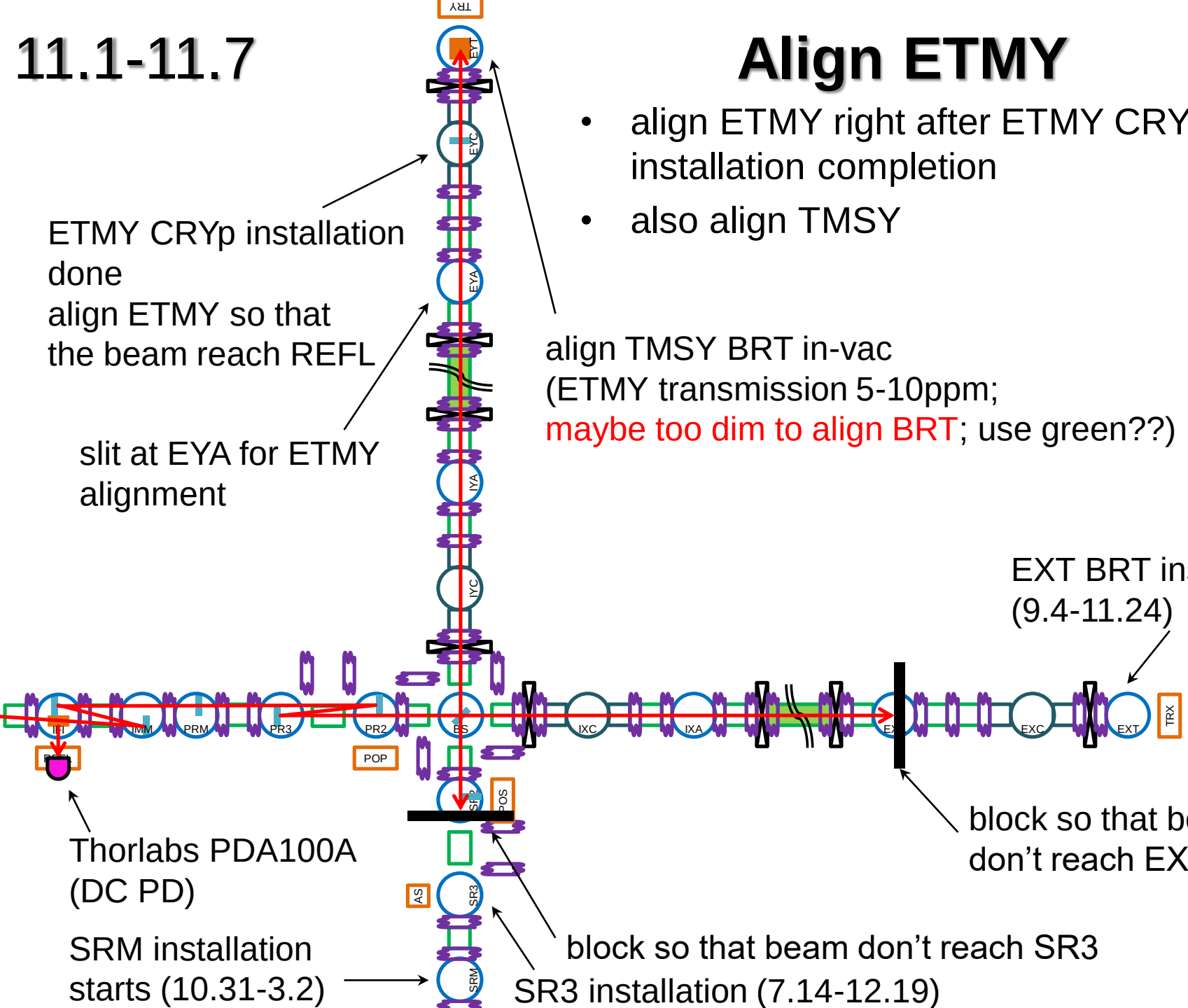
- align ETMY right after ETMY CRYp installation completion
- also align TMSY

ETMY CRYp installation done
align ETMY so that the beam reach REFL

slit at EYA for ETMY alignment

align TMSY BRT in-vac
(ETMY transmission 5-10ppm;
maybe too dim to align BRT; use green??)

EXT BRT installation
(9.4-11.24)



Thorlabs PDA100A
(DC PD)

block so that beam don't reach EXT

SRM installation starts (10.31-3.2)

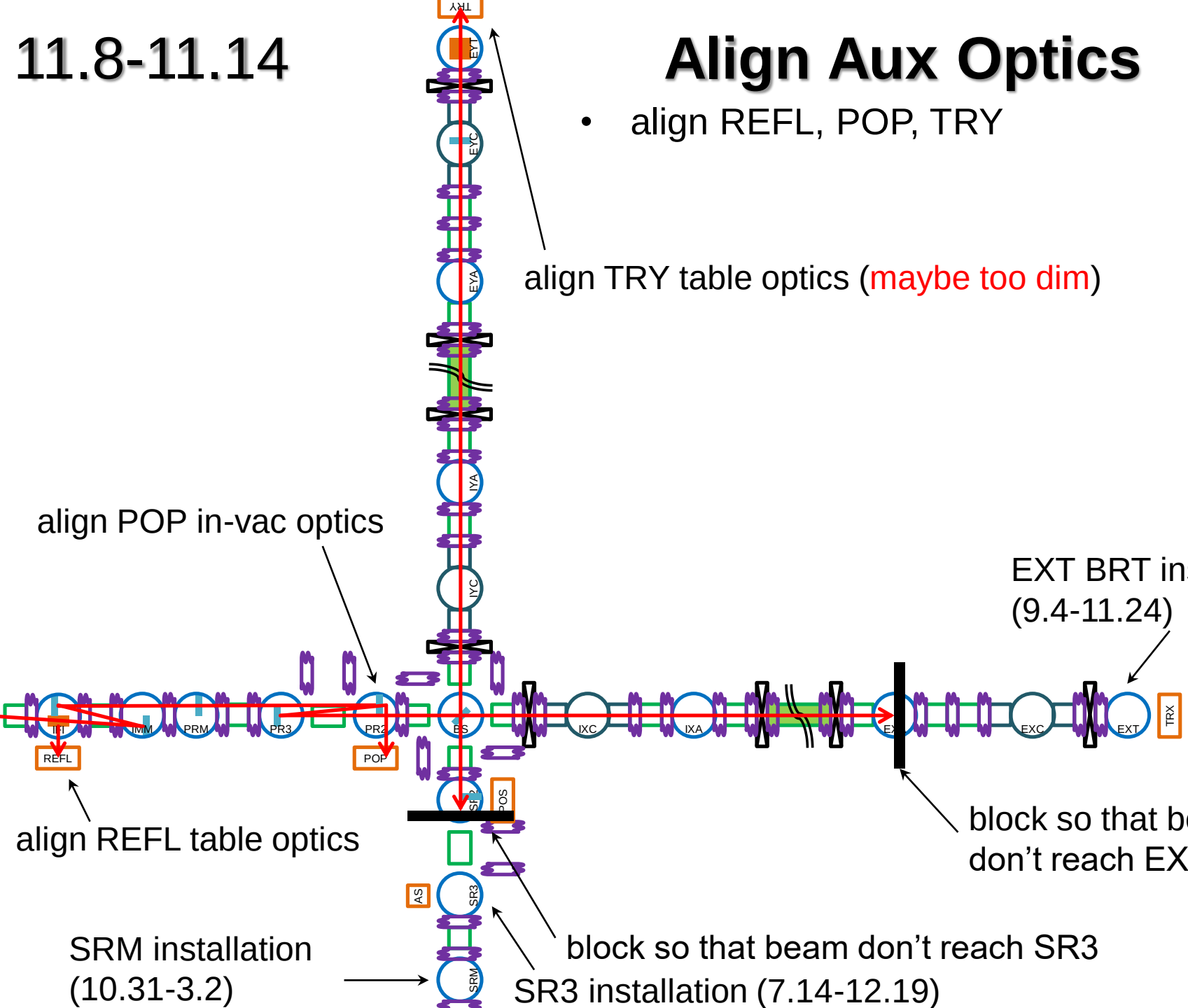
block so that beam don't reach SR3

SR3 installation (7.14-12.19)

11.8-11.14

Align Aux Optics

- align REFL, POP, TRY



align TRY table optics (maybe too dim)

align POP in-vac optics

EXT BRT installation (9.4-11.24)

align REFL table optics

block so that beam don't reach EXT

SRM installation (10.31-3.2)

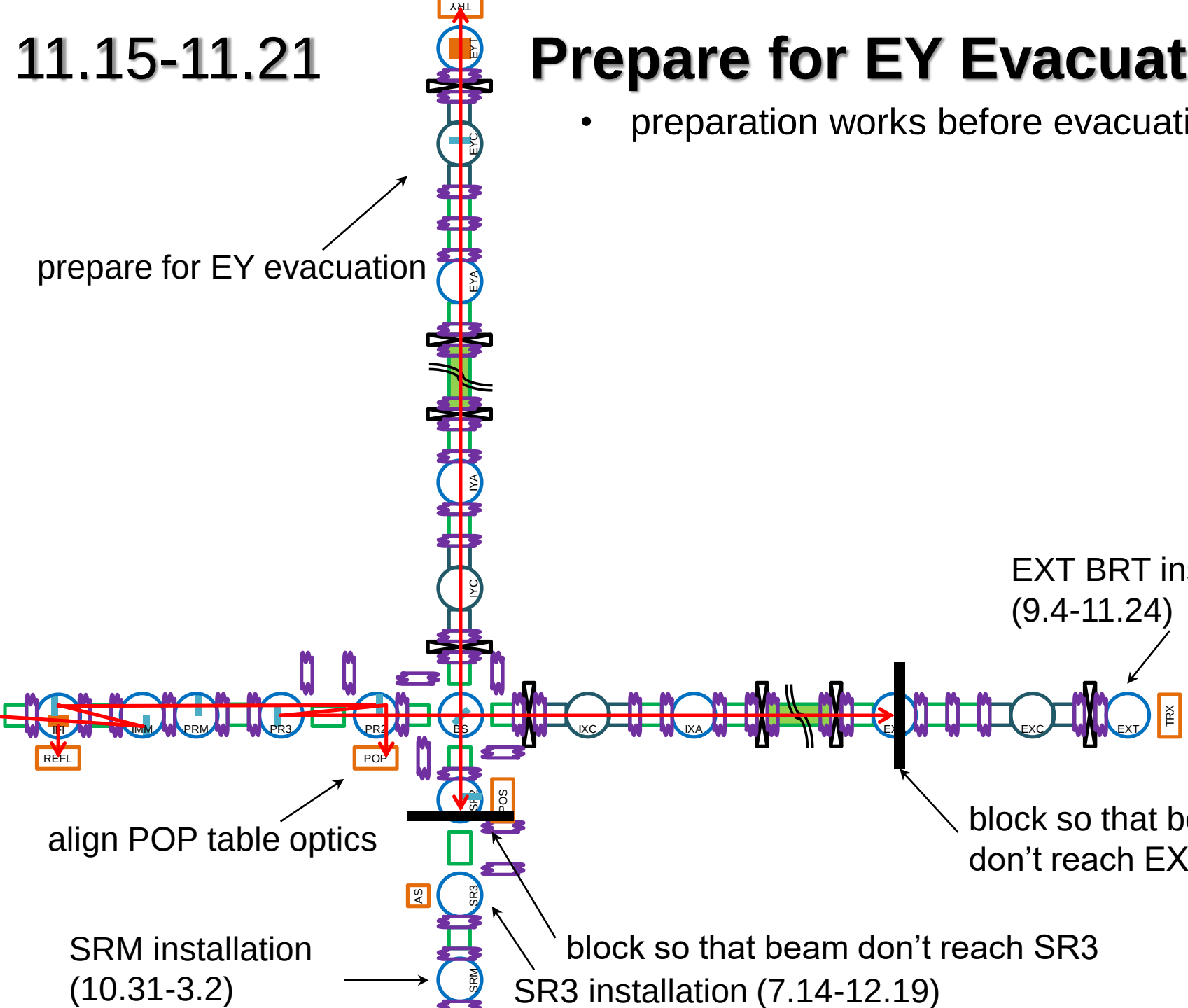
block so that beam don't reach SR3

SR3 installation (7.14-12.19)

11.15-11.21

Prepare for EY Evacuation

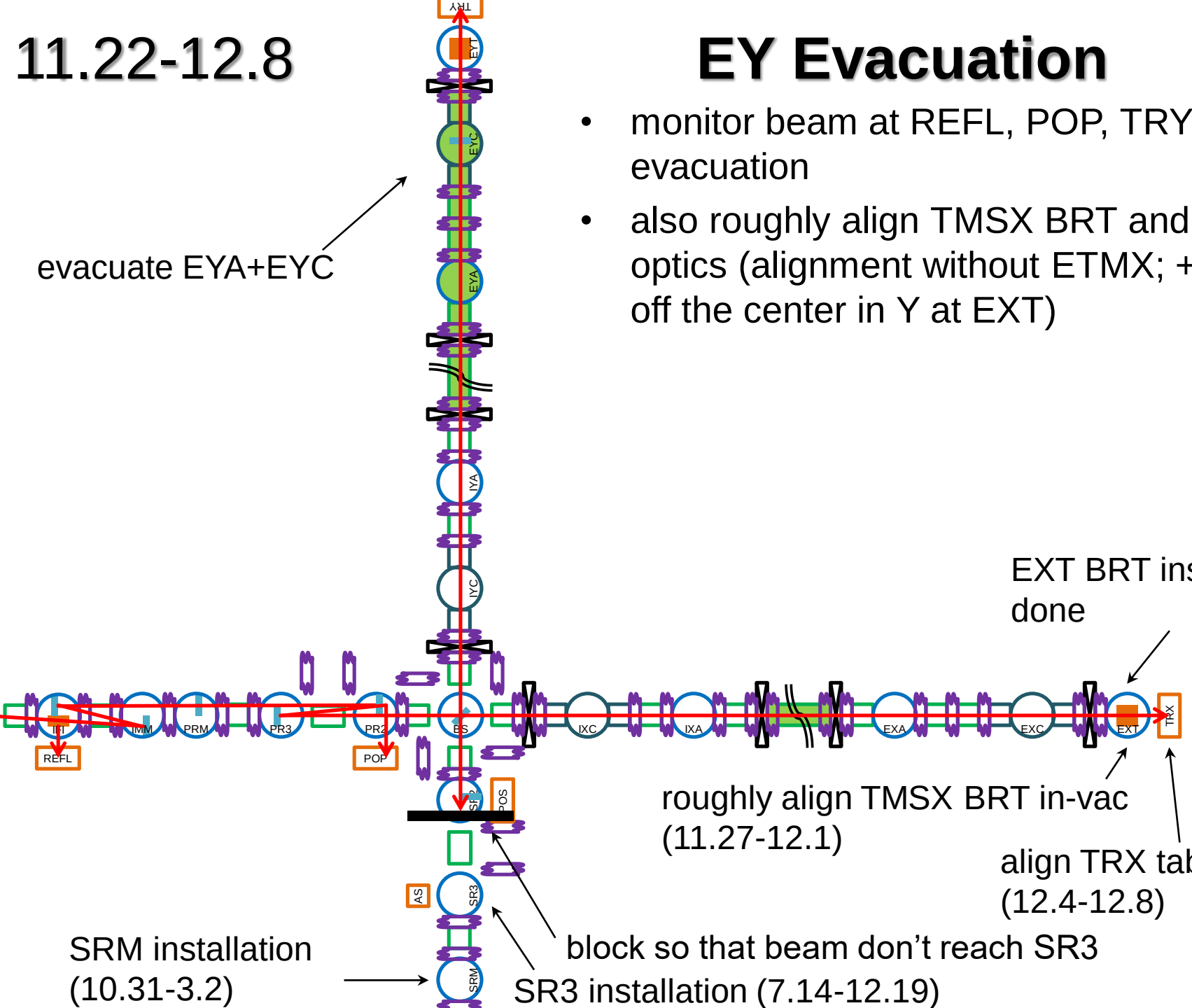
- preparation works before evacuation



11.22-12.8

EY Evacuation

- monitor beam at REFL, POP, TRY during evacuation
- also roughly align TMSX BRT and TRX optics (alignment without ETMX; +5.6 mm off the center in Y at EXT)



evacuate EYA+EYC

EXT BRT installation done

roughly align TMSX BRT in-vac (11.27-12.1)

align TRX table optics (12.4-12.8)

block so that beam don't reach SR3

SRM installation (10.31-3.2)

SR3 installation (7.14-12.19)

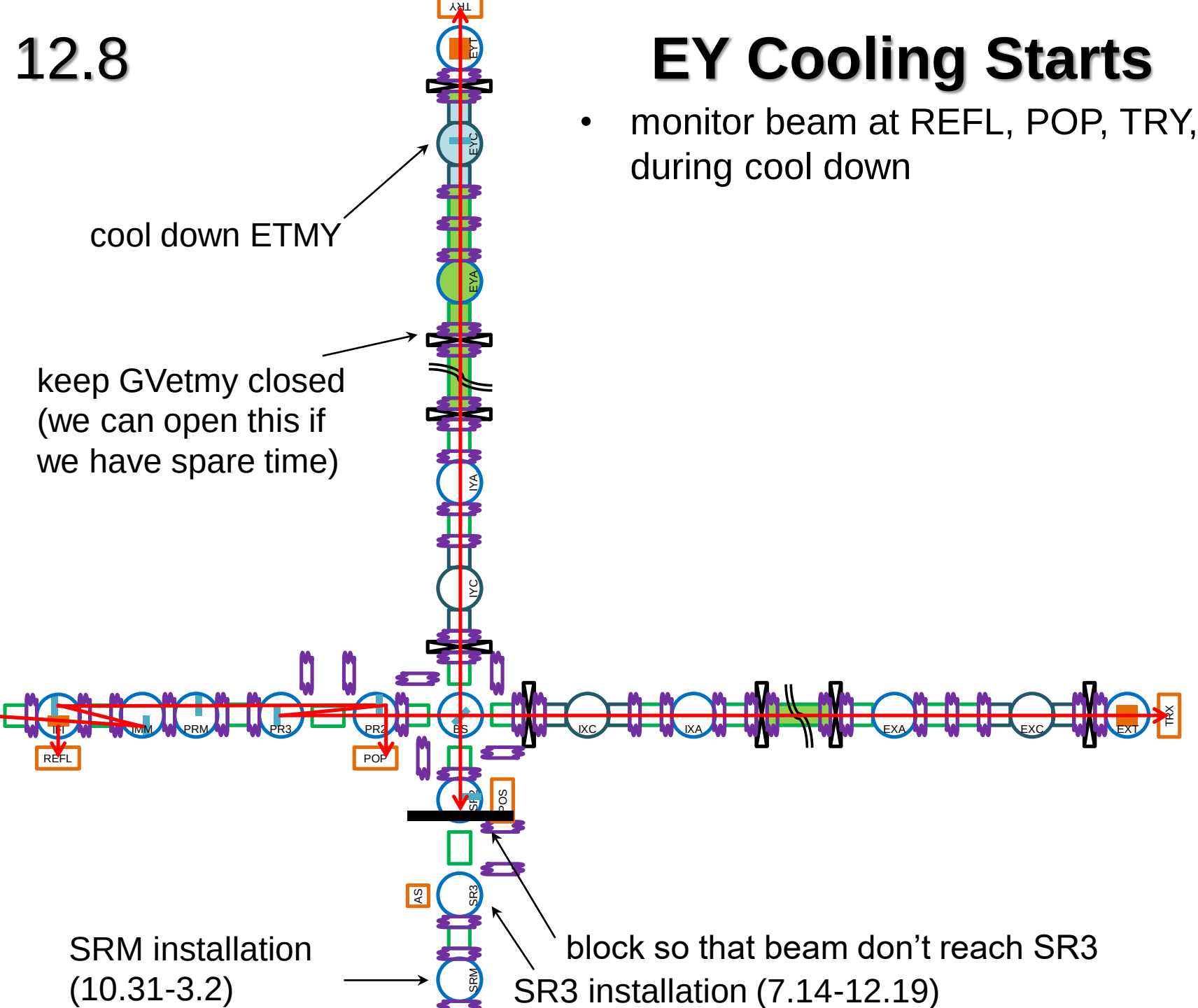
12.8

EY Cooling Starts

- monitor beam at REFL, POP, TRY, TRX during cool down

cool down ETMY

keep GVetmy closed
(we can open this if
we have spare time)



SRM installation
(10.31-3.2)

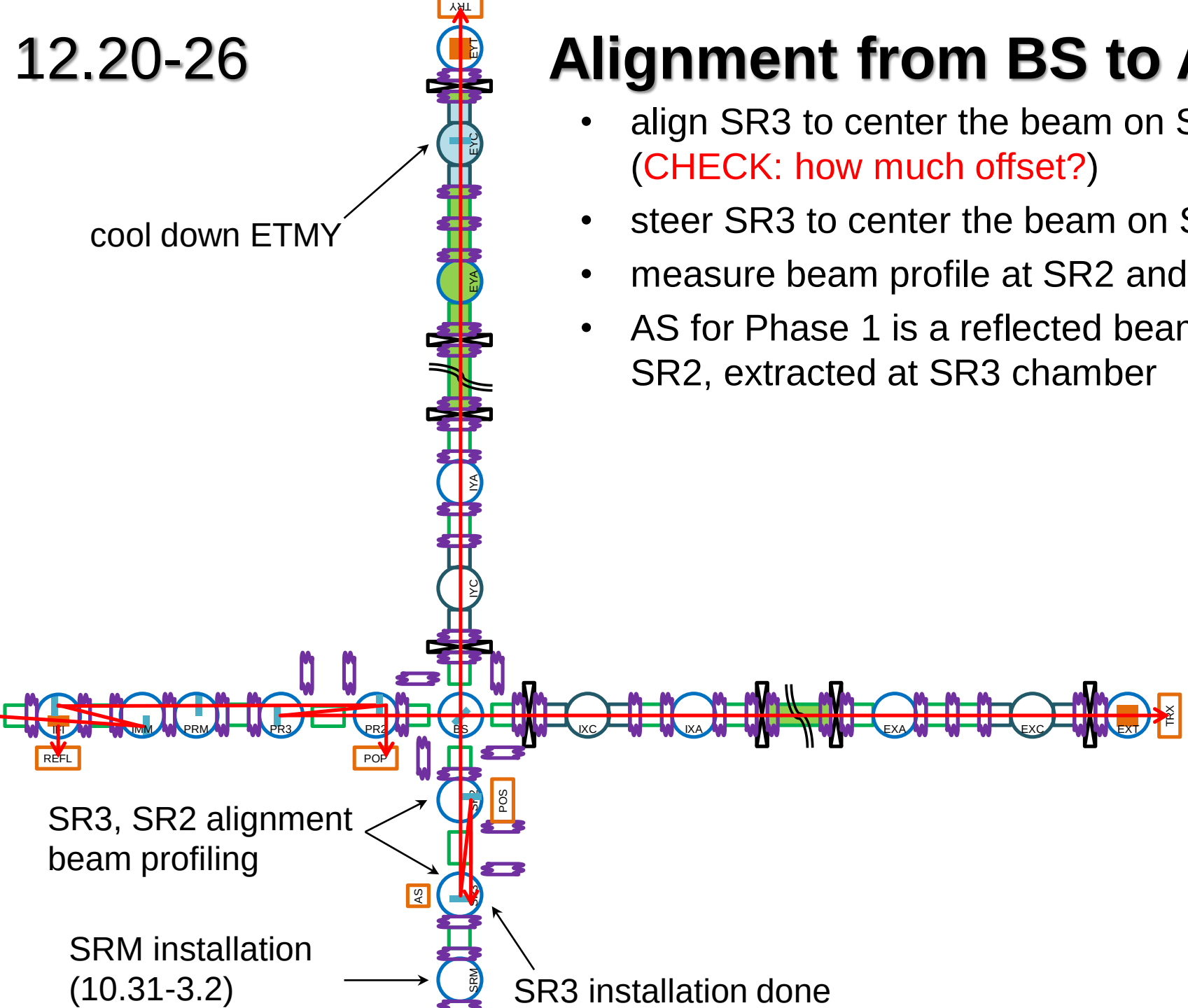
block so that beam don't reach SR3

SR3 installation (7.14-12.19)

12.20-26

Alignment from BS to AS

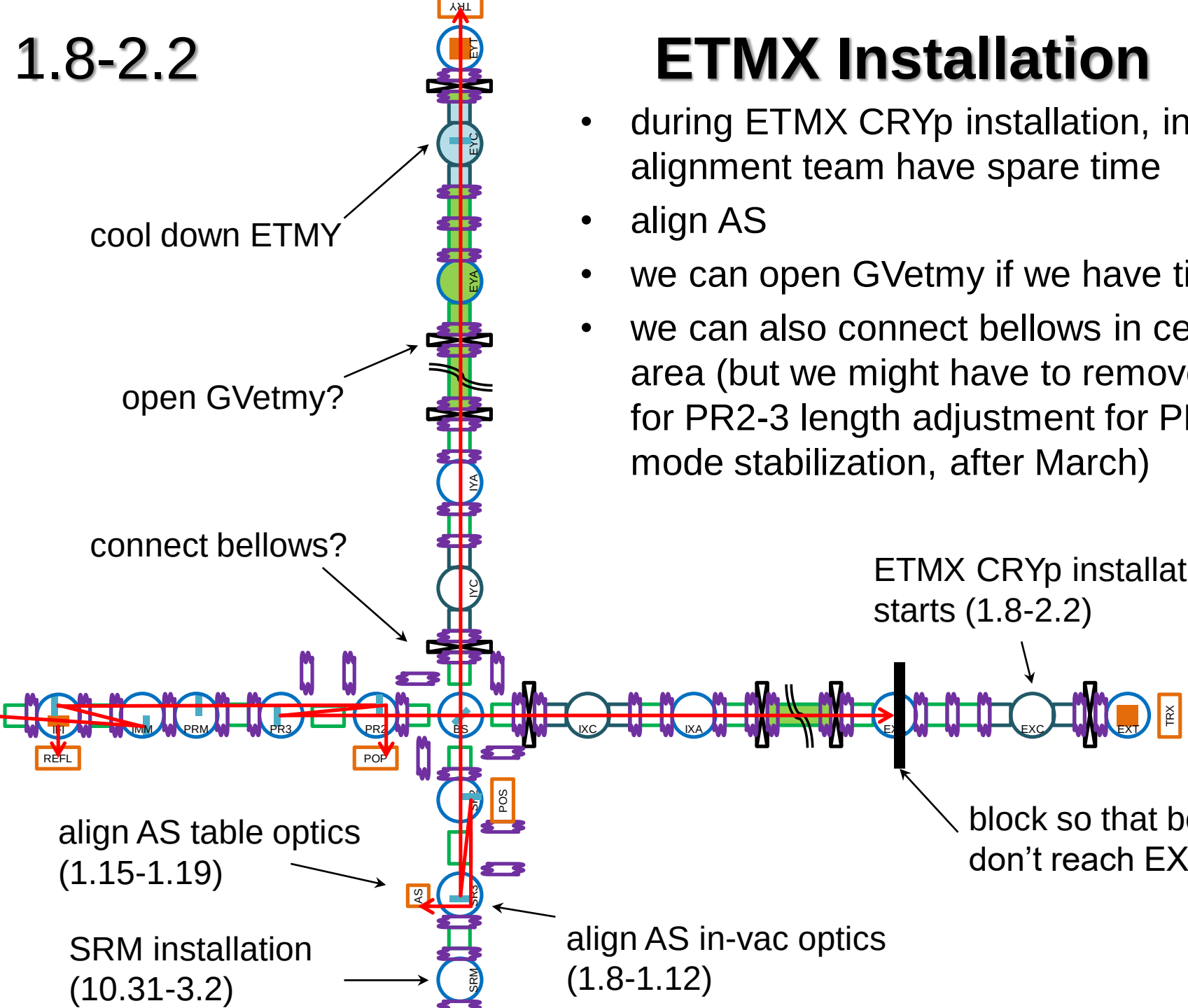
- align SR3 to center the beam on SR3 (CHECK: how much offset?)
- steer SR3 to center the beam on SR2
- measure beam profile at SR2 and SR3
- AS for Phase 1 is a reflected beam from SR2, extracted at SR3 chamber



1.8-2.2

ETMX Installation

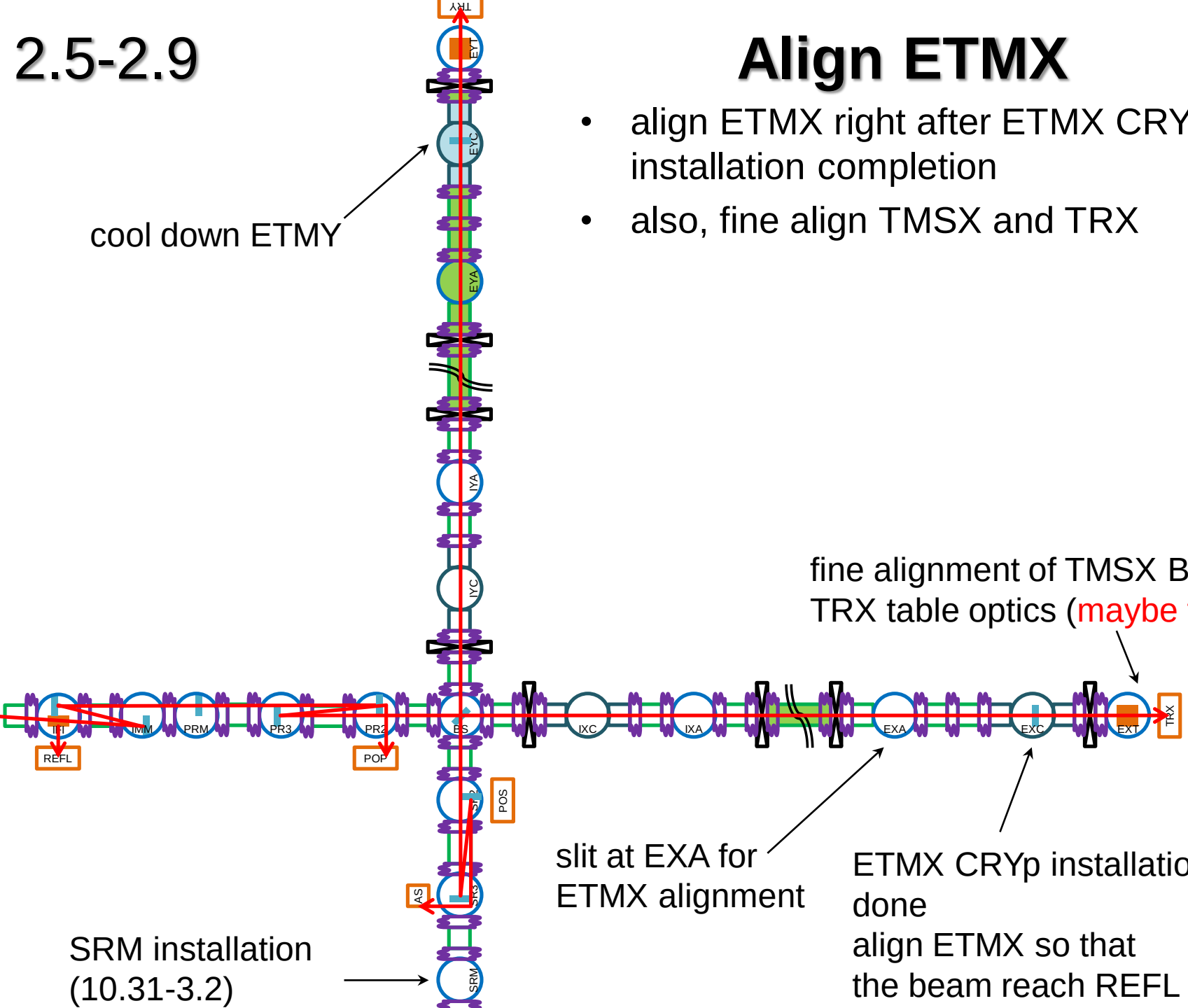
- during ETMX CRYp installation, initial alignment team have spare time
- align AS
- we can open GVetmy if we have time
- we can also connect bellows in central area (but we might have to remove again for PR2-3 length adjustment for PRMI mode stabilization, after March)



2.5-2.9

Align ETMX

- align ETMX right after ETMX CRYp installation completion
- also, fine align TMSX and TRX



cool down ETMY

fine alignment of TMSX BRT and TRX table optics (maybe too dim)

slit at EXA for ETMX alignment

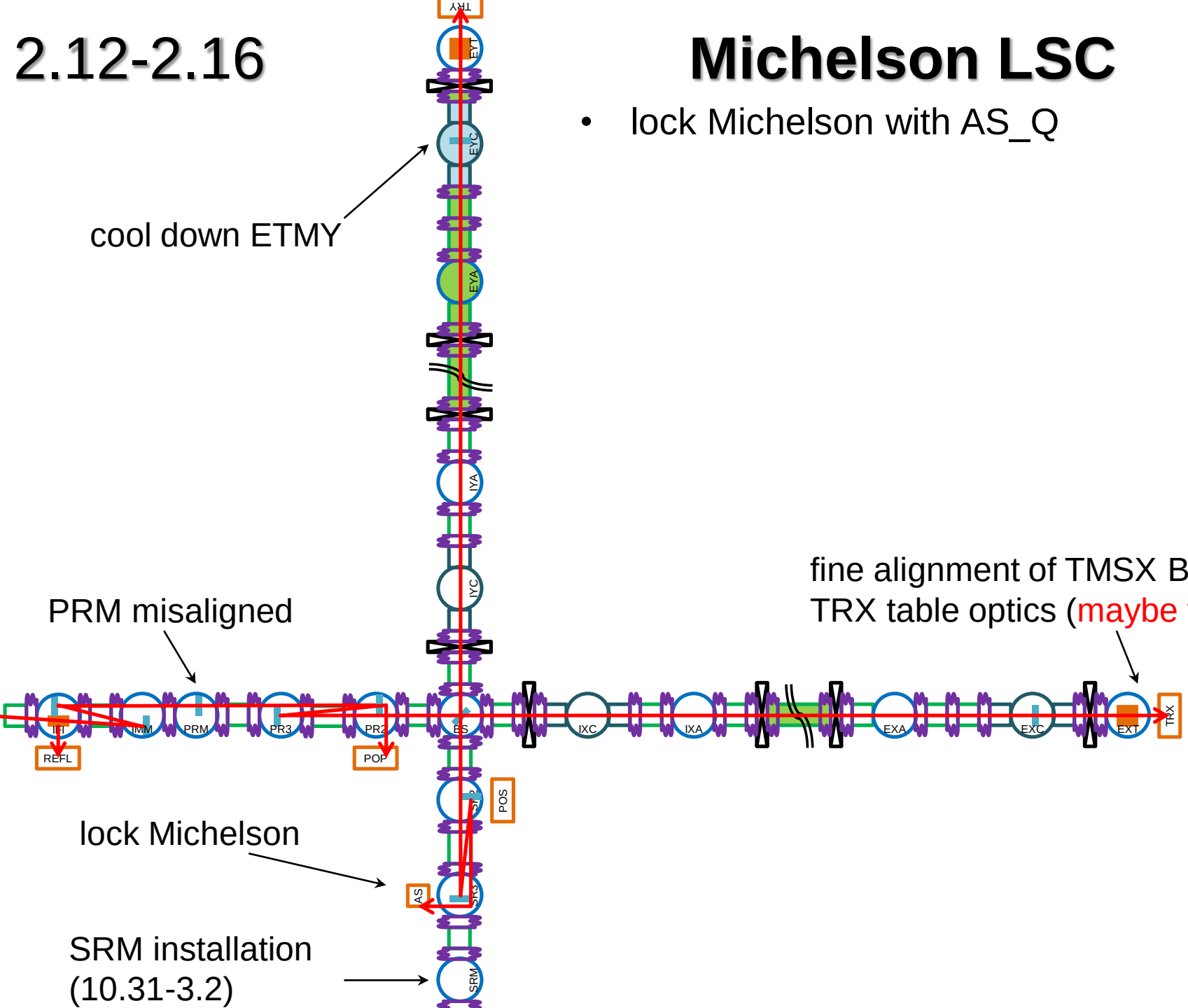
ETMX CRYp installation done
align ETMX so that the beam reach REFL

SRM installation (10.31-3.2)

2.12-2.16

Michelson LSC

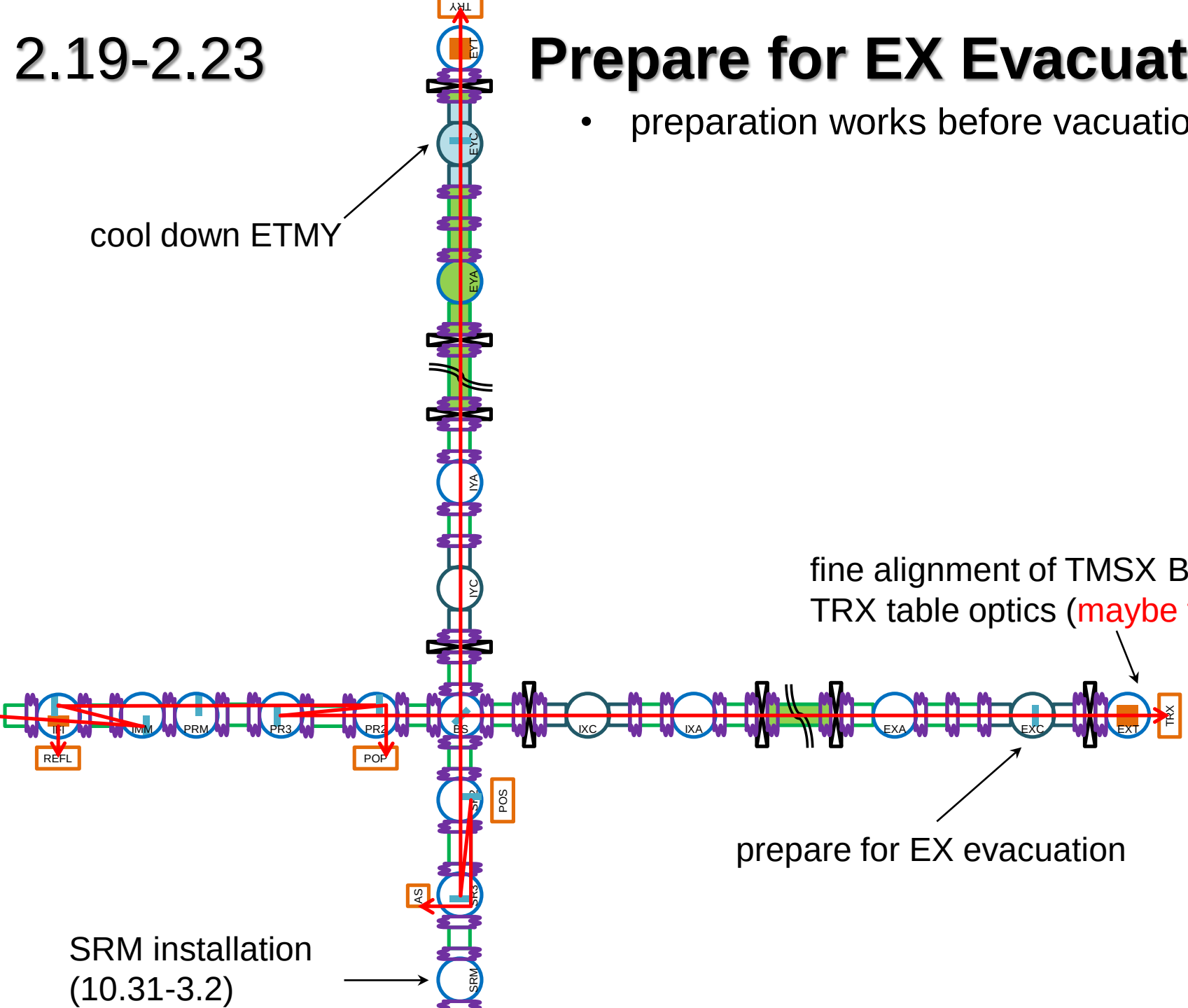
- lock Michelson with AS_Q



2.19-2.23

Prepare for EX Evacuation

- preparation works before vacuation



cool down ETMY

fine alignment of TMSX BRT and TRX table optics (maybe too dim)

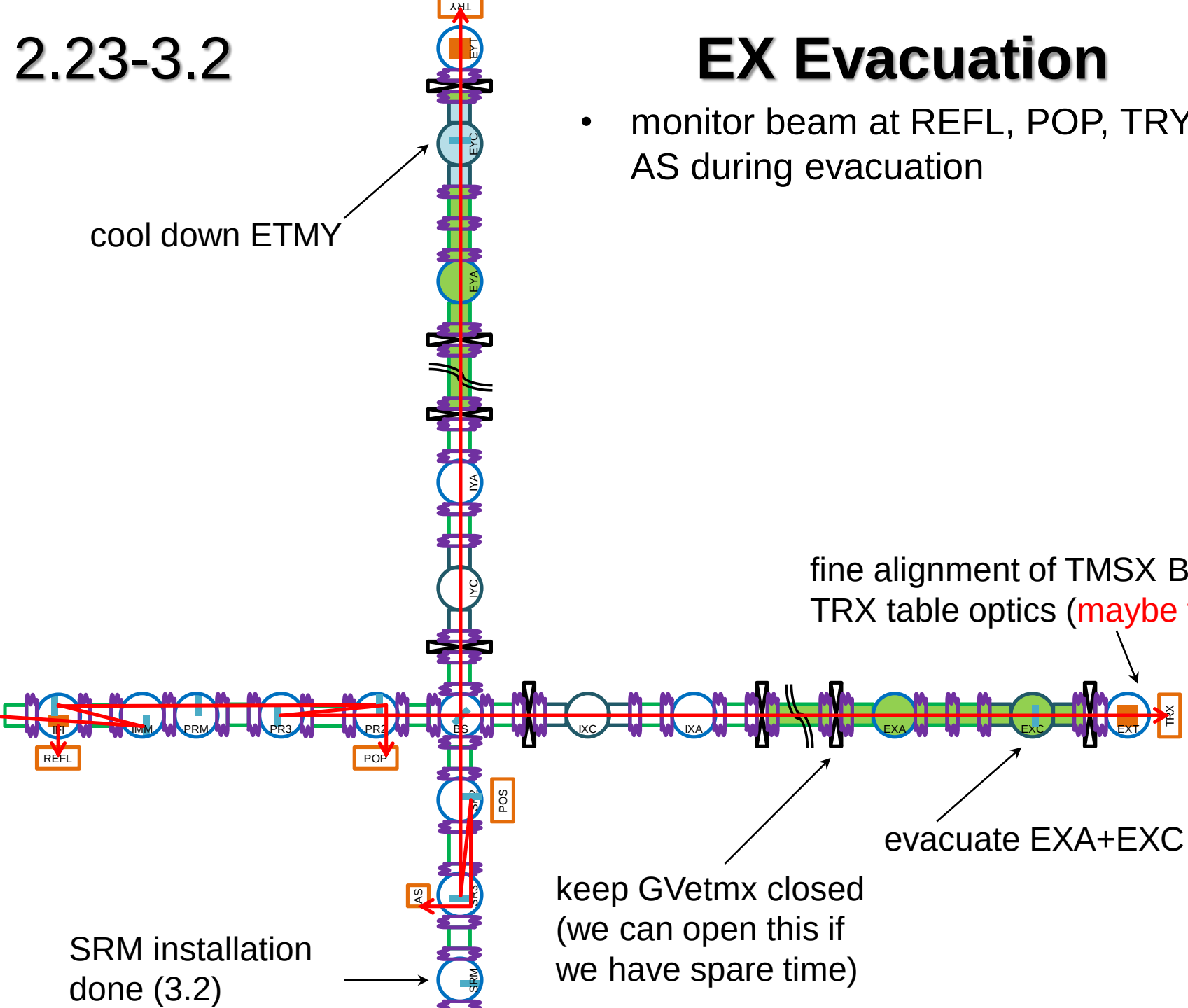
prepare for EX evacuation

SRM installation (10.31-3.2)

2.23-3.2

EX Evacuation

- monitor beam at REFL, POP, TRY, TRX, AS during evacuation



cool down ETMY

fine alignment of TMSX BRT and TRX table optics (maybe too dim)

evacuate EXA+EXC

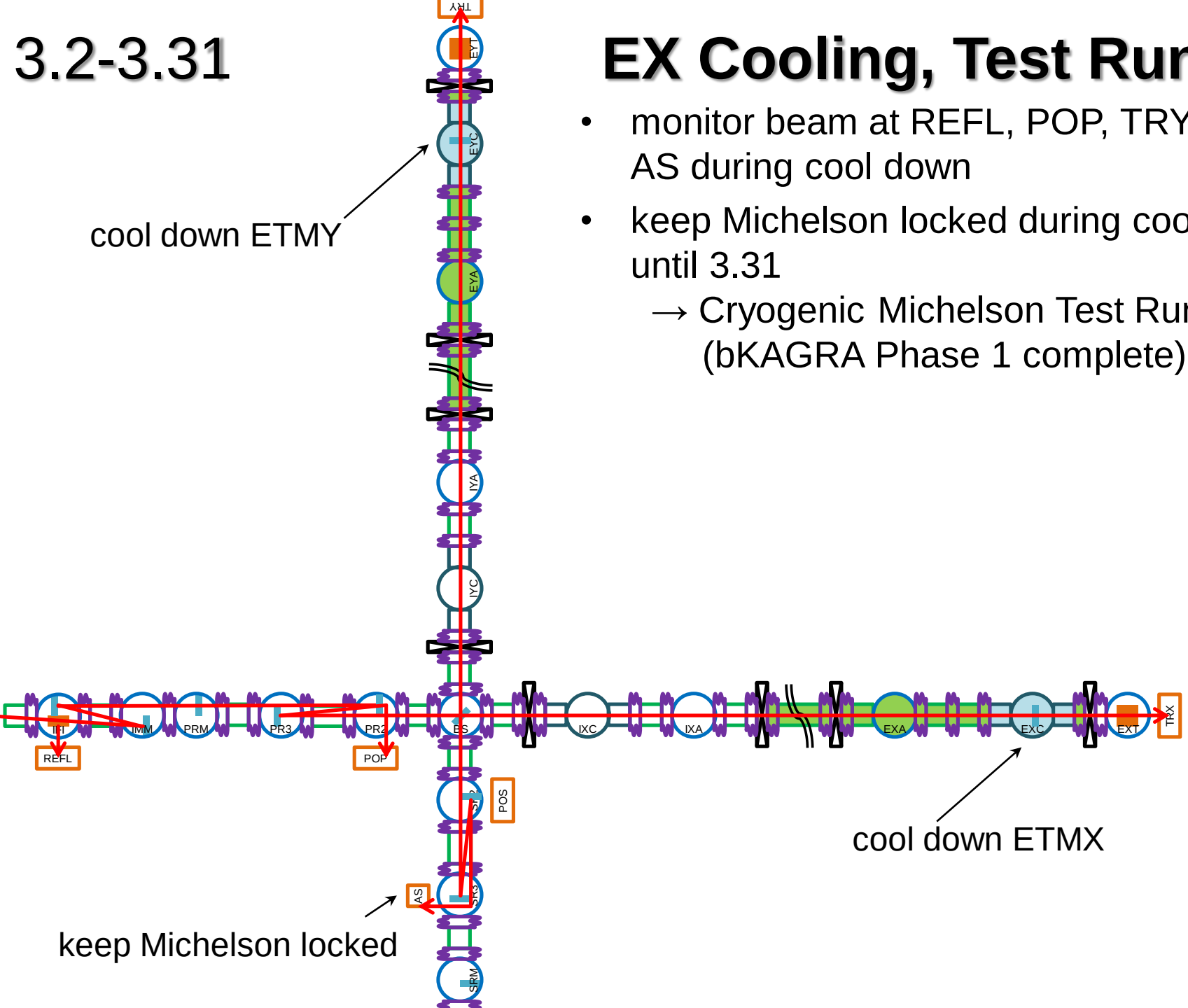
keep GVetmx closed (we can open this if we have spare time)

SRM installation done (3.2)

3.2-3.31

EX Cooling, Test Run

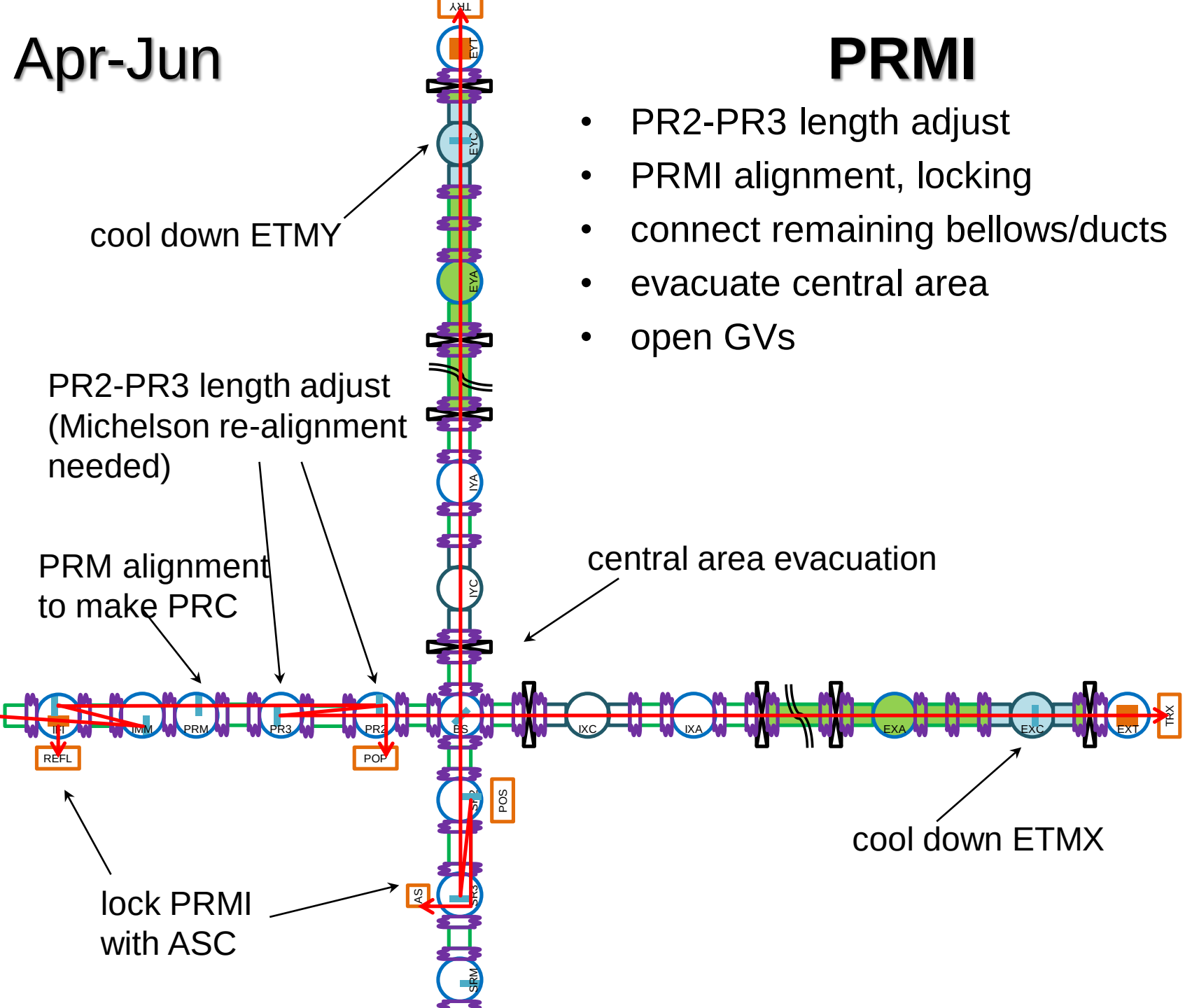
- monitor beam at REFL, POP, TRY, TRX, AS during cool down
- keep Michelson locked during cool down until 3.31
  → Cryogenic Michelson Test Run (bKAGRA Phase 1 complete)



Apr-Jun

PRMI

- PR2-PR3 length adjust
- PRMI alignment, locking
- connect remaining bellows/ducts
- evacuate central area
- open GVs



To Be Discussed

- TMS BRT installation schedule and other AOS related issues [Akutsu, Uchiyama, Michimura]
  - considering wedge, ETMs should be installed before BRT alignment, but transmitted beam from ETM is too dim (~ 0.1 uW); use green?
  - when to install narrow-angle baffles?
- Wide-angle baffles (for Pcal and main beam) compatible with ETM HR camera? [Akutsu, Kokeyama, Inoue]
- Confirm beam spot positions at GVs [Michimura, Aso]