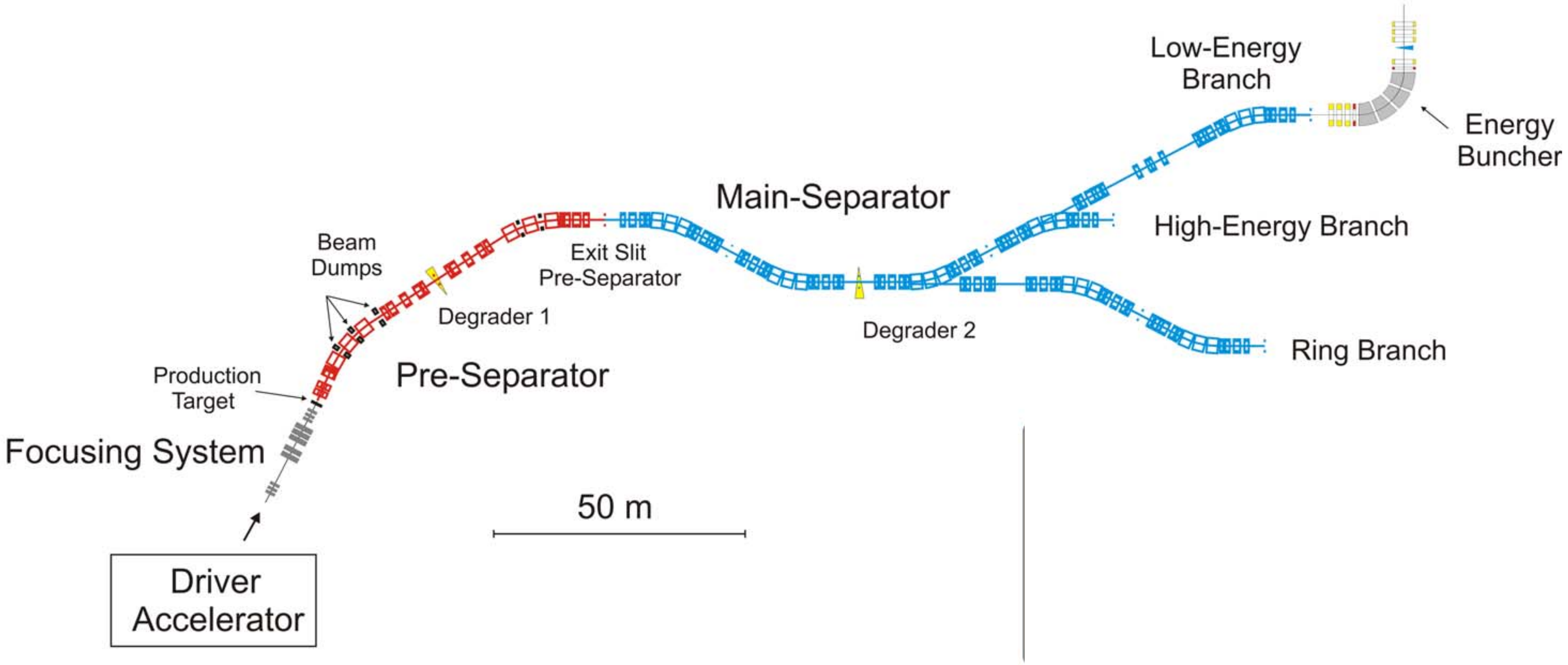
Super-FRS Status

Helmut Weick, GSI
EXL / R3B collaboration meeting
Milano, 5. Oct. 2006

- Function of the Super-FRS
- Magnet status
- Target, beam catcher status
- Buildings
- Detailed “room book”
- Load Lists

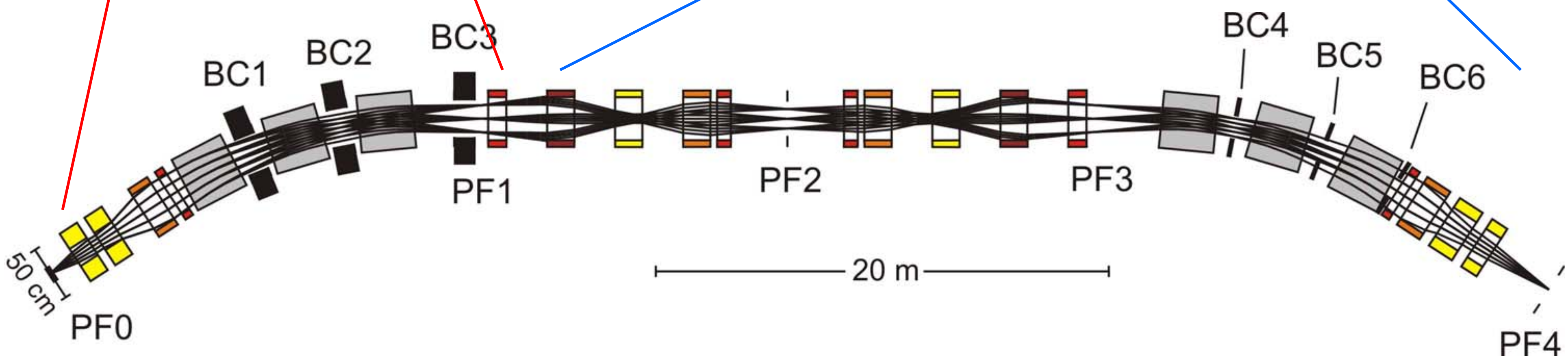
Design parameters and layout of the Super-FRS
(FBTR 03/2006)



Pre-Separator

Normal conducting warm coils

Superconducting cold coil, warm iron



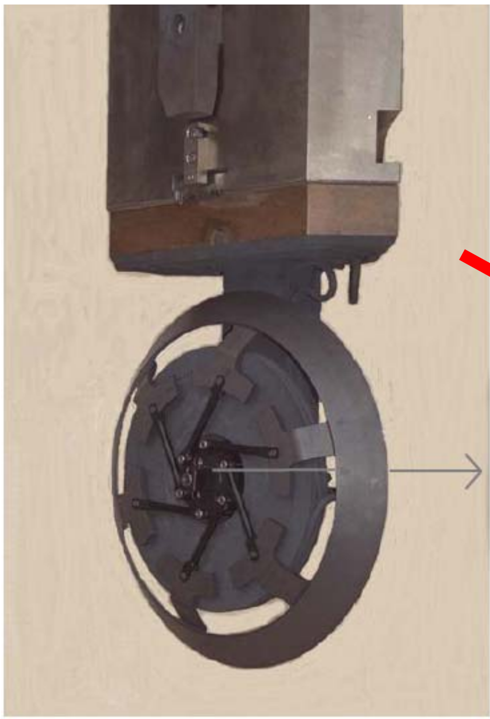
Large Energy deposition, Heat load on cryogenic system would be too high.

But large aperture magnets also need high power ~ 1 MW

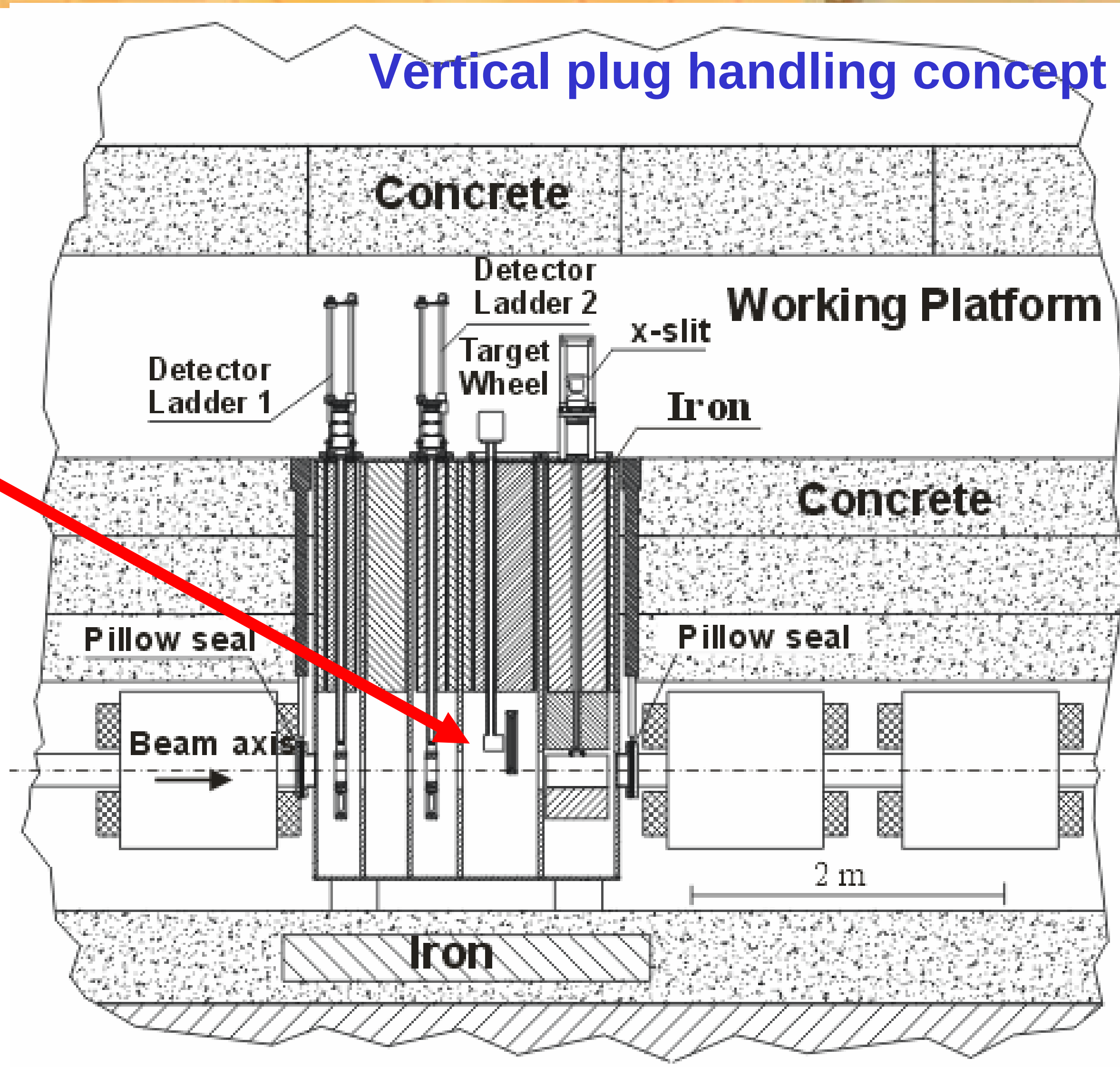
Adapted PSI Target Concept

G. Heidenreich, K. Sümmerer

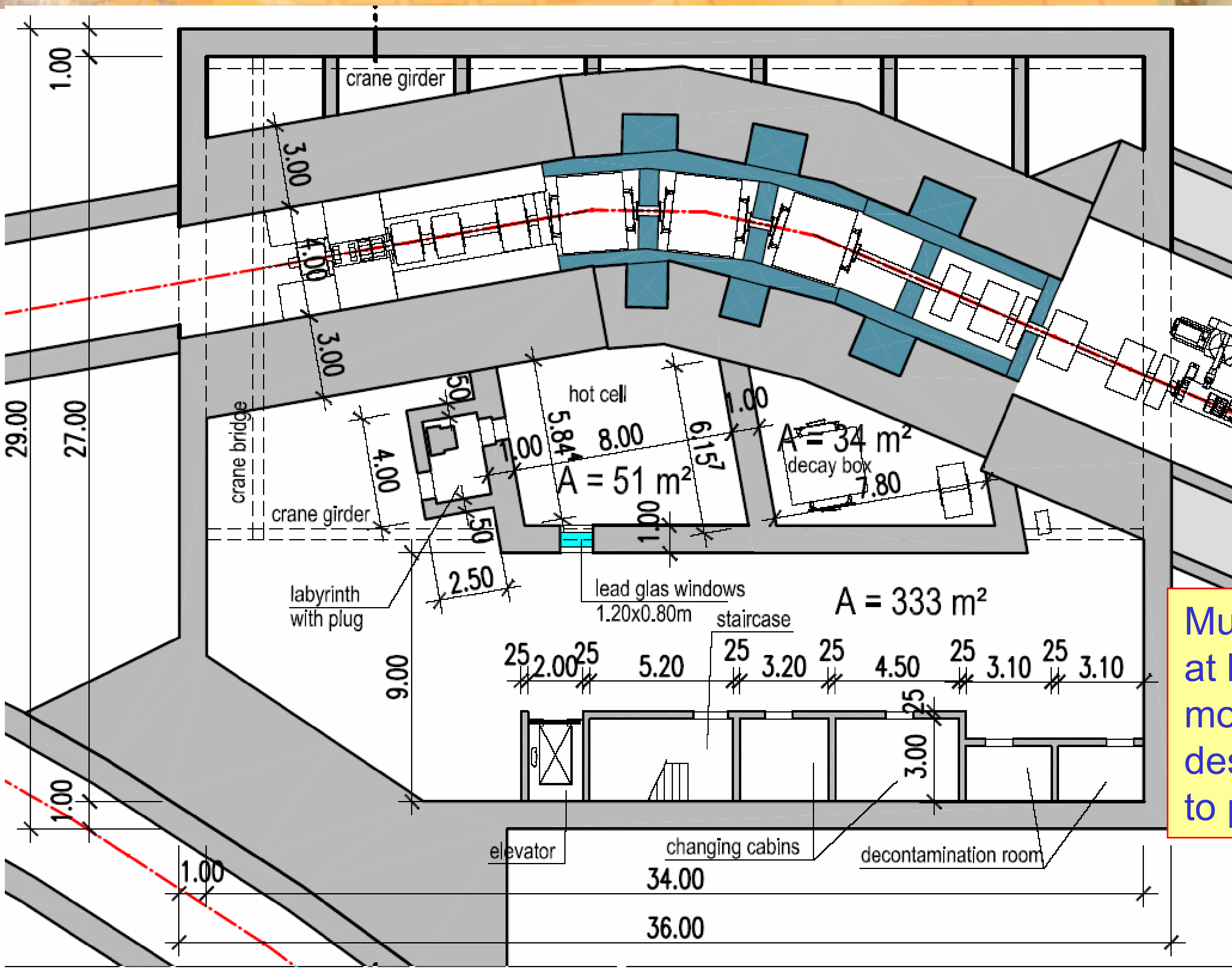
Target Wheel



Vertical plug handling concept

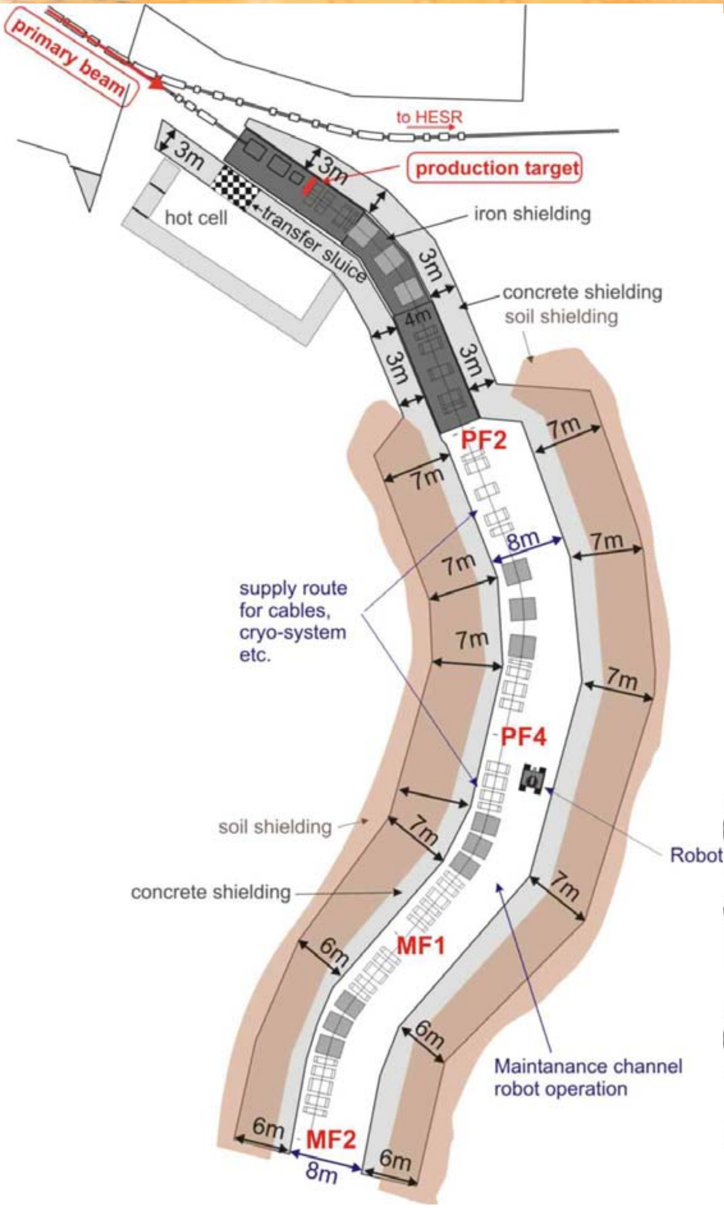


Building 18 (Super-FRS Target)

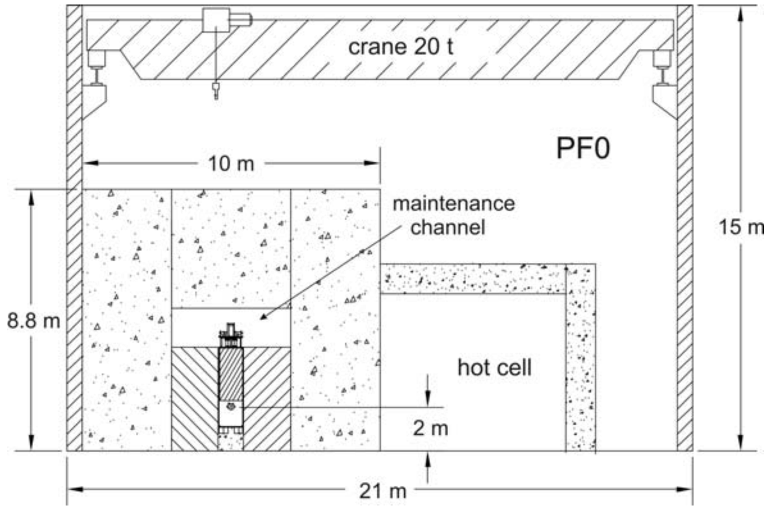


Much effort, but at least safer and more advanced design compared to pbar target.

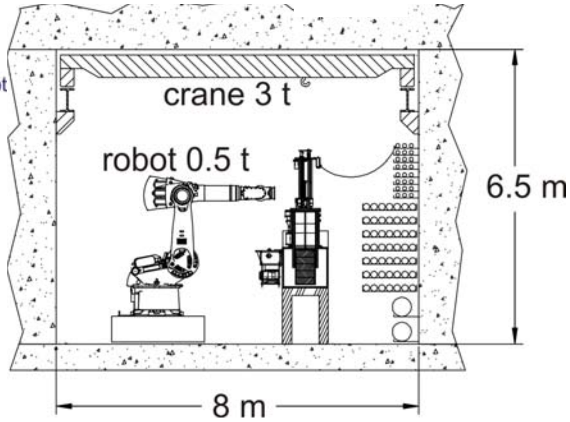
Layout and Shielding up to MF2

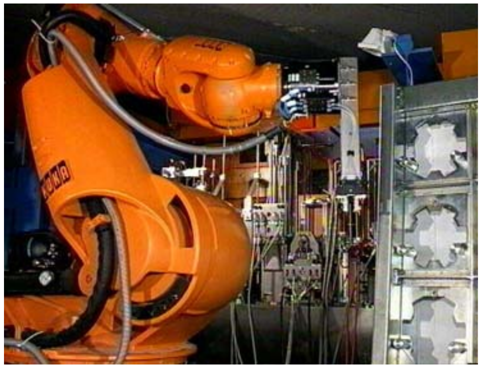


Cross section of the target area



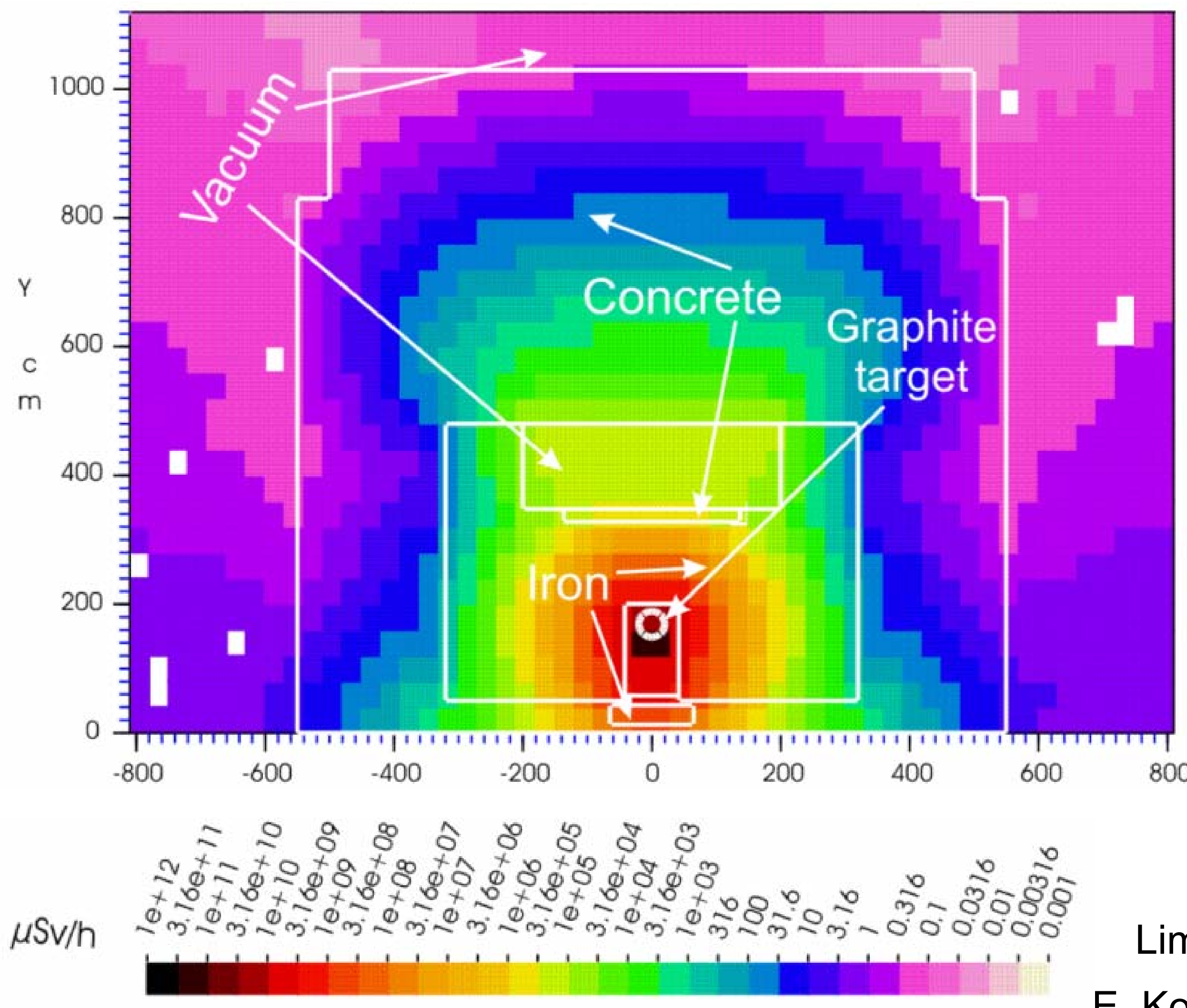
Cross section at PF4





Shielding / Activation

Prompt dose from 10^{12} U/s at 1 GeV/u, cross-section at target



Simulations in TR mainly by H. Iwase (PHITS code) in future more with FLUKA by T. Radon, E. Kozlova for final definition of values for buildings.

In general agreement between the two codes.

Concept: iron + concrete:
But iron is much more expensive than concrete.
We need iron for free!

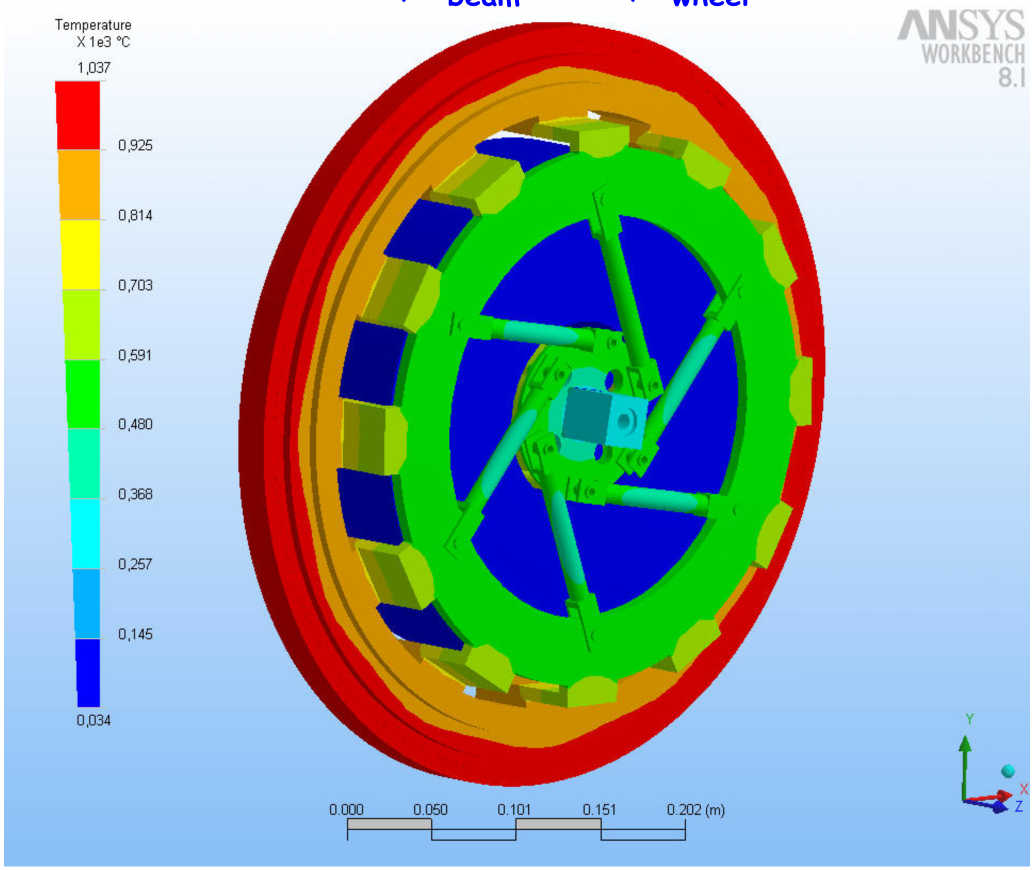
Limit < 0.5 μSv/h

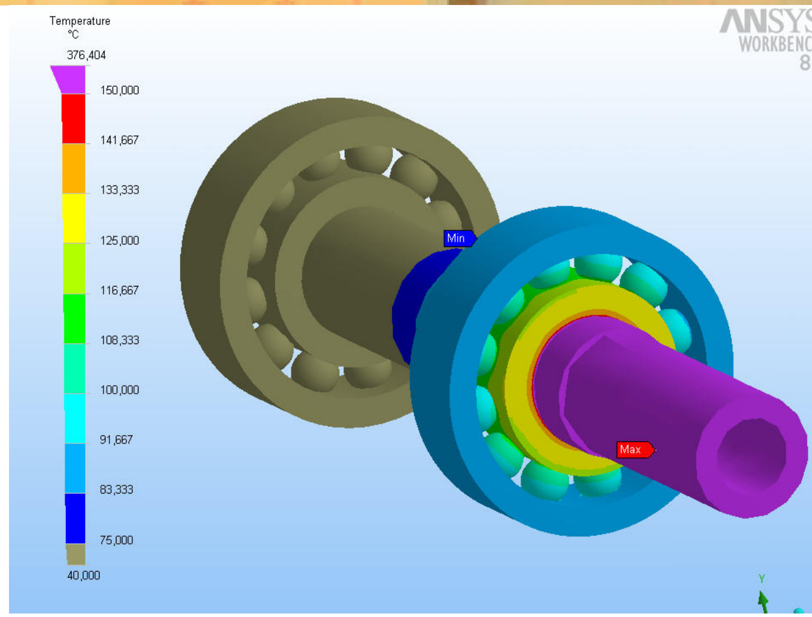
E. Kozlova, T. Radon

Target Wheel ANSYS Calculations

B. Achenbach

10^{12} $^{238}U/s$, $d_{beam}=1mm$, $r_{wheel}=450mm$





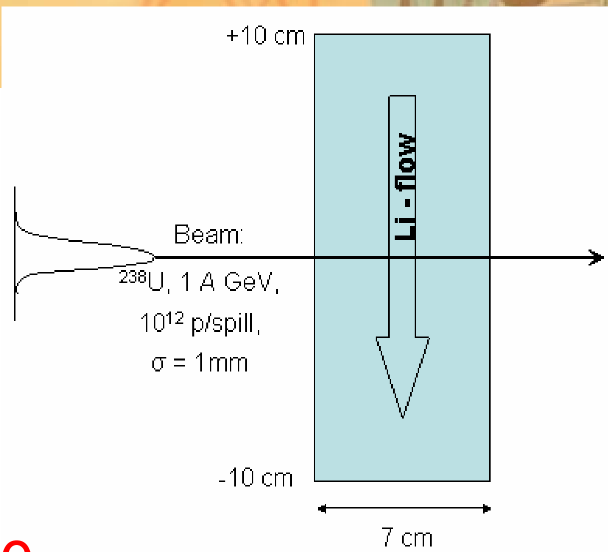
Can also work for fast extraction for lighter ions and with much enlarged beam spot size for Uranium

Target with 5 steps in thickness, construction could start.

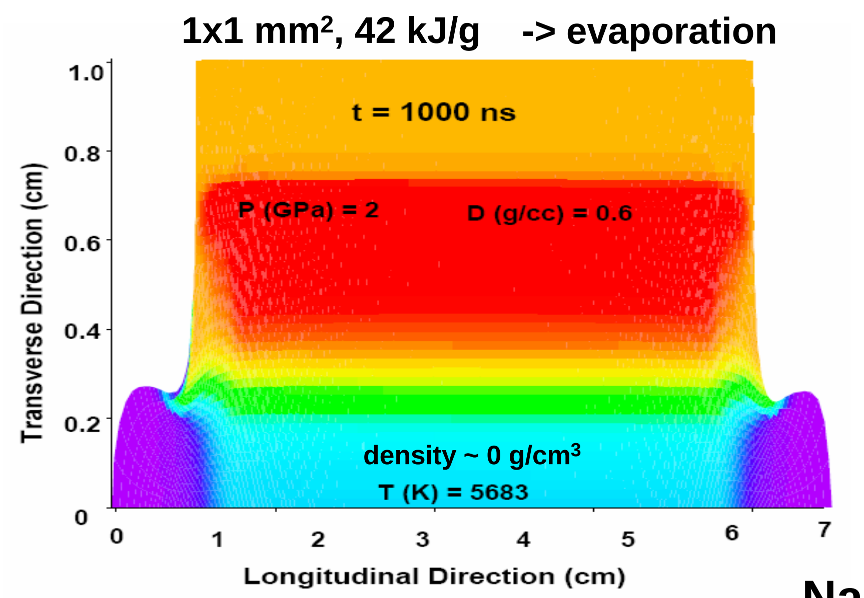
Question: Longterm effects of pressure waves ?

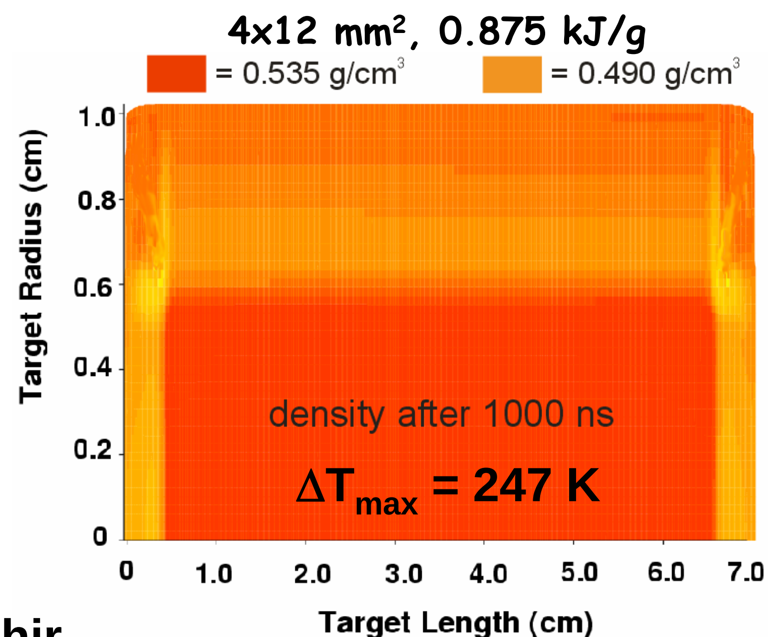
Fast Extraction: Liquid-lithium jet

FZ Karlsruhe group working on liquid metal flow, R. Stieglitz et al.



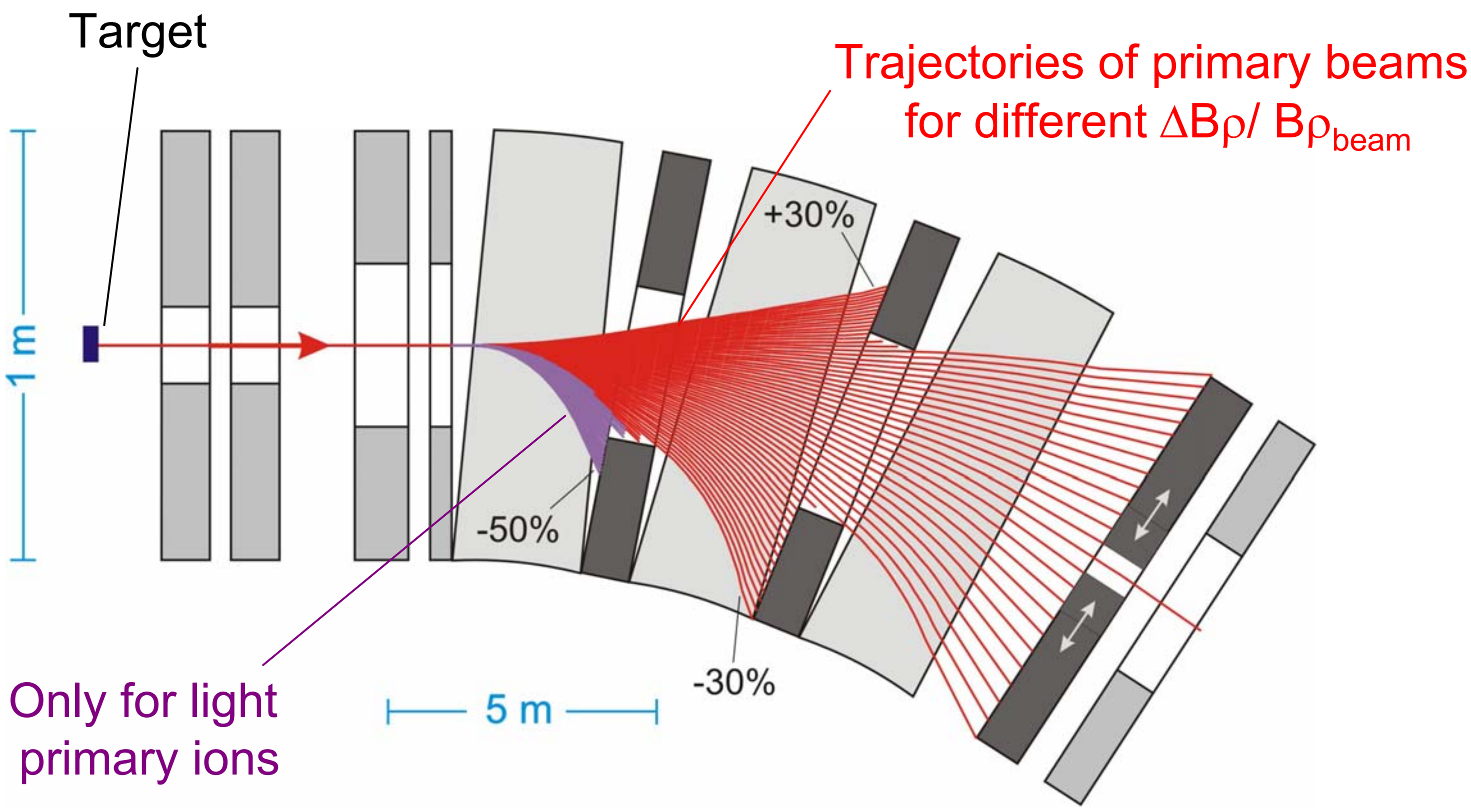
Investigate benchmark case:
1GeV/u 10^{12} ^{238}U ions/spill, after 1000 ns





Naeem Tahir

Beam dump locations in the 1st stage of the Pre-Separator

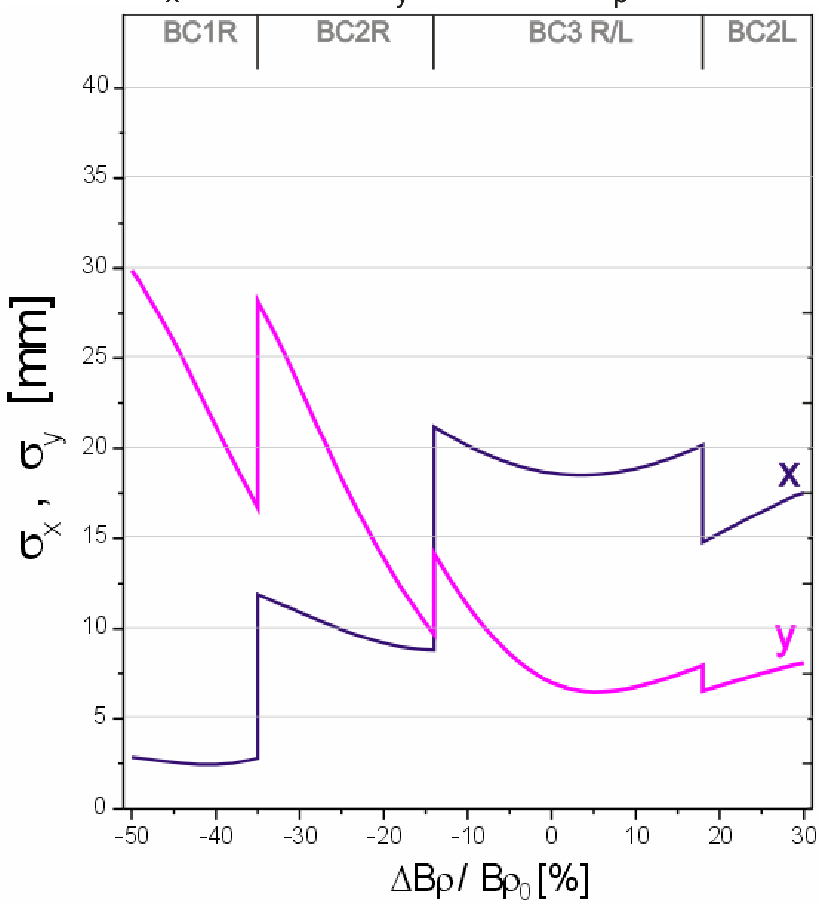


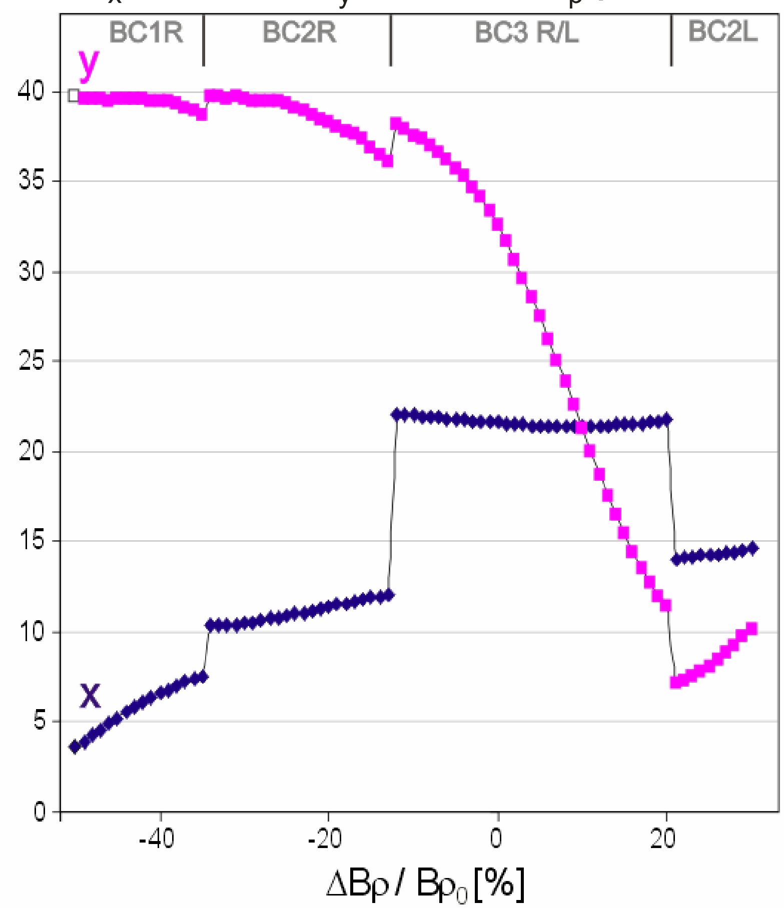
In all cases the primary beam is dumped only at dedicated positions !

Spot Size on Beam Catchers

MOCADI simulation with a bunched U beam at 1500 MeV/u and 4g/cm^2 C-target

σ_x = 1 mm, σ_y= 2 mm, σ_p/p=0.5% σ_x = 4 mm, σ_y=12 mm, σ_p/p=0.5%



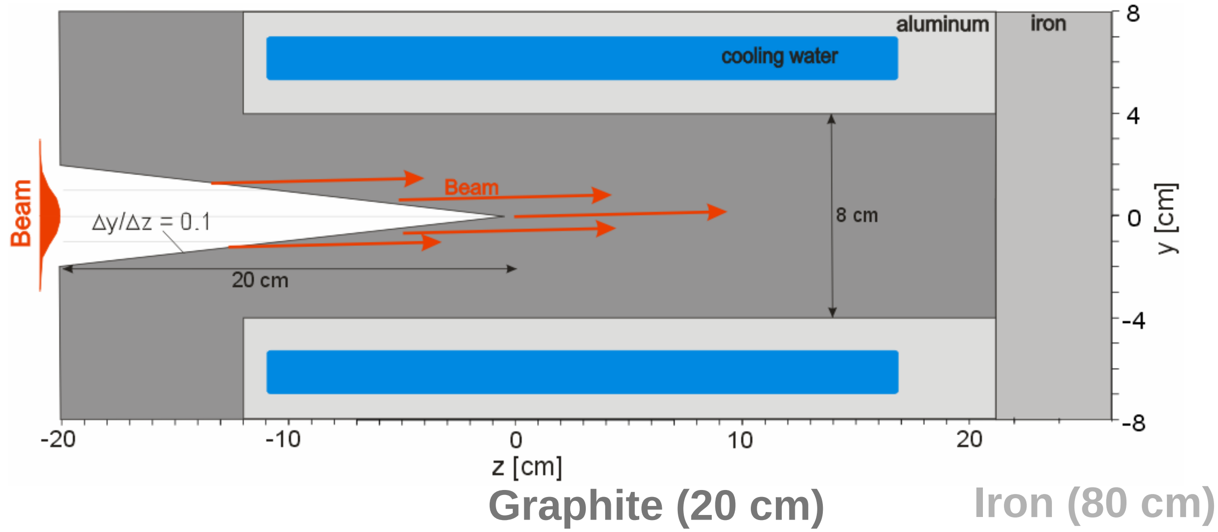


Nice larger spot size, but it has to be defined to catcher design.
Beam also hits dipole gap.

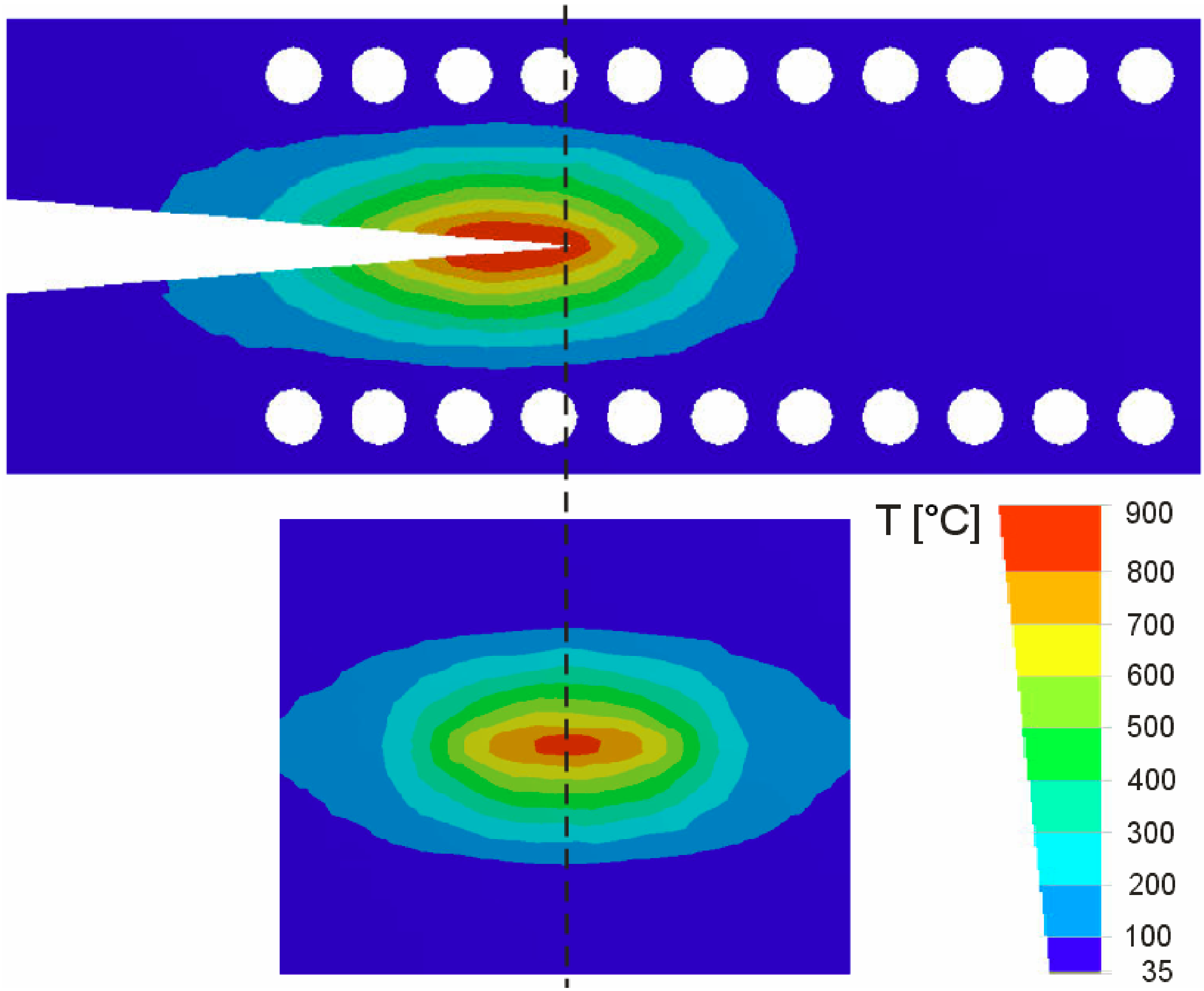
Beam Catcher Design

- Graphite is the only construction material that can stand the fast high intensity beam pulses.
- Mechanical Design started by VECC Kolkata, India
  Alok Chakrabarty, Sumanta Nayak, Manas Mondal
- Needed calculation of pressure wave propagation.
  Text experiment proposed to GSI PAC, with CERN people.
- Effects of radiation damage and annealing by fast heavy ions near Bragg peak (track formation).

Cut through beam catcher



Heating of beam Catcher



ANSYS calculation
40 kW DC beam
after reaching
equilibrium.

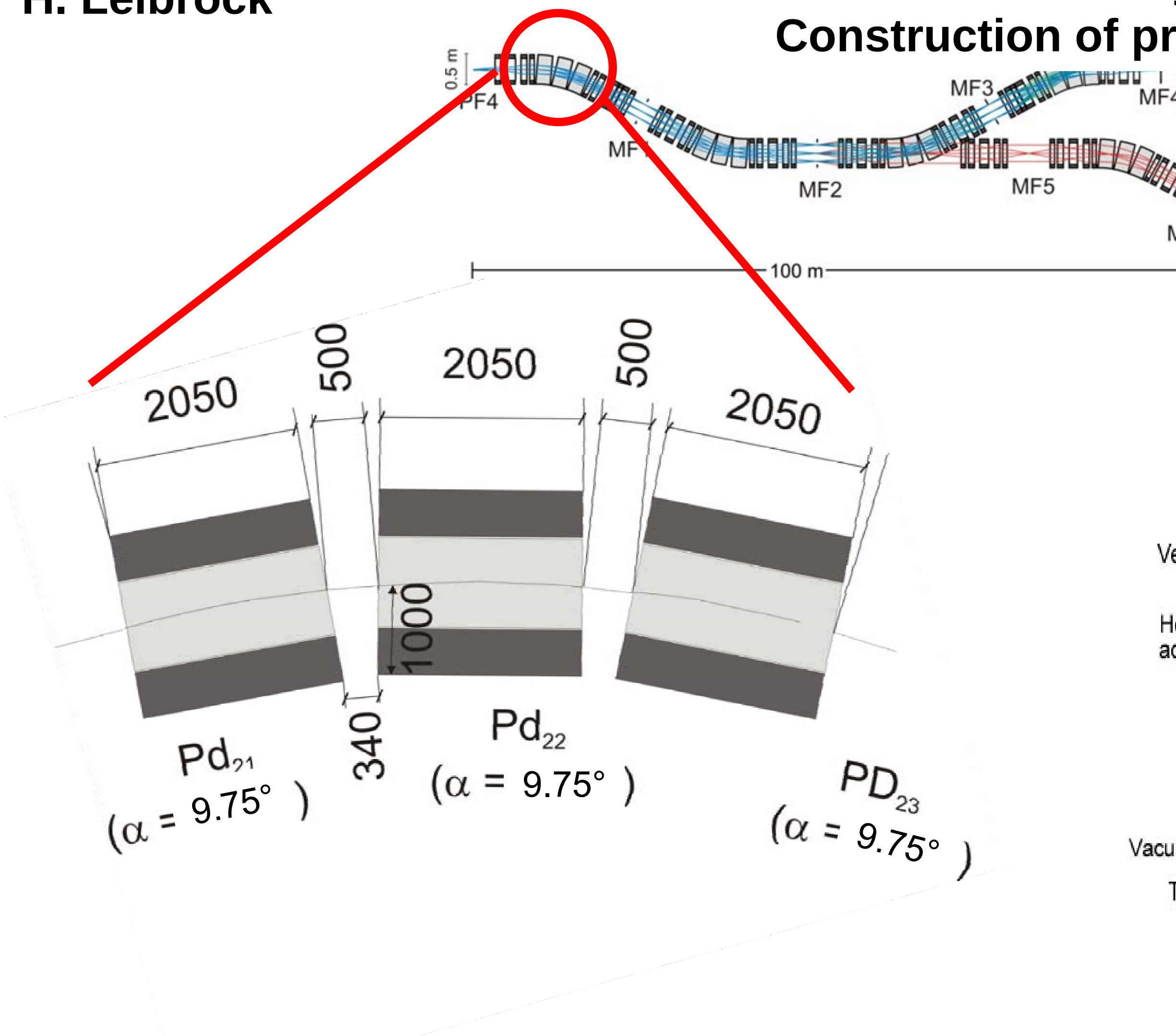
Equilibrium temperature
Tmax ≈ 900° C

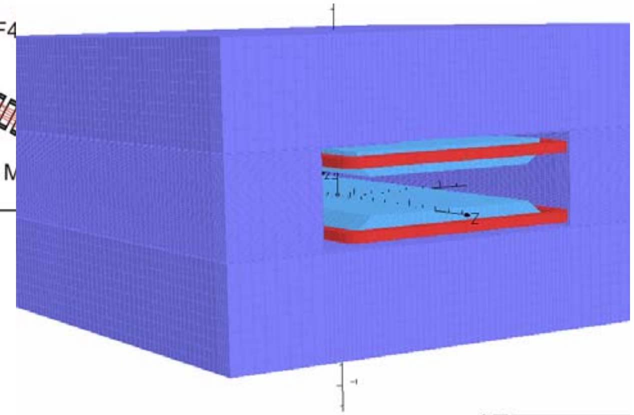
Boris Achenbach

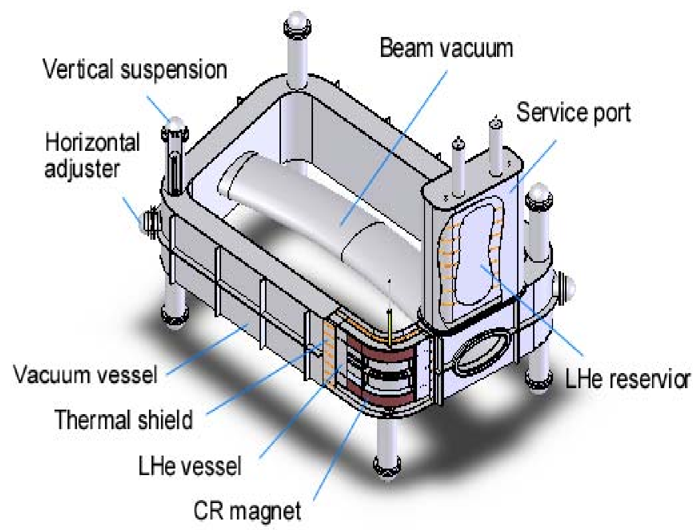
Superferric Dipole Magnets

M. Winkler
H. Leibrock

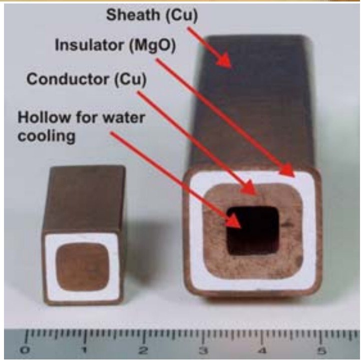
Magnet and Cryo design by CAS
IMP Lanzhou, Inst. of El. Eng. Beijing,
Inst. of Plasma Phys. Heifei
Construction of prototype.



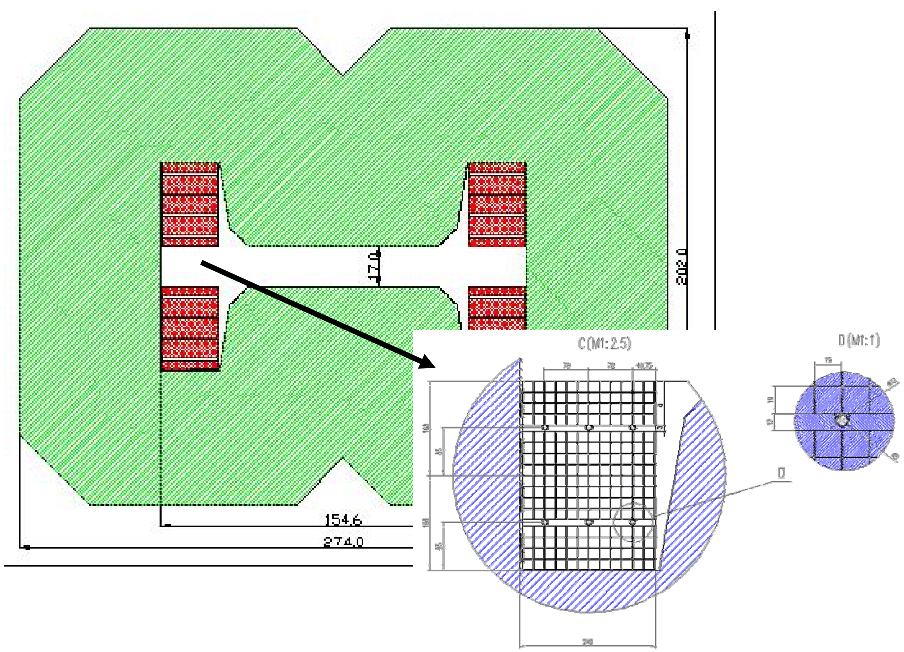


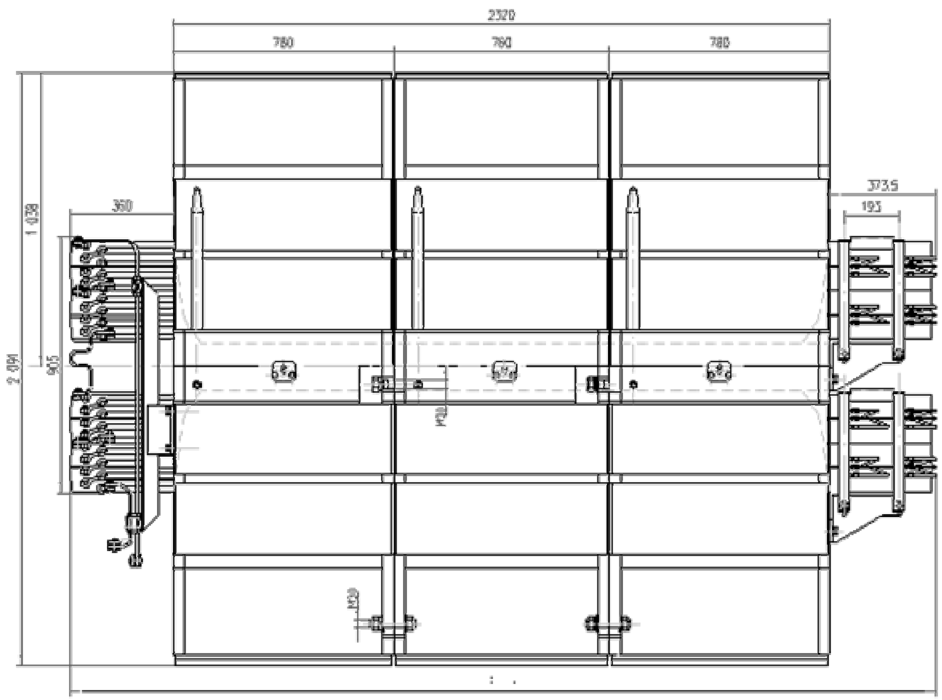


Radiation Resistant Magnets



- Normal conducting magnets using MIC
- Part of EU Design Study (NUSTAR 2) → goal: prototype dipole magnet (R = 12.5 m, ϕ = 11°, B_{max} = 1.6 T, W ≈ 100 ton)
- Conceptual Design Study for all magnet types (1 dipole, 2 quadrupoles, 1 hexapole), by BINP, Sept. 2006
- Remote control for assembly/disassembly
- Next steps: engineering design, production of 1 pancake coil, full magnet
- Problems: available conductor length (≈ 60m) to short, TIME! Money (≈ 900 k€ only material)?

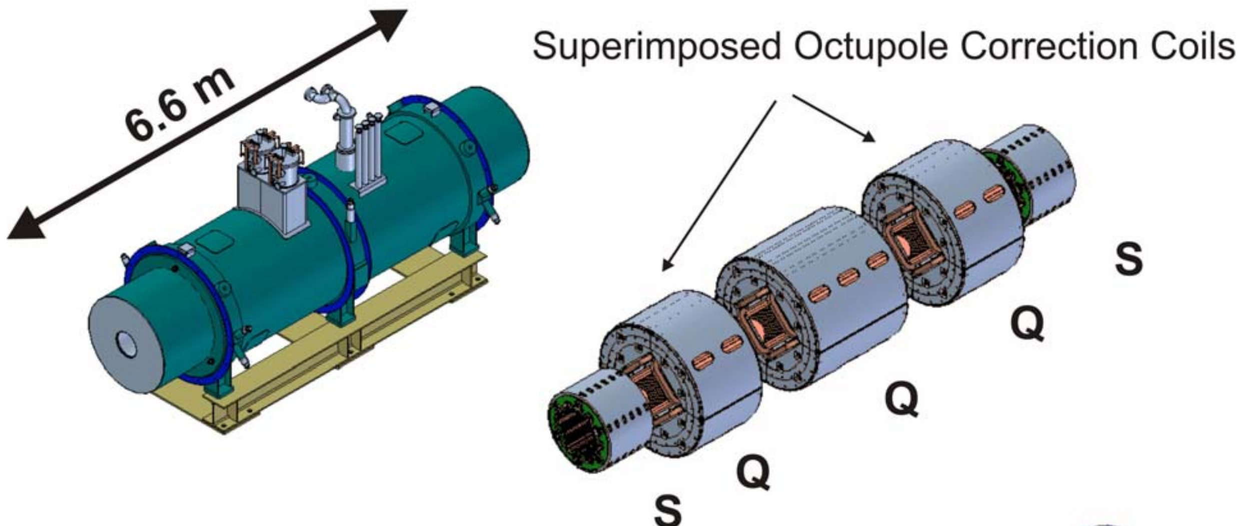




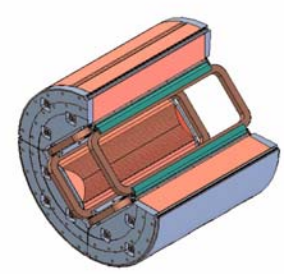
Superferric Quadrupole Multiplets

- Iron dominated, SC coils, cold iron, warm beam pipe
- Conceptual design study for a superferric multiplet by Toshiba, May. 2006
- Next steps: production of one prototype quadrupole (≈ 400 k€, 200k€ in 2006 still available), contract in preparation
- Alternative: warm iron solution (discussion with BINP)

Superferric Multiplet (SQQS)



Effective length (quads)	0.8 / 1.2 m
Aperture (warm)	± 190 mm
Pole radius	240 mm
Field gradient	1.0 - 10.0 T/m
Gradient field quality	$\pm 8 \cdot 10^{-4}$

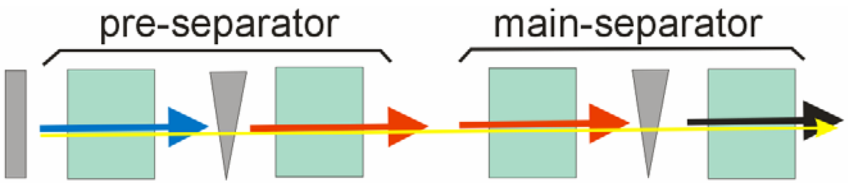


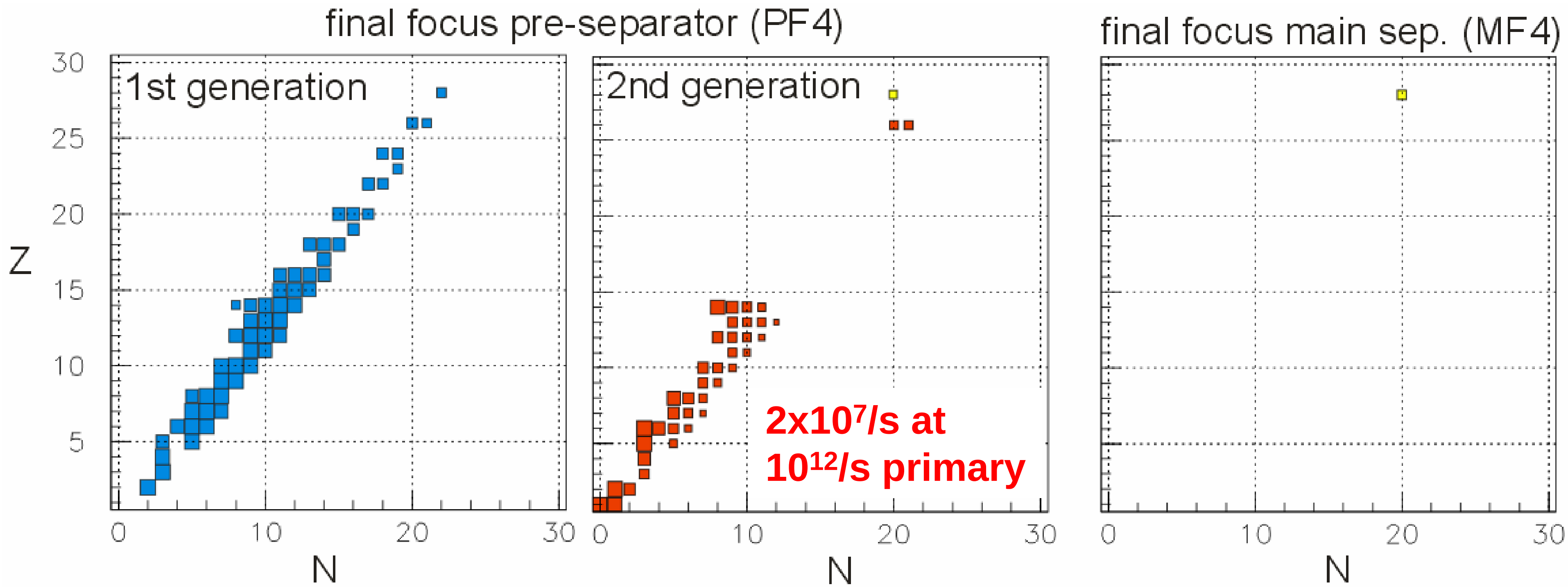
Two Stage Separation

Problem: contamination from reactions in degrader

Example: ^{48}Ni from ^{58}Ni primary beam with two thick degraders (d/R=0.5)

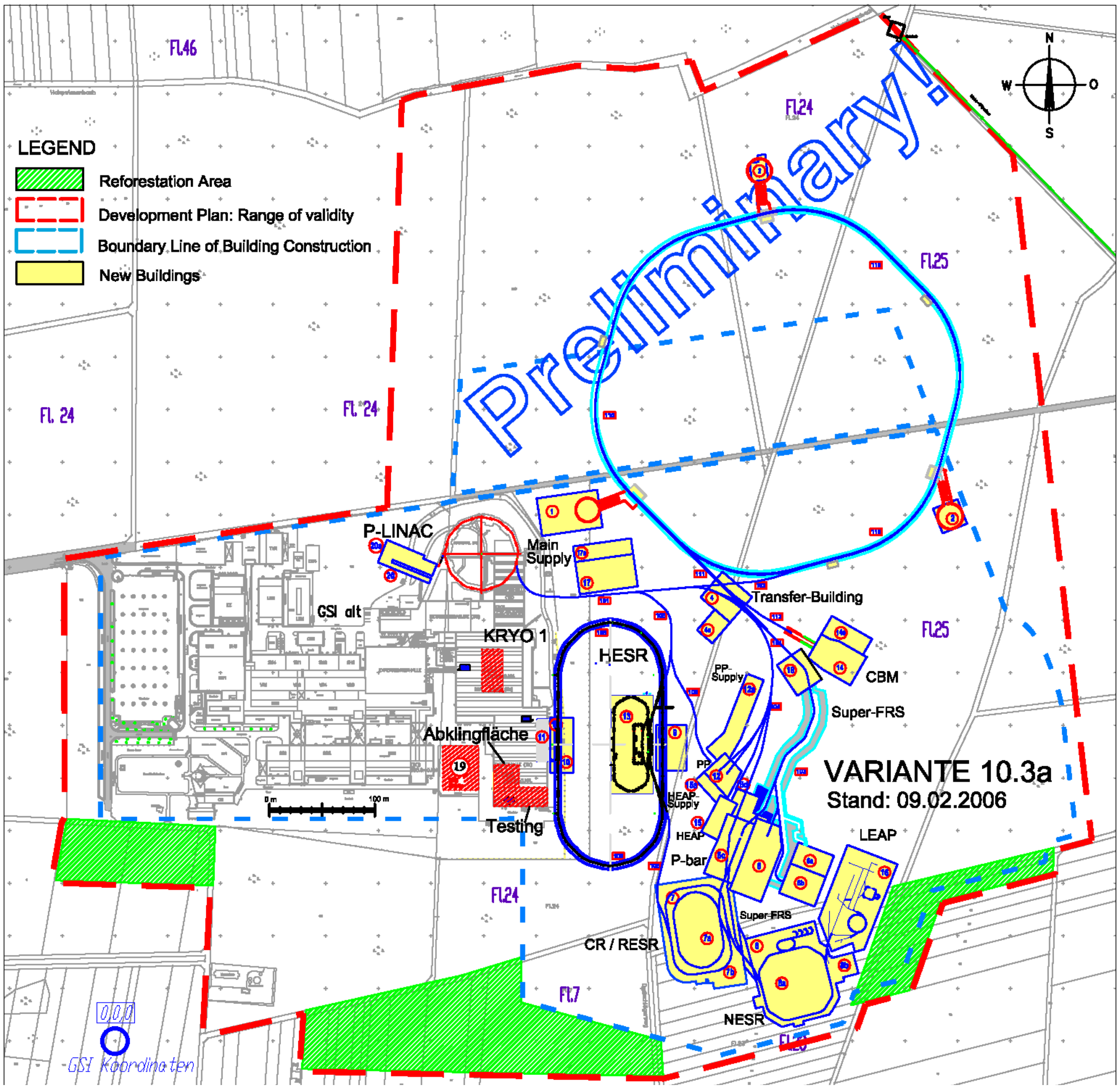
Solution: two degrader stages.





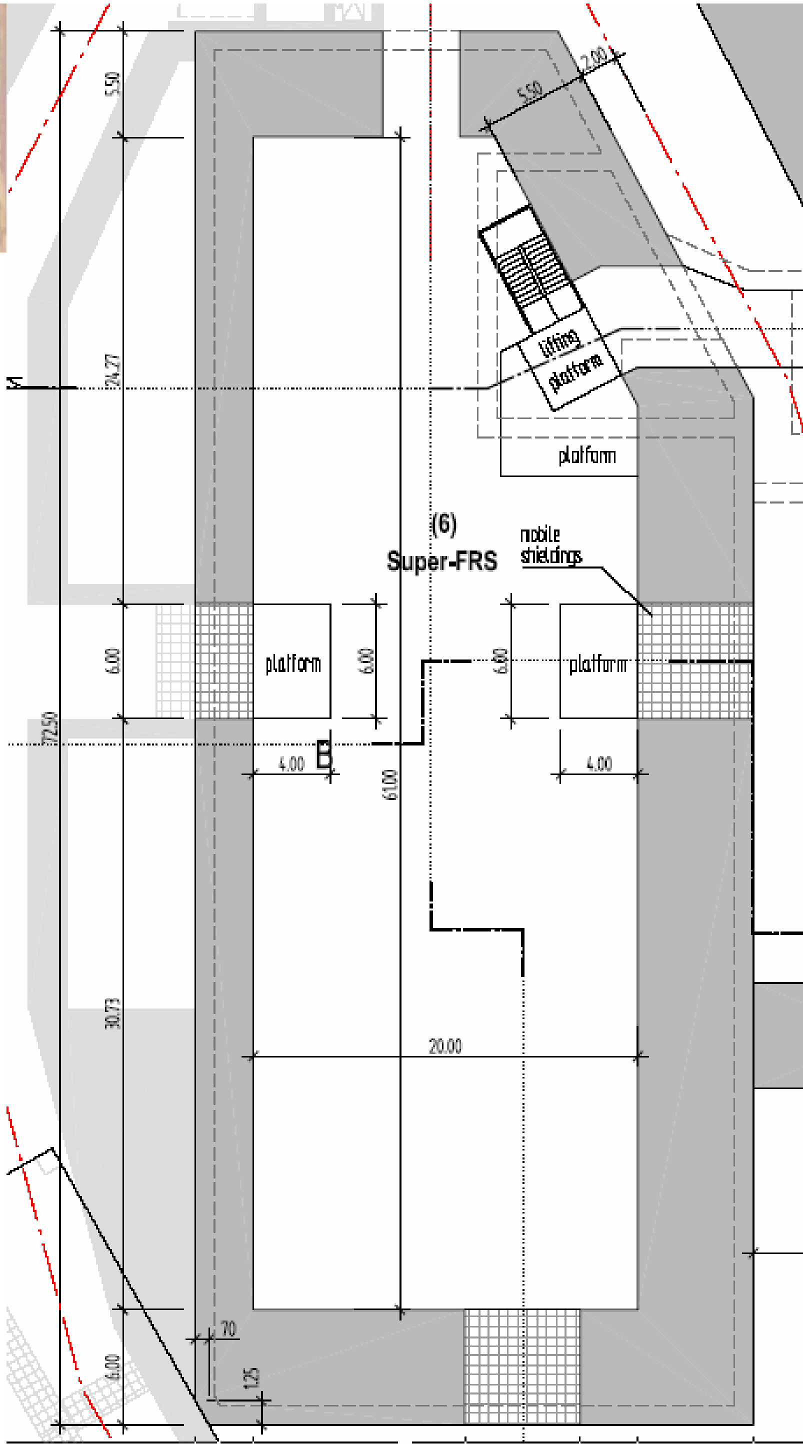
Simple analytical transmission program verified by MOCADI simulation with 1400 input files 5*10^8 ions

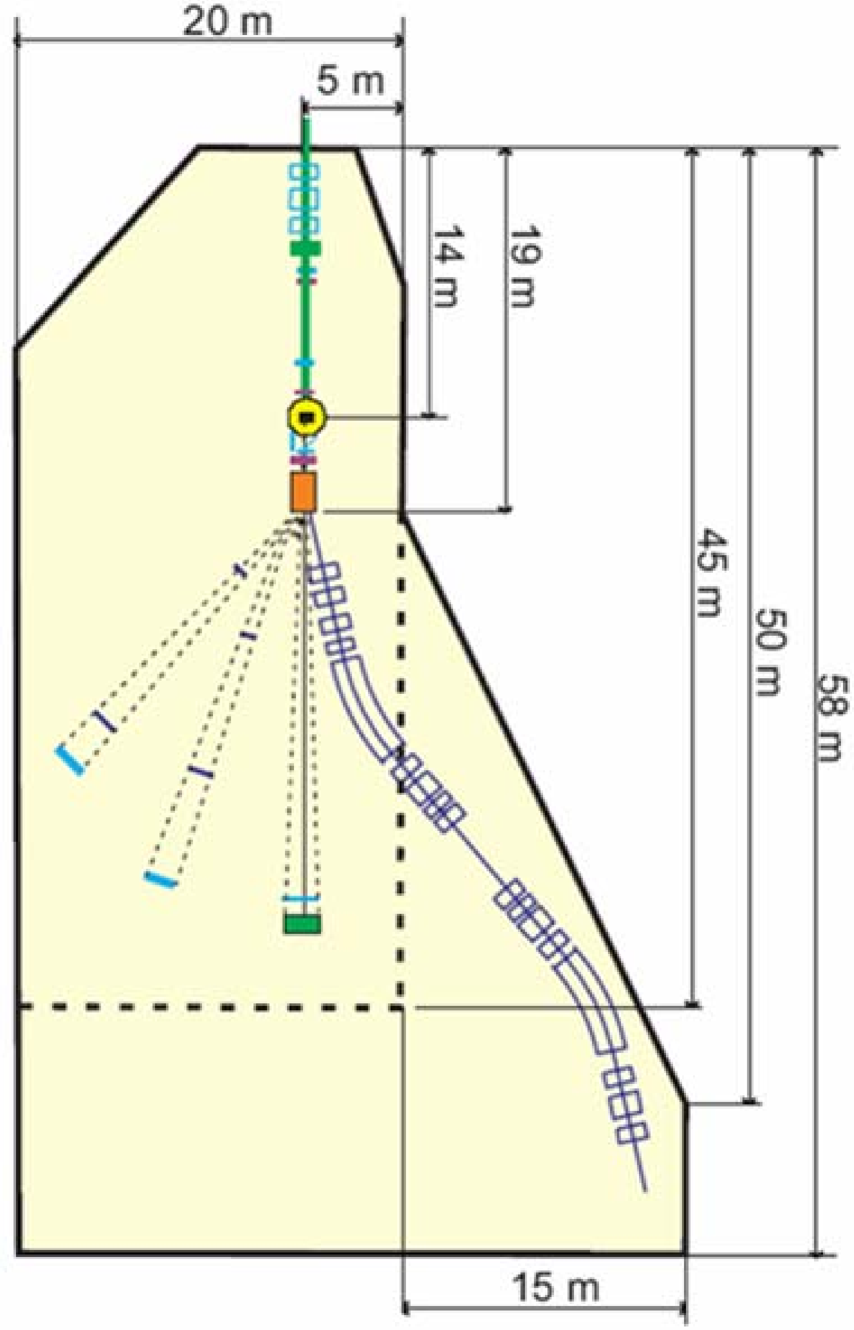
Topology of FAIR (FBTR 03/2006)



1	Extraction Building
2	Injection Building
3	Emergency Exit
4	Transfer Building
4a	Transfer - Supply
6	Super - FRS
6a	Super - FRS Supply
6b	Super - FRS LE - Branch
6c	P-bar - Target
6d	P-bar - Target Supply
7	CR / RESR
7a	CR / RESR Supply
7b	CR / RESR High Building
8	NESR
8a	NESR Supply
8b	NESR - Preparation
9	HESR PANDA Detector
10	HESR - Cooler
10a	HESR - Cooler Tower
11	HESR Supply
12	PP
12a	PP/HEBT Supply & LASER
13	HESR - COSY
14	NC (CBM)
14a	NC (CBM) Supply
15	HEAP
15a	HEAP Supply
16	LEAP Supply
17	Main Supply Building
17a	Compressor Building
18	Super - FRS Targethalle
19	Office Building
20	P - Linac
20a	P - Linac Supply

101	SIS18 - Transfer
102	Transfer Injection SIS100
103	Super - FRS
104	Transfer SIS100/300 - Exp.
105	Transfer SIS18 - PP
106	Transfer CR/RESR - HESR
107	HESR - Injection
108	HESR
110	SIS100/300 Tunnel
111	Extraktion SIS100/300

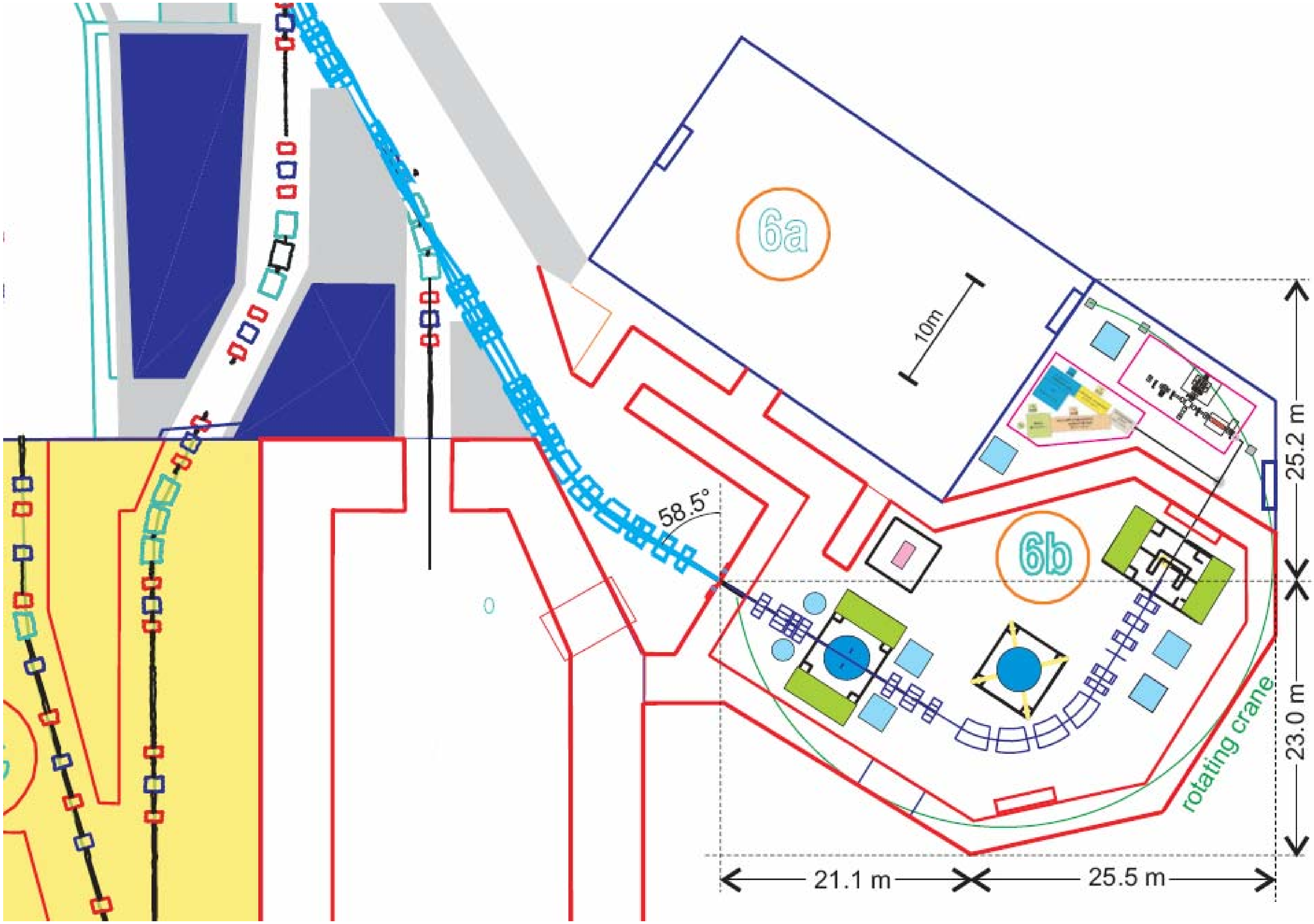




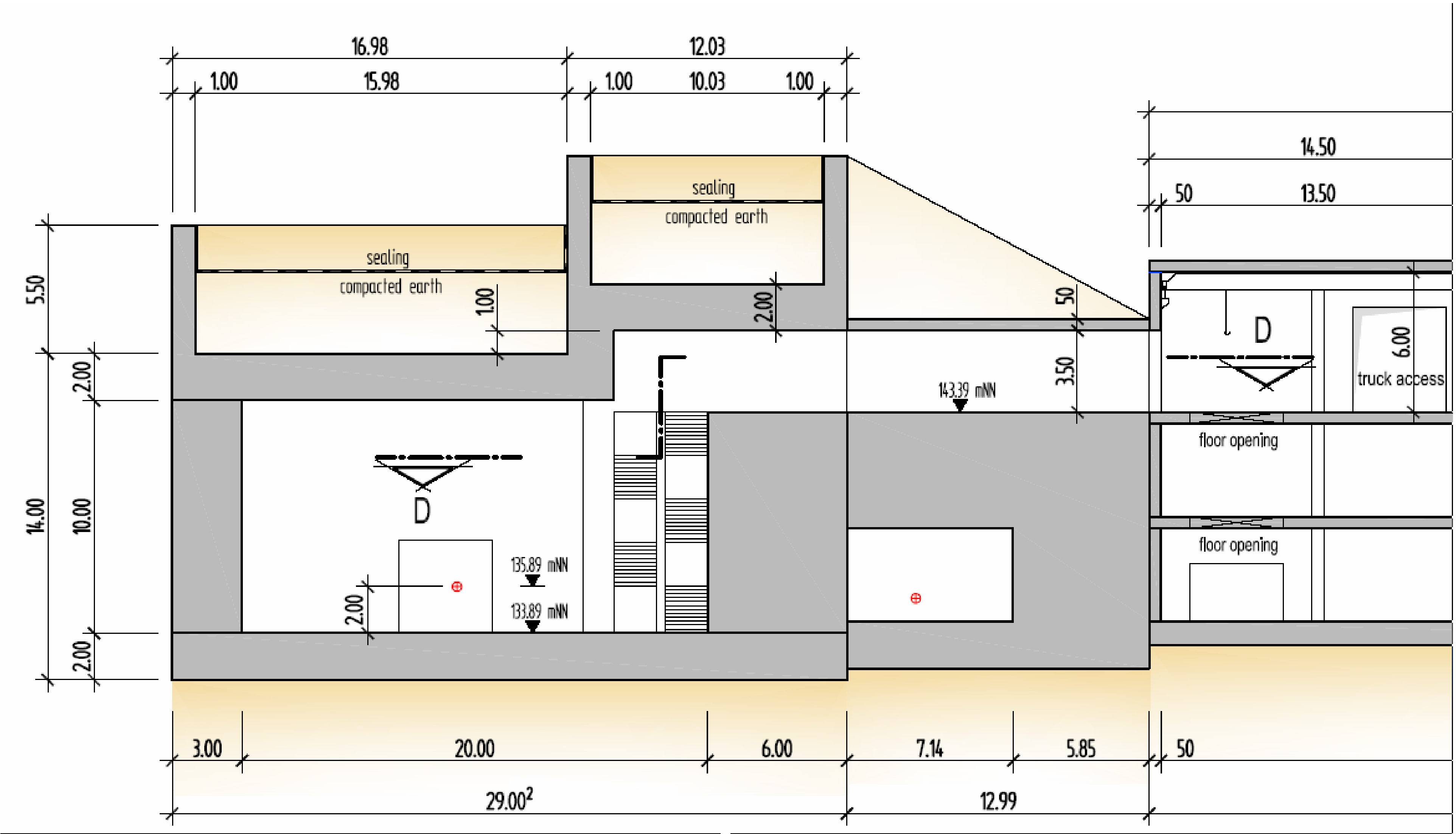
HEB (R3B) Cave, Building 6

Topology LEB Cave

LEB - Proposed Topology



Building 6



16.98
12.03
1.00
15.98
1.00
10.03
1.00
14.50
50
13.50
sealing
compacted earth
sealing
compacted earth
1.00
2.00
50
3.50
143.39 mNN
D
6.00
truck access
floor opening
floor opening
5.50
2.00
14.00
10.00
2.00
D
2.00
135.89 mNN
133.89 mNN
3.00
20.00
6.00
7.14
5.85
50
29.00
12.99

Building 6a (Level organisation)

Status 11.08.2006

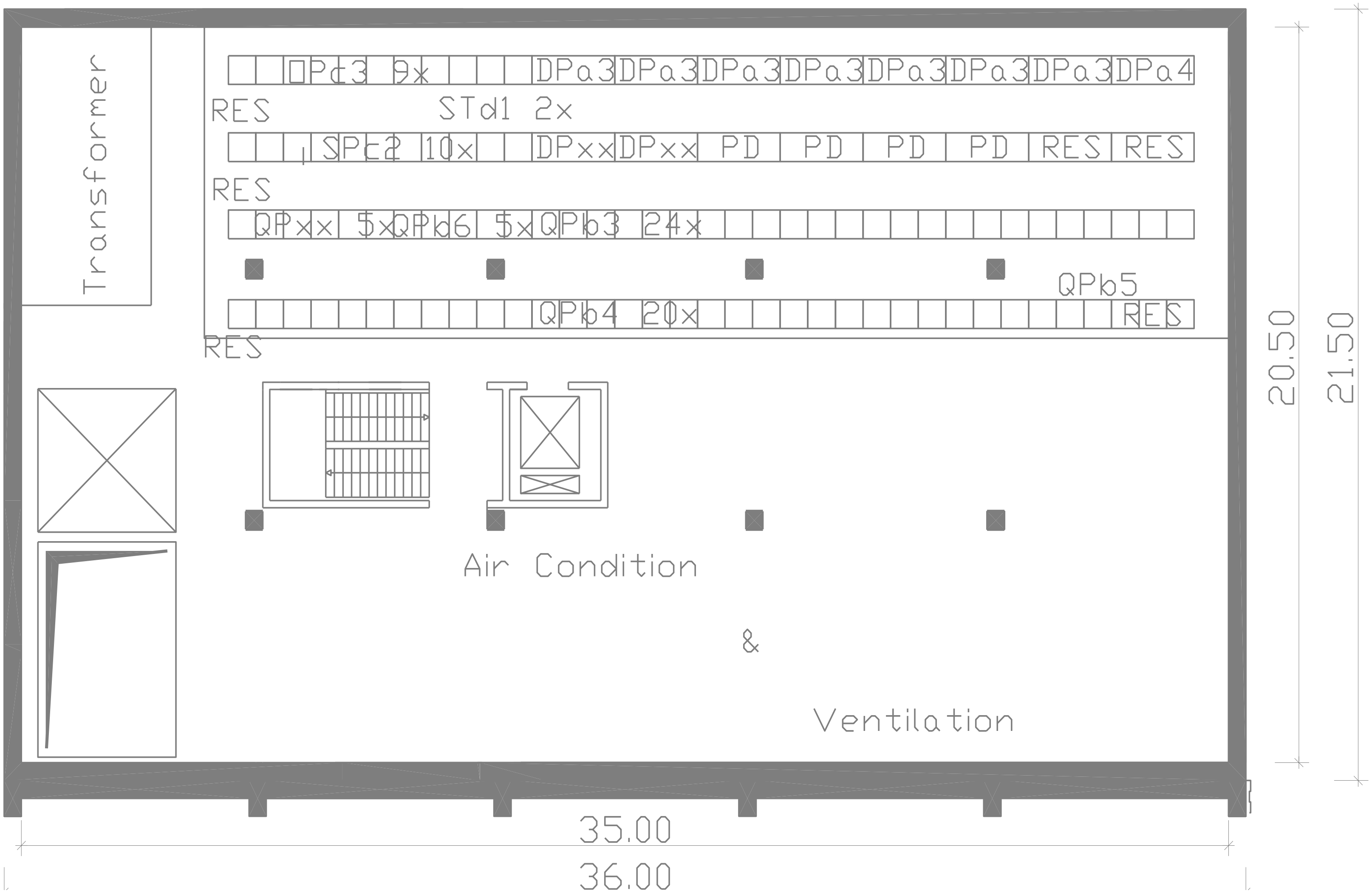
	Labs			Area
Level 2	2.1	Super-FRS	Detektors	33,9 m^2
	2.2	HEB	R3B	47,4 m^2
	2.3	LEB	Stopping-Cell	57,6 m^2
	2.4	LEB	MATS	44,8 m^2
	2.5	LEB	LaSpec	60,5 m^2
	2.6-2.8	Super-FRS + HEB + LEB	Workshop/Assembly/Storage	230,4 m^2
			Stairs/Lift/Slot	46,6 m^2
			Corridor/Cargo area	160,0 m^2
			Toilets	23,3 m^2
	Sum			**704,3 m^2**
Level 3	3.1	Super-FRS + HEB + LEB	Console	96,0 m^2
	3.2		Exp. Electronics	96,0 m^2
	3.3		Meeting Room	47,5 m^2
	3.4	LEB, HISPEC/DESPEC	Filling Station	16,4 m^2
	3.5		Spectroscopy	25,6 m^2
	3.6		Ge (HQCR)	24,6 m^2
	3.7		Electronics	51,2 m^2
	3.8		Pumps	32,8 m^2
	3.9		Mechanics	38,4 m^2
	3.10	Super-FRS	Electronics	41,0 m^2
			Stairs/Lift/Slot	46,6 m^2
			Corridor/Cargo area	162,0 m^2
			Toilets	23,3 m^2
	Sum			**701,3 m^2**

Level 1:

- Power supplies
- Transformer
- FAIR infrastructure (air, water)

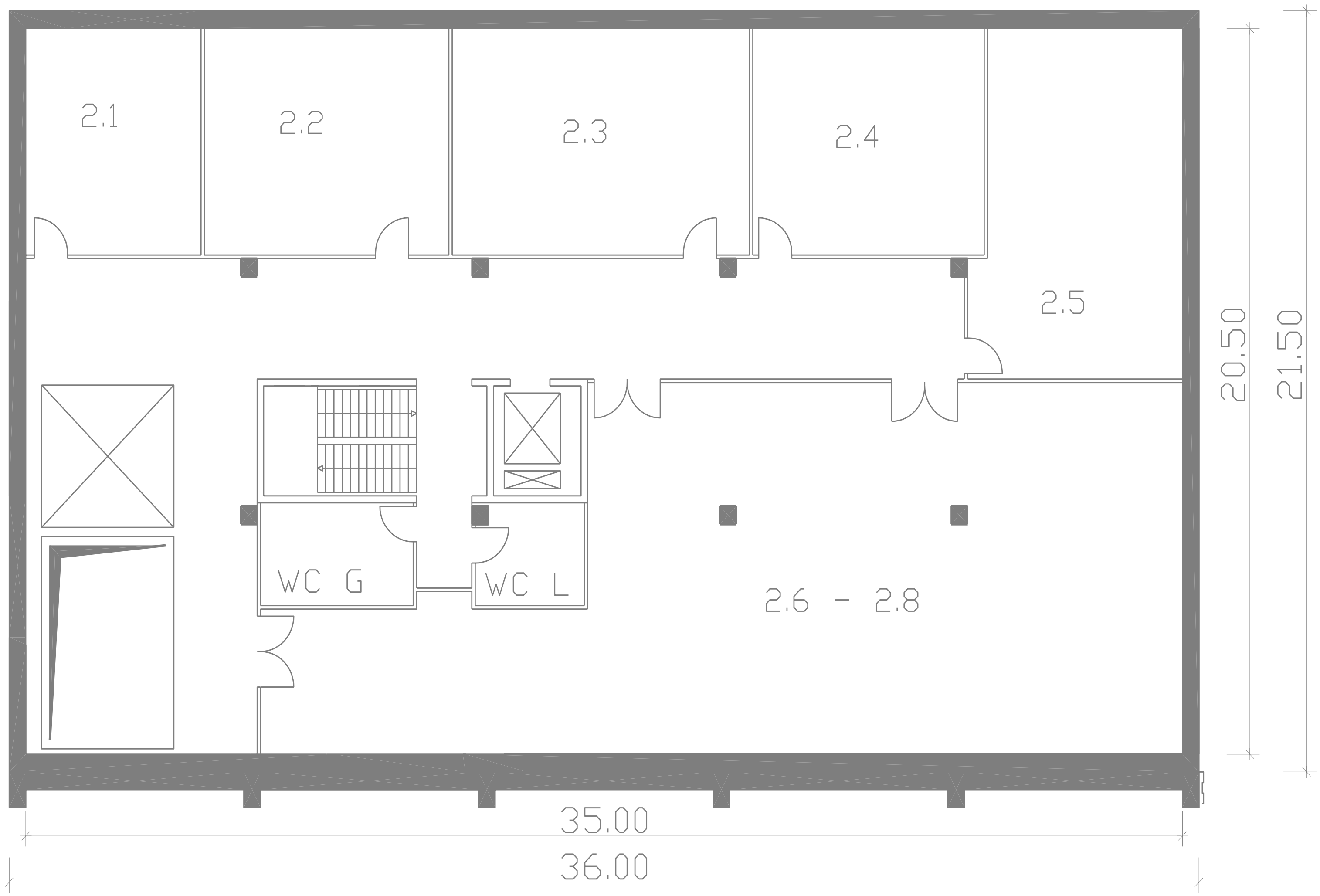
Building 6a (Level 1, Draft)

Power supplies, transformers, FAIR infrastructure (air, water)



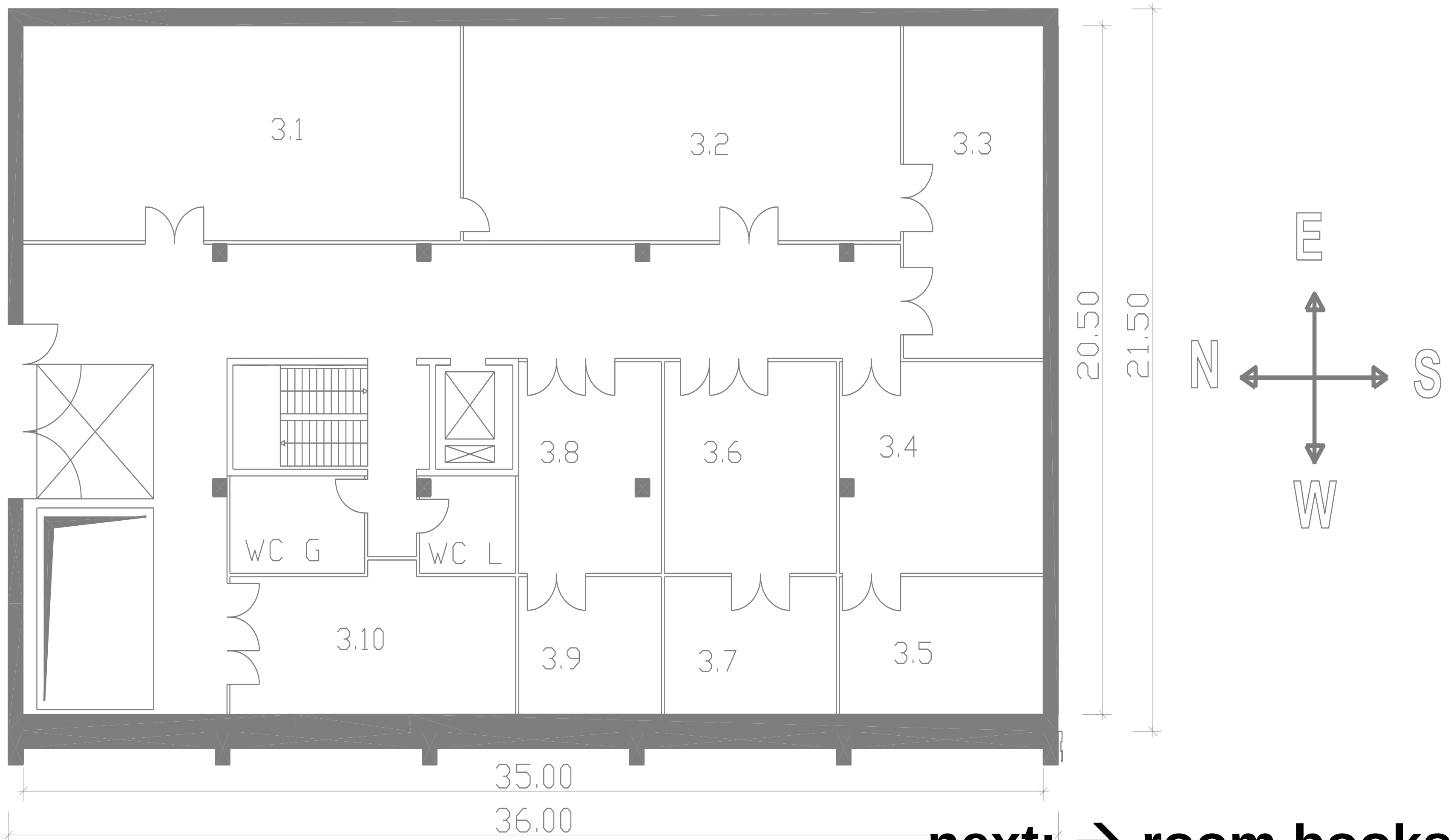
Building 6a (Level 2, Draft)

Super-FRS preparation, lab rooms (R3B 47m²)



Building 6a (Level 3, Draft)

Super-FRS electr.+control, LEB supplies (Ge), meeting room



next: → room books

Room Book

Description of areas/rooms:

room size, purpose, type according to industry standard DIN277
layout, media (water, electricity, ventilation), other technical equipment

Why?: Overview within FAIR.

Costs for civil construction are derived from this description.
-> basis for tenderes
Defines the tasks of the contractors, is used to check fulfillment.
Legal basis: VOB = German Construction Contract Procedures.
Changes in this description will increase the costs considerably.

Step to construction permit.

Who?

Builder (FAIR): up to now GSI Department for Construction+Engineering.
Civil Engineers (Mr. Goos, Mrs. Alberin-Wolters)
Representatives of machines + experiments

Super-FRS: K-H. Behr, M. Winkler
NESR: M. Steck, Th. Stöhlker, H. Weick

Time: first draft was envisaged already for October 2006, basis for TDR

Example Building 6a
Super-FRS Supply

Building Parts

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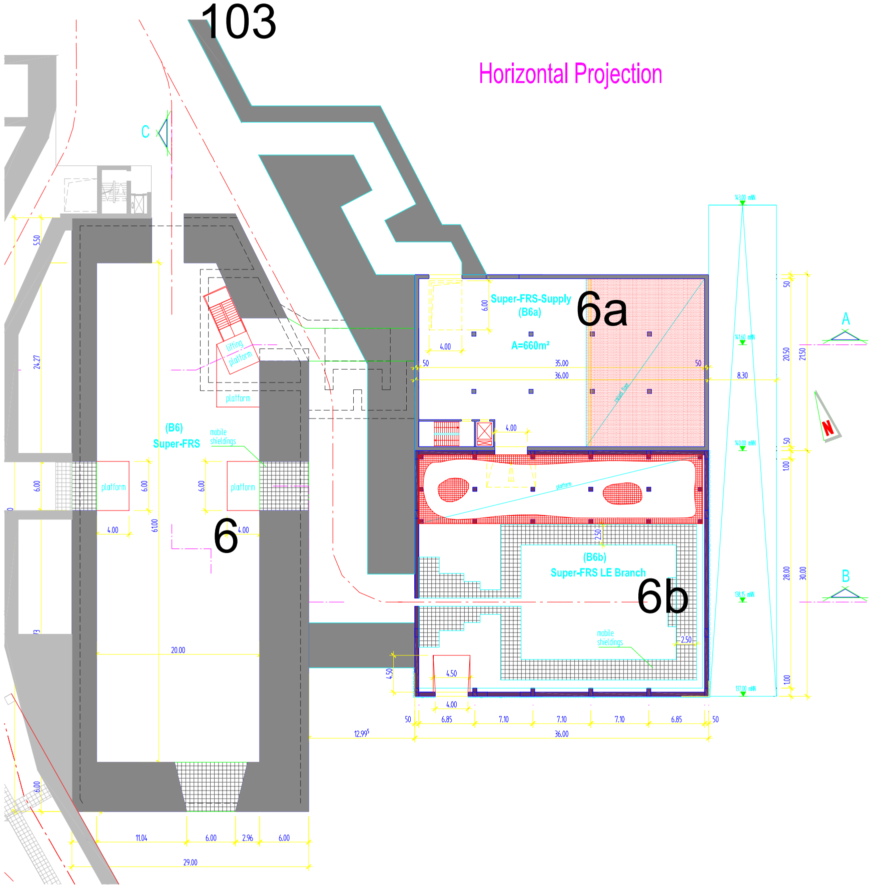
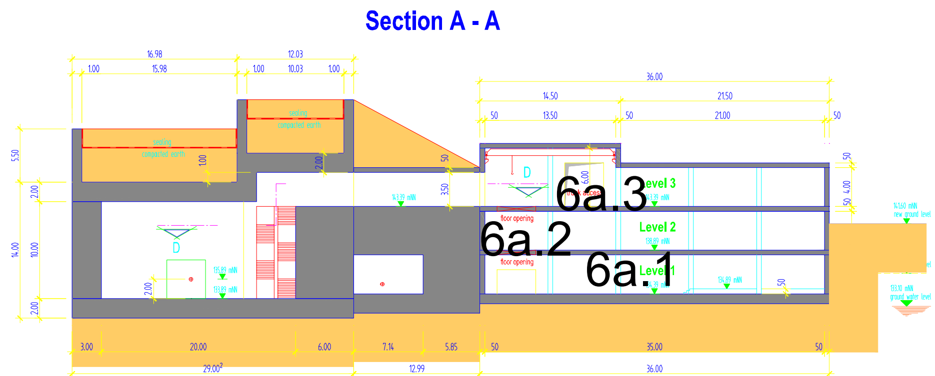
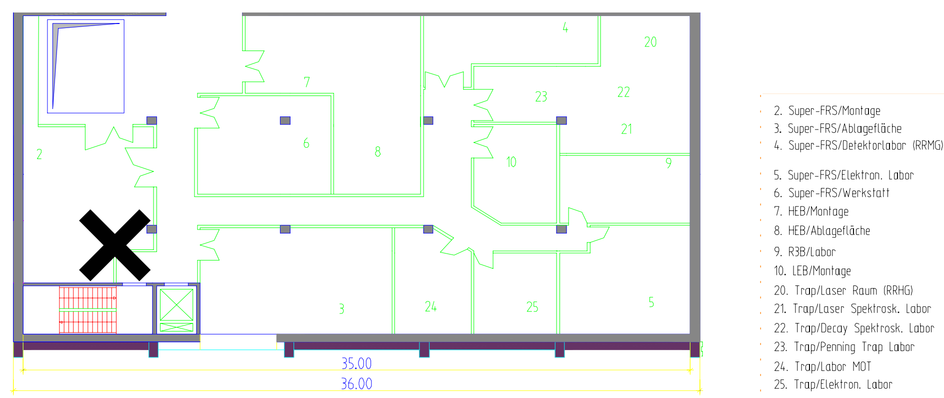


Levels of Building 6a





Vorläufiger Entwurf

Structuring of level (floor) into 15 rooms:
The marked room gets room number: 6a.3.02

IGR Raumbuch-Kurzform (Beispiel)

Raumeigenschaften – Wohnungs-Typ 1 D – Modellangaben

Raumtyp C

A 2 Raumbezeichnung					B 2 Raumgrößen						B 4 Haustechn. Anschlüsse für						B 5 Haustechn. Werte		
1.			2.	3.	1.		2.		3.		1.	2.	3.	4.	5.	6.	1.	3.	6.
Prov Raumnr			Nutzung	Nutzer (Abt.)	Art	Fläche		Höhe	Art	Inhalt	Heizung	Lüftung	Sanitär	Elt./St.	Elt./Schw.	Ford-Tech.	Temp.	Lw	Licht
A	B	C				M2		M		M3							°C	Fch	Lux
	W	104	Diele		N	6,02	L	2,47	N	14,87	–	–	–	SCH DB WVT	TAD SPA	–	20	1	
	W	204	Bad/WC		N	3,47	L	2,475	N	8,588	WWH	ZWE	WA WB WC	WB STD PA	–	–	24	7	
	W	304	Kochen		N	6,09	L	2,47	N	15,04	WWH	ZWE	SP	SCH STD WBS GAD DB	–	–	20	4	
	W	404	Loggia		N	1,69	L	2,365	N	4,000	–	–	–	–	–	–	–	–	
	W	504	W-E-S		N	19,77	L	2,47	N	48,83	WWH	–	–	SCH STD DB	AAD	–	22	1	
	W	V 04	Lue.+ Inst.		F	0,36	L	2,475	N	0,891	–	–	–	–	–	–	–	–	

AAD – Antennenanschlußdose
DB – Deckenbrennstelle
GAD – Geräteanschlußdose
PA – Potentialausgleich
SCH – Schalter

SP – Spüle
SPA – Sprechanlage
STD – Steckdose
TAD – Telefonanschlußdose
WA – Wanne

WB – Waschbecken (B.4.3)
WB – Wandbrennstelle ohne SCH (B.4.4)
WBS – dto. mit SCH
WC – WC

WVT – Wohnungsverteiler
WWH – Warmwasserheizung
ZWE – Zwangsentlüftung

Load Lists

Power consumption of each device in a building, with cooling water and air conditioning
Just submitted, at least for Super-FRS (6,6a,6b) and NESR (8).

	Bezeichnung				ET				VT								
						Wirkleistung				Abwärme an Kühlwasser					Abwärme an Luft		
	Gebäude					einzeln	gesamt			Leistung	Leistung	Qualität	Temp. Ein	Max. zul	Leistung	Leistung	Max. zul
lfd. Nr.	Nr.	Bezeichnung	Ansprechpartner	Teilsystem/Objekt	Anzahl	[kW]	[kW]	Netz	Anzahl	[kW]	ges. [kW]	[µS/cm]	[°C]	Temp. [°C]	[kW]	ges. [kW]	Temp [°C]
1	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Elektronik (HISPEC, DESPEC)	4	10	40	Normalnetz	1	35	35	2 - 5µS/cm	18	40	5	5	22
2	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Rechner (HISPEC, DESPEC)	200	0,3	60	Normalnetz	1	50	50	2 - 5µS/cm	18	40	10	10	22
3	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Labor (HISPEC, DESPEC)	1	25	25	Messnetz	1	5	5	2 - 5µS/cm	18	40	20	20	22
4	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Labor (HISPEC, DESPEC)	1	25	25	Normalnetz	1	5	5	2 - 5µS/cm	18	40	20	20	22
5	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Reinraum (HISPEC, DESPEC)	1	25	25	Normalnetz	1	5	5	2 - 5µS/cm	18	40	20	20	20
6	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Werkstatt (gemeinsame Nutzung)	1	20	20	Normalnetz	1		0				20	20	23
7	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Elektronik Racks (R3B)	10	10	100	Messnetz	10	7	70				3	30	22
8	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Rechner (R3B)		fehlt	#WERT!	Normalnetz	1		0					fehlt	22
9	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Labors (R3B)	2	25	50	Normalnetz	1		0				25	25	22
10	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Labor (MATS)	1	25	25	Normalnetz	1	12	12	2 - 5µS/cm	18	40	13	13	22
11	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Labor (LASPEC,Laser)	1	60	60	Normalnetz	1	55	55	2 - 5µS/cm	6	20	5	5	22
12	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Labor (LASPEC)	1	25	25	Normalnetz	1	10	10	2 - 5µS/cm	18		15	15	22
10	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Dipol 2 (Super-FRS)	1	36,4	36,4	Normalnetz	1	3,8	3,8	2 - 5µS/cm	25	45	0,7	0,7	28
11	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Dipol 3 (Super-FRS)	7	31,3	219,1	Normalnetz	7	3,7	25,9	2 - 5µS/cm	25	45	0,6	4,2	28
12	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Dipol 4 (Super-FRS)	1	74,6	74,6	Normalnetz	1	5,7	5,7	2 - 5µS/cm	25	45	0,9	0,9	28
13	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Quadrupole 3 (Super-FRS)	34	19,2	652,8	Normalnetz	34	2,1	71,4	2 - 5µS/cm	25	45	0,6	20,4	28
14	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Quadrupole 4 (Super-FRS)	27	26,7	720,9	Normalnetz	27	3,2	86,4	2 - 5µS/cm	25	45	0,5	13,5	28
15	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Quadrupole 5 (Super-FRS)	2	19,7	39,4	Normalnetz	2	2,1	4,2	2 - 5µS/cm	25	45	0,6	1,2	28
16	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Quadrupole 6 (Super-FRS)	5	14,3	71,5	Normalnetz	5	1,8	9	2 - 5µS/cm	25	45	0,5	2,5	28
17	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Hexapole 2 (Super-FRS)	38	7	266	Normalnetz	38	1,6	60,8	2 - 5µS/cm	25	45	0,4	15,2	28
18	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Octupole 1 (Super-FRS)	34	7,8	265,2	Normalnetz	34	1,4	47,6	2 - 5µS/cm	25	45	0,4	13,6	28
19	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Steerer (Super-FRS)	12	5,3	63,6	Normalnetz	12	1	12	2 - 5µS/cm	25	45	0,3	3,6	28
20	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Aladin	1	1500	1500	Normalnetz	1	fehlt	#WERT!	2 - 5µS/cm	25	45	fehlt	#WERT!	28
21	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	R3B	1	fehlt	#WERT!	Normalnetz	1	fehlt	#WERT!	2 - 5µS/cm	25	45	fehlt	#WERT!	28
22	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Dipol (Low Energy Beam)	3	15	45	Normalnetz	3	1	3	2 - 5µS/cm	25	45	0,5	1,5	28
23	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Quadrupole 6 (LEB)	3	14,3	42,9	Normalnetz	3	1,8	5,4	2 - 5µS/cm	25	45	0,5	1,5	28
24	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Quadrupole 3 (HEB)	2	19,2	38,4	Normalnetz	2	2,1	4,2	2 - 5µS/cm	25	45	0,6	1,2	28
25	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Quadrupole 4 (HEB)	1	26,7	26,7	Normalnetz	1	3,2	3,2	2 - 5µS/cm	25	45	0,5	0,5	28
26	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Dipol 3 (HEB Separator)	2	36,4	72,8	Normalnetz	2	3,7	7,4	2 - 5µS/cm	25	45	0,6	1,2	28
27	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Quadrupole 3 (HEB Separator)	8	19,2	153,6	Normalnetz	8	2,1	16,8	2 - 5µS/cm	25	45	0,6	4,8	28
28	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Quadrupole 4 (HEB Separator)	4	26,7	106,8	Normalnetz	4	3,2	12,8	2 - 5µS/cm	25	45	0,5	2	28
29	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Hexapole 2 (HEB Separator)	4	7	28	Normalnetz	4	1,6	6,4	2 - 5µS/cm	25	45	0,4	1,6	28
30	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Konsolraum	1	15	15	Normalnetz	1		0				15	15	22
31	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Besprechungsraum	1	8	8	Normalnetz	1		0				8	8	22
32	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Elektronik Racks (Super-FRS)	20	10	200	Messnetz	20	7	140	2 - 5µS/cm	18	40	3	60	22
33	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Detektorlabor (Super-FRS)	1	15	15	Messnetz	1	7,5	7,5	2 - 5µS/cm	18	40	7,5	7,5	22
34	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Montageraum (Super-FRS)	1	15	15	Normalnetz	1	5	5	2 - 5µS/cm			10	10	22
35	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Elektroniklabor (Super-FRS)	1	15	15	Normalnetz	1		0				15	15	22
36	6a	Super - FRS Supply	M. Winkler / K.-H. Behr	Stopcell (Labor für Test, Montage)	1	25	25	Normalnetz	1	15	15	2 - 5µS/cm	18	40	10	10	22

-> Next step, assign these to different rooms.

Summary

- Magnet Design in Progress.
  SC Dipoles + Quadrupoles,
  radiation hard Dipoles + Quadrupoles
- Target wheel will work for slow extraction
  For fast extraction still open questions
- Buildings are being finalized.
  Power requirements and media connections
  Next step detailed layout of rooms.

Time schedule of the Super-FRS project

Nr.	
1	**Super-FRS**
2	Development for the Super-FRS setup at the FRS
3	Ion-optical design studies for the Super-FRS
4	Technical Report
5	FP6 EU Design Studies, R&D, Prototyping
6	Technical Design Report
7	EU Design Study completed
8	Pre-Separator
9	Comissioning of preseparator
10	High-Energy Branch
11	Comissioning of High-Energy Branch
12	Ring Branch
13	Comissioning of Ring Branch
14	Low-Energy Branch and Energy Buncher
15	Comissioning of Low-Energy Branch