



Cristina González Torres  
ESRF - The Measurements of the Storage Ring  
IWAA, 7-11 October 2024

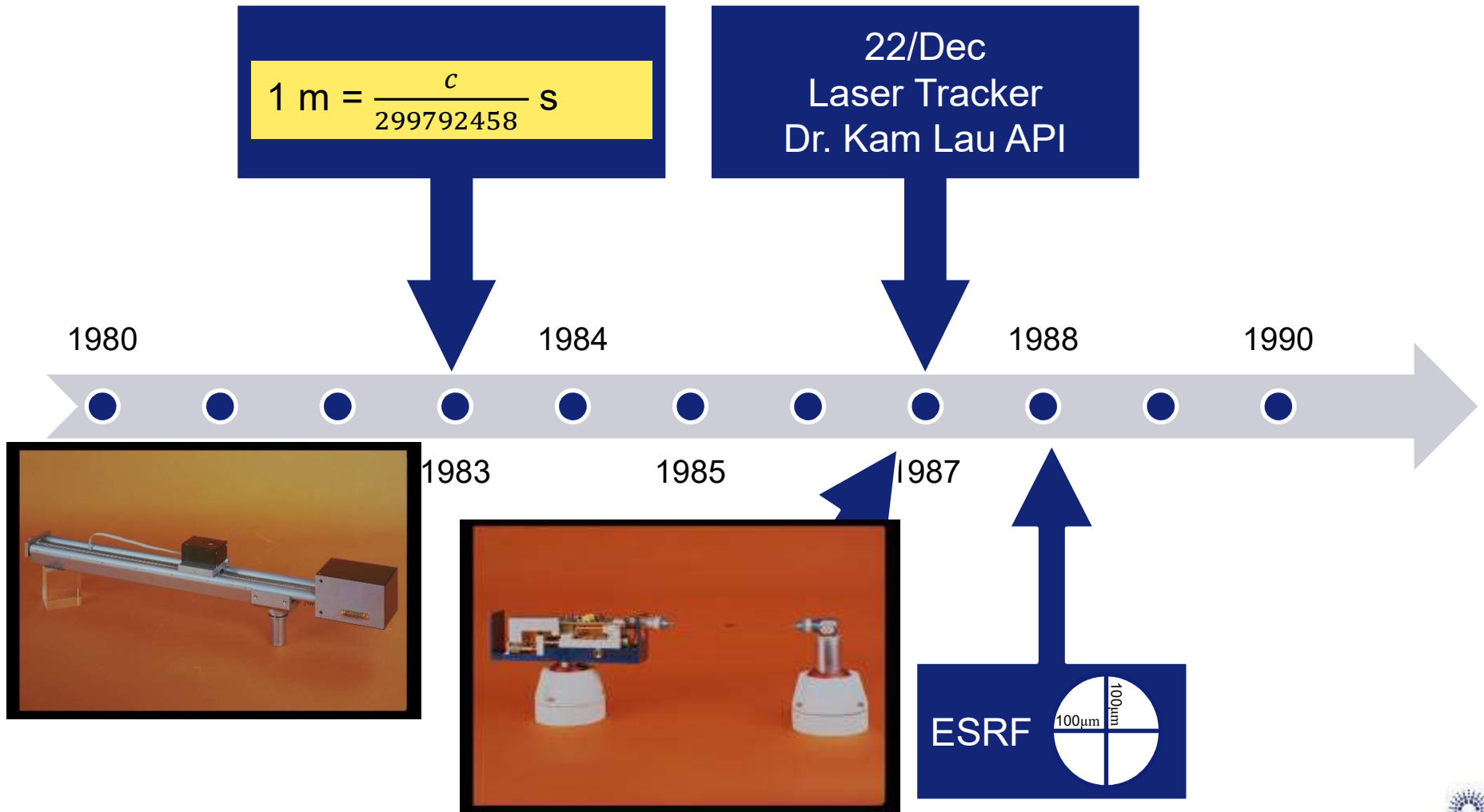
# ESRF-INTRODUCTION



BEAMLINE	DESCRIPTION	STATUS
ID01	Nano/Micro-diffraction Imaging Beamline	OPEN
BM01	Swiss-Norwegian Diffraction and Crystallography CRG Beamline (SNBL-I)	OPEN
ID02	Time-Resolved Ultra Small-Angle X-Ray Scattering Beamline	OPEN
BM02	French Anomalous Diffraction and SAXS/WAXS CRG Beamline (D2AM)	OPEN
ID03	<b>New Beamline</b> EBSL Hard X-ray Microscopy Beamline	Opening 2023
BM05	X-ray Imaging Beamline	OPEN at 50%
ID06-HXM	<b>New Beamline (moves to ID03 in October 2022)</b> Hard X-ray Microscopy Beamline	CLOSED
ID06-LVP	Large Volume Press Beamline	OPEN
BM07	French Biological Macromolecules Diffraction CRG Beamline (FIP2-BM07)	OPEN
BM08	Italian X-ray Absorption and Spectroscopy CRG Beamline (LISA)	OPEN
ID09	Time resolved Structural Dynamics Beamline	OPEN
ID10	Soft Interfaces and Coherent Scattering Beamline	OPEN
ID11	Materials Science Beamline	OPEN
ID12	Circular Polarisation Beamline	OPEN
ID13	Microfocus Beamline	OPEN
BM14	Dutch-Belgian Spectroscopy CRG Beamline (DUBBLE-II)	OPEN at 50%
ID15A	Materials Chemistry and Materials Engineering Beamline	OPEN
ID15B	High Pressure Diffraction Beamline	OPEN
ID16A	Nano-Imaging Beamline	OPEN
ID16B	Nano-Analysis Beamline	OPEN
BM16	French Absorption Spectroscopy CRG Beamline (FAME-UHD)	OPEN
ID17	Biomedical Beamline	CLOSED
ID18	Nuclear Resonance Beamline	OPEN
BM18	<b>New Beamline</b> EBSL Imaging Beamline. Samples limited to maximum 30 kg / 30 cm (until March 2023)	OPEN
ID19	Microtomography Beamline	OPEN
ID20	Inelastic Scattering I Beamline	OPEN
BM20	The Rossendorf Beamline (ROBL)	OPEN
ID21	X-ray Micro spectroscopy Beamline	OPEN
ID22	High Resolution Powder Diffraction Beamline	OPEN
ID23-1	Structural Biology MAD Beamline	OPEN
ID23-2	Structural Biology Microfocus Beamline	OPEN
BM23	X-ray Absorption Spectroscopy Beamline	OPEN
ID24	High Brilliance X-ray Absorption Spectroscopy • Energy Dispersive XAS branch and on-line HPLF (High Power Laser Facility) • Scanning XAS branch	OPEN
BM25	Spanish Spectroscopy and Diffraction CRG Beamline (SpLine)	OPEN
ID26	X-ray Absorption and Emission Spectroscopy Beamline	OPEN
BM26	Dutch-Belgian SAXS/WAXS CRG Beamline (DUBBLE-I)	OPEN at 50%
ID27	High Pressure Beamline	OPEN
ID28	Inelastic Scattering II Beamline	OPEN
BM28	UK Materials Science CRG Beamline (XMAS)	OPEN
ID29	<b>New Beamline</b> EBSL Structural Biology Serial Synchrotron Crystallography (SSX) Beamline	OPEN
BM29	Structural Biology Bio-SAXS Beamline	OPEN
ID30A-1	Structural Biology Mail-in Beamline	OPEN
ID30A-3	Structural Biology Minibeam Beamline	OPEN
ID30B	Structural Biology MAD Beamline	OPEN
BM30	French Absorption and Spectroscopy CRG Beamline (FAME)	OPEN
ID31	Interface and Material Processing Beamline	OPEN
BM31	Swiss-Norwegian XAS and HRPD Beamline (SNBL-II)	OPEN
ID32	Soft X-ray Spectroscopy Beamline	OPEN
BM32	French Surfaces & Interfaces CRG Beamline (IF)	CLOSED until August 2023
Cryo-EM CM01	Structural Biology Single Particle Cryo-Electron Microscope	OPEN

Musique: Color Filter (Sleep in a Synchrotron) 1988

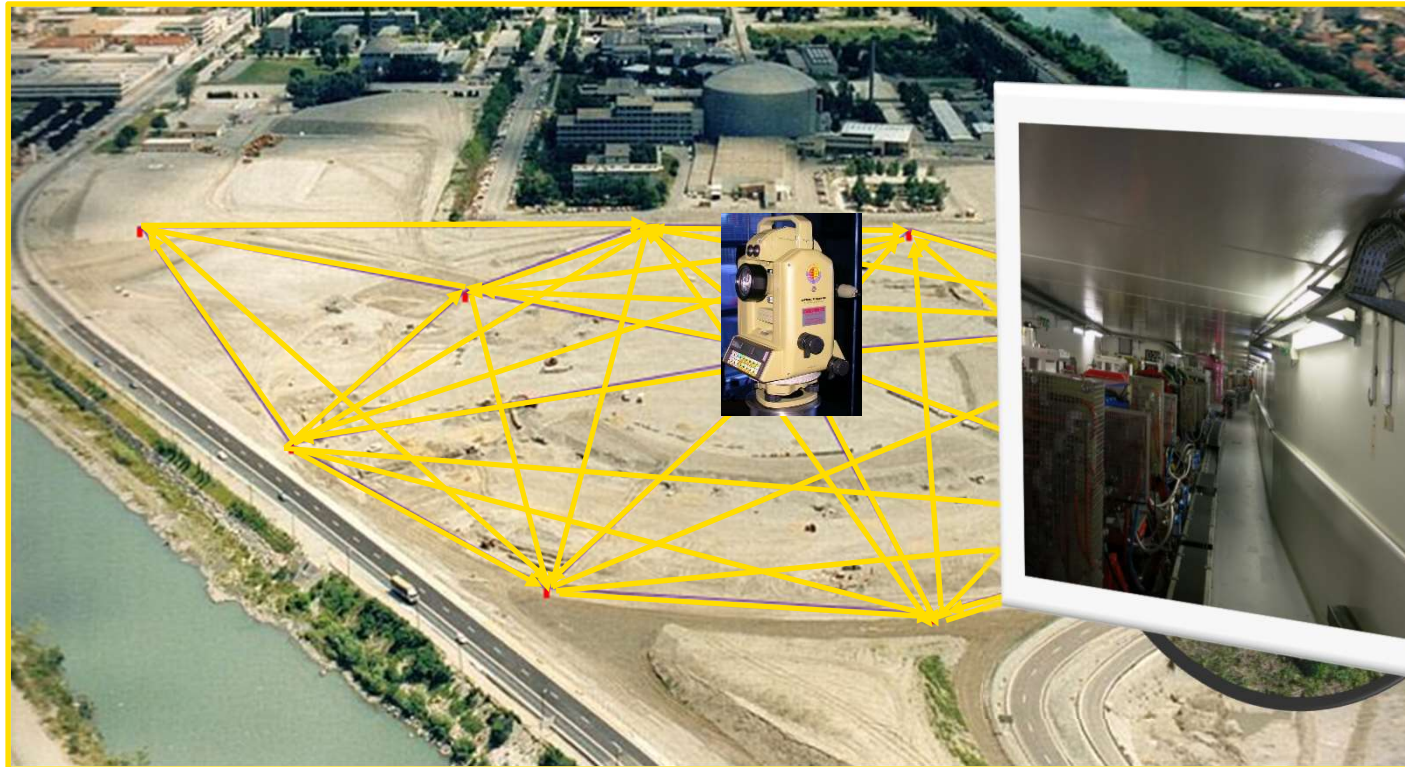
# ESRF-INSTRUMENTS BACKGROUND





# ESRF- INITIAL NETWORK 1990

10 exterior concrete pillars



DI2000 Distancemeter

Cyclic error → Calibration Bench

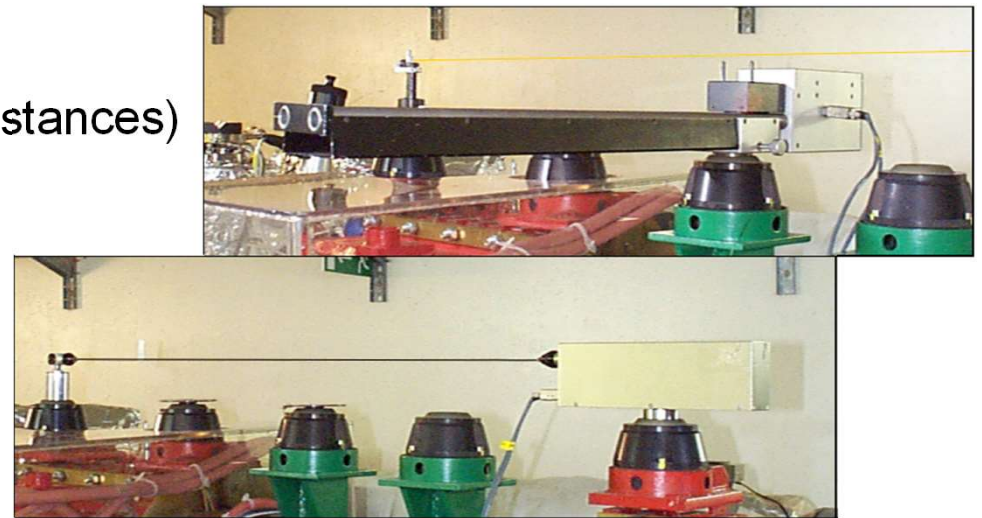
# ESRF- SECONDARY NETWORK 1992

(24 Pillars + 24 articulated wall brackets) SY + (32 pillars + 32 wall brackets) SR + 128 tripod



SR Network → 64 points: 452 measurements

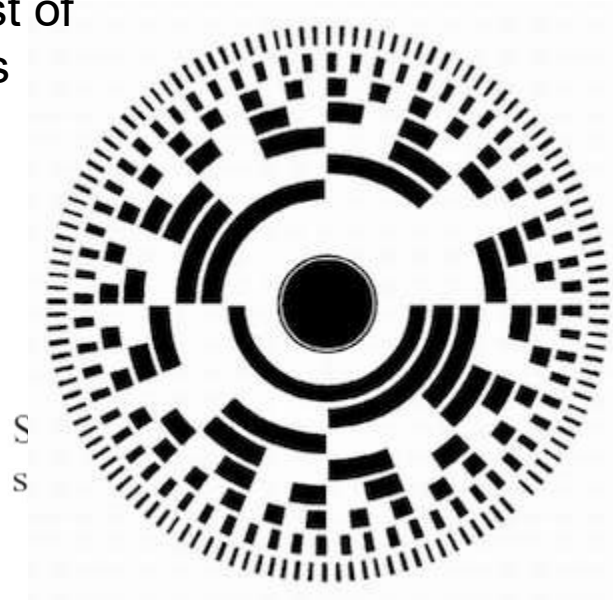
From Secondary Network to machine :  
320 points (480 ecartometer and 760 distances)







Factor of 4 more  
precise than most of  
the laser trackers



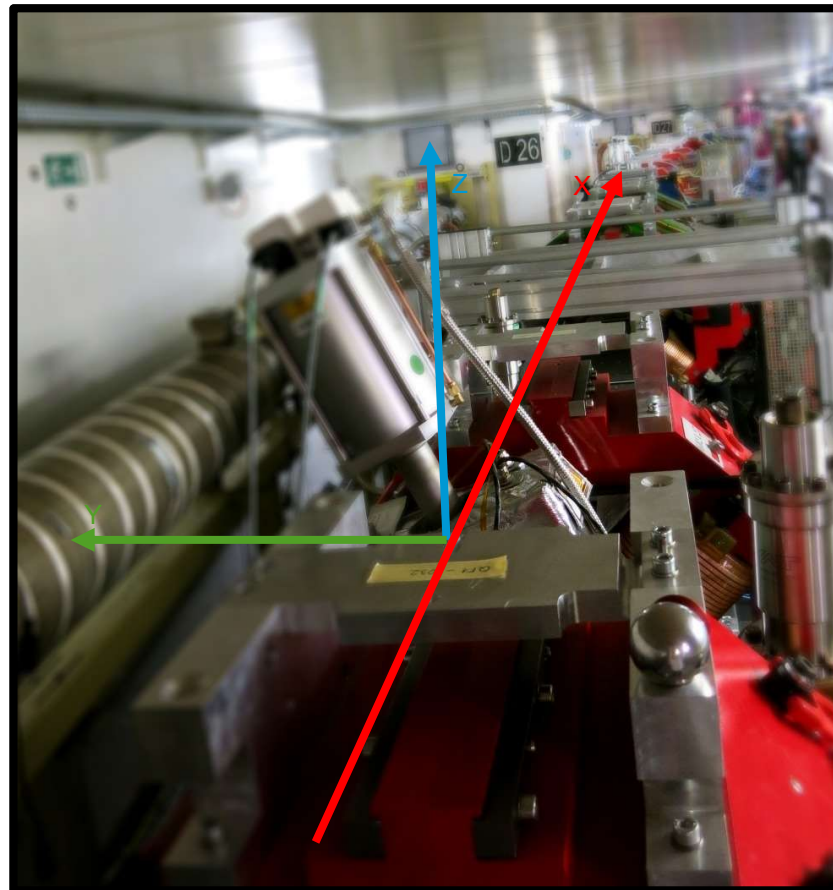
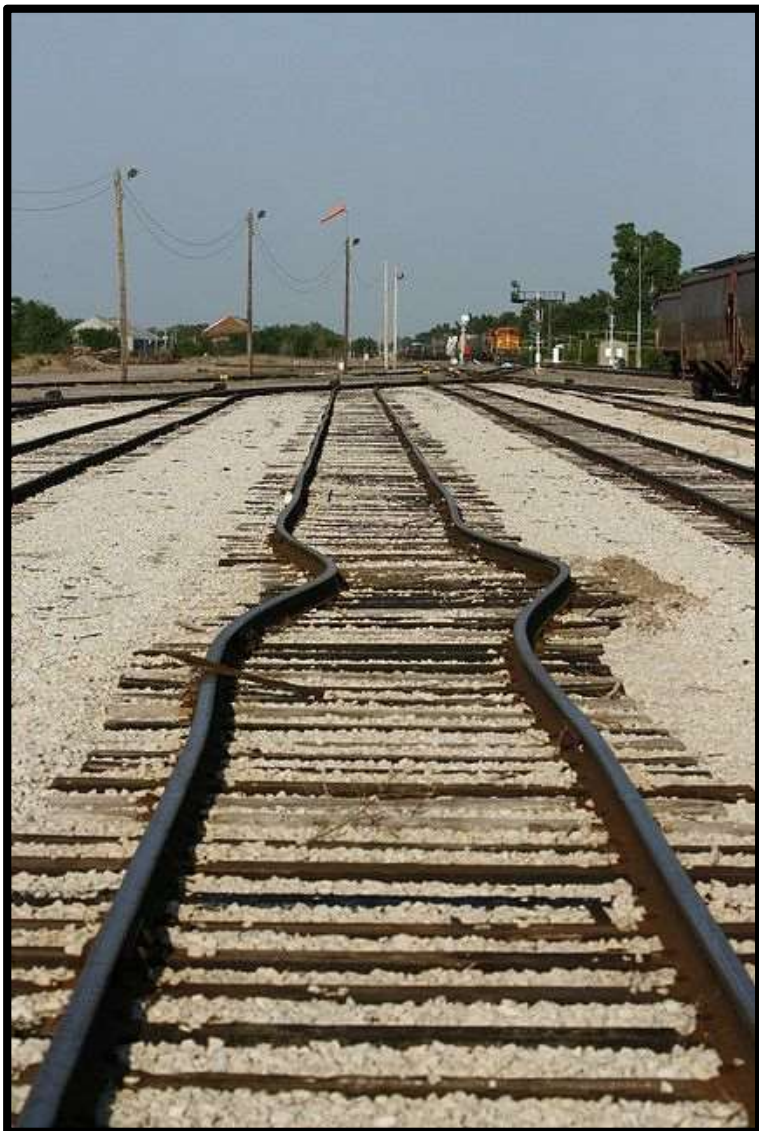
Portable

ATR

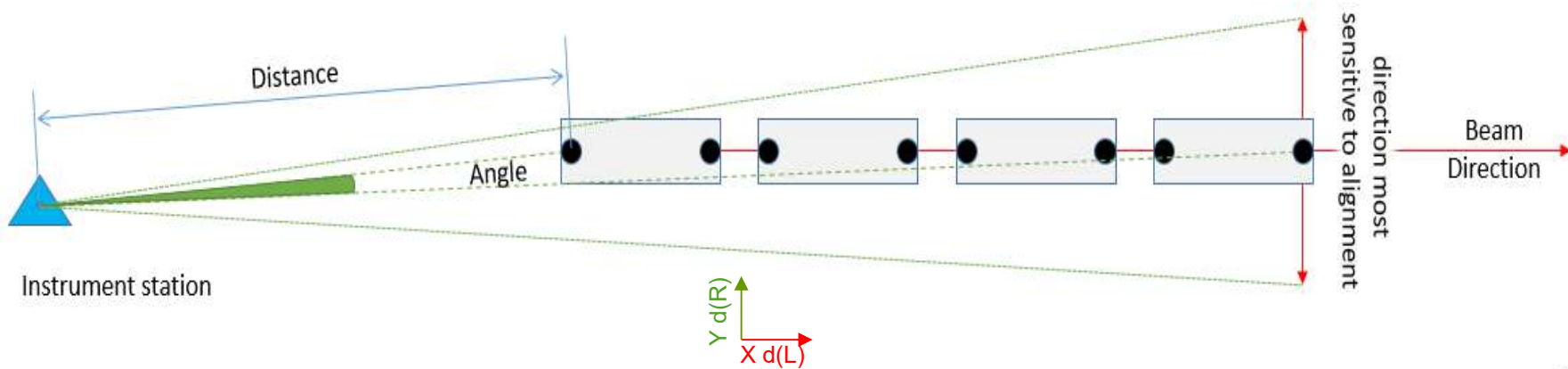
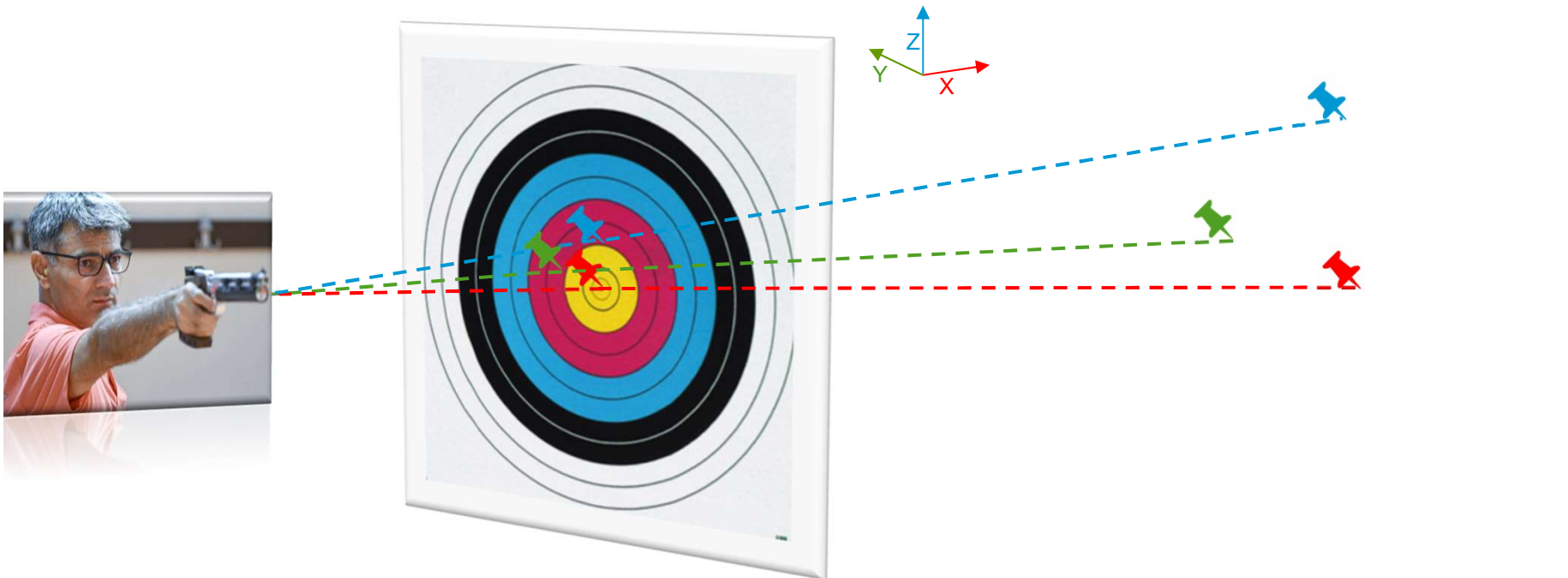
Rugged and reliable

Angles encoders more precise than laser trackers

# ESRF- ANGLES

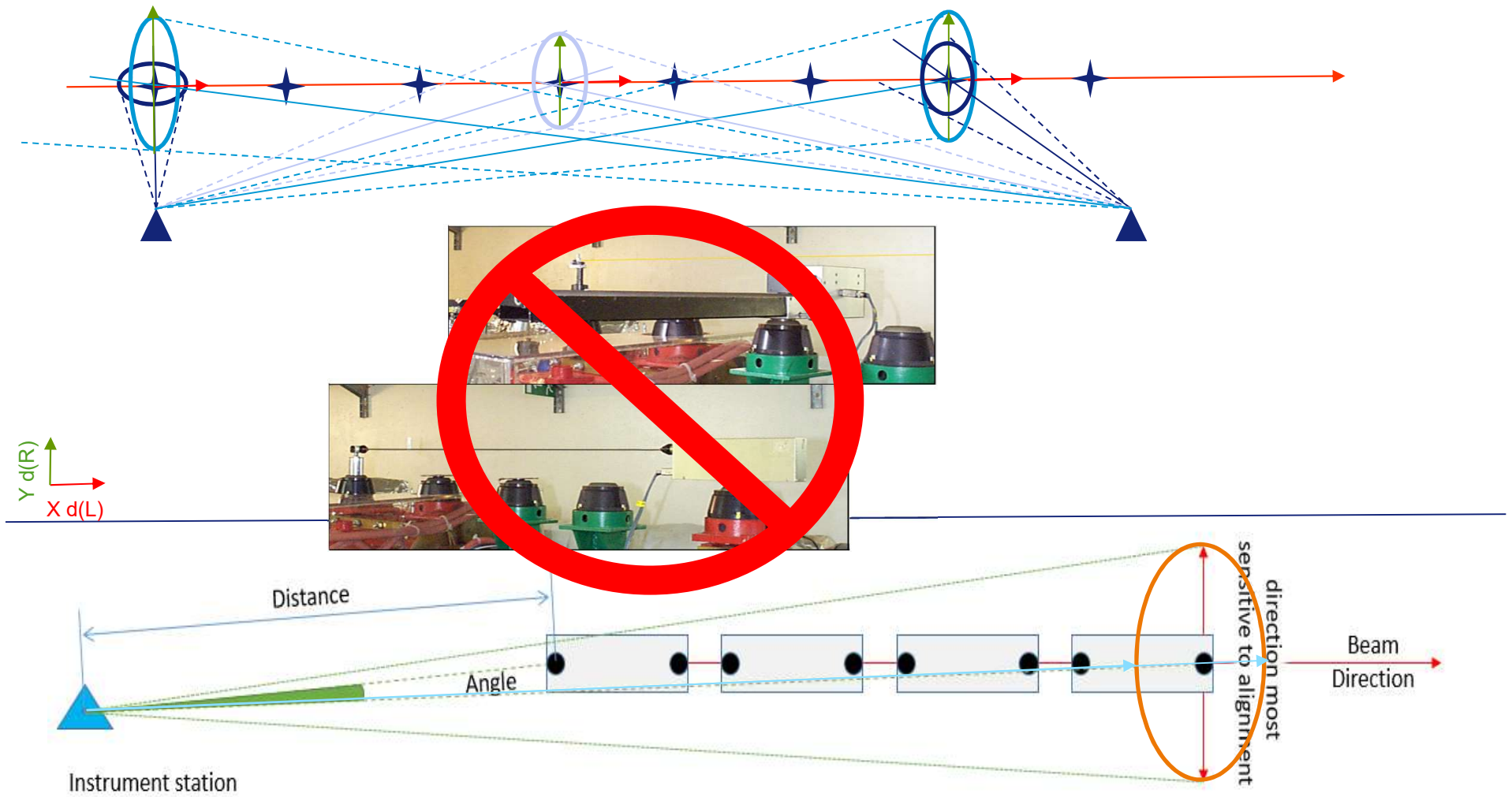


# ESRF- ANGLES

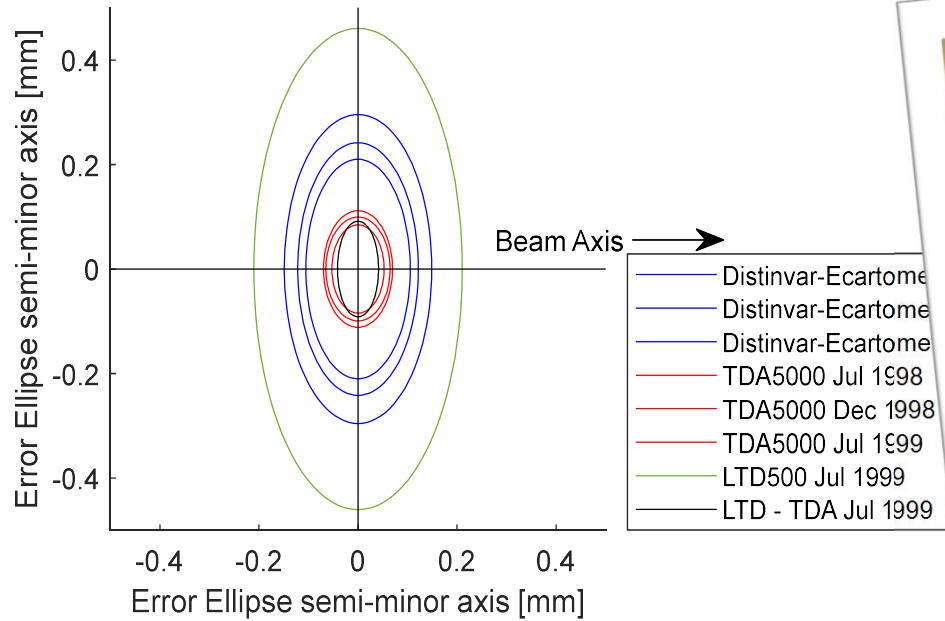




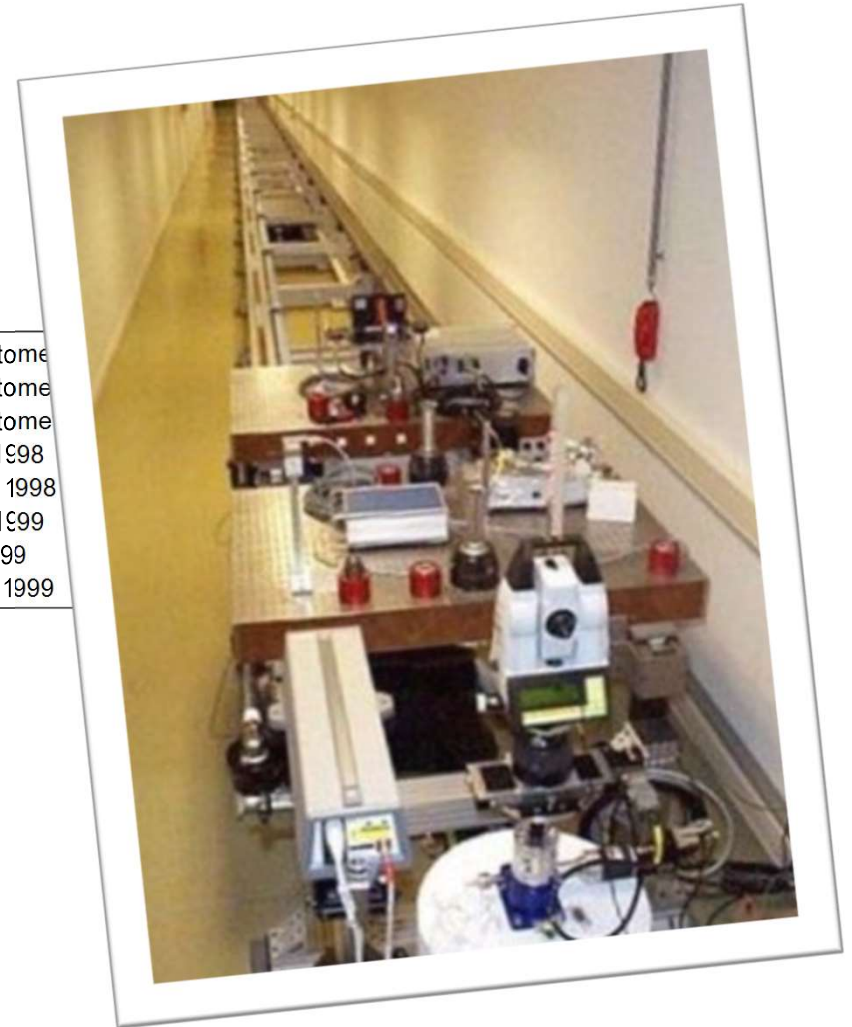
# ESRF- ANGLES



# ESRF- ANGLES



LTD5000 → 10ppm (10 $\mu$ rad)  
**TDA5000 → 3 $\mu$ rad**  
 Distinvar & Ecartometer →  $\approx$ 50 $\mu$ m  
 Faro Vantage → 20 $\mu$ m+5 $\mu$ m/m

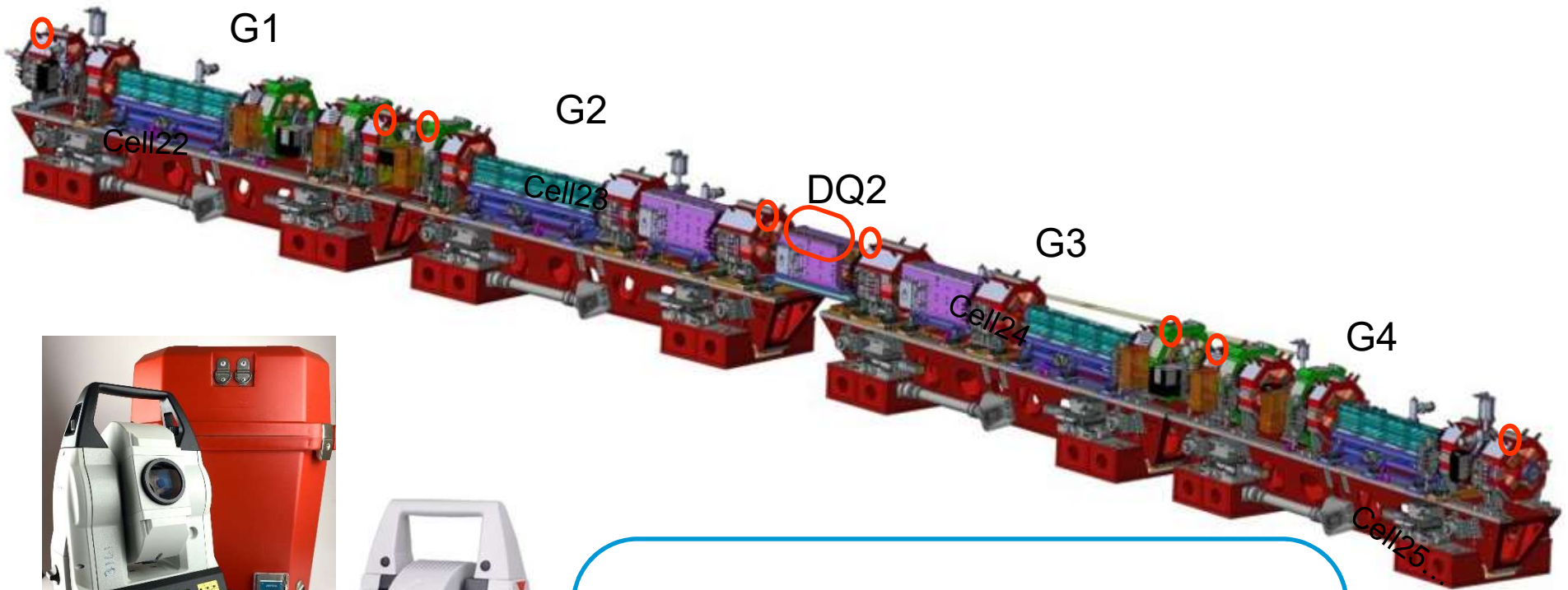


# ESRF- 2010 AT40X





# ESRF- TDA AND AT40X METHODOLOGY



**Uncertainty of movement between magnets**

2018 → 2022

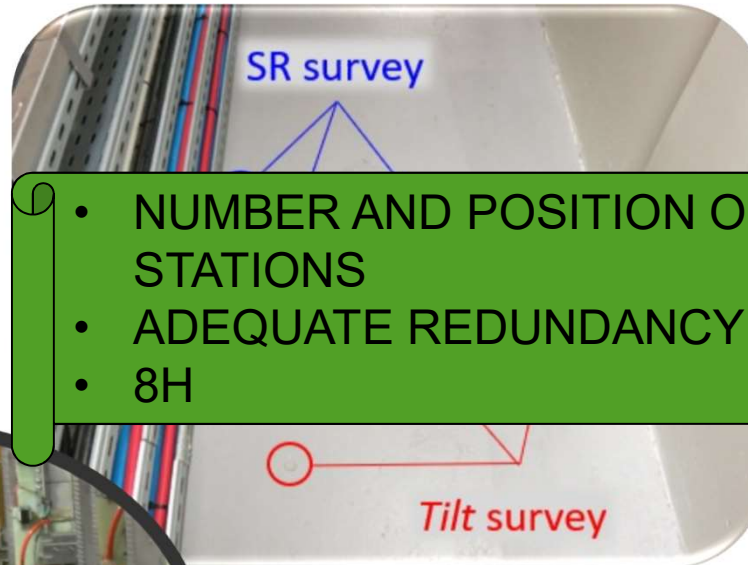
$U(R) = 15\mu\text{m}$

$U(z) = 13\mu\text{m}$

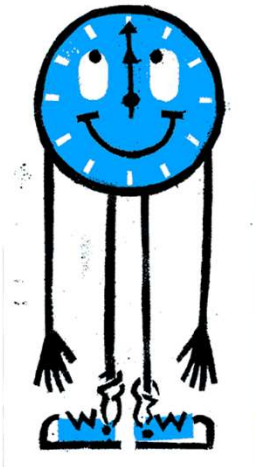
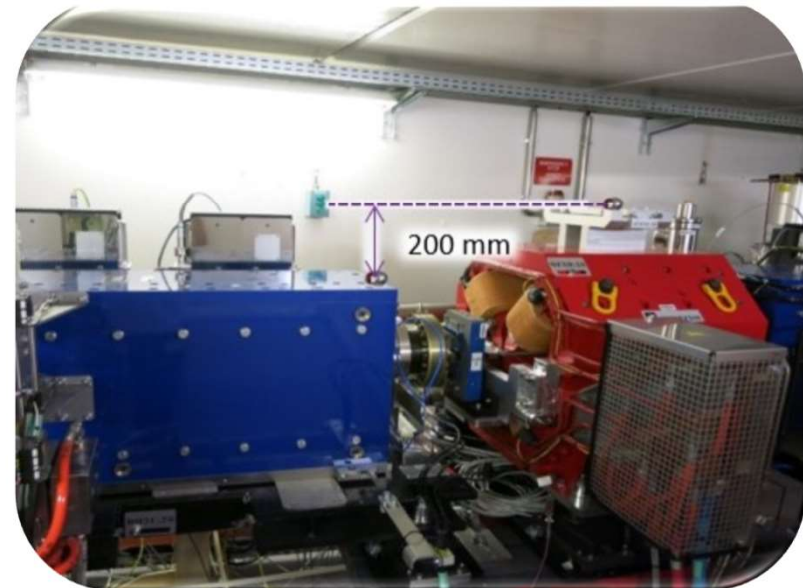
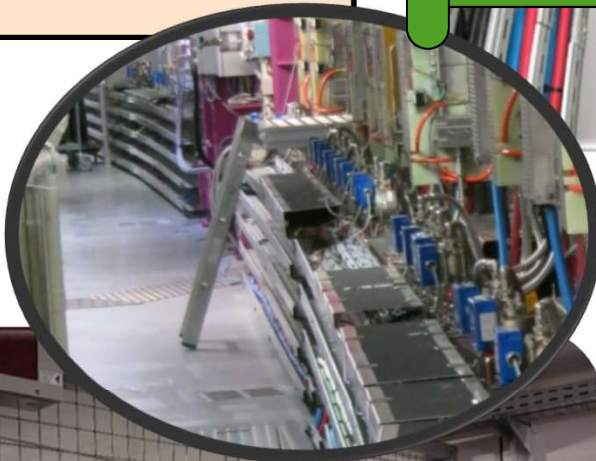
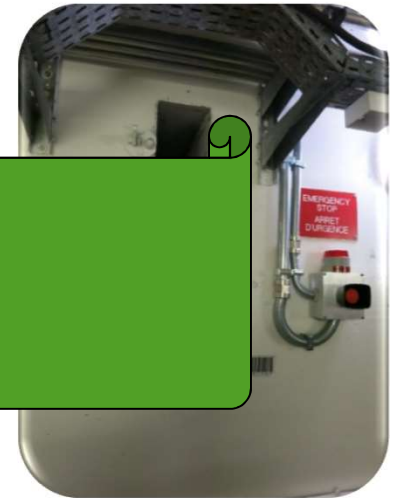
# ESRF-METHODOLOGY

## Constraints:

- Time: 8h
- Line of sight
  - DQ2
  - Straight Sections
  - Fences

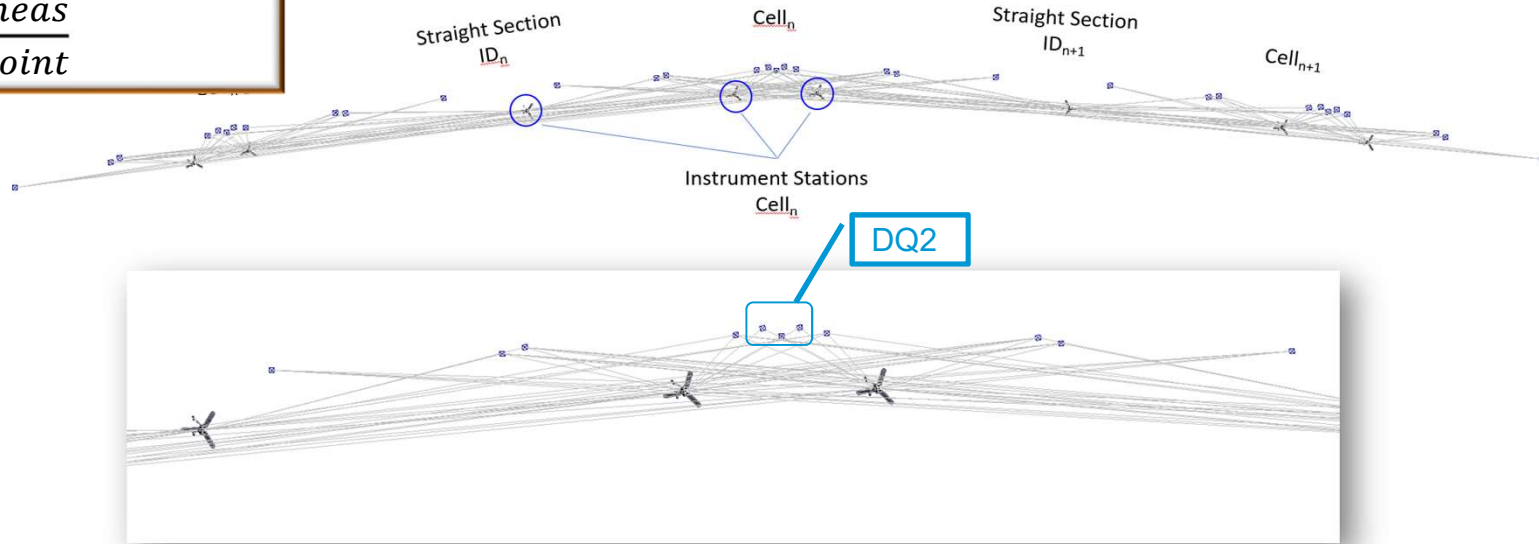


- NUMBER AND POSITION OF STATIONS
- ADEQUATE REDUNDANCY
- 8H



# ESRF- 2010 METHODOLOGY

9600 Observations  
 $8-12 \frac{meas}{point}$

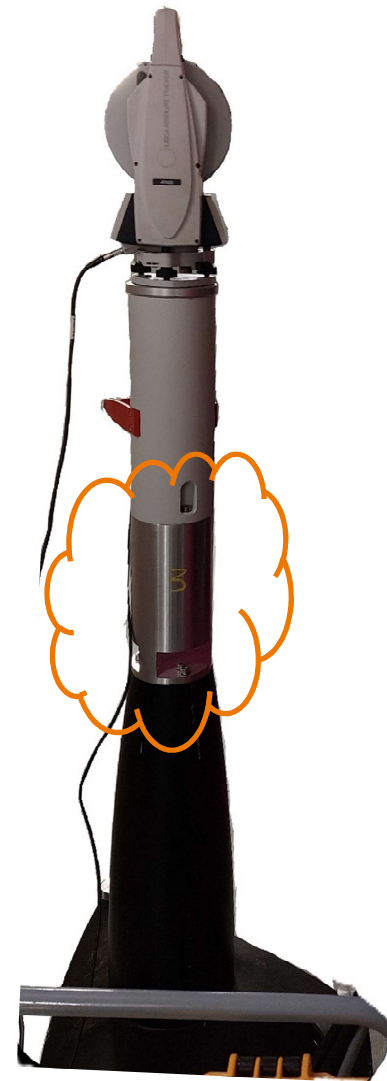


$$32cell \times 3 \frac{positions}{cell} \times 2 \frac{instruments}{position} + 3 special stations = 195 instrument stations$$

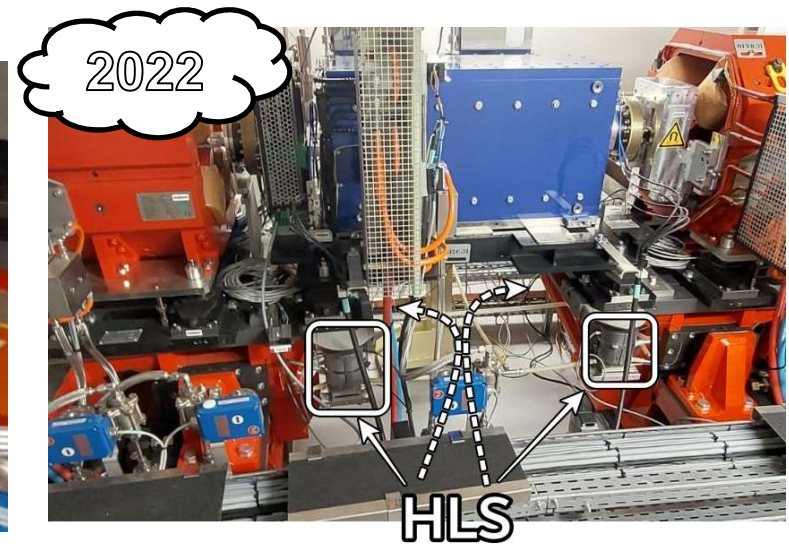
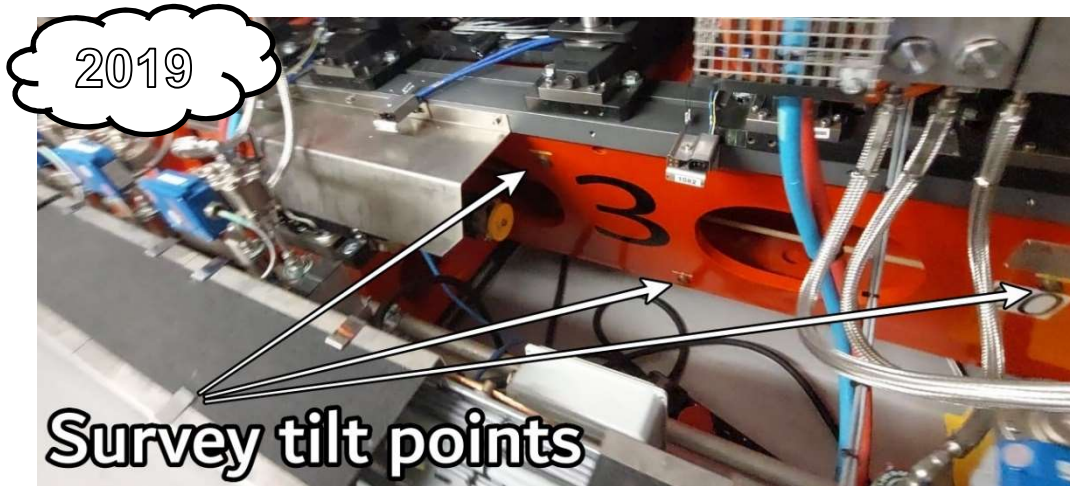
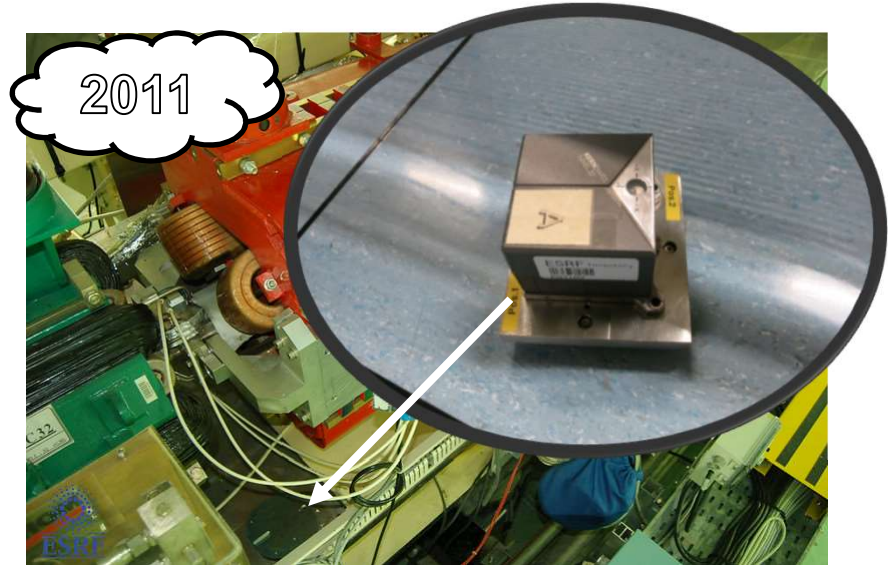
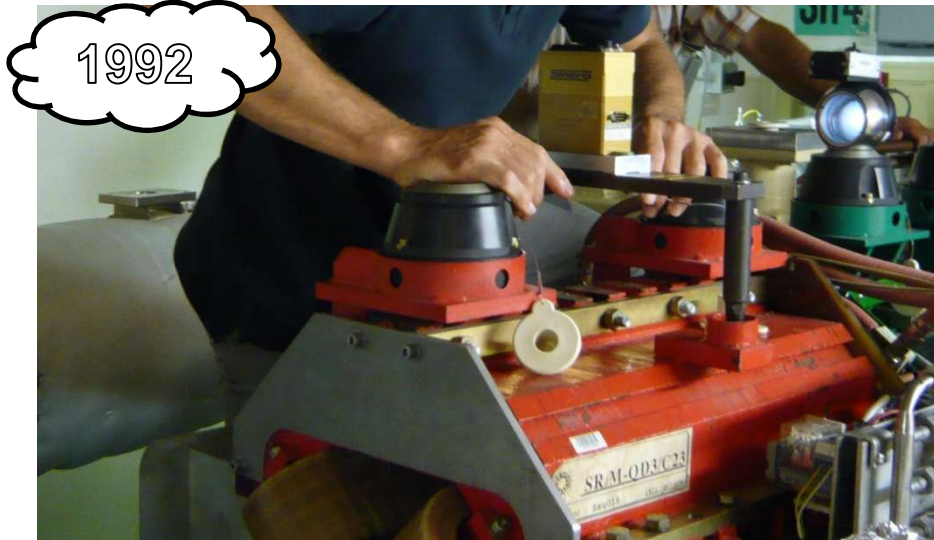




# ESRF-METHODOLOGY



# ESRF- SURVEY TILT









# ESRF- APPLICATION SOFTWARE

1990s - Levelling



A circular magnified view of a data table from the ESRF application software. The table contains columns for station identifiers, coordinates, and distances. The data is organized into rows, with some cells highlighted in yellow and others in green. The table is titled "lect RAY 1 Sph Tay lect AR 2 lect AV2 lect RAY 2 Sph Tay ctri Diff Ctri Z Denivelé Distance (m)".

lect RAY 1	Sph Tay	lect AR 2	lect AV2	lect RAY 2	Sph Tay	ctri	Diff Ctri	Z	Denivelé	Distance (m)
						0		20623549.5	0	20.6
						0		20623549.5	0	21
						0		20623549.5	0	15.5
						0		20627149.5	3600	15.6
PID 19						0		20627149.5	0	23.7
PID 18						0		20627149.5	0	23.3
						0		20627149.5	0	15.7
RN502						0		20623549.5	-3600	15.6
ST505						0		20623549.5	0	12.5
PID 17						0		20627149.5	3600	12.3
ST506						0		20627149.5	0	21.8
RN503						0		20623549.5	-3600	23
ST507						0		20623549.5	0	16.8
PID 16						0		20627149.5	3600	16.6
RN504						0		20627149.5	-3600	23.6
ST508						0		20623549.5	0	23
RN505						0		20623549.5	0	24.9
RN506						0		20623549.5	0	24.7
ST510						0		20623549.5	0	26.6
PEX17bis						0		20627149.5	3600	26.7
PEX17bis						0		20627149.5	0	18.2
RN508						0		20623549.5	-3600	18.3
RN506						0		20623549.5	0	18.2
RN507						0		20623549.5	0	18.3
						0		20623549.5	0	20.3
						0		20627149.5	3600	21.8
						0		20712880		
fermeture						-85510.5		2.1E+07		482.1



# ESRF-SOFTWARE

2024 - Labview

The screenshot displays the LabVIEW interface for 'SurveyMainAutoPlus.vi'. A 'Tank Simulation.vi Block Diagram' window is open, showing a complex flowchart with various control and data handling blocks. A data table is visible in the background, and a dialog box is overlaid on it.

	dX (mm)	dY (mm)	dZ (mm)	Ext. (mm)
QF1A/C26-G1-EI				
QF1B/C26-G1-SI				
SD1B/C26-G2-EI				
QF8B/C26-G2-SI				
QF8D/C26-G3-EI				
SD1D/C26-G3-SI				

Dialog Box Content:

Alert on SR/A-GQF1A/C26-G1-EI

OK Cancel

Front Panel Data:

HDHAVA: 0.0000, 0.0000, 0.0000

Instrument Name: AT403

HDHAVA: 8.0740, 211.3499, 100.5136

Instrument Name: AT403-12 393781

# ESRF-SOFTWARE

6h →

1min

The screenshot shows the SurveyMainAutoPlus.vi software interface. At the top, there is a menu bar with 'File', 'Edit', 'Operate', 'Tools', 'Window', and 'Help'. A yellow circle highlights the 'Operate' menu. Below the menu bar, the text 'ATR' is visible. A table of station data is shown, with columns for Station, Measured Point, Horiz. Dist. (m), Weight HD (mm), Hz Angle (gon), Weight Hz Angle (dmgon), Vert. Dist. (m), and Weight VD (mm). Below this table, there is a table of measurement logs with columns for Date, Time, Tracker, Slope Dist. (m), T (°C), P (hPa), H (%), Horiz. Dist. (m), Calib. Corr. (TDA only) (m), Extension (m), Vert. Angle (gon), and Sphericity Corr. (m). At the bottom, there is a control panel with an 'Interrupt Measure' button, a 'Stop Program' button, and a field for 'Instrument Name' containing 'AT403-12 393781'. There are also some numerical values in a box labeled 'HDHAVA'.

Station	Measured Point	Horiz. Dist. (m)	Weight HD (mm)	Hz Angle (gon)	Weight Hz Angle (dmgon)	Vert. Dist. (m)	Weight VD (mm)
STAT_EXPH/A-FW/ID01	EXPH/A-PII/004E	29.928940	0.015	184.4518	1.50	0.324833	0.03
STAT_EXPH/A-FW/ID01	EXPH/A-PII/003E	37.545354	0.015	182.2869	1.50	0.418198	0.03
STAT_EXPH/A-FW/ID01	EXPH/A-PII/002E	45.133869	0.015	180.3121	1.50	0.415194	0.03

Date	Time	Tracker	Slope Dist. (m)	T (°C)	P (hPa)	H (%)	Horiz. Dist. (m)	Calib. Corr. (TDA only) (m)	Extension (m)	Vert. Angle (gon)	Sphericity Corr. (m)
Tue 30 Jul 2024	15:28:00	AT403-12 393781	29.930702	23.50	992.8	62.5	29.928940	0.000000	0.000000	99.3092	0.000070
Tue 30 Jul 2024	15:28:00	AT403-12 393781	37.547681	23.50	992.8	69.9	37.545354	0.000000	0.000000	99.2911	0.000110
Tue 30 Jul 2024	15:29:00	AT403-12 393781	45.135777	23.50	992.7	63.9	45.133869	0.000000	0.000000	99.4146	0.000159

Too late!

m

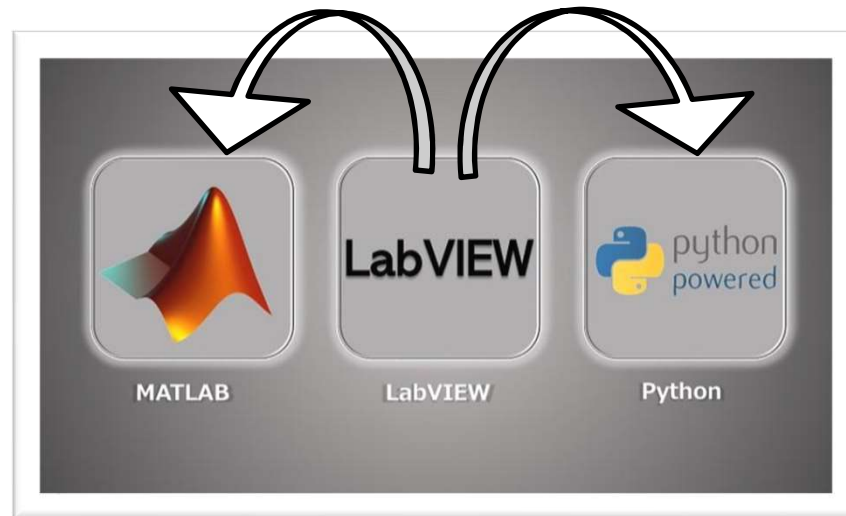
am



# ESRF-FUTURE

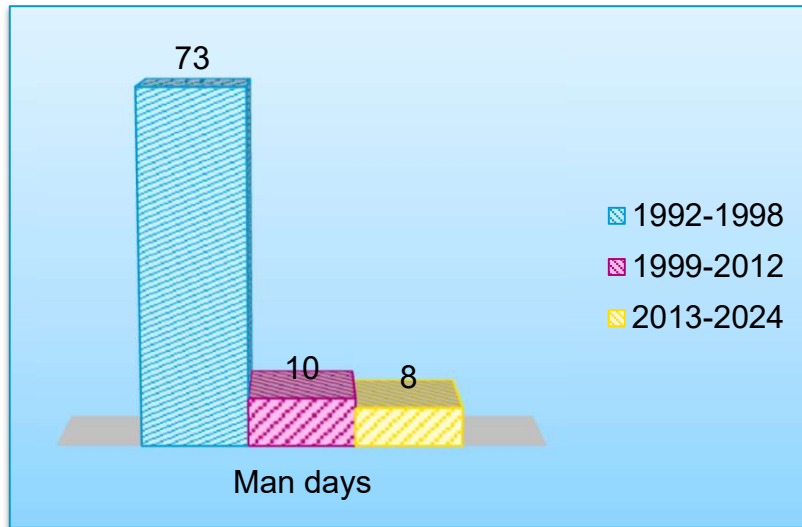


# SDK

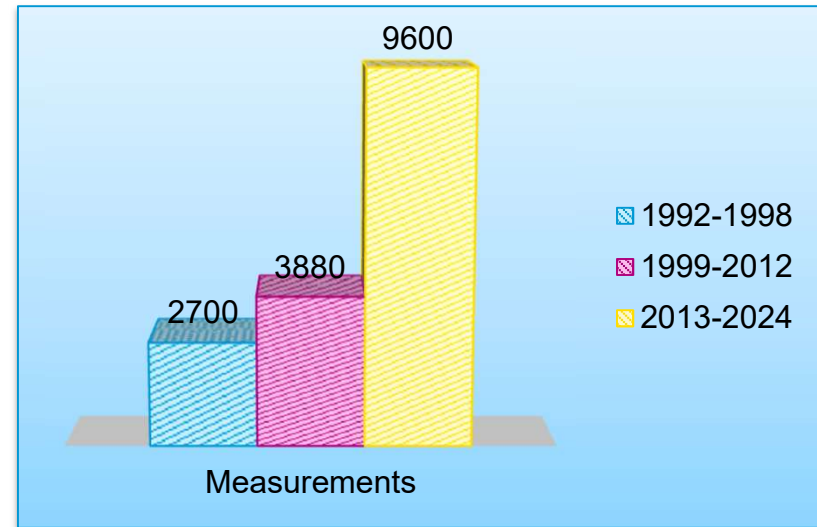


# ESRF- SUMMARY

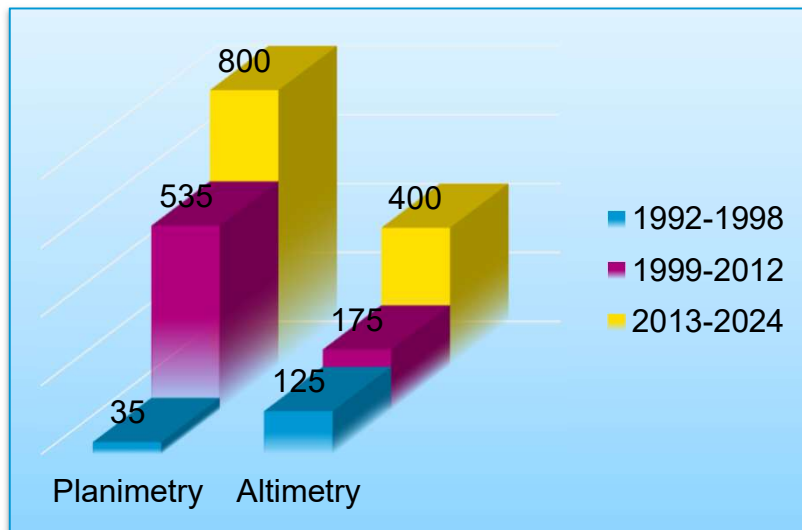
Time required to survey the ESRF SR



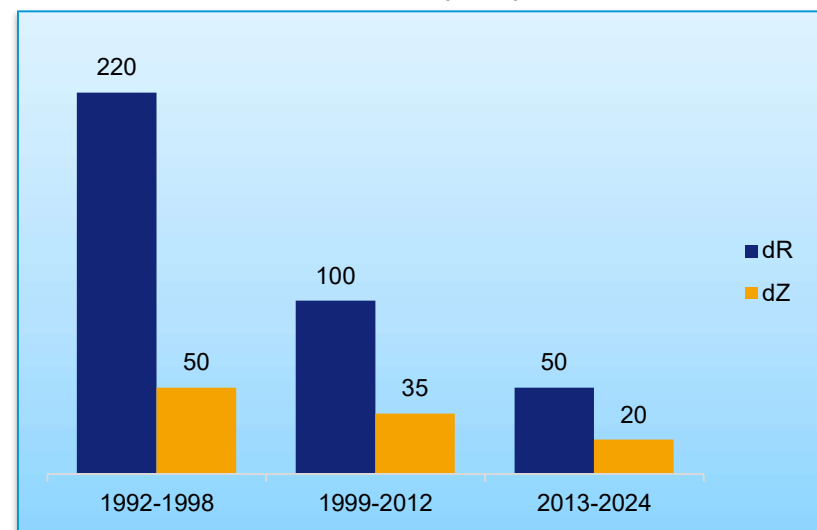
Number of observation



Observation/person



dR and dZ ( $\mu\text{m}$ )



# ESRF- BACK TO SLAC



Musique: Color Filter (Sleep in a Synchrotron) 1988