WP15

SBT Approach

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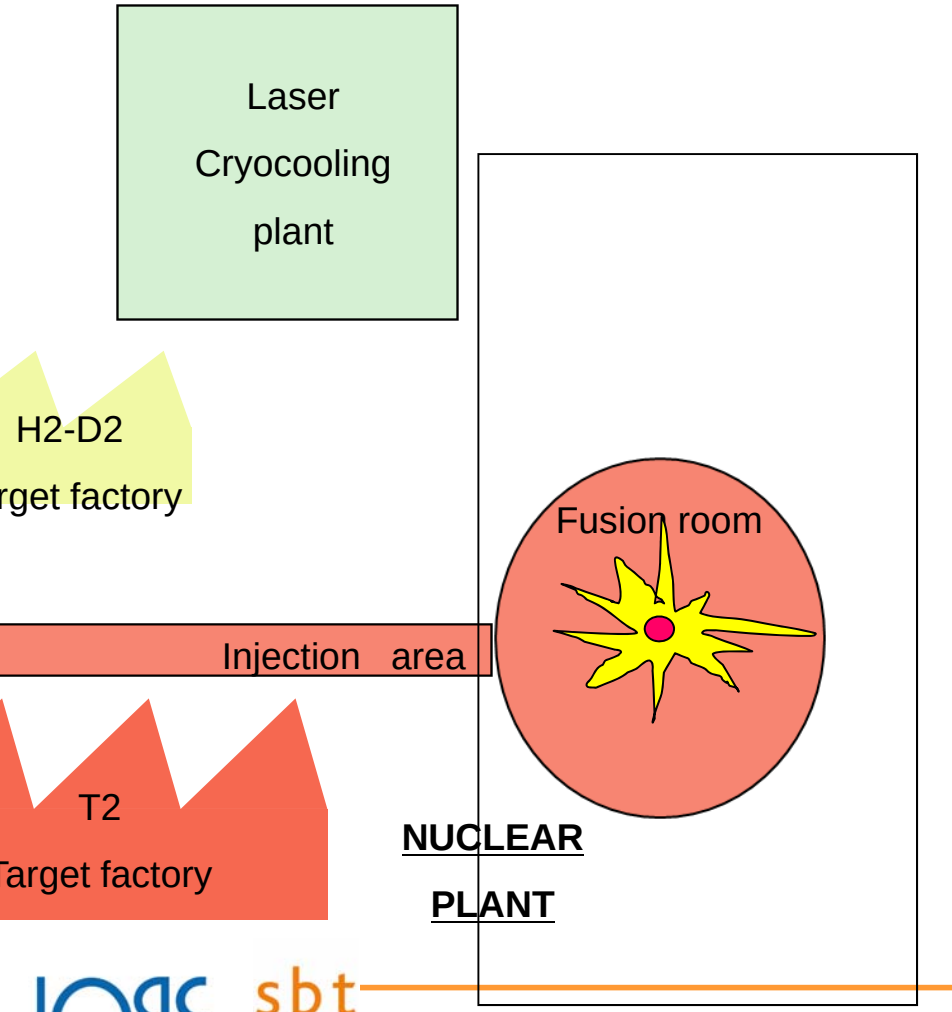
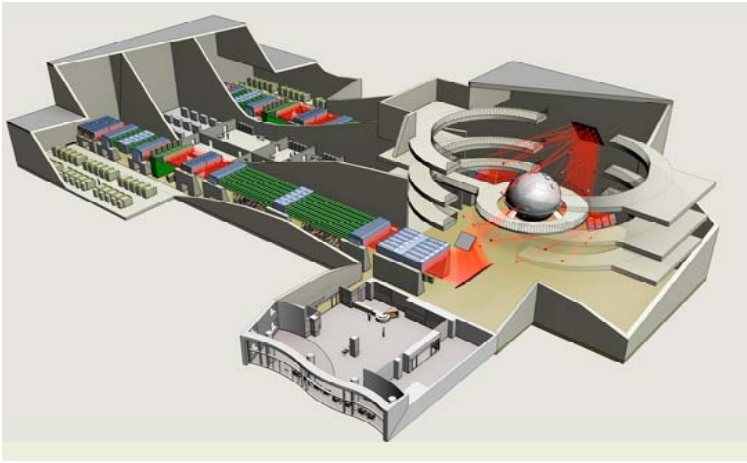
3rd European Target Fabrication Workshop - Oxford

HiPER cryogenic design

From ideas → WP15 → to first plans





Our guides: SAFETY PRINCIPLES

Radiologic risk have to be controlled during all the time life **FOR** **Workers, Everyone Nature**

To reach this goal we set some

Safety Important Functions

including

Safety Important Elements

Confinement control

Static confinement

(process, cryostat, Gloves Box, cells)

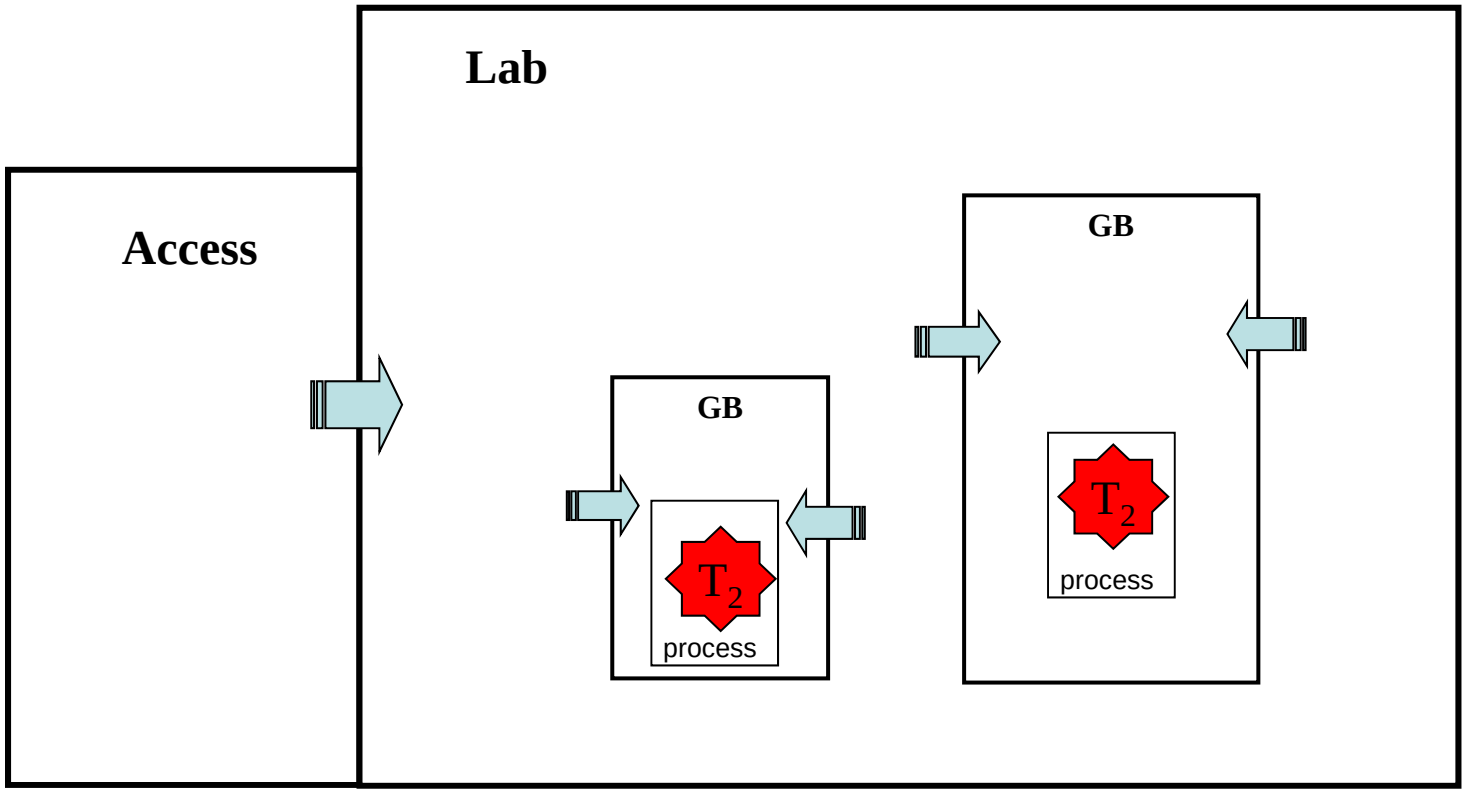
Dynamic confinement

(Ventilation..)

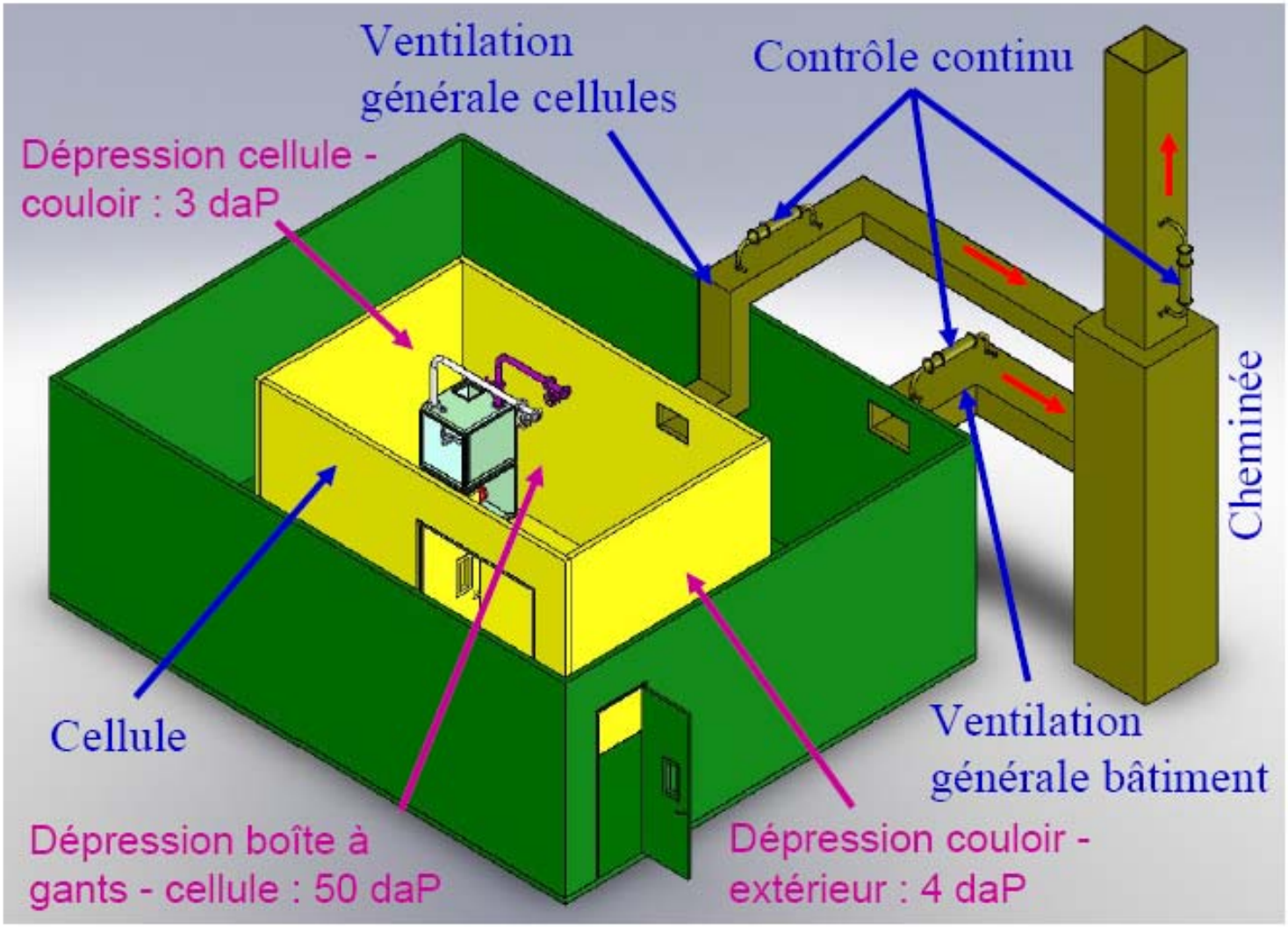
Radiation limitation

Radiation measuments & protection, Using rules…

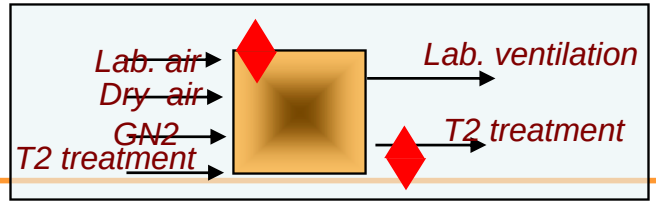
One exemple: ventilation



One exemple: ventilation



GB Ventilation sketch



Air

factory

chimney

Process

GB process

T2 treatment
(2 levels)

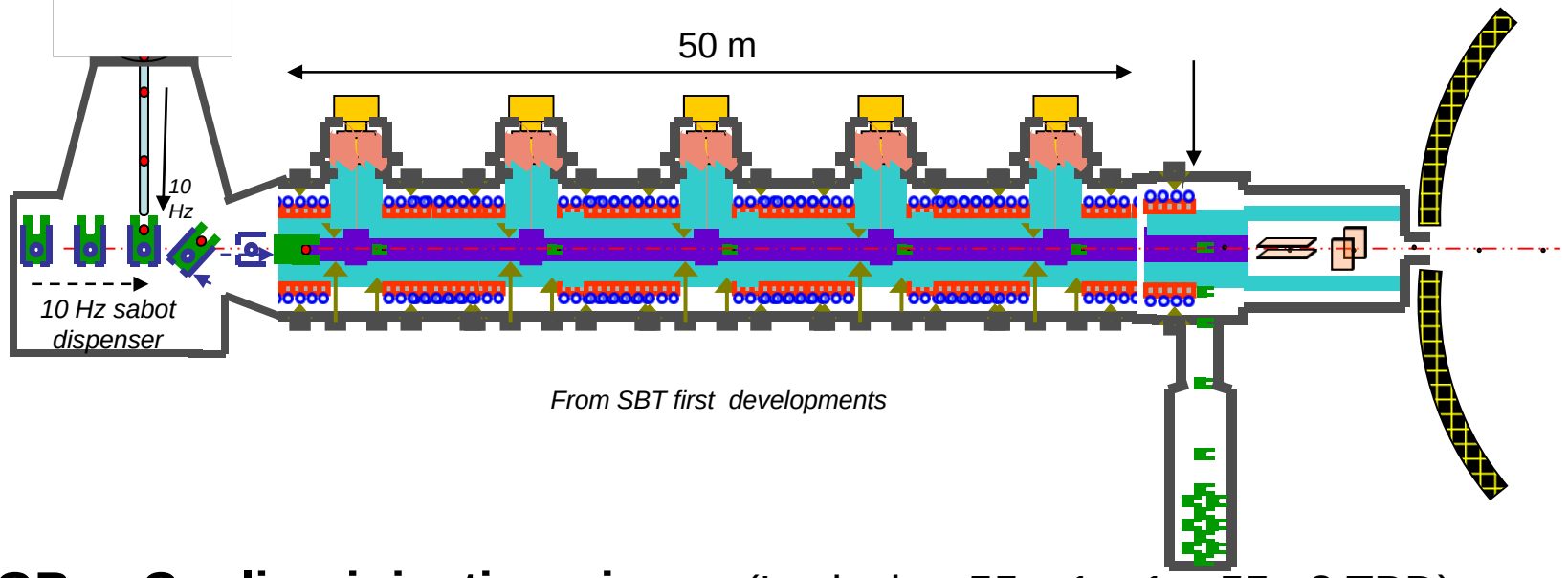
inlet

inlet

One lab. T2 lab

Target factory operating laboratories

1/ Injection (L = 60 m - 320 m2)



From SBT first developments

GB **Cooling injection pipe** (L x l x h = 55 x 1 x 1 = 55m3 TBD)

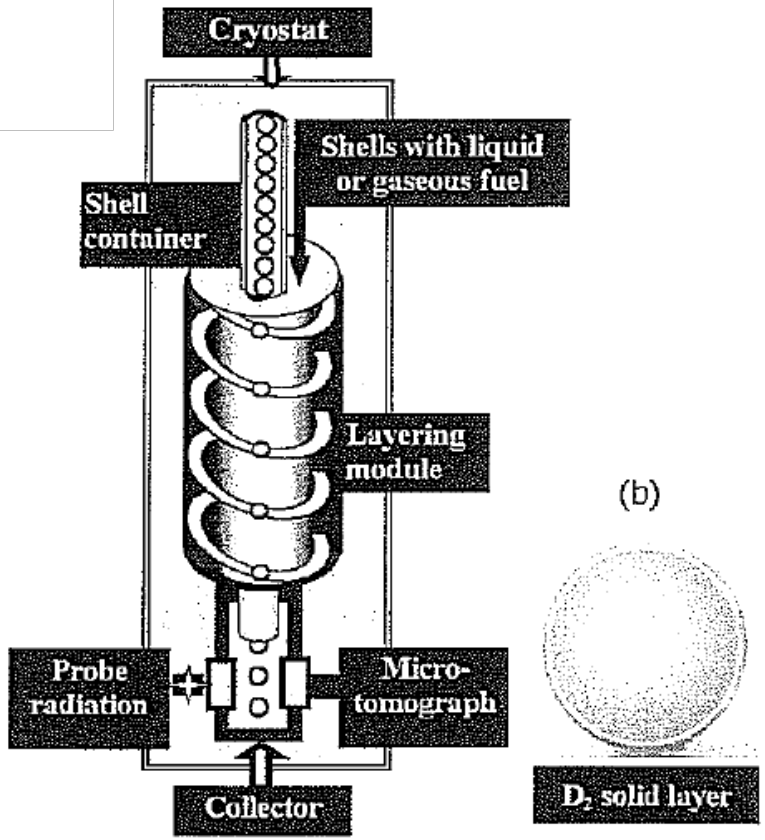
GB **target provider** (L x l x h = 2 x 1 x 1 = 2m3 TBD)

GB **injector** (L x l x h = 3 x 2 x 3 = 12m3 TBD)

GB **sabot** (L x l x h = 2 x 2 x 2 = 8 m3 TBD)

GB **wastes** (L x l x h = 1 x 1 x 1 = 1 m3 TBD)

Target factory operating laboratories
2/ target layering (80 m2)



From Lebedev physical institute developments

Access transfert cryostat

(L x l x h = 1 x 1 x 1 = 1m3 TBD)

GB target filling

(L x l x h = 2 x 2 x 2 = 8m3 TBD)

GB conformation cryostat

(L x l x h = 2 x 2 x 3 = 12m3 TBD)

GB collector

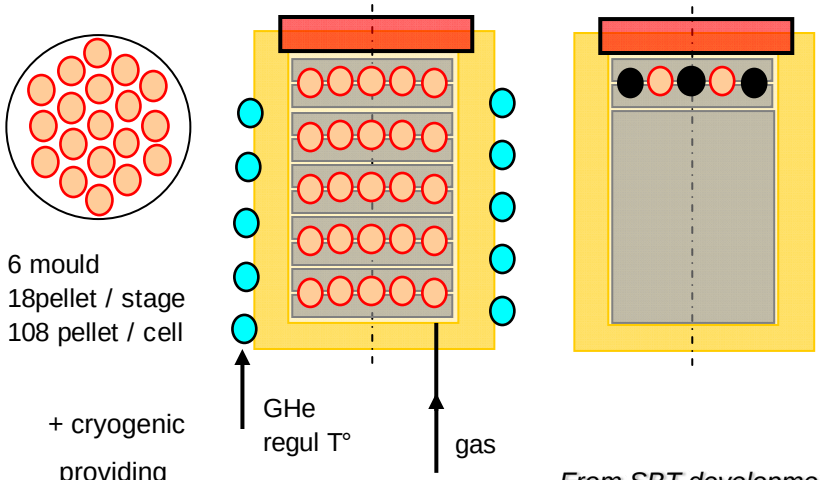
(L x l x h = 2 x 2 x 2 = 8 m3 TBD)

Access for control

(L x l x h = 1 x 1 x 1 = 1 m3 TBD)

Target factory operating laboratories

3/ Target filling (80m2)



From SBT developments

LMJ target factory in Valduc center

Access transfert vessel

(L x l x h = 1 x 1 x 1 = 1m3 TBD)

GB cryocompressor HP 600 atm

(L x l x h = 2 x 2 x 1 = 4m3 TBD)

& GB Cryogenic target recovery

(L x l x h = 2 x 4 x 3 = 24m3 TBD)

GB filling cells HP 600 atm & cooling down

(L x l x h = 2 x 2 x 2 = 8m3 TBD)

Target filling : some target elements

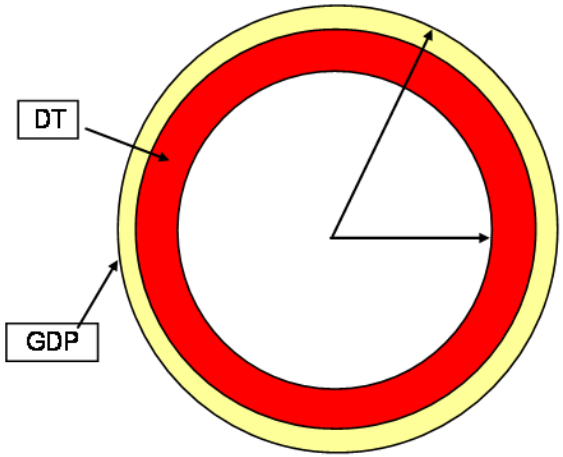
Balloon

Rext	1,023E-03	m
Rint	1,02E-03	m
thickness	3,0E-06	m
inner volume	4,45E-09	m3
mass	4,130E-08	kg

target

Rext	1,020E-03	m
Rint	8,330E-04	m
thickness	1,9E-04	m
ice volume	2,024E-09	m3
mass	5,121E-07	kg
or	2,267E-06	m3 TPN

So the filling pressure is: 510 bars



Target D- T 50-50
mass T2 3,146E-07 kg

Target H - D- T x - x - 70
mass T2 4,404E-07 kg

T2 Budget: 2target 50-50 + 98 target HDT
mass T2 4,4E-05 kg
or 1,6E+13 Bq

We still have to take into account all the dead space

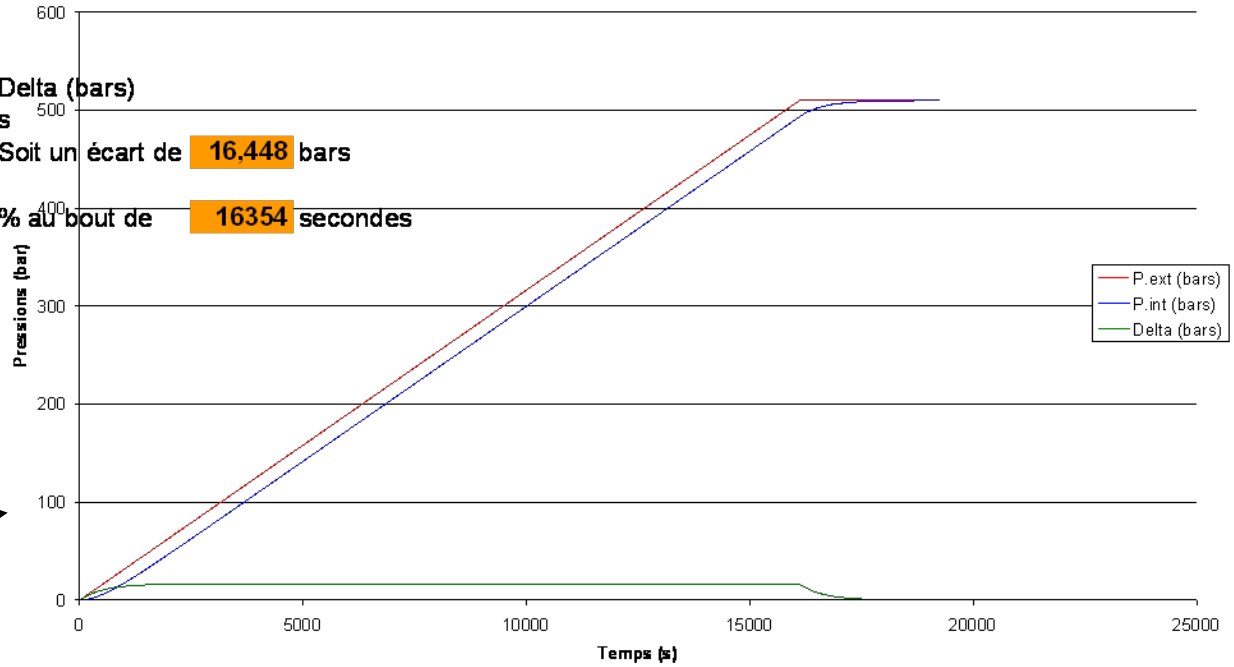
Target filling : balloon thickness vs filling time

D/e = 97

Valeur fin rampe

Ecart de pression de rupture	20,576	Delta (bars)
Consigne atteinte en	16105	s
Pression interne (bars)	493,55	Soit un écart de 16,448 bars
Pressions externe et interne identiques à	98	% au bout de 16354 secondes

e (µm)	25
ϕ ext (µm)	2430
K (mol/(m.s.Pa))	7,50E-15
T (°C)	20
Prempliissage (bars)	510
dP/dt (bars/min)	1,9



Based on CHx ballon calculation

HiPER target type: diameter 2,43 mm

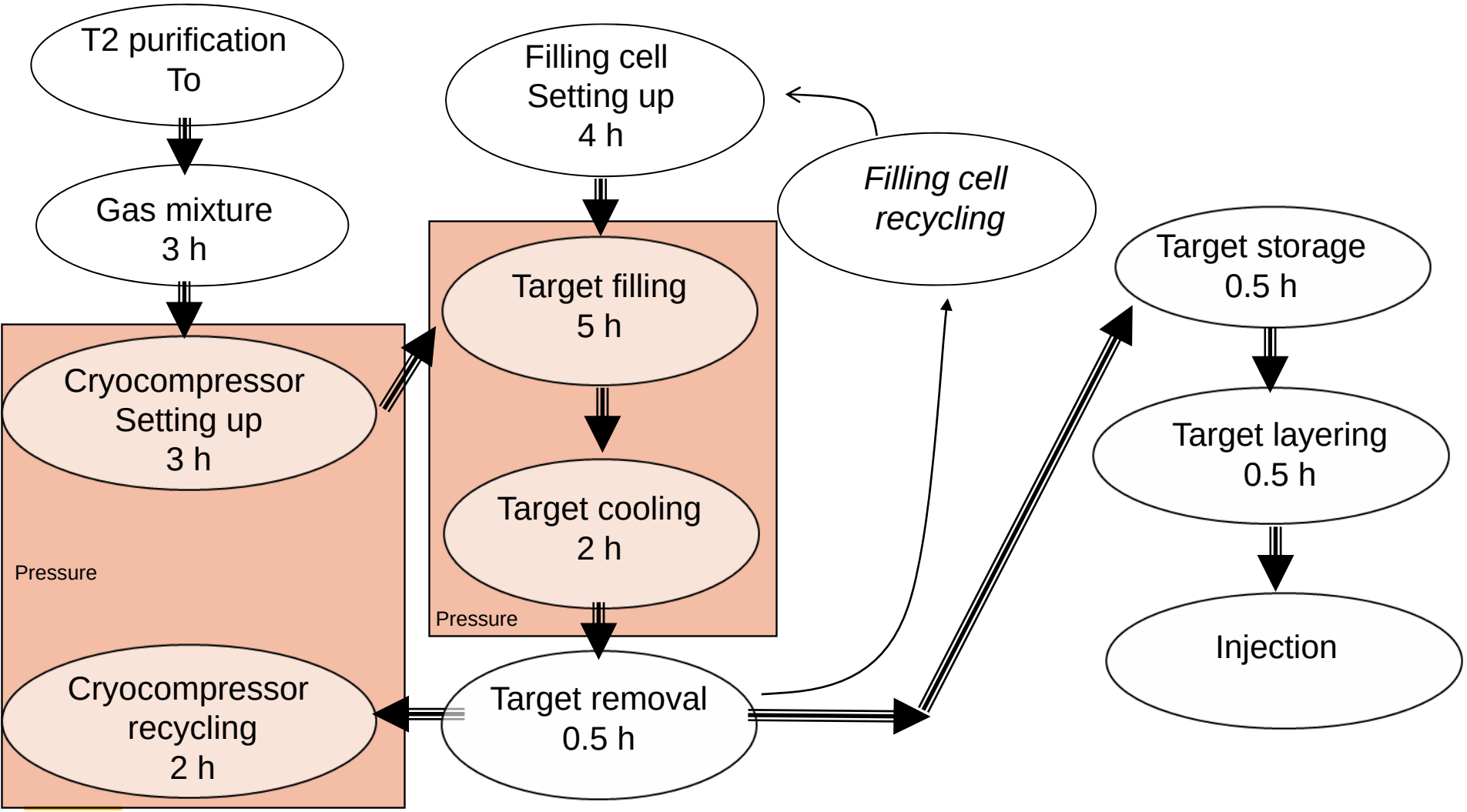
hot gas filling through balloon

pressure 510 bars

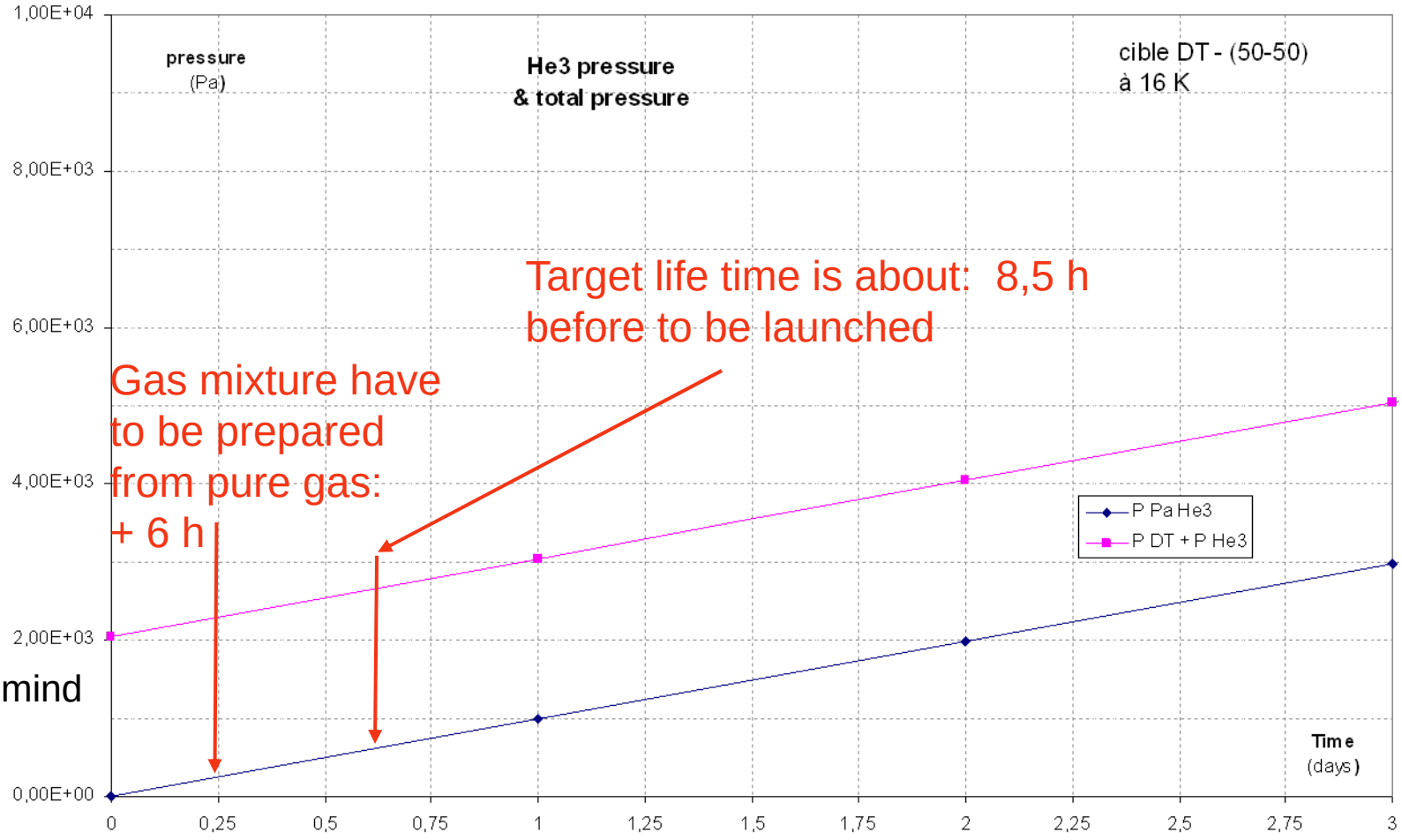
with DP < 80 % ballon resistance limit

Balloon thickness *micro meter*	filling speed *bar/mn*	time to 510 bars *s*	int = 98% ext *s*	DP max < 80% rupt limit *bar*	
1	1,6	19125	19125	0,6	
3	1,7	18000	18001	1,8	!
10	1,8	17000	17001	6,4	
25	1,9	16105	16354	20,6	
50	2	15300	16434	38,7	
100	2,3	13304	16489	65,6	
200	3,1	9871	18250	130	

Target life time : process overview



Tritium pollution: T2 ⟹ He3 evolution



Please keep in mind
that time
doesn't help us

Target factory operating laboratories
4/ Thermal & optic analysis (8 x 7 =56m2)

Access transfert vessel

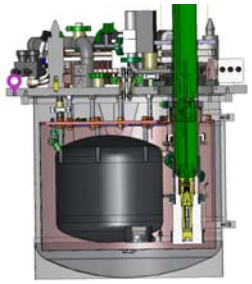
(L x l x h = 1 x 1 x 1 = 1m3 TBD)

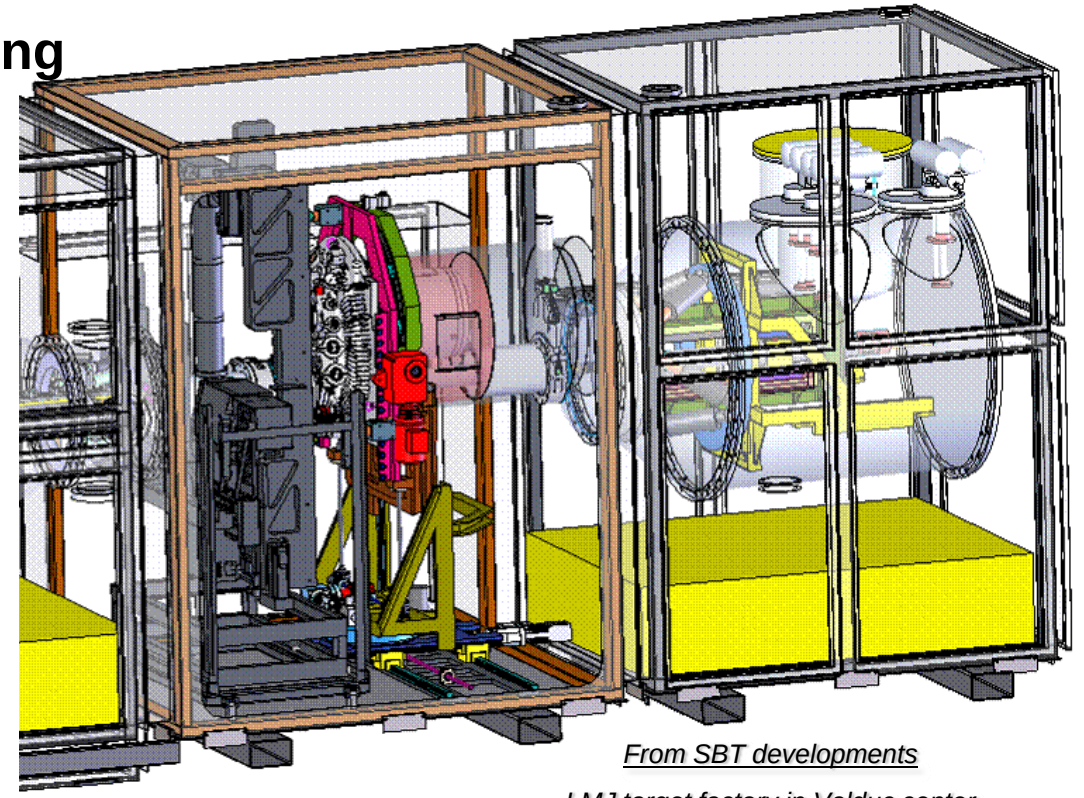
GB Tools, support and cooling

(L x l x h = 3 x 2 x 2 = 12m3 TBD)

GB Analysis

(L x l x h = 2 x 2 x 2 = 8m3 TBD)





From SBT developments

LMJ target factory in Valduc center

Target factory operating laboratories
5/ R&D lab

Improve HiPER process

T2 test for continuous 10 Hz process

- other process than permeation (liquid filling?)

- permeation still possible but targetry have to manage about 8 hours complete process (+ recycling time)

reducing process time
LHe instead cryocooler, 2 cryocomp. for each cell…
> 350 000 targets

bigger, parallel & redundancy for continuous operating

Nuclear Plant includes ancillary systems

Some place…..

Tritium storage

Tritium treatment

Vacuum,

Wastes

Radiation control, analysis

Control room

Access, offices, maintenance laboratories and meeting room

And functions TBD

Remote control

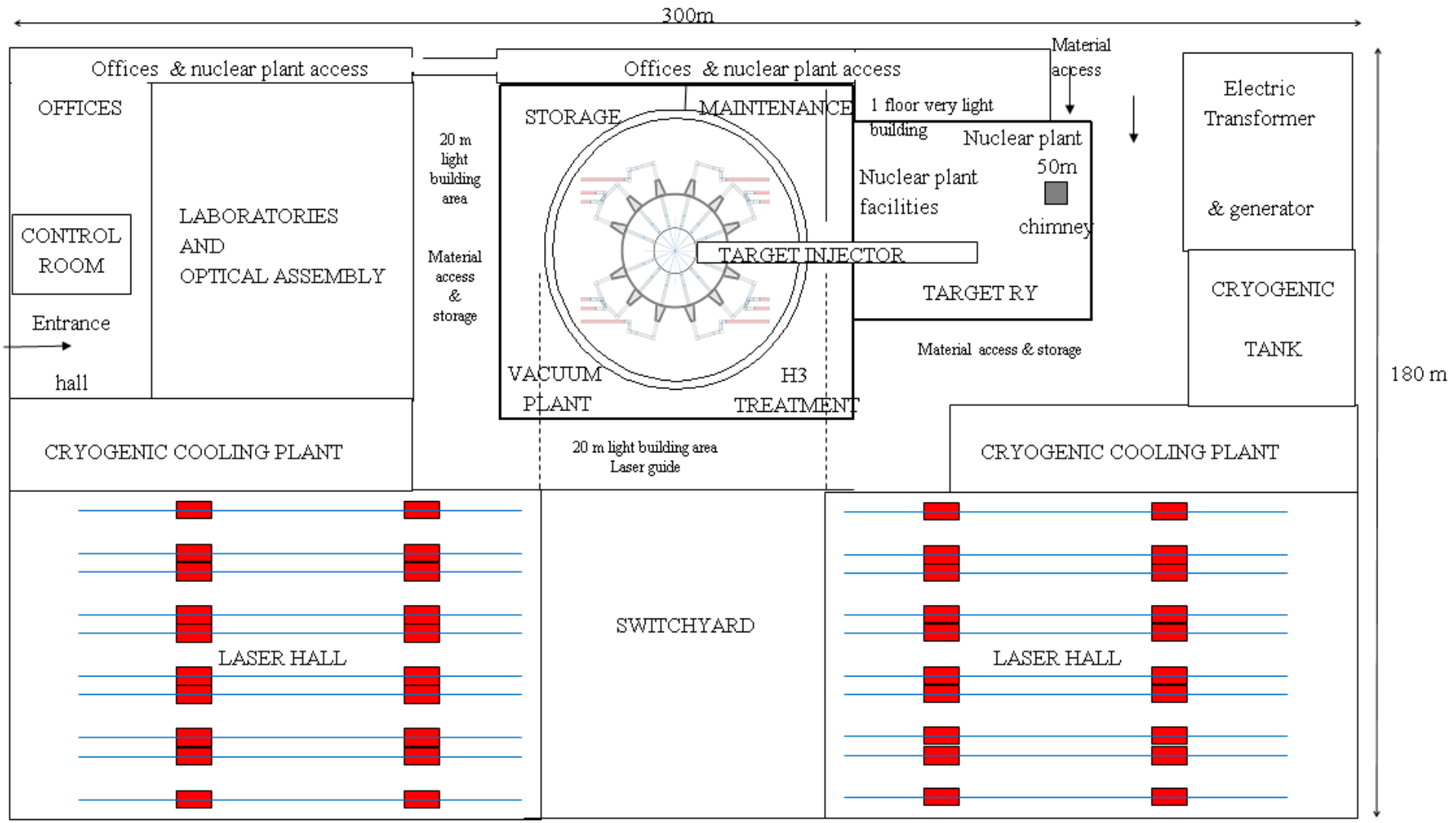
Fluids

Ventilation

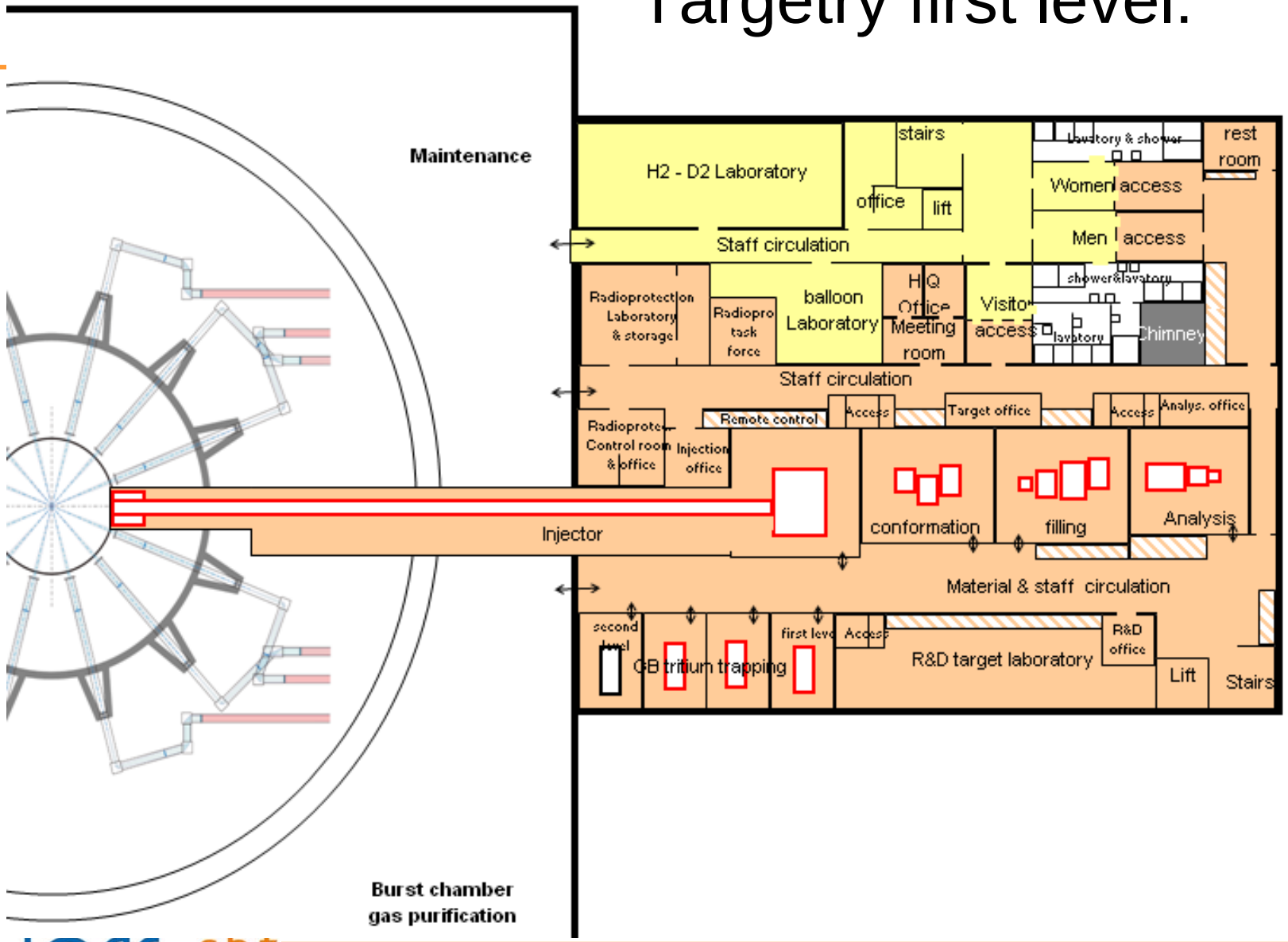
Vacuum,

Wastes

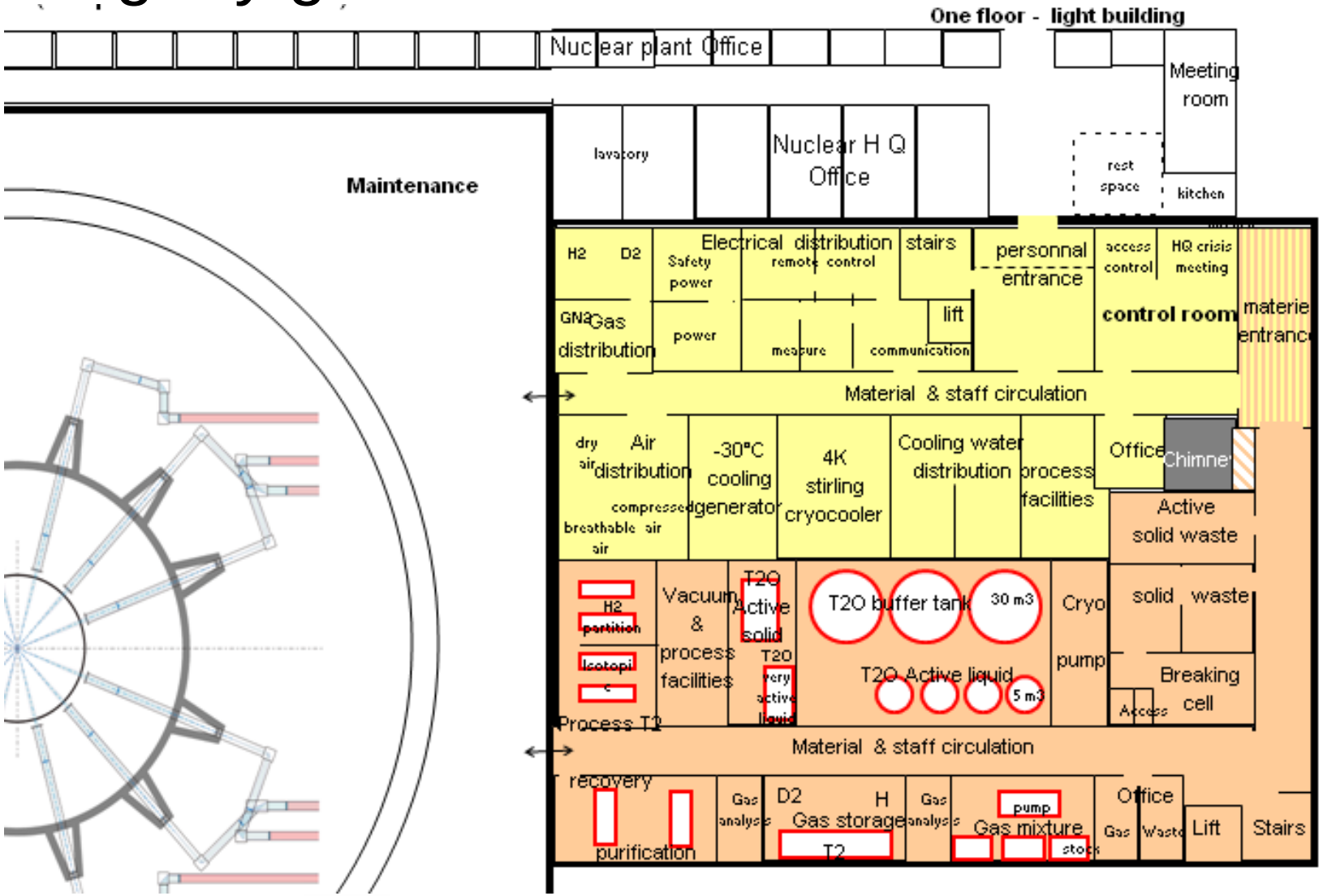
HiPER first drawing



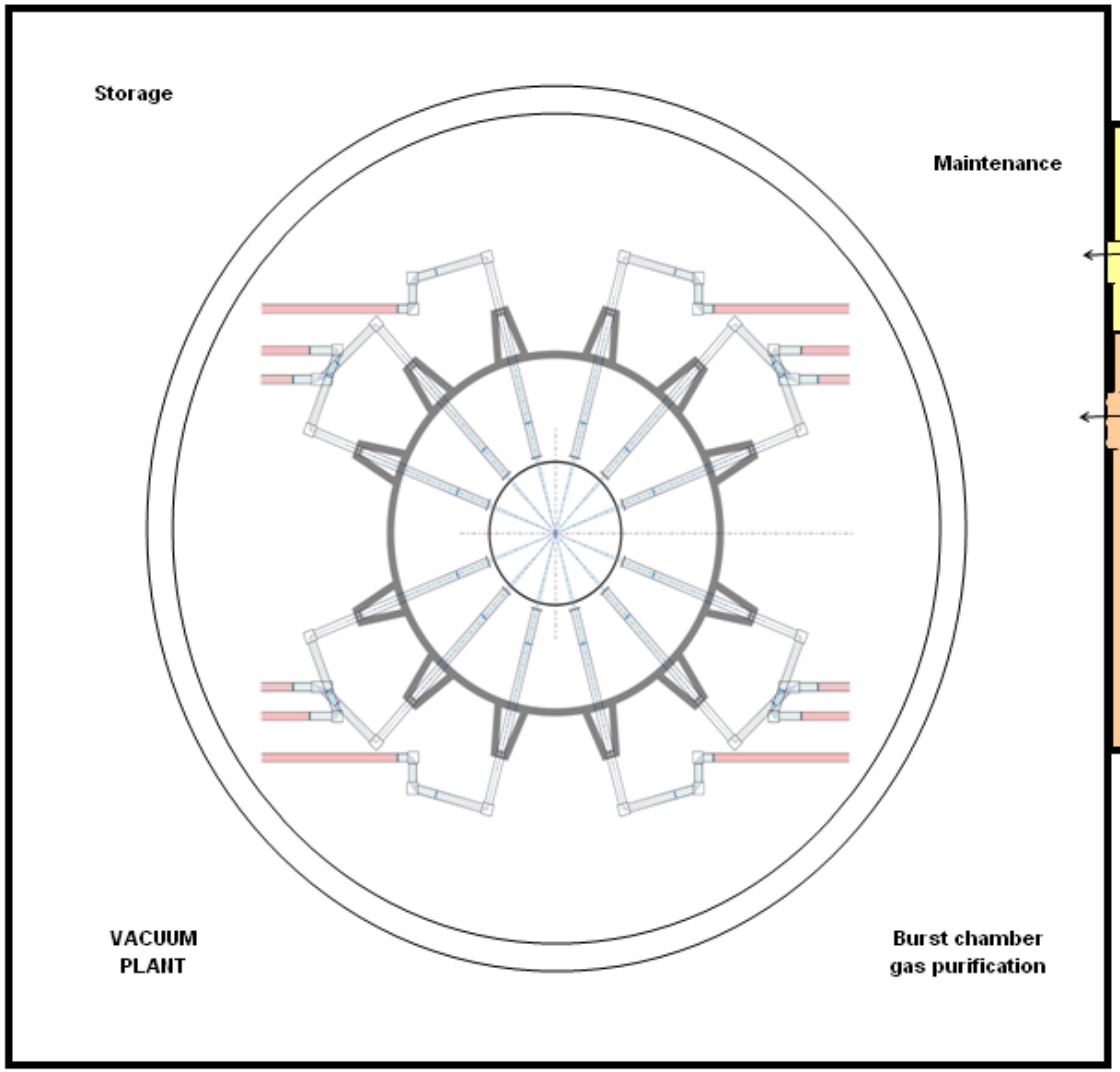
Targetry first level:

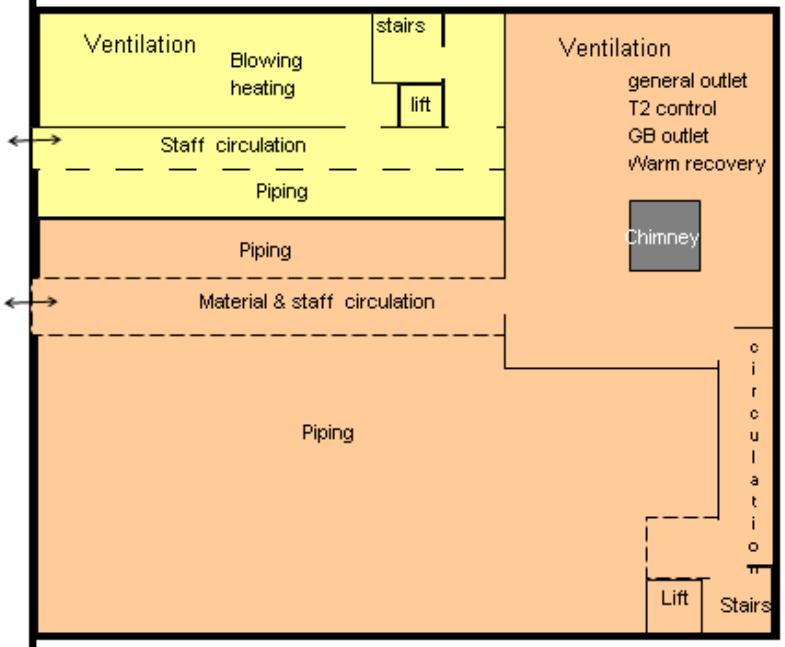


Targetry ground level:



Targetry second level:





Targetry budget elements:

burst chamber: 10 m diameter	targetry	2380 m2
building chamber: 64 m diameter	Chamber building	5776 m2
	NUCLEAR PLANT:	8156 m2/ level

HiPER tritium budget about 50 g

Targetry Total area	7143 m2
Survey area	2161 m2
controlled area	1441 m2
Active laboratories	1609 m2
Gloves boxes	324 m3

GB ventilation		3200 m3/h
Ventilation	in	150 000 m3/h
	out	100 000 m3/h
Pelec	total	800 kW
	Safety	200 kW

Budget about :	**70**	**M€**
Studies	3%	
building	24%	
equipment	38%	
fluids	35%	

Rough estimation based on our latest french tritium nuclear plant modification