EPAC08 - Preview

L. Lari on behalf of the FLUKA team

Phase 2 Specification and Implementation Meeting
13/6/2008

2 Papers

- **PRELIMINARY EXPLORATORY STUDY OF DIFFERENT PHASE II COLLIMATORS**

  L. Lari, C. Bracco, EPFL, Lausanne and CERN, Geneva, Switzerland
  R. Assmann, A. Bertarelli, M. Brugger, F. Cerutti, A. Dallocchio, A. Ferrari, M. Mauri, S. Roesler, L. Sarchiapone, V. Vlachoudis, CERN, Geneva, Switzerland
  E. Doyle, L. Keller, S. Lundgren, T. Markiewicz, J. Smith, SLAC, Menlo Park, California

- **EVALUATION OF BEAM LOSS AND ENERGY DEPOSITION FOR ONE POSSIBLE PHASE II DESIGN FOR LHC COLLIMATION**

  L. Lari, C. Bracco, EPFL, Lausanne and CERN, Geneva, Switzerland
  R. Assmann, M. Brugger, F. Cerutti, A. Ferrari, M. Mauri, S. Redaelli, L. Sarchiapone, T. Weiler V. Vlachoudis, CERN, Geneva, Switzerland
  E. Doyle, L. Keller, S. Lundgren, T. Markiewicz, J. Smith, SLAC, Menlo Park, CA

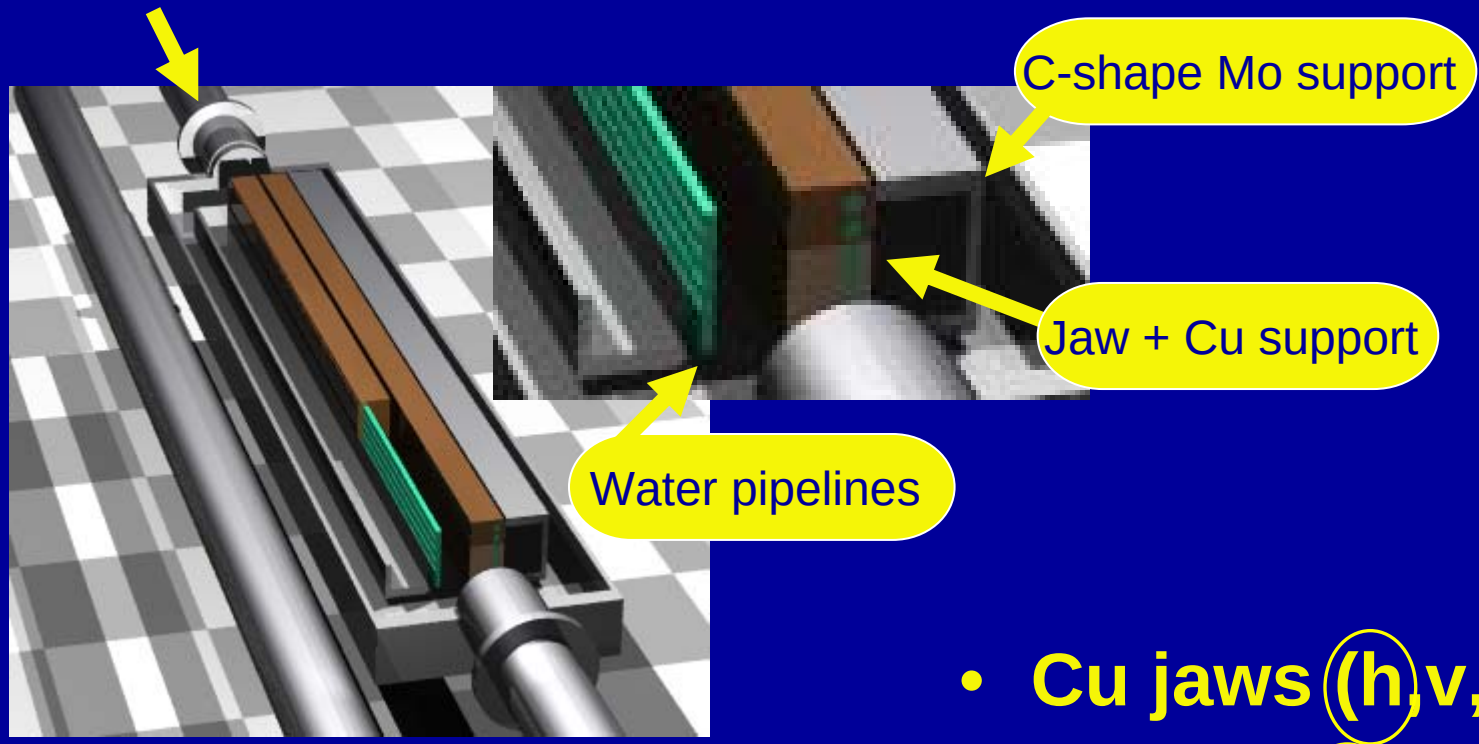
*Phase II **different designs** evaluation using the horizontal halo distribution*

- **CERN Metallic Collimator** design
- **Metallic Foil Collimator** design (CERN)
- **Rotatable Jaw Collimator** design (SLAC through LARP program)

11 collimators in IR7 Fluka model

TCSG opened like during Inj.

CERN Metallic Collimator design (1)



Courtesy A.Bertarelli / A.Dallocchio

1 m long jaw

- **Cu jaws (h,v,s)**
- **Al jaws (h,v)**
- **W jaws (h,v)**

PRELIMINARY EXPLORATORY STUDY OF DIFFERENT PHASE II COLLIMATORS

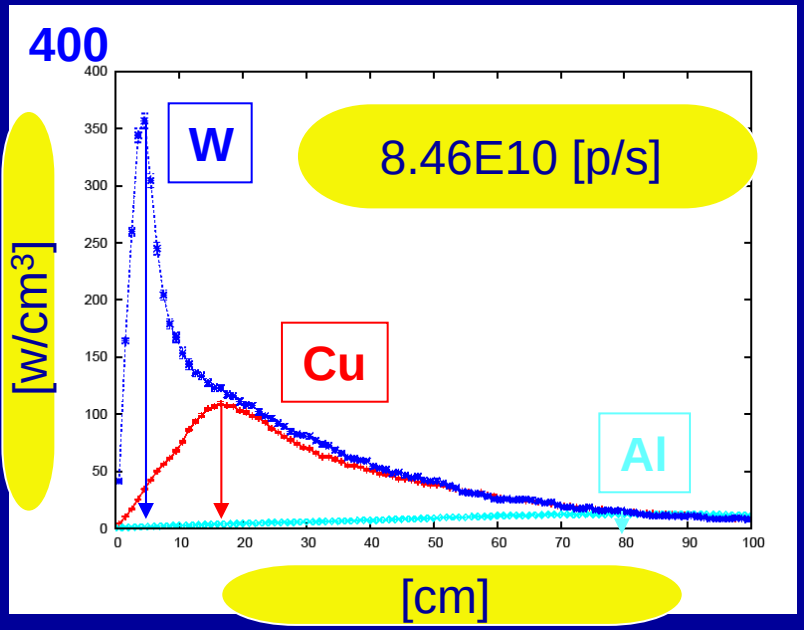
CERN Metallic Collimator design (2)

Summary of Energy Deposition results on the hottest TCSM.A6L7.B1 for hor. halo

Jaw Material	Energy deposition	0.2h [kW]	1h [kW]
Cu	Whole collimator One jaw Peak on the jaw surface	115 45 0.55/cm^3	23 9 0.11/cm^3
Al	Whole collimator One jaw Peak on the jaw surface	60 17 0.065/cm^3	12 3 0.013/cm^3
W	Whole collimator One jaw Peak on the jaw surface	120 53 1.75/cm^3	25 11 0.35/cm^3

Thanks to C. Bracco for tracking simulations

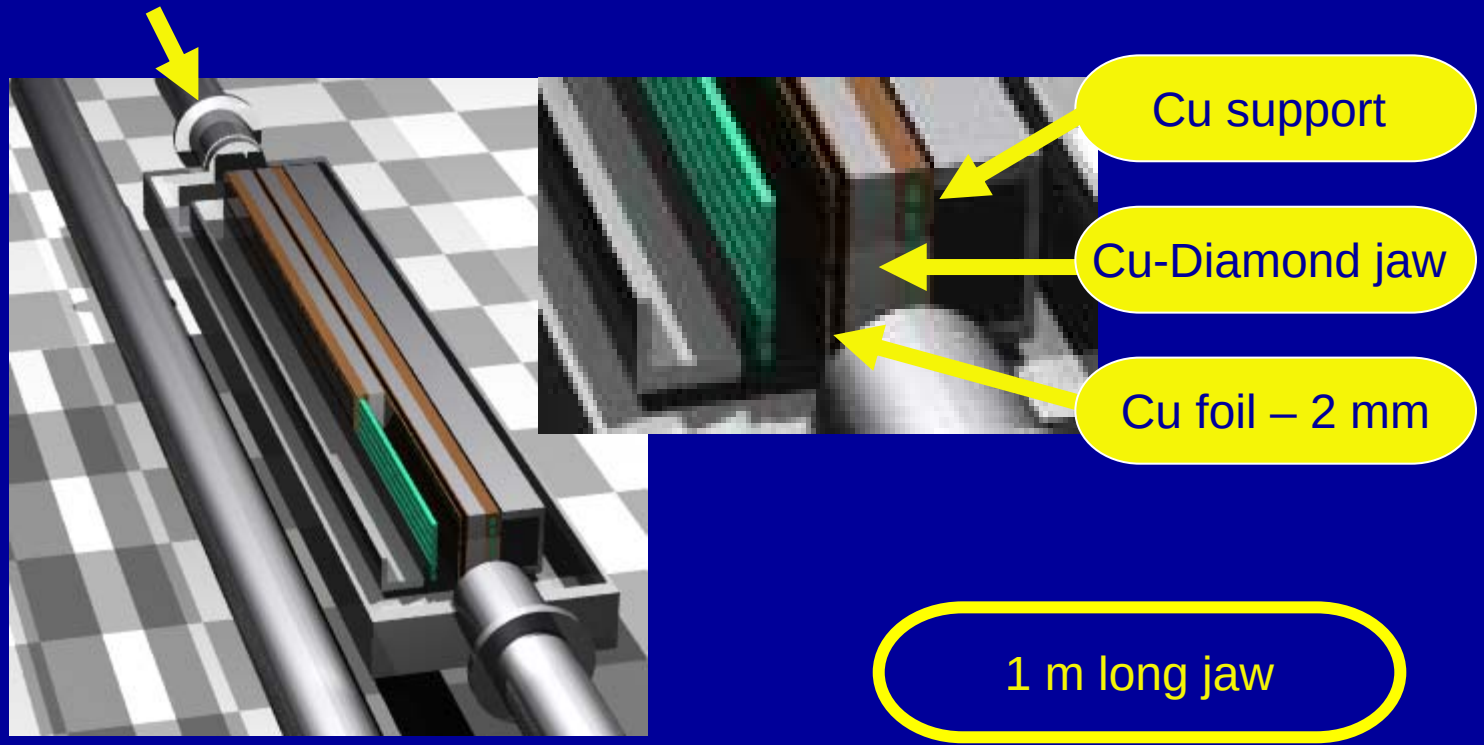
hottest TCSM.A6L7.B1 jaw for hor. losses



- Tank (steel) and support structures contribute significantly to the residual dose rates (to more than 60 %)
- Nevertheless, the overall activation level depends on the jaw material i.e. it is 20-50% higher for collimator with W than Cu jaws

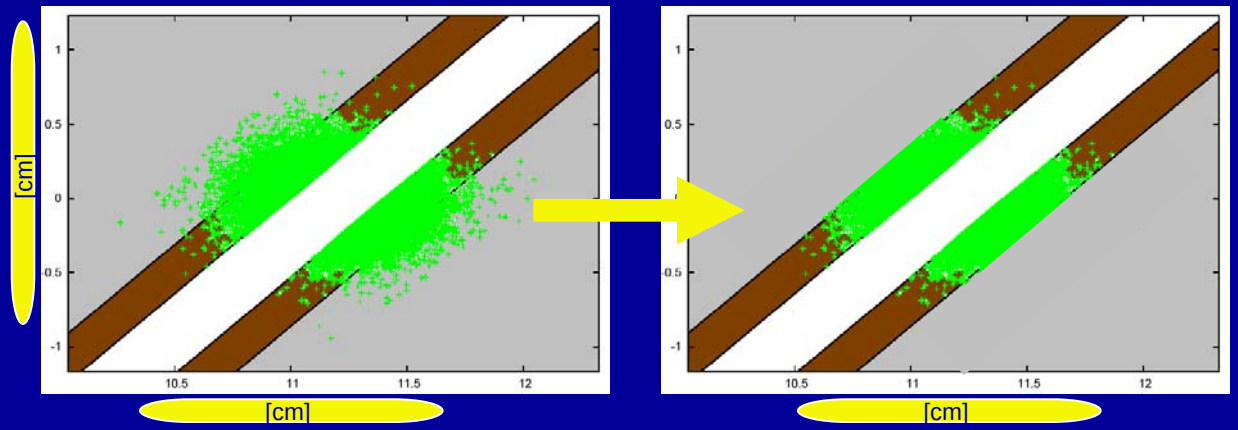
Courtesy S. Roesler

Metallic Foil Collimator design (CERN) (1)



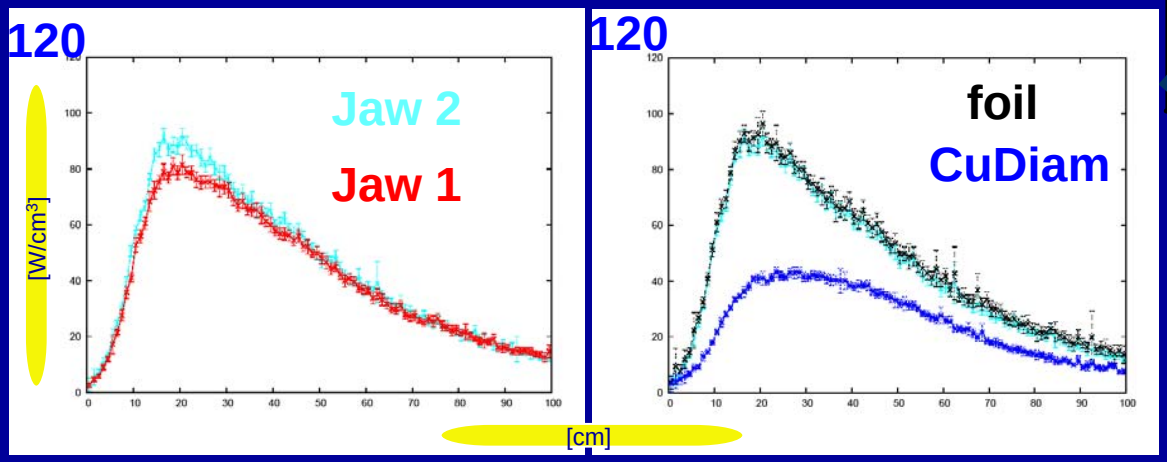
Courtesy A.Bertarelli / A.Dallocchio

Metallic Foil Collimator design (CERN) (2)



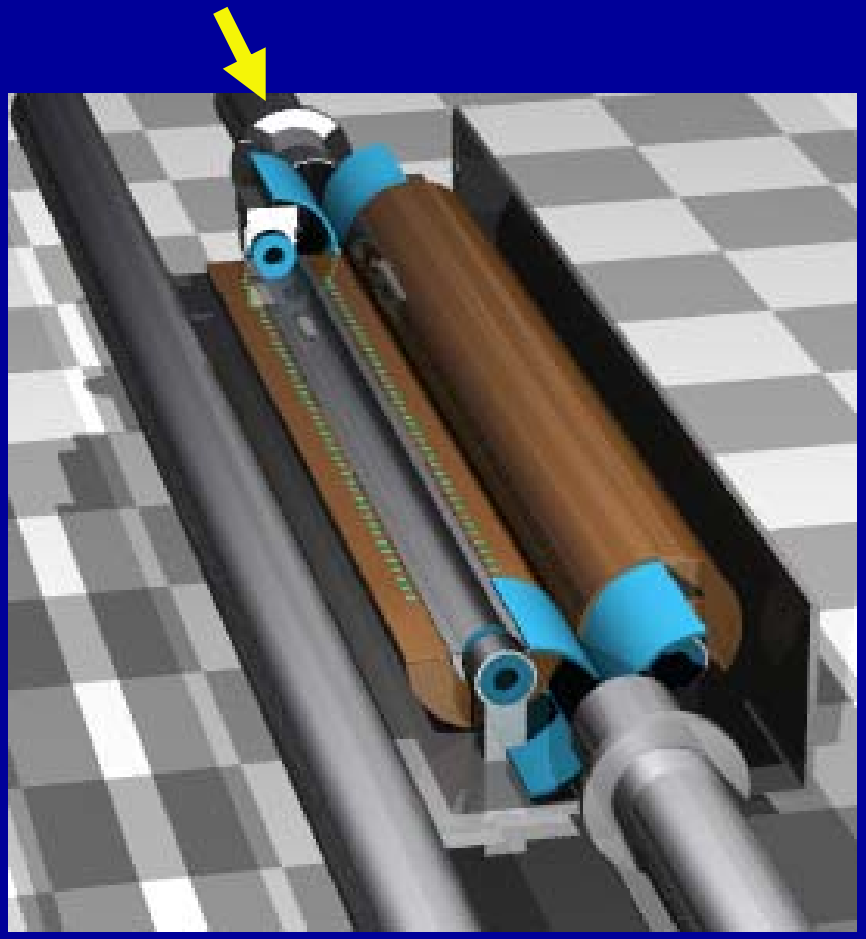
TCSM	% outside foil particles
A6L7	8
B5L7	30
5L7	14
D4L	0
B4L7	0.1
A4L7	0.1
A4R7	0
B5R7	2
D5R7	0.3
E5R7	0
6R7	0.1

Preliminary results, using the same tracking (hor. scenario) for the Cu horizontal halo



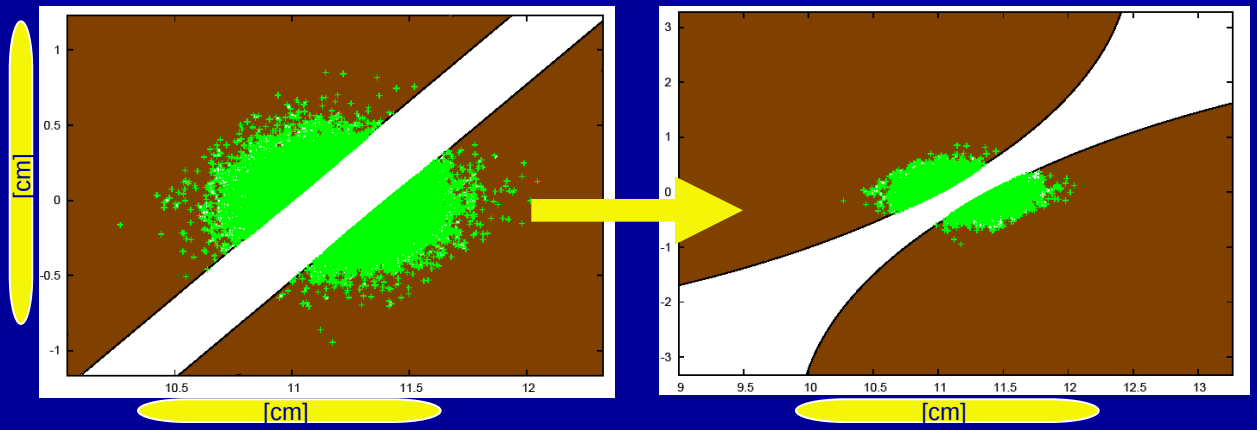
Rotatable Jaw Collimator design, (SLAC/LARP) (1)

0.93 m long jaw



Courtesy SLAC team

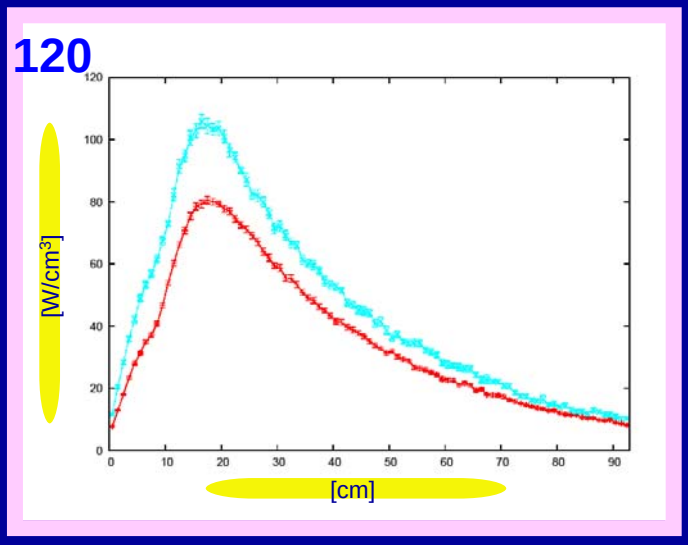
Rotatable Jaw Collimator design, (SLAC/LARP) (2)



Preliminary results, using the same tracking files for the Cu horizontal halo

TCSM	% outside foil particles
A6L7	3
B5L7	4
A5L7	4
D4L7	3
B4L7	2
A4L7	2
A4R7	2
B5R7	3
D5R7	7
E5R7	25
6R7	0.2

120



Conclusions

- W jaws high energy deposition for the TCSM.A6L7
- Better choice has to be address to Al and Cu → supporting the choice with thermal analysis
- In particular for the Cu foil ←

Future investigation :

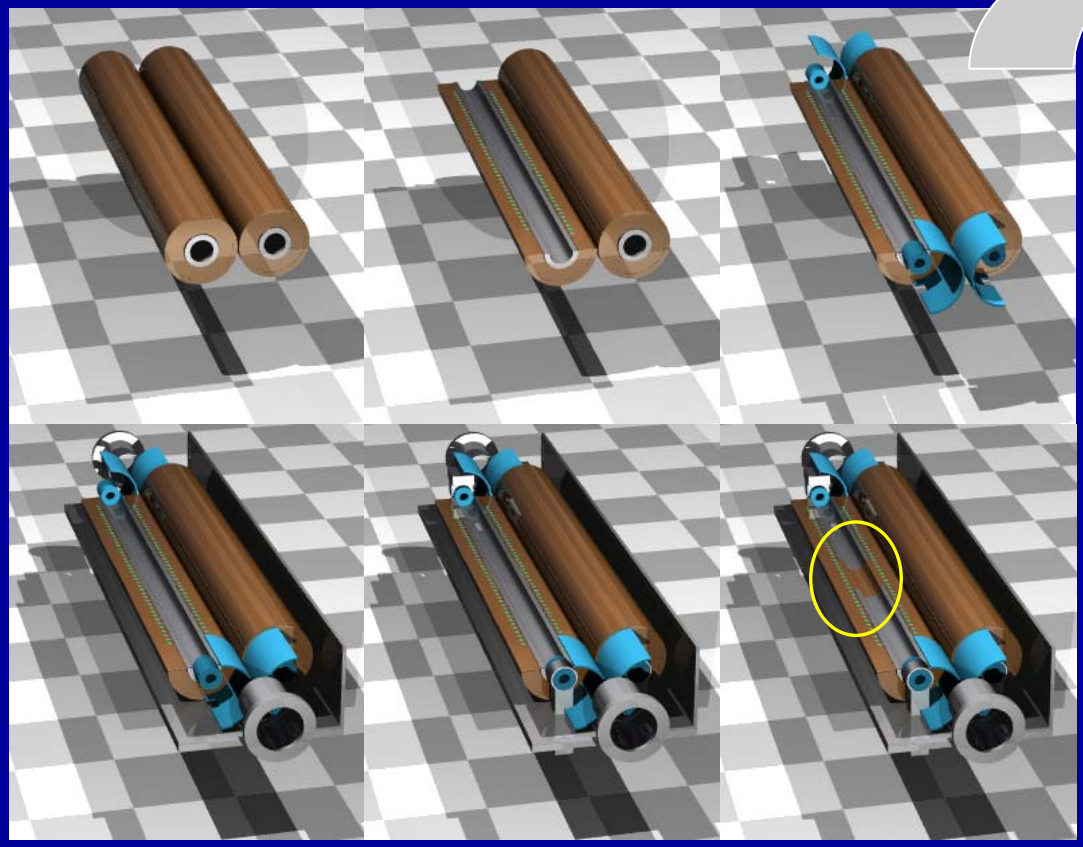
- **Combination of different design**
- **Ceramic collimator**
- **Cryogenic collimator**
- **Active or passive absorber**

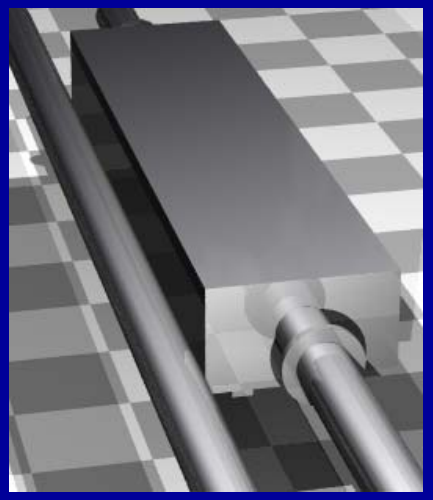
One *Phase II design evaluation*

Results refer to the SLAC Rotatable Jaw design, because is presently the most advanced one

- Phase II collimator calculation methodology
- The complete analysis of operational scenario (h, v, s) with TCSG opened like at Inj.
- The Asynchronous dump scenario

Phase II collimator calculation: Methodology





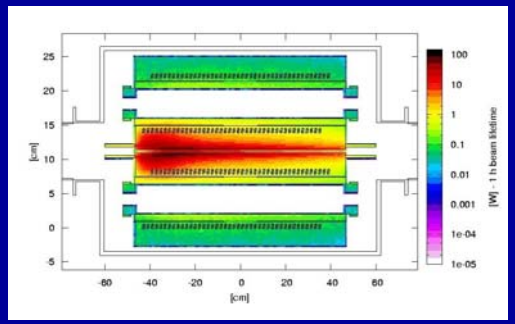
Each time integration in the IR7 model
Following the evolution of IR7 and the loss map
(e.g. TCSG opened/closed)

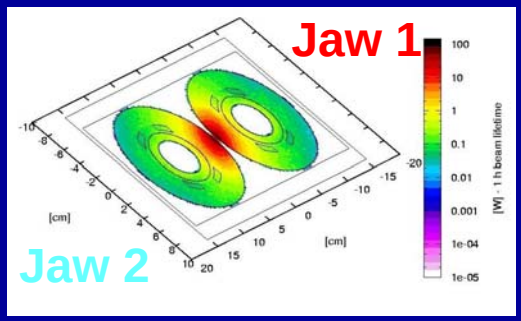
Results refer to the most advanced Fluka model

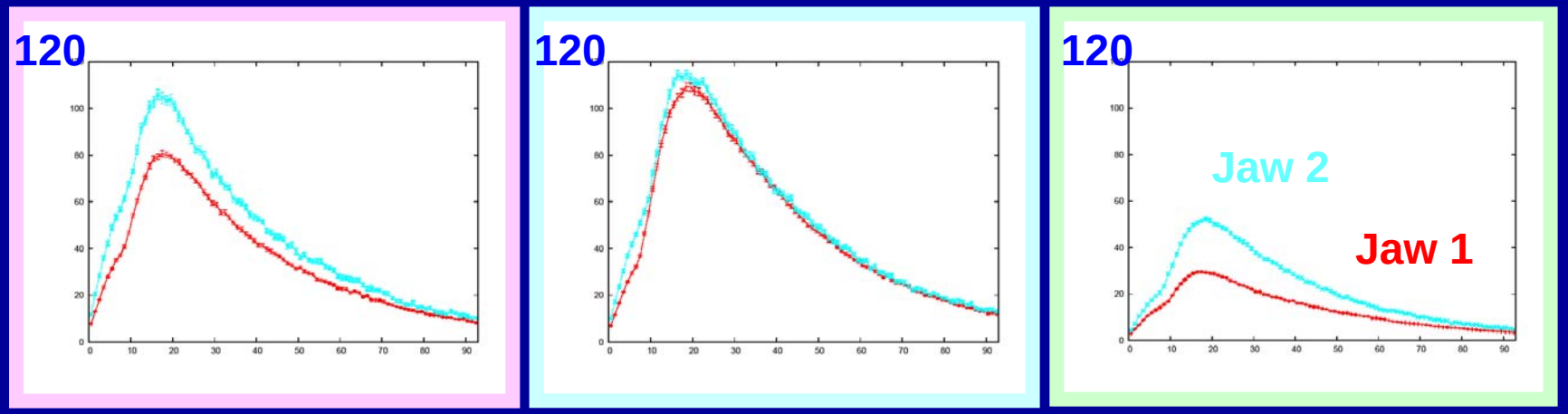
Operation scenario (1)

hottest TCSM.A6L7.B1

Halo	Energy Deposition	1h [kW]
Horizontal	Whole collimator One jaw Peak on the jaw surface	22 8.5 0.11/cm^3
Vertical	In total One jaw Peak on the jaw surface	22 8.5 0.12/cm^3
Skew	Whole collimator One jaw Peak on the jaw surface	8.5 3.5 0.05/cm^3



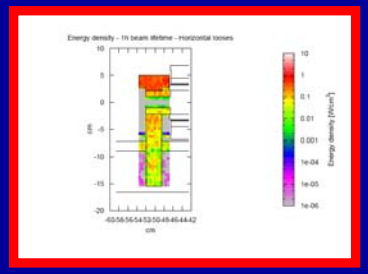


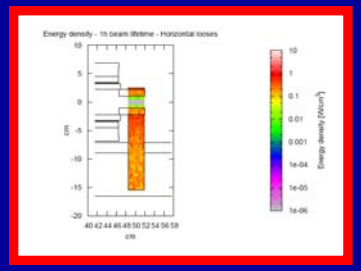


Operation scenario (2)

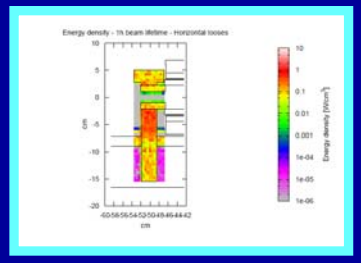
Energy Deposition	1h [kW]
In the Molybdenum with Copper shaft	0.5 (x 2 jaws)
In the Copper mandrel and Copper pipeline	0.8 (x2 jaws)
Only in the water	0.03 (x2 jaws)
In the Aluminium motor supports	
In the steel tank	1.5
In the steel flanges	0.07

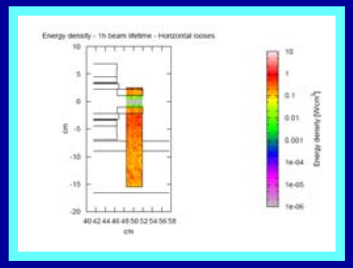
Jaw 1





Jaw 2





Asynchronous Dump (1)

…due to a spontaneous trigger of the hor. extraction kicker at top energy.

In principle, any collimator can be hit by miss-kicked particles, but in practice the horizontal ones are those actually impacted.

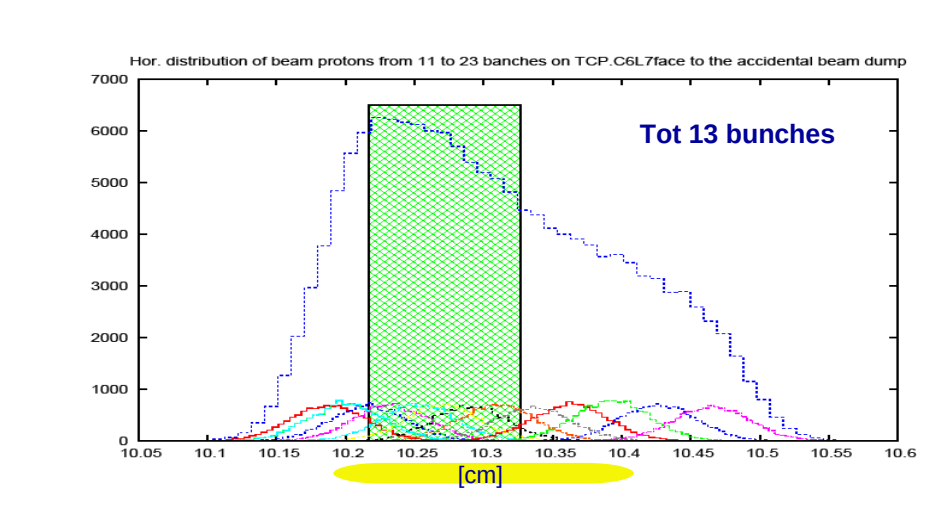
Three scenarios studied, using a very pessimistic case, actually with a low probability associate:

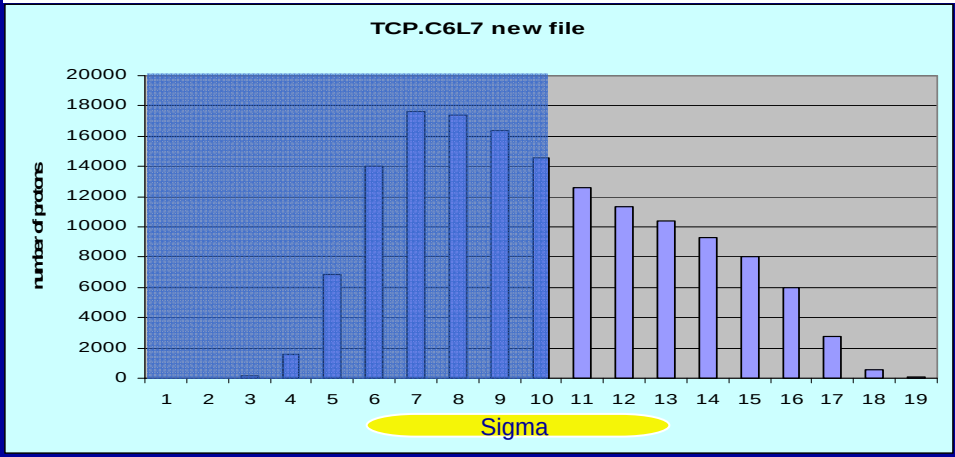
- Direct impact on one jaw of TCP.C6L7.B1
- Direct impact on one jaw of TCSM.B4L7.B1
- Direct impact on one jaw of TCSM.6R7.B1

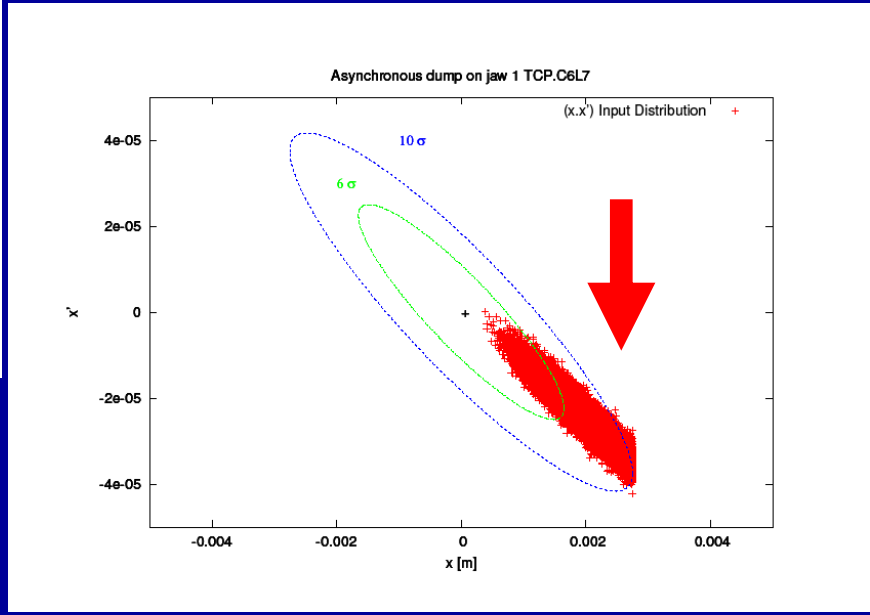
Asynchronous Dump (2)

Only 1 jaw hit

Data TCP.C6L7.B1, as an example



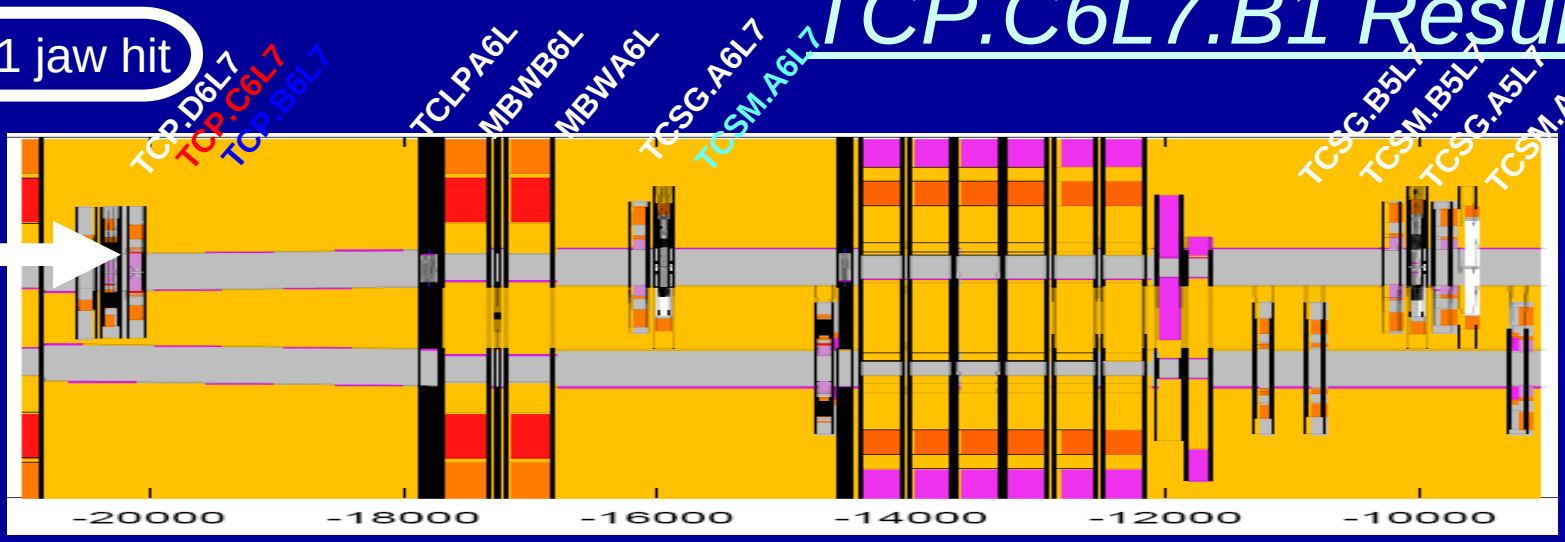


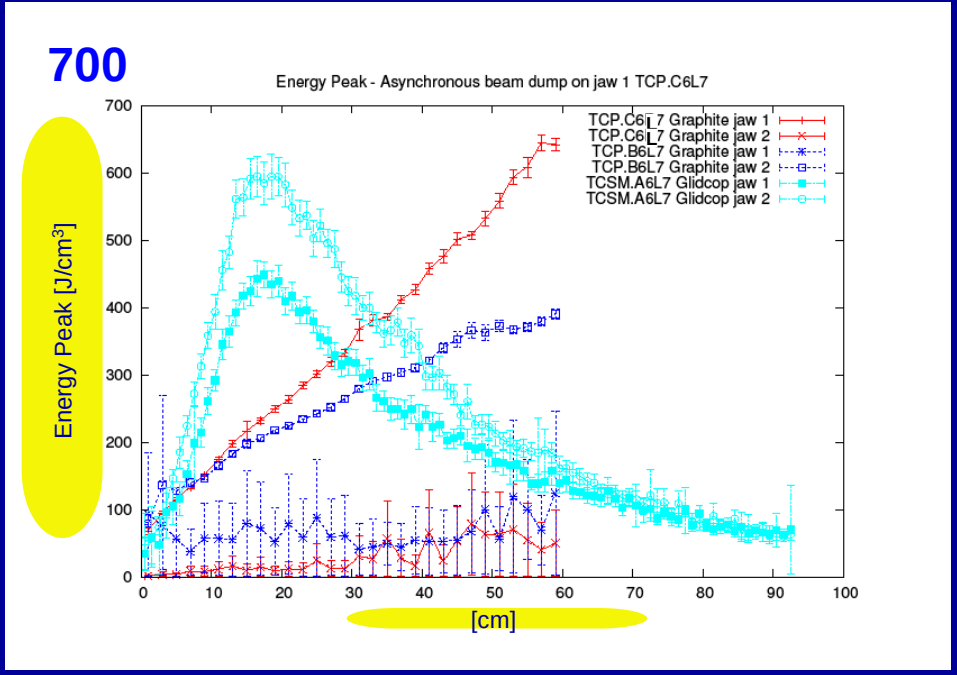


Thanks to T. Weiler for tracking simulations

TCP.C6L7.B1 Results

Only 1 jaw hit





	[kJ]
TCSM.A6L7	130
TCP.B6L7	48
TCLPA6L	41
MBWB6L	37
MBWA6L	35
TCSM.B5L7	24
TCP.C6L7	22

TCSM.B4L7.B1 and TCSM.6R7 Results (1)

TCP.C6L7.B1

	[kJ]
TCSM.A6L7	130
TCP.B6L7	48
TCLPA6L	41
MBWB6L	37
MBWA6L	35
TCSM.B5L7	24
TCP.C6L7	22

TCSM.B4L7.B1

	[kJ]
TCSM.B4L7	295
TCSM.A4L7	61
TCSM.A4R7	17
TCSG.A4L7	15
TCSG.A4R7	7

TCSM.6R7.B1

	[kJ]
TCSM.6R7	285
TCLA.A6R7	60
TCLA.C6R7	13
MBWA6R	6
MBWB6R	3

TCSM.B4L7.B1 and TCSM.6R7 Results (2)

TCP.C6L7.B1 directly impacted TCSM.A6L7.B1 most loaded	
Total energy deposition Energy density peak on the jaw Instantaneous variation of temperature	130 [kJ] 600 [J/cm^3] 180^o
TCSM.B4L7.B1 directly impacted TCSM.B4L7.B1 most loaded	
Total energy deposition Energy density peak on the jaw Instantaneous variation of temperature	300 [kJ] 50000 [J/cm^3] **>5000^o**
TCSM.6R7.B1 directly impacted TCSM.6R7.B1 most loaded	
Total energy deposition Energy density peak on the jaw Instantaneous variation of temperature	300 [kJ] 50000 [J/cm^3] **>5000^o**

Conclusions

- The Rotatable Jaw design is actually in phase of prototyping at SLAC

  → ***FLUKA studies for operational scenario support the mechanical integration***

- The simulation of Asynchronous Dump scenario point out that the Phase II collimators are always the most loaded ones

  → **Why not investigate other solution for these special locations?**