

Beam Induced Background Simulations in FLUKA

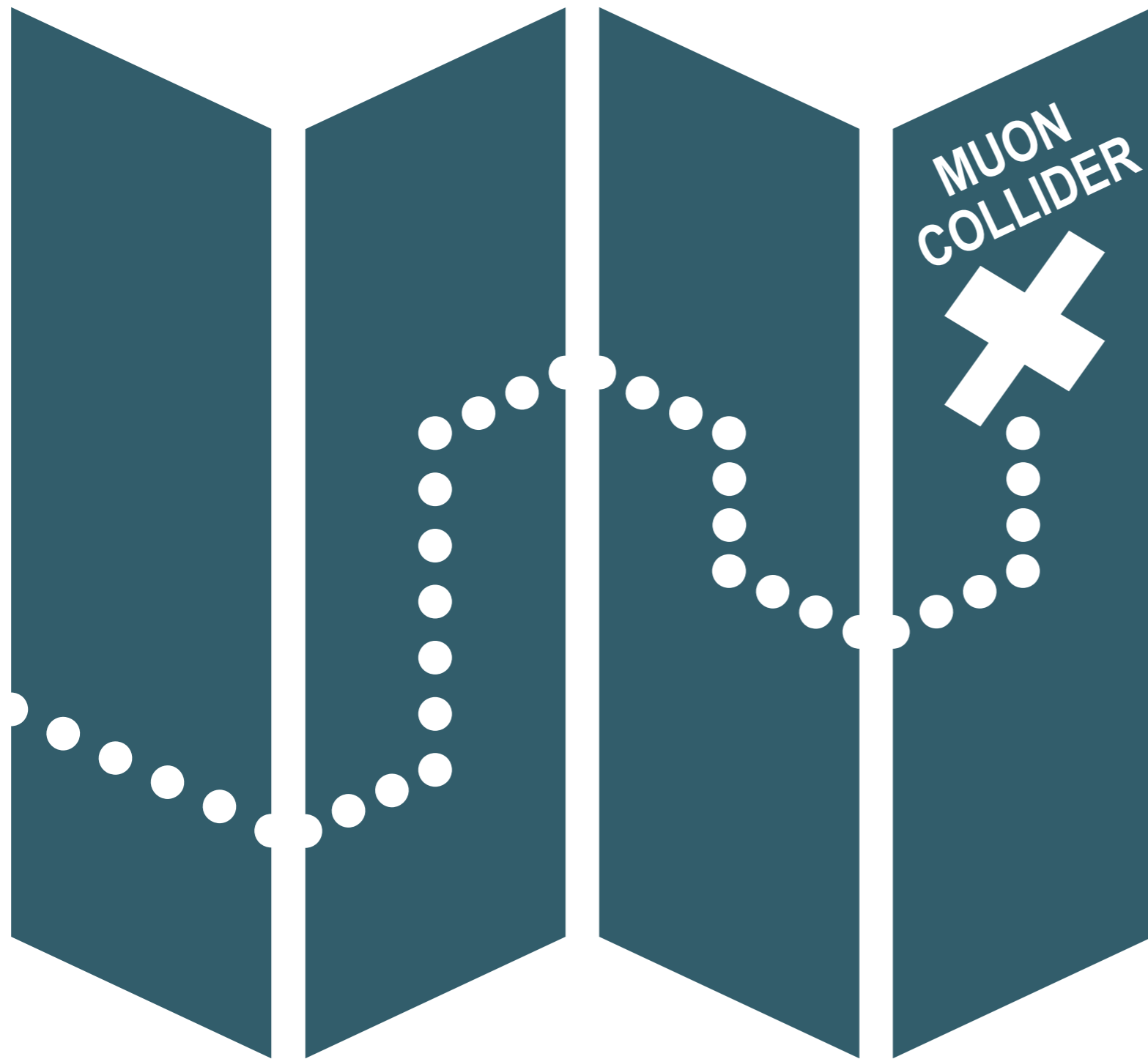
F. Collamati

Workshop on Detector and Physics simulation at a Muon Collider

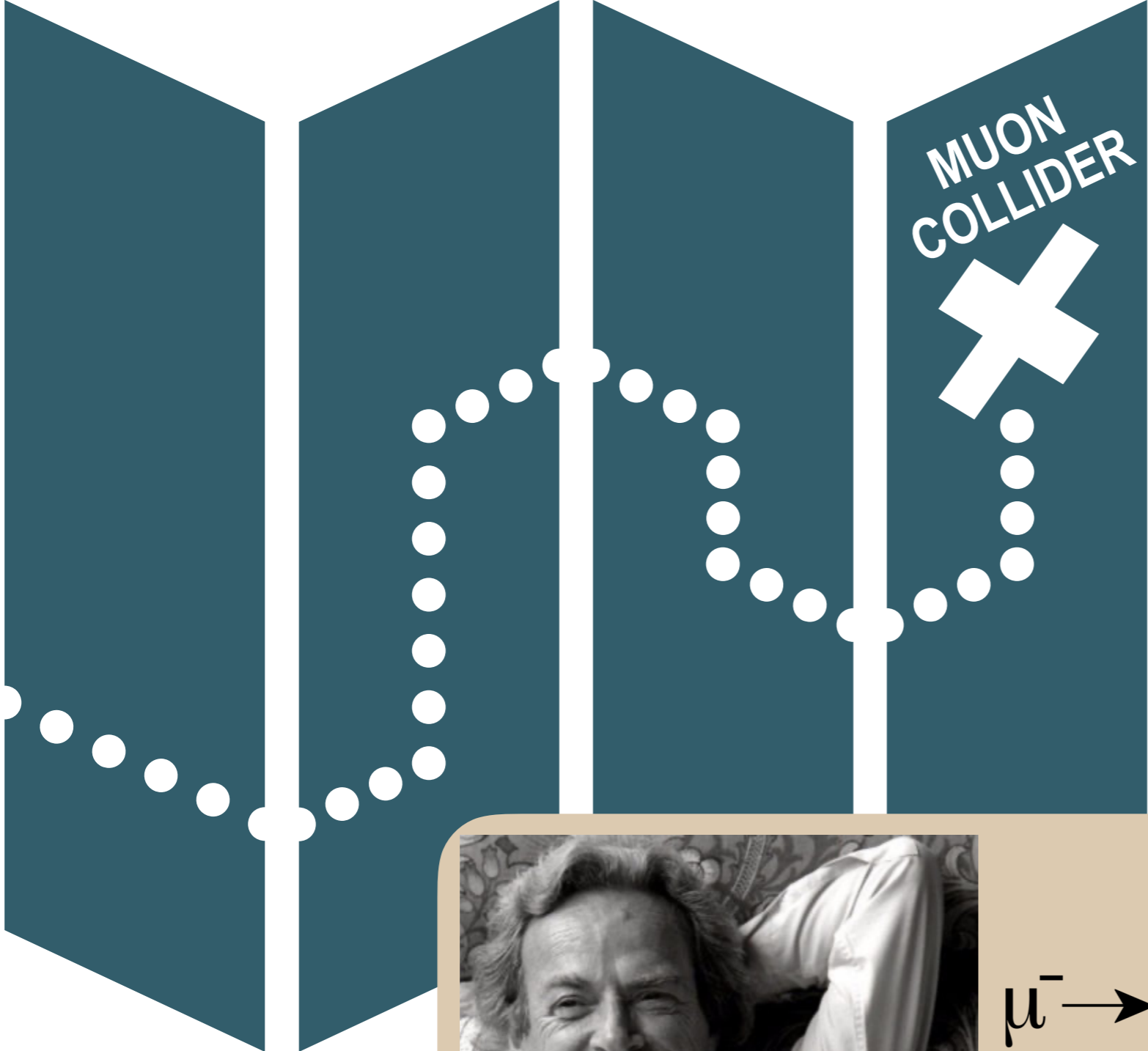
Padova

23/24.1.20

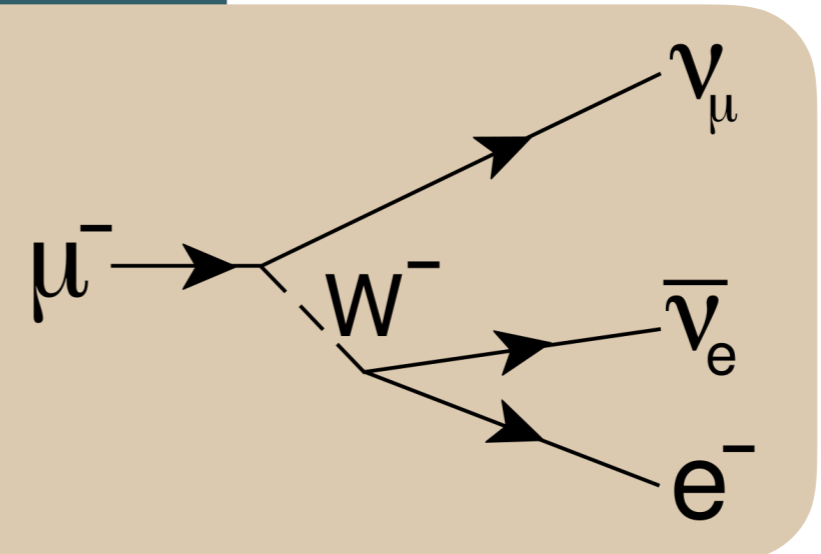
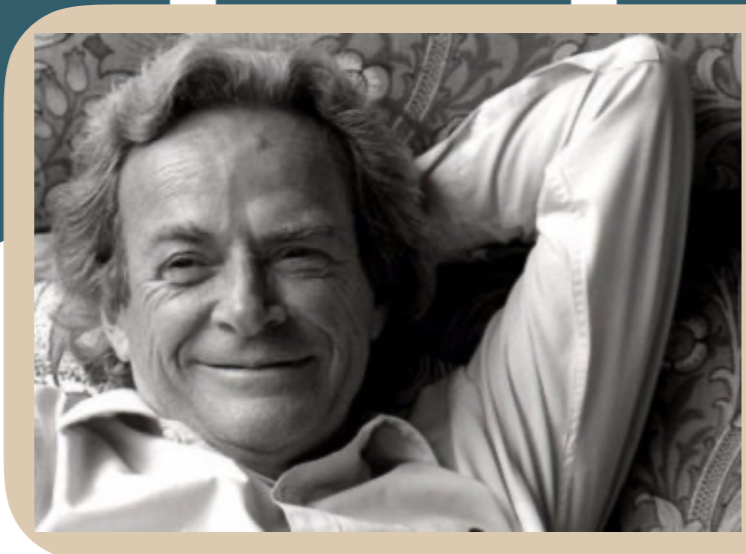




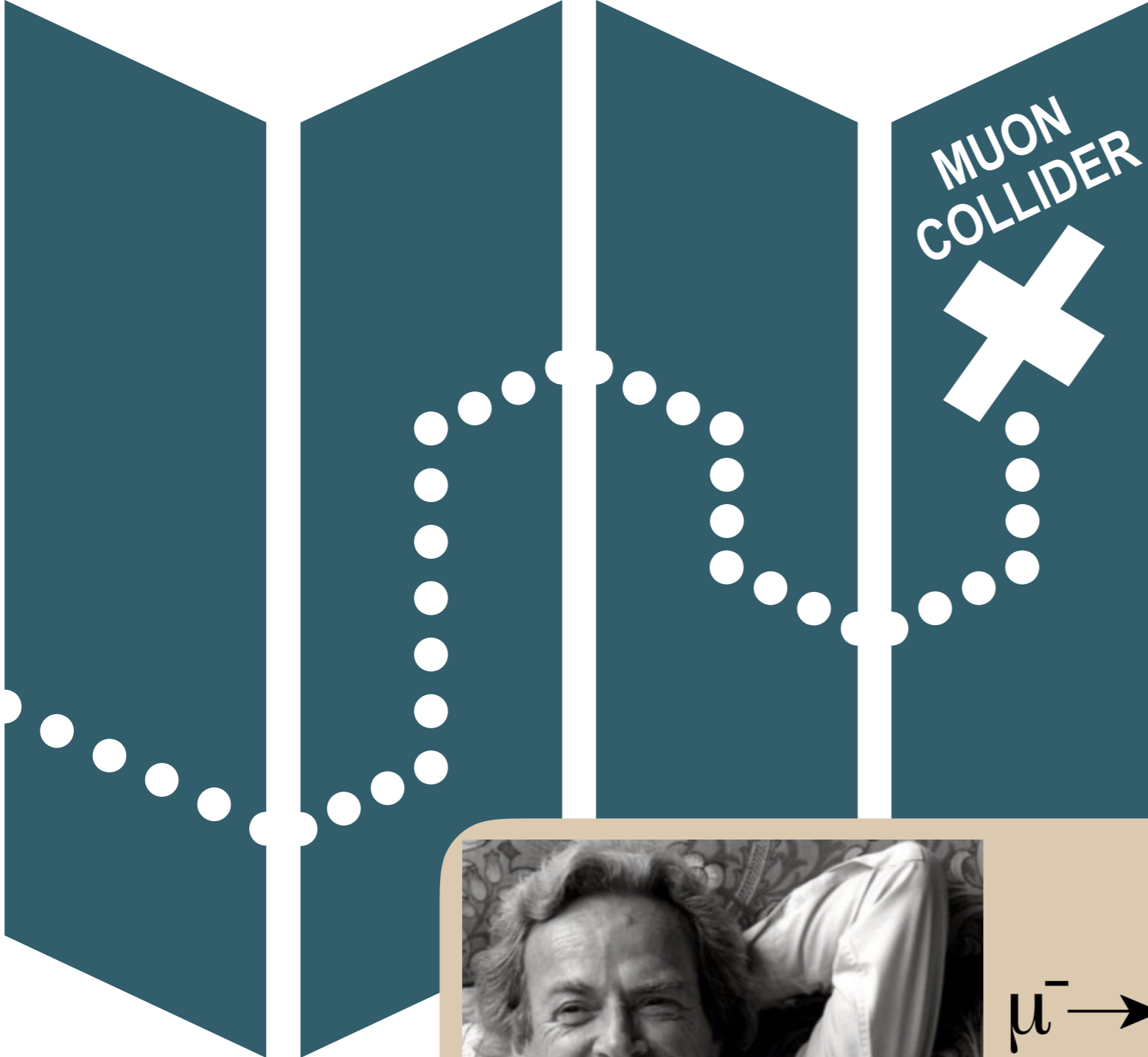
How did we get here?



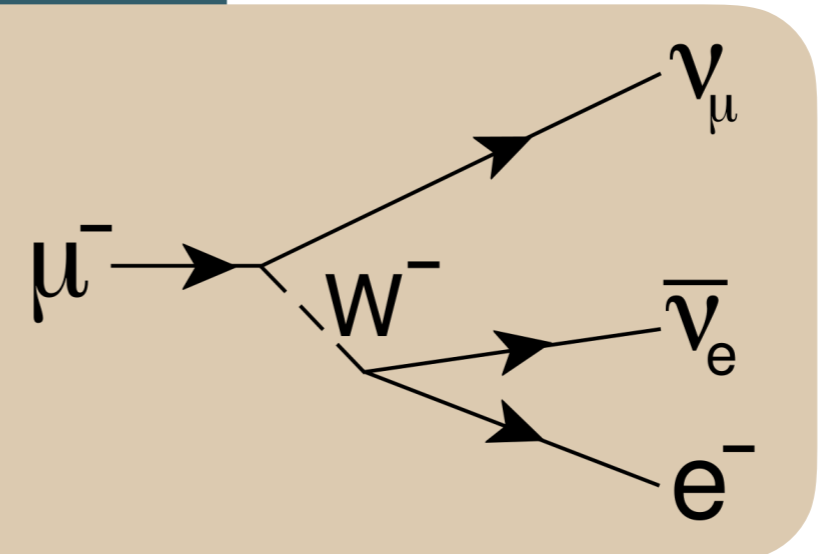
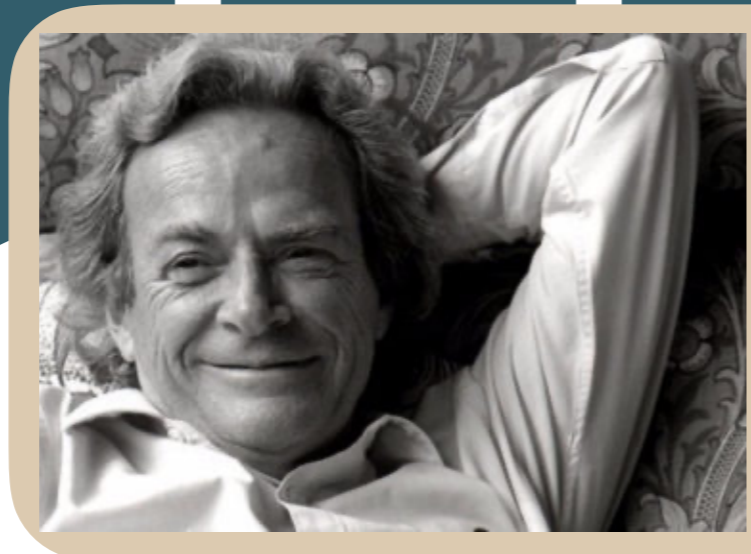
How did we get here?



muons decay!
(all along the machine!)



How did we get here?



muons decay!
(all along the machine!)

→ Magnet quenching

→ Detector bkg

→ Radio protection



**Where are
we now?**

Where are we now?

- In the last months, a first study of Beam Induced Background (**BIB**) has been performed exploiting late **MAP** studies:
 - MARS simulation of $\pm 200\text{m}$ from IP
 - Tungsten nozzles to mitigate bkg in the IR
 - $E_{\text{cm}} = 1.5 \text{ TeV}$

[arXiv:1905.03725]

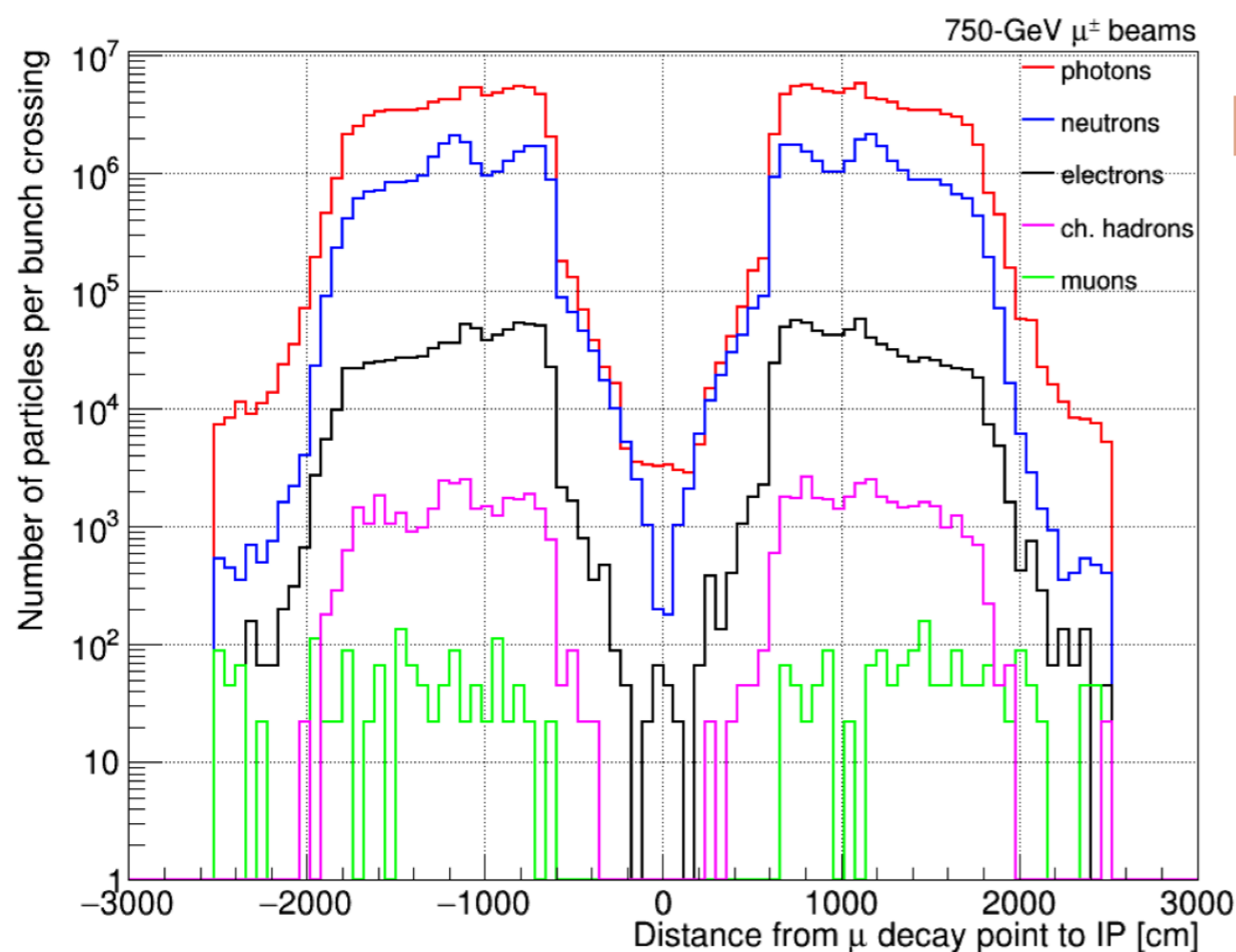
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Beam Induced Background comes from 10s-100s meters from the IP

*depending on E_{cm}

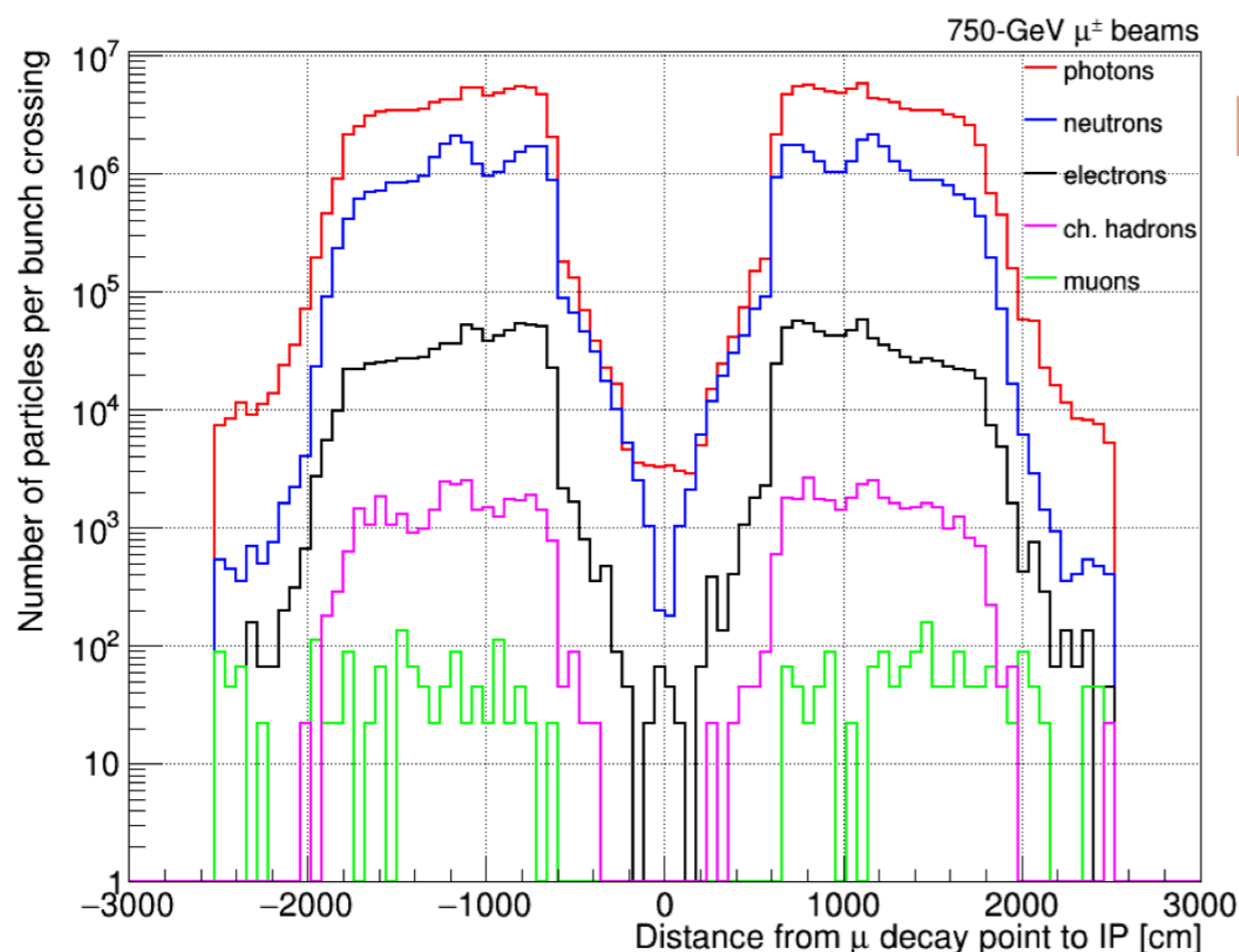
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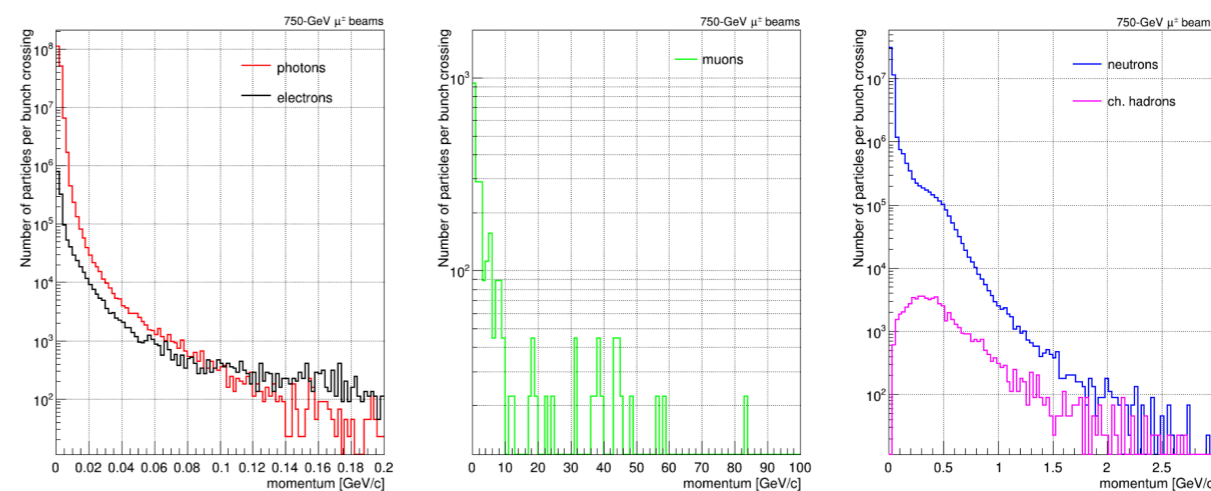
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Beam Induced Background comes from 10s-100s meters from the IP

*depending on E_{cm}



$P_{e/g} \sim \text{MeV}$, $P_{n/ch.h} \sim 500 \text{ MeV}$, $P_{\mu} \sim 10 \text{ GeV}$



Where do we want to go?



Where do we want to go?

- ◆ 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



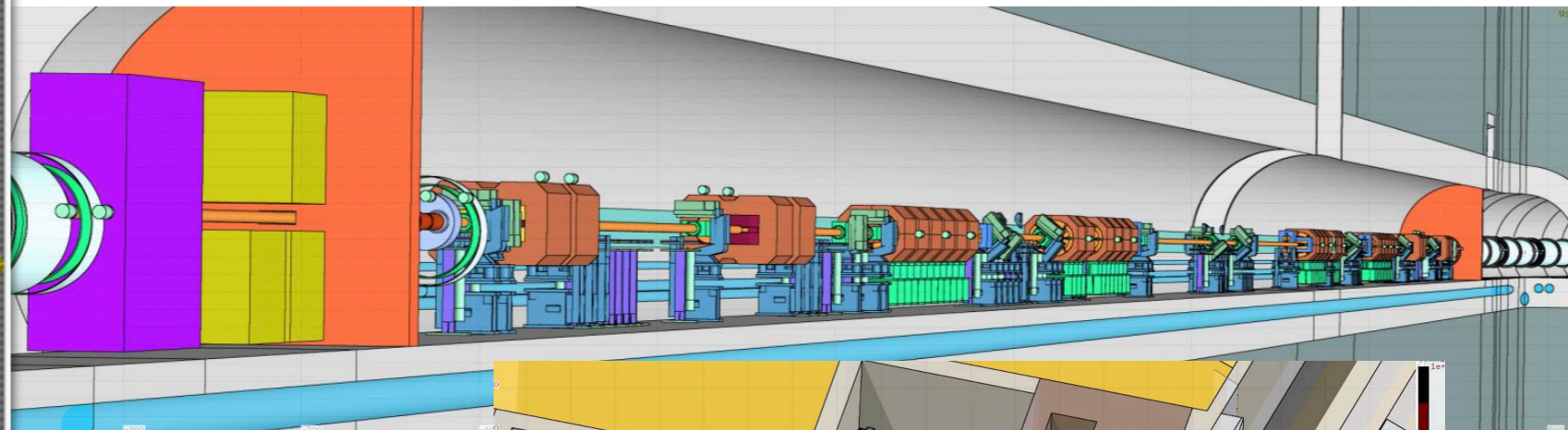
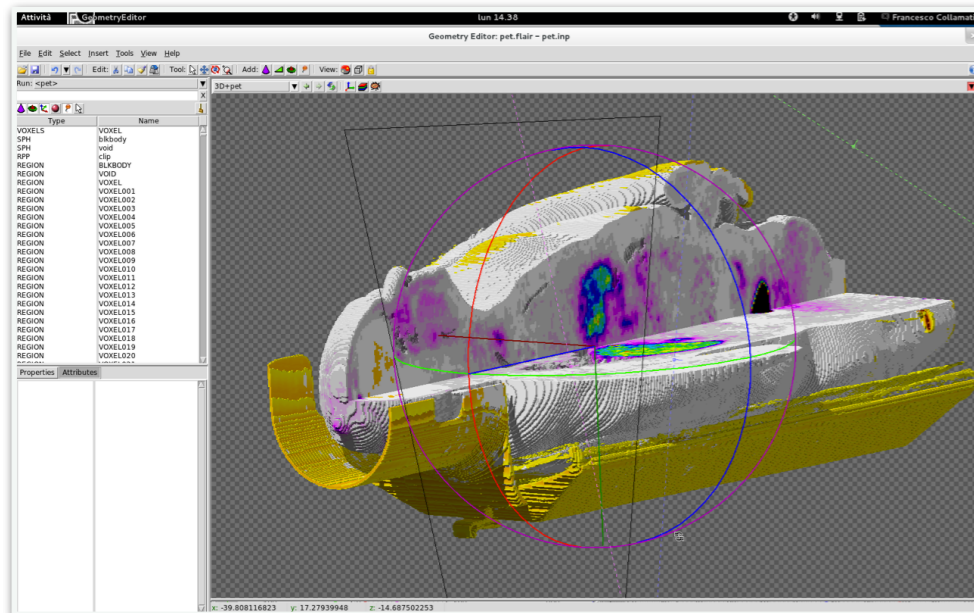
The Tool identification

- ◆ **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**



The Tool identification

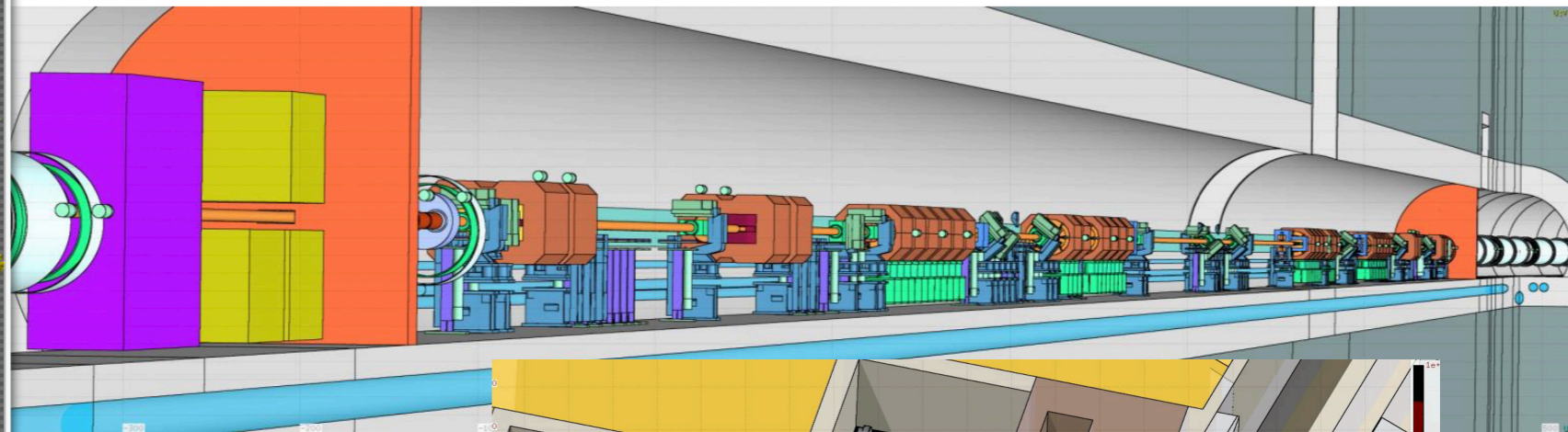
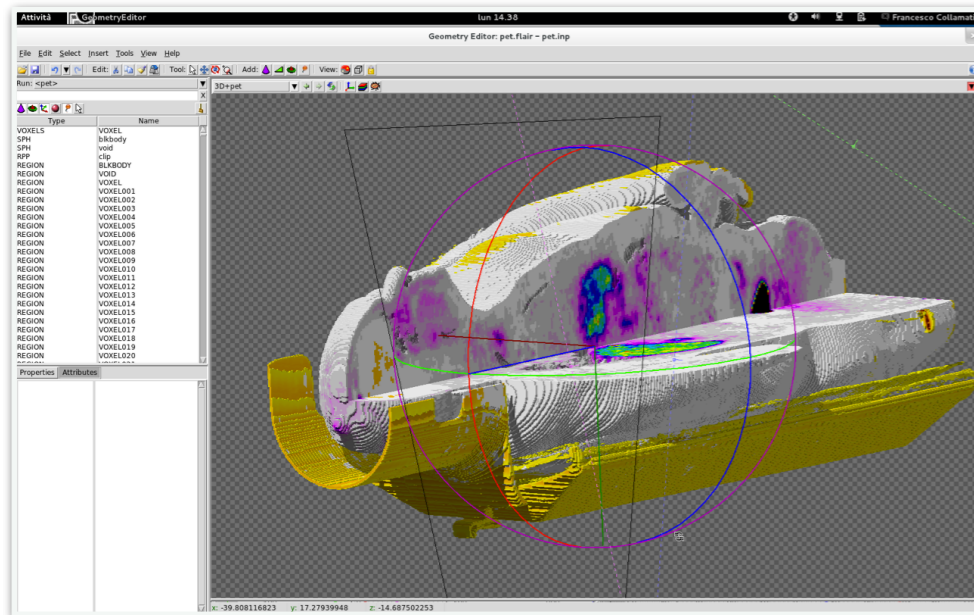
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 - ◆ Natively supports very **complicated** and detailed **geometries**



- ◆ BUT the **manual construction** of such complicated geometries is
 - ◆ **Difficult**
 - ◆ **Not scalable-flexible**
 - ◆ Error prone





The Tool identification

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

credits: A. Mereghetti @CERN

Fluka Element DataBase

Line Builder



The Tool identification

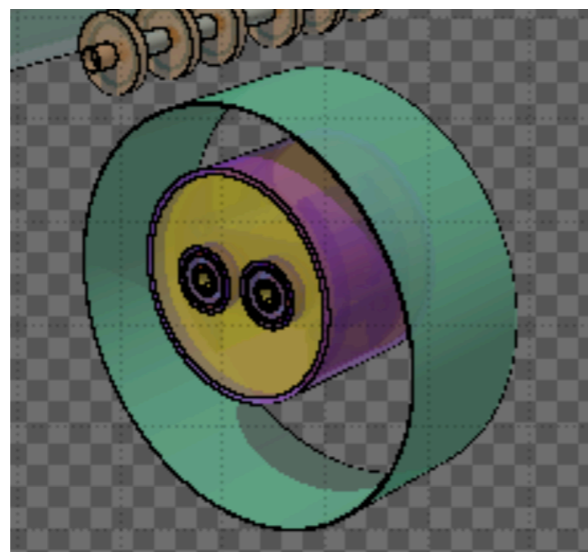
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Fluka Element DataBase

Collection of models of single accelerator devices in Ascii files

```
> tree fedb/
fedb/
├── [4.0K] assemblies
├── [4.0K] bodies
│   ├── [ 787] myacc_MBS.bodies
│   ├── [ 254] myacc_MBSORI.bodies
│   └── [ 103] myacc_MOBODY.bodies
├── [4.0K] materials
│   ├── [2.3K] materials.inp
│   ├── [ 251] myacc_MBS.assignmat
│   ├── [ 135] myacc_MBSORI.assignmat
│   └── [  96] myacc_MOBODY.assignmat
├── [4.0K] regions
│   ├── [ 404] myacc_MBSORI.regions
│   ├── [1.8K] myacc_MBS.regions
│   └── [  90] myacc_MOBODY.regions
├── [4.0K] stepsizes
│   ├── [2.1K] structure.py
│   └── [1.3K] structure.pyc
├── [4.0K] test
│   ├── [ 18] expand.sh -> ../tools/expand.sh
│   ├── [2.1K] flair-autosave.pickle
│   ├── [4.1K] myacc_MB.inp
│   ├── [1.5K] myacc_MBorig.inp
│   ├── [1000] myacc_MQ.inp
│   ├── [ 193] pippo.inp
│   ├── [  21] template.inp -> ../tools/template.inp
│   ├── [3.8K] TestElement_exp.inp
│   ├── [ 865] TestElement.inp
│   └── [  23] TestElement.sh -> ../tools/TestElement.sh
├── [4.0K] tools
│   ├── [6.9K] cut.py
│   ├── [ 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
│   ├── [6.3K] scan-fedb.py
│   ├── [1.1K] split.py
│   ├── [ 796] template.inp
│   ├── [ 13K] test_assembly.py
│   └── [2.1K] TestElement.sh
└── 7 directories, 34 files
```



Line Builder

```
myacc_MBSORI.regions - emacs@pcbe16165
File Edit Options Buffers Tools Help

*
* . yoke
RPP dipyoke      -200.0 20.  -10.0 10.0  -200.0 30.0
YCC MBSORIKo     -200.0 -200.0 210.0
YCC MBSORIKi     -200.0 -200.0 190.0
*
* . pipe
XZP MBS0bpu      1.5
[XZP MBS0bpd     -1.5
YCC MBS0bpo      -200.0 -200.0 203.0
YCC MBS0bpi      -200.0 -200.0 197.0
*

--:-- myacc_MBSORI.bodies All (8,0) (FLUKA Ovwrt)
*
* . yoke
MBSOYOKE 5 | +dipyoke +MBSORIKo -MBSORIKi -MBS0bpu
          | +dipyoke +MBS0bpu -MBS0bpd +MBSORIKo -MBS0bpo
          | +dipyoke +MBS0bpu -MBS0bpd +MBS0bpi -MBSORIKi
          | +dipyoke +MBSORIKo -MBSORIKi +MBS0bpd
*
* . pipe
MBS0BPVC 5 +dipyoke +MBS0bpu -MBS0bpd +MBS0bpo -MBS0bpi
*
* . out
MBS0OUT_ 5 | +dipyoke -MBSORIKo
          | +dipyoke +MBSORIKi
*

--:-- myacc_MBSORI.regions All (4,14) (FLUKA)
* dipole:
* ...+...1...+...2...+...3...+...4...+...5...+...6...+...7...
ASSIGNMA IRON MBSOYOKE
ASSIGNMA VACUUM MBS0BPVC 1.0
ASSIGNMA [X]ACUUM MBS0OUT_
*

--:-- myacc_MBSORI.assignmat All (5,14) (FLUKA)
```

Bending Dipole Prototype



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Fluka Element DataBase

Line Builder

```
File Edit Options Buffers Tools Help
* .....1.....2.....3.....4.....5.....6.....7.....
#include include_define.inp
GLOBAL      10000.0    0.0    0.0    1.0    1.0
TITLE
MY_TITLE_
RANDOMIZ     1.0    1.0
#include include_settings_physics.inp
#include include_settings_beam.inp
*
GEOBEGIN    1.0E-04    1.0    COMBNAME
0 0 MC-CAD
*
RPP  outerb  -3.E8    3.E8    -3.E8    3.E8    -3.E8    3.E8
RPP  innerb  -2.E8    2.E8    -2.E8    2.E8    -2.E8    2.E8
RPP  cont    -1.E8    1.E8    -1500.0  10000.0  -1.E8    1.E8
RPP  park    -3000.0  3000.0  -4000.0  -2000.0    0.0    1.E5
*
$START:build_line:BODIES$
$SEND:build_line:BODIES$
*
END
*
OUTERr    5 +outerb -innerb
INNERr    5 +innerb -cont -park
PARKr    50 +park
*
$START:build_line:PARKING_regions$
$SEND:build_line:PARKING_regions$
*
$START:build_line:REGIONS$
$SEND:build_line:REGIONS$
*
END
*
$START:build_line:LATTICES$
$SEND:build_line:LATTICES$
*
GEOEND
*
FREE
*
$START:build_line:ROT-DEFIS$
$SEND:build_line:ROT-DEFIS$
*
FIXED
*
ASSIGNMA  BLCKHOLE  OUTERr
ASSIGNMA  BLCKHOLE  INNERr
ASSIGNMA   GOLD     PARKr
*
*
$START:build_line:ASSIGNMAS$
$SEND:build_line:ASSIGNMAS$
*
#include include_custom_assignmat.inp
*
FREE
*
$START:build_line:USRCALLS$
$SEND:build_line:USRCALLS$
*
FIXED
*
MGNFIELD    30.0    0.0001    0.01    0.0    0.0    0.0
*
$START:build_line:STEPSIZES$
$SEND:build_line:STEPSIZES$
*
#include include_custom_biasing.inp
*
$START:build_line:SCORINGS$
$SEND:build_line:SCORINGS$
*
#include include_custom_scoring.inp
*
This statement is un-commented by the configure.sh in case of direct
loss scenario: the file contains USRCALL cards, providing the
source routine for losses on LHC collimators with further collimator
settings
#include include_colspe.inp
*
Number of primaries
START    2.00+09
STOP
*
*
$START:build_line:ROT-DEFIS$
$SEND:build_line:ROT-DEFIS$
*
FIXED
*
generic_frame.fluka Top (47,0) Git-master (FLUKA)
generic_frame.fluka Bot (77,27) Git-master (FLUKA)
```

Python (v2.7)
program that inserts
the needed
magnetic elements
in a pre-existent
“template geometry”



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Line Builder

FINAL RESULT

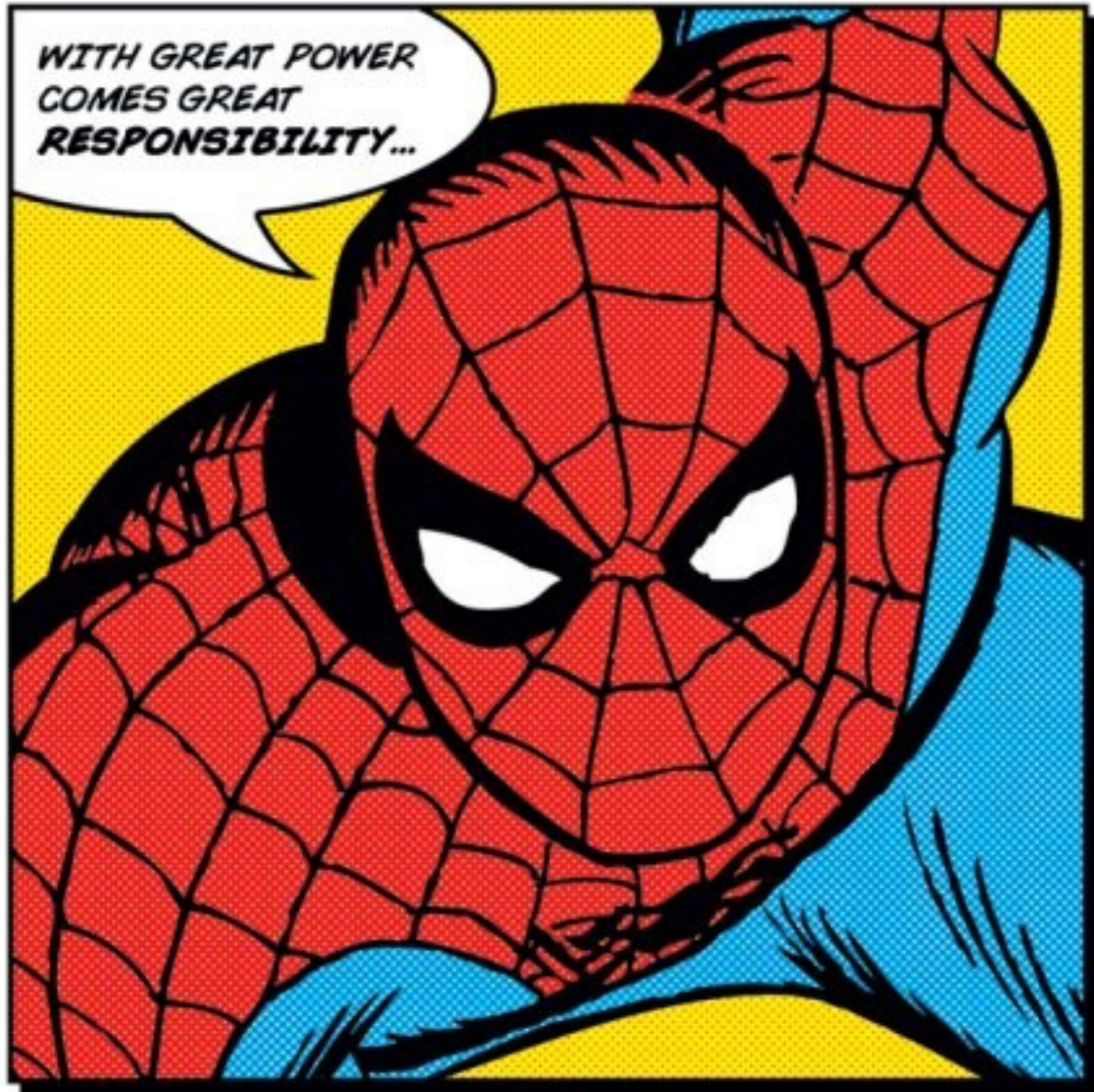
+ tunnel shape/ geometry

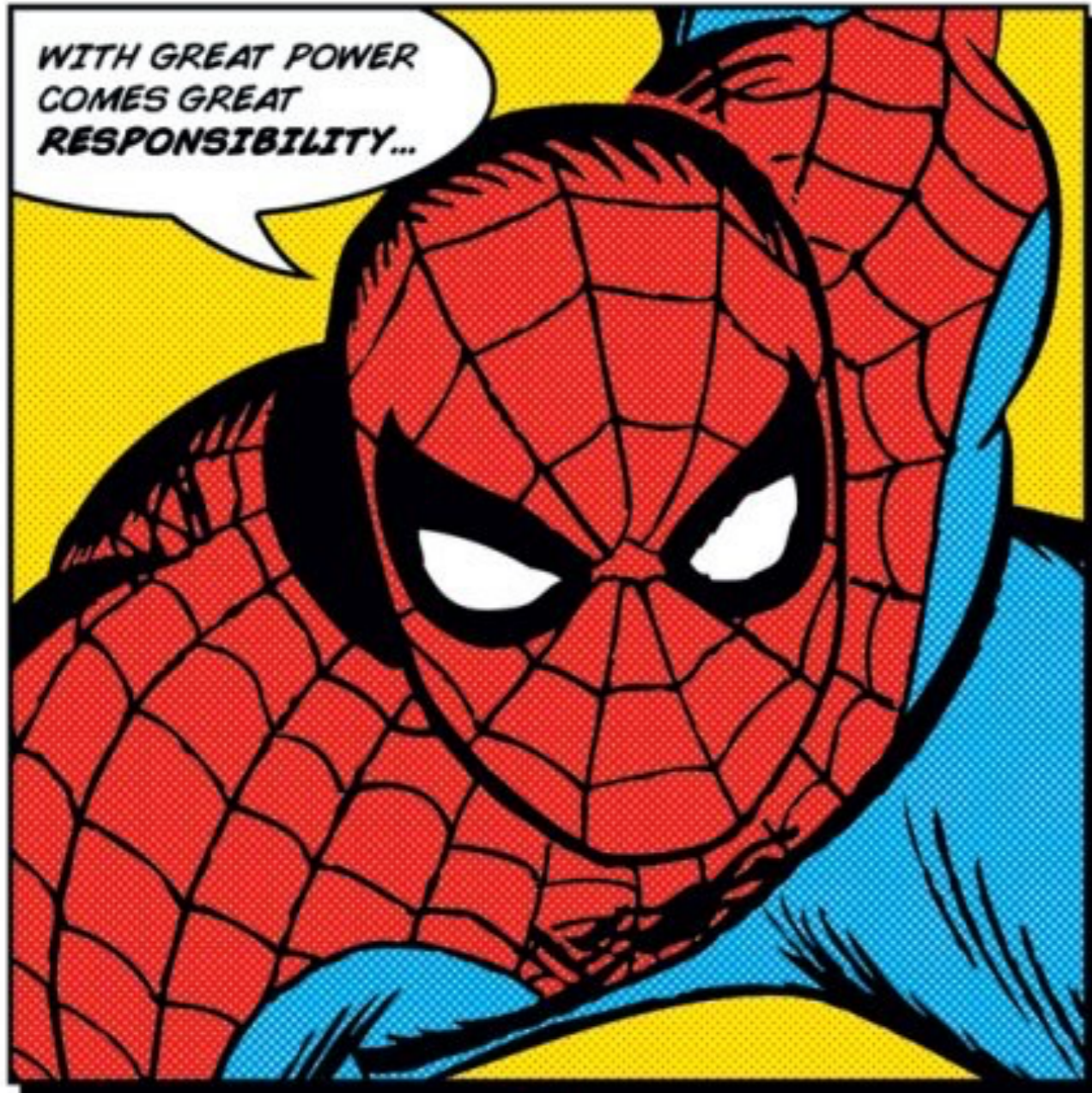
Actual Fluka geometry (with tunnels, magfields, scorings, etc...)
REPLICAs of models

Parking region: collection of Fluka **MODEL**s (**PROTOTYPE**s/**ASSEMBLIE**s) of single devices

The screenshot shows a 3D visualization of an accelerator tunnel with various components like magnets and RF cavities. A 2D top-down view of the parking region is also visible, showing the layout of individual device models. The interface includes a 3D view on the left, a 2D top-down view on the right, and a bottom panel with a coordinate system and labels for different components.

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





WITH GREAT POWER
COMES GREAT
RESPONSIBILITY...



TO REACH HIGH
PRECISION WE HAVE
TO GIVE HIGH
PRECISION



→ **FLUKA LINE BUILDER** needs to know in detail our machine!



FLUKA LINE BUILDER

Ingredients lists:
(minimal)

- ✓ Machine optics file
- ✓ Magnetic fields
- ✓ Accelerator
elements description
- ✓ Primary beam
characteristics



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TWISS FILE

- ◆ Typically generated running MADX on the optics file, contains (for each point along the s coordinate):
 - ◆ Name, size and positioning of the **element** to place
 - ◆ **Strength** for different kind of magnets (dipoles, quads, kick..)
 - ◆ Linear optics functions



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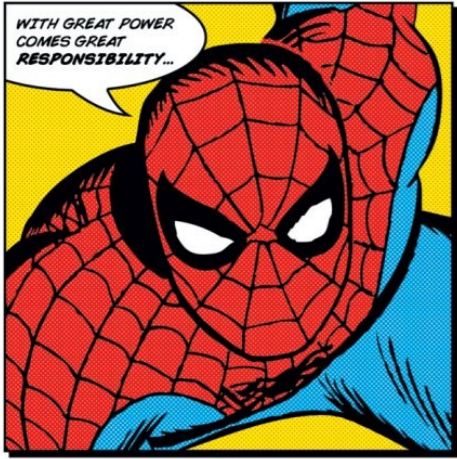
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```
@ TIME %08s "14.17.20"
* NAME KEYWORD S L TILT KICK HKICK VKICK ANGLE KOL
$ %s %s %le %le %le %le %le %le %le %le
"MYACCEL$START" "MARKER" 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_0" "DRIFT" 0.1999999999999999 0.3999999999999999 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"S. ARC. 12" "MARKER" 0.3999999999999999 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_1" "DRIFT" 0.4499999999999999 0.1000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"MB. 1T2" "SBEND" 2.07079632679489656 3.14159265358979312 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 1.57079632679489656 0.0000000000000000
"DRIFT_2" "DRIFT" 3.69159265358979294 0.1000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"E. ARC. 12" "MARKER" 3.74159265358979320 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_3" "DRIFT" 4.14909265358979340 0.81499999999999995 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"MQ. 1X2" "QUADRUPOLE" 4.64159265358979312 0.1700000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_4" "DRIFT" 5.64159265358979312 1.8300000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"MQ. 2X2" "QUADRUPOLE" 6.64159265358979312 0.1700000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_5" "DRIFT" 6.77659265358979290 0.1000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"BPM. 2X2" "MONITOR" 7.07659265358979361 0.5000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_6" "DRIFT" 7.94159265358979294 1.22999999999999865 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"MQ. 3X2" "QUADRUPOLE" 8.64159265358979312 0.1700000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_7" "DRIFT" 9.64159265358979134 1.82999999999999829 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"MQ. 4X2" "QUADRUPOLE" 10.64159265358979134 0.1700000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_8" "DRIFT" 11.13409265358978928 0.81499999999999950 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"S. ARC. 23" "MARKER" 11.54159265358978992 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_9" "DRIFT" 11.59159265358978885 0.09999999999999964 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"MB. 2T3" "SBEND" 13.21238898038468612 3.14159265358979312 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_10" "DRIFT" 14.83318530717958339 0.09999999999999964 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"E. ARC. 23" "MARKER" 14.88318530717958232 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_11" "DRIFT" 15.29068530717958296 0.81499999999999950 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"MQ. 1X3" "QUADRUPOLE" 15.78318530717958268 0.1700000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_12" "DRIFT" 16.78318530717957913 1.82999999999999829 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"MQ. 2X3" "QUADRUPOLE" 17.78318530717957913 0.1700000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_13" "DRIFT" 17.91818530717957714 0.09999999999999978 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"TCP. 2X3" "RCOLLIMATOR" 18.21818530717957785 0.5000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_14" "DRIFT" 19.08318530717957628 1.2300000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"MQ. 3X3" "QUADRUPOLE" 19.78318530717957913 0.1700000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
"DRIFT_15" "DRIFT" 20.78318530717957913 1.82999999999999829 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000 0.0000000000000000
```

It tells the LB where to place what



FLUKA LINE BUILDER

Ingredients lists:
(minimal)

- ✓ Machine optics file
- ✓ Magnetic fields
- ✓ Accelerator elements description
- ✓ Primary beam characteristics

The LB needs also to know what to place there!

- ◆ Technically speaking is a **FLUKA-like description** of the **single element** prototype
- ◆ Three files:
 - ✓ *Bodies* definition
 - ✓ *Regions* definition
 - ✓ *Materials* assignment
 - + *Assembly*: if defining a complex entity (e.g. dipole with moving collimator)
- ✓ In order to ensure code quality and portability naming and ref. syst. conventions are suggested
 - ✓ e.g. myacc_MQBODY.bodies



FLUKA LINE BUILDER Recipe

```
> l
total 192K
drwxrwxr-x 9 amereghe amereghe 4.0K Jun  4 22:49 fedb/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  4 22:52 optics/
-rw-r--r-- 1 amereghe amereghe 3.5K Jun  5 11:31 TU_profile.txt
-rw-r--r-- 1 amereghe amereghe 2.9K Jun  5 15:31 tunnel_DS.inp
-rw-r--r-- 1 amereghe amereghe 28K Jun  7 16:24 customize_tws_parser.py
-rw-r--r-- 1 amereghe amereghe 11K Jun  7 16:24 customize_tws_parser.pyc
-rw-r--r-- 1 amereghe amereghe 23K Jun  7 16:53 customize_geo_builder.py
-rw-r--r-- 1 amereghe amereghe 8.3K Jun  7 16:53 customize_geo_builder.pyc
-rw-r--r-- 1 amereghe amereghe 1.8K Jun  7 17:34 prototypes.tbp
-rw----- 1 amereghe amereghe 1.7K Jun  7 17:45 inputcard.txt
-rw-r--r-- 1 amereghe amereghe 6.9K Jun  7 18:01 BP_profile.txt
-rw-rw-r-- 1 amereghe amereghe 175 Jun  7 18:15 statistics.bk.txt
-rw-rw-r-- 1 amereghe amereghe 498 Jun  7 18:15 list_of_replica.bk.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  7 18:15 myGeometry.bk.inp
-rw-rw-r-- 1 amereghe amereghe 175 Jun  8 09:37 statistics.txt
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 out/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 log/
-rw-rw-r-- 1 amereghe amereghe 498 Jun  8 09:37 list_of_replica.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  8 09:37 myGeometry.inp
-rw-rw-r-- 1 amereghe amereghe 332 Jun  9 09:10 commands.txt
```

```
-LM-LM-L-- J 9w6L6dµ6 9w6L6dµ6 335 1µu 8 08:10 commands.txt
-LM-LM-L-- J 9w6L6dµ6 9w6L6dµ6 51K 1µu 8 08:31 wlc6ow6f1y.1µb
-LM-LM-L-- J 9w6L6dµ6 9w6L6dµ6 488 1µu 8 08:31 112f_0f_16b11c9.txt
qLMXLMLXL-X 5 9w6L6dµ6 9w6L6dµ6 4'0K 1µu 8 08:31 f0d\
qLMXLMLXL-X 5 9w6L6dµ6 9w6L6dµ6 4'0K 1µu 8 08:31 onf\
-LM-LM-L-- J 9w6L6dµ6 9w6L6dµ6 112 1µu 8 08:31 21612212c5.txt
-LM-LM-L-- J 9w6L6dµ6 9w6L6dµ6 51K 1µu 8 10:12 07660611x10v1µu
```



FLUKA LINE BUILDER

Recipe

✓ A general config file:
inputcard.txt

```
> l
total 192K
drwxrwxr-x 9 amereghe amereghe 4.0K Jun  4 22:49 fedb/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  4 22:52 optics/
-rw-r--r-- 1 amereghe amereghe 3.5K Jun  5 11:31 TU_profile.txt
-rw-r--r-- 1 amereghe amereghe 2.9K Jun  5 15:31 tunnel_DS.inp
-rw-r--r-- 1 amereghe amereghe 28K Jun  7 16:24 customize_tws_parser.py
-rw-r--r-- 1 amereghe amereghe 11K Jun  7 16:24 customize_tws_parser.pyc
-rw-r--r-- 1 amereghe amereghe 23K Jun  7 16:53 customize_geo_builder.py
-rw-r--r-- 1 amereghe amereghe 8.3K Jun  7 16:53 customize_geo_builder.pyc
-rw-r--r-- 1 amereghe amereghe 1.8K Jun  7 17:34 prototypes.tbp
-rw----- 1 amereghe amereghe 1.7K Jun  7 17:45 inputcard.txt
-rw-r--r-- 1 amereghe amereghe 6.9K Jun  7 18:01 BP_profile.txt
-rw-rw-r-- 1 amereghe amereghe 175 Jun  7 18:15 statistics.bk.txt
-rw-rw-r-- 1 amereghe amereghe 498 Jun  7 18:15 list_of_replica.bk.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  7 18:15 myGeometry.bk.inp
-rw-rw-r-- 1 amereghe amereghe 175 Jun  8 09:37 statistics.txt
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 out/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 log/
-rw-rw-r-- 1 amereghe amereghe 498 Jun  8 09:37 list_of_replica.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  8 09:37 myGeometry.inp
-rw-rw-r-- 1 amereghe amereghe 332 Jun  9 09:10 commands.txt
```

```
-LM-LM-L-- J 9w6Le6me 9w6Le6me 335 juu 8 08:10 commands.txt
-LM-LM-L-- J 9w6Le6me 9w6Le6me 51K juu 8 08:31 wlc6owefly.tub
-LM-LM-L-- J 9w6Le6me 9w6Le6me 488 juu 8 08:31 list_of_replica.txt
qLMXLMLX-L X 9w6Le6me 9w6Le6me 4'0K juu 8 08:31 fod\
qLMXLMLX-L X 9w6Le6me 9w6Le6me 4'0K juu 8 08:31 onf\
-LM-LM-L-- J 9w6Le6me 9w6Le6me 112 juu 8 08:31 g1e1t2tcs.txt
-LM-LM-L-- J 9w6Le6me 9w6Le6me 51K juu 8 08:32 07e60e1t1x10v'000
```



FLUKA LINE BUILDER Recipe

- ✓ A general config file:
inputcard.txt
- ✓ The list of used prototypes:
prototypes.lbp

```
> l
total 192K
drwxrwxr-x 9 amereghe amereghe 4.0K Jun  4 22:49 fedb/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  4 22:52 optics/
-rw-r--r-- 1 amereghe amereghe 3.5K Jun  5 11:31 TU_profile.txt
-rw-r--r-- 1 amereghe amereghe 2.9K Jun  5 15:31 tunnel_DS.inp
-rw-r--r-- 1 amereghe amereghe 28K Jun  7 16:24 customize_tws_parser.py
-rw-r--r-- 1 amereghe amereghe 11K Jun  7 16:24 customize_tws_parser.pyc
-rw-r--r-- 1 amereghe amereghe 23K Jun  7 16:53 customize_geo_builder.py
-rw-r--r-- 1 amereghe amereghe 8.3K Jun  7 16:53 customize_geo_builder.pyc
-rw-r--r-- 1 amereghe amereghe 1.8K Jun  7 17:34 prototypes.lbp
-rw----- 1 amereghe amereghe 1.7K Jun  7 17:45 inputcard.txt
-rw-r--r-- 1 amereghe amereghe 6.9K Jun  7 18:01 BP_profile.txt
-rw-rw-r-- 1 amereghe amereghe 175 Jun  7 18:15 statistics.bk.txt
-rw-rw-r-- 1 amereghe amereghe 498 Jun  7 18:15 list_of_replica.bk.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  7 18:15 myGeometry.bk.inp
-rw-rw-r-- 1 amereghe amereghe 175 Jun  8 09:37 statistics.txt
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 out/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 log/
-rw-rw-r-- 1 amereghe amereghe 498 Jun  8 09:37 list_of_replica.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  8 09:37 myGeometry.inp
-rw-rw-r-- 1 amereghe amereghe 332 Jun  9 09:10 commands.txt
```

```
-LM-LM-L-- J 9w6Le0ne 9w6Le0ne 335 juu 0 00:10 commanqs.txt
-LM-LM-L-- J 9w6Le0ne 9w6Le0ne 51K juu 8 00:31 wlc0w0eFlY.TuB
-LM-LM-L-- J 9w6Le0ne 9w6Le0ne 408 juu 8 00:31 fTzf of repJtca.txt
qLMXLMLX-L X 9w6Le0ne 9w6Le0ne 4'0K juu 8 00:31 fo0\
qLMXLMLX-L X 9w6Le0ne 9w6Le0ne 4'0K juu 8 00:31 onf\
-LM-LM-L-- J 9w6Le0ne 9w6Le0ne 112 juu 8 00:31 g0eTgTcs.txt
-LM-LM-L-- J 9w6Le0ne 9w6Le0ne 51K juu 8 00:32 07e00eTtX0vT00
```



FLUKA LINE BUILDER

Recipe

- ✓ A general config file:
inputcard.txt
- ✓ The list of used prototypes:
prototypes.lbp
- ✓ Beam Pipe characteristics
(extension, shape.):
BP_profile.txt

```
> l
total 192K
drwxrwxr-x 9 amereghe amereghe 4.0K Jun  4 22:49 fedb/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  4 22:52 optics/
-rw-r--r-- 1 amereghe amereghe 3.5K Jun  5 11:31 TU_profile.txt
-rw-r--r-- 1 amereghe amereghe 2.9K Jun  5 15:31 tunnel_DS.inp
-rw-r--r-- 1 amereghe amereghe 28K Jun  7 16:24 customize_tws_parser.py
-rw-r--r-- 1 amereghe amereghe 11K Jun  7 16:24 customize_tws_parser.pyc
-rw-r--r-- 1 amereghe amereghe 23K Jun  7 16:53 customize_geo_builder.py
-rw-r--r-- 1 amereghe amereghe 8.3K Jun  7 16:53 customize_geo_builder.pyc
-rw-r--r-- 1 amereghe amereghe 1.8K Jun  7 17:34 prototypes.lbp
-rw-r--r-- 1 amereghe amereghe 1.7K Jun  7 17:45 inputcard.txt
-rw-r--r-- 1 amereghe amereghe 6.9K Jun  7 18:01 BP_profile.txt
-rw-rw-r-- 1 amereghe amereghe 175 Jun  7 18:15 statistics.bk.txt
-rw-rw-r-- 1 amereghe amereghe 498 Jun  7 18:15 list_of_replica.bk.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  7 18:15 myGeometry.bk.inp
-rw-rw-r-- 1 amereghe amereghe 175 Jun  8 09:37 statistics.txt
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 out/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 log/
-rw-rw-r-- 1 amereghe amereghe 498 Jun  8 09:37 list_of_replica.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  8 09:37 myGeometry.inp
-rw-rw-r-- 1 amereghe amereghe 332 Jun  9 09:10 commands.txt
```

```
-LM-LM-L-- J 9w6Le6me 9w6Le6me 332 juu 8 08:10 commands.txt
-LM-LM-L-- J 9w6Le6me 9w6Le6me 332 juu 8 08:31 wlc6owefly.tub
-LM-LM-L-- J 9w6Le6me 9w6Le6me 488 juu 8 08:31 list_of_replica.txt
qLMXLMLX-L X 9w6Le6me 9w6Le6me 4'0K juu 8 08:31 fod\
qLMXLMLX-L X 9w6Le6me 9w6Le6me 4'0K juu 8 08:31 onf\
-LM-LM-L-- J 9w6Le6me 9w6Le6me 132 juu 8 08:31 g1e1t2tcs.txt
-LM-LM-L-- J 9w6Le6me 9w6Le6me 332 juu 8 08:32 07e606t1x707700
```



FLUKA LINE BUILDER Recipe

- ✓ A general config file:
inputcard.txt
- ✓ The list of used prototypes:
prototypes.lbp
- ✓ Beam Pipe characteristics
(extension, shape.):
BP_profile.txt
- ✓ The Fluka Element Data
Base:
fedb/

```
> l
total 192K
drwxrwxr-x 9 amereghe amereghe 4.0K Jun  4 22:49 fedb/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  4 22:52 optics/
-rw-r--r-- 1 amereghe amereghe 3.5K Jun  5 11:31 TU_profile.txt
-rw-r--r-- 1 amereghe amereghe 2.9K Jun  5 15:31 tunnel_DS.inp
-rw-r--r-- 1 amereghe amereghe 28K Jun  7 16:24 customize_tws_parser.py
-rw-r--r-- 1 amereghe amereghe 11K Jun  7 16:24 customize_tws_parser.pyc
-rw-r--r-- 1 amereghe amereghe 23K Jun  7 16:53 customize_geo_builder.py
-rw-r--r-- 1 amereghe amereghe 8.3K Jun  7 16:53 customize_geo_builder.pyc
-rw-r--r-- 1 amereghe amereghe 1.8K Jun  7 17:34 prototypes.lbp
-rw----- 1 amereghe amereghe 1.7K Jun  7 17:45 inputcard.txt
-rw-r--r-- 1 amereghe amereghe 6.9K Jun  7 18:01 BP_profile.txt
-rw-rw-r-- 1 amereghe amereghe 175 Jun  7 18:15 statistics.bk.txt
-rw-rw-r-- 1 amereghe amereghe 498 Jun  7 18:15 list_of_replica.bk.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  7 18:15 myGeometry.bk.inp
-rw-rw-r-- 1 amereghe amereghe 175 Jun  8 09:37 statistics.txt
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 out/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 log/
-rw-rw-r-- 1 amereghe amereghe 498 Jun  8 09:37 list_of_replica.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  8 09:37 myGeometry.inp
-rw-rw-r-- 1 amereghe amereghe 332 Jun  9 09:10 commands.txt
```

```
-LM-LM-L-- J 9w6Le6me 9w6Le6me 335 juu 8 08:10 commands.txt
-LM-LM-L-- J 9w6Le6me 9w6Le6me 51K juu 8 08:31 wlc6owefly.tub
-LM-LM-L-- J 9w6Le6me 9w6Le6me 488 juu 8 08:31 list_of_replica.txt
qLMXLMLX-L X 9w6Le6me 9w6Le6me 4'0K juu 8 08:31 fod\
qLMXLMLX-L X 9w6Le6me 9w6Le6me 4'0K juu 8 08:31 onf\
-LM-LM-L-- J 9w6Le6me 9w6Le6me 112 juu 8 08:31 g19t2tcs.txt
-LM-LM-L-- J 9w6Le6me 9w6Le6me 51K juu 8 08:32 07660611x70700
```



FLUKA LINE BUILDER Recipe

- ✓ A general config file:
inputcard.txt
- ✓ The list of used prototypes:
prototypes.lbp
- ✓ Beam Pipe characteristics
(extension, shape.):
BP_profile.txt
- ✓ The Fluka Element Data
Base:
febd/
- ✓ The optics directory:
optics/

```
> l
total 192K
drwxrwxr-x 9 amereghe amereghe 4.0K Jun  4 22:49 febd/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  4 22:52 optics/
-rw-r--r-- 1 amereghe amereghe 3.5K Jun  5 11:31 TU_profile.txt
-rw-r--r-- 1 amereghe amereghe 2.9K Jun  5 15:31 tunnel_DS.inp
-rw-r--r-- 1 amereghe amereghe 28K Jun  7 16:24 customize_tws_parser.py
-rw-r--r-- 1 amereghe amereghe 11K Jun  7 16:24 customize_tws_parser.pyc
-rw-r--r-- 1 amereghe amereghe 23K Jun  7 16:53 customize_geo_builder.py
-rw-r--r-- 1 amereghe amereghe 8.3K Jun  7 16:53 customize_geo_builder.pyc
-rw-r--r-- 1 amereghe amereghe 1.8K Jun  7 17:34 prototypes.lbp
-rw----- 1 amereghe amereghe 1.7K Jun  7 17:45 inputcard.txt
-rw-r--r-- 1 amereghe amereghe 6.9K Jun  7 18:01 BP_profile.txt
-rw-rw-r-- 1 amereghe amereghe 175 Jun  7 18:15 statistics.bk.txt
-rw-rw-r-- 1 amereghe amereghe 498 Jun  7 18:15 list_of_replica.bk.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  7 18:15 myGeometry.bk.inp
-rw-rw-r-- 1 amereghe amereghe 175 Jun  8 09:37 statistics.txt
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 out/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 log/
-rw-rw-r-- 1 amereghe amereghe 498 Jun  8 09:37 list_of_replica.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  8 09:37 myGeometry.inp
-rw-rw-r-- 1 amereghe amereghe 332 Jun  9 09:10 commands.txt
```

```
-LM-LM-L-- J 9w6Le0j6 9w6Le0j6 335 jnu 8 08:10 commands.txt
-LM-LM-L-- J 9w6Le0j6 9w6Le0j6 51K jnu 8 08:31 wlc6w6f1y.tub
-LM-LM-L-- J 9w6Le0j6 9w6Le0j6 488 jnu 8 08:31 f1zf of repj1ca.txt
qLMXLMLX-L X 9w6Le0j6 9w6Le0j6 4'0K jnu 8 08:31 f0d\
qLMXLMLX-L X 9w6Le0j6 9w6Le0j6 4'0K jnu 8 08:31 onf\
-LM-LM-L-- J 9w6Le0j6 9w6Le0j6 112 jnu 8 08:31 g1e1t2tcs.txt
-LM-LM-L-- J 9w6Le0j6 9w6Le0j6 51K jnu 8 08:32 07e00e11x107tub
```



FLUKA LINE BUILDER Recipe

- ✓ A general config file:
inputcard.txt
- ✓ The list of used prototypes:
prototypes.lbp
- ✓ Beam Pipe characteristics
(extension, shape.):
BP_profile.txt
- ✓ The Fluka Element Data
Base:
febd/
- ✓ The optics directory:
optics/
- ✓ Python modules to handle
twiss file:
customize_tws_parser.py

```
> l
total 192K
drwxrwxr-x 9 amereghe amereghe 4.0K Jun  4 22:49 febd/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  4 22:52 optics/
-rw-r--r-- 1 amereghe amereghe 3.5K Jun  5 11:31 TU_profile.txt
-rw-r--r-- 1 amereghe amereghe 2.9K Jun  5 15:31 tunnel_DS.inp
-rw-r--r-- 1 amereghe amereghe 28K Jun  7 16:24 customize_tws_parser.py
-rw-r--r-- 1 amereghe amereghe 11K Jun  7 16:24 customize_tws_parser.pyc
-rw-r--r-- 1 amereghe amereghe 23K Jun  7 16:53 customize_geo_builder.py
-rw-r--r-- 1 amereghe amereghe 8.3K Jun  7 16:53 customize_geo_builder.pyc
-rw-r--r-- 1 amereghe amereghe 1.8K Jun  7 17:34 prototypes.lbp
-rw----- 1 amereghe amereghe 1.7K Jun  7 17:45 inputcard.txt
-rw-r--r-- 1 amereghe amereghe 6.9K Jun  7 18:01 BP_profile.txt
-rw-rw-r-- 1 amereghe amereghe 175 Jun  7 18:15 statistics.bk.txt
-rw-rw-r-- 1 amereghe amereghe 498 Jun  7 18:15 list_of_replica.bk.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  7 18:15 myGeometry.bk.inp
-rw-rw-r-- 1 amereghe amereghe 175 Jun  8 09:37 statistics.txt
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 out/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 log/
-rw-rw-r-- 1 amereghe amereghe 498 Jun  8 09:37 list_of_replica.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  8 09:37 myGeometry.inp
-rw-rw-r-- 1 amereghe amereghe 332 Jun  9 09:10 commands.txt
```

```
-LM-LM-L-- J 9w6Le6m6 9w6Le6m6 335 jnu 8 08:10 commands.txt
-LM-LM-L-- J 9w6Le6m6 9w6Le6m6 51K jnu 8 08:31 wlc6owefly.tub
-LM-LM-L-- J 9w6Le6m6 9w6Le6m6 488 jnu 8 08:31 fzf_of_l6bjtca.txt
qLMXLMLX-L-X 5 9w6Le6m6 9w6Le6m6 4'0K jnu 8 08:31 f0d\
qLMXLMLX-L-X 5 9w6Le6m6 9w6Le6m6 4'0K jnu 8 08:31 onf\
-LM-LM-L-- J 9w6Le6m6 9w6Le6m6 112 jnu 8 08:31 g19t2tcs.txt
-LM-LM-L-- J 9w6Le6m6 9w6Le6m6 51K jnu 8 10:12 07660611x70700
```




FLUKA LINE BUILDER

Recipe

- ✓ A general config file:
inputcard.txt
- ✓ The list of used prototypes:
prototypes.lbp
- ✓ Beam Pipe characteristics
(extension, shape.):
BP_profile.txt
- ✓ The Fluka Element Data
Base:
febd/
- ✓ The optics directory:
optics/
- ✓ Python modules to handle
twiss file:
customize_tws_parser.py
- > Tunnel geometry:
TU_profile.txt

```
> l
total 192K
drwxrwxr-x 9 amereghe amereghe 4.0K Jun 4 22:49 febd/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun 4 22:52 optics/
-rw-r--r-- 1 amereghe amereghe 3.5K Jun 5 11:31 TU_profile.txt
-rw-r--r-- 1 amereghe amereghe 2.9K Jun 5 15:31 tunnel_DS.inp
-rw-r--r-- 1 amereghe amereghe 28K Jun 7 16:24 customize_tws_parser.py
-rw-r--r-- 1 amereghe amereghe 11K Jun 7 16:24 customize_tws_parser.pyc
-rw-r--r-- 1 amereghe amereghe 23K Jun 7 16:53 customize_geo_builder.py
-rw-r--r-- 1 amereghe amereghe 8.3K Jun 7 16:53 customize_geo_builder.pyc
-rw-r--r-- 1 amereghe amereghe 1.8K Jun 7 17:34 prototypes.lbp
-rw----- 1 amereghe amereghe 1.7K Jun 7 17:45 inputcard.txt
-rw-r--r-- 1 amereghe amereghe 6.9K Jun 7 18:01 BP_profile.txt
-rw-rw-r-- 1 amereghe amereghe 175 Jun 7 18:15 statistics.bk.txt
-rw-rw-r-- 1 amereghe amereghe 498 Jun 7 18:15 list_of_replica.bk.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun 7 18:15 myGeometry.bk.inp
-rw-rw-r-- 1 amereghe amereghe 175 Jun 8 09:37 statistics.txt
drwxrwxr-x 2 amereghe amereghe 4.0K Jun 8 09:37 out/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun 8 09:37 log/
-rw-rw-r-- 1 amereghe amereghe 498 Jun 8 09:37 list_of_replica.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun 8 09:37 myGeometry.inp
-rw-rw-r-- 1 amereghe amereghe 332 Jun 9 09:10 commands.txt
```

```
-LM-LM-L-- J 9w6Le6m6 9w6Le6m6 335 jnu 8 08:10 commands.txt
-LM-LM-L-- J 9w6Le6m6 9w6Le6m6 51K jnu 8 08:31 wlc6owefly.tub
-LM-LM-L-- J 9w6Le6m6 9w6Le6m6 488 jnu 8 08:31 fzf_of_l6bjtca.txt
qLMXLMLX-L-X 5 9w6Le6m6 9w6Le6m6 4'0K jnu 8 08:31 fof\
qLMXLMLX-L-X 5 9w6Le6m6 9w6Le6m6 4'0K jnu 8 08:31 of\
-LM-LM-L-- J 9w6Le6m6 9w6Le6m6 112 jnu 8 08:31 g6f6t6t6t6.txt
-LM-LM-L-- J 9w6Le6m6 9w6Le6m6 51K jnu 8 08:32 6766666666666666
```



FLUKA LINE BUILDER Recipe

- ✓ A general config file:
inputcard.txt
- ✓ The list of used prototypes:
prototypes.lbp
- ✓ Beam Pipe characteristics
(extension, shape.):
BP_profile.txt
- ✓ The Fluka Element Data
Base:
febd/
- ✓ The optics directory:
optics/
- ✓ Python modules to handle
twiss file:
customize_tws_parser.py
- > Tunnel geometry:
TU_profile.txt

```
> l
total 192K
drwxrwxr-x 9 amereghe amereghe 4.0K Jun  4 22:49 febd/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  4 22:52 optics/
-rw-r--r-- 1 amereghe amereghe 3.5K Jun  5 11:31 TU_profile.txt
-rw-r--r-- 1 amereghe amereghe 2.9K Jun  5 15:31 tunnel_DS.inp
-rw-r--r-- 1 amereghe amereghe 28K Jun  7 16:24 customize_tws_parser.py
-rw-r--r-- 1 amereghe amereghe 11K Jun  7 16:24 customize_tws_parser.pyc
-rw-r--r-- 1 amereghe amereghe 23K Jun  7 16:53 customize_geo_builder.py
-rw-r--r-- 1 amereghe amereghe 8.3K Jun  7 16:53 customize_geo_builder.pyc
-rw-r--r-- 1 amereghe amereghe 1.8K Jun  7 17:34 prototypes.lbp
-rw----- 1 amereghe amereghe 1.7K Jun  7 17:45 inputcard.txt
-rw-r--r-- 1 amereghe amereghe 6.9K Jun  7 18:01 BP_profile.txt
-rw-rw-r-- 1 amereghe amereghe 175 Jun  7 18:15 statistics.bk.txt
-rw-rw-r-- 1 amereghe amereghe 498 Jun  7 18:15 list_of_replica.bk.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  7 18:15 myGeometry.bk.inp
-rw-rw-r-- 1 amereghe amereghe 175 Jun  8 09:37 statistics.txt
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 out/
drwxrwxr-x 2 amereghe amereghe 4.0K Jun  8 09:37 log/
-rw-rw-r-- 1 amereghe amereghe 498 Jun  8 09:37 list_of_replica.txt
-rw-rw-r-- 1 amereghe amereghe 27K Jun  8 09:37 myGeometry.inp
-rw-rw-r-- 1 amereghe amereghe 332 Jun  9 09:10 commands.txt
```

```
-LM-LM-L-- J gweledme gweledme 335 jnu 8 08:10 commuqg*.txt
-LM-LM-L-- J gweledme gweledme 51K jnu 8 08:31 wlcsewefly.tub
-LM-LM-L-- J gweledme gweledme 488 jnu 8 08:31 fzf of lebjtca.txt
qlmxlmxl-x S gweledme gweledme 4'0K jnu 8 08:31 fod\
qlmxlmxl-x S gweledme gweledme 4'0K jnu 8 08:31 onf\
-LM-LM-L-- J gweledme gweledme 112 jnu 8 08:31 gretstctcs.txt
-LM-LM-L-- J gweledme gweledme 51K jnu 8 08:31 wlcsewefly.tub
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python2.7 ~/repos/linebuilder/src/build_line.py inputcard.txt

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