FEL alignment procedure up to TCC

FEE mirrors and XRT M2 + YAG crosses on the following excel spreadsheet:
https://docs.google.com/spreadsheets/d/1xgT8UrfPWLqSAILuuV55vnMd3h12Th5gPgZcomI5VY8/edit?usp=sharing

Check that the the mirrors are on the correct strip; the wrong strip can damage the mirrors:

https://confluence.slac.stanford.edu/pages/viewpage.action?spaceKey=XBD&title=HXR+Mirror+Operation+For+Ni+and+W+Coating

Some comments on the new procedure after the upgrade
Mirrors in Fee : MR1L0 and MR2L0
MEC mirror in XRT : XRT M2 (M1 is before and M3 is after M2…)
Yag screen IM2L0 is the screen used for handover from ACR

To check before inserting YAG0: (orientation 270deg)
- IM2L0:
  - When yag at -87.66mm
  - Cross at : (X, Y) = (626, 172)
- MR1L0: (last update: 02/03/2021)
  - x up: 200.945 mic
  - pitch : 7.0 urad (+-0.1 urad)
  - bender: 1.15 mic, setpoint -1.285 mic (old: 0.784 um (setpoint at -0.938))
  - y up: +5000 mic
- MR2L0: (last update: 02/03/2021)
  - x up: -0.160 mic
  - pitch : 16.854 urad (+-0.025 urad)
  - bender: -1.76 mic, setpoint -1.765 mic (old: -1.27 um (setpoint: -1.269))
  - y up: -5000 mic

- HX2_SB1 yag screen IN at:
  - Y = 0mm
  - Zoom = -70
- XCS_YAG1 = UM6 yag IN at:
  - Y = 0mm
  - Zoom = 30
  - XPP slits (UM6) at 100 mic opening centered at (X, Y) = (257, 421)

- XRT M1: values to be in OUT position
  - gantry X: -6 mm
  - pitch : -1.4 urad (not too relevant, as it seems not to clip the beam when in OUT position)
- XRT M3: values to be in OUT position
  - gantry X: 0 mm
  - pitch : 95 urad (not relevant)

Positions of the beam on YAG0 when above values are true:
- XRT M2 is OUT (meaning position of the beam when CXI is aligned):
  - when camera zoom is at 26%, cross position is **(416, 576)** (before 2021/02/02: 436, 587)
  - **gantry X : >15 mm (gantry Y fixed: -4.9931 mm), usually 18 mm for OUT position**
- **XRT M2 is IN** (meaning send the beam to MEC beamline):
  - **gantry X : -1.5 mm (sometimes -1.8 mm)**
  - **pitch : 775.8 urad (common trajectory 780 urad)**
  - when camera zoom is at 26%, cross position is **(894, 580)** (before 2021/02/02: 922, 587) and position read 8.7 mm (before 2021/02/02: 8.5 mm) on the YAG fiducial
- YAG1: (last update: 02/12/2021)
  - (X, Y) = (215,401) -- 2/12/2021 [previous (222, 342)--2/03/2021 (old: (181, 319))]
  - Zoom: 40%
  - Orientation: 270°
- YAG2: (last update: 02/12/2021)
  - (X, Y) = (306, 482)--2/12/2021 [previous (308, 442)--2/03/2021 (old: (240, 416))
  - Zoom: 30%
  - Orientation: 270°
- YAG3: Camera is fixed, 2/12/2021
  - (X, Y) = (333, 368)
  - Zoom: 30%
  - Orientation: 270°
- TCC yag: yag position at (tgx, hexy)=(133.4, -5.5), preset position, 2/3/2021
  - (X, Y) = (338, 563) (old: (349, 530))
  - Questar Zoom: 123.5%
  - Orientation: None
- Gige4: Not aligned due to blocking, 2/12/2021
  - (X, Y) = (352, 155), at 205mm on the large translation stage
  - Zoom: NA
  - Orientation: 180°

Date	Gantry X (mm)	Pitch (urad)	Photon energy (eV)	Comments	Beam position on screen (mm)?
2021-02-15	-1.65	772.8	9575	Phil alignment	-
2021-02-04	-1.8	771.8	15000	Alignment is	
2021-02-02	-1.5	775.8	9800	Pointing seems low on the yags	
2020-12-14	-1.9	775.0	9500		Yag 3 (324,355)
2020-10-15	-1.9	772.8	7390		
2020-09-18	-1.8	+774.5	8000	We optimized the shape to have it not looking clipped on one side	
2020-08-20	-1.9	+773.15	9831	Changed the bender from -26.5 to -20.009 mm	
2020-08-16	-1.9	+779.2	7942	Pitch on MR2L0 was 0.5 urad off our reference value	
2020-08-15	-1.9	+779.7	7971	Using XPP slits for checking alignment down to yag3, can ee 0.2 urad change	
2020-08-12	-1.9	+780	9797	Might need to move the yag screen if needed	8.5
2020-08-10	-1.9	+776		After move of the XRT	
2020-07-30	-0.96	+686		10 keV (new LCLS II undulators), not perfect common alignment (pointing too high)	
2021-02-02	-1.9	780			

##

######## Everything below is before the LCLS-II upgrade ########

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Temporary procedure while skywalker is being debugged (2017-07-11)

0) Make sure M1H XRT is out : horizontal= -4.3 and M3H is out : horizontal=-0.2
1) Move M2H XRT Horizontal to : -0.3
2) Move M2H XRT Pitch to nominal MEC position : 792
3) If the beam does not hit M2H XRT in the middle, tweak the pitch of M2H FEE and steer the beam to the center of M2H XRT, by watching YAG0 (minimize straight-through beam, maximize reflected beam) : minimize vertical line in Yag
4) Change pitch of M2H XRT to get beam on MEC YAG1, and the on YAG3. The change in this pitch may be very large (see table below).
5) Check XRT be lenses (out = 0, set1=-33, set 2 =-60, set3=-86)

History of M2H-XRT position to get beam to MEC.

Beam position on YAG0; **this was before zoom control zo probably not valid any more:**

      M2H XRT out : (868,989) with badly focussed camera, with no zoom control;

      M2H XRT in   : (879,989)

Position M2H XRT :

      OUT   : Horizontal Gantry >5mm, fully out at 18.5 mm (needed for CXI)

      IN   : Horizontal Gantry = -0.3

              : Pitch = 792.

Date	Horzontal Gantry (mm)	Pitch (urad)	Comments	Beam position on screen (mm)
2017-06-28	-0.3	656.0		
2017-07-04	-0.596	622.7	Horizontal center on the YAG3 center marks	
2017-07-05	-0.3	775		
2017-07-06	-0.49	797	15.5 keV	
2017-7-06	-0.47	792	8 keV	
2017-07-11	-0.290	793	8keV	
2017-07-13	-0.30	820	7.2 keV (FEE-M2, X:0.0006, pitch:109)	

2017-07-19	-0.299	816	7.2 keV (FEE-M2, X:-0.0004, pitch:109)	
2017-07-23	-0.504 1	847	9.5 keV (FEE-M2, X:-0.0004, pitch:111)	
2017-07-24	-0.505	839	11 keV	
2017-07-25	-0.505	840	9.8keV (FEE-M2: X(0), pitch(134.7)	
2017-07-26	-0.505	830	9.8keV (FEE-M2: X(0), pitch(134.9)	
2017-08-08	-0.25	841	8.98keV (FEE-M2: X(0), pitch(120)	
2017-08-10	-0.3	842.5	8.99keV (FEE-M1:-0.56,283.3, FEE-M2:0,149.6)	
2017-08-11	-0.314	846	8.99keV (FEE-M1:-0.56,283.3, FEE-M2:0,149.6)	
2017-09-07	-0.3	840	6.8 keV (FEE-M1:-0.67, 236, FEE-M2:0,141)	
2017-10-11	-0.3	840	7.41keV	8.5
2017-11-08	-0.3	844	8 keV	
2017-11-14	-0.3	843.2	7.2 keV	
2017-12-20	-0.313	856	8.2 keV (FEE M2H: 156)	
2018-03-22	-0.3	772	11 keV	
2018-06-01	-0.3		7.050keV	8.55
2018-06-03	-0.3	770	6595 eV	8.4-8.6
2018-09-03	-0.3	771.85	9500 eV	
2018-10-13	-0.3		8000eV	
2018-11-06	-0.3	771.3	8240eV	
2018-12-09	-0.3	773.5	11.2 keV	
2018-12-15	-0.3	774.7	7.9 keV	
2020-07-30	-0.96	+686	10 keV (new LCLS II undulators), not perfect common alignment (pointing too high)	

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OBSOLETE OLD ALIGNMENT PROCEDURE

1. Check that angle is correct (or close enough) to MEC position: dX = 1290.932 (+-n*360), or encoder to : 818677.
2. Steer the beam with M2H mirror using dX motion onto YAG0 (PIM0) to be centered on the crosshair at position:

   zoom = 0% (**to be checked**)

   Y = 0.0 (**to be checked**)

   camera crosshair positions:

period starts	period ends	X	Y
beginning operation	12/31/12	81	386
14/01/13	2014-10-21	77	392
2014-10-21	2015-08-10	74	392
2015-10-27	**Current (zoom 0%)** **Current (zoom 100%)**	272 **262**	253 **260**

2. Move M3H X motion to center the beam on the cross (**value is about -3.455 mm**).
3. Move M3H X motion 295 mic to have the mirror more in the beam and capture it.
4. Steer the beam with dX motion of M3H onto YAG2 (PIM2) until you reached the middle of the YAG crosshair when vertical position of the screen is at Y = 0.
5. Check encoder value using the command in MEC python:

   > m3h.get_angle_encoder()

   It should be around 818548 **(818605 updated on 4/26/2016) counts (+-100). (angle on motor: 1292.0 deg)**

   Steer beam to cross position : 518, 254 (zoom 100%)
6. Beam on YAG1 (PIM1) can be checked in case you don't see the beam on YAG2. In this case, use dX motion of M3H until you see the beam appears on the screen.
7. Send the beam until YAG3 (PIM3) and tweak dX on M3H to center the beam on the crosshair.
8. Recheck crosshair 2, and iterate steps 2) and 3) as required
9. Up/down alignment is done by calling MCC and ask them to move the undulator the corresponding amount that the beam is off the center divided by 3-4 approximately. This is done at YAG3 only (furthest point in the beamline).

Beam sharing operation; obsolete most likely. Common axis never really worked well. In principle MEC aligns M3H to whatever CXI or XCS have aligned to. Beamsharing with MFX is not yet defined.

1. Steer the beam using M2H dX angle motion to center it on XCS YAG2 crosshair.

2. Call MCC for undulator steering to tweak up/down.
3. Check beam on MEC YAG0 crosshair.
4. Then, alignment becomes identical to the **NO beam sharing operation** but **no** undulator steering can be used, **only** angle (so avoid step 8).

note: values in the table below were not checked after new alignment on 2014-10-21

PIM name	Zoom value [%]	X	Y
SXR Shared	-5	142(?)	251
MEC YAG0	0	74	392
XCS YAG2	60	171(?)	290