# MDI - Simulation Studies

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- - rom IP
  - Tungsten nozzles to mitigate bkg in the IR
  - $E_{cm} = 1.5 \text{ TeV}$ 
    - [arXiv:1905.03725]

### In the last months, a first study of Beam Induced Background (**BIB**) has been performed exploiting late **MAP** studies:

MARS simulation of ±200m f







- - rom IP
  - bkg in the IR
- $E_{cm} = 1.5 \text{ TeV}$





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Beam Induced Background comes from 10s-100s meters from the IP

\*depending on E<sub>cm</sub>





- - rom IP
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Proceeding in the RD for a possible muon collider, we would like to be able to test all possible machine designs to compare their BIB ✓ Change beam energy ✓ Change machine optics ✓ MDI optimisation (nozzle..)







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#### We need to become independent!

i.e. able to generate ourselves the background distribution in a handy, flexible way





# Natively supports very complicated and detailed geometries





**FLUKA** is one of the most common general purpose Monte Carlo software, and is the established standard for example for radio protection studies





# Natively supports very complicated and detailed geometries





#### +BUT the manual construction of such complicated geometries is +Difficult +Not scalable-flexible

**FLUKA** is one of the most common general purpose Monte Carlo software, and is the established standard for example for radio protection studies



# FLUKA LINE BUILDER is a program aimed at automatically build accelerator geometries, consists of 2 parts:

# Fluka Element DataBase

> tree fedb/
fedb/
<pre>— [4.0K] assemblies</pre>
- [4.UK] DOGLES
[ 254] myacc_MBSORT hodios
[ 103] myacc_MOBODY bodies
[4 AK] materials
[4.0K] materials inp
[ 251] myacc MBS.assignmat
[ 135] myacc MBSORI.assignmat
[ 96] mvacc MOBODY.assignmat
<pre>— [4.0K] regions</pre>
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<pre>— [1.8K] myacc MBS.regions</pre>
<pre>[ 90] myacc MQBODY.regions</pre>
<pre>— [4.0K] stepsizes</pre>
<pre>— [2.1K] structure.py</pre>
[1.3K] structure.pyc
— [4.0K] test
[ 18] expand.sh ->/tools/expand.sh
[2.1K] flair-autosave.pickle
- [4.1K] <u>myacc_MB.1np</u>
[1.5K] <u>Myacc_MBorig.inp</u>
[1000] <u>myacc_MQ.1np</u>
$\begin{bmatrix} 195 \end{bmatrix} \underline{p1pp0.1np} \\ \begin{bmatrix} 211 \\ topplate \\ inp \\ \\ \end{bmatrix} $
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[ 865] TestElement inp
[23] TestElement sh -> /tools/TestElement sh
[4.0K] tools
[6.9K] cut.pv
[ 679] display elem.inp.template
[3.0K] display elem.sh
[1.1K] expand.sh
[2.0K] find paths.py
[1.2K] find_paths.pyc
[6.0K] roto_traslate.py
<pre>[6.3K] scan-fedb.py</pre>
<pre>[1.1K] split.py</pre>
[ 796] <u>template.inp</u>
<pre>[ I3K] test_assembly.py</pre>
Lestelement.sn
7 directories 34 files
/ UTIECCUITES, 34 ITCES

Collection of models of single accelerator devices in Ascii files



## Line Builder



# FLUKA LINE BUILDER is a program aimed at automatically build accelerator geometries, consists of 2 parts:

#### Fluka Element DataBase

<pre>     START:build line:ROT-DEFISS     SEND:build_line:ROT-DEFISS     SEND:build_line:ROT-</pre>	File Edit Options Buffers Tools Help				
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	-: generic_frame.fluka Top (47,0)	Git-master	(FLUKA)		-: generic_frame.fluka Bot (77,27) Gi

# Line Builder



lereghetti @CERN

Python (v2.7) program that inserts the needed magnetic elements in a pre-existent "template geometry" based on machine optics



# FLUKA LINE BUILDER is a program aimed at automatically build accelerator geometries, consists of 2 parts:

## Fluka Element DataBase



## **Line Builder**

# FINAL RESULT

Once the geometry has been built in FLUKA, we can simulate whatever we want..!



@ TYPE	%05s	"TWISS"		
@ SEQUENCE	%-07s	"MYACCEL"		
@ PARTICLE	%06s	"PROTON"		
@ MASS	%le	0.	93827208129999995	
@ CHARGE	%le	1.	000000000000000000	
@ ENERGY	%le	1.	3/120018030500010	
@ PC	%le	1.	46147303025459472	
@ KRUNCH	%le	1.	000000000000000000000000000000000000000	
@ BCURRENT	%le	ô.	11463416918410078	
@ SIGE	%le	0.	000450000000000000	
@ SIGT	%le	0.	07550000000000000	
@ NPART	%le	1999999999	99.9999694824218756	00
@ EX	%le	0.	00000171060184396	
@ ET	%Le	<i>v</i> .	000001/1000184390	
@ ET	sle	ю. 1	001000000000000000	
@ LENGTH	%le	44.	56637061435915115	
@ ALFA	%le	0.	02452735406345014	
@ ORBIT5	%le	-0.	0000000000000000000	
@ GAMMATR	%le	6.	38520212960327616	
@ Q1	%le	2.	23430396971649170	
@ Q2	%le	2.	39886628492304776	
@ DQ1	%le	-13.	15027500931211080	
@ DQ2	%le	-12.	03854917694575200	
@ DXMAX	%le	-0	/2418111948598485	
a XCOMAX	%le	-0.	000000000000000000000000000000000000000	
@ YCOMAX	sle	0.	000000000000000000000000000000000000000	
@ BETXMAX	%le	56.	74023186627047721	
@ BETYMAX	%le	30.	53217555627889368	
@ XCORMS	%le	0.	0000000000000000000	
@ YCORMS	%le	0.	0000000000000000000	
@ DXRMS	%le	1.	95163328969153160	
@ DYRMS	%le	0.	0000000000000000000	
@ DELIAP	%le	v.	00000000000000000000	
@ SYNCH 2	%le	0.	000000000000000000000000000000000000000	
a SYNCH 3	%le	0.	000000000000000000000000000000000000000	
@ SYNCH 4	%le	ő.	0000000000000000000	
@ SYNCH_5	%le	0.	000000000000000000	
@ TITLE	%08s	"no-title"		
@ ORIGIN	%16s	"5.05.01 L	inux 64"	
@ DATE	%08s	"11/06/19"		
@ IIME	3005	-14.1/.20		c
* NAME \$ %<	RE1 9/15	WURD		s %le
"MYACCEL\$START"	' ''M	RKER"	0.00	000000000000000000000000000000000000000
"DRIFT_0"	"DF	RIFT"	0.19	9999999999999999996
"S.ARC.12"	"M	ARKER"	0.39	999999999999999999
"DRIFT_1"	"DF	RIFT"	0.44	1999999999999999996
"MB.1T2"	"SE	BEND"	2.07	/079632679489656
"DRIFT_2"	·· DF	RIFT"	3.65	9159265358979294
"E.ARC.12"	····PF	ARKER"	3./4	159205358979320
"M0.1X2"	"0		4.64	1159265358979312
"DRIFT 4"	"ĎF	RIFT"	5.64	159265358979312
"MQ.2X2"	"QL	JADRUPOLE"	6.64	159265358979312
"DRIFT_5"	"DF	RIFT"	6.77	7659265358979290
"BPM. 2X2"	"MC	NITOR"	7.07	7659265358979361
"DRIFT_6"	"DF	RIFT"	7.94	159265358979294
'TIQ.3X2"	"QL	JADRUPULE"	8.64	159265358979312
"0KIFI_/"	"DF		9.64	+159205358979134
"DRIFT 8"	"QU	TFT"	10.04	409265358979134
"S. ARC. 23"	"M	RKER"	11.54	159265358978992
"DRIFT_9"	"DF	RIFT"	11.59	159265358978885
"MB.2T3"	"SE	BEND"	13.21	238898038468612
"DRIFT_10"	"DF	RIFT"	14.83	3318530717958339
"E.ARC.23"	"M	RKER"	14.88	318530717958232
"DRIFT_11"	"DF	RIFT"	15.29	068530717958296
'MQ.1X3"	"QL	JADRUPOLE''	15.78	3318530717958268

# •We started from the muon collider machine optics from MAP Studies @ 1.5TeV CM Old optics format! (Mad-8) Different conventions from LHC studies Very limited use of markers

	TILT
	%le
0.000000000000	00000
0.000000000000	00000
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#### The Procedure

KICK	HKICK	
%le	%le	
0.00000000000000000	0.000000000000000000	0
0.00000000000000000	0.000000000000000000	0
0.0000000000000000	0.00000000000000000	0
0.00000000000000000	0.00000000000000000	0
0.0000000000000000	0.000000000000000000	0
0.00000000000000000	0.000000000000000000	0
0.0000000000000000	0.00000000000000000	0
0.00000000000000000	0.00000000000000000	0
0.00000000000000000	0.00000000000000000	0
0.00000000000000000	0.000000000000000000	0
0.00000000000000000	0.00000000000000000	0
0.0000000000000000	0.000000000000000000	0
0.00000000000000000	0.000000000000000000	0
0.00000000000000000	0.000000000000000000	0
0.00000000000000000	0.00000000000000000	0
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# • A first Fluka Elements Data Base has been developed with some "First order" magnetic elements geometries: Dipoles and Quadrupoles



#### The Procedure



# •A very first geometry of the whole muon collider (half ring) has been produced...

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### The Procedure



# To Sum Up

- Beam Induced Background in the experimental area of a Muon Collider is mainly due to muon decays from 10-100m from the IP
- A powerful flexible tool for simulating such sections of the machine starting from the optics is needed
- FLUKA Line Builder has been chosen and started to use
  - First magnetic elements and geometries developed

credits: A.Mereghetti @CERN



# Next Steps and Help Needed

- <u>Geometry</u>: •
  - Add missing models for Super Conducting magnets (sextupoles)
  - Verify that the reconstructed optics is closed
  - Build the external shell of the **detector** inside the experimental cavern
- <u>Physics</u>:
  - Setup all the relevant physics cards
- <u>Scoring</u>:
  - Setup scoring of BIB
- **Machine Detector Interface design and** optimisation

Currently involved people: • F. Collamati - INFN Rome

- C. Curatolo INFN Padova
- A. Mereghetti CERN
- P. Sala INFN Milano





