Optical/Electrical Components Needed for iKAGRA IMC Servo

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Scope

- Start discussion on listing up what we need for iKAGRA IMC (and PSL) servo

- Focus mainly on optical and electrical components

- References:
  - [JGW-T1402349](#) (iKAGRA PMC study)
  - [JGW-G1402302](#) (FSS modeling)
  - [JGW-G1402520](#) (GWADW2014 IOO poster by Nakano)
  - [JGW-D1402507](#) (IOO 3D drawing)
  - [JGW-T1302068](#) (layout around IMMT)
  - [JGW-D1402492](#) (IMC suspension cabling)
  - [JGW-D1402516](#) (anchor, floor mortar, floor cutting lines)
  - [Wiki/SmallOptics](#) (list of small optics)
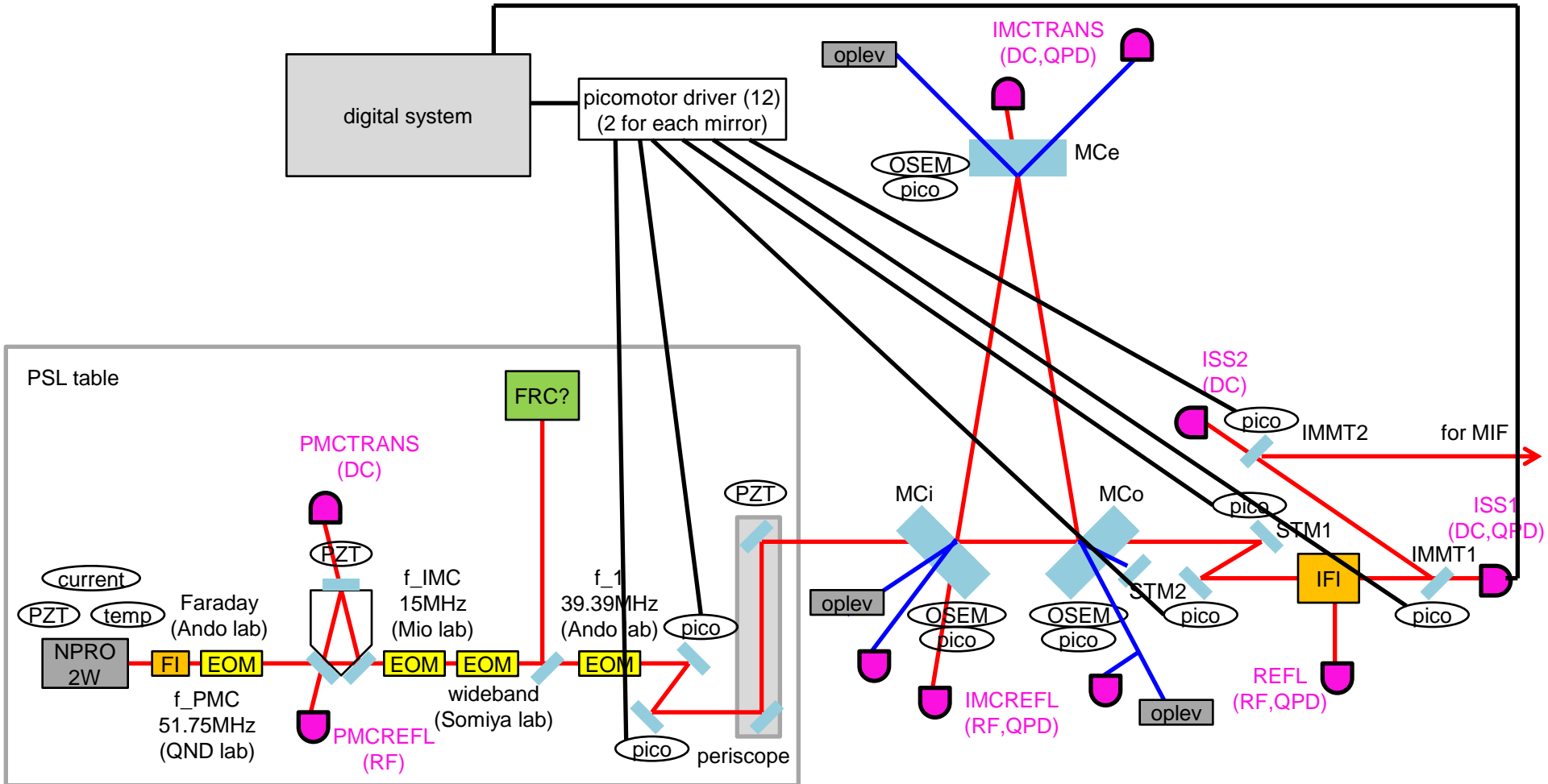 - [Wiki/OutputTables](#) (list of output optical tables)

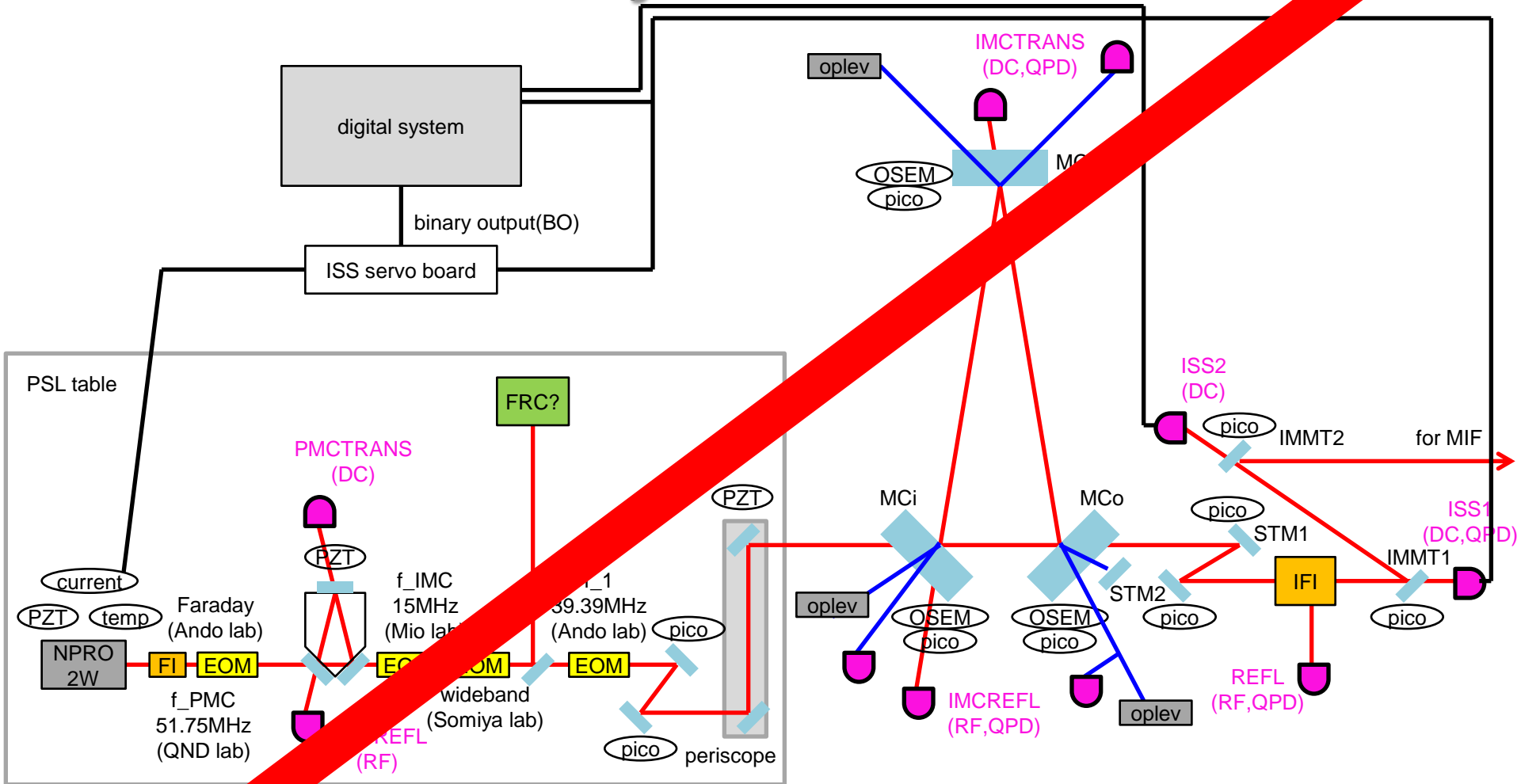# Optical Configuration
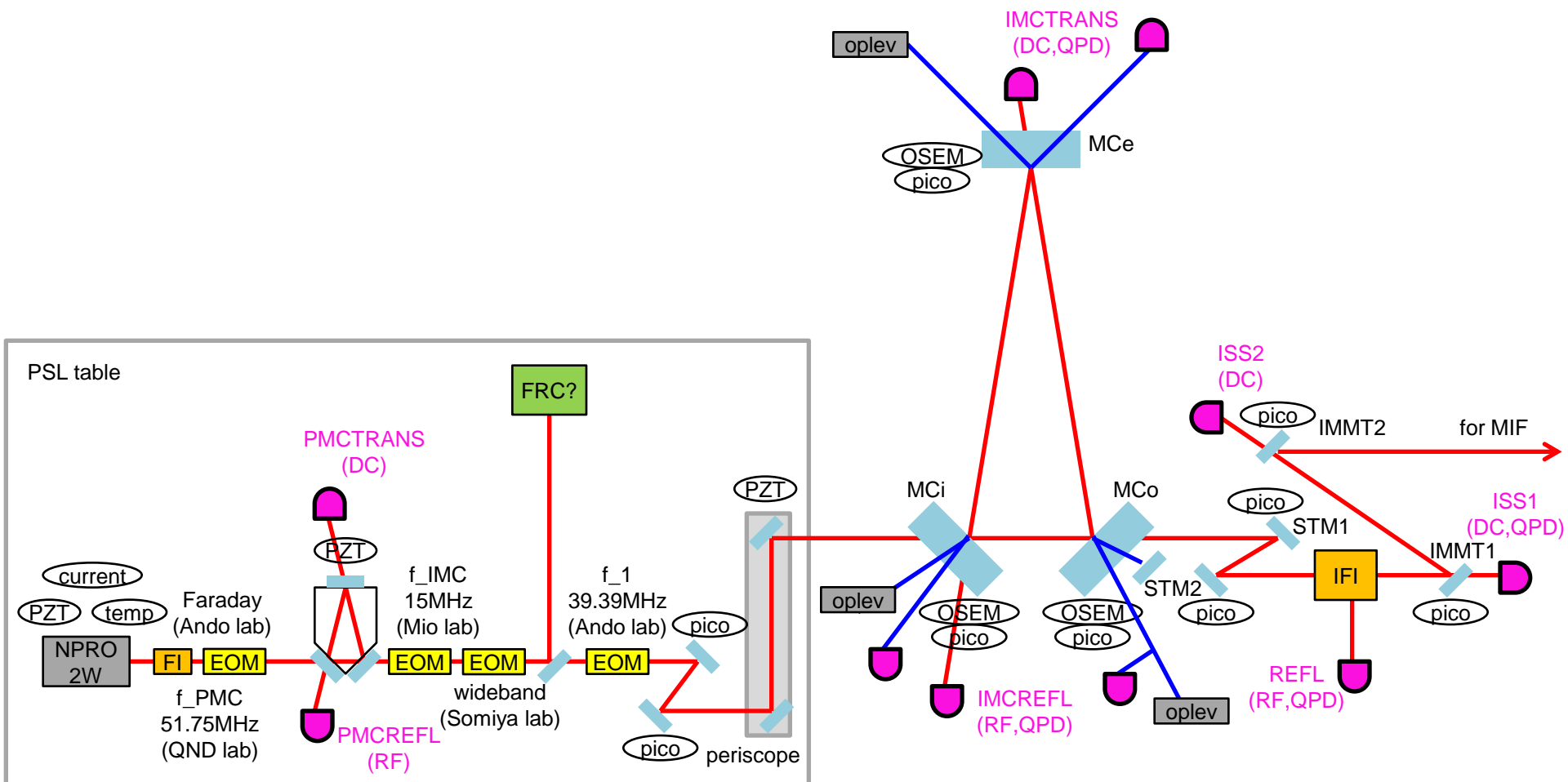
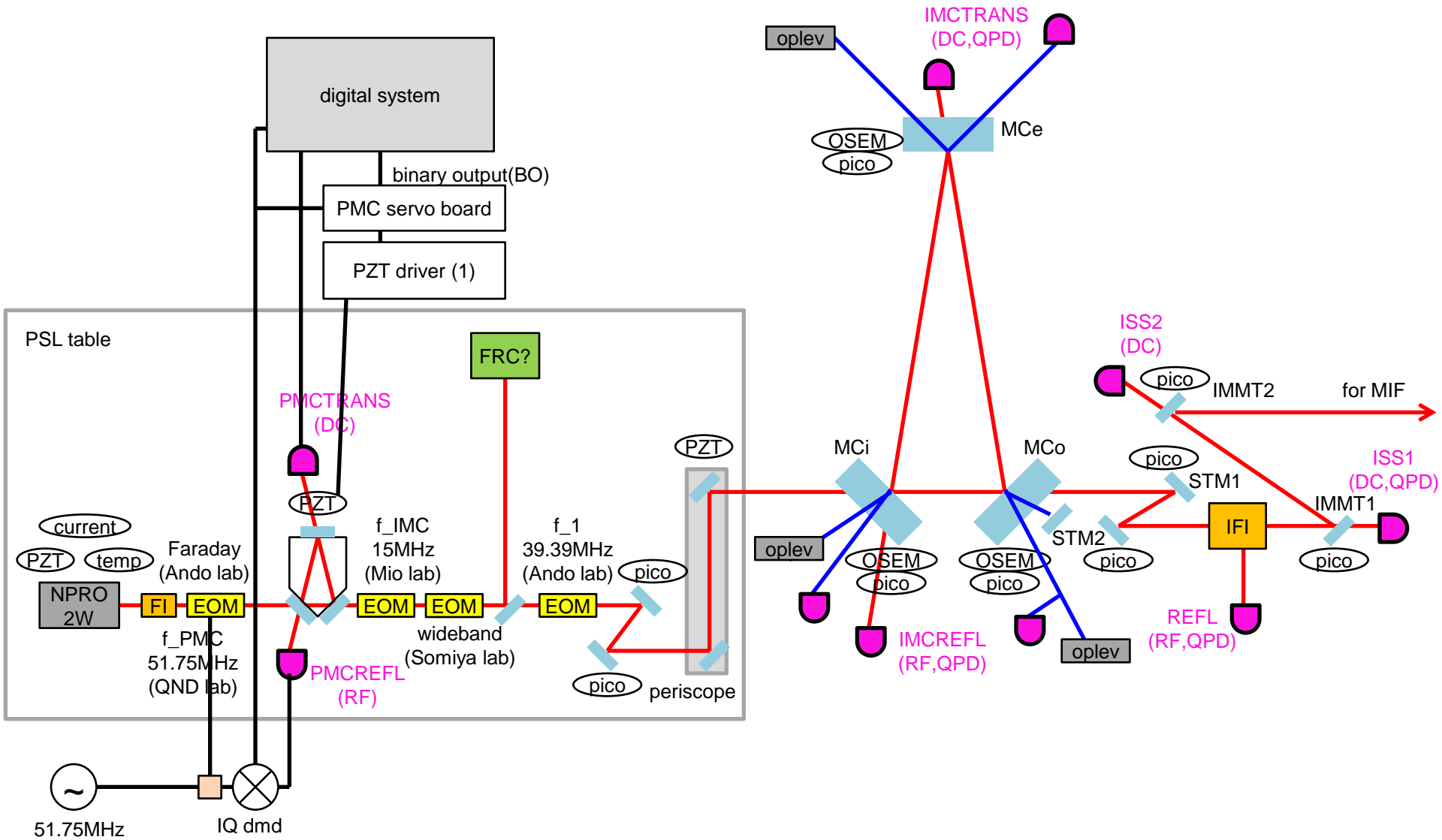# Suspension Local Damping
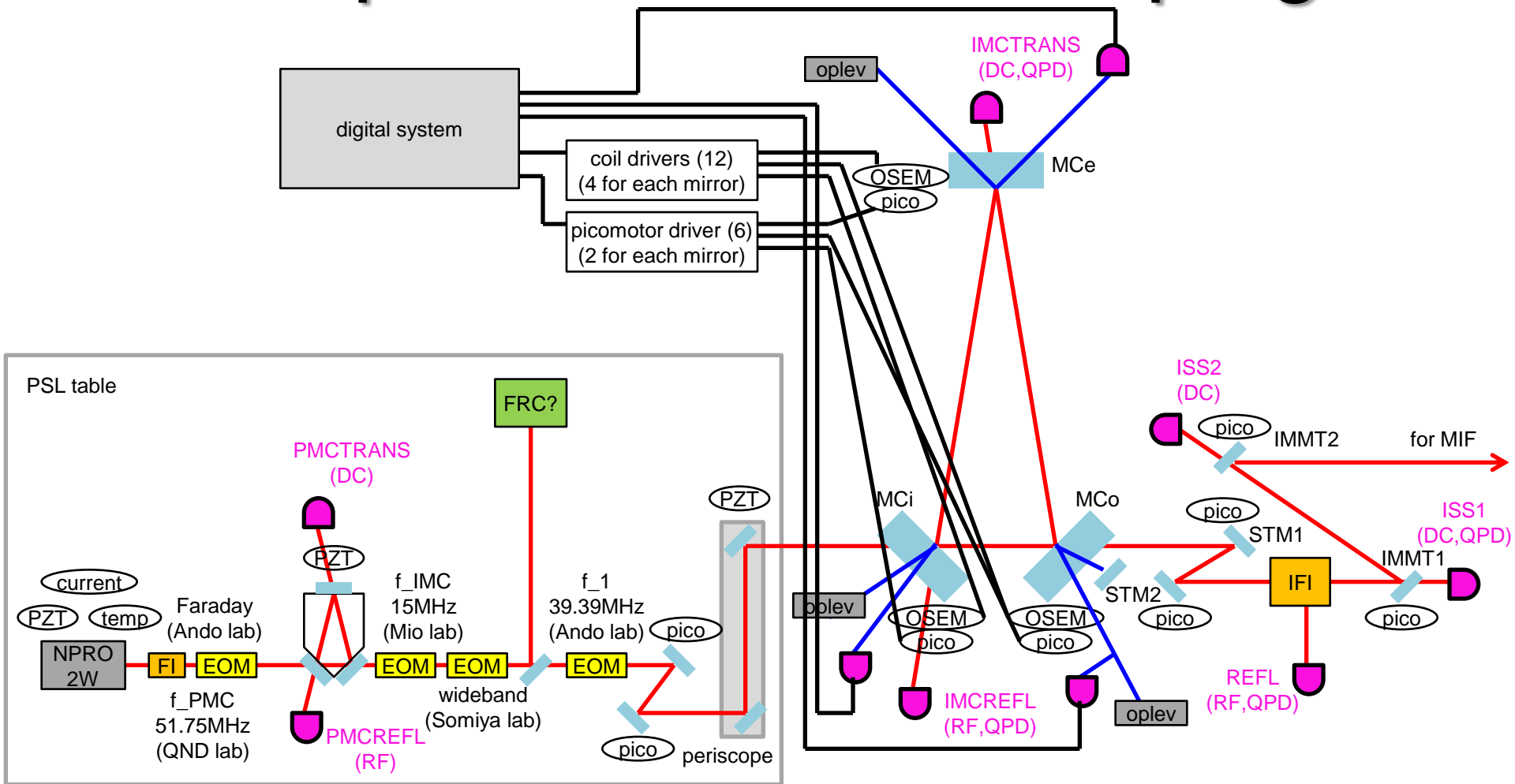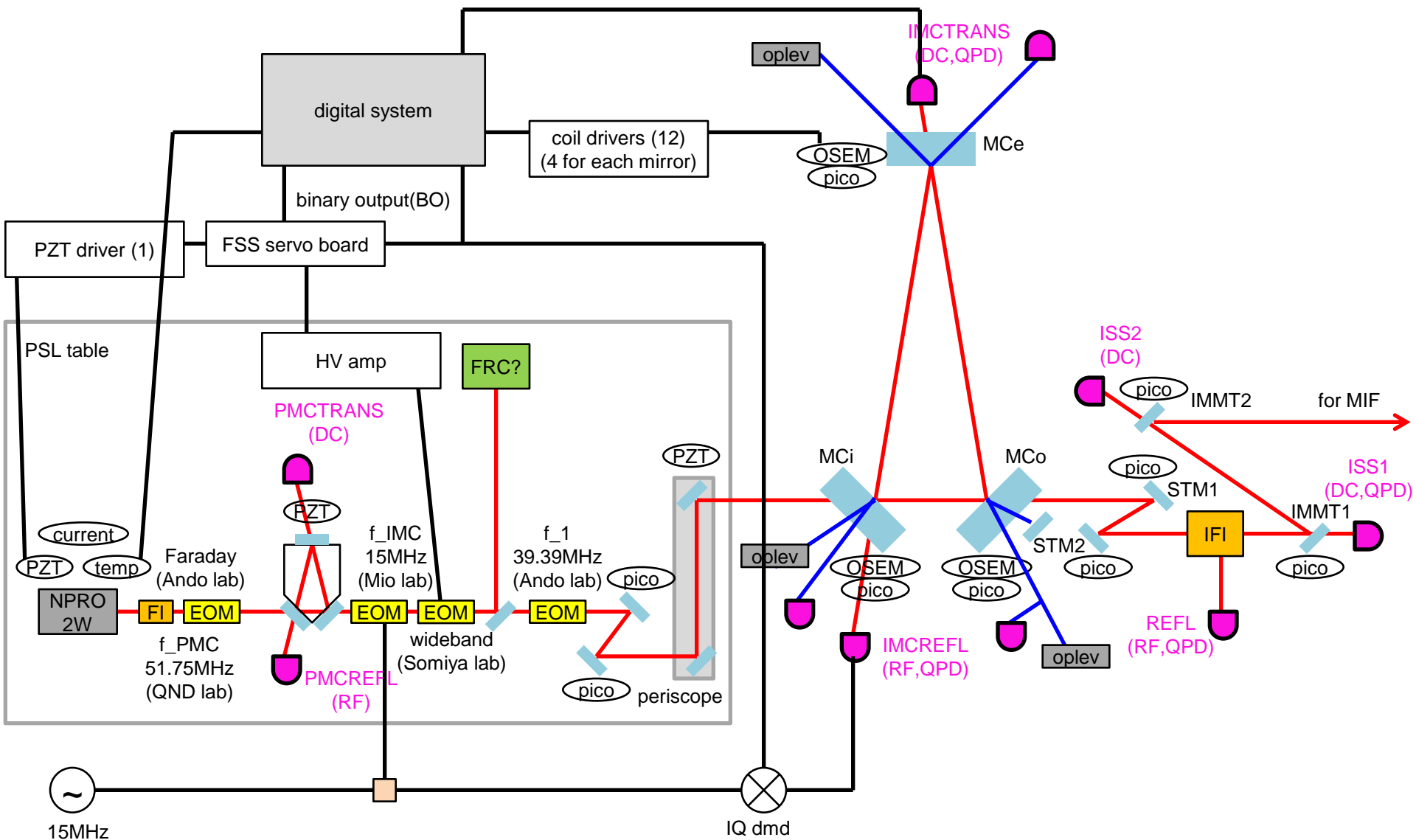
Initial Alignment

Intensity Stabilization

ISS is not a default plan in iKAGRA

PMC Servo

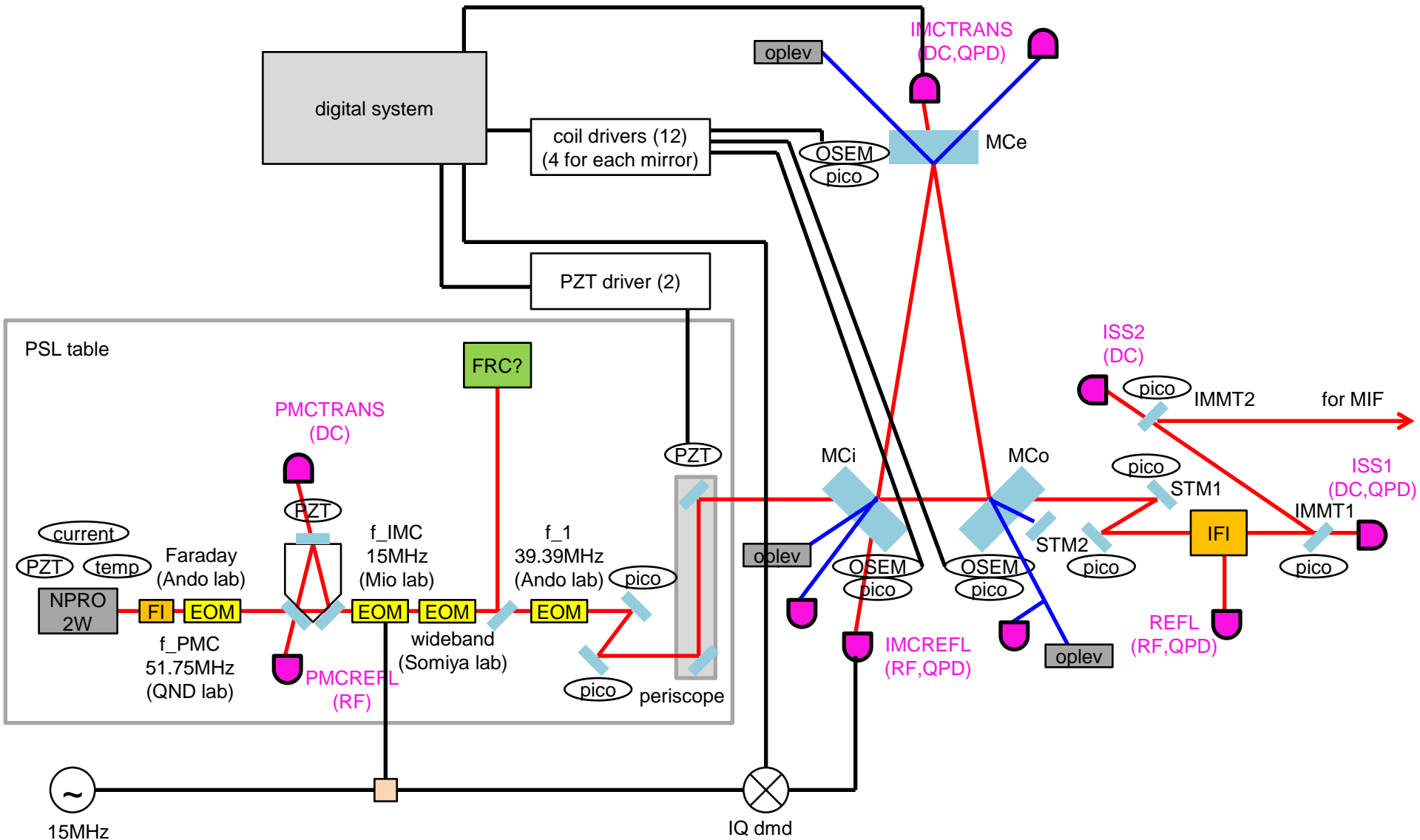# Frequency Stabilization

FRC is not included in this FSS diagram

Alignment Sensing and Control

Cameras

IMCTRANS

IMCTRANS
(DC,QPD)

oplev

OSEM
pico

MCe

MCeF

digital system

PSL table

FRC?

ISS2
(DC)

pico   IMMT2   for MIF

PMCTRANS
(DC)

PMCTRANS

PZT

MCi   MCo   pico   STM1   ISS1
(DC,QPD)

IMMT1

current

PZT

f_IMC
15MHz
(Mio lab)

f_1
39.39MHz
(Ando lab)

PZT   STM2   pico   IFI   pico

PZT temp

Faraday
(Ando lab)

pico

oplev   OSEM   OSEM
pico   pico

NPRO
2W   FI EOM   EOM EOM   EOM

f_PMC
51.75MHz
(QND lab)

wideband
(Somiya lab)

pico

periscope

IMCREFL
(RF,QPD)

oplev   REFL
(RF,QPD)

PMCREFL
(RF)

IMCREFL

IFIF

PMCREFL

6 cameras?
How do we put their signals in the digital system?

10

Gouy Phase Telescopes

- We need two QPDs for each port we want to monitor the beam alignment

- It would be nice to have standardized Gouy phase telescopes for each port

- Below is an example aLIGO one (~ 15 cm x 55 cm)
  LIGO-T1000247
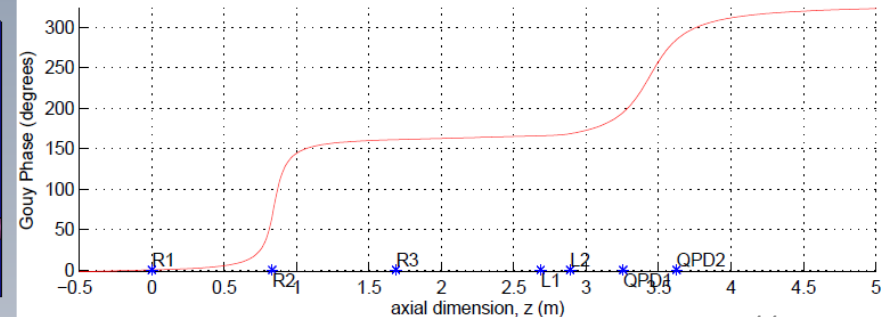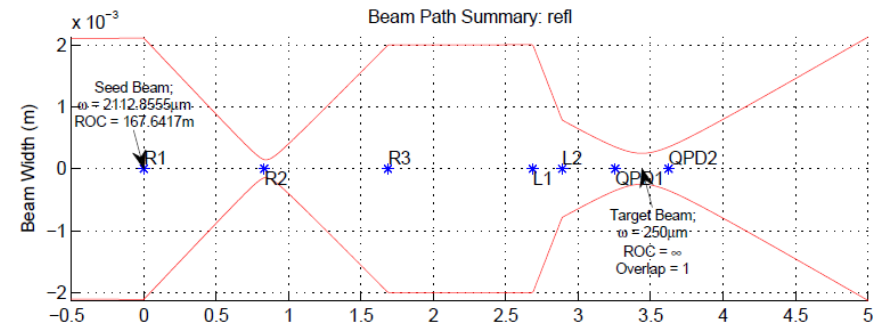
Figure 2: The REFL port QPD layout.

Figure 1: The REFL port telescope beampath.

Optical Components Missing

- PSL periscope
  - we have dumped rods available in Ando Lab
    http://search.newport.com/?x2=sku&q2=45
    http://search.newport.com/?q=*&x2=sku&q2=M-340-RC

- Gouy phase telescopes and other optical components for each port
  - we can buy flat mirrors and mounts with a rough estimate of numbers, but what do we do for lenses?

- AOM for FRC?

- I suppose there are much more……

DGS Related

- standalone digital system is needed by Nov 2014

- it is not considered as a baseline DGS schedule
    - full digital system with networks will be available only from Jan 2015

- VIS will also need a standalone for IMC suspensions
    - maybe one standalone will do for VIS & IOO

AEL Related (FRC not fully included)

- PMC(1) / FRC(1) / IMC(1) servo circuits

  IOO already got
  one for FRC?

- RF PD(3) / RF QPD(4) /DC PD(4) /DC QPD(4) (at least!)

PMCREFL	IMCREFL A/B	PMCTRANS	IMCTRANS A/B
IMCREFL	REFL A/B	IMCTRANS	ISS1 A/B
REFL		ISS1	(it would be nice to have
		ISS2	2 more at PSL table for
			incident beam monitor)

- IQ demodulators(19ch) 1 for each RF PD, 4 for each RF QPD

- RF distributors   f_PMC: split into 2 (EOM, PMCREFL)
                      f_IMC: split into 10 (EOM, IMCREFL, 4xIMCREFLA/B)
                      f_1: split into 21? (EOM, REFL, 4xREFLA/B, AS, 4xASA/B, POX?, POY?)

- RF source(3)

- picomotor drivers(18ch, at least!)
  2 for each mirror
  PSLSTM1/2
  STM1/2
  IMMT1/2
  MCi/e/o   (top stage)
  (it would be nice to have 2 for each PD/QPD for
  aligning the beam into them)

- PZT drivers(4ch)
  2 for periscope mirror
  1 for laser
  1 for PMC

- coil drivers(12ch)   4 for each MC mirror

Picomotor Driver

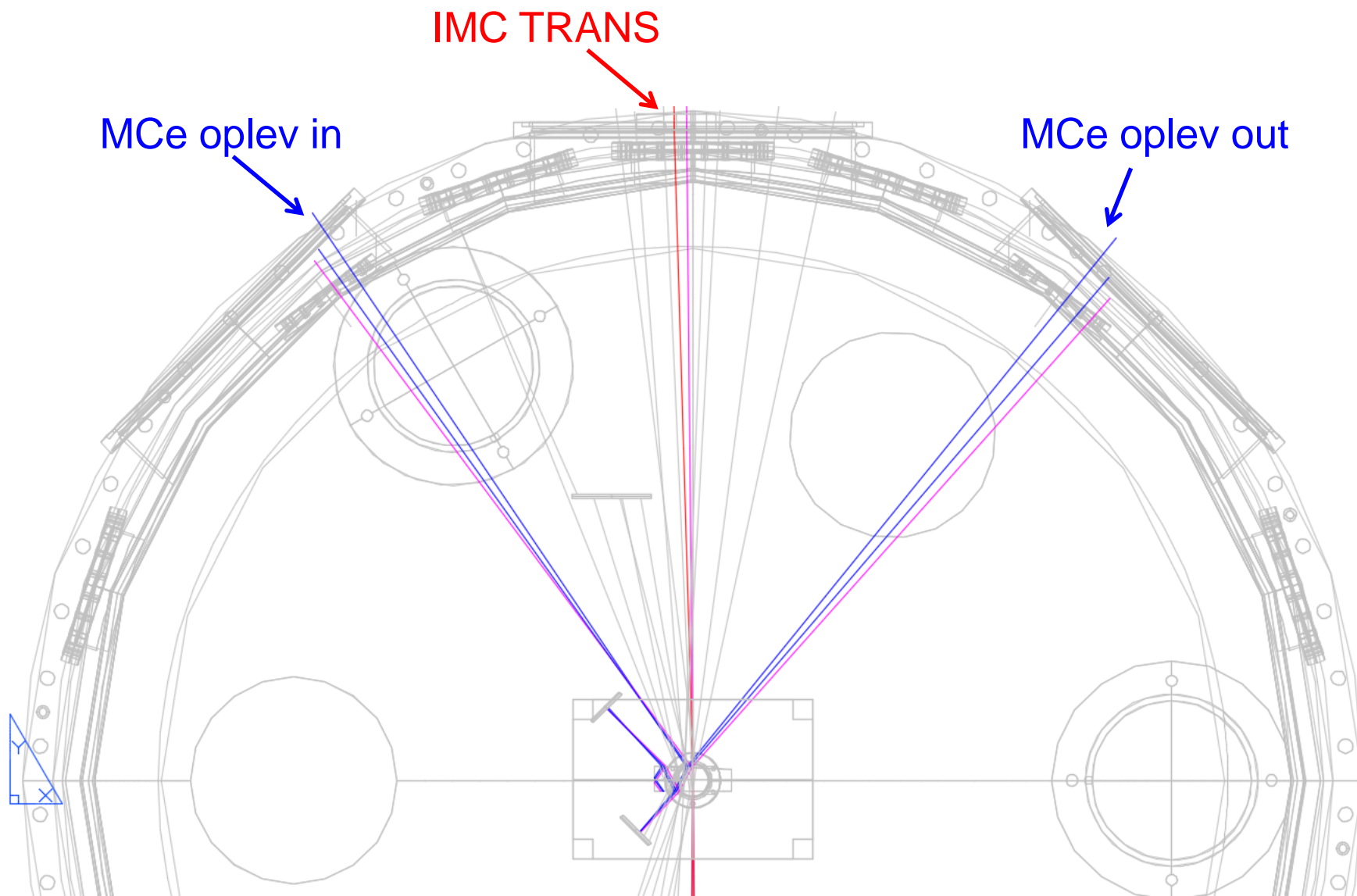- NewFocus
  PICOMOTOR EHTERNET CONTROLLER 8752
  INTELLIGENT PICOMOTOR DRIVER 8753

- Picomotor control with EPICS and Python
  http://gwwiki.icrr.u-tokyo.ac.jp/JGWwiki/CLIO/Technicals/PMEPICS
  http://gwclio.icrr.u-tokyo.ac.jp/lcgtsubgroup/digitalsystem/2012/03/new-focus-picomotor-controlled-at-stda.html

- No special interface circuit is needed for controlling picomotor from digital system

Cables

- TBD
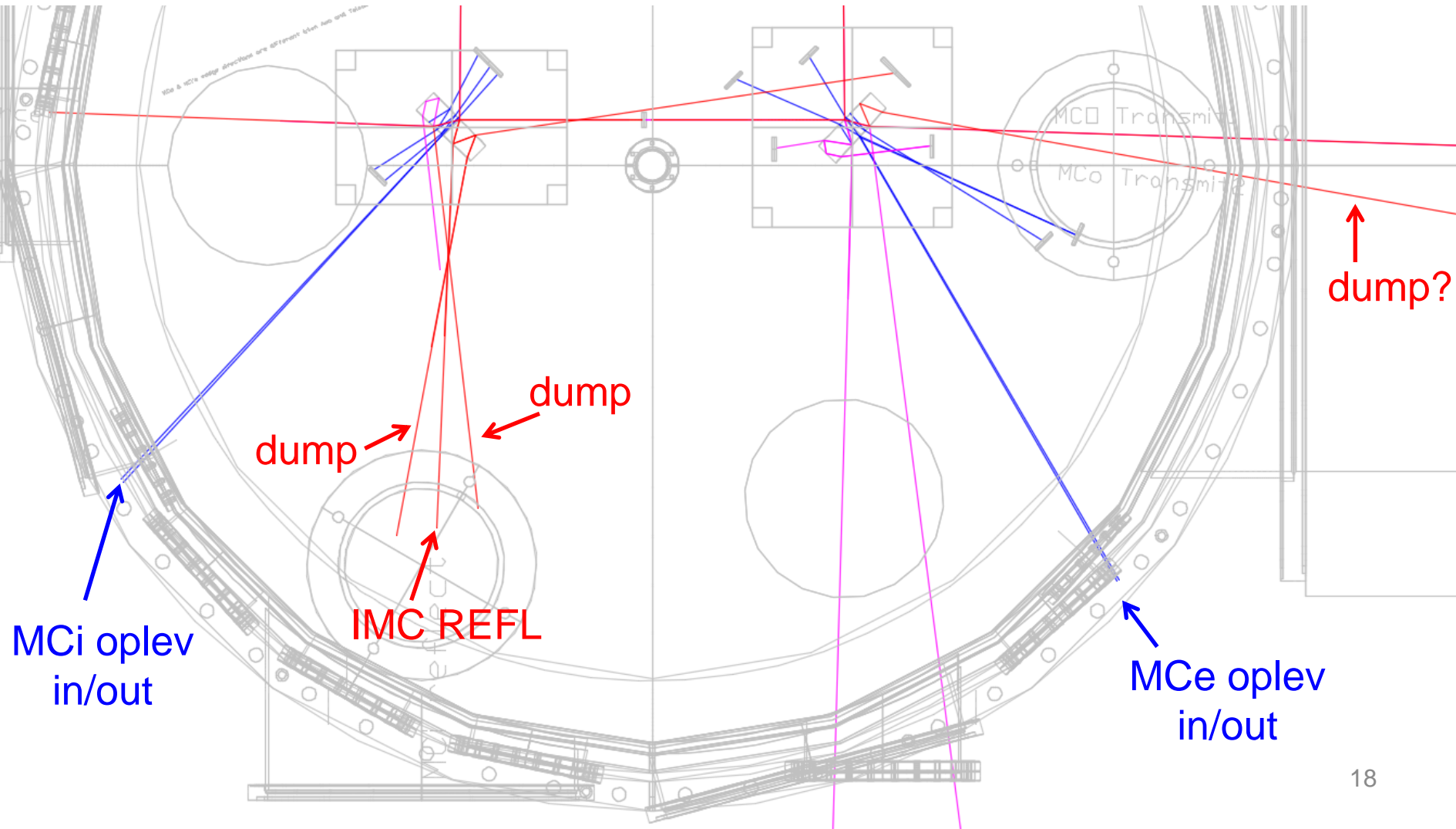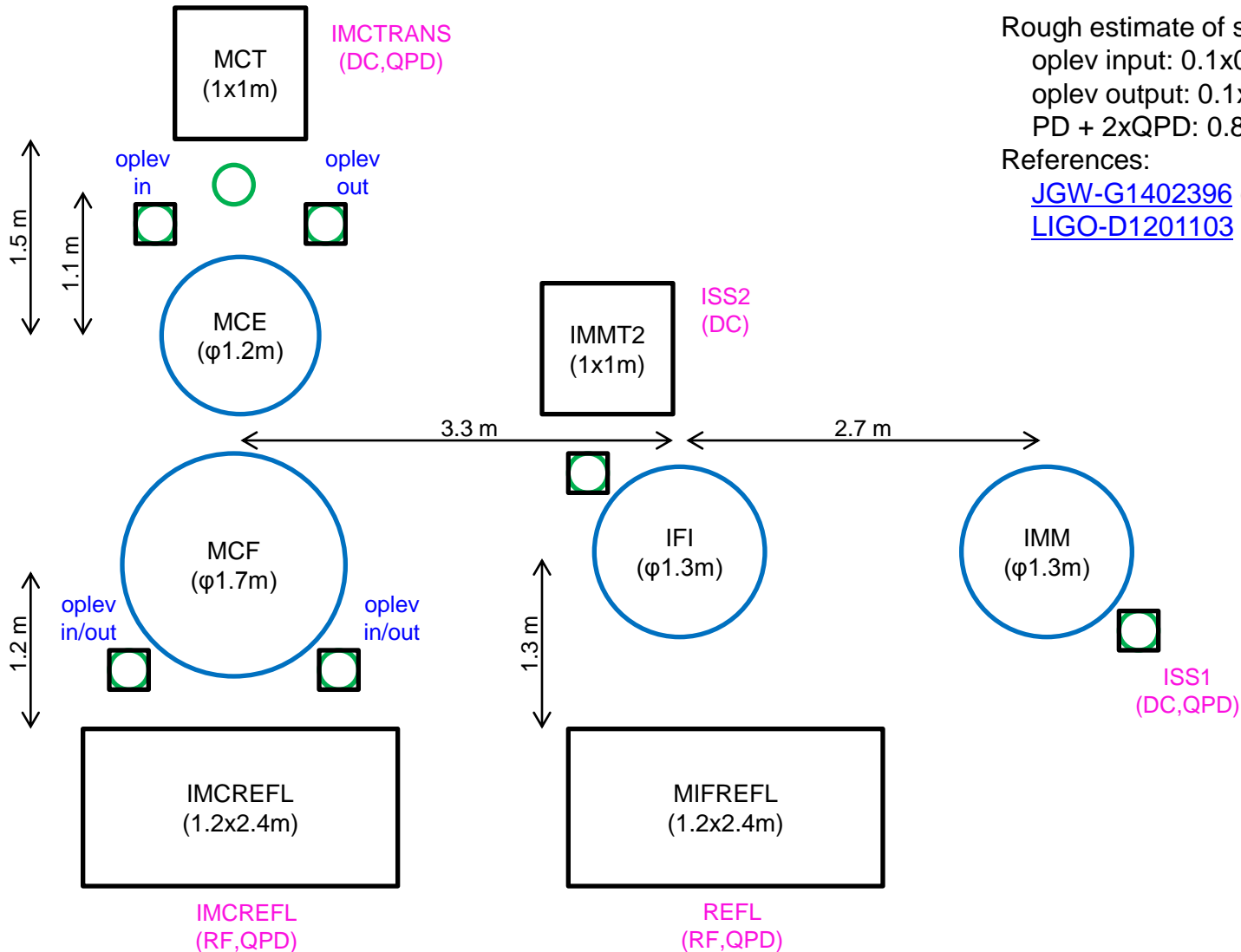- [JGW-D1402492](#) (IMC suspension cabling)

Beams around MCe

IMC TRANS

MCe oplev in

MCe oplev out

Beams around MCi and MCo

dump?

dump

dump

IMC REFL

MCi oplev
in/out

MCe oplev
in/out

Optical Tables / Pylons Layout

- chamber: ◯ pylon: ◯ table: ▭

MCT
(1x1m)

IMCTRANS
(DC,QPD)

Rough estimate of space required
  oplev input: 0.1x0.1 m
  oplev output: 0.1x0.1 m
  PD + 2xQPD: 0.8x0.8 m
References:
  JGW-G1402396 (oplev)
  LIGO-D1201103 (aLIGO ISCT1 table)

oplev in   oplev out

1.5 m

1.1 m

MCE
(φ1.2m)

IMMT2
(1x1m)

ISS2
(DC)

3.3 m   2.7 m

MCF
(φ1.7m)

IFI
(φ1.3m)

IMM
(φ1.3m)

oplev in/out   oplev in/out

1.2 m

1.3 m

ISS1
(DC,QPD)

IMCREFL
(1.2x2.4m)

MIFREFL
(1.2x2.4m)

IMCREFL
(RF,QPD)

REFL
(RF,QPD)

Some Important Info (for iKAGRA)

- Suspended optics from laser to PRM chamber are just IMC mirrors
  - we don't suspend IFI nor IMMTs
  - oplevs only for IMC mirrors (no oplevs for IMMTs)

- IMMTs are flat and have picomotors

- we don't need hardware interface between picomotor drivers and digital system

Questions

- Are we going to use IMMTs as actuators for ASC of FPMI?
- Are there PDs/QPDs which should be in vacuum?
  - only MIF REFL?
- What are we going to do with MCo AR reflected beam?
  - I don't think it is essential for ISC point of view
- How many standalone digital system will be needed by Nov 2014?
- What's the situation about FRC servo circuit?
  - Miyakawa-san said he delivered to IOO on Sep 2013
- Are we really going to use FRC? Is it a default plan?
- How many picomotors for a MC mirror?
- What do we need for digital system to picomotor driver interfaces? Do we need some interface circuits?
- What's the camera situation? How do we put them in the digital system?
- Where and how many do we have optical tables and pylons? What are the sizes of them? Do we need periscopes for them?