



**ESS**  
bilbao

# MIRACLES

Workshop for neutron optics and instrument shielding

## Consorcio ESS-BILBAO

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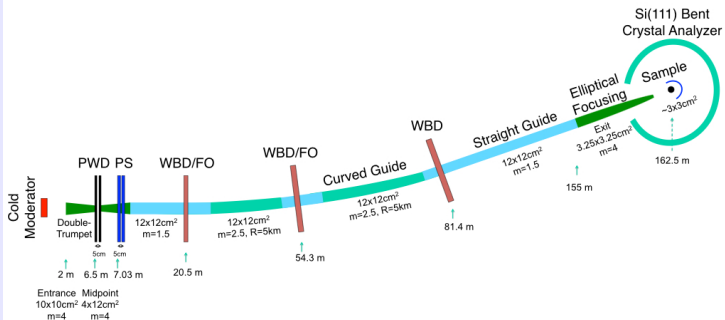
# MIRACLES

## General overview (according to proposal, not definitive)

- TOF backscattering spectrometer.
- Located in W5 (between MAGIG and BIFROST).
- Now in review process (proposal based on TDR moderator).
- **Primary spectrometer:**  $L=162.5$  m, 7 choppers (2 PWD + 2 PS + 2 WBD/FO + 1 WBD). The majority of the guide is  $12 \times 12$  cm, with the exception of a double trumpet at the beginning of the instrument and a focusing guide at the end of the primary spectrometer.  $m$  is 4 in the first and last guide section, 3 in the diverging guides after G1, 1.5 in the straight guide sections and 2.5 in the curved guide sections.
- **Secondary spectrometer:** near-backscattering, spherical Si analyser with  $R=2,5$ , radial collimator, Be filter,  $He^3$  detectors.
- Sample size from  $1 \times 1$  to  $3 \times 3$  cm.
- Variable energy resolution at the expense of flux.

# Initial Concept

Proposal. 2015. Heloisa, Nikolaos, Marton, Ruep.



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TABLE I. Technical specifications of the MIRACLES chopper cascade.

Component	Position (mm)	Nominal Frequency (Hz)	Maximum Frequency (Hz)	Slit Opening s (")	Slit Locations (")	Chopper Disk Diameter (mm)	Chopper Window Height (mm)
Moderator	0	14	14	-	-	-	100
Ch1, PWD	6500	252	252	7.95 & 40	0,90,180,270	700	124
Ch2, PWD	6550	-252	-252	7.95 & 40	0,90,180,270	700	124
DCh3, PS	7030	28	56	14.3	0	700	124
Ch4, PS	7080	-28	-56	14.3	0	700	124
Ch5, FO/WBD	20100	14	56	48.99	0	700	124
Ch6, FO/WBD	53800	14	56	129.65	0	700	124
Ch7, WBD	80500	14	56	163.93	0	700	124
Sample	162500						
Analyzer	165000						
Detector	167250						

# Initial Concept

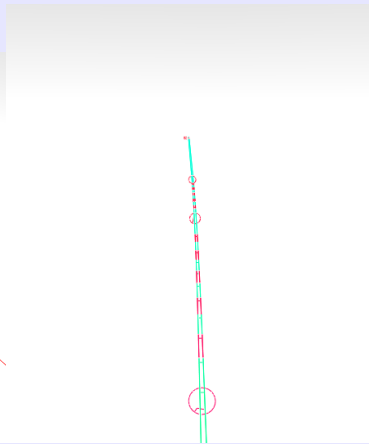
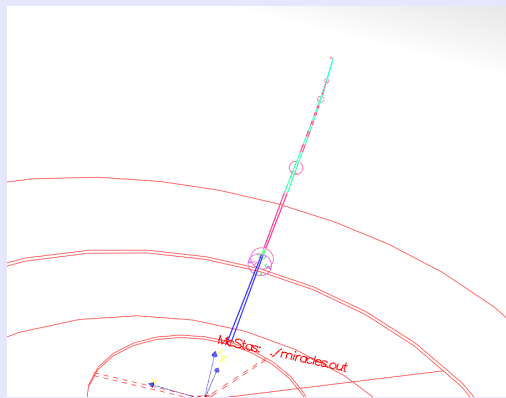
Proposal. 2015. Heloisa, Nikolaos, Marton, Ruep.

Length (m)	Type	Cross section (cmxcm)	m-coating
4.5	Linear, converging in the horizontal plane and diverging in the vertical plane	10x10→4x12	4
0.5	Straight between the PWD choppers	4x12	3
0.47	Linear diverging in the horizontal plane between the PS choppers	4x12→6.19x12	3
6.35	Linear diverging in the horizontal plane	6.19x12→12x12	3
7.1	Straight	12x12	1.5
25	Curved (R=5km)	12x12	2.5
8.78	Straight	12x12	2.5
20	Curved (R=5km)	12x12	2.5
7.11	Straight	12x12	2.5
74.1	Straight	12x12	1.5
6.725	Elliptical focusing	12x12→3.25x3.25	4

Brilliance transmission optimized with this design. Checked and optimized by guide-bot.

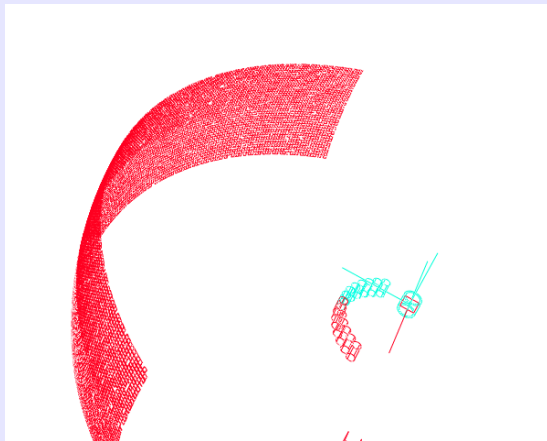
# Initial Concept

Proposal. 2015. Heloisa, Nikolaos, Marton, Rued.



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# Initial Concept

## Beam requirements (according to proposal)

- Transport a wavelength band range above 2 Å.
- Sample size = 1x1-3x3 cm<sup>2</sup>. Review process.
- Divergence at sample position:  $\pm 2,5^\circ$ . Review process.

## Other requirements

- Low background. E.g. SPHERES has SNR > 1700:1
- $Si_{111}$  [6,27 Å] is the main mode of the instrument, and the only analyser in the first version of the instrument.
- $Si_{333}$  [2,08 Å] could be used with the same analyser (in study process). The idea **in this moment** is to build a guide that allow to use this mode.
- $Si_{311}$  [3,27 Å] is in principle a future update of the instrument. The idea is to build a guide that allow to use this mode in a future update.
- Nevertheless this has to be decided in the next months (with numbers of cost of the guide if it works to one mode or both).



# Current state of the project

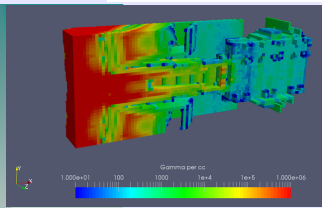
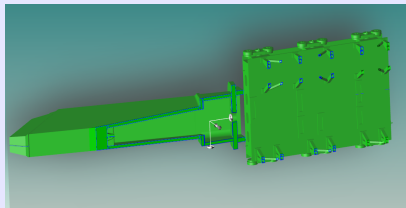
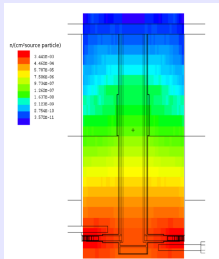
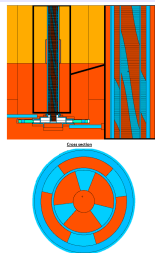
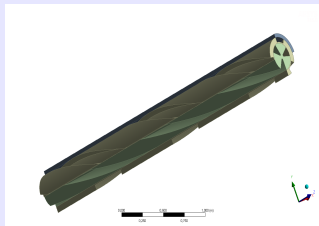
## MIRACLES team and roughly roles.

- Javier Bermejo. Scientific responsible.
- Iñigo Herranz. Engineering responsible. Neutronic and simulations.
- Supporting activities: ESS Bilbao Target and Neutronic Applications Group.
- Paula Luna, Jorge Villamor. Mechanical design and CAD.
- Fernando Sordo. Management and coordination.
- Miguel Magán, Tomás Mora. Shielding design.
- Heloisa Bordallo. Previous responsible of the project. Collaboration with the team in phase 1, sample environment development, MD integration.
- Other collaborations not decided yet.

# Current state of the project

ESS Bilbao Target and Neutronic Applications Group.

## Experience in shielding design



# Changes in ESS that affect MIRACLES

## New moderator

- Proposal according to old moderator (12x12 cm).
- Current moderator: Butterfly, 3 or 6 cm height.

## (New) beamport

- MIRACLES will be located at W5.
- This changes the orientation with which the instrument see the cold part, and consequently, the divergence profile at the guide entrance.

## New first chopper position

- According to the proposal, CH1 position was positioned at 6.5m from moderator.
- CH1 will be, in principle, positioned at 7.0m from moderator.

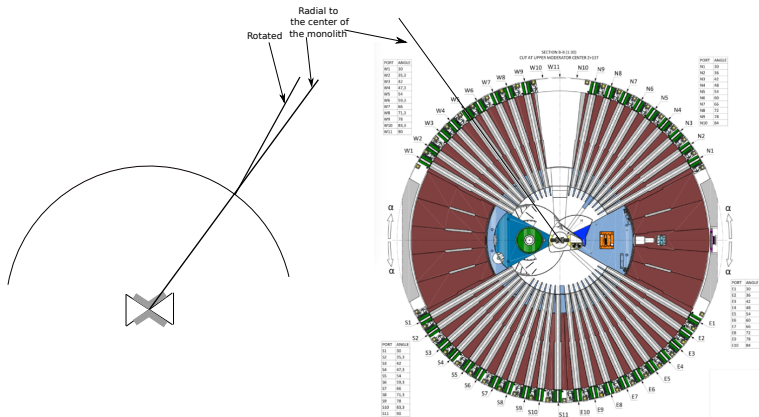
# Redesign of MIRACLES Primary spectrometer

## Working plan (in progress). Main aspects to review

- Study of the performance of the ESS Butterfly moderator on MIRACLES.
- Orientation of the whole instrument (simulation optimum vs physical restrictions).
- Review of the guide cross sections.
- Review of the  $m$  distribution: possibility of reducing  $m$  in some sections, and increasing  $m$  in the last one.
- Choice between s-c-s-c-s or s-c-s guide.
- Review of curvatures if  $m$  and guide width change.
- Redesign of the PWD pair + PS pair.
- Chopper cascade. CH5, CH6, CH7 position and slit opening.

# Redesign of MIRACLES Primary spectrometer

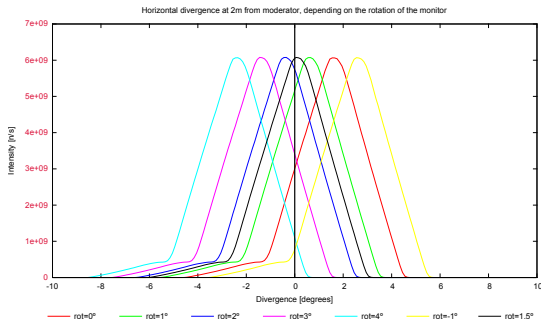
## Rotation of the first guide



# Redesign of MIRACLES Primary spectrometer

## Rotation of the first guide

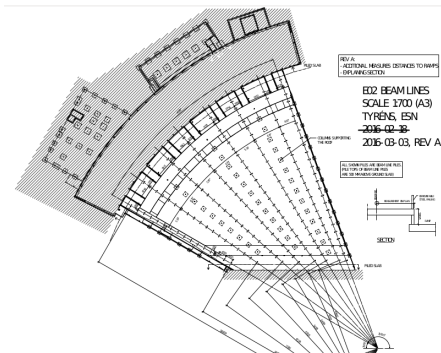
- The rotation of the instrument seems to have large influence in its performance.
- From a simulation point of view, a certain rotation is favorable in terms of horizontal divergence at the guide entrance, and consequently, in terms of transport efficiency.



# Redesign of MIRACLES Primary spectrometer

Review of guide parameters. Aspects with influence on shielding.

- Maintain the guide within the available space and piling corridors vs neutronic aspects/shielding as the criteria to choose the curvature of the guides, and at which distance the instrument lose the direct view of sight.



# Redesign of MIRACLES Primary spectrometer

## Review of guide and choppers parameters. Aspects with influence on shielding.

- Changes in guide sections (specially reduction in height) since the moderator has changed from the proposal. In review process.
- Possibility of just one curved guide section (s-c-s instead of s-c-s-c-s-c). This decision is influenced by neutronic aspects and also engineering restrictions.
- Possibility of reducing the m in the intermediate part of the guide.
- Possibility of increasing m in the last (focusing part of the guide).
- Position of last chopper (80 m of cleaner beam vs tuning the beam closer to the sample). Possibility of additional chopper at the end of the primary spectrometer as an upgrade.



## Other topics to discuss.

Some of these topics are related with NOSG document.

- Maximum  $m$  allowed in the first guide section (degradation of guides).
- Maximum  $m$  on inside and outside curved surfaces.
- Where do we need to use metallic substrate?.
- Is it necessary to use copper in the first guide section?.
- Where do we need to lose direct vision?.
- Shielding design methodology.