Ph.D itee
INFORMATION TECHNOLOGY ELECTRICAL ENGINEERING

Gianni Caiafa

Tutors: Pasquale Arpaia –Stephan Russenschuck

XXXI Cycle - I st year presentation

A magnetic measurement system for extracting pseudo-multipoles in accelerator magnets

Università degli Studi di Napoli Federico II

CERN

Magnetic Measurements

Master’s Degree in Electrical Engineer (cum laude)
LM-28 - University of Naples “Federico II”

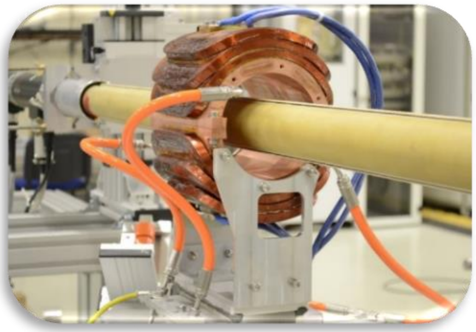
Ph.D. student XXXI Cycle Information Technology and Electrical Engineering, DIETI

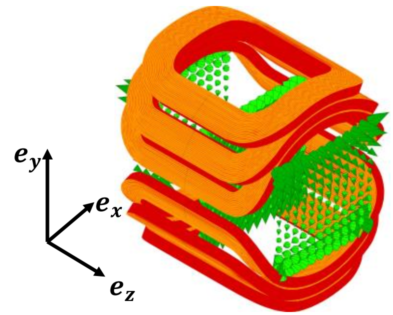
Member of Instrumentation & Measurement for Particle Accelerator Lab IMPALAB

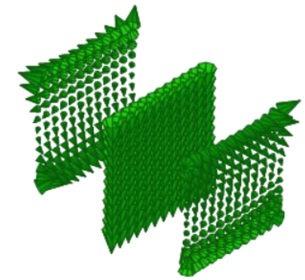
Member of Doctoral Student Program at CERN (European Organization for Nuclear Research) Magnetic Measurement (MM) section of the Magnets, Superconductors and Cryostats (MSC) group in the Technology Department (TE)

Research Objective

Measure the local field distribution in accelerator magnets

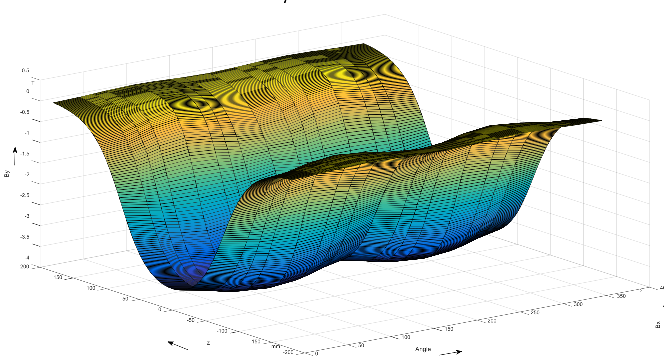




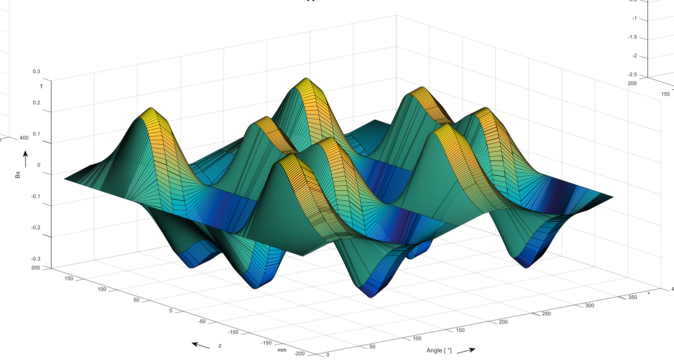


The field distribution in the end-regions of the magnet can be reconstituted from measurements on the boundary surface applying the concept of pseudo-multipoles [1]

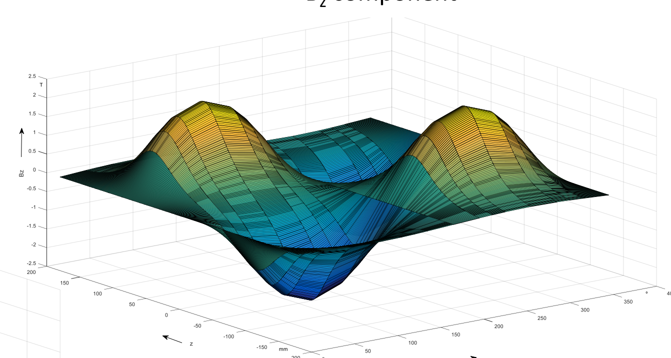
B_y component



B_x component



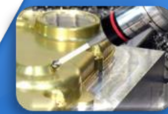
B_z component



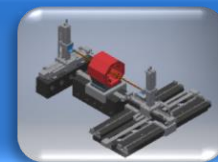
[1] B. Erdélyi, M. Berz, M. Lindemann *"Differential algebra based magnetic field computations and accurate fringe field maps"*

Project Structure

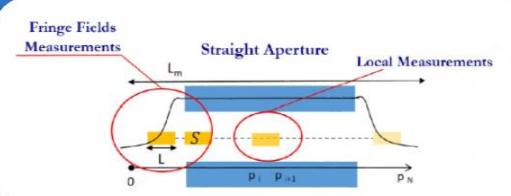
Metrological characterization



Flexible, high-precision measurement system



Rotating coil measurement



Mathematical model of the Pseudo-Multipoles Analysis

$$B_r(r,\varphi,z) = -\mu_0 \sum_{n=1}^{\infty} r^{n-1}(\bar{C}_n(r,z)\sin(n\varphi) + \bar{D}_n(r,z)\cos(n\varphi))$$

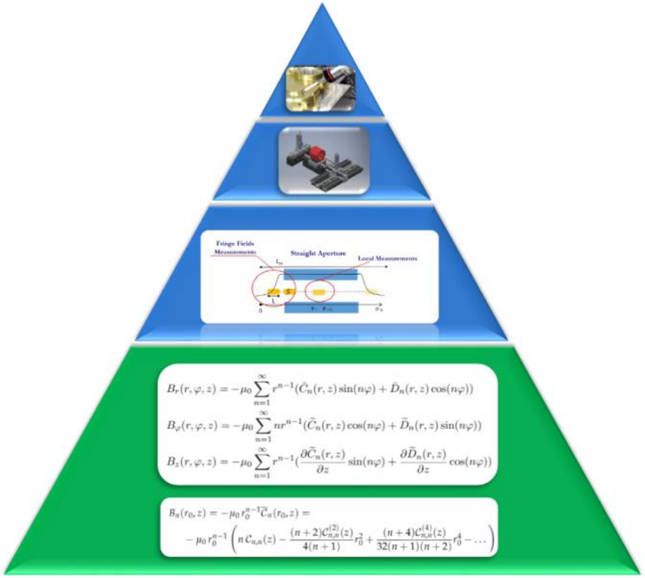
$$B_\varphi(r,\varphi,z) = -\mu_0 \sum_{n=1}^{\infty} n r^{n-1}(\widetilde{C}_n(r,z)\cos(n\varphi) + \widetilde{D}_n(r,z)\sin(n\varphi))$$

$$B_z(r,\varphi,z) = -\mu_0 \sum_{n=1}^{\infty} r^{n-1}(\frac{\partial \widetilde{C}_n(r,z)}{\partial z}\sin(n\varphi) + \frac{\partial \widetilde{D}_n(r,z)}{\partial z}\cos(n\varphi))$$

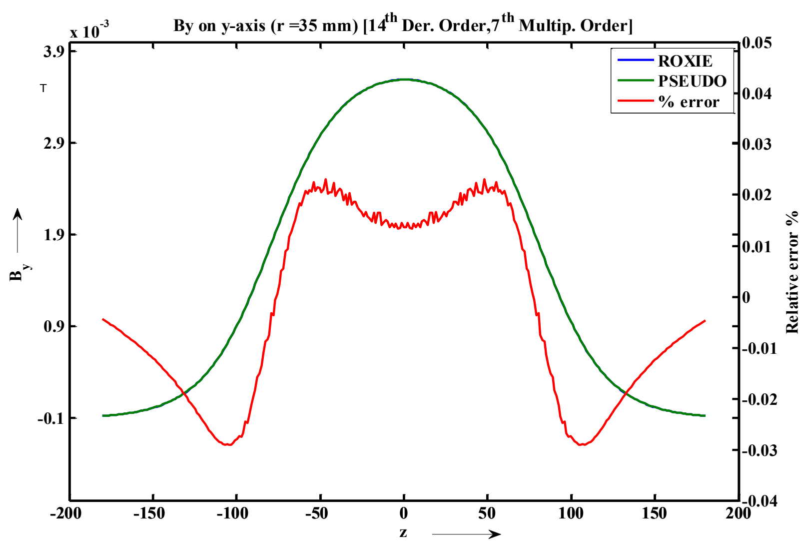
$$B_n(r_0,z) = -\mu_0\, r_0^{n-1}\widetilde{C}_n(r_0,z) = -\mu_0\, r_0^{n-1}\left(n\, C_{n,n}(z) - \frac{(n+2)C^{(2)}_{n,n}(z)}{4(n+1)}r_0^2 + \frac{(n+4)C^{(4)}_{n,n}(z)}{32(n+1)(n+2)}r_0^4 - \dots\right)$$

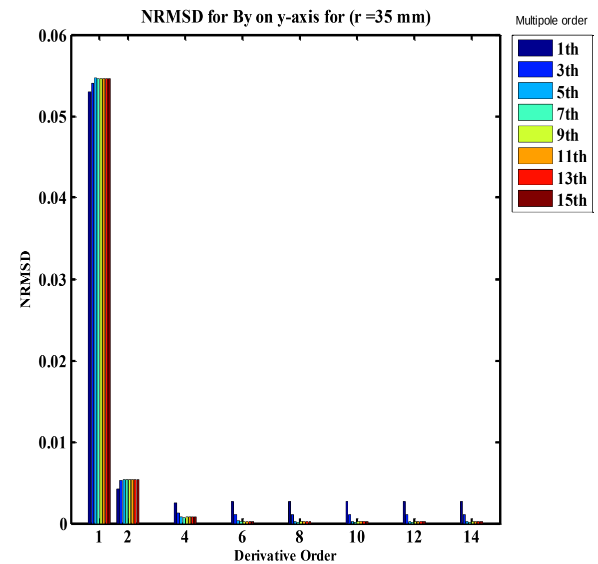
iNFORMATION tECHNOLOGY eLECTRICAL eNGINEERING Ph.D

Completed Steps



Mathematical model validation

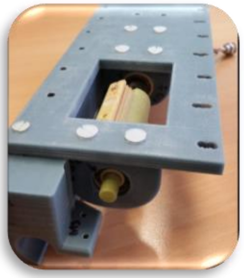


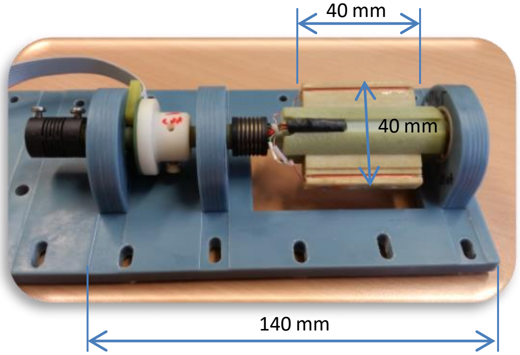


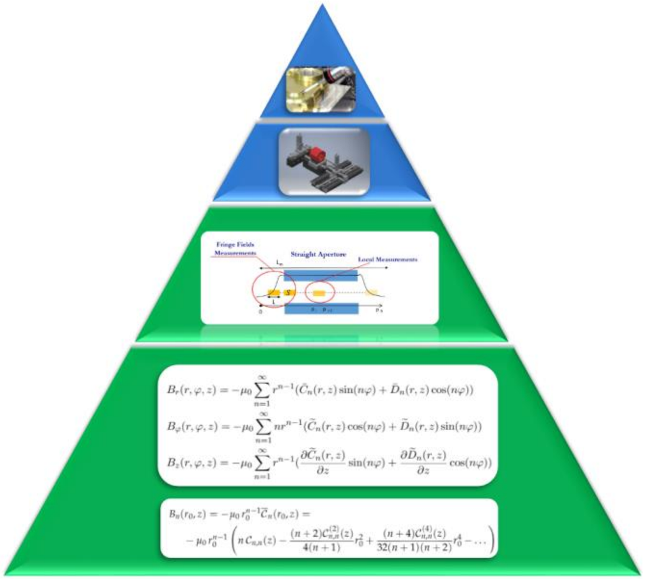
INFORMATION TECHNOLOGY ELECTRICAL ENGINEERING Ph.D itee

Completed Steps

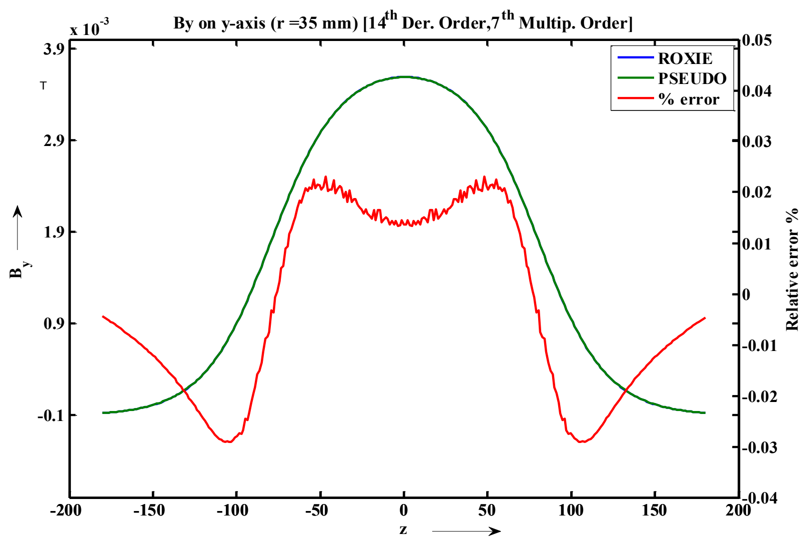
Design and prototyping of a longitudinal carriage system

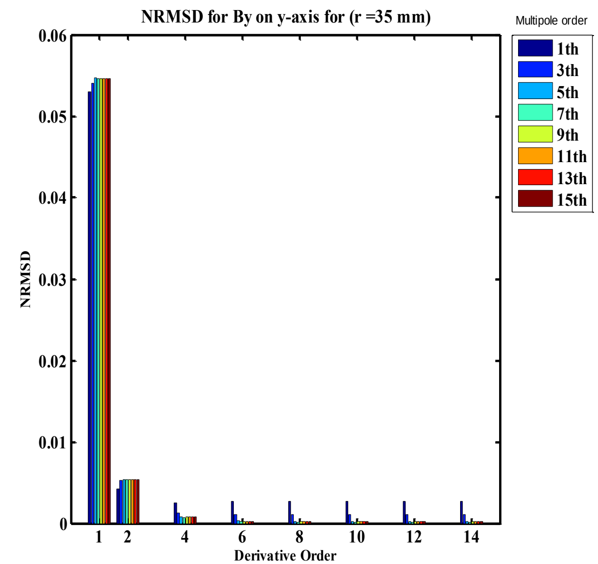




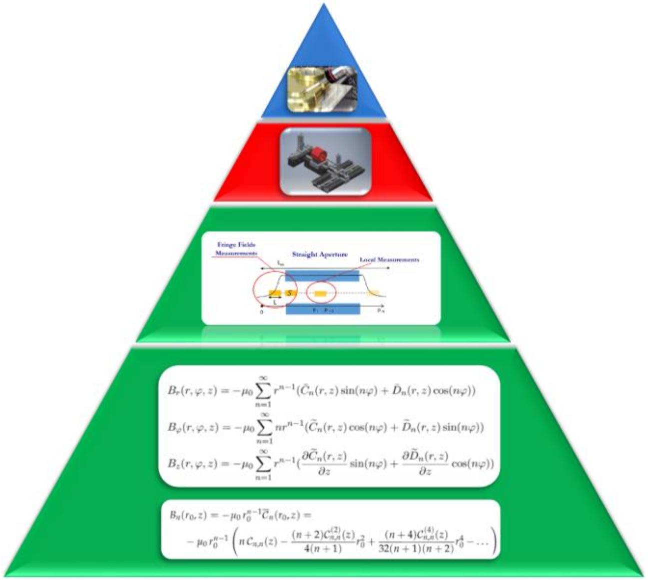


Mathematical model validation

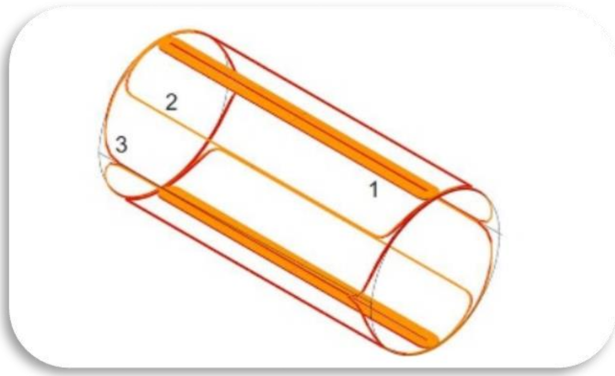


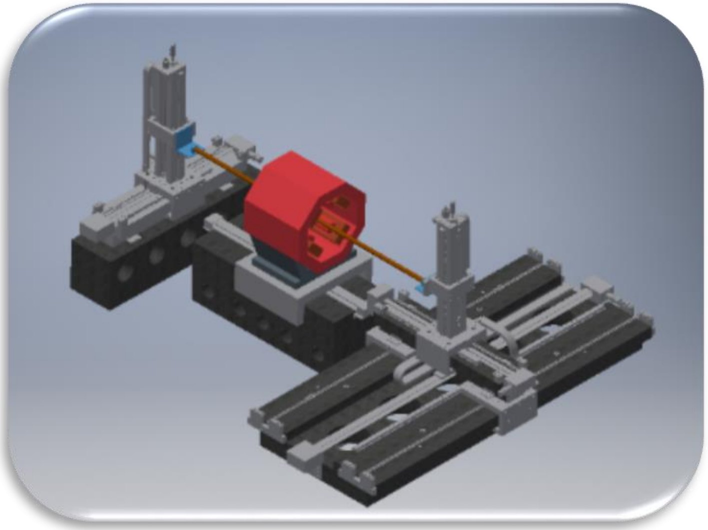


Next Steps



Study and design of an iso-perimetric coil and measurement system

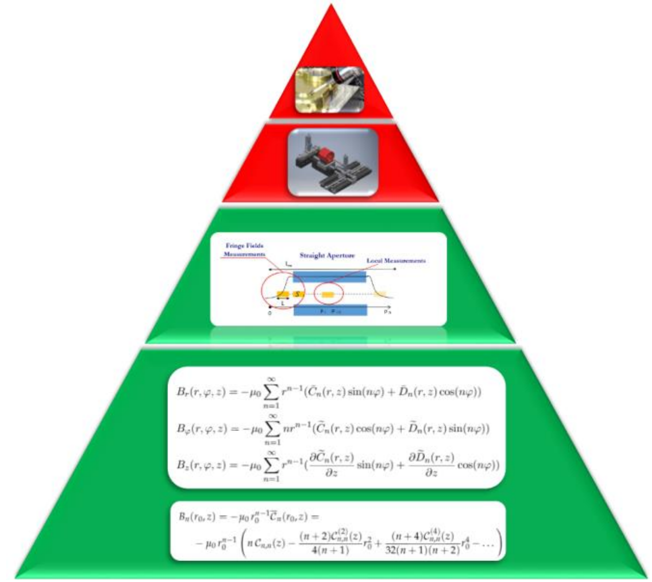




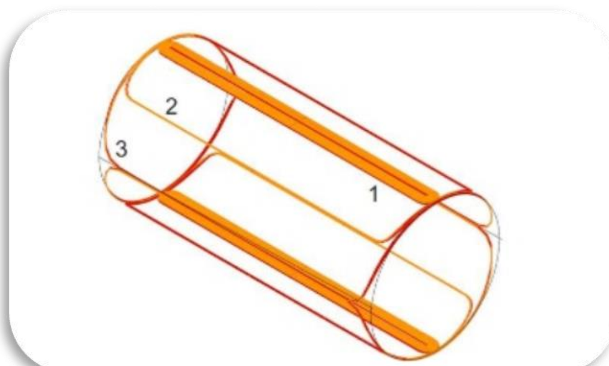
Ph.D itee INFORMATION TECHNOLOGY ELECTRICAL ENGINEERING

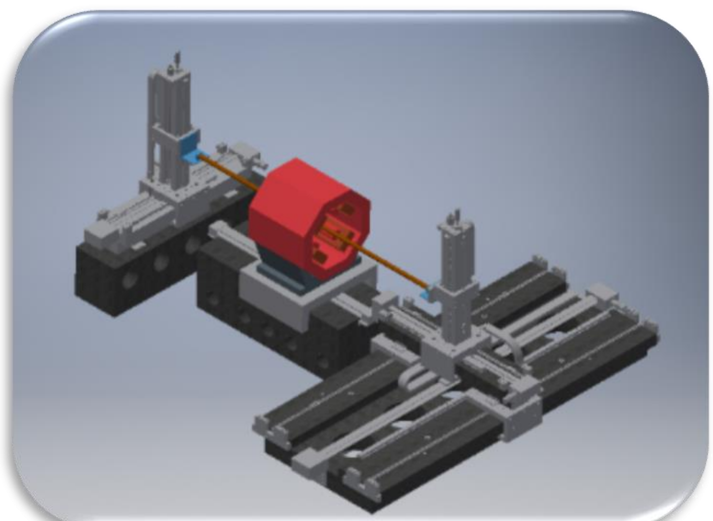
Next Steps

Measurement system setup and metrological characterization

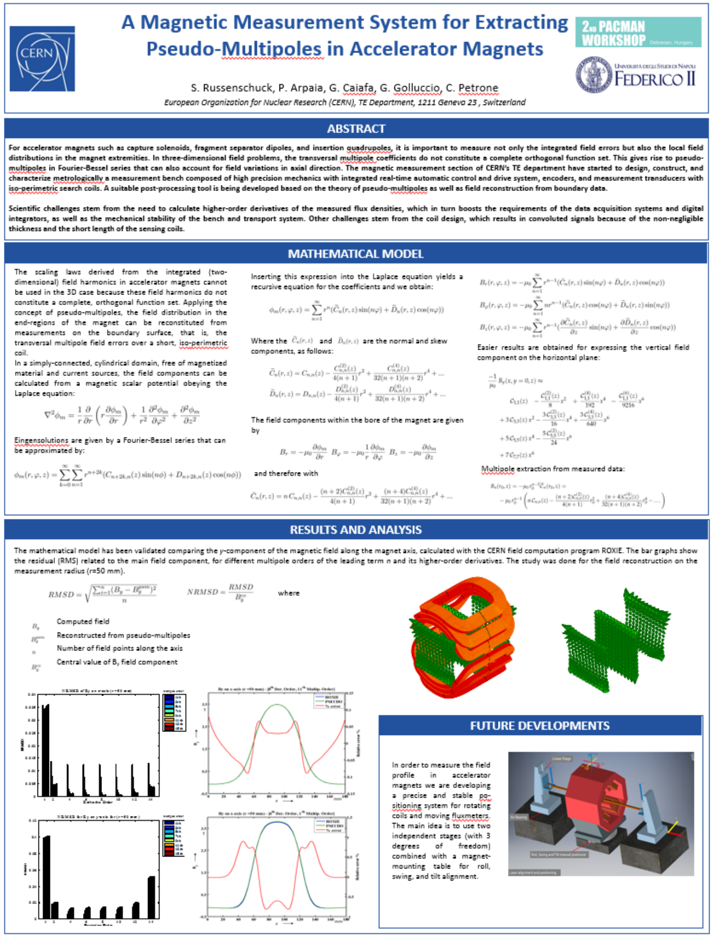


Study and design of an iso-perimetric coil and measurement system





Publications



Poster for the 2nd PACMAN workshop, *"A Magnetic Measurement System for Extracting Pseudo-Multipoles in Accelerator Magnets"*, held in Debrecen (Hungary) June 2016

Next Years

Student: Gianni Caiafa
gianni.caiafa@unina.it

Tutors: Pasquale Arpaia - Stephan Russenschuck
pasquale.arpaia@unina.it
stephan.Russenschuck@cern.ch

	Credits year 1								Credits year 2								Credits year 3									
		1	2	3	4	5	6			1	2	3	4	5	6			1	2	3	4	5	6			
	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Estimated	bimonth	bimonth	bimonth	bimonth	bimonth	bimonth	Summary	Total	Check
Modules	20	4	0	0	10	9	0	23	10							0	0							0	23	30-70
Seminars	5	0	0	0.5	3	0.5	6.2	10	5							0	0							0	10	10-30
Research	35	0	3	7	10	7	7	34	45							0	60							0	34	80-140
	60	4	3	7.5	23	17	13	67	60	0	0	0	0	0	0	0	60	0	0	0	0	0	0	0	67	180

THANK YOU FOR YOUR ATTENTION!

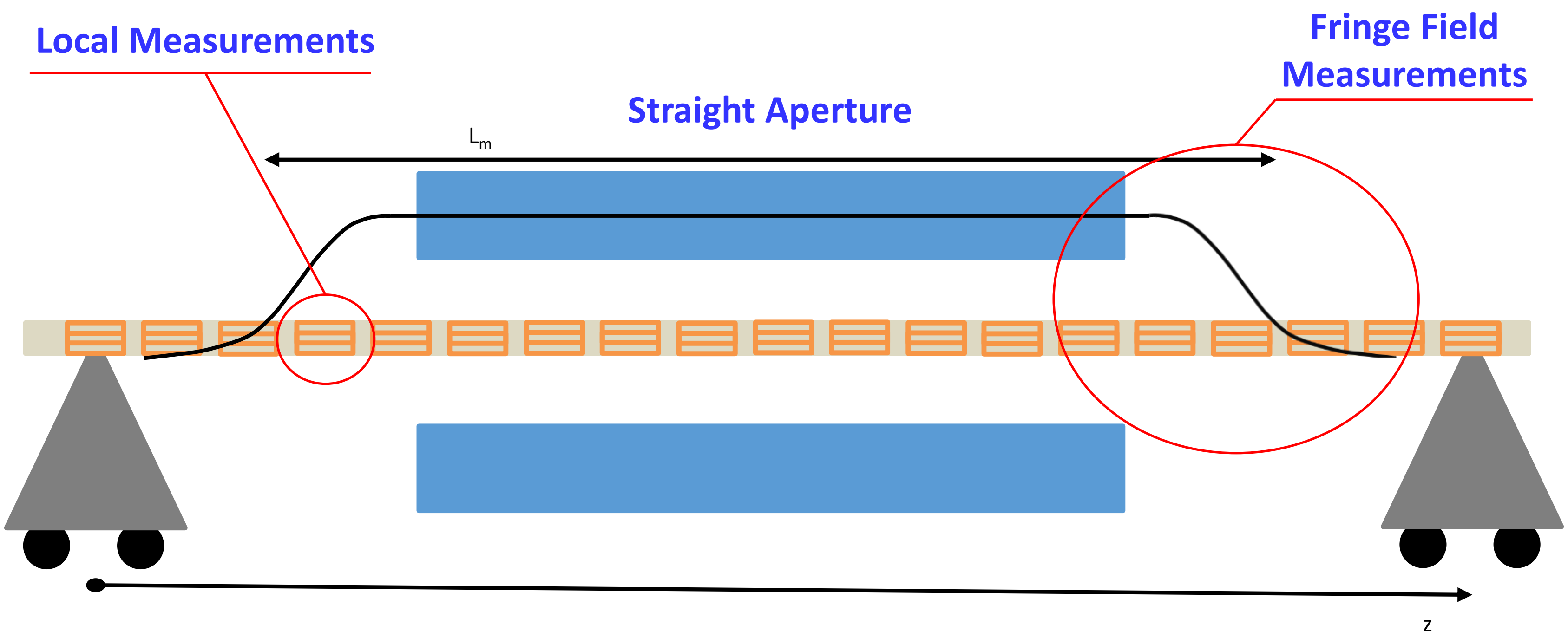
Ph.D itee INFORMATION TECHNOLOGY ELECTRICAL ENGINEERING

UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II

CERN

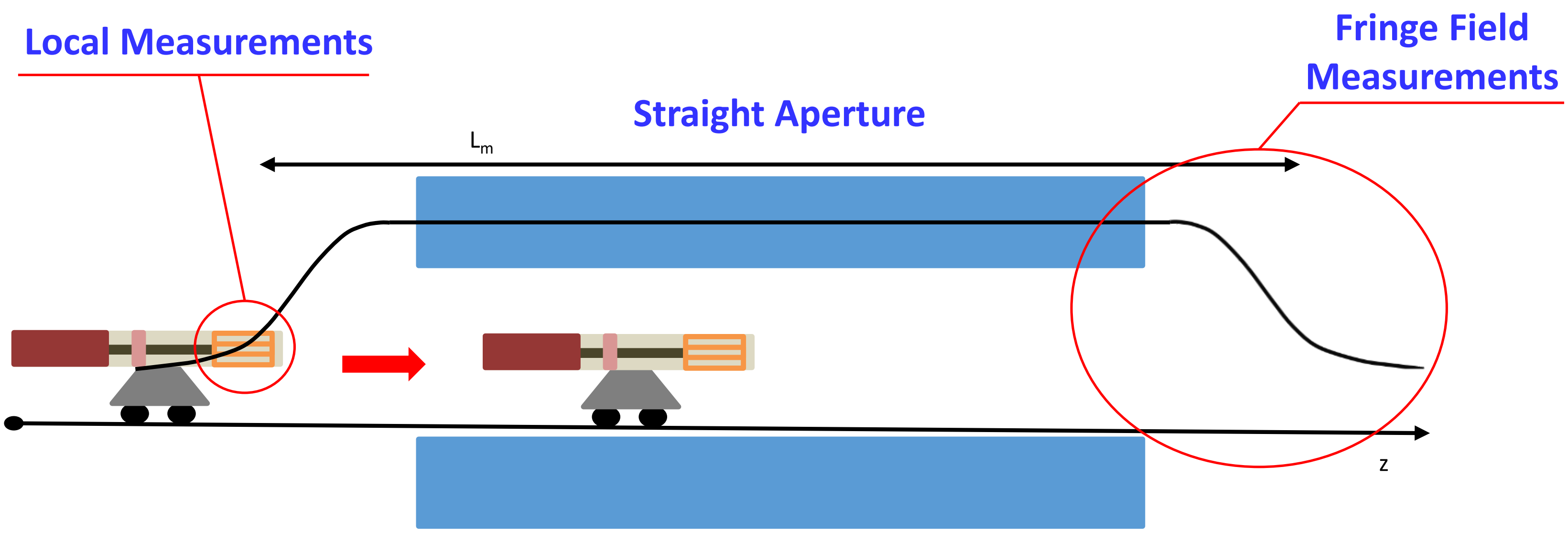
Magnetic Measurements

Long shaft



Local Measurements
Fringe Field Measurements
Straight Aperture
L_m
z

Short shaft


Local Measurements
Fringe Field
Measurements
Straight Aperture
L_m
z