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DTT interferometric and polarimetric systems

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WPDIV IDTT Mid term meeting

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DTT interferometric and polarimetric systems

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DAY0

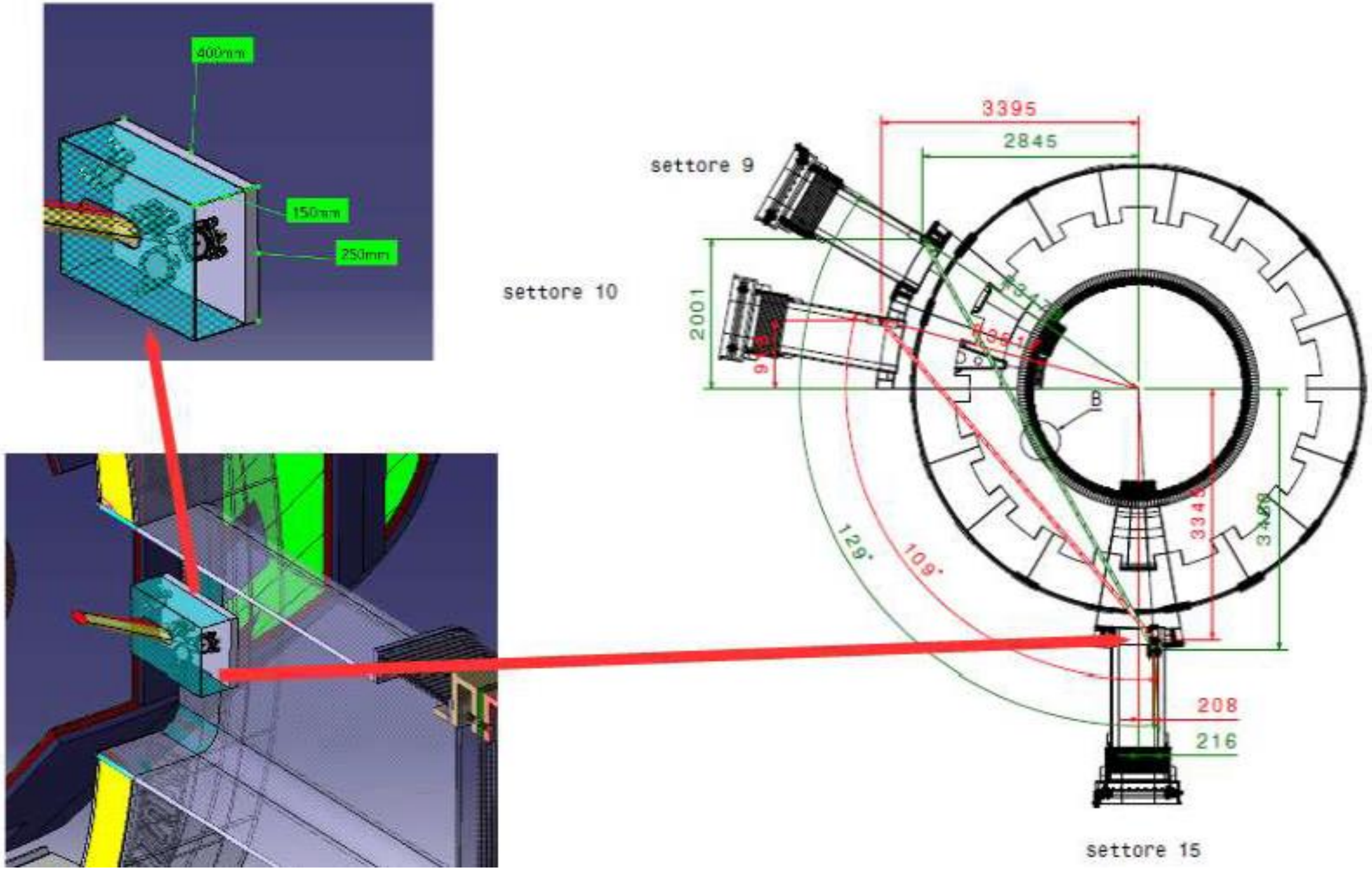
Tangential dispersion interferometer: density control with real time capabilities

DAY1

Vertical interferometer/polarimeter: The system will allow determining plasma density profiles, it will give valuable information on the internal magnetic field and it will contribute to evaluate the plasma magnetic equilibrium and to the real time estimation of the q-profile

Divertor scanning dispersion interferometer: detachment conditions assessment

Tangential dispersion interferometer-Previous work-I



F. Filippi and G. Rocchi

Tangential dispersion interferometer-Previous work-II

Choice of the wavelength: 1.55 um

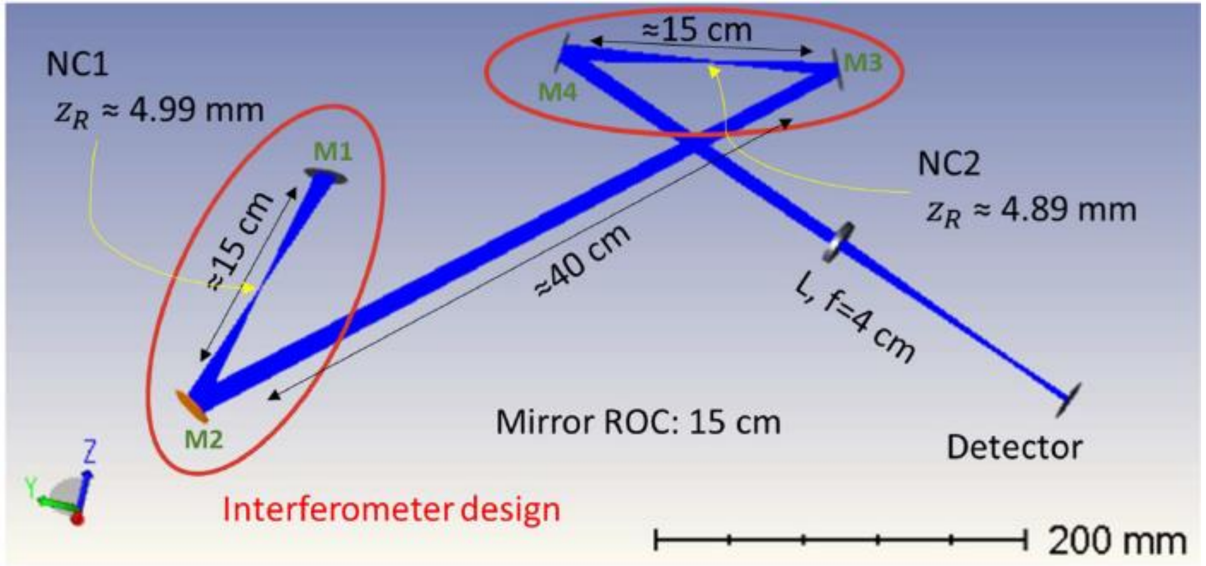
	10.6/5.3μm		1.064/0.532μm	
	Outer	Inner	Outer	Inner
$\Delta\phi$ (deg.) interferometry	4600° (12.78 fringes)	4488° (12.47 fringes)	458° (1.27 fringes)	448° (1.24 fringes)
Φ (deg.) Faraday rot.	15.94°	14.62°	0.16°	0.14°
Φ (deg.) Cotton-Moutton	0.020°	0.050°	0.00002°	0.00004°

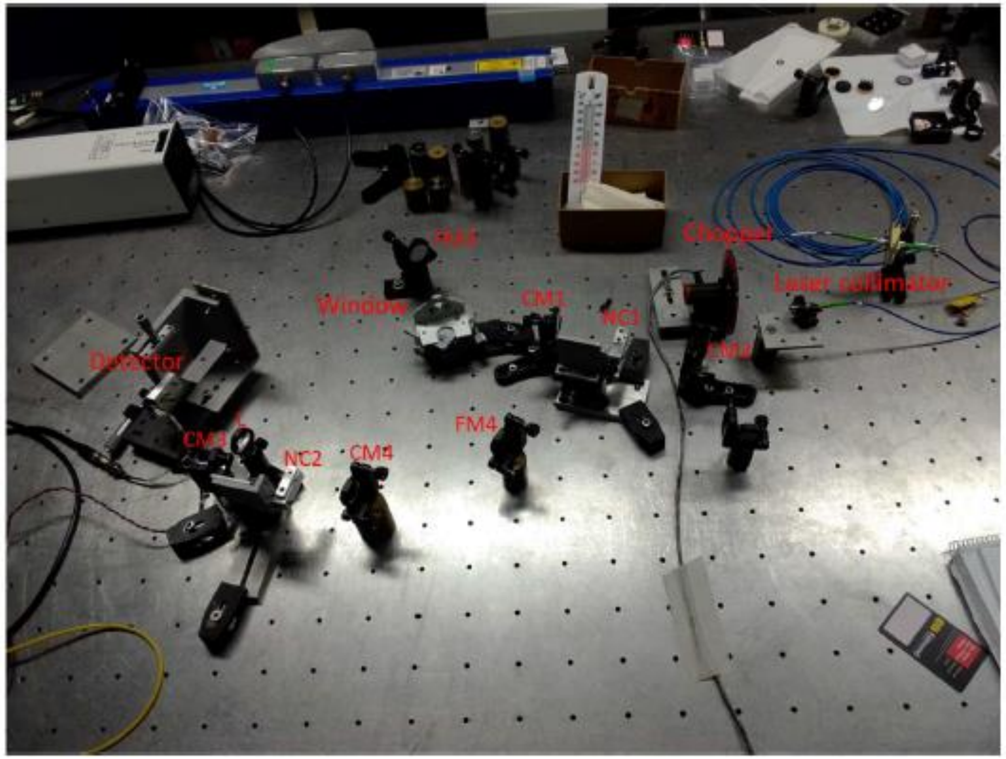
Electron density ~ 10^{20} m^{-3}

L. Giudicotti, F. Filippi and D. Fiorucci

Tangential dispersion interferometer-Previous work-III

Experimental tests: homodyne configuration



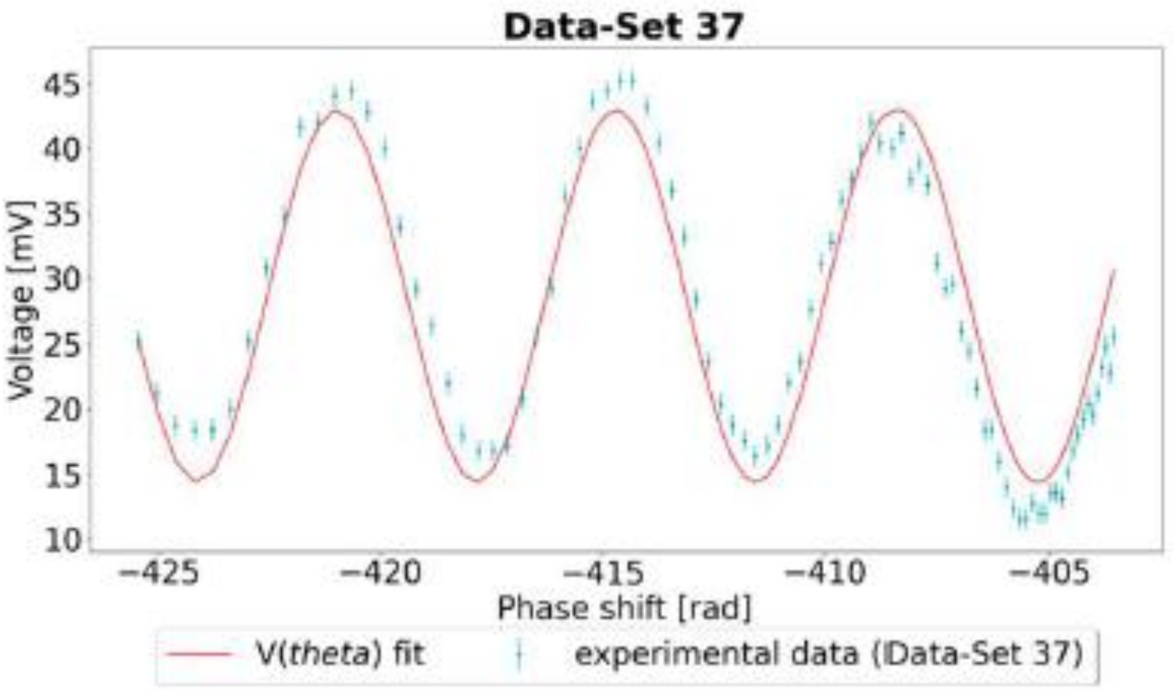


D. Fiorucci, M. La Matina

Tangential dispersion interferometer-Previous work-IV

Experimental tests: homodyne configuration

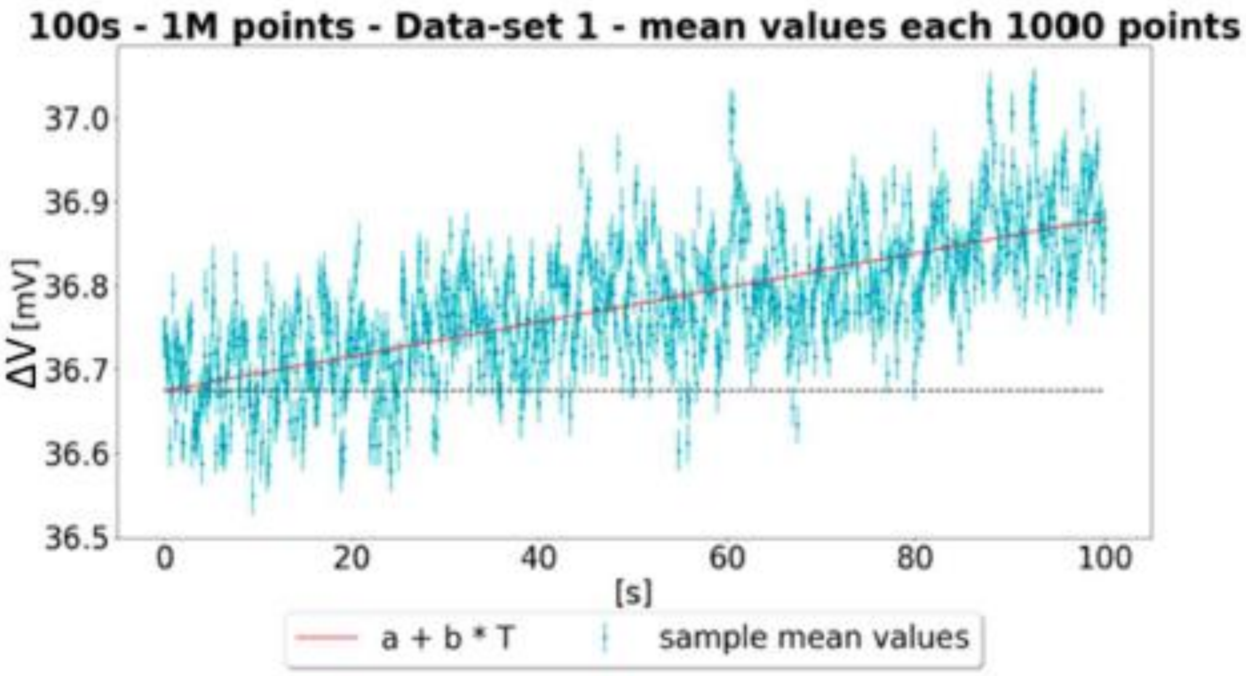
Fit with $V(\theta) = A + B\ cos\left(\frac{2\omega}{c}\left[n(\omega) - n(2\omega)\right]\frac{d}{cos(\theta+\phi)} + C\right)$



D. Fiorucci, M. La Matina

Tangential dispersion interferometer-Previous work-V

Experimental tests: homodyne configuration



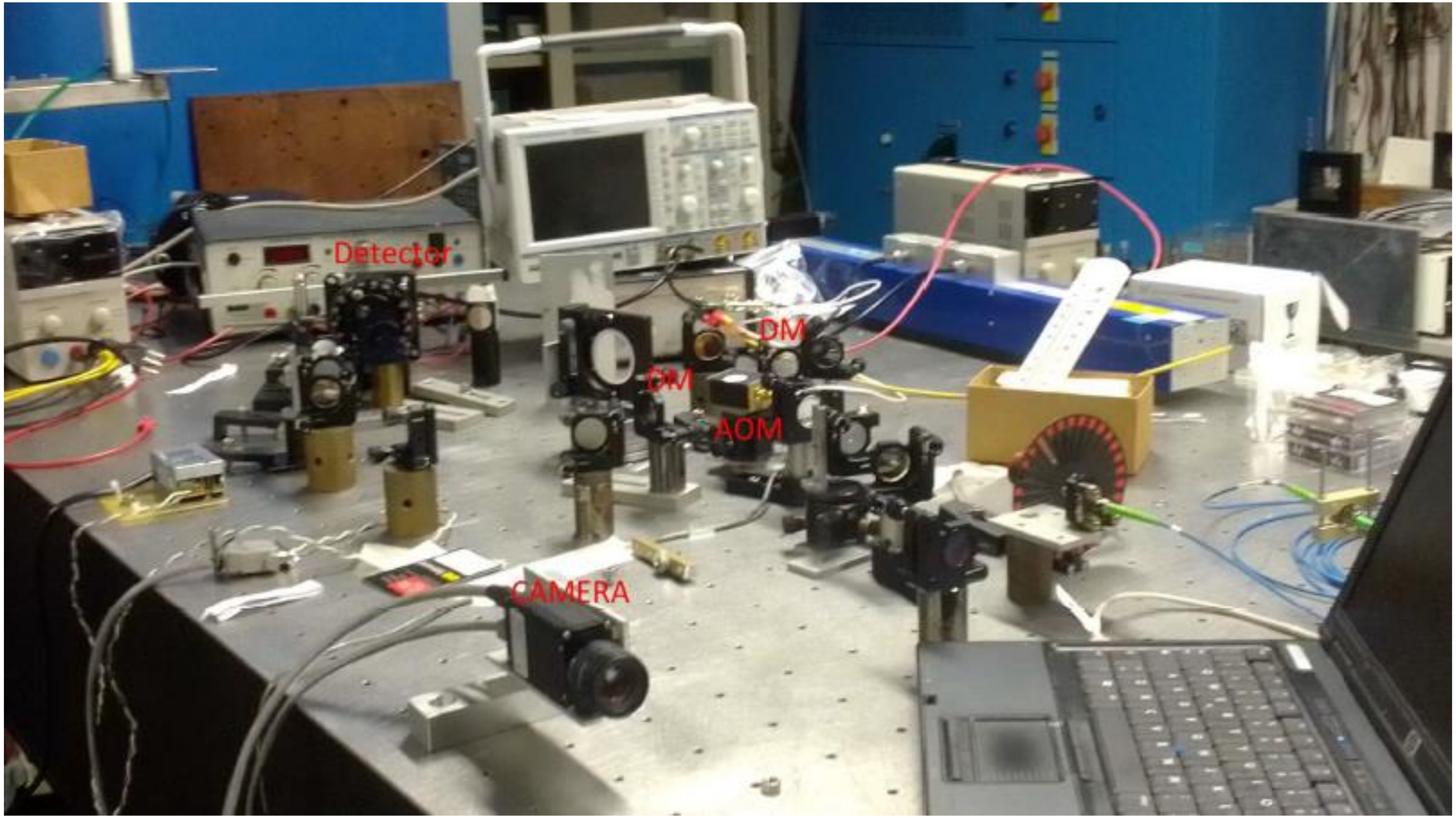
Time Range	Data-Set	Sensitivity for $\int n_e dl$
$1\ s$	1kpts	$3.925\ 10^{17}\ m^{-2}$
$100\ s$	1Mpts	$1.81\ 10^{18}\ m^{-2}$

D. Fiorucci, M. La Matina

Tangential dispersion interferometer-Previous work-VI

Experimental tests: heterodyne configuration

D. Fiorucci,
A. Fassina



Tangential dispersion interferometer-Previous work-VII

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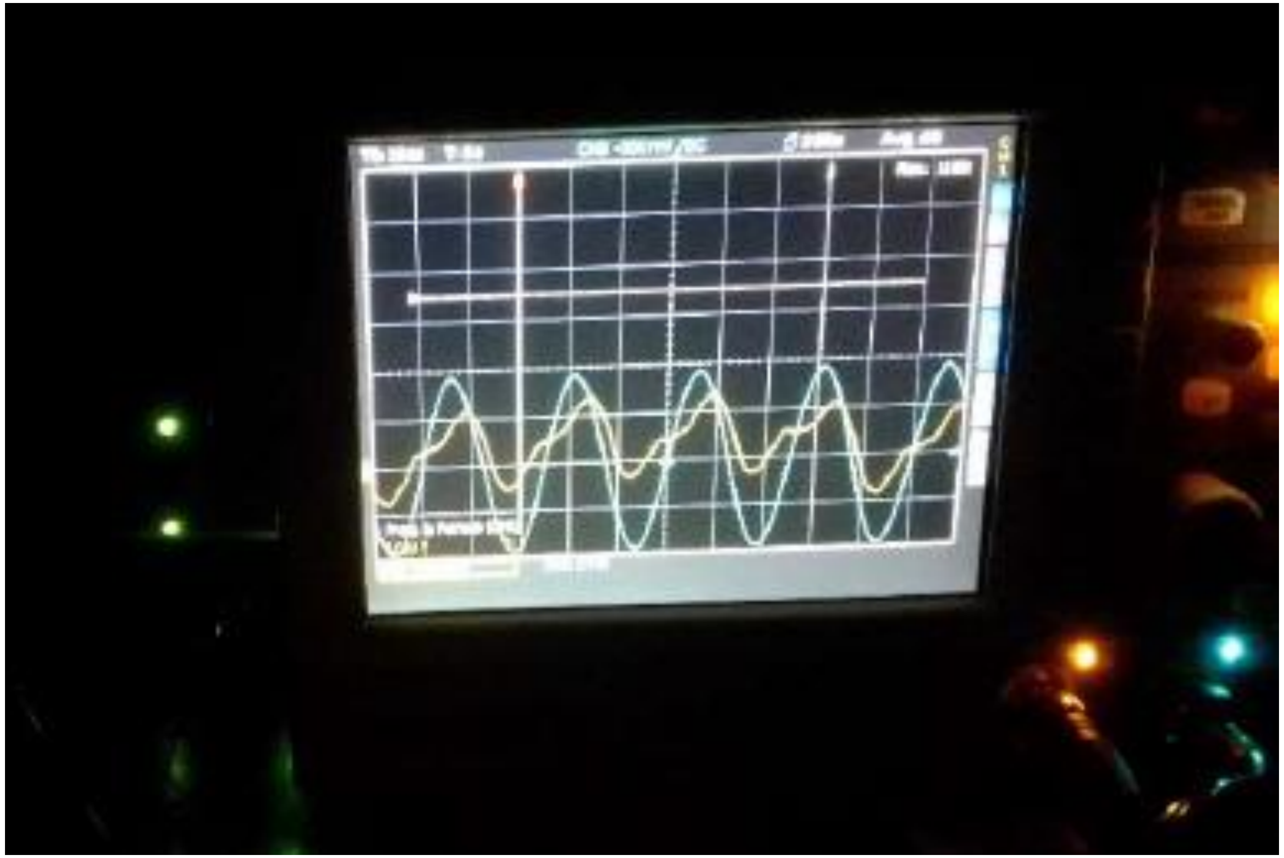
Experimental tests: heterodyne configuration

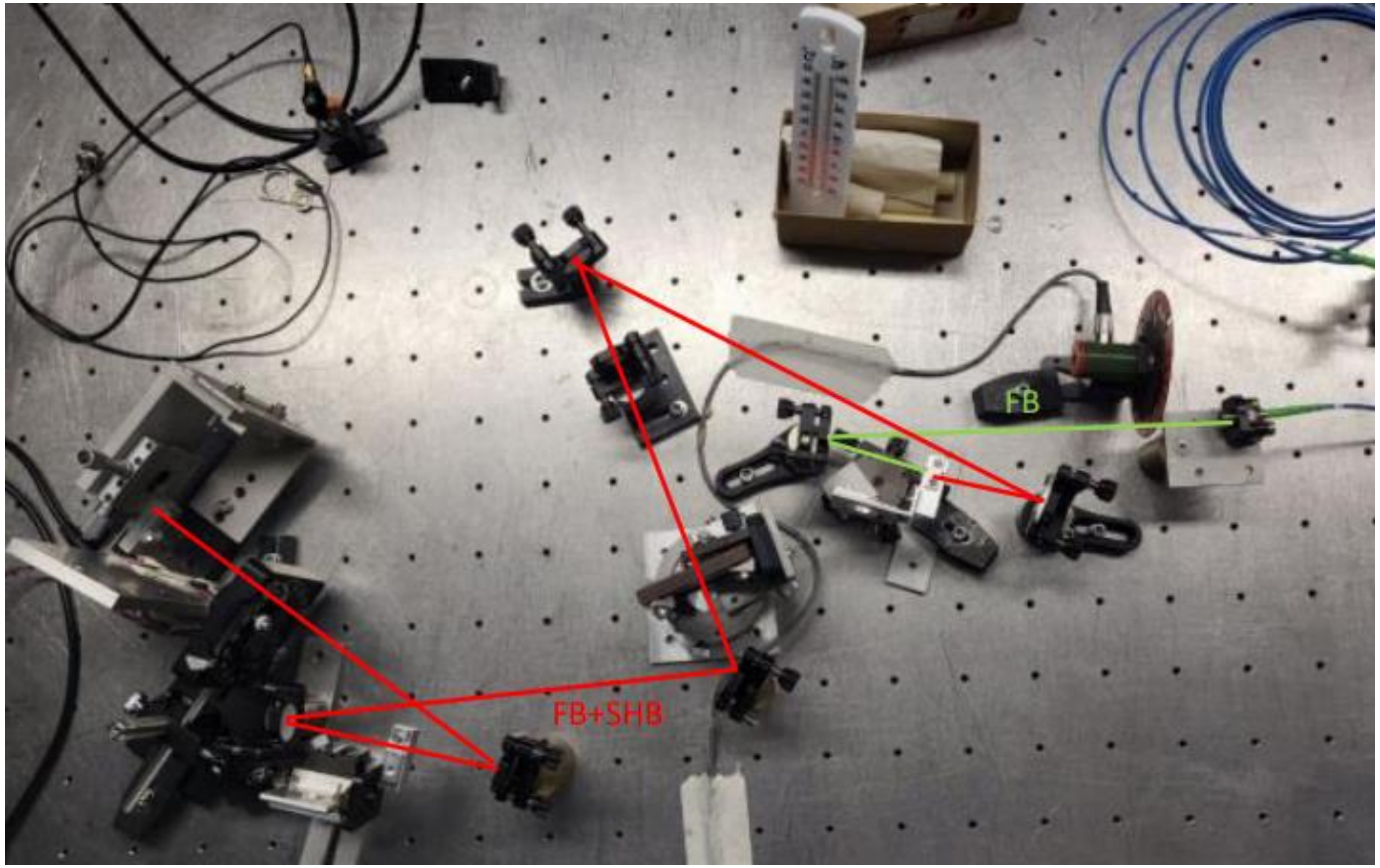


Very low signal, we had to investigate the reason for this

D. Fiorucci,
A. Fassina

Tangential dispersion interferometer-2023 work-I

Experimental tests: check if the observed issues were related to a lack of coherence introduced by the non-linear crystals or were due to the optical path difference (OPD). Comparison of three homodyne configurations.

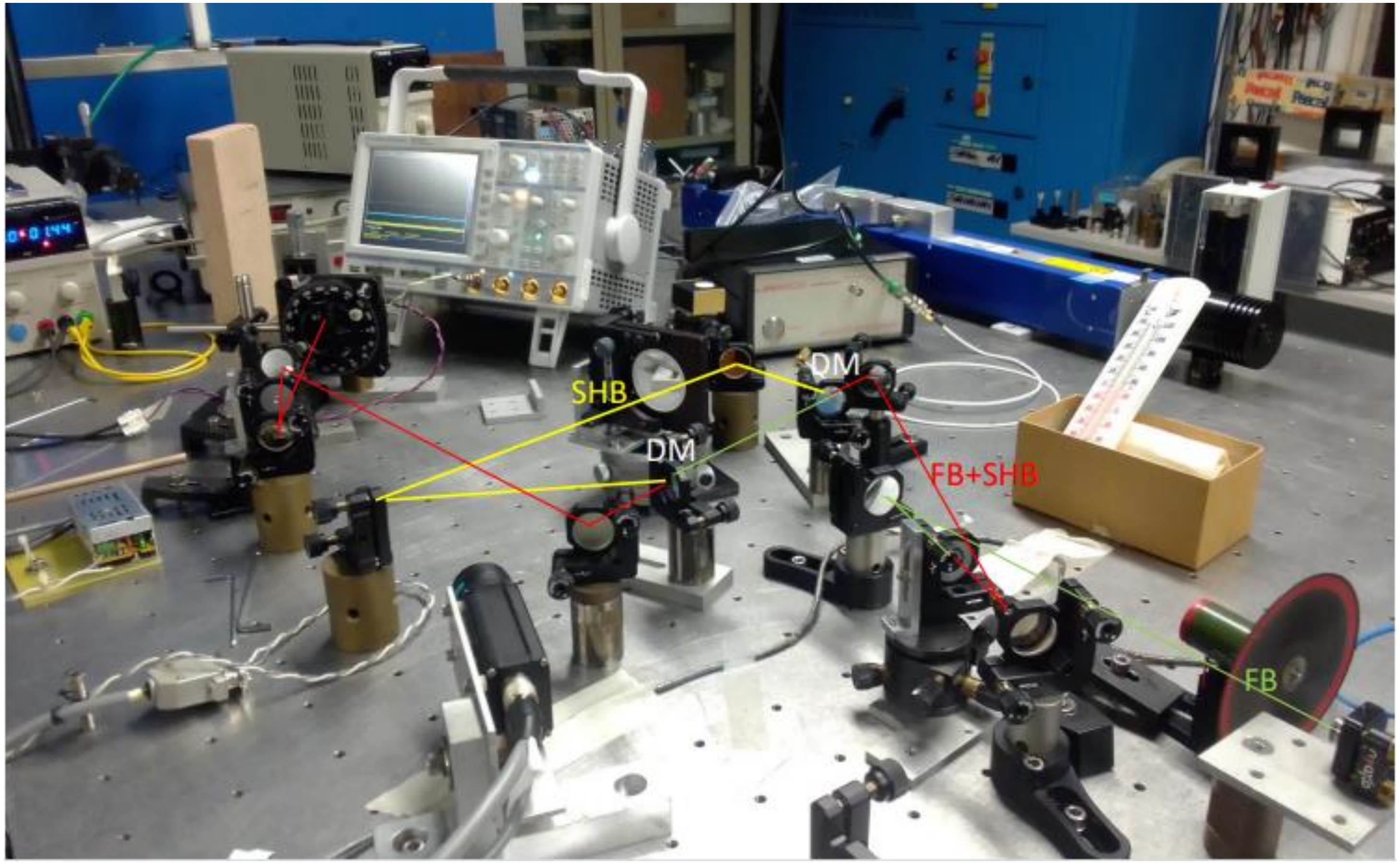


Set 37
OPD=0

Tangential dispersion interferometer-2023 work-II

Experimental tests: check if the observed issues were related to a lack of coherence introduced by the non-linear crystals or were due to the optical path difference (OPD). Comparison of three homodyne configurations.

D. Fiorucci

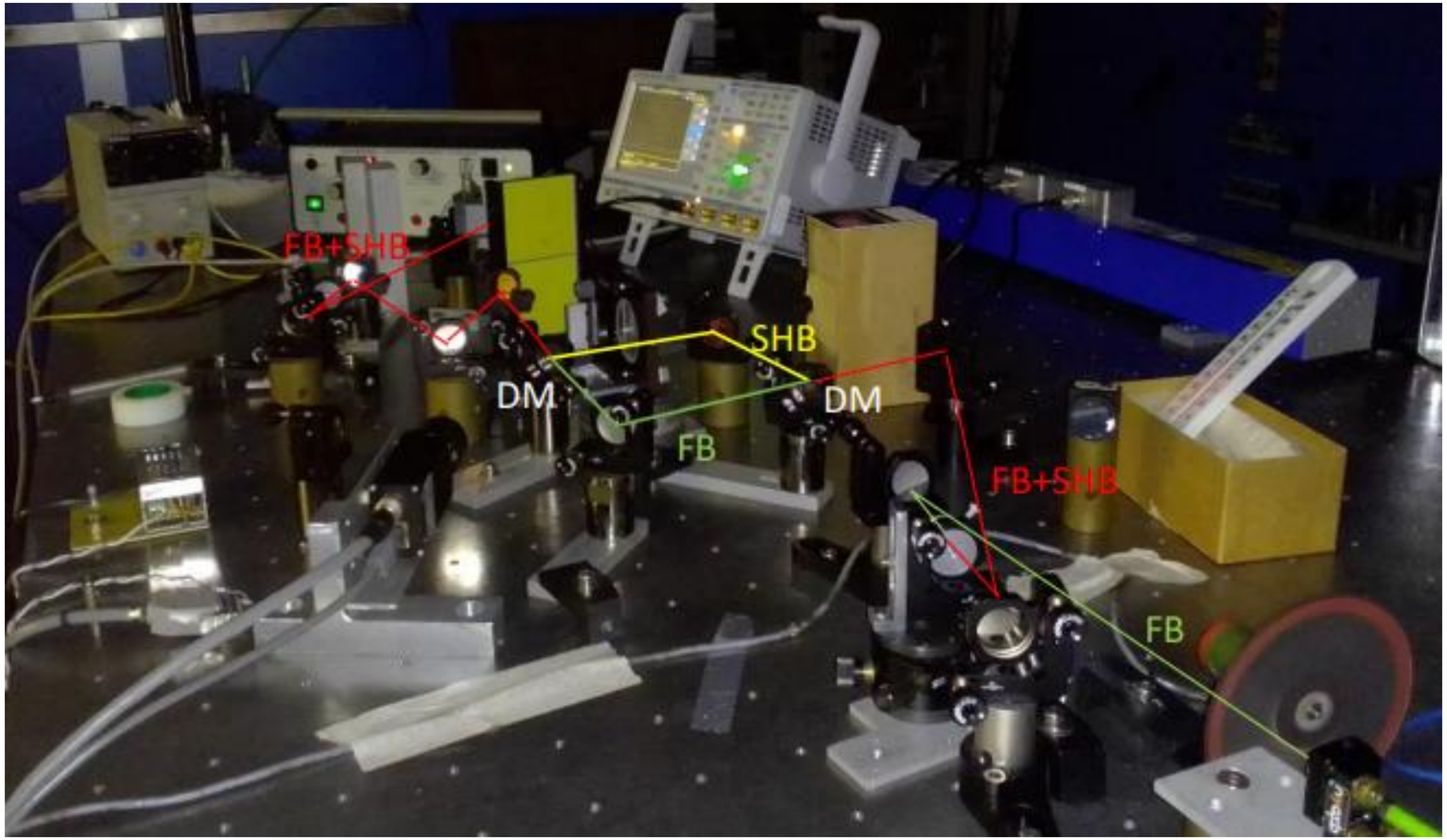


Set 38
OPD~40 cm

Tangential dispersion interferometer-2023 work-III

Experimental tests: check if the observed issues were related to a lack of coherence introduced by the non-linear crystals or were due to the optical path difference (OPD). Comparison of three homodyne configurations.

D. Fiorucci

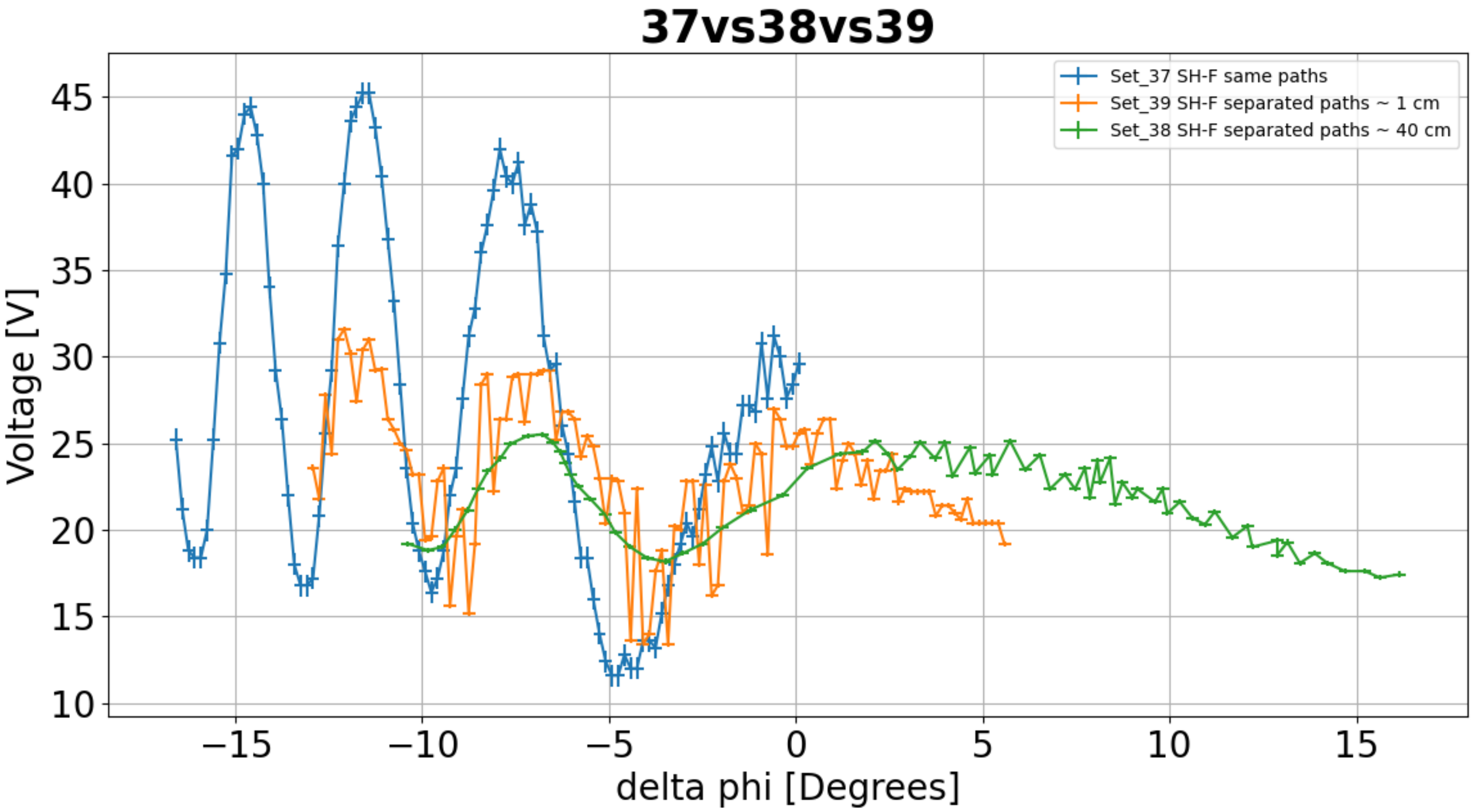


Set 39
OPD~1 cm

Tangential dispersion interferometer-2023 work-IV

Experimental tests: check if the observed issues were related to a lack of coherence introduced by the non-linear crystals or were due to the optical path difference (OPD). Comparison of three homodyne configurations.

D. Fiorucci

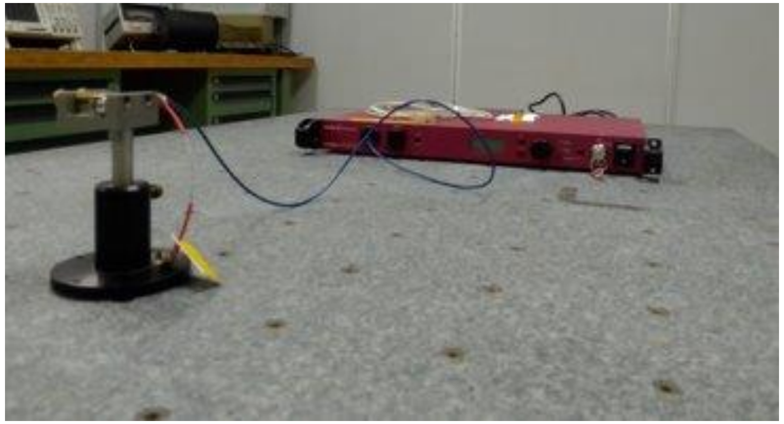


Probably the observed issues are due to misalignment problems

Tangential dispersion interferometer-2023 work-V

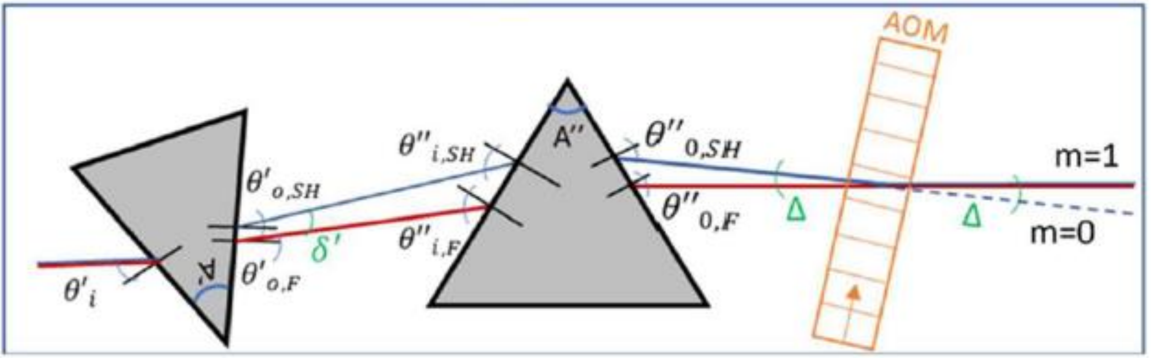
Realization of a full-scale dispersion interferometer: different heterodyne configurations will be tested

- Purchase of laser+collimator and their tests
- Purchase of protection glasses and IR beam viewer
- Purchase of an optical bench for the dispersion interferometer



Laser Koheras ADJUSTIK HP E15 & 1550 nm, f = 8.18 mm, NA = 0.49 FC/APC Fiber Collimation

- Optics to realize a heterodyne dispersion interferometer with prisms will be bought in the next months



D. Fiorucci, A. Fassina, M. La Matina., Feasibility study of an enhanced heterodyne dispersion interferometer, 2023_JINST_18_C02057

Tangential dispersion interferometer-2023 work-VI

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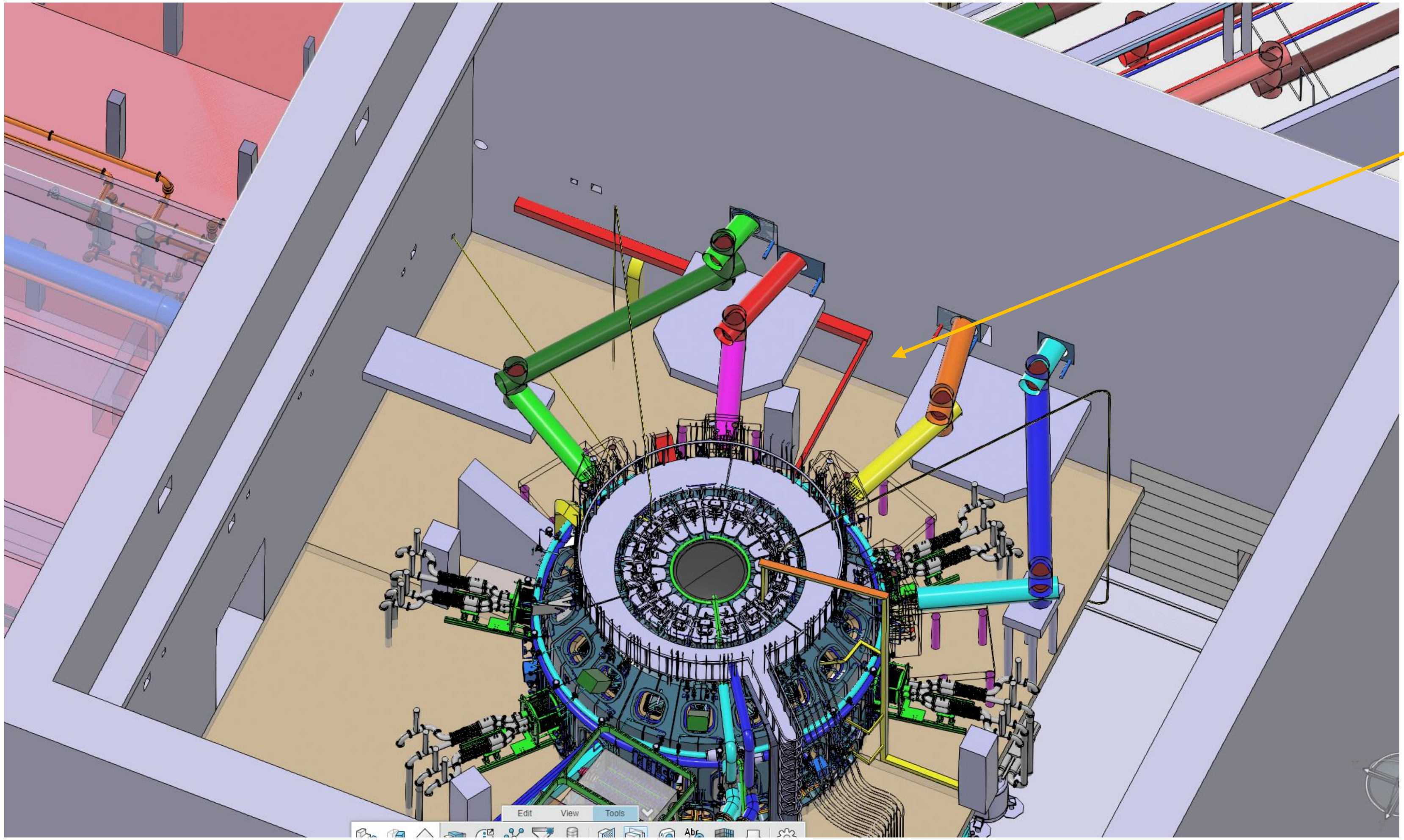


- Laser beam path space in the tokamak hall has been allocated
- Definition of the exact optical path length to calculate the focusing optics
- Optical bench design outside the tokamak

Problems with the design activities are highlighted which are due to the 3D experience transition

D. Fiorucci, A. Fassina, V. Orsetti

Tangential dispersion interferometer-2023 work-VII

Critical Optical Components: analysis of the required electronic components to align the systems

Data acquisition: Signal detection and acquisition

Deliverables 2023:

- ✓ June 2023: cost estimate of the diagnostics;
- ➢ December 2023: conceptual design;
- ➢ December 2023: construction planning.

Vertical interferometer polarimeter-I

Chosen wavelength for the measurement laser 119 um (compromise between space availability, beam dimensions, expected signals and plasma refraction)

Vibration compensation laser:

1. Commercial FIR methanol laser at 96.5 um (wavelength very close to the measurement laser)
2. Quantum cascade 50 um (it is not a commercial system yet)
3. CO_2 laser (very different wavelength, problems due to optics damages and vibrations);

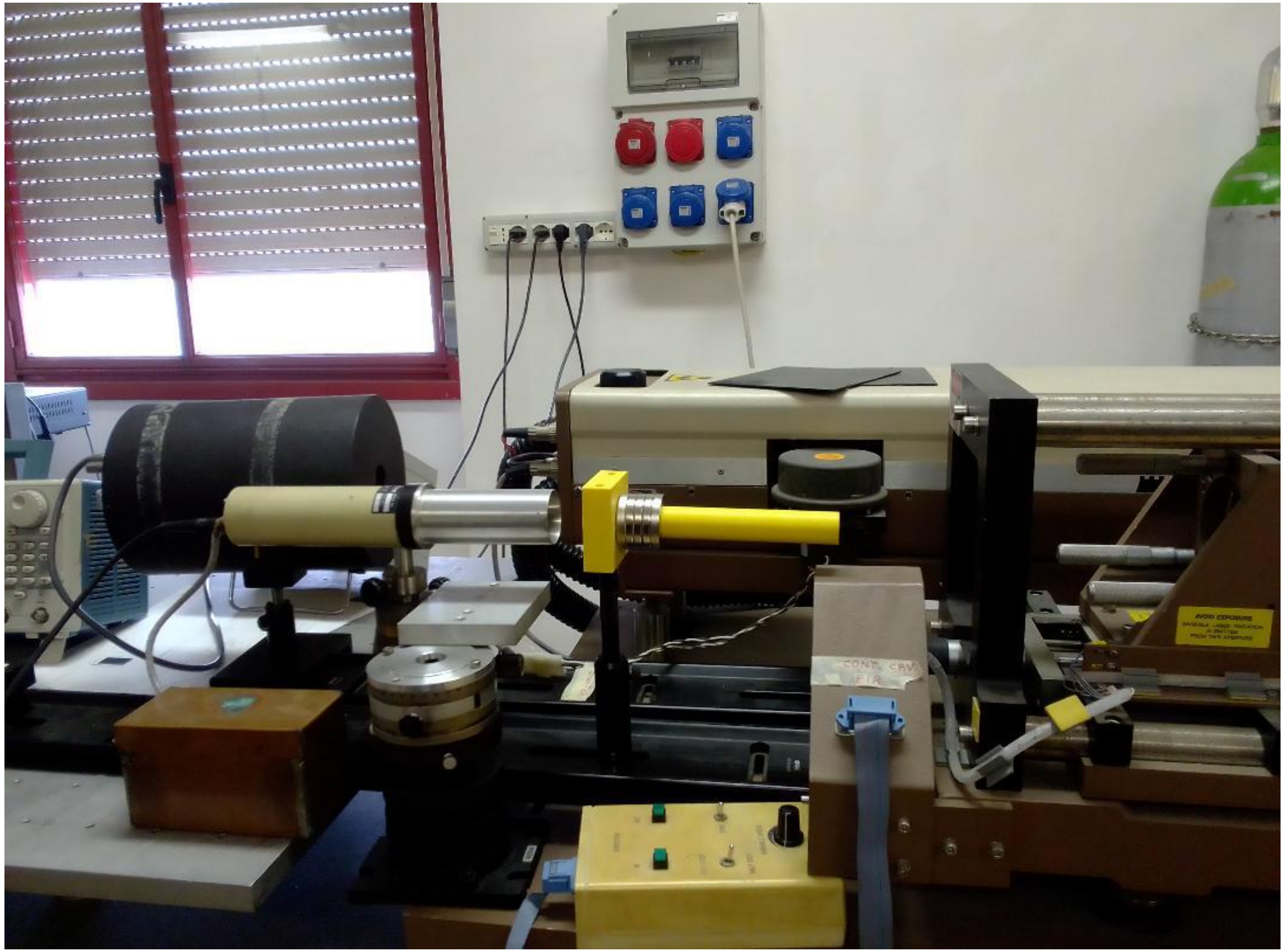
4. Internal development of H_2O laser (possible wavelengths 28, 47, 79, 119, 220 um)

Vertical interferometer polarimeter-II

Interferometer optical scheme: Michelson vs Mach–Zehnder

- SiC cristal was tested, but it seems that it cannot work for a FIR Faraday isolator, still SiC can be used for the windows (A. Doria, M. Alonzo, D. Fiorucci, A. Fassina).

The problem of the laser beam coming back towards the laser seems not to affect other experiments, so there should not be problems. Other materials could also be used (e.g. ferrite), if issues will appear.

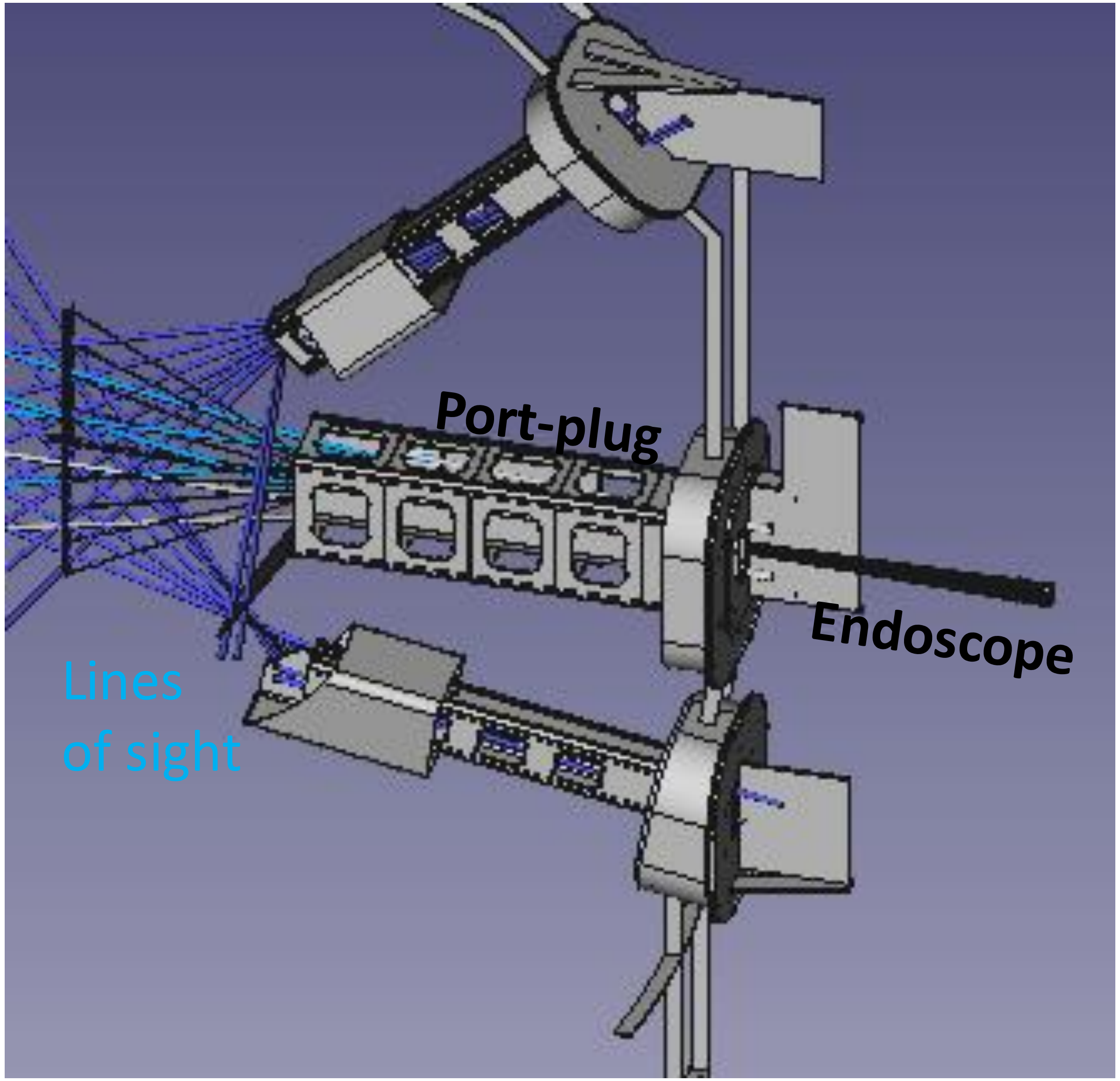


Vertical interferometer polarimeter-III

Chords: analyses performed with VMEC and V3FIT codes show that lines of sight from port 2 and port 4 are required to get enough information (D. Terranova). However, to cover the central part of the plasma, we also added lines of sight from port 3.

A possible scheme for the port-plug was also presented (A. Fassina)

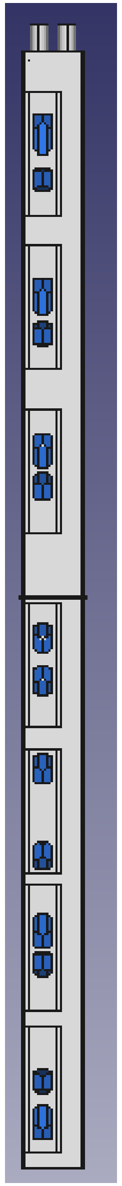
An endoscope for the corner cube inspection was designed (A. Fassina)

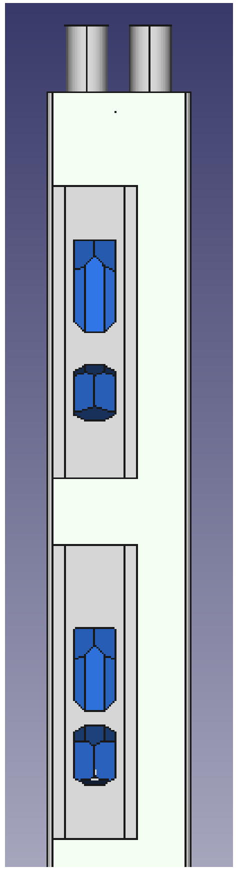


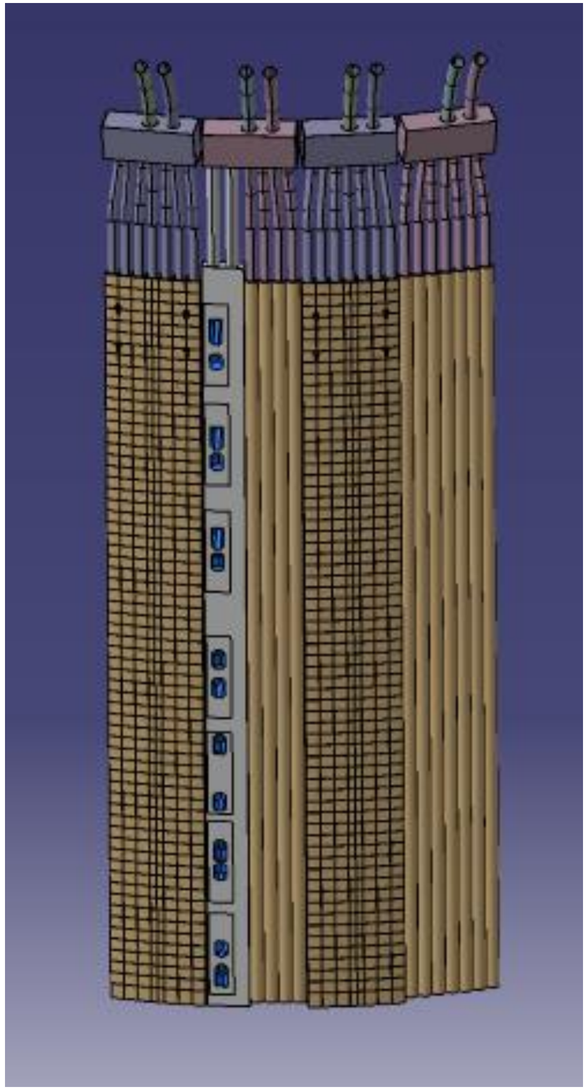
Vertical interferometer polarimeter-IV

Corner Cube design (A. Fassina, O. Tudisco, V. Orsetti, D. Fiorucci)

Under consideration: the possibility of rotating the first wall of 5 degrees.







Vertical interferometer polarimeter-V

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Path from the laboratory to the sector and port of the diagnostics (activity delayed due to to the 3D experience transition)

D.Bonomi
(Promech)

Vertical interferometer polarimeter-VI

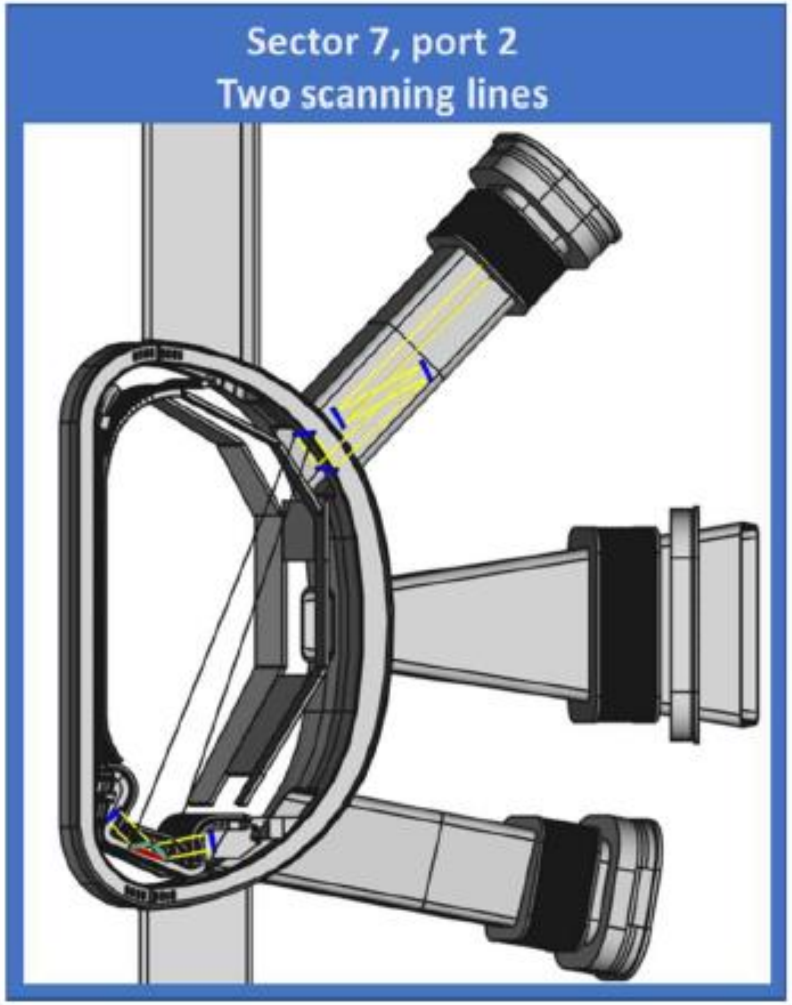
- Critical Optical components: Corner cubes design and issues **, alignment system components.**

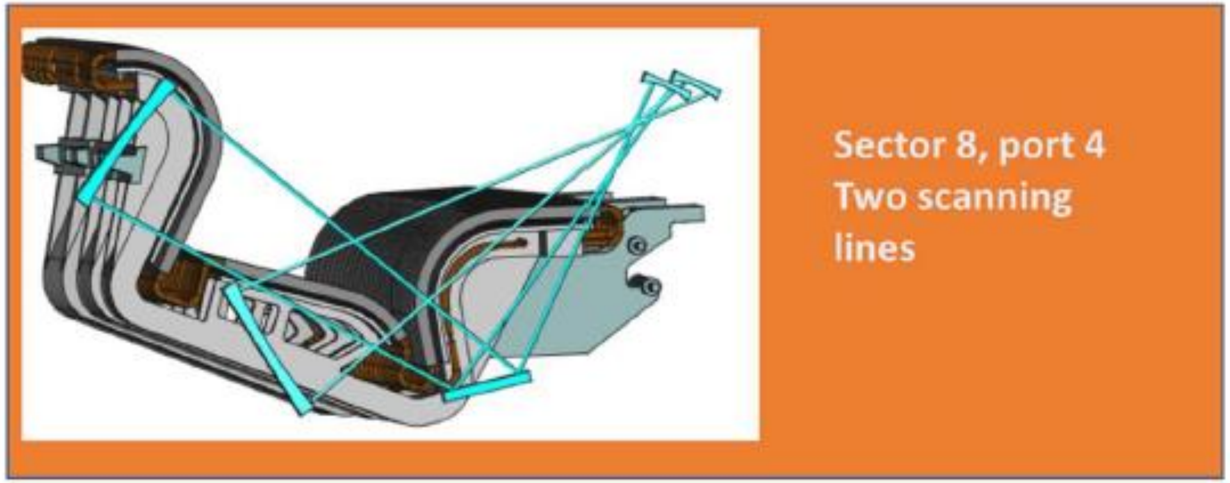
- **Signal detection and acquisition**

Deliverables 2023:
December 2023: Corner Cube design;
December 2023: advances in the optical scheme

Divertor scanning dispersion interferometer-Previous work

Baseline choice for the wavelength: 10.6 um



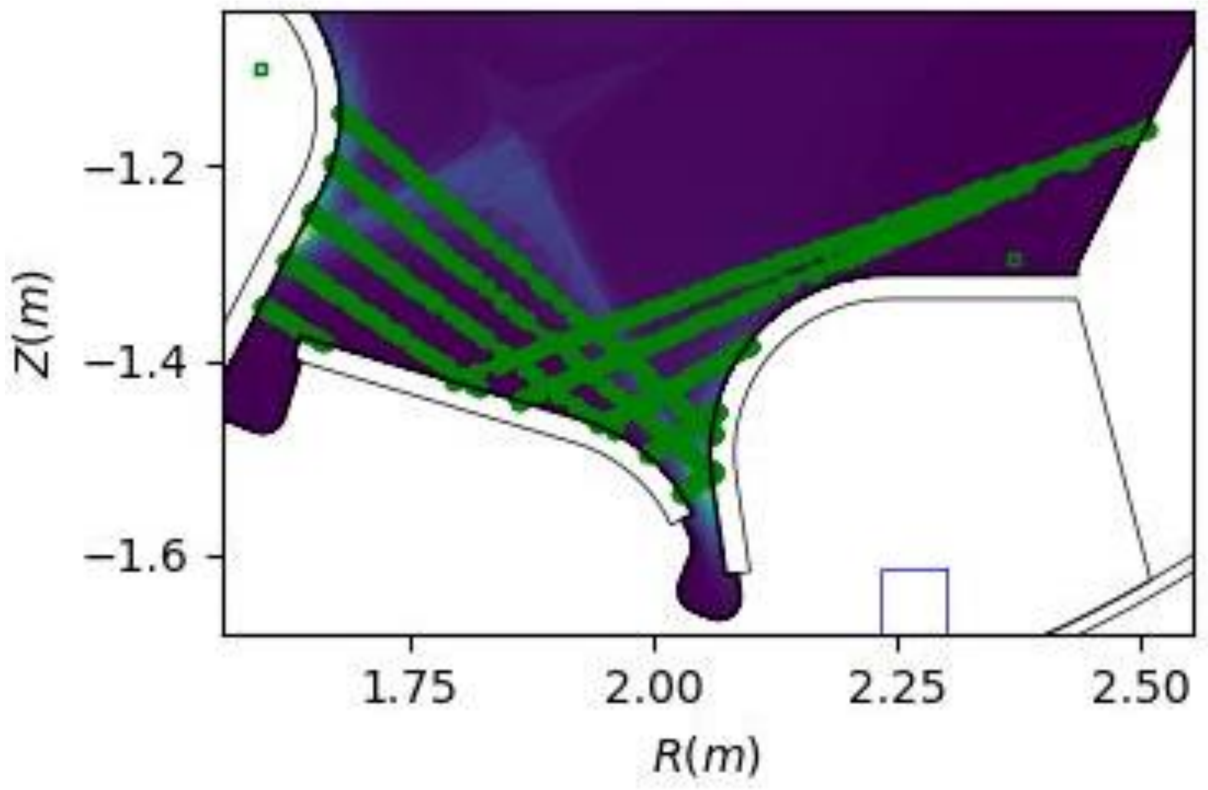


P. Innocente, D. Fiorucci, A. Fassina

Divertor scanning dispersion interferometer-2023 work-I

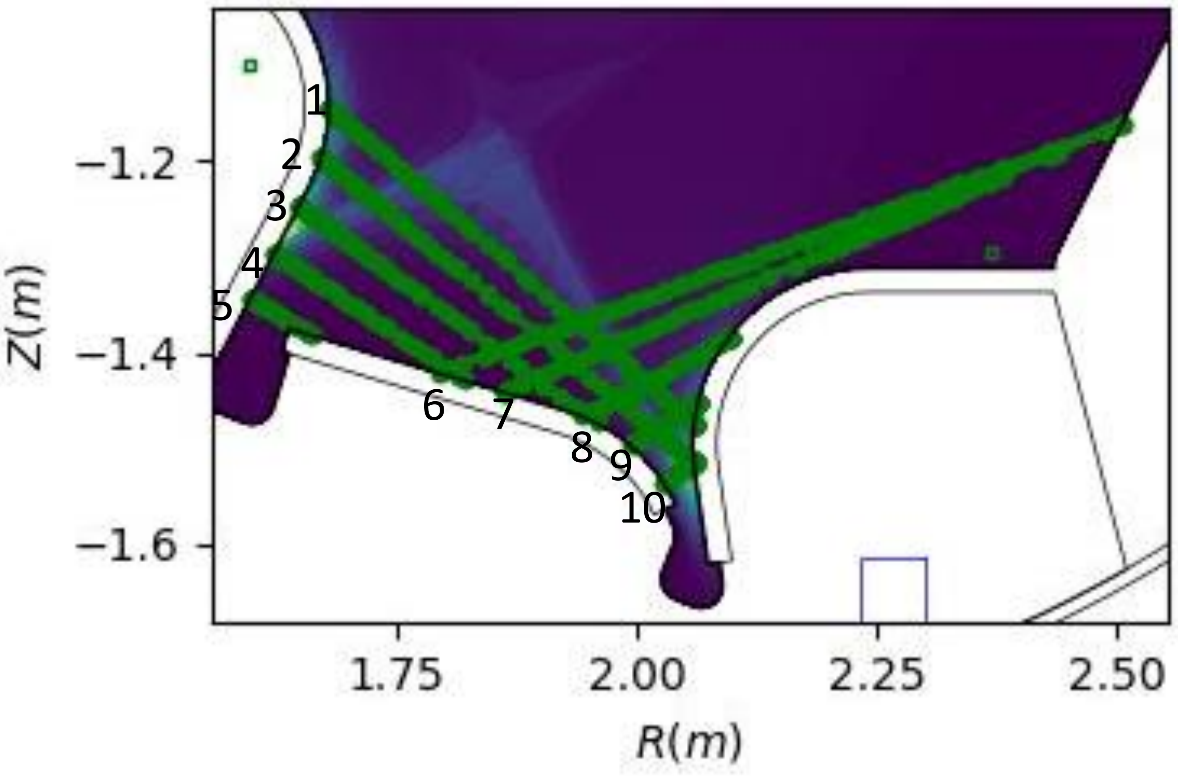
- The solution with launching optics from port 4 (sector 8) was analyzed and it seems a good solution, better than the one from port 2 (sector 7) for the space availability close to the divertor

The divertor is still not in its final design



P. Innocente

Divertor scanning dispersion interferometer-2023 work-II

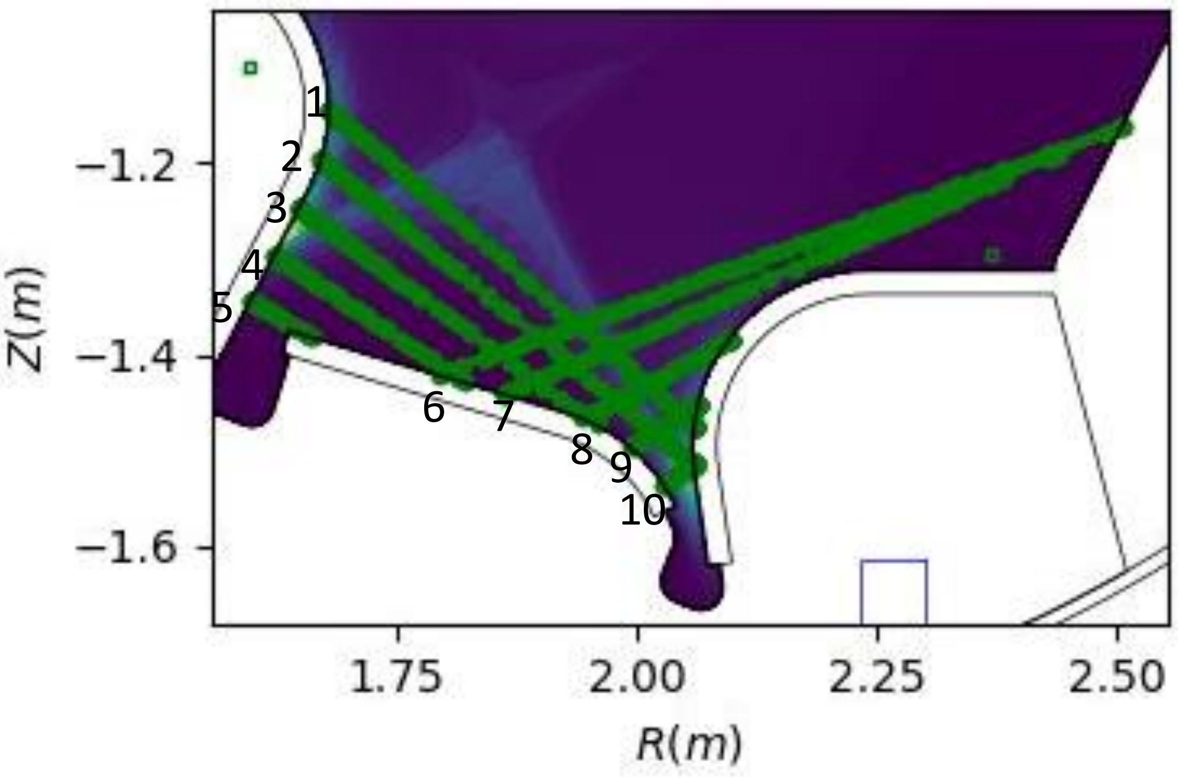


P. Innocente

Chord number	Line integrated density m^{-2}
1	3.5536481e+20
2	3.5361327e+20
3	1.4361118e+20
4	3.7079249e+19
5	2.6820641e+18
6	9.4375283e+19
7	1.0152385e+20
8	9.3072185e+19
9	9.2394071e+19
10	1.0377168e+20

SN, D puffing from equatorial plane, full power with Ne seeding,separatrix density 7.5e19 m^{-3}

Divertor scanning dispersion interferometer-2023 work-III

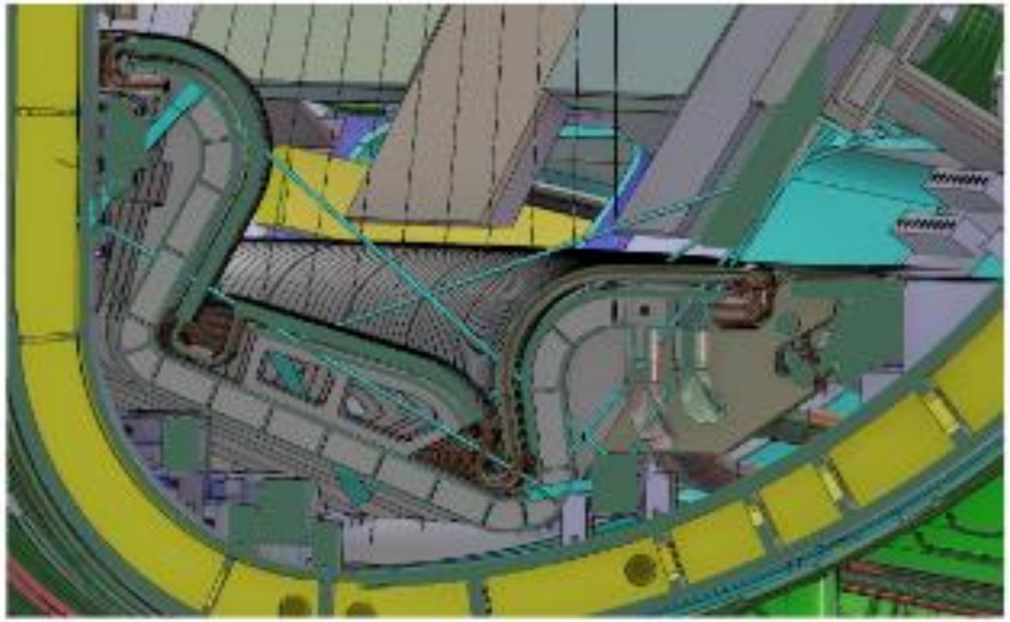


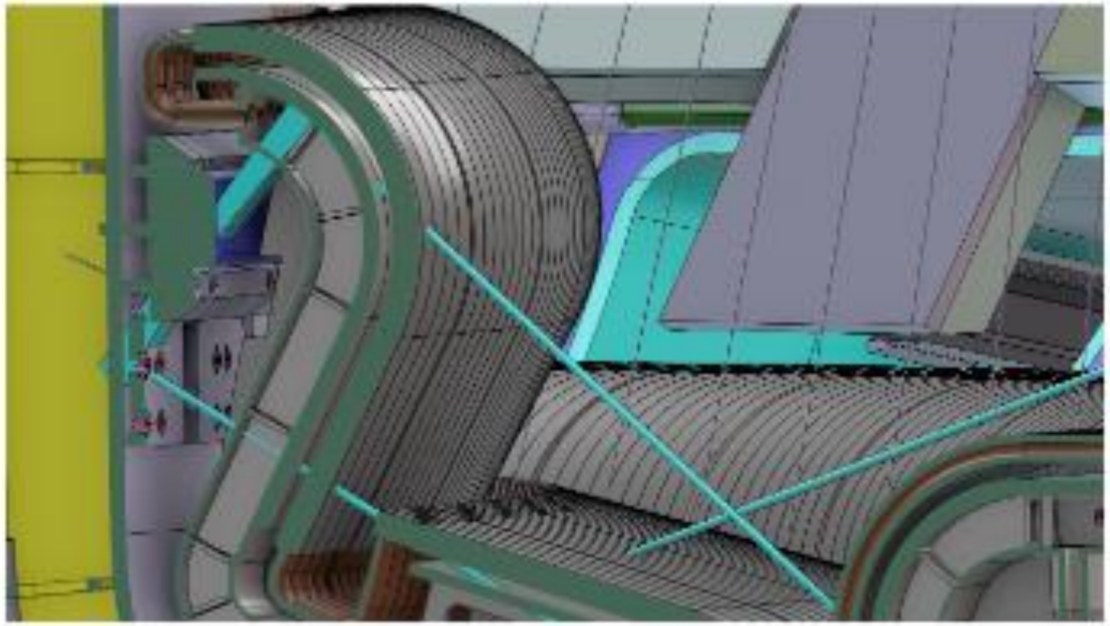
Chord number	Line integrated density m^{-2}
1	4.4433597e+20
2	4.6542580e+20
3	1.8576323e+20
4	4.2173202e+19
5	2.3630533e+18
6	9.2054151e+19
7	8.6425901e+19
8	8.9963912e+19
9	1.3891747e+20
10	1.2071856e+20

P. Innocente

SN, D puffing from dome, full power with Ne seeding,separatrix density 8.6e19 m^{-3}

Divertor scanning dispersion interferometer-2023 work-IV





D. Bonomi (Promech)

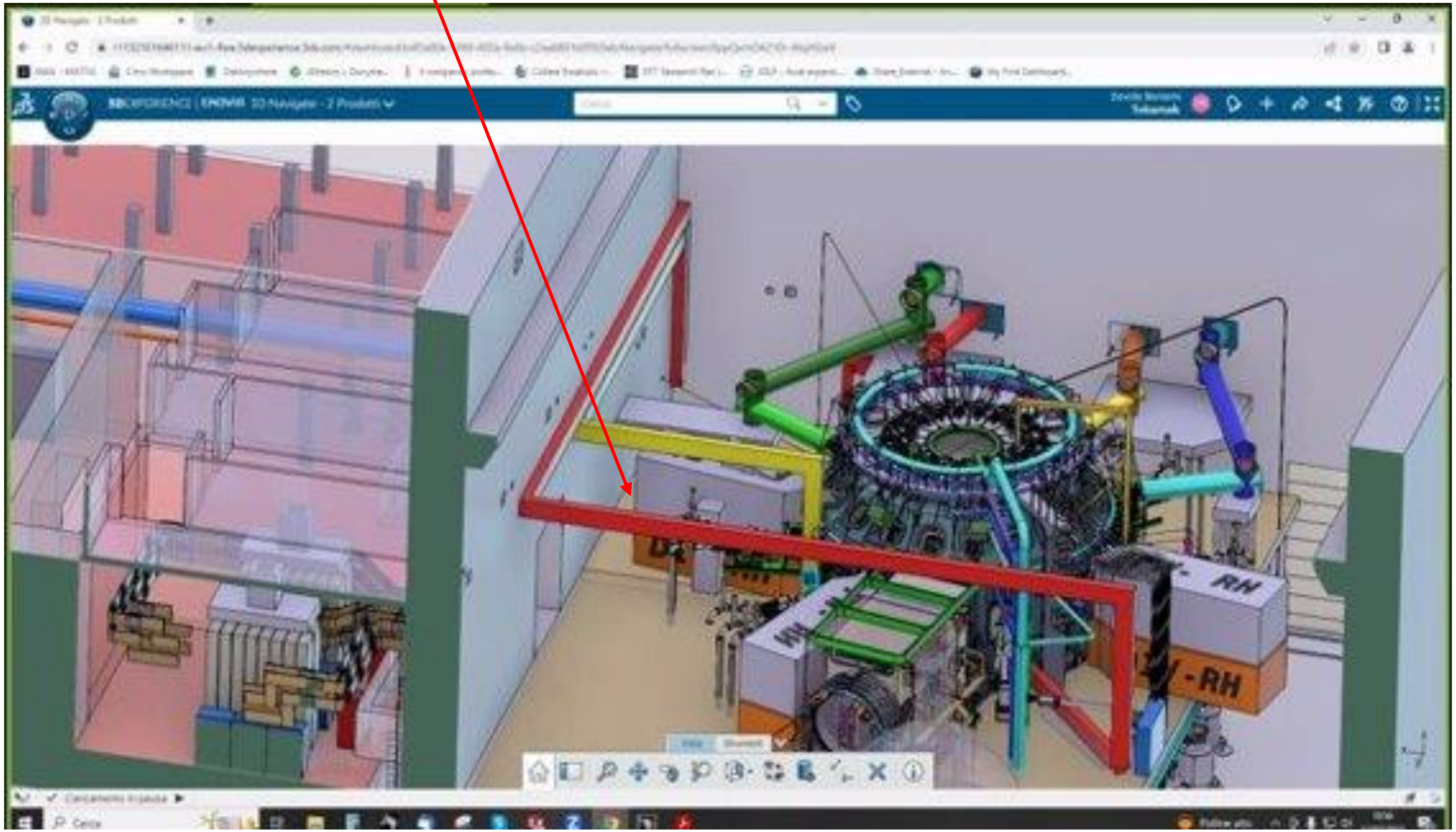
When integrating the design in the main cad, we found interferences, so we are currently trying to reduce the required space. However, since the design of the divertor is going to be changed, we'll wait for the new design of the divertor to continue the detailed aspects of this work.

Divertor scanning dispersion interferometer-2023 work-V

Path from the laboratory to the sector and port of the diagnostics (activity delayed due to to the 3D experience transition)

This is only a preliminary design

D. Bonomi (Promech)



Divertor scanning dispersion interferometer-2023 work-VI

Deliverables 2023:

December 2023: critical aspects in the space availability for the mirrors close to/under the divertor;

December 2023: advances in the optical scheme.

Conclusions: highlighted points

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DAY0

Tangential dispersion interferometer: both experiemntal and design activities are carried out. A prototype of the system will be realized in order to tests different heterodyne configurations.

DAY1

Vertical interferometer/polarimeter: both experimental and design activities are carried out. A first design for the Corner Cubes has been realized. The optical benches for the three ports of sector 3 have been designed.

Divertor scanning dispersion interferometer: the solution exploiting port 4 of sector 8 has been analyzed and it seems to work. Further studies are required since interference issues are present.