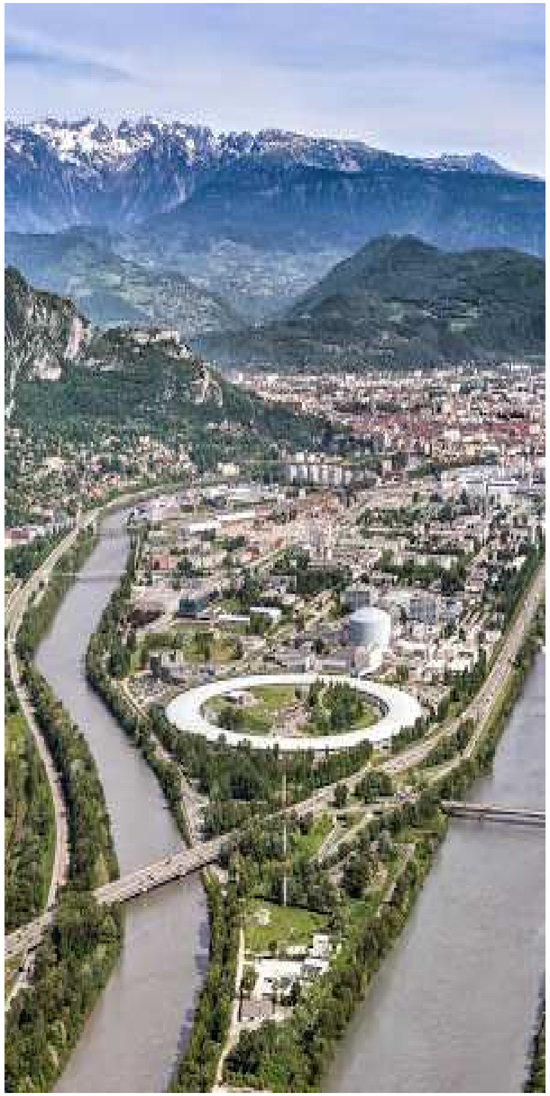


Laser and Interface with the ID24 Beamline (HPLF-I)

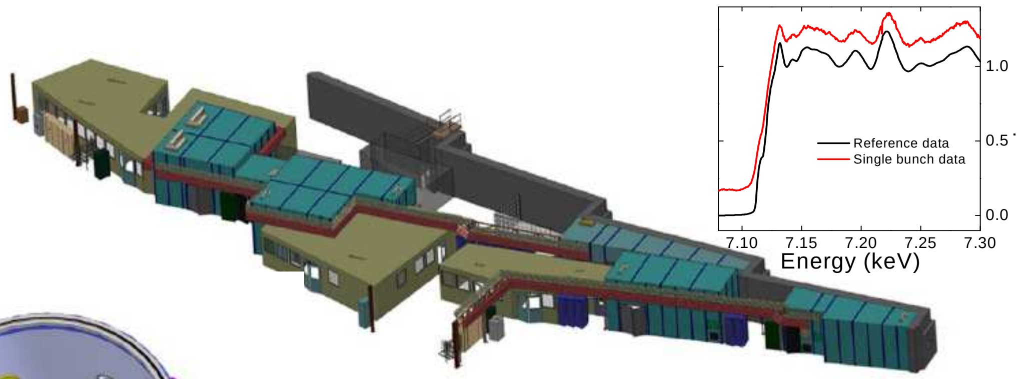
Raffaella Torchio

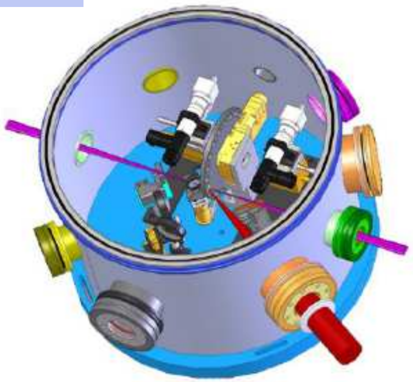
O. Mathon, R. Briggs, C. Clavel, S. Pascarelli, A. Sollier, J.-P. Zhou

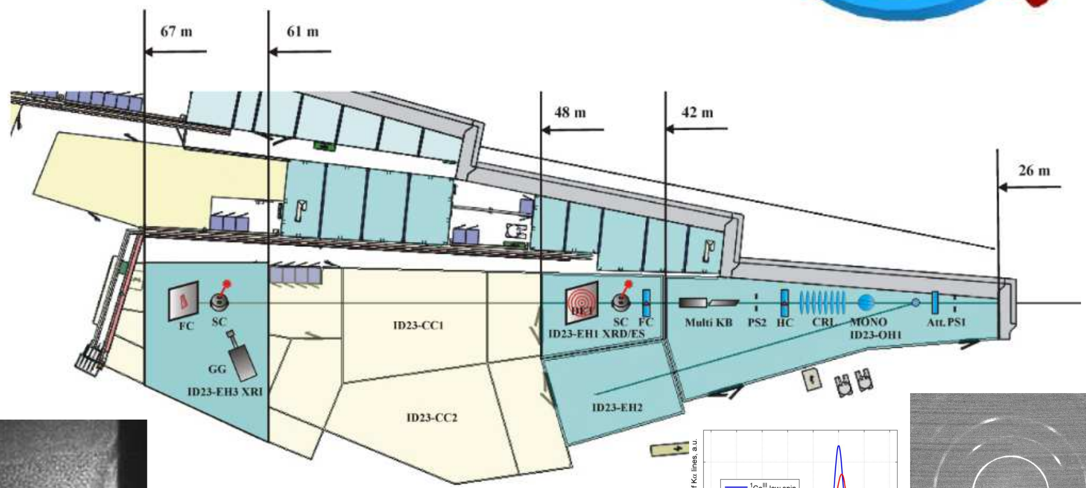
torchio@esrf.fr

HIGH POWER LASER FACILITY AT ESRF

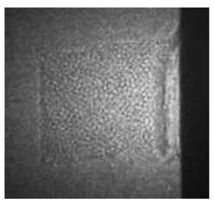
HPLF-I (2018) :
installation of a ~100-200J laser at beamline ID24, user operation of HPLF-I should start before the shutdown (2018).



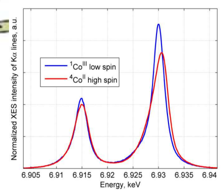


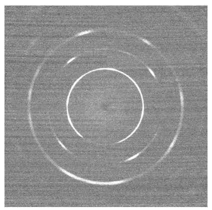


HPLF-II (2022):
extension of the facility to offer additional X-ray diagnostics: XRD, XRI, XES as part of the Extremely Brilliant Source (EBS) upgrade. An upgrade of the laser power, to > 300 J, is also envisaged.



V. Svitlyk talk



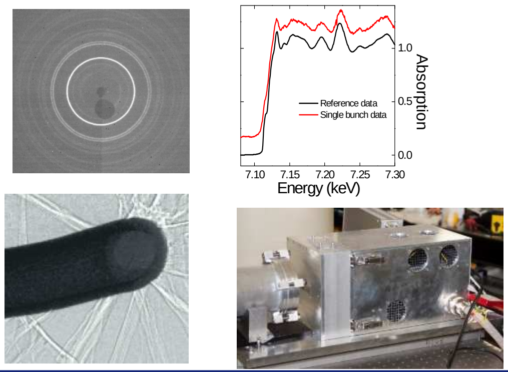


PROJECT HISTORY

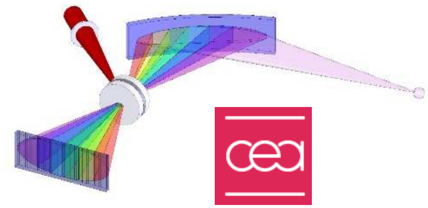
2012

Proposal and planning of first laser shock experiment using XAS on Fe

2013 single bunch



May 2014
First laser shock experiment at ID24 on Fe



Feb 2015

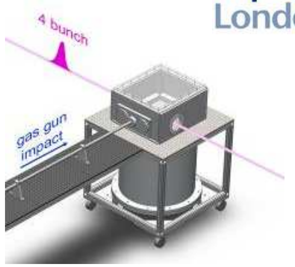
Workshop on Studies of Dynamically Compressed Matter with X-rays

Monday 16 and Tuesday 17 February 2015

Venue: ILL Chadwick Amphitheatre

Sept 2015
first gus gun exp at ID19

Imperial College London



Oct 2015

EUCALL

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 654220

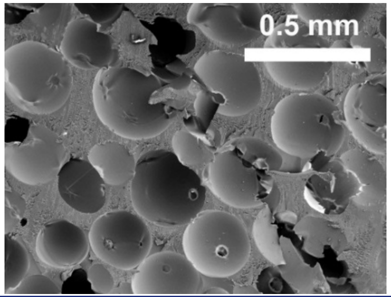
Post doc R. Briggs

PROJECT HISTORY

March 2016

7 EOI

May 2016
second laser exp on ID24
first laser exp at ID19

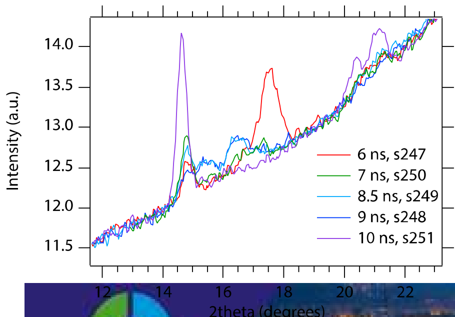


June 2016

HPLF-I approved

100/200 J laser
on beamline ID24

Dec 2016



First laser
shock exp
XRD @ ID09

CDR-6 for the HPFL-II

Currently

TDR for HPLF-I

HPFL-II submitted to the SAC

technical offers from the lasers companies

LASER PARAMETERS: CRUCIAL POINTS

Because of the experimental requirements (coupling to x-rays techniques) some aspects are crucial:

- Good shot-to-shot stability for energy and pointing direction
- Flat and reproducible spatial profile
- Reproducible top-hat or/and adjustable temporal profile
- Synchronization with the ESRF radio frequency (RF) signal

  with a very low jitter

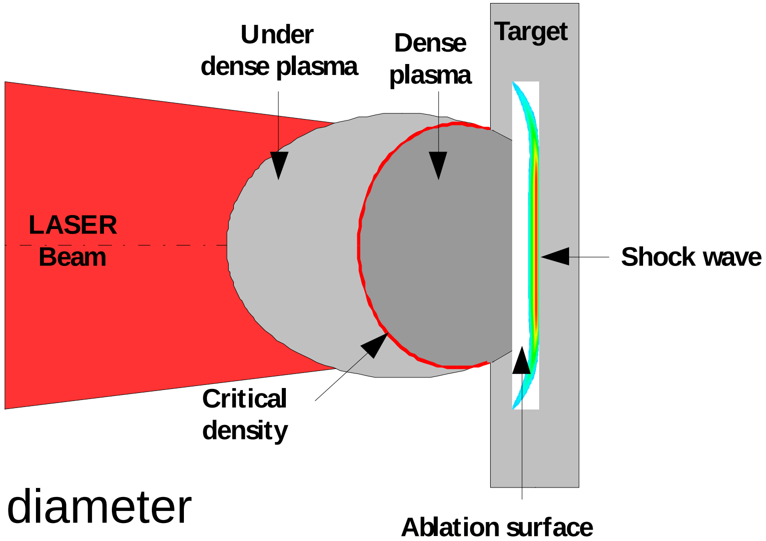
LASER PARAMETERS

5-10 Mbar in shock

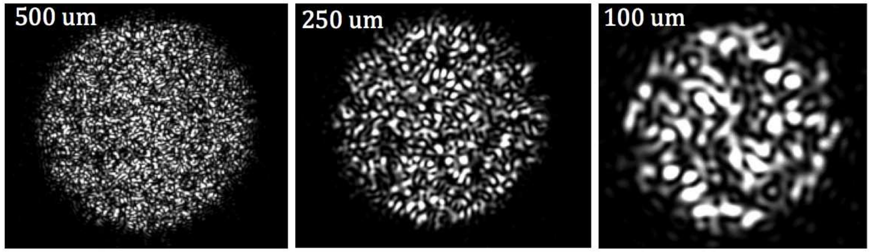
- 100 -200 J max at 1053 nm (specified for a top hat pulse of 4-6 ns)
- possibility to convert to 2ω using LBO crystals → avoid hot e^-

  energy @ 2 ω: 70 J -140 J max at 526.5 nm
- tunable energy 0-E_{max}
- repetition rate: 1 shot/min to 1 shot/10min at full power
- super Gaussian spatial profile
- pulse shaping , variable 4-15 ns → limit T
- shot-to-shot jitter < 50 ps
- upgradable to higher energy: 300J

LASER SPATIAL PROFILE

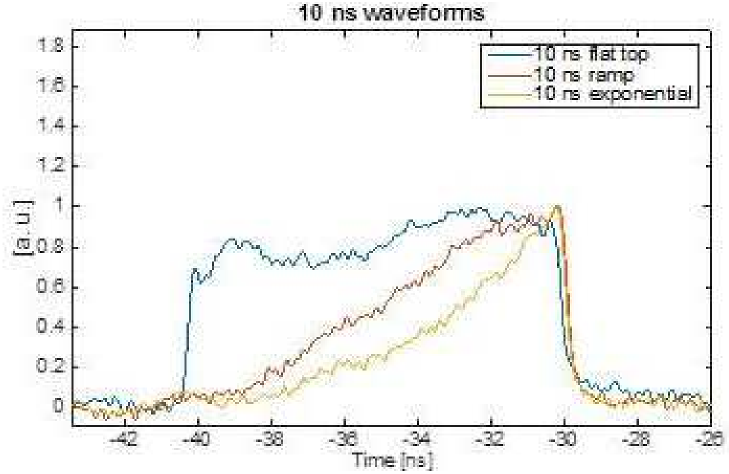


- Circular beam top-hat shape.
- Beam diameter
  laser fluence <<damage threshold
  propagation of 12 m
- Wave front (static) deformation
  <λ peak-to-peak and λ/5 rms over the predefined diameter
- Super Gaussian profile with N=8-10, with 90 % of the energy in the pre- defined diameter
- Intensity modulations:
  5 % rms and 15 % peak-to-peak for spatial frequencies >1 mm^{-1}
  10 % rms for spatial frequencies <1 mm^{-1} (low frequency)
- Residual divergence < 0.5 mrad
- Pointing stability < 25 µrad.



phase plates at MEC

LASER TEMPORAL PROFILE



- top-hat profile 4 and 15 ns ± 0.25 ns FWHM, adjustable with at least 0.5 ns step.

- The rising edge < 0.25 ns
  no pre-edge features
  contrast > 10^5

- Temporal modulations
  5 % rms and 15 % peak-to-peak for high frequency > 1 GHz (y)
  3 % rms for low frequency <1 GHz

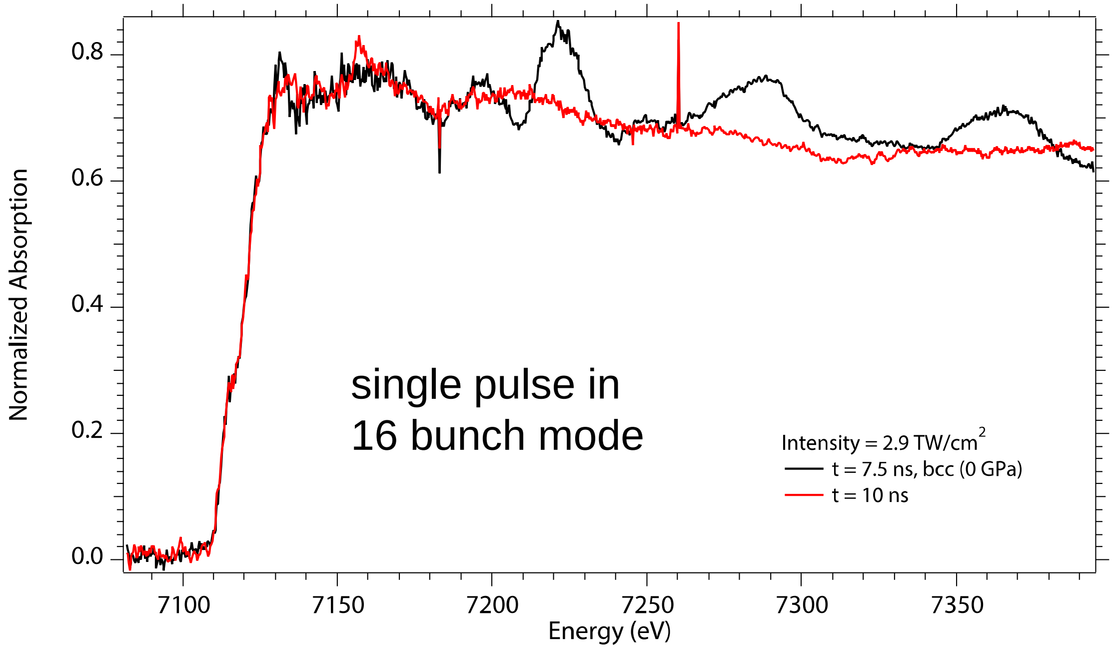
- shot-to-shot jitter < 50 ps.

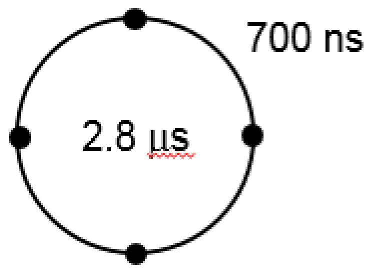
- 2ω LBO crystal must be optimized for 6 ns top-hat

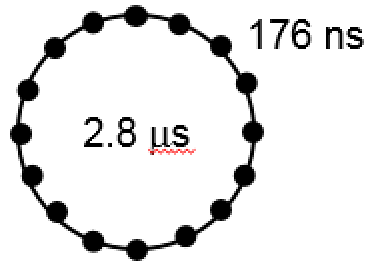
- pulse shaping: possibly t^3 followed by plateau

STABILITY, DIAGNOSTICS AND ALIGNMENT

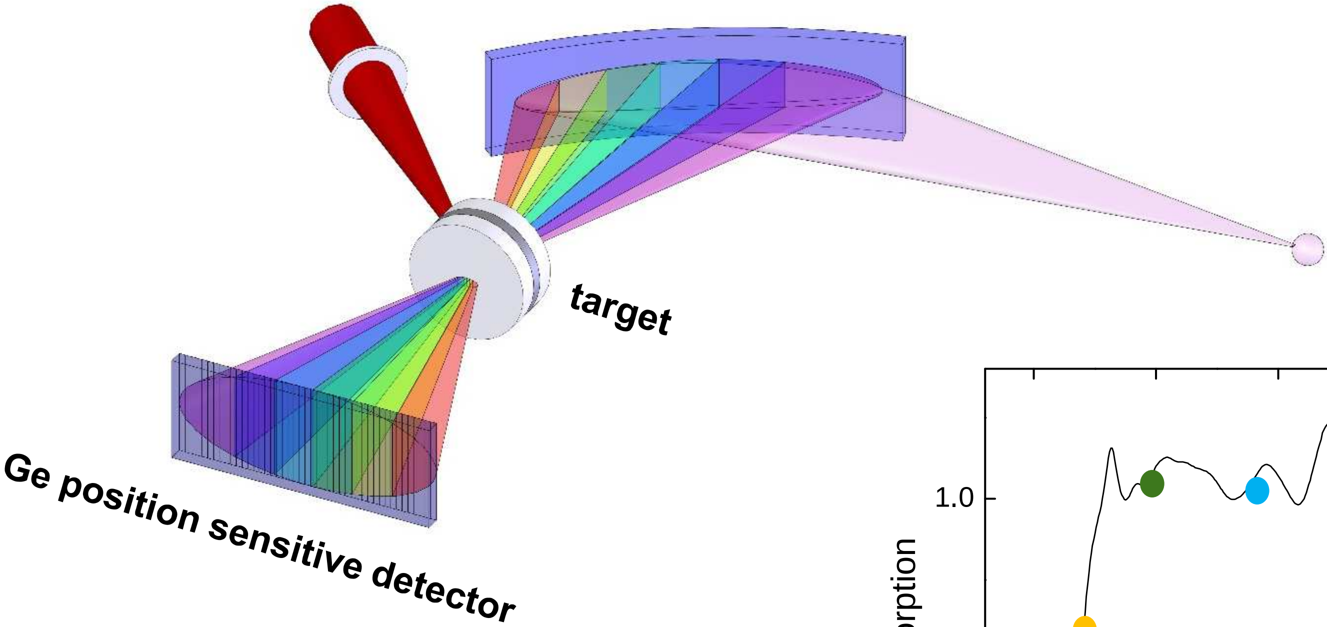
- shot-to-shot E stability <2% rms for 95% of the shots over 250 pulses at max E
- spatial profile and temporal profile reproducibility <2% rms for 95 % of the shots over 250 pulses at max E

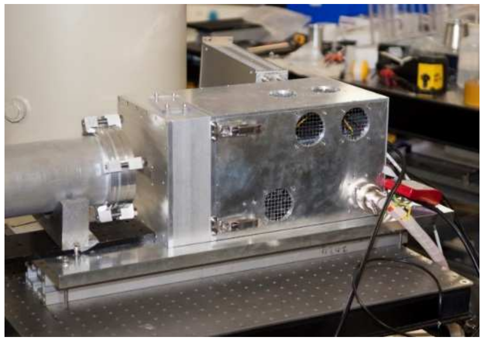


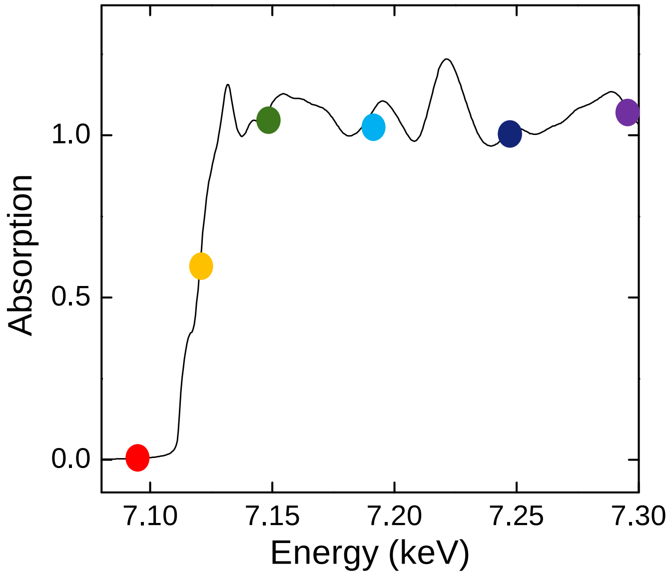




ID24 beamline dispersive setup

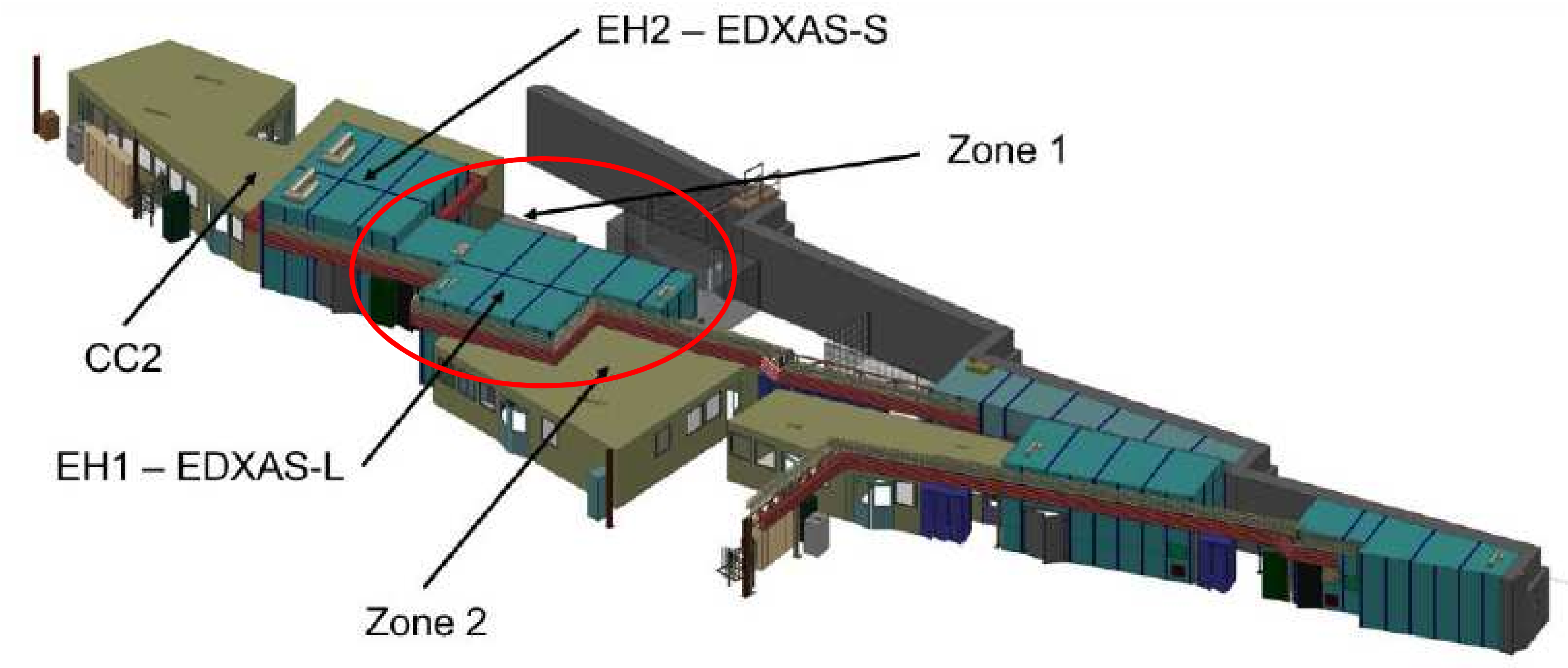




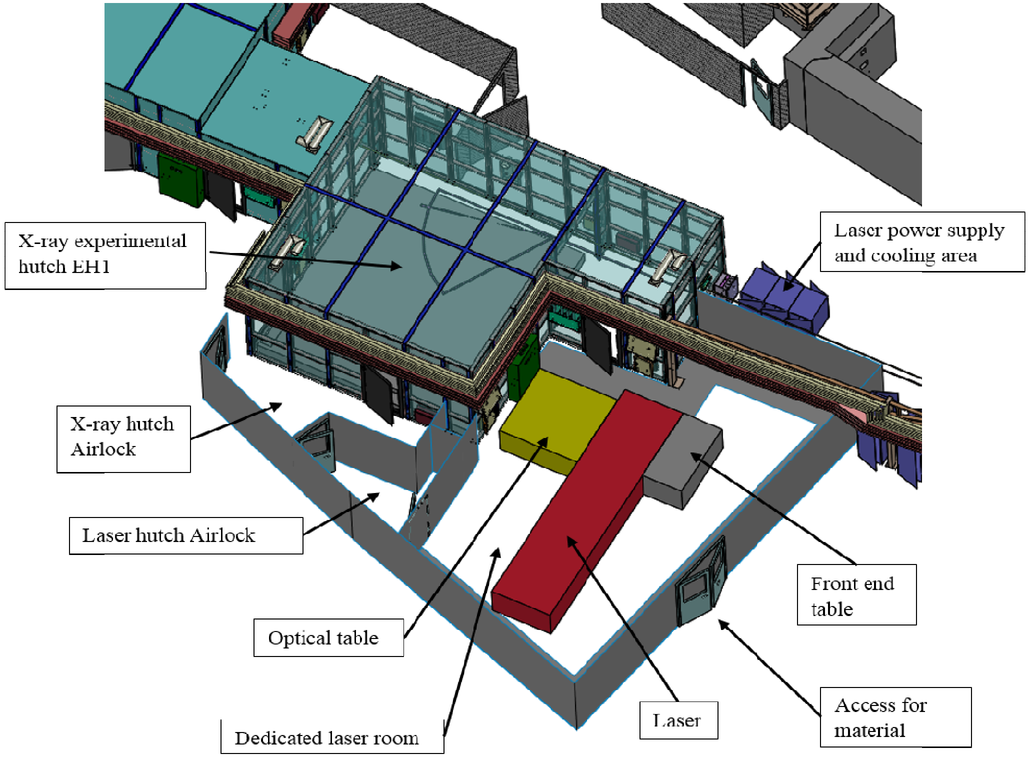


integration time150 ns
1 scan every 2.8 µs

INFRASTRUCTURE: ID24 BEAMLINE



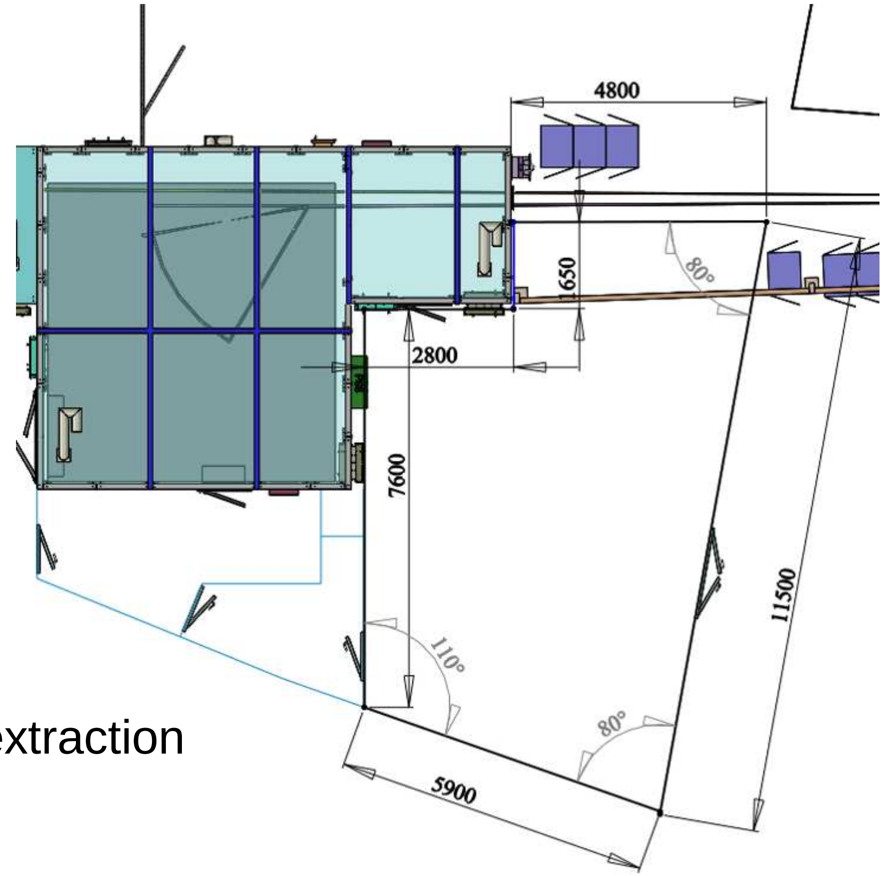
OPTION 1



Dedicated laser room

60 m^2

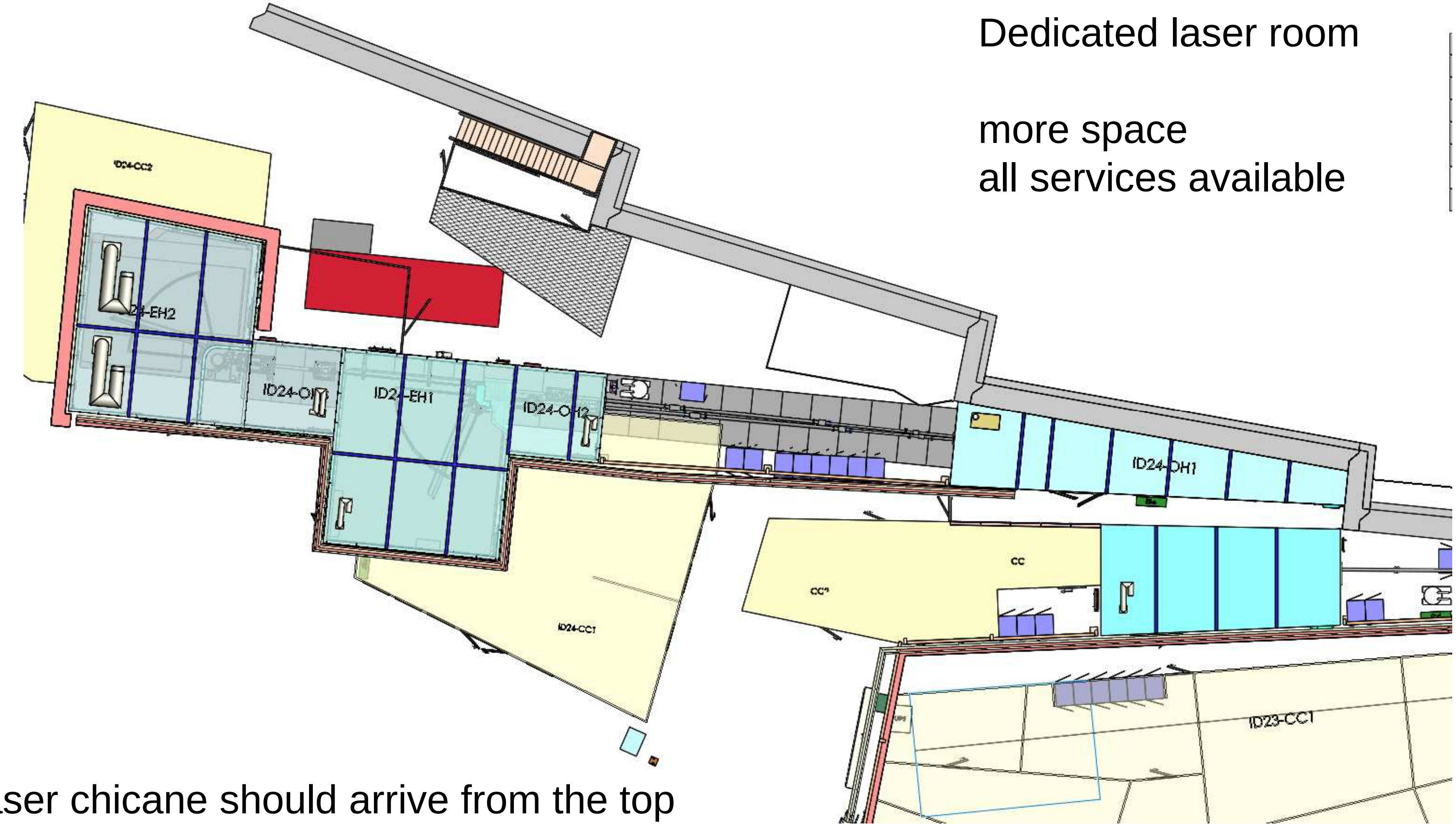
Class 100 000



All services available

Water, power, N2, compressed air, LN2, extraction

OPTION 2

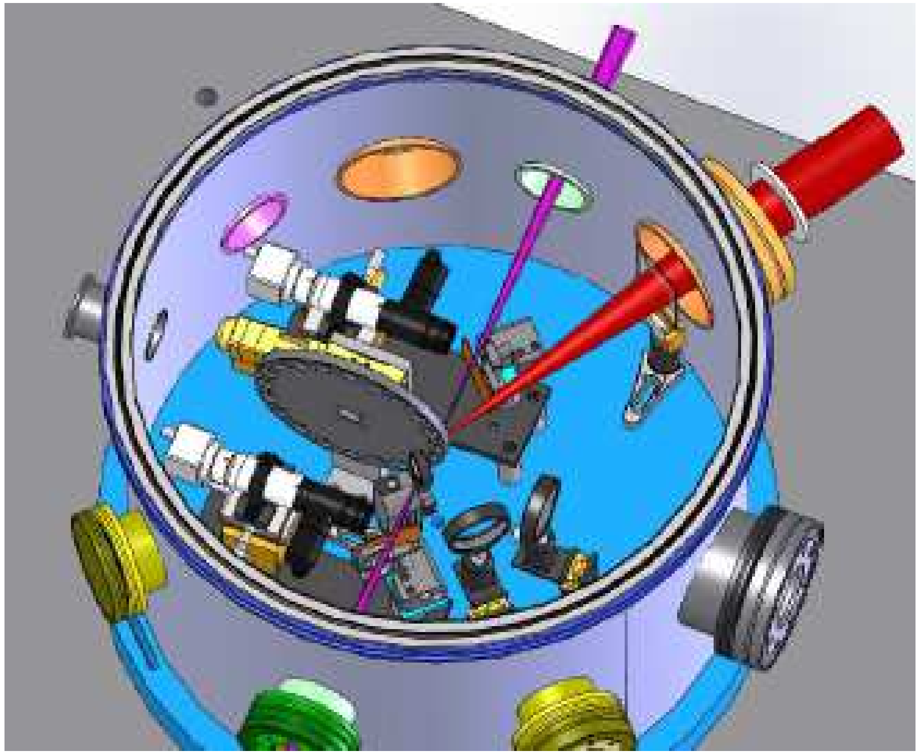


Dedicated laser room

more space
all services available

laser chicane should arrive from the top
because of the x-ray tube

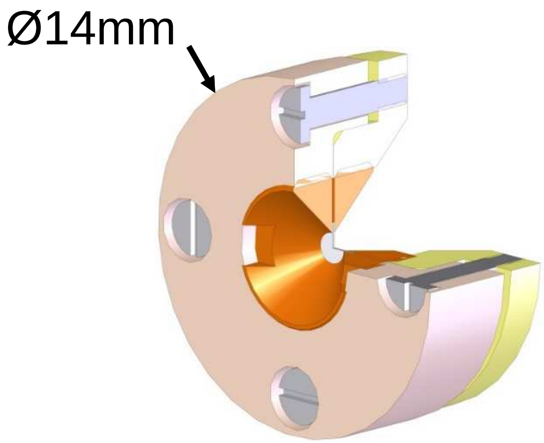
SAMPLE CHAMBER AND TARGETS

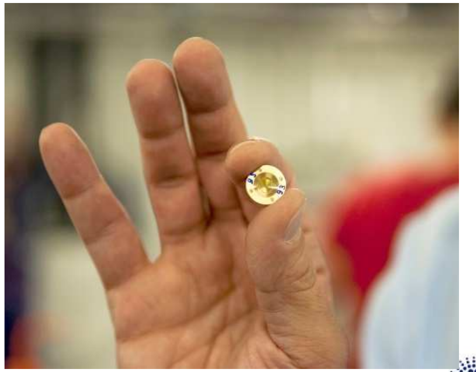


A specific vacuum chambers has to be designed to host:

- multiple targets on a motorized stage,
- two optical cameras to visualize the sample from both size,
- opening windows and proper optics for the VISAR and SOP diagnostics
- opening windows for the x-ray

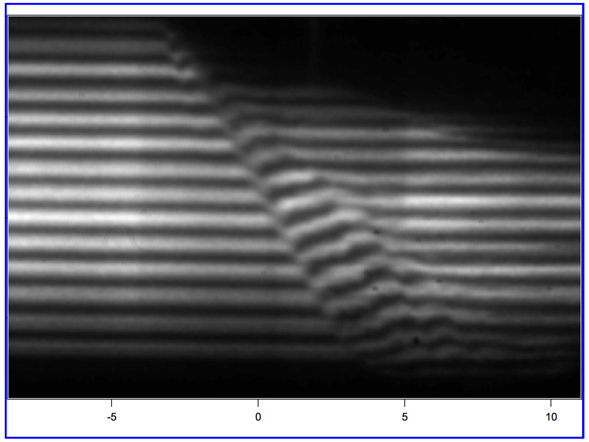
F. Occelli, S. Pasternak



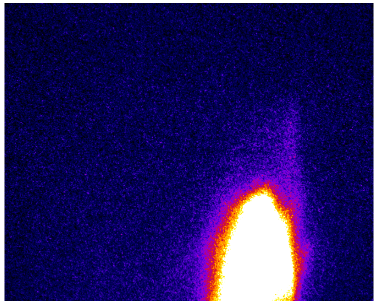


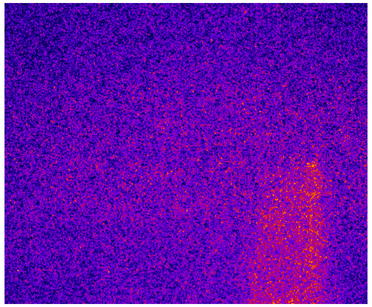
SHOCK DIAGNOSTICS

VISAR system (Velocity Interferometer System for Any Reflector) for the determination of shock velocities and pressure



SOP system (Streaked-Optical-Pyrometry) for temperature measurements.

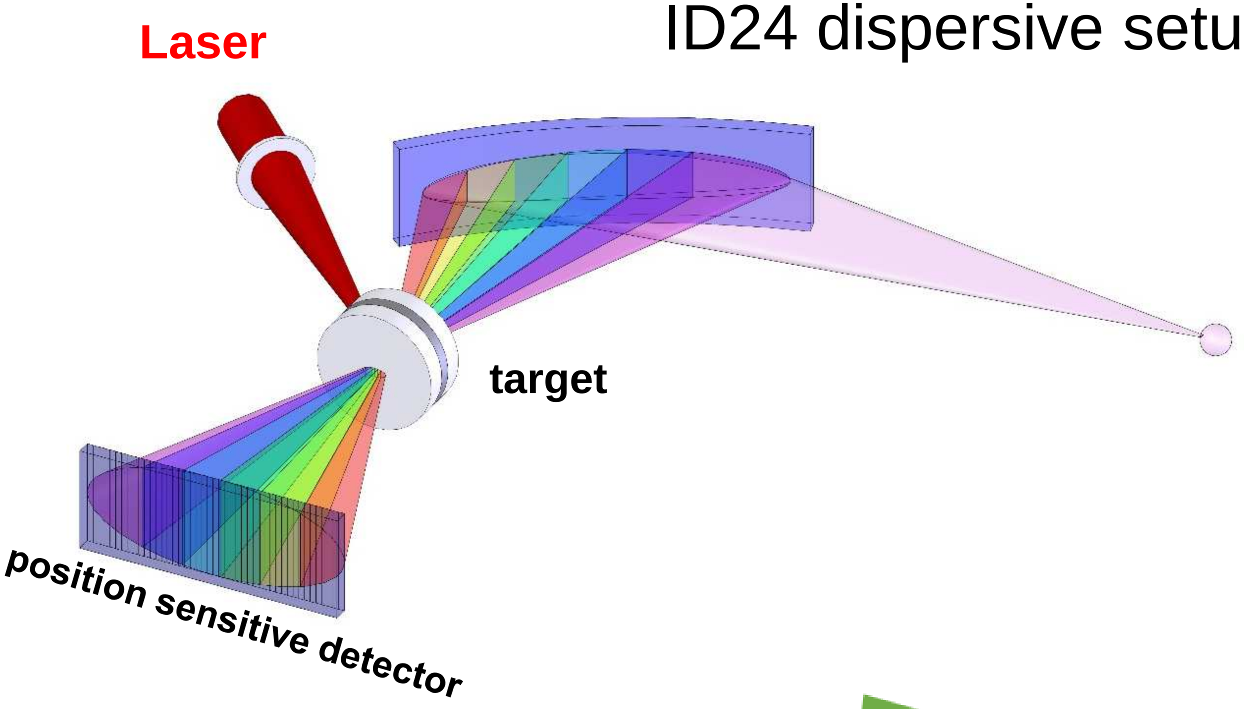


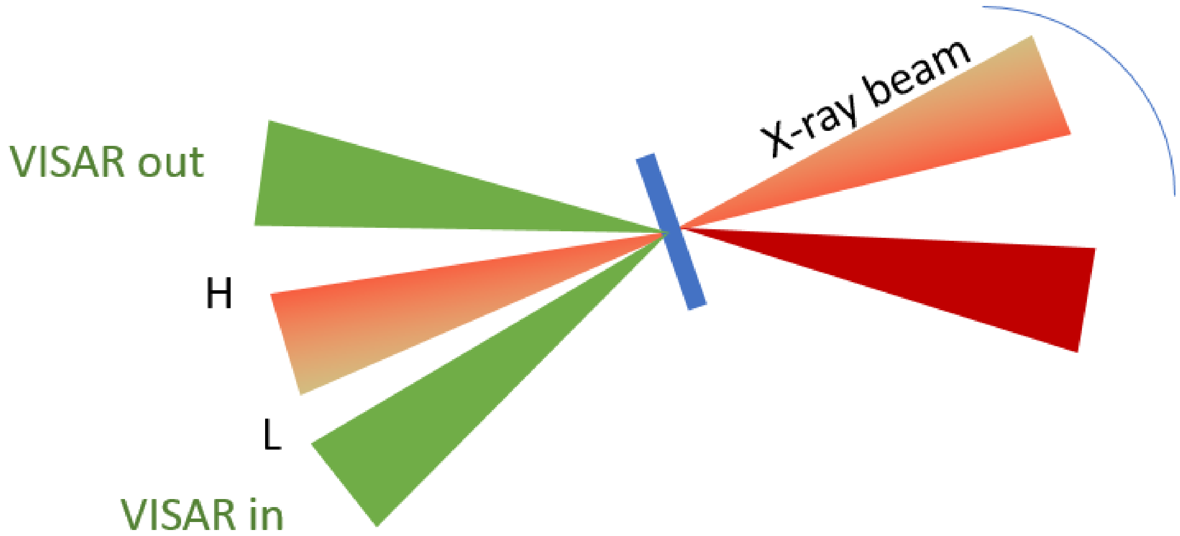


D. Kraus talk

SAMPLE ENVIRONMENT GEOMETRY

ID24 dispersive setup





CONCLUSIONS

Technical Design Report due by 30th September 2017

1. choose laser cabin location and design the propagation chicane
2. design a new target chamber
3. start the design of VISAR and SOP diagnostics
4. prepare first experiment in 2018

Thank you for your attention and feedback